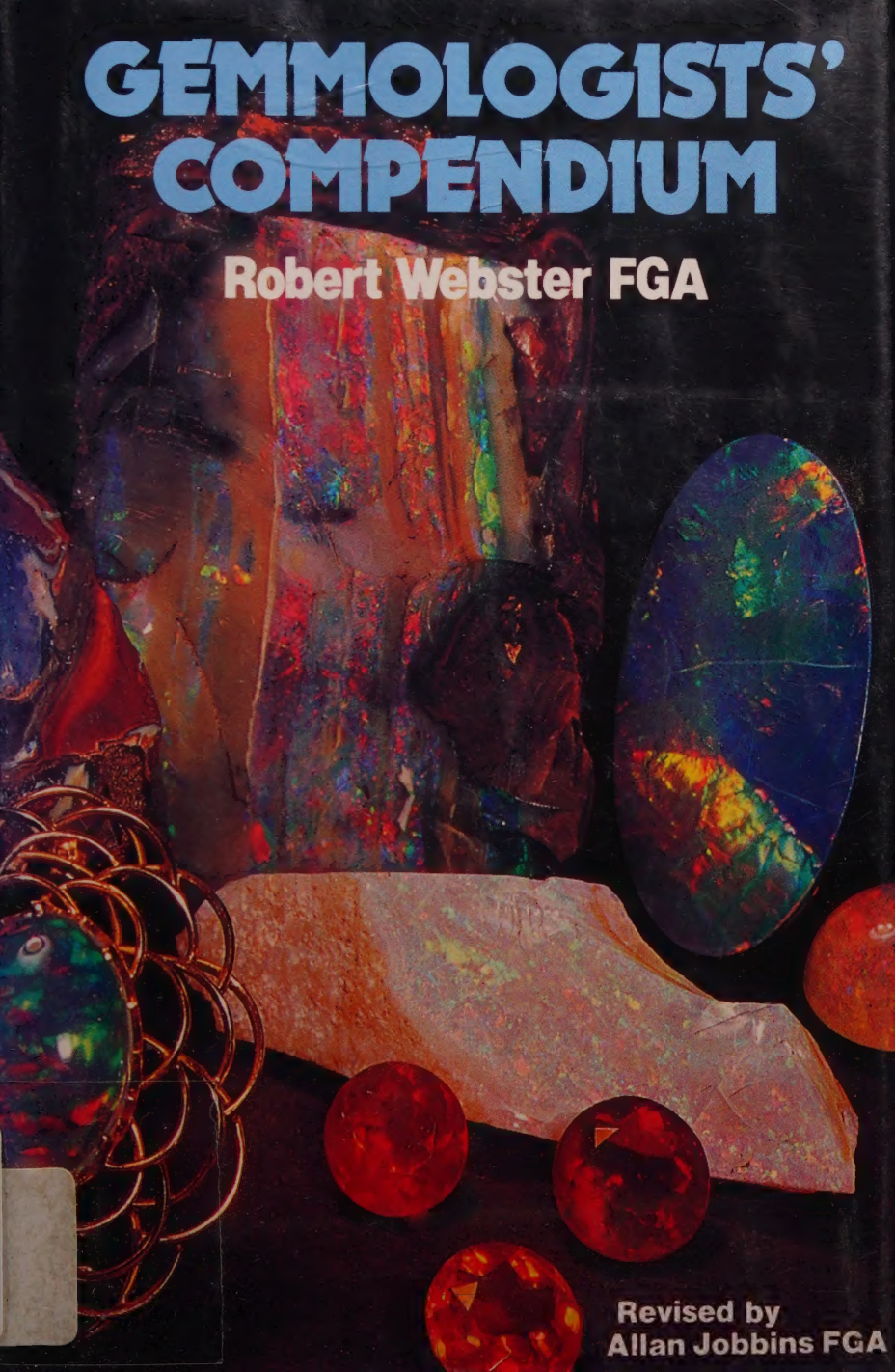
GEMMOLOGISTS' COMPENDIUM

Robert Webster FGA



Revised by
Allan Jobbins FGA

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This is the sixth edition of a book that has been for years the "bible" of professional gemmologists, as well as retail jewelers. Originally written by Robert Webster, an expert who devoted most of his life to the subject and who worked in the London Gem Laboratory for 25 years, this edition has been completely revised and updated by Allan Jobbins, Keeper of Minerals and Gemstones at the Institute of Geological Sciences, London.

The first part of the book is a comprehensive glossary of gemstones and the terms used in connection with them. The second part contains tables of essential information for gem identification. There are also sections on such useful topics as cuts for gemstones, synthetic and manufactured gems, tests for precious metals, and conversion formulae. Fifteen pages of color illustrations have been added to assist in the identification of inclusions.

Acknowledged as one of the most useful reference books available, this should be beside every serious gemmologist at work.

A VAN NOSTRAND REINHOLD BOOK

GEMMOLOGISTS' COMPENDIUM

GEMMOLOGISTS' COMPENDIUM

(Sixth Edition)

ROBERT WEBSTER FGA

Author of
Practical Gemmology
Gems: Their Sources, Descriptions and Identification
Gems in Jewellery

Revised by

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Minerals and Gemstones at the Institute of
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PREFACE TO FIFTH EDITION

It is now thirty-two years since the first edition of this small work was published with the intention to include under one cover as concisely as possible all the information most useful to the practical gemmologist.

In 1947 the science of gemmology had developed in many directions and a re-written second edition became a necessity. Now, after another decade and a half, that necessity is again manifest and the work had again to be thoroughly revised, and further revision has been made in this fifth edition.

Certain changes have been made in this fresh edition, but the original arrangement making two parts has been maintained. Part 1 consists of a comprehensive glossary in which definitions of the terms and descriptions of the materials associated with gemmology are provided. Part 2 is made up of the essential data and tables needed in gem testing and for the assistance of the student making a study of the subject.

The work is primarily the correlated data obtained from various standard textbooks, supplemented with the personal recordings of B. W. Anderson and C. J. Payne. To these gentlemen I owe many thanks. Particularly in the field of ornamental stones, and in some organic materials, the data has been taken from my own researches.

Some of the colour plates have been removed and the information on notable stones removed from the glossary for it was considered that the space these entries took up could be better used by the inclusion of the many newer gem materials fashioned as gemstones.

Wimbledon, 1970. R. WEBSTER

PREFACE TO SIXTH EDITION

In revising the Gemmologists' Compendium I have endeavoured to retain the general Websterian flavour and have not changed the original text unless it proved absolutely necessary. New data has been included for recent synthetics and the section of colour photographs has been expanded. The names of many countries have been changed in recent years and an attempt has been made to incorporate the most important of these. I gratefully acknowledge the help of my colleagues Dr R. R. Harding and Miss P. M. Statham during this revision. The editors will be most grateful to hear of errors or omissions.

London, 1979. E.A. JOBBINS

NOTE

In a compilation of this nature, though every effort has been made to make the Glossary and Tables as comprehensive as the scope of the book allows, omissions are well-nigh bound to occur. The Author will therefore welcome constructive criticisms and suggestions which will benefit any future editions.

PART ONE

A GLOSSARY OF NAMES AND TERMS

Among the following definitions will be found names commonly applied to imitation gem materials and the "fashion" or "trade" names given to materials of small value which approximate in their appearance to gem minerals. There can be no end to the invention and use of such names, particularly when new materials are introduced and advertised. In these pages only such names that are in general use are included. In order to emphasise that these names should not be used for trade purposes by the gemmologist they are described as misnomers and are printed within inverted commas.

Abbreviations—R.I.=refractive index, S.G.=specific gravity, H.=hardness.

Abalone (*Haliotidae*); also known as ear-shells. They produce pearls of various hues, such as greens, yellows, blues.

Abrasive material; hard, and sometimes brittle, substances used for abrading and polishing purposes, e.g., diamond dust, boron carbide (B_4C), carborundum (SiC), aluminium oxide (Al_2O_3), garnet, emery, etc. Diamond dust, the most important, is made in various grain sizes, from the finest which is made to 1 micron (0·001 mm.).

Absorption, Differential selective; see *Pleochroism*, page 147.

Absorption, Selective; the absorption of certain colours (wavelengths) from the incident white light when passing through a coloured medium. The colour of the medium results from the mingling of the colours which are not absorbed.

Absorption Spectra; the pattern of dark lines or bands seen when light which has passed through a gemstone is examined by a spectroscope. See page 150.

Accarbaar (Akabar); name applied to black coral.

Acetone; CH_3COCH_3; an organic liquid which softens the cellulosic types of plastics and can therefore be of use in their distinction.

Acetylene tetrabromide (tetrabromoethane); a liquid having the formula $C_2H_2Br_4$ which may be used as a heavy liquid or as a medium in refractive index determination, S.G. = 2·95, R.I. = 1·63.

Achroite; colourless tourmaline.

Acicular crystals; crystals which have a needle-like form, for

example, the crystal inclusions in rutilated quartz (Venus' hair stone).

Acid rocks; a subdivision of the igneous group of rocks. Generally of light colour, they contain a high content of silica (over 66 per cent). The acid rocks include the granites, syenites and pegmatites.

Actinolated quartz; rock crystal with included crystals of green actinolite.

Actinolite; a member of the amphibole family of minerals, actinolite is an end member of the tremolite-actinolite series and accords to the formula $CaO.3(Mg,Fe)O.4SiO_2$. Nephrite (q.v.) is a variety of actinolite while the fibrous variety is the asbestos of commerce.

Acute bisectrix; the line bisecting the acute angle between the optic axes in biaxial crystals.

Adamantine; the term used to describe a type of lustre, that typical of diamond.

Adamantine spar; name applied to silky brown sapphire.

Adamas; ("unconquerable") an ancient name for diamond.

"Adelaide ruby"; an undesirable name which has been applied to the almandine garnet found near Adelaide (Australia).

Adularescence; the name given to the sheen seen in moonstone caused by alternate layers of orthoclase and albite feldspar.

Adularia; variety of orthoclase feldspar of which moonstone is a gem variety.

"African emerald"; a misnomer applied to the green fluorite from South-West Africa. It must not be confused with the true emerald which is also found in southern Africa.

Agalmatolite; a soft compact material used for carvings. Some is a silica-rich variety of pinite, a decomposition mineral with variable composition, but approximating to muscovite (mica) namely $K_2Al_6Si_6O_{20}(OH)_4$. Another agalmatolite is steatite (q.v.) and the hydrous aluminium silicate in compact form, pyrophyllite (q.v.), having formula $Al_4Si_8O_{20}(OH)_4$ is also termed agalmatolite.

Agate; see *Chalcedony*.

Agatised coral; fossil coral.

Agatised wood; see *Chalcedony*.

Ahrens prism; a calcite prism used for the production of plane polarised light. It is essentially a modification of the Nicol prism designed to obtain a more economical use of calcite.

Akabar; name applied to black coral. See also *Accarbaar.*

Alabaster; a massive form of gypsum, see *Gypsum.*

"Alabaster, Oriental"; a misnomer for a stalagmitic variety of calcite characterised by well-marked banding. Another misnomer for this material is "Algerian Onyx".

Alalite; see *Diopside.*

"Alaska black diamond"; a misnomer for hematite.

"Alaska diamond"; a misnomer for rock crystal.

Alasmoden pearls; certain freshwater pearls.

Albertite; a jet-like mixture of hydrocarbons; R.I. 1·55; S.G. 1·097; H. 2½. Moderately insoluble in most organic solvents.

Albite; see *Feldspar.*

Alcohol (ethyl alcohol; ethanol); a volatile liquid having the composition C_2H_5OH. May be used for diluting certain heavy liquids and as an immersion liquid (R.I. 1·36).

"Alencon diamond"; a misnomer for rock crystal.

Alexandrite; see *Chrysoberyl.*

Alexandrite-like synthetics; suitably coloured synthetic corundums and spinels made to imitate the chrysoberyl alexandrite. See *Manufactured gems,* page 170.

"Algerian oynx"; a misnomer for a stalagmitic variety of calcite characterised by well-marked banding. Also known as "Oriental Alabaster".

Allochromatic minerals; minerals which are perfectly colourless when pure, but may be coloured by impurities, generally a metallic oxide which has no essential part in the chemical composition, or by sub-microscopic particles or inclusions of a coloured mineral, *e.g.,* corundum when pure is colourless (white sapphire), when containing a trace of chromium is red (ruby), a titanium and iron combination gives a blue shade (sapphire), while iron gives green and yellow shades (green and yellow sapphires). See also *Idiochromatic minerals.*

Allotropic; the name applied to the phenomenon shown by

some chemical bodies of assuming different forms, *e.g.*, carbon may form either diamond, charcoal or graphite.

Alluvial deposits; deposits of minerals which have been brought down by rivers and are found in their dried-up beds.

Almandine (Almandite); a name applied to the iron-aluminium group of garnets.

Almandine-pyrope series; the isomorphous garnet series with end-members, pyrope, $Mg_3Al_2(SiO_4)_3$ and almandine $Fe_3Al_2(SiO_4)_3$. Practically all red garnets belong to this series, being mixtures of pyrope and almandine molecules.

"Almandine spinel"; a name applied to the reddish-violet colour of gem spinel.

Almandite; see *Garnet* (Almandine).

"Aloxite"; trade name for an abrasive made of synthetically produced aluminium oxide.

"Alundum"; trade name for an abrasive made of synthetically produced aluminium oxide.

Amatrix; a name, a contraction of American matrix, applied to concretions of variscite in quartz (or chalcedony). The material is usually cut with the green variscite as centre surrounded by grey, reddish or brownish quartz. S.G. about 2·6 with H from 5 to 6.

Amazonite; name applied to the green microcline feldspar, see *Feldspar*.

"Amazon jade"; a misnomer applied to the green microcline feldspar, see *Feldspar*.

Amazon-stone; see *Feldspar* (Microcline).

Amber; a natural resin hydrocarbon. R.I. 1·54; S.G. 1·03 to 1·10; H. 2 to 2½; Amorphous; Colours, yellow, reddish-brown, bluish, whitish and black. Varieties, Succinite (North German), Roumanite (Rumania), Simetite (Sicily), Burmite (Burma), Bacalite (Mexico).

Amblygonite; $LiAl(F,OH)PO_4$. R.I. 1·611–1·637, S.G. 3·015 to 3·033, H. 6; Triclinic; Colourless, yellow and pale mauve; Localities, Brazil, U.S.A.

Ambroid; see *Pressed amber*.

"American jade"; a misnomer for the massive green variety of idocrase. See *Californite*.

"American ruby"; a misnomer for garnet or rose quartz.

Amethyst; violet-coloured quartz, see *Quartz.*

Amethystine quartz; a massive quartz with patchy amethyst colouring. Sometimes used for small carvings.

"Amethyst, Lithia"; a misnomer for lilac spodumene.

"Amethyst, Oriental"; a misnomer for violet corundum.

Amino plastics; name applied to the urea and thiourea in formaldehyde condensation product. They are synthetic resins of the "bakelite" type. See page 180.

Amorphous; (without form) material which has no definite internal structure and havings its properties the same in all directions.

Amphibole; the name applied to a family of minerals with similar physical and chemical characters. They are complex silicates of iron, magnesium, calcium, sometimes sodium (rarely potassium), with or without aluminium and a hydroxyl (OH) group. Nephrite (q.v.), asbestos and hornblende (q.v.) are amphiboles.

Amygdule; a rounded or other shaped gas cavity in volcanic rocks which later fills with mineral matter, often chalcedony.

Amyl acetate; a liquid having a refractive index of 1·37. The liquid is useful as a test for the cellulosic plastics which soften under its influence.

Analcite (Analcime); $NaAlSi_2O_6H_2O$; R.I. 1·49; S.G. 2·22–2·29; H. 5–5½. Gem material is colourless. Localities, U.S.A., Italy, Czechoslovakia, Japan, Scotland, etc.

Analyser; the Nicol prism or "Polaroid" disc which is placed above the objective in the polarising microscope, see also *Polariscope.*

Anatase; TiO_2; R.I. 2·493–2·554; S.G. 3·82 to 3·95; H. 5½ to 6; Tetragonal; Colours, blue, brown to black; Localities, Switzerland, Brazil.

Andalusite; Al_2SiO_5; R.I. 1·633–1·644; S.G. 3·1 to 3·2; H. 7 to 7½; Rhombic; Colours, green, brown and red; Localities, Andalusia (Spain), Ceylon, Madagascar and Brazil. See also *Chiastolite.*

Andradite; see *Garnet.*

Anglesite; $PbSO_4$; R.I. 1·877–1·894; S.G. 6·30–6·39; H. 3.

Orthorhombic; White and yellow; Localities, U.S.A. and Scotland.

Ångström Unit; the unit used for the small measurements required in the electro-magnetic spectrum below the infra-red, it is the ten-millionth part of a millimetre. See page 150.

Anhedral crystals; crystals which do not show good outward form.

Aniline; $C_6H_5NH_2$; a liquid having R.I. 1·58, useful as an immersion medium.

Anisotropic; a term for crystals which exhibit double refraction, *i.e.*, break up a ray of light into two rays which move with different velocities within the crystal. See also, *Ordinary ray* and *Extraordinary ray*.

Anomalous double refraction; double refraction in isotropic material, as seen by irregular extinction when viewed between crossed nicols. Due to internal strain.

Anorthite; see *Feldspar*.

Antigorite; a serpentine resembling jade.

Antilles pearl; a type of "pearl" cut from the shell of the sea snail. Also called "oil pearls".

Anyolite; a green zoisite rock containing large opaque ruby crystals. Used as an ornamental stone. Found in Tanzania.

Apache tears; obsidian.

Apatite; $Ca_5(F,Cl)(PO_4)_3$; R.I. 1·63–1·64 to 1·64–1·65; S.G. 3·15 to 3·22; H. 5; Hexagonal; Colours, blue-green (Moroxite), yellow-green (Asparagus stone), pink, violet, purple, blue (sometimes chatoyant) and colourless; Localities, Saxony, Bohemia, Maine (U.S.A.), Ceylon and Burma.

Aplite; a sugary-textured white to grey granitic rock containing silvery muscovite. Used for statuary carving.

Apophyllite; $KF.Ca_4Si_8O_{12}(OH)_{16}$; R.I. 1·535–1·537; S.G. 2·3 to 2·4; H. 4½ to 5; Tetragonal; Colours, white, grey, yellowish, greenish, and flesh red; Localities, Harz Mountains (Germany), India, Sweden, Tyrol and Transylvania.

Aquamarine; see *Beryl*.

"Aquamarine, Brazilian"; a misnomer for blue topaz.

"Aquamarine, Siam"; a misnomer for the heat-treated blue zircon.

"Aquamarine, Synthetic"; a misnomer for the sea-blue or sea-green colours of synthetic corundum or spinel.

Aqua regia; a mixture of the powerful nitric and hydrochloric acids in the proportion of one of nitric to two of hydrochloric used as a solvent for gold.

Aragonite; $CaCO_3$; R.I. 1·531–1·686; S.G. 2·93; H. 3 to 3½; Rhombic; Colour, colourless and white; Localities, Aragon (Spain), Bohemia, Sicily, Alston Moor (England), U.S.A., Germany and Hungary. This mineral is the major constituent of pearl.

"Aragonite"; a yellow stalagmitic calcite from South-West Africa.

"Arizona Ruby"; misnomer for pyrope garnet from Arizona.

"Arizona Spinel"; a misnomer for red garnet.

"Arkansas Diamond"; a misnomer for rock crystal.

Artificial resins; general name applied to the synthetic products known as plastics. See *Plastics*, page 180.

Artificial stones; see *Synthetic stones*, page 170.

Artificial treatment of gemstones; see page 182.

Asparagus stone; see *Apatite*.

Asterias; stones exhibiting a four, six or twelve-rayed star of light when cut en-cabochon in the correct crystallographic direction. Generally seen in corundums (star rubies and star sapphires with either six or twelve rays) and with rose quartz (generally six rays). Some garnets and spinels may also show the effect usually with four rays but if cut in certain directions may also show six rays. Star corundums can be made synthetically.

Asterism; a reflection from fibres or fibrous cavities in a stone, cut en-cabochon with its base parallel to the basal plane of the crystal, in a similar manner to chatoyant stones (see *Chatoyancy*) but having sets of fibres crossing at angles of 60° (hence a six-rayed star), or at or near 90° (a four-rayed star). See also *Diasterism* and *Epiasterism*.

Atom; a unit which is the smallest part of a chemical element which remains unchanged during all chemical reactions. Although partly composed of electrically charged units such

as electrons, protons, etc., atoms as a whole are electrically neutral.

Atomic diamonds; see *Irradiated diamonds.*

Atomic weight; the weight of the atom of an element compared with the weight of an atom of oxygen taken as 16. A table of atomic weights is given on page 214.

Augelite; $2Al_2O_3P_2O_5 3H_2O$; R.I. 1·574–1·588; S.G. near 2·7; H. 5; Monoclinic; Colourless; U.S.A. and Bolivia.

Australite; a name applied to the button-shaped pieces of natural glass found in the south of Australia and Tasmania. See also *Tektite.*

Autoclave; a thick walled steel cylinder provided with a removable cover at the top to contain mineral saturated water at fairly high pressures. Used in the hydrothermal method of producing synthetic stones.

Aventurine feldspar; see *Feldspar* (Oligoclase).

Aventurine glass; a glass made with included copper crystals to produce an imitation of the yellow and red aventurine quartz. An alternative name for this imitation is "Goldstone". Now made in a blue colour.

Aventurine quartz; quartzite with iridescent spangled effect due to green mica or to reddish iron minerals. There is also a grey aventurine quartz which is again due to some form of mica.

Axes, Crystallographic; see page 114.

Axe-stone; see *Nephrite.*

Axinite; $HMgCa_2BAl_2(SiO_4)_4$; R.I. 1·674–1·684; S.G. 3·27 to 3·29; H. $6\frac{1}{2}$ to 7; Triclinic; Colours, brown, honey-yellow and violet; Localities, France and Tasmania, also Cornwall (England), near Ottawa (Canada), Pennsylvania and New York (U.S.A.) and Baja California (Mexico).

Axis of symmetry; the axis about which rotation of a crystal will cause it to occupy the same position in space more than once in a complete turn. The terms applied to the different classes of axes are:

Twice; two-fold, diad, half-turn or digonal axis.

Three times; three-fold, triad, one-third-turn or trigonal axis.

Four times; four-fold, tetrad, quarter-turn or tetragonal axis.

Six times; six-fold, hexad, one-sixth-turn or hexagonal axis.

Axes, Optic; see *Optic axes.*

Azure quartz; siderite.

Azurite; $2CuCO_3Cu(OH)_2$; R.I. 1·730–1·838; S.G. 3·77 to 3·89; H. 3½; Monoclinic; Colour, blue; Localities, Russia, Chile, South West Africa, Arizona (U.S.A.), and Chessy (France). An alternative name is Chessylite.

Azurmalachite; an ornamental stone consisting of intimate association of azurite and malachite.

Bacalite; name applied to a variety of amber from Lower California, Mexico.

Baguette-cut; a modern style of cutting producing a long rectangular-shaped stone with parallel facets; sometimes called *batons*, both terms being French. See *Cuts of stones*, pages 186, 188.

Bakelite; a synthetic resin sometimes used for imitations of gem materials. Two types:

(1) a condensation product of phenol (carbolic acid) and formaldehyde. R. I. 1·54 to 1·70 (usually 1·62 to 1·66); S.G. 1·25 to 2·00 (clear types 1·25 to 1·30).

(2) known as Amino Plastics. Urea replaces phenol in the composition. R.I. 1·55 to 1·62; S.G. 1·48 to 1·55.

"Balas Ruby"; a misnomer for the paler red spinels (q.v.).

Ballas; an important industrial variety of diamond. The stones are spherical masses of minute diamond crystals arranged more or less radially. They have no well-defined cleavage planes and thus have great resistance to abrasion. Found in Brazil and Africa. Spherical white or greyish diamonds which have cleavage planes are often called "ballas" although they should more correctly be called "boart".

Barite; see Barytes.

Barium titanate; $BaTiO_3$. This compound has been made synthetically and may at some time be produced as a gem-stone. The S.G is 5·90 and the R.I. 2·40.

Baroque (Barrok) pearls; name applied to pearls which are irregular in shape.

Barytes (Barite, Baryte); $BaSO_4$; R.I. 1·636–1·648; S.G. 4·5; H.3; Orthorhombic; Colourless, white, yellow, green, red, blue or brown; Localities, world-wide.

Basanite; a fine-grained siliceous rock used as a touchstone for testing gold. Also a name for a dark fine-grained volcanic rock (alkali basalt).

Base System of Calculation for Pearls; see page 225.

Basic rocks; the name applied to igneous rocks with less than 52% of SiO_2. See *Acid rocks.*

Bastite; an altered enstatite; S.G. 2·6; H. 3½ to 4; Colour, leek green; Locality, Harz Mountains.

Bastard-cut; a term used for fashioned stones which do not conform to the recognised typical forms, or which show some slight modification from the "pure" forms. The term applies only to those stones which have a regular and symmetrical arrangement of the facets; should they be irregular or haphazard the term "Cap-cut" (q.v.) is used.

Batons; an alternative name for stones cut in the baguette style. See *Baguette-cut.*

Becke's test; a method of refractive index determination. See page 132.

Beilby layer; the name applied to the liquid-like layer of ultramicroscopic depth produced during the polishing of gemstones. It may be described as a local fusion at the minute projecting points on the nearly plane surface and the consequential spreading of a liquid-like layer over the entire surface. The nature of the polish layer may be divided into four groups:

(1) The melting point appears too high for the production of a Beilby layer. The polishing process being merely a fine grinding, *e.g.*, Diamond (and graphite).

(2) The Beilby layer is amorphous (liquid-like) at the moment of formation, but immediately recrystallises in the same orientation as the underlying crystal structure, *e.g.*, Quartz.

(3) In which the Beilby layer recrystallises only on surfaces

which approximate to important crystal planes (as cleavage surfaces and possible crystal faces), *e.g.*, Calcite and Kyanite.

(4) In which the Beilby layer remains amorphous on all surfaces, *e.g.*, Spinel and Zircon.

"Bengal Amethyst"; a misnomer for purple sapphire.

Benitoite; $BaTiSi_3O_9$; R.I. 1·757–1·804; S.G. 3·64 to 3·65; H. 6½; Trigonal; Colour, blue; Locality, California.

Benzene; a liquid hydrocarbon (C_6H_6) used for dilution of heavy liquids of organic origin. S.G. 0·88. The vapour is poisonous and its use is now discontinued.

Benzyl benzoate; an organic liquid used as an immersion liquid; R.I. 1·57.

Bernat; an amber imitation in plastic.

Beryl; $Be_3Al_2(SiO_3)_6$; R.I. 1·560–1·565 to 1·590–1·599; S.G. 2·65 to 2·85; H. 7½ to 8; Hexagonal; Colours, grass-green (Emerald), sea-green and sea-blue (Aquamarine), blue, violet, yellow (golden beryl or Heliodor), pink (Morganite), colourless (Goshenite); Localities, (emerald) Egypt, Colombia, Brazil, Ural Mountains (Russia), S. Africa, Rhodesia, India and Pakistan, Zambia, (aquamarine) Madagascar, Ural Mountains, Brazil, Ceylon and S.W. Africa. Fine blue aquamarines are most commonly the result of heat treatment.

Beryl glass; fused beryl which thereby loses its crystalline character and becomes a glass. S.G. 2·41 to 2·49; R.I. 1·50 to 1·52. This glass is sometimes used for green and blue imitation gems.

Beryllonite; $NaBePO_4$; R.I. 1·552–1·564 to 1·554–1·566; S.G. 2·80 to 2·85; H. 5½ to 6; Rhombic; Colour, colourless to pale yellow; Locality, Stoneham, Maine (U.S.A.).

Beryloscope; an instrument containing coloured glass dichromatic filters acting similarly to the Chelsea colour filter. See page 159.

Bezel; see *Crown*.

Bezel facets; name applied to four of the eight large four-sided facets surrounding the table in the crown of a brilliant-cut stone. An alternative name is Templet.

Biaxal; the term used to describe the optical character of anisotropic crystals which have two directions of single refraction; confined to minerals belonging to the rhombic, monoclinic and triclinic crystal systems.

Billitonite; a natural glass (tektite) found in Billiton Island (Indonesia), Borneo and Malaysia. R.I. 1·51; S.G. 2·45. See *Tektite.*

Birefringence; double refraction, the amount being measured by the difference between the maximum and minimum refractive indices in an anisotopic mineral.

Bivalve molluscs; the name applied to certain species of shellfish whose shelly covering consists of a pair of shells, slightly hollow on the inner side and hinged along one edge; *e.g.*, oyster and mussel.

Biwa pearls; non-nucleated cultured pearls from Biwa Lake, Japan.

Black coral; a coral consisting mainly of conchiolin and is fished from Pacific waters. The material has a density of 1·34 and has a limited use in jewellery. See *Coral.*

Black diamond; (1) crystalline diamond, black and virtually opaque, occasionally cut as a gem. (2) Carbonado (q.v.).

Black dyed opal; a type of Australian opal which has been stained black to enhance the play of colour.

Black garnet; see *Garnet* (Andradite and Almandine).

Black marble; see *Slate.*

Black moonstone; name applied to transparent labradorite. See *Feldspar.*

Black opal; a highly-prized opal found in New South Wales, Australia. The body colour is black, dark grey or dark brown; as compared to the paler tints of white opal. See *Opal.*

Black pearls; pearls of greyish, brownish or greenish black, found in the Gulf of Mexico and certain of the Pacific Islands. The cause of the colour is not clear but is thought to be due to the nature of the water in which the animal lives.

Black pearls are occasionally imitated by polished spheres of hematite. Black clam pearls (q.v.) are not nacreous.

Blende (Zinc-blende); see *Sphalerite.*

Blister pearls; pearls which have been formed over an irritant which had become cemented to the shell of the mollusc. When removed the pearl has a rough back not covered by nacre which is generally ground flat and covered by the setting. These pearls are mostly of an irregular shape.

Blond shell; plain yellow tortoise-shell.

Bloodstone; a dark green chalcedony containing spots of red jasper, also called Heliotrope. See *Chalcedony.*

Blue earth; the glauconite sands in which amber is found in the Baltic deposits.

Blue gold; gold of bluish tint induced by the use of steel or iron as an alloy.

Blue ground; see *Kimberlite.*

Blue John; massive violet-blue and white or yellowish banded fluorspar (q.v.) from Derbyshire, hence known as "Derbyshire Spar".

"Blue moonstone"; a misnomer for chalcedony stained blue.

Blue pearls; really a lead-grey in tint, these pearls owe their colour to a large kernel of conchiolin.

Blue-white; a name applied to perfection colour in gem diamond. Open to abuse, it is not a satisfactory term.

Boart, Boort, Bort, Bortz; the name applied to a cryptocrystalline form of diamond, translucent to opaque, usually of a dark colour, and sometimes possessing a radial structure. Unlike "ballas" they possess a cleavage. Found in Africa but a smaller production in Brazil, Venezuela and Guyana. Imperfectly crystallised diamond, lacking cohesive strength, multiple crystals, coated fragments, chips, etc., of various shapes and colours unfit for gems are also called boart or crushing boart, and are used for crushing into diamond powder.

"Bohemian diamond"; a misnomer for rock crystal.

Bohemian garnet; the name applied to the pyrope garnet found in Bohemia. These stones cut as roses were prevalent in

Victorian jewellery. Many of these Bohemian pyropes show an absorption spectrum more reminiscent of the spinel than the usual spectrum seen in the almandine-pyrope series.

"Bohemian ruby"; a misnomer for red garnet.

"Bohemian topaz"; a misnomer for yellow quartz.

Bonamite; see *Smithsonite.*

Bone; the hard material composing the skeleton or framework of mammalian animals sometimes used in the simulation of ivory. The material is distinguished from ivory by the difference in structure seen by the microscopical observation of a thin section or peeling.

Bone turquoise; see *Odontolite.*

Boracite; $Mg_6Cl_2B_{14}O_{26}$; R.I. 1·66; S.G. 2·96; H. 7; Cubic; Pale green; Localities, U.S.A. and Germany.

"Borazon"; a cubic form of boron nitride (BN); a synthetic product made in a similar fashion to synthetic diamonds. Said to be as hard as, or harder than diamond. Density is 3·45, but it is only produced as microscopic crystals.

Boron carbide; B_4C, an artificially prepared high quality abrasive material. H = 9½ but usually considered to be harder than silicon carbide (carborundum).

Bortz; in U.S.A. specially refers to industrial diamonds while "Bort" is used for crushing purposes.

Botryoidal forms; when the surface of a mineral is covered with spherical protruberances due to areas of compact radially arranged fibrous crystals.

"Bottle-stone"; see *Moldavite.*

Boule; the pear-shaped mass of corundum or spinel as it comes from the oxy-hydrogen furnace used in the Verneuil process.

Bowenite; a hard variety of serpentine which simulates jade. R.I. near 1·56; S.G. 2·59; H. about 5; has been marketed under the misnomer "New Jade". Some bowenite may be stained.

Brazilianite (Brasilianite); $Na_2O.3Al_2O_3.2P_2O_5.4H_2O$; R.I. 1·598–1·617; S.G. 2·94; H. 5½; Monoclinic; Colour, yellow-green; Locality, Brazil and the U.S.A.

"Brazilian onyx"; a misnomer for banded calcite.

"Brazilian peridot"; a misnomer for yellow-green tourmaline.

"Brazilian ruby"; a misnomer for pink or "fired" topaz, or pink tourmaline.

"Brazilian sapphire"; a misnomer for either blue topaz or similar colour tourmaline.

Brazilian topaz; yellow topaz, see *Topaz*.

Break facets; name applied, in one form of nomenclature, to the 16 small triangular facets on the crown and edging the girdle, and to the 16 similar facets on the pavilion. They are the cross and skill facets. They are sometimes known as the Half Facets or Halves.

Breccia; a mass consisting of broken pieces of rock or mineral with angular edges which has been cemented together by secondary mineralization.

Brewster's angle; the angle at which light reflected from a transparent substance exhibits maximum polarisation. This depends upon the R.I. of the substance and R.I. $= \tan \theta$.

Brilliant; a term used for diamonds cut in the brilliant form.

Brilliant-cut; the most important style of cutting for the diamond. The cut consists of 58 facets, a table and 32 facets in the crown and 25 in the base or pavilion of the stone. In the case of large stones the number of facets may be increased. See *Cuts of stones*, pages 184, 187.

Brillianteerer; the Dutch name applied to the diamond cutter who completes the final facets in a brilliant-cut stone.

Briolette; a drop-shaped stone covered with triangular facets. The cut may be considered as a modified double rose. See pages 185, 188.

"Bristol diamonds"; a misnomer for rock crystal, see *Quartz*.

Brittleness; the tendency of a material to easy fracture.

Bromoform; $CHBr_3$; S.G. 2·9; R.I. 1·59. See page 121.

Bromotoluene; an organic liquid used for certain refractive index tests. R.I. = 1·55.

Bronzite; a mineral closely related to enstatite, which has a chatoyant bronzy lustre.

Brookite; TiO_2; R.I. 2·583–2·705; S.G. 3·87 to 4·08; H. 5½ to 6; Orthorhombic; Yellowish, hair-brown and reddish-brown. Localities, France, Switzerland and U.S.A.

Brown; one of the classifications of gem diamond.

Bruting; the actual cutting of one diamond with another diamond, is employed whenever it is necessary to remove diamond rapidly and where finish is unimportant, since only a frosted surface is generated. Formerly a laborious hand operation but is now carried out by an electric eccentric chuck.

Bubbles; the spherical, oval or tadpole-shaped inclusions of gas seen in some synthetic stones and most glasses (pastes). They may also be seen in natural and synthetic resins. Also seen in liquid-filled cavities in emerald, topaz, quartz and many other natural minerals.

Buddstone; a massive opaque green quartz from South Africa. Used as an ornamental stone.

Burmite; name applied to the amber found in Burma.

Button pearls; pearls having a rounded top and a flat base.

Bye (Byewater); a term used for diamonds tinged with yellow, stones being termed "first bye" or "second bye" according to the amount of yellow colour.

Byon; the native name for the gem-bearing ground of Upper Burma.

Cabochon; a style of stone cutting with a dome-shaped top. See pages 184, 189.

Cacholong; a bluish-white porcelain-like variety of opal.

Cacoxenite; an iron phosphate mineral, often found as yellowish radiating tufts. The name is often misleadingly applied to quartz (often amethyst) containing yellowish tufts of goethite (limonite).

Cairngorm; a brownish-yellow variety of crystalline quartz found in the Cairngorm Mountains, Scotland.

Calamine; the name used in some older English mineralogical books for the zinc carbonate *Smithsonite* (q.v.). In other works this name is used for a zinc silicate, Hemimorphite.

Calcite; $CaCO_3$; R.I. 1·486–1·651; S.G. 2·71; H. 3; Trigonal; Colour, colourless and white, sometimes with grey; yellow, blue, red, brown or black tints. Marble is a massive calcite, a fibrous form being known as "Satin-spar" and stalagmitic forms with well-marked banding are used for small objects and ornaments and are known under the misnomers:

"Algerian onyx", "Mexican onyx" and "Oriental alabaster". Calcite of optical quality, known as Iceland-spar, is used in the construction of Nicol prisms and in the dichroscope.

Calcium titanate (Perovskite); $CaTiO_3$. This compound has been synthesized and may appear on the market as a new gemstone. The material is colourless, orthorhombic, but near cubic, in crystallization. The hardness is 6 to $6\frac{1}{2}$, the density 4·05 and the refractive index 2·40.

Calculation of prices of gemstones and pearls; see page 225.

Calibre-cut; the term applied to stones cut to special shapes. Usually trap cut in style with sharp angular corners. The small square stones used for "eternity" rings are sometimes called calibre. See page 186.

Californite; a massive variety of idocrase which simulates jade. See *Idocrase.*

Callaite (Callaica, Callaina, Callais); earlier mineralogical names for turquoise, see *Turquoise.*

Calorescence; the term applied to the phenomenon exhibited by certain minerals which, when irradiated with heat rays produce visible light. See also *Thermoluminescence* and *Luminescence.*

Cameo; the term used to designate those stones, generally composed of two differently coloured layers, in one of which a raised figure or design is cut, while the layer of the second colour forms a background. Agates and certain sea shells are usually the materials used.

Canada balsam; a resin obtained from a species of fir and used as a mountant for microscopic specimens. R.I. = 1·53.

Canada moonstone; a name applied to the peristerite variety of feldspar. See *Peristerite.*

Cancrinite; $3H_2O4Na_2O\ CaO4Al_2O_3\ 9SiO_2 2CO_3$. R.I. approx. 1·51; S.G. 2·42 to 2·50; H. 5 to 6; Hexagonal; Massive opaque yellow or orange. Gem locality is Canada.

Canutillos; the name by which good quality emerald crystals are locally known by the miners working the Colombia emerald mines.

Cap-cut; a fashioned stone in which the facets are irregular and haphazard. See *Bastard-cut.*

"Cape emerald"; a misnomer which has been applied to the mineral prehnite found in South Africa. See *Prehnite*.

"Cape ruby"; a misnomer for pyrope garnet found in association with diamond in South Africa.

Cape stones; a classification of gem diamond sub-divided into: fine silver Cape, silver Cape; light Cape, Cape, dark Cape. This group is classified next in order to blue-whites and whites. See *Comparison Table of Diamond Colour Grading*, page 228.

Carat; a term used to express the fineness of gold used in jewellery. It may be better understood as a twenty-fourth-part, thus 9 carat gold contains 9 parts of pure gold and 15 parts of alloy, likewise 22 carat gold contains 22 parts of pure gold and 2 parts of alloy. The term is sometimes spelt Karat.

Carat weight; the unit of weight for diamonds and gemstones. It is defined as one-fifth of a gram (200 milligrams = 0·200 gram). It became legal standard on the 1st of April, 1914, and was and frequently still is, known as the metric carat. The old London carat weighed 0.20530 gram, was not a legal standard and did not conform to the carat weight in other parts of the world, which varied in different countries from 0·1885 gram to 0·2135 gram.

Carbon; (1) see *Carbonado*.
(2) black inclusions in diamond, often referred to as carbon marks.

Carbonado; an opaque, black, tough and compact variety of diamond found in Brazil and Zaire, specific gravity being between 2·9 to 3·5. It is used for drilling bits for deep boring and for slow running abrasive wheels.

Carborundum; SiC; H. 9½; S.G. = 3·17; a synthetic product made by heating coke and sand in an electric furnace. Used as an abrasive.

Carbuncle; a name for almandine garnet which has been cut en cabochon.

Carnelian; see *Cornelian*.

Cascalho; the native name for the diamond-bearing gravel of Brazil.

Casein; a synthetic substance made from the albumen of milk and used occasionally as an imitation of amber and tortoise-shell and some ornamental stones. R.I. 1·55 to 1·56; S.G. 1·32 to 1·39 (usually 1·32 to 1·34). See page 182.

Cassia oil; a vegetable oil akin to cinnamon oil. R.I. = 1·60.

Cassiterite; SnO_2; R.I. 1·997–2·093; S.G. 6·8 to 7·1; H. 6 to 7; Tetragonal; Colours, red, brown, black and yellow; Localities, Cornwall, Bohemia and Saxony.

Castor oil; a pale yellow oil obtained from the seeds of *Ricinus communis* and used as an immersion medium in certain refractive tests. R.I. = 1·48.

Cat's-eyes; stones which, when cut en cabochon, show a wavy changeable band of light across the dome. The phenomenon is known as "chatoyancy", and is often observed in quartz, chrysoberyl and tourmaline. See also *Chatoyancy*, *Hawk's-eye* and *Tiger's-eye*.

Cedar wood oil; a vegetable oil used in immersion refractive index tests. R.I. = 1·51.

Celestine (Celestite); $SrSO_4$; R.I. 1·62–1·63; S.G. 3·97 to 4·00; H. 3 to 3½; Orthorhombic; Colourless to bluish; Localities, U.S.A., England and Madagascar.

Celluloid; a thermoplastic material made from a nitro-cellulose base, sometimes used as an imitation of amber, etc. Two types:

(1) Ordinary celluloid (cellulose nitrate). R.I. 1·495 to 1·51; S.G. 1·36 to 1·80 (usually in the clear types 1·36 to 1·42).

(2) Safety celluloid (cellulose acetate). R.I. 1·490 to 1·505; S.G. 1·29 to 1·80 (usually 1·29 to 1·40).

See page 180–1.

Cerussite; $PbCO_3$; R.I. 1·80–2·1; S.G. 6·5; H. 3½; Orthorhombic; White, grey, green, blue and black. World wide occurrence.

"Ceylon diamond"; a misnomer for colourless zircon.

"Ceylonese chrysolite"; a misnomer for greenish-yellow tourmaline.

"Ceylonese peridot"; a misnomer for yellowish-green tourmaline.

Ceylonite; a dark green, almost opaque, spinel, rich in iron, sometimes used in jewellery. An alternative name for this variety is Pleonaste, see *Spinel*.

"Ceylon opal"; a misnomer for moonstone.

C.G. (Certified Gemmologist); suffix used by gemmologists who have qualified by the examination of the Gemmological Institute of America.

Chalcedony; a crypto crystalline variety of quartz (SiO_2), with the following varieties:

Agates; chalcedony where the colour is variously distributed, generally in parallel layers.

Agatised wood; chalcedonic pseudomorph after wood.

Banded agate; colours in parallel bands.

Bloodstone or Heliotrope; dark green with scattered red spots.

Chalcedony; common; translucent with a white or bluish colour, green when containing chromium.

Cornelian; translucent flesh-red.

Chrysoprase; translucent apple green.

Eyed-agate; bands having a circular arrangement.

Fortification agate; bands are angularly arranged.

Hornstone; a grey impure form which is sometimes stained to imitate lapis-lazuli. (This shows red under the colour filter whereas true lazurite does not.)

Jasper; an impure variety of micro-crystalline quartz, opaque reds and browns also greyish blue and greens. Riband jasper is striped.

Moss agate or Mocha stone; containing dendritic inclusions.

Onyx; similar to agate except that the bands are straight. donies, can be stained, the black onyx nearly always has been so treated.

Plasma; often green with white or yellowish spots.

Prase; dull green, sometimes coloured by actinolite fibres.

Sard; brownish red.

Sardonyx; as onyx except that instead of the colours being black and white they are brownish red and white.

The refractive indices and specific gravity of Chalcedony are but slightly lower than for Quartz.

Charoite; a calcium potassium silicate, spectacularly purple in colour, from the Charo River, Yakutia, U.S.S.R. Massive, often fibrous, can be carved.

Chatham emerald (Chatham Cultured Emerald, Chatham Created Emerald); names applied at various times to an American synthetic emerald, grown by C. F. Chatham.

Chatons; paste (glass) stones backed with a reflecting foil.

Chatoyancy (cat's-eye effect); is due to the reflection of light from fine fibres or fibrous cavities within the stone. The wavy band of light seen across the stone being at right angles to the direction of the fibres. To show this best stones must be cut en-cabochon. See also *Asterism.*

Chatter marks; see *Fire marks.*

Chelsea colour filter; see page 159.

Chemical composition; the composition of a molecule of a substance, which may be an element or a combination of different elements in quantities which must obey certain definite chemical laws.

Chemical composition of gem minerals; see page 208.

Chemical elements; matter composed of only one chemical type, and which thus cannot be decomposed into simpler substances by chemical means. See page 215.

Chessylite; see *Azurite.*

Chiastolite; a variety of Andalusite (q.v.) containing carbonaceous inclusions in the form of a cross.

Chicot pearls; an alternative name for blister pearls. See *Blister pearls.*

Chlorastrolite; (CaO, $3Al_2O_3.7SiO_2.4H_2O$) a greenish fibrous mineral forming a rock with distinct (circular) markings. Largely pumpellyite. R.I. 1.70; S.G. 3·2; H. 5 to 6; Colour, chatoyant green and white; Locality, Lake Superior (U.S.A.).

Chloromelanite; a dark green, nearly black, ferruginous variety of jadeite. S.G.=3·4. H=6½ to 7.

Chlorospinel; see *Spinel.*

Chondrodite; $2Mg_2SiO_4Mg(F,OH)_2$; R.I. 1·60–1·63; S.G. 3·1; H. 6½; Monoclinic; Yellow, red, brown; Localities, Sweden and U.S.A.

Chrome chalcedony; green chalcedony coloured with chromium. Found in Rhodesia. Not to be confused with chrysoprase which it resembles. Sometimes called Mtorolite.

Chrome diopside; a bright green diopside found in association with diamond in South Africa.

Chromite; $FeCr_2O_4$; S.G. 4·3 to 4·6; H. 5½; Cubic; Colour, iron-black to brownish-black; Localities, U.S.A., etc.

Chromium oxide; a green powder used as a polishing agent. See *Green rouge.*

Chryselephantine; the name applied to objects of art composed or overlaid, partly with gold and partly with ivory.

Chrysoberyl; $BeAl_2O_4$; R.I. 1·742–1·749 to 1·750–1·757; S.G. 3·68 to 3·78; H. 8½; Rhombic; Colour, greenish-yellow, greenish chatoyant (Cymophane or Cat's-eye), emerald-green in daylight and red in artificial light (Alexandrite); Localities, Brazil, Ceylon, Ural Mountains (Russia), and Rhodesia.

Chrysocolla; a hydrous copper silicate; R.I. 1·50; S.G. 2·1 to 2·2; H. 2 to 4; Amorphous; Colour, green and greenish-blue; Localities, Ural Mountains (Russia), Chile and Arizona (U.S.A.). Often impregnating quartz.

Chrysolite; an ancient name applied to various kinds of yellow and greenish-yellow stones. A name which is better discontinued.

"Chrysolite, Water"; a misnomer for moldavite.

Chrysoprase; apple-green chalcedony.

C.I.B.J.O.; Comité International des Bijoutiers, Joailliers et Orfèvres. Originally European, but now extended, organisation for jewellery, horological and silverware trades.

Cinnamon oil; an aromatic oil used in certain refractive index tests. R.I. = 1·59.

Cinnamon-stone; brownish-red hessonite garnet.

Circular polarisation; the peculiar property of quartz, among gemstones, of rotating the plane of polarisation of a ray of light passing parallel to the optic axis, and showing an inter-

ference figure in convergent polarised light, in which the arms do not meet at the centre, the four arms stopping at the innermost ring.

Citrine; yellow quartz, see *Quartz*.

Clam pearls; pearls obtained from the clams such as the quahog or hard clam (*Venus mercenaria*) and the giant clam (*Tridacna gigas*). Density varies from 2·20 to 2·66.

Cleavage; the tendency of a crystallised mineral to break along certain definite directions producing more or less smooth surfaces. See page 117.

Cleavage; name applied to diamond crystals showing many flaws, or to broken fragments of crystals.

Cleaving; the method of dividing a diamond crystal into two or more pieces by splitting the stone through the grain (cleavage direction).

Clerici's solution; see page 121.

Clinozoisite; an epidote containing less than 10% of the iron molecule; R.I. 1·724–1·734; S.G. near to 3·37. It is a lighter green than epidote.

Close goods; are whole diamond crystals which contain no flaws.

Clove oil; an aromatic oil used in certain refractive index tests. R.I. = 1·54.

Coated stones; diamond crystals having a coat of green, brown or yellow colouring removable by cutting.

Cobalt glass; a glass coloured blue by cobalt oxide. Often used in the production of imitation gems, this glass is characterised by a typical absorption spectrum.

Cobaltite; CoAsS; S.G. 6·0 to 6·4; H. 5½; Cubic; Colour, silver-white; Localities, Scandinavia, U.S.A. and England.

Cohesion; the name given to the force of attraction existing between the molecules of one and the same body in consequence of which they offer a resistance to any influence tending to separate them.

Colemanite; $Ca_2B_6O_{11}5H_2O$; R.I. 1·58–1·61; S.G. 2·42; H. 4½; Monoclinic; Colourless and white; Locality, U.S.A.

Collet, Collette; alternative names for culet (q.v.).

Collimator; the lens system in certain optical apparatus used to parallelise the incident light rays. See also *Spectrometer.*

Colloid; the term applied to a liquid or solid compound of one substance in fine particles of ultra-microscopic size diffused through another.

"Colorado jade"; a misnomer for amazonite. See *Feldspar.*

"Colorado ruby"; a misnomer for pyrope garnet found in Colorado, U.S.A.

Coloriscope; a Swiss instrument for the colour grading of diamonds.

Colour dispersion; see page 145.

Coloured diamonds; diamonds having a definite shade of colour, termed *Fancy diamonds*, such as red, pink, blue, mauve, green, canary-yellow and brown. (See note on irradiated diamonds, page 183).

Colour filters; coloured films or glasses used to filter out certain colours of the spectrum. See page 159.

Colours of gemstones; see page 161.

Composite stones; see page 176.

Conchoidal fracture; broken surface shows a shell-like rippled form.

Conchiolin; a dark brown organic material secreted by the pearl molluscs, and a constituent of pearl. The dark brown outer coating of the oyster shell is conchiolin.

Conch pearls; pearls obtained from the great conch, a univalve mollusc (*Strombus gigas*). These pearls are pink in colour and are characterised by a lack of nacreous coating. They have high density. S.G. = 2·85.

Conglomerate; a sedimentary rock consisting of rounded pebbles cemented together by secondary mineralization. An example is the Hertfordshire pudding stone which is sometimes cut and polished.

Connemara marble; serpentinous calcite found in Galway Eire.

Convergent polarised light; plane polarised light which is made convergent by a converging lens placed above the polariser and below the rotating stage in polariscopes, and is of service for the production of Interference figures (q.v.).

Copal; a natural and recent resin resembling amber and having similar constants to it. Unlike amber it is softened by ether.

Coque de perle; the name applied to a gem resembling a blister pearl which is constructed from an oval section of the rounded whorl of the Indian nautilus. Because of the thinness of the shell it is backed by cement.

Coral; the axial skeleton of the coral polyp (*Corallium nobile*) consisting mainly of calcium carbonate. S.G. 2·6 to 2·7; H. 3½; Colour, red, pink, white and black (S.G. 1·34); Localities, Mediterranean, Persian Gulf, and Australia.

Cordierite; see *Iolite.*

Cornelian; translucent flesh-red chalcedony. An alternative but less correct spelling is carnelian. See *Chalcedony.*

"Cornish diamond"; a misnomer for rock crystal.

"Corundite"; trade name for sparking plugs incorporating synthetic corundum as insulating material.

"Corundolite"; a suggested, but undesirable, name for the colourless synthetic spinel.

Corundum; Al_2O_3; R.I. 1·759–1·767 to 1·770–1·779; S.G. 3·96 to 4·01; H. 9; Trigonal; Colours, red (Ruby), blue (Sapphire), colourless (White Sapphire), yellow (Golden Sapphire), pink (Pink Sapphire), green (Green Sapphire), purple and violet (Violet Sapphire). Star sapphires and rubies show asterism (6 rayed star). Localities, (ruby) Burma, Thailand and Ceylon; (sapphire) India (Kashmir), Ceylon, Burma, Thailand, Australia, Tanzania, Malawi and U.S.A.

Created emerald; the name, allowed in some countries, as a term for synthetic emerald.

Crinkles; a term used to describe diamonds having a corrugated, grooved or scaly appearance due to the manner in which successive thin layers, each slightly smaller than the one underneath it, have apparently grown on the face of the diamond during its formation.

Critical angle of total reflection; that angle where a ray of light, travelling from a denser medium to one less dense, is refracted at an angle of 90 degrees to the normal, that is it skims along the surface separating the two media; any further increase of the incident ray angle would cause the

refracted ray to turn back into the first medium where it obeys the ordinary laws of reflection.

Crocidolite; name used for pseudomorphs of quartz after oxidised blue crocidolite asbestos. Properly called "Tiger's-eye". See *Quartz*.

Crocoite; $PbCrO_4$; R.I. 2·3–2·6; S.G. 5·9 to 6·1; H. $2\frac{1}{2}$–3; Monoclinic; Hyacinth red; Localities, Tasmania, Russia, Rumania, Brazil and U.S.A.

Crocus (Crocus martis); a polishing powder produced from an iron oxide.

Cross-cut; see *Scissors-cut*.

Cross facets; the name applied to eight of the small three-sided facets around the girdle edge on the crown, which in the case of a modern circular stone have the same size and shape as the eight skill facets adjacent. In older oval-shaped stones these facets are the eight larger of the 16 edge facets. In modern nomenclature the eight cross and the eight skill facets are combined as 16 half or break facets. An alternative name for cross facets is skew facets. In modern usage, they are known as upper girdle facets.

Cross stones; fancy name for the twinned crystals of staurolite. Also known as "Fairy stones".

Cross-work; the name applied to the first operation in grinding a brilliant-cut stone, consisting in grinding the table and four main facets

Crown; that part of a cut stone which lies above the girdle, or setting edge. In the brilliant-cut stone it has the table facet and 32 surrounding facets. An alternative name is the bezel.

Crown glass; a classification or family of glasses which do not include lead oxide in their composition. In general they have lower constants than for the more highly dispersive "flint" or "lead" glasses. See page 179, 180.

Crypto-crystalline; the term used to describe material made up of an aggregate of sub-microscopic crystals.

Crystals; solids possessing a certain definite internal atomic structure, which is identical in the case of crystals of any one species. This definite arrangement directly influences the geometrical form and the physical and optical properties.

Crystal axes; imaginary lines of reference running through the ideal crystal and intersecting in the centre at a fixed point, termed the origin. They are reference lines from which can be measured the relative positions of the various faces.

Crystal faces; the flat surfaces of geometrical outline which form the bounding surfaces of crystals. In the case of some diamonds these surfaces are curved.

Crystalline material; any material which shows by physical and optical means the regular arrangement of its internal atoms.

Crystallography; the study of crystals and their structure.

Crystal, Rock; see *Quartz*.

Crystal systems; see page 114.

"Crystolon"; trade name for an abrasive made of silicon carbide.

Cube; a solid of six square faces with all its angles right-angles. The fundamental crystal form of the cubic system.

Cubic system; one of the crystal systems, see page 114.

Cubo-octahedron; a crystal form combining the cube and the octahedron.

Culet; the small facet at the base of the pavilion of a brilliant-cut stone parallel to the table facet. Its main function is to prevent splintering but it is often omitted in modern cut stones.

Cullinan diamond; also known as the Star of Africa, is the largest gem diamond ever found. Found at the Premier mine in the Transvaal on 25th January, 1905, the rough stone weighed 3,106 metric carats. From this magnificent stone two important diamonds were cut; one, a pendeloque brilliant weighing 530·2 metric carats is the largest cut diamond in the world and is mounted in the Royal Sceptre of the British Regalia; the other, a square brilliant weighing 317·4 metric carats is set in the Imperial State Crown. These two stones are known respectively as Star of Africa No. 1, and Star of Africa No 2.

Cultured pearl; a pearl produced by the insertion in the pearl oyster of an artificial nucleus, usually mother-of-pearl, and the deposition of nacre thereon by the mollusc.

Cuprite; Cu_2O; R.I. 2·85; S.G. 5·85 to 6·15; H. 4; Cubic; Red; Widespread occurrence.

Curvette-cut; see page 185.

Cut-cornered triangle; the name applied to a trap-cut stone in which the outline is that of a triangle with two of the corners bevelled off. See page 186.

Cuts of stones; see pages 184–91.

Cuttable rough; a name which has been applied to all diamonds suitable for manufacturing into ornamental or gem stones.

Cutting; the process of cutting gemstones on revolving diamond-charged grinding wheels.

Cyanite; alternative spelling for kyanite.

Cyclotroned diamonds; diamonds which are coloured green by bombardment with atomic particles which have been accelerated to a high speed by a cyclotron. After subsequent heat treatment the stones become yellow or brown. The colouration is only skin deep and the stones are not radio-active.

Cymophane; see *Chrysoberyl.*

Cyprine; see *Idocrase.*

Cyst pearls; pearls formed within the tissue of the mollusc itself. These pearls are the most perfect.

Dallasite; a name applied to the green and white jasper from Vancouver Island, British Columbia, Canada.

Danburite; $CaB_2Si_2O_8$; R.I. 1·630–1·636; S.G. 3·00; H. 7; Rhombic; Colour, colourless and yellow; Localities, Madagascar, Japan, Burma, Mexico and Switzerland.

Dark brown; a classification of gem diamond.

Dark cape; a classification of gem diamond. See *Cape stones.*

Datolite; $Ca(B,OH)SiO_4$; R.I. 1·625–1·669; S.G. 2·9 to 3·0; H. 5 to 5½; Monoclinic; Colour, whitish, yellowish, colourless, reddish, greenish, brownish and mottled; Localities, U.S.A.

Deer horn; the horn or antler of certain of the deer family has been used instead of ivory for small carvings, particularly for the netsukes of Japan. S.G. 1·6 to 1·85.

Delawarite; a name applied to the aventurine feldspar found in Delaware Co., Pennsylvania, U.S.A.

Demantoid; see *Garnet* (Andradite).

Dendritic; the tree or fern-like form assumed by some minerals, particularly when they are inclusions in others, such as the dark pigmenting minerals in quartz producing moss agates.

Density; the comparison of the weight of a given volume of a substance with the weight of a similar volume of another substance used as a standard, see also *Specific gravity*, page 120.

Density correction tables; see page 232.

Derbyshire spar; see *Fluorspar* and *Blue John*.

Deviation, minimum; see *Refractive index*, page 131.

Diakon; see *Perspex* and *Plastics*, page 180.

Diamanté; a term used in jewellery for paste set articles.

"Diamantine"; trade name for an abrasive made of aluminium oxide. *Note*, there is no diamond content.

"Diamonair"; name misleadingly applied to the synthetically produced yttrium aluminium garnet.

Diamond; C; R.I. 2·417 to 2·420; S.G. 3·51 to 3·53; H. 10; Cubic, with a perfect cleavage parallel to the faces of the octahedron; Colour, colourless and pale tints of yellow, red, pink, green, blue, also brown. Some green diamonds have been artificially tinted by radium emanations. There are two distinct types of diamond; Type 1, to which the majority of stones belong, which exhibits complete absorption below 3,000 Å; and Type 2, the rarer "transparent" type, which transmits light down to 2,250 Å. The dispersion (B–G)= 0·044; Occurrence is from alluvial deposits and from pipes (volcanic?) in South Africa; Localities, India, Brazil, South Africa, South West Africa, Tanzania, West Africa, Australia, Guyana, Zaire, Ghana, Borneo, Venezuela and U.S.S.R. See *Radium-treated diamonds, Irradiated diamonds, Coloured diamonds, Fancy Diamonds* and *Diamonds, Industrial.*

Diamond colour grading, Comparison Table of; see page 228.

Diamond colorimeter; an American instrument for the colour grading of diamonds. The Diamolite is a similar instrument.

Diamond dust; see *Diamond powder.*

Diamond gauge; devices of assistance in the estimation of the weight of a mounted diamond. They are of two general types:

(1) A stencil gauge consisting of a thin sheet of metal or celluloid (the metal types often being in the form of folding leaves) in which are a series of differently sized circular apertures, each of which has a diameter agreeing with the diameter of a correctly fashioned diamond of given weight. The gauge is placed over the stone to be estimated and the aperture which just fits over the girdle of the stone gives the approximate weight of the diamond, each hole being marked with its value in carats or decimals of a carat.

(2) a pair of spring calipers with the moving arm fitted with a pointer which moves over a scale of numbers. The diameter of the stone is first measured and then the depth. The readings obtained are looked up in a book of tables supplied with the instrument and the approximate value read from them. It is considerably more accurate than the stencil gauge. See also *Moe's gauge.*

Diamondlite; an American microscope used for the grading of diamonds.

Diamond point; the relation of the table of a cut diamond to the underlying regular octahedron. It is said to be four-point, if the table be cut parallel to the face of the cube, that is across the corner of the octahedron so that the resulting section is square; three-point, if the table be parallel to an octahedral face; and two-point, if the table be parallel to the face of the rhombic dodecahedron and therefore to an edge of the octahedron, while equally inclined to its two faces meeting in that edge.

Diamond (four) point; the earliest form of diamond fashioning, being merely the polishing of the octahedral faces of the crystal to a regular shape.

Diamond powder; boart and remainders from diamond cleaving and bruting reduced to powder by various mechanical methods (usually by crushing in an iron mortar) and then

segregated into micron size groups by either air sifting, centrifuge, elutriation or settling in oil. Finest material commercially produced has a grit size of 1 micron (1 micron = 0·001 mm.). Diamond powder is used for grinding and polishing diamonds and other hard stones and for diamond saws and other industrial purposes. See *Diamond saw*.

Diamond saw; a disc of phosphor bronze about 2″ in diameter and about ·07 to ·12 millimeter in thickness, with a thickened periphery charged with diamond powder.

Diamondscope; an American instrument consisting of a binocular microscope with a specially designed dark-field illuminator used for observing imperfections and internal features in diamonds and coloured stones.

Diamonds, Industrial; certain types of diamonds, generally those unsuited for gemstone production, which have applications in modern industrial and engineering practice. They are used for industrial purposes, such as deep well boring, turning tools for metals and plastics, truing abrasive wheels, dies for fine wiredrawing, hardness indenters, and as powder for grinding and polishing metals.

See also *Ballas, Boart, Carbonardo, Diamond powder* and *Diamond saws.*

Diamonesque; a misleading term applied to synthetic cubic zirconia (q.v.).

Diaphaneity; see *Transparency.*

Diasterism; a star effect which is best seen when light is transmitted through the specimen. Phlogophite mica and some rose quartz shows this effect.

Diatomite; a polishing powder produced from a soft silica composed of minute plant skeletons or diatoms. Sometimes known as "Fossil tripoli", it should not be confused with tripoli.

Dibromoethane; the modern chemical name for Ethylene dibromide (q.v.).

Dichroism; the differential selective absorption of light seen in some doubly refractive stones. See page 147.

Dichroite; see *Iolite.*

Dichroscope; an instrument comprising a suitably cut rhomb of Iceland-spar and a lens system in a short tube, used for viewing the effects of dichroism.

Differential selective absorption of light; see *Pleochroism*, page 147.

Diffraction grating; a series of fine lines ruled on glass or metal and used to produce spectra. They are used in some types of spectroscopes.

Diffraction of light; the breaking up of white light into the spectrum colours when it passes through a narrow aperture. It is a special case of interference of light.

Diffusion column; a tube containing two heavy liquids, one being less dense than the other, allowed to diffuse together so that the resultant liquid varies in density from top to bottom. Stones having specific gravities between the limits of the liquid will take up positions at differing levels. It is a method for quickly ascertaining the density of stones of slightly differing specific gravity such as stones of different colour of the same species.

Diffusion melt; similar to flux fusion (q.v.) except the chemical compounds used are usually in separate layers and the crystalization occurs after diffusion of the chemicals when the mass is fused.

Di-iodomethane; the modern chemical name for Methylene iodide (q.v.)

Dimethylaniline; a liquid having an application in certain refractive index determinations. R.I. = 1·56.

Dimetric system; alternative name for the Tetragonal system.

Dimorphism; term applied to the case where two minerals have the same composition but a different crystal structure.

Dinny bone (Dinosaur bone); fossil dinosaur bone used as an ornamental stone.

Diopside; $CaMg(SiO_3)_2$; R.I. 1·67–1·70; S.G. 3·20 to 3·32; H. 5 to 6; Monoclinic; Colour, green; Localities, Italy and the U.S.A. Alternative names, Alalite and Malacolite. A massive dark violet-blue variety from Piedmont known as "Violane", is used as an ornamental stone.

Dioptase; H_2CuSiO_4; R.I. 1·655–1·708; S.G. 3·3; H. 5; Trigonal; Colour, emerald-green; Localities, Siberia, Chile, Zaire and Namibia.

Dispersion; the breaking up of white light into the spectrum colours when a ray passes across two inclined faces of the stone. In a gemstone it is known as fire (q.v.). See page 145.

"Djevalite"; a trade name for synthetic cubic zirconia.

Dodecahedron; a geometrical solid having twelve faces. The rhombic dodecahedron has twelve lozenge-shaped faces and is a form found in the cubic system.

Dop; (1) Solder: A brass cup with a malleable copper stem filled with lead-tin solder into which the diamond is set in order to cut and polish the facets.

(2) Mechanical: A holder in which the diamond is held between steel claws tightened by a screw, enabling the stone to be automatically adjusted without re-setting.

Double refraction; the effect caused by all crystals, except those of the cubic system, of splitting a ray of light which passes into them into two rays, which travel with different velocities.

Double rose; the name applied to a cut stone of spherical shape covered all over with triangular facets; it may be assumed to be two rose-cut stones base to base.

Doublets; (1) Composite stones, see page 176.

(2) Spectroscopic, close pairs of lines seen in emission and absorption spectra.

Dravite; brown tourmaline.

Drop pearls; pearls having a drop or pear-shape. Sometimes called "pear-eyes".

Dullam; the concentrated gem gravel (illam) of Ceylon which contains the gem minerals.

Dumortierite; $Al(AlO)_7(B,OH)(SiO_4)_3$; R.I. 1·678–1·689; S.G. 3·26 to 3·36; H. 7; Rhombic; Colour, blue-violet; Locality, California, Arizona and Nevada (U.S.A.).

Durability; the resistance a stone possesses to forces which tend to destroy its lustre and polish. These forces may be physical or chemical.

Durangite; $Na(Al,F)AsO_4$; R.I. 1·66–1·71; S.G. 3·97 to 4·07; H. 5; Monoclinic; Orange-red. From Mexico.

Dust, diamond; see *Diamond powder.*

Dust diamond, Assorted; diamonds, usually 60 per carat down to 150 per carat in size, and having a degree of brilliancy so that they can be used for ornamentation of cheap jewellery without further polishing. A portion of this material is used industrially. Not to be confused with diamond dust.

Dyed stones; a number of gem materials are sufficiently porous to readily take colouring agents and such treatment is commercially carried out. Chalcedony is often inorganically stained various colours. Other stones sometimes dyed are turquoise, jadeite, opal, serpentine and alabaster. If the material has been stained and this can be proved, the fact should be disclosed, but in some cases this may not be possible, and in these cases, particularly the black and red colours of chalcedony, the names onyx, cornelian and sard would be commercially acceptable.

Ear-shells; see *Abalone.*

Egeran; a name applied to the variety of idocrase found at Eger, Hungary. See *Idocrase.*

"Egyptian alabaster"; name applied to a banded calcite. The alabaster of the ancients was calcite. The modern alabaster is massive gypsum.

Egyptian jasper; jasper in which the colours run in zones.

Egyptian marble; a marble stained black by bitumen and veined yellow with dolomite. It is usually obtained from Italy.

Eight-cut; a simple modification of the brilliant-cut used for small diamonds. The table being surrounded by eight four-sided faces. See page 190.

Eilat (Elath) stone; a blue to green mottled stone consisting of a mixture of chrysocolla and other copper minerals. Found in Israel.

Ekanite; a metamict calcium thorium silicate; R.I. 1·60; S.G. 3·28; H. $6\frac{1}{2}$. Stones have a green colour, are singly refractive and are radio-active. Only known source is Ceylon.

Elaeolite; see *Nepheline.*

Elath stone; same as Eilat stone (q.v.).

Elements, Chemical; see page 214.

Elements, Periodic classification of; see page 215.

Electron volt; unit of energy used in nuclear physics. It is used by physicists rather than wavelength to which it has a definite relation.

Electro-conductivity; when a substance, whether mineral or not, after being held between two electrodes at different electrical potentials allows current to pass the substance is said to be electro-conductive. The test has a value with blue diamonds, for, as far as has been found, all natural blue diamonds conduct electricity as they are of the Type IIb, while the diamonds artificially coloured by electron bombardment are not electro-conducting.

Electro-magnetic spectrum; the term used for the range of wave-lengths of radiant energy from the long waves of wireless to the extremely short wave-lengths of the cosmic radiations. Below the wireless waves come the infra-red or heat rays, light rays, ultra-violet rays, X-rays, the gamma rays of radium and the cosmic rays (q.q.v.).

Electroned diamonds; diamonds coloured an aquamarine blue colour by treatment with high-speed electrons from a Van de Graaf generator. The colouring is only skin deep and the stones are not radio-active, nor are they electro-conductive.

Emerald; grass-green Beryl (q.v.).

"Emerald, African"; green fluorspar.

"Emerald, Brazilian"; a misnomer for green tourmaline.

Emerald coated beryl; cut and polished aquamarine or yellow beryl upon which a coating of synthetic emerald has been deposited. See *Emerita*.

"Emerald, Evening"; a misnomer for peridot.

"Emerald matrix"; a misnomer for green fluorspar.

"Emerald, Oriental"; a misnomer for green corundum.

"Emerald, Scientific"; may be synthetic corundum or spinel, a beryl glass or just paste.

"Emerald, Spanish"; a misnomer for green glass.

Emerald, Synthetic; see page 174.

"Emerald, Synthetic"; a misnomer for the green variety of synthetic corundum or spinel.

"Emerald, Uralian"; a misnomer for demantoid garnet.

Emerald-cut; name applied to stones cut in the trap (step) cut style, so called from the method of cutting emeralds. See pages 185, 189, 191.

"Emeraldine"; a misnomer for a chalcedony stained green with chromic oxide. It is a deeper green than the stained chalcedony which owes its colour to nickel and, unlike the nickel type, shows a red residual colour under the dichromatic filter.

"Emeraldite"; a misnomer for green tourmaline.

"Emerita"; the name given to the emerald coated beryls made by the Lechleitner process which causes a deposit of synthetic emerald on to the surfaces of previously fashioned aquamarine or yellow beryl. Now called "symerald".

Emery; an intimate mixture of granular corundum, magnetite and some hematite. Often used for abrasive purposes, the grain is found to break down under pressure, so that new cutting edges are constantly present. The material is best suited for polishing purposes.

Enantiomorphism; crystals which show right and left-handed formation, not only in their outward appearance but in their optical properties also are said to exhibit enantiomorphism. These crystals show circular polarisation. Example, quartz.

Endoscope; an instrument for the detection of cultured pearls. It shows the difference between the concentric structure of real pearls and the parallel structure of the mother-of-pearl bead in cultured pearl. Can only be used for drilled pearls.

Enstatite; $(Mg,Fe)SiO_3$; R.I. 1·665–1·674; S.G. 3·25 to 3·30; H. $5\frac{1}{2}$; Rhombic; Colour, green; Localities, South Africa, Burma.

Eosite; an aventurine quartz with reddish veins. The best of this material is probably from the Altai Mountains of Russia.

Epiasterism; a star effect seen in a suitably cut cabochon stone when light is reflected from suitably oriented inclusions within the stone. The asterism of star corundum is of this type.

Epidote; $Ca_2(Al,Fe)_2(AlOH)(SiO_4)_3$; R.I. 1·735–1·765; S.G. 3·25 to 3·50; H. 6 to 7; Monoclinic; Colours, yellow, green, pistachio green, brown, and red; Localities, Italy, France, Germany and Alaska. Pistacite is a yellow-green variety of epidote.

Epithelium; the name applied to the surface layer of cells of the "mantle" which covers the pearl oyster. These cells have secretory powers and produce the pearl-shell and the pearl.

"Erinide"; an American trade-marked name for greenish synthetic spinel.

"Erinoid"; a trade name for the formalised casein plastic.

Essence d'orient; a preparation of fish scales (from the underpart of the "bleak") which is used to produce the orient in imitation pearls.

Essonite; see *Garnet* (Hessonite).

Etch figures; small geometrical elevations or depressions produced on the faces of crystals due to solvent action, and which have a definite relation to the internal crystal structure.

Ether (ethyl ether); $C_2H_5–O–C_2H_5$; a volatile inflammable liquid used as a test for amber and copal. Copal is softened by this liquid while amber is unaffected.

Ethylene dibromide (Dibromoethane); $C_2H_4Br_2$; a useful liquid with a low surface tension which thus may be used in place of water for density determinations by the direct weighing method. It is necessary to correct for temperature when using this liquid. See page 234.

Euclase; $Be(Al,OH)SiO_4$; R.I. 1·650–1·669 to 1·652–1·671; S.G. 3·05 to 3·10; H. 7½; Monoclinic; Colours pale green, pale blue and colourless; Localities, Brazil, Rhodesia and Russia.

Euhedral crystals; crystals which show good faces and form.

"Evening Emerald"; misnomer for peridot.

Extinction; when a doubly refracting crystal is viewed in parallel polarised light with the Nicol prisms (or Polaroid discs) crossed, on rotation of the stage, the field becomes four times light and four times dark, *i.e.*, extinction at 90 degrees. With isotropic materials the field remains dark at

all positions. Isotropic material, when under strain, may show anomalous extinction but rarely orientated at 90 degrees (anomalous double refraction).

Extraordinary ray; that ray in a doubly refracting uniaxial mineral in which the velocity varies according to the direction in which it passes through the crystal.

Eyed agate; agate in which the coloured bands are circularly arranged in such a way that they resemble an eye.

"Fabulite"; trade name for strontium titanate.

Faces, Crystal; see *Crystal faces.*

Facets; the name applied to the plane geometrical faces of a polished stone. The name is sometimes used also for the inclined faces at the top of prismatic crystal.

Fairy stones; see *Cross stones.*

Falcon's-eye"; see *Hawk's-eye.*

False cleavage; see *Parting.*

False lapis; name sometimes applied to the stained chalcedony made to imitate lapis-lazuli; also known as "Swiss lapis" or "German lapis".

"False topaz"; see *Quartz* (citrine).

Fancy diamonds; coloured diamonds which have a definite shade of colour, such as: canary yellow, green, blue, red, pink, brown, etc. Green and yellow coloured diamonds may have been treated. See also *Coloured diamonds.*

Fancy shapes; the name used for oblong, pentagon, half-moon and other fancy shapes in cut-stones. See page 185.

Fashioning of stones; see page 184.

Fayalite; Fe_2SiO_4; one end member of the isomorphous series of which peridot is a variety. See *Peridot.*

Feathers; layers of liquid or crystalline inclusions having a feather-like appearance sometimes found in natural crystals of rubies and sapphires, etc.

Feldspar (Felspar); name given to an important group of rock-forming minerals, consisting of a silicate of aluminium with essentially potassium (Orthoclase and Microcline) or sodium and calcium (Plagioclase).

Labradorite; (30% to 50% of albite to 50% to 70% of anorthite); R.I. 1·56–1·57; S.G. 2·70 to 2·72; H. 6 to 6½; Tri-

clinic; Colour, blue and grey with play of colour; Locality, Labrador, Canada.

Microcline; $KAlSi_3O_8$; R.I. 1·52–1·53; S.G. 2·54 to 2·57; H. 6 to 6½; Triclinic; Colour, bright verdigris green (Amazon-stone); Locality, Pikes Peak, Colorado (U.S.A.).

Oligoclase (Sunstone or Aventurine); (70% to 90% of albite and 10% to 30% of anorthite); R.I. 1·54–1·55; S.G. 2·62 to 2·65; H. 6 to 6½; Triclinic; Colour, spangled bronze due to included flakes of hematite or goethite; Locality, Norway, Canada, etc.

Orthoclase; $KAlSi_3O_8$; R.I. 1·52–1·53 to 1·53–1·54; S.G. 2·55 to 2·58; H. 6 to 6½; Monoclinic; Colours yellow and colourless with opalescence (Moonstone); Localities, yellow, Madagascar; Moonstone, Ceylon, Switzerland and Burma.

Plagioclase forms an isomorphous series from Albite ($NaAlSi_3O_8$) to Anorthite ($CaAl_2Si_2O_8$). Only two members of this group come within the scope of gemmology: Oligoclase (Sunstone or Aventurine) and Labradorite.

F.G.A. the suffix used by holders of the fellowship diploma of the Gemmological Association of Great Britain.

F.G.A.A.; the suffix used by holders of the fellowship diploma of the Gemmological Association of Australia.

Fibrolite; Al_2SiO_5; R.I. 1·658–1·677; S.G. 3·25; H. 7½; Rhombic; Colours, pale blue and greenish; Localities, Burma and Ceylon. Alternative name "Sillimanite".

Figure stone; a term used for material used for small stone carvings. It is generally Agalmatolite (q.v.).

Fine light brown; a classification of gem diamond.

Fine silver cape; a classification of gem diamond.

Fire; the flashes of spectrum colours seen from the crown of a stone and due to dispersion (q.v.).

Fire marble; see *Lumachella.*

Fire marks; small cracks seen along the facet edges in corundum. They are due to overheating on the polishing lap. They are seen both in natural corundums and in synthetic corundums, but are usually more prevalent in the latter.

Fire opal; see *Opal.*

"Fire pearl"; a misnomer used for billitonite.

Firestones; the name applied to rock crystal which has had cracks artificially produced by heat. See *Quartz* (Iris).

First bye; a classification of gem diamond.

First cape; a classification of gem diamond.

First water; term used for diamonds which are perfectly limpid and free from flaws.

Flame-fusion process; a process used in growing synthetic single crystals. A high temperature flame is used. The Verneuil process is a flame-fusion method.

Flats; term used for those diamond crystals which are distorted octahedra.

Flaws; may be fractures or cleavages either on the surface or running partly or completely through the stone. See *Feathers.*

Flêches d'amour; see *Quartz.*

Flint glass; glass containing lead oxide which gives high dispersion. The material used for imitation gem stones usually has a range of R.I. from 1·58 to 1·68, and S.G. 3·15 to 4·15. The hardness is low in this type.

Fluorescence; the effect exhibited by certain materials of producing visible light on being irradiated with invisible ultraviolet rays, cathode rays, X-rays or gamma rays. If the effect is continued after the removal of the exciting radiation it is then termed phosphorescence. See also *Luminescence*, and page 168.

Fluorite; mineralogical name for fluorspar.

Fluorspar; CaF_2; R.I. 1·43; S.G. 3·17 to 3·19; H. 4; Cubic; Colours, violet, green, yellow, orange, blue, red, pink, brown and colourless; Localities, England, Namibia (green), Switzerland and U.S.A. Massive variety, Blue John (Derbyshire spar), Castleton, Derbyshire, England.

Flux fusion (Fluxed melt); a method of growing crystals, similar in many respects to crystallization from aqueous solutions, but the solvents used are solids with relatively high melting points. Some synthetic emeralds and rubies are grown by this method.

Foiled stones; gemstones set with silver or coloured foil at the back in order to lighten a dark stone or to enhance the colour of a pale stone.

Form-birefringence; the usually small birefringence commonly seen in material having a mineral of one refractive index embedded in another which has another index. Often seen in chalcedony.

Forsterite; Mg_2SiO_4; one end member of the olivine isomorphous series of which peridot is a variety. See *Peridot.*

Fossil ivory; ivory obtained from the tusks of extinct mammoths (*Elephas primigenius*) whose bodies have been preserved in solid ice since the last Ice Age. Found mainly in Siberia. Also from equivalent animals in North America. Some of this material is suitable for use in the arts.

Fossil resin; see *Amber.*

Fossil tripoli; see *Diatomite.*

"Fossil turquoise"; a misnomer for odontolite. See *Odontolite.*

Four-point; see *Diamond point.*

Fracture; the term used to describe the surface of a stone when chipped or broken. The character of the surface varies with different stones and names are applied to the different kinds:

Conchoidal; when the surface takes the form of many more or less concentric ridges resembling the lines on certain shells.

Even; when the surfaces are smooth and even.

Splintery; when the substance breaks into long splinters. Fibrous substances produce this type.

Uneven; when the surfaces are rougher, this is sometimes termed "hackly fracture".

Fraunhofer lines; dark lines seen in the spectrum of the sun, which represent the absorption of certain wave-lengths of light by elements present in the outer-chromosphere. Certain of these lines are denoted by alphabetical letters and may be used for calibration. See page 158.

Freshwater pearls; pearls found in the pearl mussels which inhabit inland waterways of Europe and America. See *Mussel pearls.*

Frictional electricity; charge of electricity developed by certain substances vigorously rubbed with a cloth; diamond, tourmaline and topaz taking on a positive charge and amber a

negative one. (Some plastic imitation ambers also show this effect.)

Friedelite; $H_7(Mn,Cl)\,Mn_4Si_4O_{16}$; R.I. 1·63–1·66; S.G. 3·07; H. 4 to 5; Trigonal; Rose red to Orange-red; Localities, France, Sweden and the U.S.A.

Frosted diamonds; diamond crystals which have a frosted appearance but are not so heavily coated as "coated" crystals. See *Coated stones.*

Fusibility; the relative fusibility of minerals, generally determined from a scale of six minerals, suggested by Von Kobell, in which the temperature of fusion is understood to increase by approximately equal amounts. Von Kobell's scale is as follows:

1. *Stibnite*	melting at 525°C.
2. *Natrolite*	„ „ 965°C.
3. *Almandine garnet*	melting at 1,200°C.
4. *Actinolite*	„ „ 1,296°C.
5. *Orthoclase*	„ „ 1,300°C.
6. *Bronzite*	„ „ 1,380°C.

Gahnite; $ZnAl_2O_4$; R.I. 1·805; S.G. 4·40; H. 7½ to 8; Cubic; Dark green; many localities.

Gahnospinel; blue spinel containing considerable proportion of zinc. Found in Ceylon. S.G. up to 4·06; R.I. up to 1·753.

Garnet; an isomorphous series of minerals (gemstones) represented by the formula $R''_3R'''_2(SiO_4)_3$, where R″ may be any of the bivalent metals magnesium, calcium, manganese or iron, while R‴ stands for a trivalent metal, aluminium, ferric iron or chromium. All garnets crystallise in the cubic system. The garnets are divided into two series; the "pyralspite series" which consists of pyrope, almandine and spessartine; and the "ugrandite series" consisting of uvarovite, grossular and andradite.

Almandine; $Fe_3Al_2(SiO_4)_3$; R.I. 1·75 to 1·82; S.G. 3·80 to 4·20; H. 7½; Colours, deep red, violet-red and black; Localities, Australia, India, Ceylon and North and South America. Four-rayed asterism sometimes seen.

The lower range given here for the almandine is sometimes described as the pyrope-almandine series.

Andradite; $Ca_3Fe_2(SiO_4)_3$; R.I. 1·82 to 1·89; S.G. 3·80 to 3·90; H. 6½; Colours, green (Demantoid, R.I. 1·88 to 1·89; S.G. 3·83 to 3·85), yellow (Topazolite) and black (Melanite); Localities, Russia, Saxony and Italy.

Grossular; $Ca_3Al_2(SiO_4)_3$; R.I. 1·742 to 1·748; S.G. 3·55 to 3·67 ("Transvaal Jade", 3·42 to 3·72); H. 6½ to 7; Colours, brownish yellow (Cinnamon-stone), reddish orange (Hessonite), transparent green, massive green ("Transvaal Jade"), and other colours; Localities, Ceylon, Switzerland and South Africa.

Pyrope; $Mg_3Al_2(SiO_4)_3$; R.I. 1·74 to 1·75; S.G. 3·68 to 3·80; H. 7¼; Colour, red; Localities, South Africa, Bohemia, Arizona, etc.

Rhodolite; a violet variety in composition lies between pyrope and almandine in the ratio of 2:1. R.I. 1·76; S.G. 3·84; H. 7¼; Locality, Macon County, North Carolina, (U.S.A.).

Spessartine; $Mn_3Al_2(SiO_4)_3$; R.I. 1·79 to 1·81; S.G. 3·90 to 4·20; H. 7¼; Colours, brown, orange-red and hyacinth-red; Localities, Bavaria, Ceylon, Tyrol, Brazil and U.S.A.

Uvarovite; $Ca_3Cr_2(SiO_4)_3$; R.I. 1·84 to 1·85; S.G. 3·41 to 3·52; H. 7½; Colour, bright green; Localities, Russia and Finland.

"Garnet, Synthetic"; a misnomer for the synthetic dark red corundum made to represent the garnet colour.

Garnet-topped doublets; composite stones made witn a garnet top on a glass base.

Garnet-type synthetic stones; crystals which have been grown synthetically. The most important as gemstones are the yttrium aluminium garnets (Diamonair).

Gauge, Diamond; see *Diamond gauge.*

"Garnet, Synthetic"; a misnomer for the synthetic dark red corundum made to represent the garnet colour.

Gel; a jelly, a colloid.

Gem-cut diamond; any diamond cut as a gem, it is a United States definition for export purposes.

Gemmology; the science which deals with precious minerals and other materials used for personal adornment, and for *objets d'art.*

Gemolite; an American microscope used for observing imperfections and internal features in diamonds and coloured gemstones. The instrument functions similarly to the Diamondscope (q.v.).

Gemolux; a Swiss instrument incorporating a lighting device for the examination of stones.

Gem peg; see *Jamb peg.*

Gems, Composite; see page 176.

Gems, Synthetic; see page 170.

Gem stick; the appliance used by the lapidary for holding the rough stone when cutting the facets. Of a penholder-like form with a metal collet at the end filled with cement into which the material to be cut is fixed, leaving exposed just enough to cut either the front or back facets. See *Jamb peg.*

Geodes; crystal-lined cavities found in rocks.

Geology; the science which treats of the structure and mineral constitution of the earth.

"German lapis"; jasper or chert stained blue and used to imitate lapis-lazuli.

G.G.G. (Gadolinum gallium garnet); artificially produced gem material. R.I. about 2·02; S.G. 7·05; H. 6; Dispersion 0·038; Cubic. A good diamond simulant, but often slightly brown.

Ghost crystals; the so-called "phantom" or ghost crystals of quartz which appear to contain one or more crystals similar to it. The effect is due to interruption of growth.

Gilson synthetic emerald; a synthetic emerald produced by the firm of Pierre Gilson, of France.

Girasol; see *Opal.*

Girdle; name applied to the outer edge of a cut stone. It is the line of junction of the top (crown) and the base (pavilion). Also termed the setting edge.

Girdle facets; the small three-sided facets which adjoin the girdle in a brilliant-cut stone, 16 on crown and on pavilion.

Glass; see page 180.

Glycerol (Glycerine); a sweet colourless viscid liquid obtained

from oils, fat, etc. The refractive index is 1·47. See page 134.

Gneiss; a banded metamorphic rock derived either from igneous rocks (Ortho-gneiss) or sedimentary rocks (Para-gneiss).

Goethite; hydrated iron oxide, FeO(OH), is often an inclusion in oligoclase feldspar giving rise to the variety sunstone.

Gold; Au, the precious metal of yellow colour used as a setting for precious gems. See also *Carat* and *Tests for precious metals*, page 223. See also *Yellow gold, Red gold, Green gold, Blue gold, Grey gold.*

"Gold fluss"; another name for *Goldstone.*

Gold opal; an alternative name for fire opal.

Gold quartz; milky quartz containing particles of native gold. This is sometimes cut and polished for jewellery.

Goldstone; a paste (glass) imitation of reddish-brown aventurine made by the inclusion of copper crystals in the glass. See *Aventurine glass.*

Goniometer; an instrument for the measurement of crystal angles.

Goods; abbreviated name for Close goods (q.v.).

Goshenite; colourless Beryl (q.v.).

Grain; a unit of weight (Troy and Avoirdupois) see page 229; the pearl grain is one fourth of a carat.

Gram (Gramme); unit of weight of the metric system. Some ornamental stones are sold by the gram.

Granite; a granular igneous rock containing principally quartz, feldspar and mica. It is sometimes cut and polished for small jewellery articles.

Greek alphabet; see page 237.

"Green garnet"; a name at one time incorrectly used for enstatite.

Green gold; gold in which a greenish colour is induced by considerably increasing the proportion of silver in the 14 ct. quality. Several shades are obtained by careful manipulation of the percentages. Used as a contrast.

Green rouge; a polishing powder consisting of chromium oxide.

Greenstone; see *Nephrite.*

"Green stone"; a misnomer sometimes used for chlorastrolite. See *Chlorastrolite.*

Grey gold; a grey colour induced in a gold alloy by the addition of iron or steel. It has a limited application.

Grit; an alternative name for diamond powder.

Grossular; see *Garnet.*

Gypsum; $CaSO_4.2H_2O$; R.I. 1·52–1·53; S.G. 2·2 to 2·4; H. 2; Monoclinic; Colour, white (Satin-spar and Alabaster); Localities, England, U.S.A. and Italy. See also *Selenite.*

Habit; the characteristic crystal form displayed by a mineral. Habit may vary with locality.

Hæmatite; see *Hematite.*

Half-facets; see *Break facets.*

Hambergite; $Be_2(OH)BO_3$; R.I. 1·55–1·62; S.G. 2·35; Rhombic; Colourless; Locality, Madagascar.

Hardness; see page 117.

Hardness points (pencils); small conical fragments of minerals set in a pencil-shaped holder for ease in testing the hardness of a stone. Usually: Diamond (10), Sapphire (9), Topaz (8), Quartz (7), and Feldspar (6). See page 118.

Harlequin opal; see *Opal.*

Haüyne (Haüynite); a blue mineral of cubic symmetry, it is a sodium aluminium silicate and is one of the constituents of Lapis-lazuli (q.v.).

Hawk's-eye; quartz pseudomorphous after crocidolite (blue asbestos) which has not suffered oxidation. See also *Crocidolite.*

Heat treatment; the controlled heating of certain stones, such as zircon and topaz, in order to effect a change of colour. See page 182.

Heavy liquids; liquids having a high density and suitable for the determination of the specific gravity of gemstones. See page 120.

Heliodor; yellow or "golden" Beryl (q.v.).

Heliotrope; see *Chalcedony.*

Hematite (Hæmatite); Fe_2O_3; R.I. 2·94–3·22; S.G. 4·9 to 5·3; H. 5½ to 6½; Trigonal; Colour, black; Localities, England, Germany, Scandinavia and U.S.A. Sometimes used to

imitate the black pearl. The name hematite should not be used for the Heliotrope variety of chalcedony.

Hemihedral forms; those crystals which show only half the number of faces required to conform to the symmetry of the normal crystal.

Hemimorphism; the peculiarity possessed by certain crystals, presenting different forms at opposite ends of an axis of symmetry.

Herderite; $CaBe(F,OH)PO_4$; R.I. 1·59–1·62; S.G. 3·0; H. 5; greyish; Monoclinic; Saxony and U.S.A.

Hessonite; see *Garnet* (Grossular).

Hexagonal; one of the crystal systems, see page 114.

Hexagonite; see *Tremolite.*

Hiddenite; see *Spodumene.*

Hippopotamus ivory; an ivory obtained from the canine teeth of the hippopotamus (*Hippopotamus amphibus*).

Holohedral forms; those crystals which show the full number of faces for the full symmetry of the system.

Homogeneous; the term used for material which is composed of similar parts or elements. It is uniform throughout.

"Honan (Hunan) jade"; an Oriental name variously applied to nephrite; a jade and quartz mixture, or to serpentine or soapstone. An unsatisfactory term.

"Hope sapphire"; a misnomer that was suggested for the synthetic blue spinels that were the outcome of experiments in the production of synthetic blue corundum. The use of magnesia as a flux to cause even distribution of the blue colour gave the unexpected result that spinel was produced and not corundum.

Hornblende; a rock-forming mineral may be black or green (Smaragdite).

"Hot Springs diamond"; a misnomer for rock crystal.

Howlite; $8CaO\ 5B_2O_3\ 6SiO_2\ 6H_2O$; an opaque white ornamental stone veined with black consisting of an aggregate of monoclinic (?) crystals. R.I. 1·59; S.G. 2·58; H. $3\frac{1}{2}$; has been stained a turquoise-blue colour; California.

"Hungarian cat's-eyes"; an unsatisfactory name for quartz cat's-eyes from Bavaria.

Hungarian opal; the name applied to opal from the Cervenica mines, now in Czechoslovakia.

Hyacinth; name applied to the orange-red zircon or to the similarly coloured hessonite garnet. An obsolete name.

Hyalite; see *Opal.*

Hydrochloric acid; a powerful mineral acid formed by the solution of the gas HCl in water. One of the constituents of *aqua regia.*

Hydrogrossular; correct name for much massive grossular garnet (q.v.).

Hydrometer; an instrument for determining the density of liquids.

Hydrophane; see *Opal.*

Hydrostatic weighing; the direct weighing method for determining specific gravity. See page 120.

Hydrothermal method; a method of growing crystals by the use of a saturated water solution at high pressures and moderate temperatures. An autoclave is used in this process.

Hypersthene; $(Fe,Mg)SiO_3$; R.I. 1·67–1·68 to 1·69–1·70; S.G. 3·3 to 3·4; H. 5 to 6; Rhombic; Colour, dark with metalloidal iridescence. Hypersthene is related to enstatite, an intermediate form being bronzite. Members of the enstatite-ferrosilite isomorphous series.

"Iceland agate"; a misnomer for brownish or greyish obsidian.

Iceland-spar; see *Calcite.*

Ideal cut; the name given to a diamond cut to the correct proportions for maximum brilliance.

Idiochromatic minerals; those in which the colouring is due to some essential constituent, the colour being constant and therefore of assistance in identification, *e.g.*, Malachite. See also *Allochromatic minerals.*

Idocrase; $Ca_6(Al(OH,F))Al_2(SiO_4)_5$; R.I. 1·702–1·706 to 1·726–1·732; S.G. 3·35 to 3·45; H. 6½; Tetragonal; Colours, yellow, green, brown, blue (containing copper and called Cyprine), compact green (Californite); Localities, Italy, Siberia, Norway and U.S.A. Alternative name, Vesuvianite.

Igneous rocks; these crystallised from siliceous melts at high temperatures. Often of complex composition.

"Igmerald"; trade name given to a synthetic emerald produced in Germany; a true synthetic beryl having constants and colour near those of natural emerald. May be detected by certain characteristic internal markings. Not now made.

Illam; name given to the gem-bearing gravel of Ceylon.

Imitation stones; see page 180.

Immersion liquids; see page 134.

Imperial jade; the name given to the apple-green or emerald-green translucent jadeite. A highly prized colour.

"Imperial mexican jade"; a misnomer for green-dyed calcite.

Inanga; Maori name for the grey variety of nephrite.

Inca rose; a fancy name for Rhodochrosite.

Inca stone; iron pyrites.

Inclusions; general name for crystals and liquid- or gas-filled cavities enclosed in a "host" mineral. Such inclusions are often highly characteristic of the mineral concerned and are the surest basis for the distinction between natural and synthetic stones.

Index of refraction; see page 131.

"Indian emerald"; a misnomer for green-dyed crackled quartz (rock crystal).

"Indian jade"; a misnomer for aventurine quartz.

"Indian topaz"; a misnomer for yellow corundum.

Indicators; pieces of glass or small fragments of gemstones of known specific gravity used to indicate the approximate density of heavy liquids.

Indicolite; see *Tourmaline.*

Indochinites; see *Tektites.*

Industrial diamonds; see *Diamonds, Industrial.*

Infra-red (heat) rays; electro-magnetic radiations of wavelengths between 7,900 Ångstroms (790 Nm) and 10,000,000 Å (1,000,000 Nm); that is beyond the visible red. These radiations produce a luminescence (q.v.) in certain minerals. See also *Thermoluminescence*

Inorganic; not produced by animate processes; i.e. not from plants or animals.

Interfacial angle; the angle between any two faces of a crystal. In crystallography, the interfacial angle is the angle between the normals, or perpendiculars, to the two faces.

Interference figures; the figures seen when anisotropic minerals are viewed in convergent polarised light. They afford useful information concerning the optical characters.

Interference of light; where two rays travelling in the same path, but out of phase, mutually interfere with one another causing either total extinction of light or predominance of one or more colours. This is the cause of the play of colour in thin films.

Internal strain; local straining of the atomic structure due to pressure caused by solid inclusions within the crystal, or through rapid cooling, as in some glass and synthetic gems. This strain gives rise to anomalous double refraction.

Interpenetrant twins; where two or more crystals penetrate each other along a common twinning direction, common in fluorspar.

Iodobenzene; a liquid having a value in certain refractive tests. R.I. = 1·62.

Iodo-naphthalene (α type); a liquid having a refractive index of 1·704 which is suitable for use as a contact liquid for the Rayner spinel type refractometer.

Iolite; $(Mg,Fe)_2\ Al_3Si_5AlO_{18}$; R.I. 1·53–1·54 to 1·54–1·55; S.G. 2·58 to 2·66; H. 7 to 7½; Rhombic; Colour, blue (strongly pleochroic); Localities, India and Ceylon; Alternative names, Cordierite, Dichroite.

Ion; an electrically charged atom, radicle or molecule.

Iridescence; the prismatic colours seen in cracks and flaws in a stone, well seen in iris quartz. Due to interference of light at thin films of differing refractive index. The surface tarnish in hematite, etc., is due to this effect.

Iridium; Ir. S.G. 22·41; one of the platinum group of metals having little application in jewellery except in the hardening of gold and platinum.

Iris; rainbow quartz; see *Quartz*.

"Irish diamond"; a misnomer for rock crystal.

Irradiated diamonds; diamonds which are artificially coloured by bombardment with atomic particles or gamma rays. See also *Cyclotroned diamonds*, *Radium-treated diamonds*, *Pile-treated diamonds* and *Electroned diamonds*. Also called Atomic Diamonds.

Irregulars; the term used for gem diamond crystals of irregular shape, or long shape.

"Isle of Wight diamonds"; a misnomer for rock crystal.

Isomorphous replacement; where one element in the chemical composition of a mineral is replaced by another element having the same valency without sensibly altering the structure and form of the crystal. This causes wide variations in the physical properties, *e.g.*, Garnet.

Isotropic; the term used to denote all materials which are singly refractive to light, that is, light travels through them as one ray and having the same velocity and character in all directions. All crystals of the cubic system and all amorphous materials are isotropic. See also *Anisotropic*.

Ivory (dentine); an organic substance from the tusk of the elephant, walrus, hippopotamus, narwhal, etc. S.G. 1·70 to 1·98; R.I. 1·54; H. 2½.

Ivory (vegetable); the hard white kernel of the nut of certain palm trees (in particular that of *Phytelephas macrocarpa* from South America); S.G. 1·38 to 1·42; R.I. 1·54; H. 2½.

Jacinth; an unsatisfactory name variously applied to the red zircon and to the similarly coloured hessonite garnet.

Jade; a term used for both jadeite and nephrite (q.q.v.). Other massive materials sometimes confused with the jades are as follows:

Californite; green compact idocrase.

Grossular Garnet;

Hornblende;

Prehnite;

Quartz; Chalcedony (Chrysoprase and Plasma).

Saussurite;

Serpentine;
- Antigorite (thin and platy).
- Bowenite.
- Williamsite.

Smithsonite.

Jadeite ("Jade" part); $NaAl(SiO_3)_2$; R.I. 1·65 to 1·67 S.G. 3·3 to 3·5; H. 6½ to 7; Monoclinic; Colours, white, green, pink, lilac, mauve and brown; Locality, Burma. See also *Chloromelanite.*

Jade matrix (Jade albite); a rock consisting of a mixture of nephrite and albite. Sometimes called "snowflake jade".

Jamb peg; an upright post, positioned at the side of the polishing lap and containing a number of suitably placed holes into which is placed the end of the gem holder, thus regulating the angle of the facet being cut. See *Gem stick.*

"Japanese pearls"; cultured blister pearls finished with a flat base.

"Japan pearls"; cultured blister pearls finished with a spherical base. Sometimes called half-cultured pearls.

Jargoon; outmoded name for pale coloured zircons.

Jasper; an impure form of compact quartz.

Jeremyjevite (Eremeyevite); $AlBO_3$; R.I. 1·640–1·635; S.G. 3·28; H. 6·5; Colours, blue, colourless, pale yellowish-brown; Localities, Namibia and U.S.S.R.

Jet; a form of fossil wood allied to cannel coal; R.I. 1·64 to 1·68; S.G. 1·10 to 1·40; H. 3½; Localities, Spain, Turkey and Yorkshire (England).

Jolly's spring balance; a balance consisting of a spring suspended vertically against a graduated scale. At the lower end of the spring is attached two scale pans one above the other, the lower pan being immersed in water. The density is determined by recording the reading on the scale of a pointer situated at the lower end of the spring when there is no specimen in either of the pans (reading A), when the specimen is in the top pan, that is in air (reading B), and when specimen is in the lower pan, that is in water (reading C). Formula: B minus A divided by B minus C gives the specific gravity.

"Jourado diamond"; a name, reported from the U.S.A., as being an incorrect term for an imitation colourless stone. The term may have had its origin from the so-called "diamond scare" of 1935 in England, in which case the material

involved was synthetic colourless spinel. The term is definitely a misnomer.

Kahurangi; Maori name for the pale green and translucent variety of nephrite.

"Kandy spinel"; a misnomer for the reddish-violet garnet found in Ceylon.

Kaolin; hydrated silicate of alumina, a product of the disintegration of different rocks. The levigated material is used as a polishing agent.

Kauri gum; a recent resin resembling copal. See *Copal.*

Kawakawa; Maori name for the ordinary green variety of nephrite.

Keystone; the name applied to a trap-cut stone having an outline in the form of the conventional keystone. See *Cuts of stones,* page 186.

Kidney stone; a name variously applied to either nephrite or to hematite.

"Killiecrankie diamond"; a misnomer for colourless topaz from Tasmania.

Kimberlite; a variety of peridotite, a basic igneous rock which fills the diamond pipes of South Africa. Known also as "Blue ground" which weathers by oxidation at the surface to "Yellow ground".

"King topaz"; a misnomer for yellow corundum.

Kite; the name applied to a trap-cut stone having an outline in the shape of a kite. See page 186.

Kites; name sometimes applied to the eight crown facets known as the bezels and quoins.

Klein's solution; see page 121.

Knot; term used for an irregularity of crystal structure in a single diamond crystal. Owing to the difficulty of finding the cleavage planes such rough diamond is not easily fashioned. Also known as Naat.

"Korea jade"; a misnomer for green serpentine.

Kornerupine; near $MgAl_2SiO_6$; R.I. 1·665–1·678; S.G. 3·27 to 3·32; H. 6½; Rhombic; Colours, yellow, brown, blue and green; Localities, Madagascar, Ceylon, Saxony and Greenland.

Kunzite; violet-pink spodumene.

Kupfernikel; see *Niccolite.*

Kyanite (Cyanite); Al_2SiO_5; R.I. 1·712–1·728; S.G. 3·55 to 3·67; H. 5 to 7 and varies with direction; Triclinic; Colours, colourless, sky-blue, green and brown; Localities, Switzerland, Kenya, Brazil and U.S.A.

Labradorescence; name given to the play of colour seen in the labradorite feldspar.

Labradorite; a variety of plagioclase feldspar showing a play of colour (labradorescence). See *Feldspar.*

Labrador moonstone; labradorite.

Labrador spar; labradorite.

"Lake George diamond; a misnomer for rock crystal.

Lake Superior greenstone; chlorastrolite.

Lamellar structure; when the mineral is composed of thin layers of scales like the leaves of a book the structure is said to be lamellar.

Landerite; see *Xalostocite.*

Lap; the name applied to the disc upon which gemstones are cut and polished. For diamond the lap is of hard cast iron. It is also known as a scaife (q.v.).

With the softer gemstones the grinding laps are made of copper, gunmetal or lead, while pewter or wooden laps, sometimes faced with cloth or leather are used for polishing.

Lapidary; the name applied to craftsmen who cut and polish gemstones other than diamonds. The craftsmen who fashion diamonds go under the name of diamond cutters and *not* lapidaries.

Lapis, False; see *False lapis.*

Lapis-lazuli (Lazurite); a mixture of several minerals, chief of which are lazurite and calcite; R.I. 1·50; S.G. 2·75 to 2·90; H. 5½; Colour, deep blue often with spangles of pyrites; Localities, Afghanistan, Chile, Siberia, Iran and California.

Lapper; the name applied to the diamond cutter who cuts the main facets of a brilliant-cut stone.

Lasque; a flat thin diamond used by Indian jewellers. May be

the origin of the term "laxy diamond" used in the trade for rather flat diamonds cut in the brilliant style.

Lauegram; the characteristic figure of spots produced on a photographic film when a narrow beam of X-rays is passed through a single crystal, due to diffraction from the atomic layers.

The six-spot and four-spot X-ray photographs of pearls and cultured pearls are a modification of this effect.

"Lavernite"; a name applied to the synthetically produced periclase (MgO).

"Laxy diamonds"; slang trade term for rather flat brilliant cut diamonds. See *Lasque.*

Lazulite; $(Fe,Mg)Al_2(OH)_2(PO_4)_2$; R.I. 1·63; S.G. 3·1; H. 5 to 6; Monoclinic; Colour, blue; Localities, Austria and U.S.A.

Lazurite; see *Lapis-lazuli.*

Lead glass; flint glass containing a high percentage of lead oxide. This increases the dispersion but decreases the hardness. See *Flint glass.*

Lechleitner; see *Emerita.*

Lechosos opal; see *Opal.*

Lens (Loupe); a well-polished convex piece of glass used for magnifying an object. Better lenses are made of two or more pieces, generally of different types of glass in order to produce better images; these are known as compound lenses. A microscope is a system of compound lenses.

Lepidolite; $K_2Li_3Al_4Si_7O_{21}(OH,F)$; R.I. mean 1·55; S.G. 2·8 to 2·9; H. 3½; Monoclinic; A rose red to violet mica, sometimes forming an ornamental stone. Localities, Russia, Madagascar and U.S.A.

Leucite; $KAl(SiO_3)_2$; R.I. 1·51; S.G. 2·48; H. 5½ to 6 Cubic; Colourless; from Italy.

Leuco-sapphire; colourless corundum.

Leveridge gauge; a stone gauge on the principle of calipers with the measurements shown on an indicating dial.

Light; a form of radiant energy, travelling through space at the speed of 186,285 miles per second, which gives rise to

the sensation of sight. It is an "octave" of the electromagnetic spectrum and differs from wireless, heat, ultraviolet and X-rays solely in wave-length.

Light, Interference of; see *Interference of light.*

Light, Monochromatic; see *Monochromatic light.*

Light, Reflection of; see *Reflection of light.*

Light, Refraction of; see *Refraction of light.*

Light, Speed of; see *Speed of light.*

Lime; name commonly applied to calcium oxide, also used for a polishing product consisting of dolomite containing a high percentage of magnesia. It may be said to be a double oxide of calcium and magnesium and has almost entirely replaced crocus.

Limonite; a hydrated iron oxide which is often the matrix in which is found turquoise. Brown in colour, limonite is sometimes cut with turquoise to produce what is known as turquoise matrix.

Linde emerald; a synthetic emerald made by the hydrothermal method by the American firm of Linde.

"Linobate"; see *Lithium niobate.*

Lintonite; a plain green variety of thomsonite.

"Lithia amethyst (Lithium amethyst)"; a misnomer for the kunzite variety of Spodumene.

"Lithia emerald"; a misnomer for the green hiddenite variety of spodumene.

Lithium niobate; ($LiNbO_3$); a synthetically produced crystal used as a gemstone under the name 'linobate'. The hardness is 6; the density 4·64 and the refractive indices 2·21–2·30.

Liver opal; also called menilite. See *Opal.*

Localities of gemstones; see page 191.

Logarithmic tables; calculation tables.

Loupe; see *Lens.*

Low-type zircon; the division of zircon consisting of those stones, generally green in colour, which have low physical and optical constants and are practically amorphous. This type, which is said to be the result of a more or less complete breakdown of the crystalline types, shows practically no birefringence.

Lozenge; the name applied to a trap-cut stone having a lozenge-shaped outline. See page 186.

Lucidoscope; the name applied to an early method of cultured pearl testing. The pearl is immersed in monobromonaphthalene, illuminated by a strong source of light and viewed microscopically. On being slowly turned a natural pearl will show an equal density to the light, whereas a cultured pearl may show a banded structure when the mother of pearl layers of the bead nucleus are in the same plane as the light rays.

Lucinite; variscite from Lucin, Utah (U.S.A.).

Lumachella (Lumachelle); "Fire Marble", a marble containing fossil shells which show a play of colour reminiscent of opal.

Luminescence; the effect noticed in some substances of giving out visible light when they are rubbed or scratched (Triboluminescence) or when they are irradiated with invisible electro-magnetic radiations (Fluorescence, Phosphorescence and Thermoluminescence).

Lunette; the name applied to a trap-cut stone with an outline having one side a straight line and the other a segment of a circle. See page 186.

Lustre; the brilliancy of a stone by reflected light, determined by the amount of incident light reflected from its surface. Types of lustre as follows:

Adamantine; as in diamond and some zircons. Possessed only by minerals of high refractive index.

Metallic; as in gold.

Pearly; as in moonstone.

Resinous; as in certain garnets.

Silky; as in satin-spar.

Vitreous; glass-like as in quartz and most gemstones.

Waxy; as in turquoise.

The lustre of minerals may be of different *degrees* or intensity and are then described as under:

Splendent; the surface reflects light as in a mirror.

Shining; objects are reflected indistinctly.

Glistening or Glimmering; denotes a still more feeble lustre.

Dull; little or no lustre.

"Lux sapphire"; a misnomer for Iolite.

"Lynx sapphire"; a misnomer for the pale blue shade of Iolite (q.v.).

Mabe pearls; cultured blister pearls in which the original nucleus has been removed and replaced by a smaller bead cemented in with white wax and the pearl completed with a dome-shaped backing piece of mother-of-pearl.

Macles; flat, triangular twin crystals of the octahedron. Term used for diamond crystals of this type.

Madagascar aquamarine; a blue beryl from Madagascar, showing strong dichroism.

"Madeira topaz"; a misnomer for citrine.

Magma; deep seated molten material from which igneous rocks form.

Magnesite; $MgCO_3$; R.I. 1·52–1·72; S.G. 3·0 to 3·12; H. 4; Trigonal; White; World wide, but Brazil is important.

Magnetic spectrum; see *Electro-magnetic spectrum.*

Malachite; $CuCO_3Cu(OH)_2$; R.I. 1·65–1·90; S.G. 3·74 to 3·95; H. $3\frac{1}{2}$; Monoclinic; Colour, green; Localities, Ural Mountains (Russia), Chile, Rhodesia, U.S.A., Katanga (Zaire).

Malacolite; see *Diopside.*

Mammoth ivory; see *Fossil ivory.*

Manganese dioxide; MnO_2, a black powder sometimes used as a polishing agent.

Mantle; the cellular epithelial tissue of the pearl producing molluscs; that part of the animal which secretes the nacre.

Manufactured stones; synthetic stones, see page 170.

Maori stone; name for nephrite from New Zealand.

Marble; a massive form of crystalline limestone. See *Calcite.*

Marcasite; FeS_2; S.G. 4·8; H. 6 to $6\frac{1}{2}$; Rhombic; Colour, metallic grey yellow (this is a mineral dimorphous with pyrites); "Marcasite" in the trade is really pyrites, or often merely cut steel or white metal.

"Marmora diamond"; a misnomer for rock crystal.

Marquise; a stone cut on the brilliant style with the exception that the outline is boat-shaped instead of having a circular form, see pages 186, 188.

"Mass aqua"; the popular name for a special hard glass imitation of aquamarine.

Massive; a term used for minerals without definite crystal form, or composed of masses of small crystals.

Matrix; the mass of rock in which minerals and crystals are found. Turquoise and Opal are often cut with some of the matrix. Also called Mother rock.

"Matura diamond"; a misnomer for the colourless (fired) zircon.

Maw-Sit-Sit; the name applied to a jadeite-albite rock found in Upper Burma.

Maxixe-aquamarine, Maxixe-beryl; a blue beryl showing strong dichroism which decolourises on exposure to light, from the Maxixe mine, Minas Gerais, Brazil.

"Medina emerald"; a misnomer for emerald green glass.

Medium; the term applied to any material, solid, liquid or gaseous, through which light passes. The medium may not necessarily be transparent for even in opaque substances light may penetrate to a very small depth.

Meerschaum; $H_4Mg_2Si_3O_{10}$; R.I. mean 1·55; S.G. 1·0 to 2·0; H. 2 to 2½; Monoclinic; Colour, creamy white; Locality, Asia Minor. Also known as Sepiolite.

Melange; term used for diamonds of mixed sizes but larger than ¼ carat in weight.

Melanite; a black variety of andradite. See *Garnet*.

Melée; small diamonds of mixed sizes, less than ¼ carat in weight.

Melinophane; $(Ca,Na)_2Be(Si,Al)(O,F)_7$; R.I. 1·59–1·61; S.G. 3·0; H. 5; Tetragonal; Yellow; Norway.

Menilite; alternative name for liver opal. See *Opal*.

Mercury-vapour lamp; an electric discharge lamp producing an intense bluish light rich in ultra-violet rays. It is operated by the arcing of mercury vapour in a vacuum tube which is generally made of quartz glass.

Mesolite; a zeolite, sodium calcium aluminium silicate; R.I. 1·50; S.G. 2·29; H. 5; Monoclinic; White or colourless (fibrous); World-wide occurrences.

"Meta-made"; an artificial stone made in Japan. It resembles, and has properties near to, jade.

Metamict; the term used for material which has suffered a break-down from a crystalline to a partly amorphous state; common in minerals containing radio-active elements, it is the name applied to the "low" type of zircon which has decomposed into nearly amorphous SiO_2 and ZrO_2 from the "normal" fully crystalline zirconium silicate. Stones of this type, mostly found in Ceylon, are nearly singly refracting and generally green in colour. Prolonged heating returns these stones to the "normal" type.

Metamorphic rocks; are those formed from igneous or sedimentary rocks by the action of heat and pressure.

Methylene iodide (Di-iodomethane); CH_2I_2; a liquid used for immersion purposes in the microscopical examination of gemstones, for certain refractive index texts and as a heavy liquid. R.I. 1·74; S.G. 3·32.

Methylene iodide (Di-iodomethane) and dissolved sulphur; a mixture used as a refractometer contact liquid and as an immersion liquid in certain refractive index texts. R.I.=1·78.

Methylene iodide (Di-iodomethane), dissolved sulphur and tetraiodoethylene; a highly refractive liquid used as a refractometer contact fluid and as an immersion liquid in certain refractive index tests. R.I.=1·81.

Methylene iodide (Di-iodomethane) with dissolved iodine and iodoform; see page 121.

Metric carat; the legal weight unit for gemstones, one-fifth of a gram. See page 229.

"Mexican diamond"; a misnomer for rock crystal.

"Mexican jade"; a misnomer for green-dyed calcite.

"Mexican onyx"; a misnomer for banded calcite.

Mexican water opal; a variety of opal which shows a play of colour in a practically transparent body.

Mica schist; a general term for a laminated rock in which mica is an abundant metamorphic constituent.

Micro-chemical tests; tests carried out by the observation of chemical reactions on minute portions of a mineral. A scraping of the substance to be examined being placed on a

glass slip and the reactions to various reagents studied under the microscope.

Microcline; see *Feldspar*.

Microlite; $Ca_2Ta_2O_7$; R.I. 1·93; S.G. 5·5; H. 5½; Cubic; brownish-green, yellowish-brown to hyacinth-red; Elba and U.S.A.

Micron; a unit of measurement for small sizes. It is 0·001 mm. and is used in the measurement of the grains in diamond powder.

Microscope; an instrument consisting of a system of lenses fitted into a tube which can be raised or lowered for focusing, which is used to give a greatly enlarged image of an object. A petrological microscope contains in addition, two Nicol prisms, in order that observations may be made in polarised light.

Milk opal; see *Opal*.

Milky quartz; crystalline quartz of a milky white colour When containing gold, is termed "gold quartz".

Mineralogy; the science which deals with minerals.

Mineral species; a homogeneous substance produced by the processes of inorganic nature, having chemical composition, crystal structure, and physical properties which are constant within narrow limits.

Mixed-cut; a style of fashioning gem stones. See *Cuts of stones*, page 185.

Minimum deviation; the position of two facets forming a prism, in relation to a beam of light, where the beam is passing through them symmetrically, or in other words, with least deviation. (For refractive index determination by the method of minimum deviation, see page 132.)

Mocha stone; chalcedony with dendritic inclusions.

Moe's gauge; a diamond gauge on the principle of calipers, which by measuring across the diameter of the stone and also its depth and referring to tables it is possible to estimate the weight of the stone.

Mohs' scale; a scale of the hardness of minerals. See page 118.

"Mojave moonstone"; a misnomer for lilac-tinted chalcedony from the Mojave Desert, California.

Moldavite; a silica glass found in Bohemia and Moravia and not unlike obsidian. R.I. 1·48 to 1·50; S.G. 2·3 to 2·5; H. 5½; Amorphous; Colour, light to dark green, rarely brown; Alternative names, "Water chrysolite" and "Bottle-stone".

Molecular weight; of a substance is the sum of the atomic weights of the atoms composing a molecule of the substance, *e.g.*, the atomic weight of calcium is 40, of carbon 12, and of oxygen 16; therefore the molecular weight of calcite ($CaCO_3$), composed of one atom of calcium, one of carbon and three of oxygen, is $40+12+(3\times16)=100$.

Molecule; a group of two or more atoms in close combination. The smallest quantity of an element or compound which can exist alone.

Mollusc; a member of the sub-kingdom of soft bodied, and usually hard-shelled, animals, as the oyster, scallop, mussel, etc.

Momme; a Japanese weight used in the marketing of cultured pearls. 1 momme = 3·75 grams = 18·75 carats = 75 pearl grains.

Monobromonaphthalene (α type); a liquid used as an immersion fluid in the microscopical examination of gemstones, and in certain refractive index tests. R.I. = 1·66; S.G. 1·49; B.P. 279°C.

Monochlorbenzene; a liquid having a value in certain refractive index tests. R.I. = 1·53.

Monochlornaphthalene; a liquid having a value in certain refractive index tests. R.I. = 1·63.

Monochromatic light; light of one wave-length only. In practice it is usual to employ the yellow glow of sodium vapour.

Monoclinic; one of the crystal systems. See page 114, 116.

"Montana ruby"; a misnomer for red garnet.

"Mont Blanc ruby"; a misnomer for rose quartz.

Moonstone; see *Feldspar*.

Morallons; a name locally used in the Colombian emerald mines for inferior stones. See *Canutillos*.

Morganite; rose-coloured beryl, see *Beryl*.

Morion; a dark brown variety of smoky quartz.

Moroxite; see *Apatite*.

Mortar; a bowl-shaped vessel of agate or earthenware in which minerals are powdered by the aid of a club-shaped instrument known as a pestle. A variation consisting of a hollow steel body into which loosely fits a steel pestle, is used for reducing diamond to powder.

Moss agate; chalcedony with dendritic inclusions.

Moss opal; see *Opal.*

Mossy stones; stone rendered cloudy by fissures. Mostly referring to emeralds.

"Mother of emerald"; a misnomer for prase.

Mother-of-pearl; the iridescent nacreous material from the shells of molluscs. See *Nacre.*

Mother rock; see *Matrix.*

"Mountain jet"; a misnomer for black obsidian.

"Mountain ruby"; a misnomer for red garnet.

Multi-facet diamond; a term used to describe a diamond with the girdle polished or faceted. The term is American, and application has been made to use it as a trade mark.

Mussel pearls; pearls obtained from the freshwater mussel. The most important species in Europe is *Unio margaritifera.* In the U.S.A. the genus *Quadrula* supplies such pearls.

Naat; see *Knot.*

Nacre; the secretion from the mantle of certain molluscs consisting of crystalline carbonate of lime ($CaCO_3$) and an organic material called conchiolin. It is the iridescent material of pearl and mother-of-pearl.

Nanometre; unit of measurement equal to 10^{-7} cm. One nanometre (1Nm) equals 10 Ångstroms (10Å).

Narwhal ivory; an ivory obtained from the "horn" or tusk of the narwhal (*Monodon monoceros*).

Nassau pearls; conch pearls from West Indian waters.

Natrolite; a zeolite; $Na_2Al_2Si_3O_{10}.\ 2H_2O$; R.I. 1·48–1·49; S.G. 2·2; H. 5½; White (fibrous) but other colours are known; Orthorhombic; Localities, Norway and Scotland.

Natural; original surface of rough diamond sometimes left in a fashioned stone, often on the girdle.

Natural glass; see *Moldavite, Tektite* and *Obsidian.*

Navette-cut; a style of cutting, generally step (trap) cut with a boat-shaped outline, or rectangular with pointed ends. The style is similar to Marquise. See page 186.

Needle stone; quartz with needle-like inclusions of other minerals, such as rutile, actinolite, etc. Also known as Sagenitic quartz or Rutilated quartz, and Venus' or Thetis' hair stone.

Negative crystal; a cavity in a crystal having the crystal form of the host mineral. It is one form of inclusion.

Negative reading; the effect shown on a refractometer when the specimen under test has a higher refractive index than the dense glass of the instrument, or higher than the R.I. of the liquid used to make optical contact.

Neolith; an imitation turquoise of German origin.

Nepheline (Elaeolite); a massive variety is elaeolite. $(Na,K)_8Al_8Si_9O_{34}$; R.I. 1·538–1·542; S.G. 2·55–2·65; H. 5–6; Hexagonal; Colours, green, red, brown, blue and grey.

Nephrite; $Ca_2(Mg,Fe)_5(OH)_2(Si_4O_{11})_2$; R.I. 1·60–1·63 to 1·62–1·65; S.G. 2·90 to 3·02; H. 6½; Monoclinic; Colours, white, pale to dark green, various browns; Localities, Canada, China, Siberia, New Zealand, Rhodesia, Turkestan, U.S.A. and Taiwan; Alternative names, Maori stone, New Zealand greenstone, Axe-stone, and Kidney stone. It is one of the "Jades".

Neutron-treated diamonds; diamonds which have had their colour altered by neutron bombardment in an atomic pile. Same as "Pile-treated diamonds".

"Nevada black diamond"; a misnomer for obsidian.

"Nevada diamond"; a misnomer for decoloured obsidian.

"Nevada topaz"; a misnomer for smoky obsidian.

Nevada wonderstone; a volcanic rock in stripes of red and buff. Density is about 2·53; Nevada, U.S.A.

"New jade"; a misnomer for bowenite serpentine.

New Zealand greenstone; an alternative name for the nephrite found in New Zealand.

Niccolite; NiAs; a pinkish coloured mineral with a metallic lustre which has a H. of 5 to 5½ and a density varying between 7·3 and 7·6. The crystallization is hexagonal but the

mineral is always found massive. U.S.A., Canada, and Europe. Also known as kupfernikel.

Nicol prism; a device for the production of polarised light, consisting of a rhomb of Iceland-spar (calcite) cut and cemented diagonally so that the ordinary ray is reflected out of the side of the rhomb and the extraordinary allowed to pass through. Two Nicols are used in a petrological microscope, the first, the polariser, below the stage, and the second, the analyser, in the tube above the objective.

Nitric acid; HNO_3, a powerful mineral acid. One of the constituents of *aqua regia*.

Nitrobenzene; a liquid, having a value in certain refractive index tests. R.I. = 1·55.

Non-nucleated cultured pearls; cultured pearls grown by the insertion of a piece of mantle into the mantle of the Japanese freshwater mussel (*Hyriopsis schlegeli*). These pearls are usually white, small and baroque or bun-shaped. Their nature may be revealed by their strong fluorescence under X-rays and by the peculiar cavities shown by an X-ray picture.

"Norbide"; trade name for an abrasive made of boron carbide.

Nucleus; the central mass around which matter accretes or grows. Generally used with reference to the centre of the pearl.

Nyf; the name given to the skin found on some diamonds from South Africa.

Obsidian; a volcanic glass; R.I. 1·50; S.G. 2·3 to 2·5; H. 5½; Amorphous; Colour, black, red and brown. See also *Moldavite*.

Obus; the name applied to a trap-cut stone oblong in outline but with one end brought to a point. See *Cuts of stone*, page 185, 186.

"Occidental topaz"; a misnomer for yellow quartz.

Octahedrite; alternative name for anatase.

Octahedron; a crystal form having eight faces. It may be described as being two pyramids, each formed of four equilateral triangles, placed base to base; a crystal form of the cubic system.

Odontolite (Bone turquoise); fossil bone or ivory naturally coloured blue by phosphate of iron. S.G. 3·0 to 3·25; H. 5; Organic structure shown under lens and effervesces with hydrochloric acid. Colour, blue.

Off-colour; the term applied to diamonds having a yellowish or brownish tinge.

Oil pearls; "pearls" cut from the sea snail shell, also called Antilles pearls.

Oligoclase; see *Feldspar.*

Olive oil; an oil having a value in certain refractive index tests. R.I. 1·47.

Olivine; the mineralogical name for the iron magnesium silicate, the gem variety is Peridot (q.v.). Olivine, often misspelt olivene, is a misnomer for demantoid garnet.

Once the weight; the term used in the "base" system of pearl price calculation for unit base.

Ontario moonstone; peristerite variety of feldspar from Ontario.

Onyx; see *Chalcedony.*

"Onyx, Algerian"; see *Algerian Onyx.*

Onyx marble; name for banded calcite.

Opal; a silica gel (SiO_2-nH_2O); R.I. 1·39–1·47; S.G. 1·95 to 2·20; H. 5 to 6½; Varieties:

Cacholong; is a white porcelain-looking type.

Fire opal; semi-transparent of orange to red colour.

Girasol; transparent blue-white with a red play of colour.

Harlequin opal; has patches of colour of a regular size.

Hyalite; is a colourless, glass-like opal.

Hydrophane is a dehydrated opal which becomes opalescent when placed in water.

Lechosos opal; a variety showing a deep green play of colour.

Menilite (Liver) opal; is grey or brown.

Mexican water opal; a clear colourless or yellowish opal showing a play of colour.

Milk opal; is yellowish, bluish-white, or white in colour.

Moss opal; opal with dendritic inclusions.

Opal matrix; is opal cut showing some of the ironstone matrix.

Prase opal; is coloured green.

Precious opal; showing good play of colour—
White—— on pale ground.
Black—— on very dark ground.
Resin opal; yellow in colour with a resinous lustre.
Wood opal; an opal pseudomorph after wood.
Localities, (Precious Opal) Hungary, Australia and Brazil; (Fire Opal) Mexico.

Opal doublet; a composite stone consisting of a thin slice of opal backed with a piece of Potch opal (q.v.), or with a piece of black onyx or special black glass called "opalite".

Opal, Potch; Miner's term for opal which does not show the play of colour seen in precious opal.

Opal, Treated; opal which has been stained with a black carbonaceous compound to give a black colour to an otherwise white opal.

Opalescence; a reflection of a milky or pearly light from the interior of a mineral. Also used by some as an alternative to iridescence.

Opalite; a name applied to some types of common opal.

Operculum; the name applied to the calcareous disc found at the head of certain univalve molluscs and used by the animal as a door to close the aperture of the shell. The opercula from the shellfishes *Turbo petholatus*, found in the South Seas north of Australia, have a limited application in jewellery.

Ophicalcite; the mineral name for serpentinous marble, such as Connemara marble.

Optical sign; in addition to the classification of minerals into optically "uniaxial" and "biaxial" (q.v.), a further subdivision is made into those which are optically "positive" and those which are optically "negative". The conventions are as follows:

(1) with uniaxial minerals, those in which the extraordinary refractive index is greater than the ordinary are said to be *positive*, while those in which the extraordinary index is the lower are termed *negative*.

(2) in biaxial stones, those in which the intermediate index, β, is nearer to the lowest index, α, than to the greatest index,

γ, are termed *positive*, while those in which β is nearer γ are termed *negative*. Examples: tourmaline is uniaxial negative; topaz is biaxial positive.

Optic axes; directions of single refraction in doubly refracting stones. In the tetragonal and hexagonal systems there is one such direction and such crystals are termed uniaxial; rhombic, monoclinic and triclinic crystals have two directions of single refraction and are termed biaxial.

Optic axial angle; the acute angle subtended by the optic axes in biaxial crystals, usually denoted as 2V, or 2E as seen in air.

Orbicular; the term used for a mineral or rock containing numerous spherules solidly encased, *e.g.*, orbicular jasper.

Ordinary ray; a ray in a doubly refracting stone which behaves similarly to a ray passing through isotropic material, in that it travels with the same velocity whatever its direction in the stone. This ray is only possible in crystals of the tetragonal, hexagonal and trigonal systems (uniaxial crystals).

Organic; produced by animals or plants. In chemistry most compounds of carbon are termed "organic" compounds.

Organic materials; a term generally given to those substances used in jewellery, which have been produced entirely or in part by a living animal or plant, and is primarily applied to pearl, amber, tortoise-shell, coral, jet, ivory and vegetable ivory. Certain synthetic materials could with truth be classified hereunder, *e.g.*, casein, bakelite and celluloid.

"Oriental" (Emerald, Amethyst, Topaz, etc.); a prefix sometimes used to describe corundum, having similar colour to the stone described in the second part of the name viz.: "Oriental Amethyst" is violet sapphire. A most undesirable misnomer.

"Oriental Alabaster"; a misnomer for calcite.

"Oriental emerald"; this term, besides being used as an incorrect name for the green corundum, has also been applied to the green, chlorospinel type of natural spinel. Whether used for corundum or spinel the term is definitely a misnomer.

Orient of pearl; the iridescent surface sheen of gem pearl. It is due to the combined effect of a play of colour (q.v.), due to interference of light at thin films, the thin plates of the

nacreous layer; and to diffraction from the fine edges of the plates.

Ornamental stones; a term used for those minerals, which, through lack of transparency, own their beauty solely to their body colour and are used mainly for small carvings and *objets d'art*. Such stones are Malachite, Lapis-lazuli, marble, etc.

Orthoclase; monoclinic feldspar (q.v.).

Orthorhombic; a crystal system for which the term Rhombic is an alternative.

Orthotoluidine; a liquid having a value in certain refractive index tests. R.I. = 1·57.

Osmium; Os. S.G. 22·5; a metal of the platinum group having the distinction of being the heaviest known metal and a very high melting point (about 2,700°C). Osmium has no application in jewellery.

Oxidation; the chemical change by which oxygen is added to an element or compound.

Oxides; compounds of oxygen with another element. Examples are corundum (Al_2O_3) and rutile (TiO_2).

Pacific cat's-eye; alternative name for operculum. See *Operculum*.

Padparadschah; a name applied to a peculiar orange-pink variety of natural gem corundum, and also used, with variations in spelling, for synthetic corundum of similar colour.

Pagoda stone; a type of translucent agate which when cut shows markings resembling a Burmese pagoda, in opaque white bands which appear to float in the colourless translucent body material. Also used for agalmatolite.

Painite; calcium boro-silico aluminate. R.I. 1·79–1·82; S.G. 4·01; H. 7½; Hexagonal; Burma.

Painted stones; a fraudulent method used to improve the colour appearance of yellowish or brownish diamonds by applying a film of blue colour to the base facets. The best method of detecting such a fraud is to soak the stone in spirits or to boil the stone in sulphuric acid. Pale colour emeralds and rubies have had their colour enhanced by coating the back

facets with coloured varnish or dye. The detection method suggested for diamond will also apply to these stones.

Palladium; Pd. S.G. 11·4; a metal of the Platinum group, similar in colour to platinum and used, owing to lower cost, for jewellery and the arts instead of platinum.

Parian marble; a pure white marble.

Parisite; $(Ce,La)_2Ca(CO_3)_3F_2$; a pegmatite mineral, also found as inclusions in emerald.

Parti-coloration; the effect seen in crystals which are coloured differently in different parts. Stones cut from such crystals will show two or three colours, such as red one end with green the other, and, maybe, colourless in centre. Such stones are termed parti-coloured. Parti-coloration is often shown in corundum and tourmaline.

Parting (False cleavage); a direction of weakness in certain crystals (*e.g.*, corundum) due to lamellar twinning.

Paste; name given to the glass used for imitation gemstones. See also *Strass.*

Pavilion facets; the long five-sided facets on the pavilion, or base, of a brilliant-cut stone.

Pear-eyes; see *Drop pearls.*

Pearl; a concretion consisting of concentric layers of an organic material (conchiolin) and crystalline calcium carbonate in the form of aragonite arranged radially around a small body as nucleus. S.G. 2·65 to 2·78; Localities, Persian Gulf, Ceylon (Gulf of Manar), north-west coast of Australia, Philippine Islands, coast of Venezuela, Gulf of Mexico, Pacific Ocean Islands, rivers of U.S.A., Europe and China.

Pearl, Baroque; a pearl of irregular shape.

Pearl, Black; a pearl of bronze or gunmetal tint from the Gulf of Mexico and certain other localities.

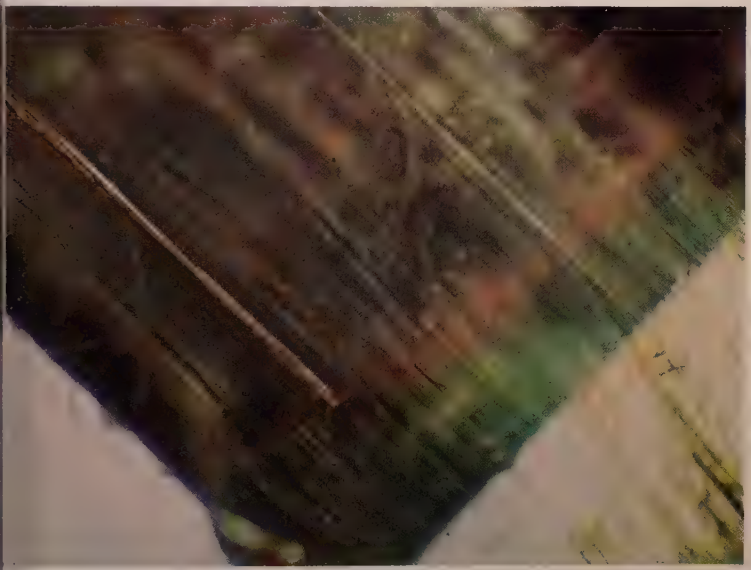
Pearl, Blister; pearl formed attached to the shell of the mollusc.

Pearl, Blue; natural pearl in which the nucleus is mud, clay or organic material.

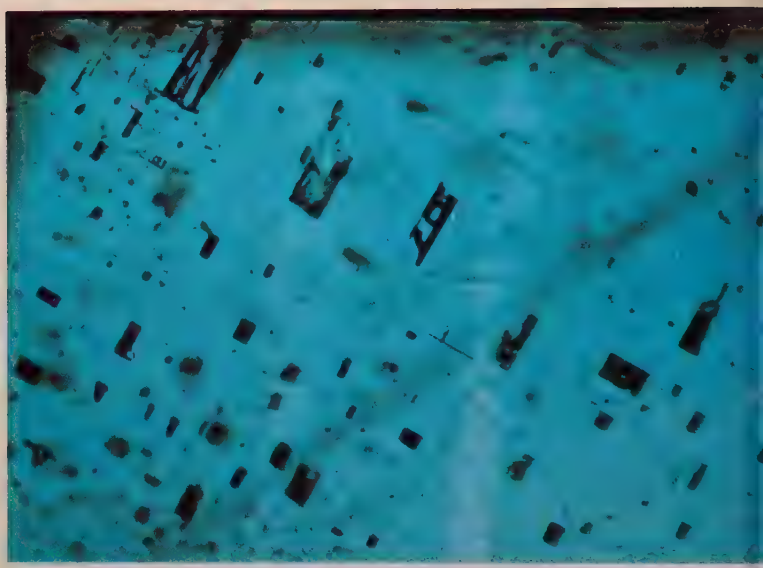
Pearl, Cultured; a pearl in which the nucleus (of mother-of-pearl) had been artificially inserted in the oyster.

Pearl, Freshwater or Mussel; a pearl found in the Pearl Mussel

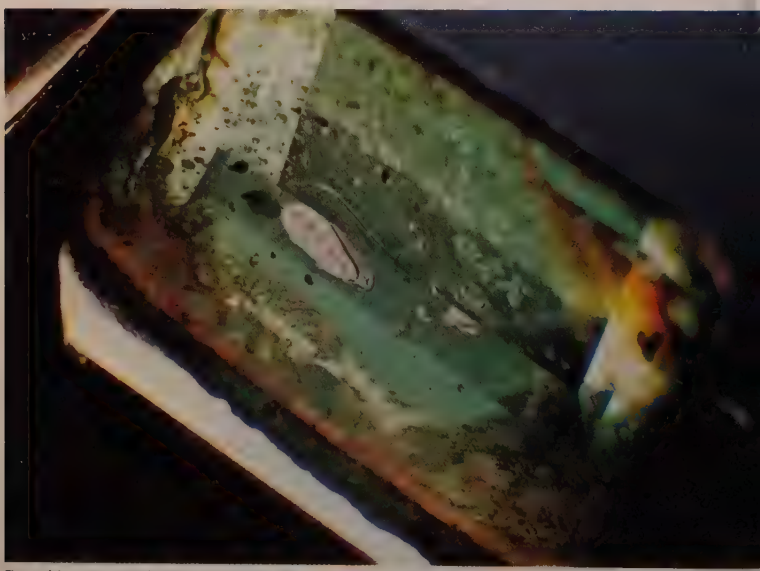
ree phase inclusions in Colombian emerald (2).



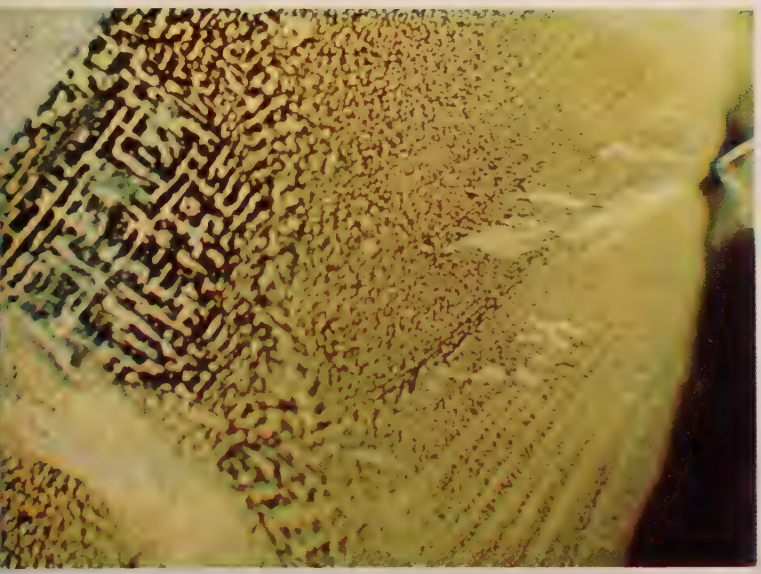
ie tubes ('rain') in Russian emerald.



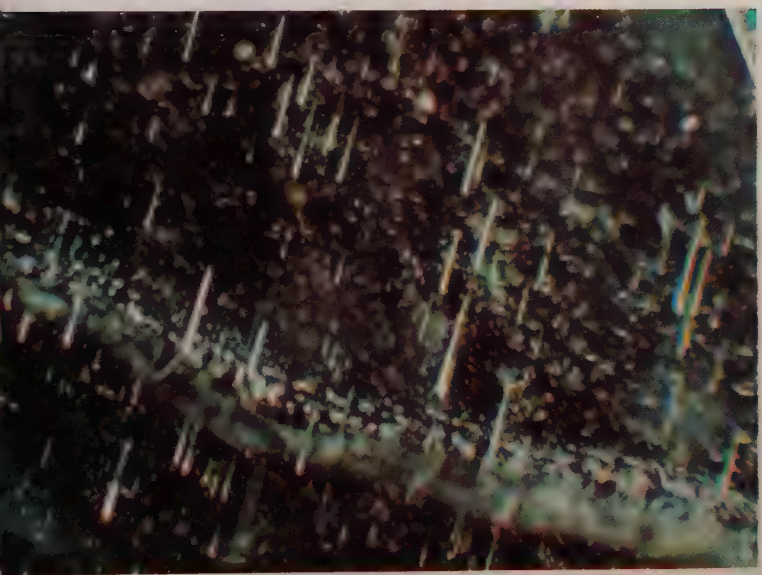
Comma-like inclusions in Indian emerald.



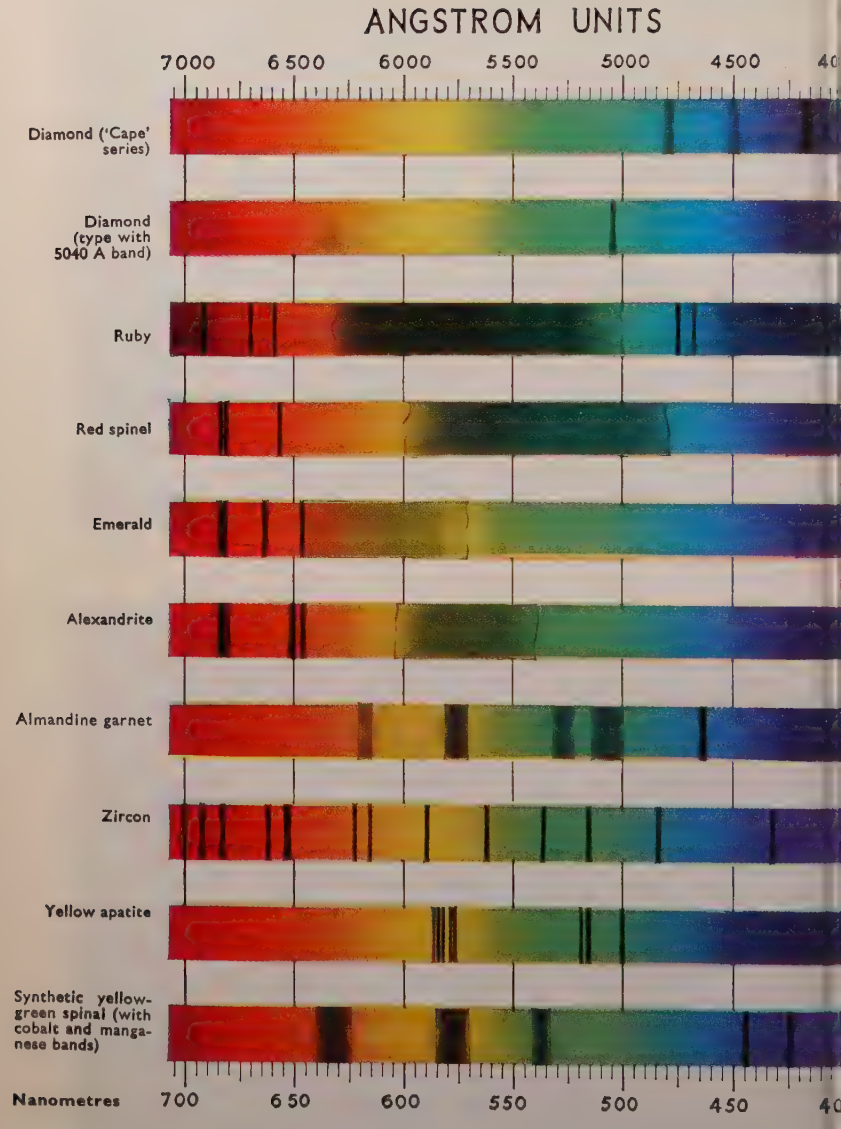
Soudé emerald showing dark green central layer, colourless quartz base a
quartz crown coloured by reflection. Note bubbles and interference colours
upper junction.



.iquid veils in Gilson synthetic emerald.

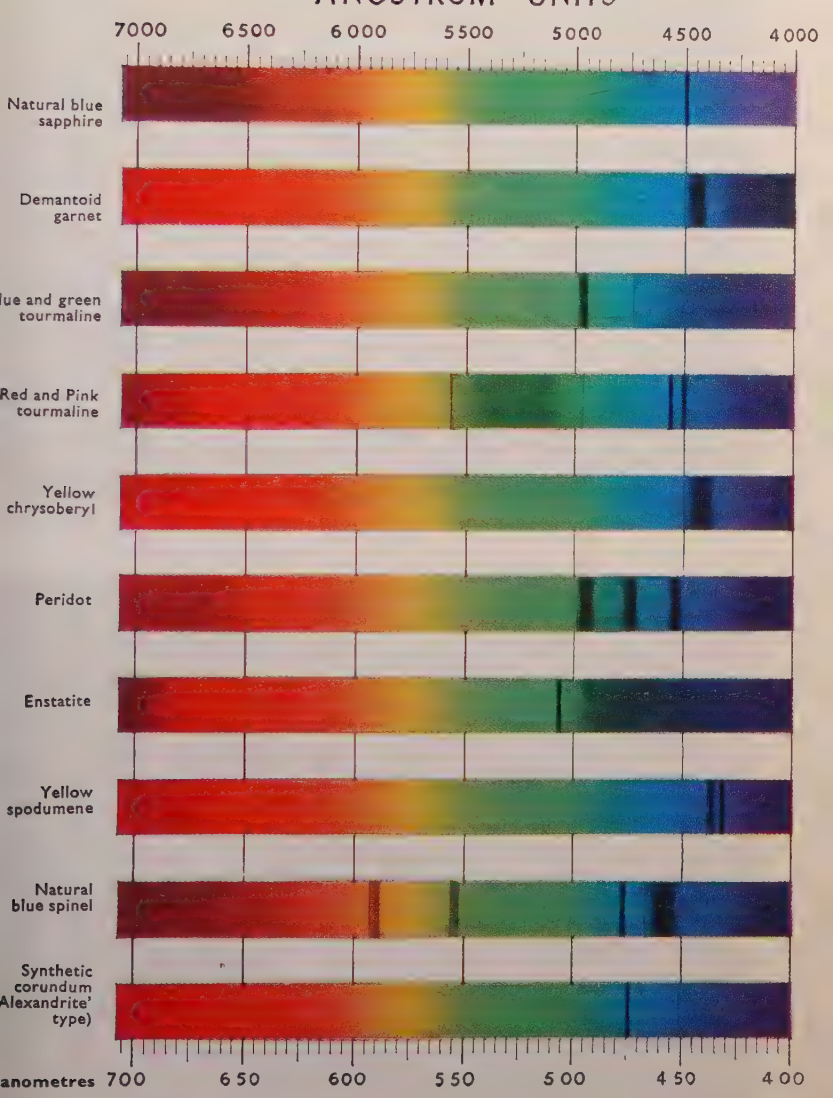


piky inclusions ('nails') in Linde synthetic emerald.



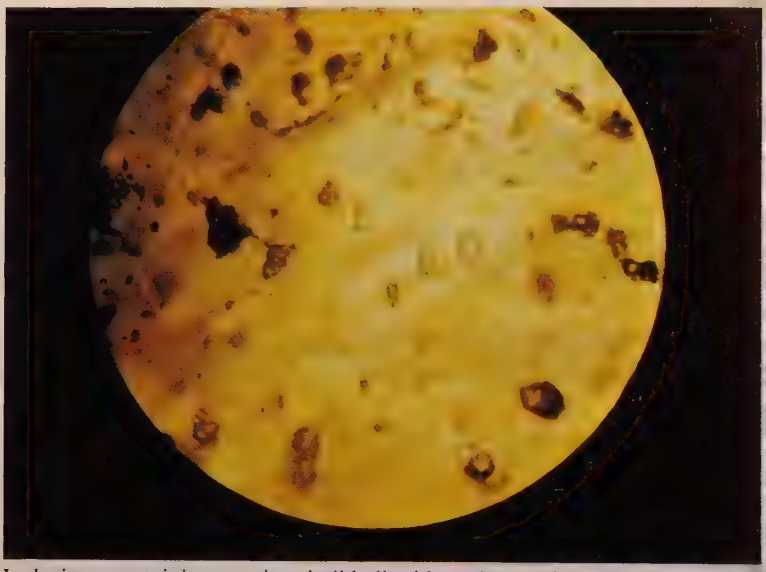
Absorption spectra of gemstones.

Note that the scales are shown linear, as with a diffraction grating spectroscope.



Absorption spectra of gemstones.

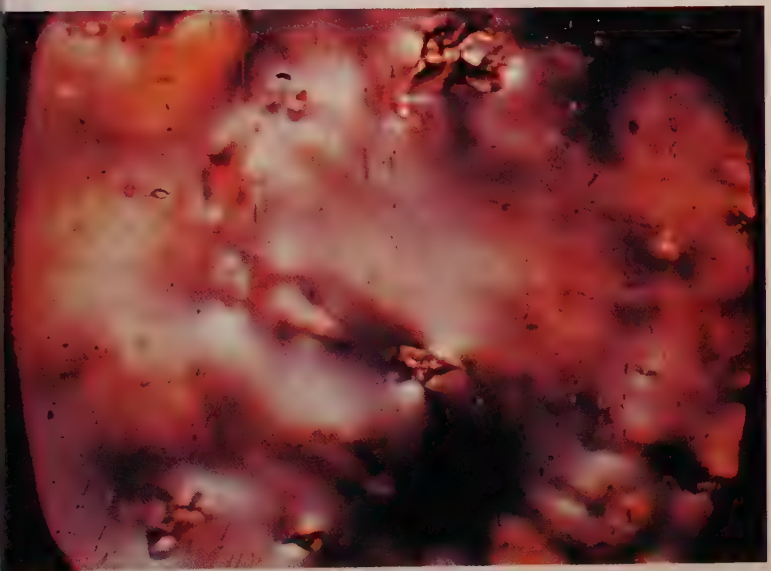
The scales here are linear, not condensed towards the red end as with a prism type spectroscope.



Inclusions containing two immiscible liquids and a gas in yellow beryl.

Synthetic spinel showing anomalous double refraction ('tabby-extinction').

Long rutile needles in Ceylon ruby.



Pleochroic haloes in Ceylon ruby (crossed Nicols).

Siam ruby showing twin planes by transmitted light and their outcrop at t
reflected surface.

Synthetic ruby showing curved growth lines and gas bubbles.

(*Unio margaritifera*) in rivers of Scotland, Europe and U.S.A.

Pearl, Pink; obtained from a univalve shellfish, the Indian conch or "Abalone". A non-nacreous pearl.

Pearl sac; the term applied to the bag of epithelial cells (part of the mantle) which surrounds the pearl in the flesh of the oyster. The pearl sac is an essential condition for the formation of cyst pearls, either natural or cultured.

Pearls, Calculation of prices; see page 225.

Pectolite; $HNaCa_2(SiO_3)_3$; R.I. 1·59–1·63; S.G. 2·74 to 2·88; H. 5; Monoclinic (massive); Greyish white; U.S.A., Italy and Scotland.

Pegmatite; a coarse-grained quartz-feldspar igneous rock.

Pendeloque; a style of cutting. A drop-shaped stone. See page 188.

Periclase; a magnesium oxide mineral now produced synthetically under the name "lavernite". Cubic. H. 5; S.G. 3·55–3·60; R.I. 1·73.

Peridot; $(MgFe)_2SiO_4$; R.I. 1·654–1·689; S.G. 3·34; H. 6½ to 7; Rhombic; Colours, oil-green, brown; Localities, Red Sea, Burma, Ceylon, U.S.A. and Norway. (Mineralogical name of the species is Olivine).

Periostracum; the name given to the outer dark horny layer of conchiolin forming the outside of the shell of the oyster.

Peristerite; a variety of albite feldspar showing a bluish opalescent sheen somewhat like moonstone.

Petalite; $Li_2OAl_2O_38SiO_2$; R.I. 1·504–1·516; S.G. 2·39 to 2·46; H. 6; Monoclinic (crystals rare, material usually massive); Colourless or white; Localities, Sweden, Rhodesia and Maine, U.S.A.

Petroleum; a hydrocarbon liquid having a value as an immersion liquid in certain refractive index tests. R.I.=1·45.

Petrology; the study of the origin, structure and composition of rocks.

Petrological microscope; see *Microscope.*

Phantom crystals; see *Ghost crystals.*

Phenakite; Be_2SiO_4; R.I. 1·651–1·666 to 1·653–1·668; S.G. 2·95 to 2·97; H. 7½ to 8; Trigonal; Colours, colourless,

yellowish and pale pink; Localities, Ural Mountains (Russia) and North and South America.

Phenyldi-iodoarsine; $C_6H_5AsI_2$; highly refractive liquid (R.I. 1·85) used for making optical contact between stone and dense glass of refractometer, and as an immersion fluid. It is poisonous and has a blistering action on the skin.

Phosphorescence; is the continuance of fluorescent light after the exciting radiations causing the luminescence have ceased. See also *Fluorescence.*

Phosphoroscope; an apparatus for measuring the duration of phosphorescence.

Photomicrograph; a photograph of the view of a subject as seen through a microscope. A special camera is used which fits on the tube of the microscope in place of the eyepiece, or over the eyepiece.

Piezo-electricity; the property certain crystals (notably quartz and tourmaline) possess of inducing a charge of electricity in themselves when pressure is applied along certain directions in the crystal.

Pile-treated diamonds; diamonds coloured by bombardment with neutrons from an atomic pile (atomic reactor). As in cyclotroned diamonds the colours are green and after heat treatment brown. These stones are not radio-active and are coloured throughout.

Pinacoidal face; a crystal face that is parallel to two of the crystal axes.

"Pink moonstone"; a name erroneously applied to the opalescent pink variety of scapolite.

Pique; the term applied to diamonds which have inclusions obvious to the naked eye.

Pistacite; see *Epidote.*

Planes of symmetry; those planes in an ideally developed crystal which divide it in such a way that one side of each plane is the mirror image of the other.

Plasma; see *Chalcedony.*

Plastics; an omnibus term used for a number of synthetic substances, generally resin-like, which can be moulded by heat and pressure. See page 180.

Platinum; Pt. S.G. 21·5; a hard and ductile greyish-white metal used for mounting gemstones, particularly diamonds. The metal has a high melting point (1755°C.) hence is employed where heat resistance is required.

Play of colour; iridescence due to interference of light impinging on thin films having a different refractivity to the surrounding mass; caused also by diffraction effects resulting from submicroscopic strata of opal. Seen in precious opal, labradorite, etc.

Pleochroism; see page 147.

Pleonaste; see *Ceylonite* and *Spinel.*

Point; the term used in describing the weight of diamonds under one carat. The "point" is 0·01 carat so that a fifty point diamond weighs 0·50 carat, or half a carat. A seventy point stone weighs 0·70 carat.

Polariscope; an instrument consisting of two units for the production of plane polarised light arranged with a rotating stage between them. The lower unit (the unit may be a Nicol prism, an Ahrens prism, a "Polaroid" disc or may be a mirror arranged at the requisite angle) is termed the "polariser" and the similar unit above the stage the "analyser". The polariser, and sometimes the analyser, are capable of being rotated at right angles to the optical axis of the instrument. The polariscope is used to examine substances in parallel and convergent light. All petrological microscopes are fitted with the device.

Polarised light; light which is vibrating in one plane only, whereas with ordinary light the plane in which the vibrations may take place are infinite in number. In all rays of light, polarised or unpolarised, the vibrations are at right angles to the directions the light is travelling. Doubly refracting crystals not only resolve the light that passes through them into two rays but completely polarise them in planes at right angles to one another.

Polaroid; sheets of plastic material containing ultra-microscopic crystals of quinine iodosulphate which have the property of transmitting only one polarised ray, the other

being almost entirely absorbed by the crystals. May be used in place of the more expensive Nicol prisms.

Pollucite; $H_2Cs_4Al_4(SiO_3)_9$; R.I. 1·51; S.G. 2·86; H. 6½; Cubic; Colourless; Localities, U.S.A. and Isle of Elba.

Polymorphism; the term used where minerals which have the same chemical composition crystallise in different forms, *e.g.*, Rutile, Anatase and Brookite all correspond to the formula TiO_2 but each appears in different crystal form. See *Dimorphism*.

Polystyrene; a plastic. A polymerisation product of vinyl benzene. R.I. 1·59 to 1·67; S.G. 1·05; H. 2½. Dissolves in hydrocarbon liquids, *e.g.*, benzene, bromoform, etc.

Polysynthetic twins; contact twin crystals producing a number of very thin plates (laminate or lamellae). Each adjacent plate is in reverse order in alternate plates they are in the same order. Sometimes called repeated or lamellar twinning. Weakness along the contact planes gives rise to "Parting" or "False cleavage".

Porcelain; a type of fine earthenware (china) made from china-clay (kaolin) sometimes used for making opaque imitation stones, such as turquoise. S.G. 2·1 to 2·5.

Porphyries; types of igneous rocks which show comparatively large and well-formed crystals embedded in a fine grained ground mass. Red and green coloured porphyries were much used in Greco-Roman times.

Powder, Diamond; see *Diamond Powder*.

Prase; green massive quartz.

Prase opal; see *Opal*.

Prasiolite; the name given to the green quartz produced by the heat treatment of some amethyst.

Precious metals, Acid tests for; see page 223.

Precious opal; see *Opal*.

Precious stones; a term usually confined to such stones as the diamond, ruby, sapphire, emerald, and perhaps black opal. It is a term with little effective meaning.

Prehnite; $H_2Ca_2Al_2(SiO_4)_3$; R.I. 1·62–1·65; S.G. 2·80 to 2·95; H. 6 to 7; Rhombic; Colour, green (may resemble jade) and brown; Localities, France, U.S.A. and Australia.

Pressed amber; amber which has been made up of small pieces welded together by hydraulic pressure under heat; a true reconstruction. Alternatively called Ambroid.

Price-calculation of gemstones and pearls; see page 225.

Princess-cut; an old and discontinued name for the profile-cut which is used for diamonds and other stones.

Profile-cut; a style of cutting for diamond (and has been used for other stones) in which flat slices of diamond are cut with grooves on the reverse side. Said to give economy of material and facilitates setting by the fact that all stones are cut to definite sizes. Previously known as the Princess-cut.

Proustite; $3Ag_2S.As_2S_3$; R.I. 2·7–3·0; S.G. 5·57 to 5·64; H. $2\frac{1}{2}$; Trigonal; Red (darkens on exposure to light); Central Europe, Chile, France, Mexico and U.S.A.

Pseudomorph; the term used to describe a mineral which has been altered from another, but in which the original form has been retained.

Pseudophite; a chlorite mineral, a hydrated silicate of aluminium and magnesium; R.I. 1·576–1·579; S.G. 2·6 to 2·85; H. $2\frac{1}{2}$; Colour, green; Localities, Switzerland, Italy, Styria (Austria) and Scandinavia. Known also as "Styrian Jade".

Psilomelane; a manganese mineral which when cut and polished resembles hematite and has been used similarly.

Pumice powder; a highly cellular, glassy volcanic rock or lava used as a polishing agent.

Pumicite (Volcanic dust); a natural glass or silicate atomised by volcanic explosions. The material is similar in composition to pumice powder and like this latter material is used for polishing purposes.

Punamu; the Maori name for the jade from New Zealand. See *Nephrite.*

Purple gold; may be obtained by the use of aluminium as an alloy. This alloy, however, is too brittle for use in jewellery.

Putty powder; a polishing medium consisting of tin oxide (about 85 to 90%) with the remainder lead oxides.

Pyknometer; see *Specific Gravity Bottle.*

Pyralspite series; the name applied to the isomorphous series of garnets which contain the pyrope/almandine/spessartine group.

Pyrite (Pyrites); FeS_2; S.G. 4·84 to 5·10; H. 6½; Cubic; Colour brass-yellow. Pyrite is the "Marcasite" of jewellery.

Pyro-electricity; the property of certain crystals (particularly tourmaline) of acquiring an electric charge when they are heated.

Pyrope; see *Garnet.*

Pyrophyllite; $H_2Al_2(SiO_3)_4$; R.I. mean 1·58; S.G. 2·8; H. 1½; White, grey or greenish and resembles soapstone. The crystallization is orthorhombic but the mineral is always massive. Localities, Russia, Brazil, U.S.A. and South Africa where the grey material has been marketed under the name "Wonderstone".

Pyroxene; the name applied to a group of minerals with similar physical and optical characters. They are silicates and are closely analogous chemically to the amphibole group (q.v.). The gem members of the pyroxene minerals are, enstatite, diopside, jadeite and spodumene.

Quartz; SiO_2; R.I. 1·544–1·553; S.G. 2·65 to 2·66; H. 7; Trigonal; Colours, colourless (Rock Crystal), violet (Amethyst), yellow (Citrine), brown (Cairngorm), pink (Rose Quartz), green (Prase), green chatoyant (Cat's-eye), yellow chatoyant (Tiger's-eye), brown, yellow, red or green with scales of mica (Aventurine), colourless with cracks showing prismatic colours (Iris), colourless with included acicular crystals of rutile, etc. (Needle stone). Quartz, owing to its piezo-electric effect, is used in radio frequency control, etc. See also *Chalcedony.*

Quartz glass; fused quartz which thereby loses its crystalline character and becomes a glass. S.G. 2·21; R.I. 1·46.

Quartzite; a metamorphic rock made up of irregular interlocking grains of quartz. Often contains flakes of green mica or a reddish iron mineral. Such types with coloured or spangled inclusions are known as aventurine quartz.

Quoin facets; the name applied to the other four facets adjacent to the bezel facets, on the crown in a brilliant-cut stone.

These eight facets, the quoins and bezels are often called collectively the bezels or kites.

"Radient"; a suggested, but undesirable name for the synthetic colourless spinel. Another of these fancy pseudonyms for this synthetic spinel is Corundolite.

"Radium diamond"; a misnomer for smoky quartz.

Radium-treated diamonds; diamonds when irradiated, that is kept adjacent to radium bromide for some time, assume a green colour which is fairly permanent. This is due to bombardment by the alpha particles of the radium. These treated stones are radio-active and can be distinguished from natural stones of a green colour by their ability to fog a photographic film.

Reconstructed stones; stones made by fusing together small pieces of real crystal to make a larger stone, care being taken to ensure continuity and better colour obtained by the addition of colouring oxide. Was usually confined to the making of ruby. Now superseded by the synthetic gem.

Red gold; an alloyed gold showing a redder colour than the normal yellow gold. It is often used for contrast and is made by alloying with copper alone, or copper and silver in the proportion of three to two.

Reduction; the term applied to the chemical change in which the oxygen or other non-metal is taken away from a compound.

Reflection of light; a ray of light striking a polished surface is reflected from it in accordance with the following laws:
(1) the angle of reflection is equal to the angle of incidence.
(2) the incident ray, the reflected ray and the normal at the point of incidence are in the same plane.

Reflectivity meter; an instrument which measures the light reflected from the facet of a stone (usually diamond or its simulants). Infra-red emitting diodes and appropriate sensors are used.

Reflectometer; alternative, and incidentally more correct name for Refractometer (q.v.).

Refraction of light; a ray of light passing from a medium to one optically denser is bent towards the normal, and similarly in passing into a medium less dense is bent away from the normal. This bending is in accordance with definite laws. See *Snell's Law*, page 131.

Refractive index; see page 131.

Refractometer; an optical instrument arranged to show the critical angle of total reflection as a shadow edge, on a scale calibrated in refractive indices. In the case of the better class instruments used in laboratories the position of the shadow edge is read off on a graduated arc. There are different types which may use highly refractive glass, synthetic spinel or diamond for the prism or hemisphere.

Relation between refractive index and density, tables for Clerici's solution and Methylene iodide; see page 236.

Relative density; alternative term for specific gravity. More usually used for liquids. See *Density* and *Specific gravity*, page 120.

Retger's salt; see page 121.

Resin opal; see *Opal.*

Rhinestone; a name applied to the transparent paste which, colourless in the main, shows patches of various colours.

Rhodium; Rh. S.G. 12·44; a white metal, nearly the same colour as platinum, used for plating. This rhodium plating process is used to improve the colour and general appearance of gem-set jewellery.

Rhodizite; a borate of aluminium and caesium; R.I. 1·69; S.G. 3·40; H. 8; Cubic; Colours, pale green and pale yellow; Locality, Madagascar. Very rare.

Rhodochrosite; $MnCO_3$; R.I. 1·597–1·817 to 1·605–1·826; H. 4; S.G. 3·45 to 3·70 for the rose red material, rising with increase of iron; Trigonal; Colour, rose-red; presence, by replacement of iron, calcium and magnesium, introduces shades of yellow and brown; Localities, Hungary, Saxony, Colorado, U.S.A., South Africa and Argentina. "Inca rose" and "Rosinca" are fancy trade names for this material.

Rhodolite; see *Garnet.*

Rhodonite; $MnSiO_3$; R.I. 1·71–1·73 to 1·72–1·75; S.G. 3·5 to 3·7; H. 5 to 6; Triclinic; Colours rose-red and pink (opaque); Localities, Russia and U.S.A. Small clear crystals found at Wermland in Sweden are occasionally cut.

Rhombic (Orthorhombic, Trimetric); one of the crystal systems. See page 114.

Rhombic dodecahedron; the geometric solid with twelve rhomb-shaped faces. A crystal form of garnets and some diamonds.

Rhombohedral; see *Trigonal.*

Rhombohedron; a solid bounded by six rhombohedral faces; a common form in trigonal crystals.

Ribbon jasper; jasper in which the colours run in stripes.

River pearl; natural pearl from freshwater mussels.

Rock crystal; see *Quartz.*

Rohrbach's solution; see page 121.

"Roman pearls"; a misnomer for glass bead pearls.

Romanzovite; brown grossular garnet.

Röntgen rays; X-rays.

Rose-cut; see *Cuts of stones,* pages 184, 187.

Rose quartz; see *Quartz.*

Roses; the name applied to small diamonds cut in the rose-cut style.

Rosinca; a fancy name for Rhodochrosite (q.v.).

Rosolite; see *Xalostocite.*

Rottenstone; a soft, friable, very finely textured earthy mass used as a polishing compound. The material is a residual product from the weathering and decaying of a siliceous limestone.

Rouge; Fe_2O_3, the red oxide of iron used as a polishing medium. *Green rouge* is chromium oxide.

Roumanite; Rumanian amber. See *Amber.*

Royal-cut; a modern cut for diamond using a great number of facets.

"Rozircon"; a misnomer for the rose coloured synthetic spinel.

Rubasse; a spangled red variety of quartz or rock crystal coloured by the inclusion of minute blood-coloured scales

of oxide or iron. The natural stone is rare and is found in Brazil. This stone may be imitated by cracked quartz which has had red dye introduced along the cracks.

Rubbish; a mining classification for diamonds which can only be used for making powder.

Rubellite; see *Tourmaline.*

Rubicelle; see *Spinel.*

Ruby; see *Corundum.*

"Ruby, Adelaide"; a misnomer for red garnet.

"Ruby, Arizona"; a misnomer for the red garnet.

"Ruby, Balas"; a misnomer for the pale red spinel.

"Ruby, Bohemian"; a misnomer for red garnet.

"Ruby, Brazilian"; a misnomer for rose-red (fired) topaz.

"Ruby, Cape"; a misnomer for the red garnet from South Africa.

"Ruby, Colorado"; a misnomer for red garnet.

"Ruby, Montana"; a misnomer for red garnet.

"Ruby, Siberian"; a misnomer for rubellite. See *Tourmaline.*

"Ruby Spinel"; a misnomer for red spinel.

Ruin marble; a yellow marble with sections of a brown colour, due to the infiltration of iron.

Ruthenium; Ru. S.G. 12·3; a metal which, though belonging to the platinum group, has so far had no application in jewellery.

Rutile; TiO_2; R.I. 2·62–2·90; S.G. 4·2 to 4·3; H. 6 to $6\frac{1}{2}$; Tetragonal; Colours, blood red, reddish-brown and black; Localities, Russia, Scandinavia, Italy, France, U.S.A., Switzerland, Madagascar and Brazil. Rutile is made synthetically by a modified flame fusion process. The colours produced are yellowish-white, yellow, orange, red and blue, the latter are very rare. They have similar constants to the natural rutile.

Rutilated quartz; clear rock-crystal with included crystals of rutile. See *Needle stone.*

Sagenitic quartz; rock crystal with included crystals of rutile. See *Needle stone.*

Sapphire; see *Corundum.*

"Sapphire, Brazilian"; a misnomer for blue tourmaline, or similar coloured topaz.

"Sapphire, Lux"; a misnomer for iolite.

"Sapphire, Lynx"; a misnomer for the pale blue shade of iolite.

"Sapphire, Spinel"; a misnomer for blue spinel.

"Sapphire, Water"; a misnomer for the dark blue shade of iolite.

Sapphirine; a term misleadingly applied to the blue spinel or to the blue quartz. It is the correct name of a rare mineral, $(MgFe)_2Al_4O_6(SiO_4)$.

Sard and Sardonyx; see *Chalcedony*.

Sark stones; amethyst found in the island of Sark in the Channel Islands. Very little found to-day.

Satin-spar; fibrous white or pink calcite, or similar gypsum.

Saussurite; a decomposed feldspar; S.G. 3·2 (variable); H. 6½ to 7; Colour, greenish-grey to white; Locality, Switzerland. Sometimes simulates jade.

Sawing; a method whereby a diamond may be cut into two or more parts in directions other than the cleavage directions. It is carried out by the use of a diamond saw, a phosphor-bronze disc fed with diamond powder and olive oil, and running at about 5,000 r.p.m. The same process is used also for the cutting of the less hard gemstones.

"Saxony diamond"; a misnomer for colourless topaz.

Scapolite; an isomorphous mixture of marialite ($Na_3Al_3Si_9O_{24}NaCl$) and meionite ($Ca_3Al_6Si_6O_{24}CaCO_3$); R.I. (blue) 1·544–1·560 (pink and yellow), 1·548–1·570; S.G. 2·61 to 2·70; H. 6½; Tetragonal; Colours yellow, pink (chatoyant), blue (chatoyant); Localities, Burma, Madagascar, Canada and Brazil.

Scaife; a name applied to the cast-iron lap, which is 10″ to 12″ in diameter and used in diamond polishing. It must have an open porous structure and is provided with a paste of olive oil and diamond dust upon which diamonds are polished.

Scheelite; $CaWO_4$; R.I. 1·918–1·934; S.G. 5·9 to 6·1; H. 4½ to 5; Tetragonal; White yellow, brownish to orange. Most of the gem material comes from the U.S.A. and Sonora,

Mexico. Scheelite does not fluoresce under the long-wave ultra-violet lamp but glows with a blue colour under the short-wave lamp. Also made synthetically.

Schiller; the silver shimmer of light seen just below the surface of a stone and due to lamellar twinning, best seen in bronzite and moonstone.

Schist; a foliated and fissile metamorphic rock with layers of different minerals.

Schorl; black tourmaline.

Scissors-cut; a variation of the trap-cut in which the side facets surrounding the table are cut as elongated triangular facets. Also called Cross-cut. See pages 185, 189, 190.

"Scotch Topaz"; a misnomer for citrine, smoky quartz or cairngorm.

Seal-cut; see page 185.

Seed pearls; very small pearls.

Selenite; the transparent form of gypsum, generally found in well-formed monoclinic crystals. See *Gypsum*.

Semi-precious stones; an unsatisfactory term for all gemstones other than Precious stones (q.v.). It is a term now discontinued by general consent.

Senaille; the name applied to small chips of diamond with irregularly polished facets set into jewellery. Often erroneously called "roses".

Sepiolite; see *Meerschaum*.

Serpentine; $Mg_6(OH)_6Si_4O_{11}H_2O$; R.I. 1·50 to 1·57 (mean); S.G. 2·50 to 2·65; H. $2\frac{1}{2}$ to 4; Monoclinic; Colours, greens, etc.; varieties, Williamsite, Bowenite, and Verd antique may resemble jade. Bowenite (q.v.) is unusual in having hardness $5\frac{1}{2}$ to 6. Mineralogical varieties include antigorite, chrysotile and lizardite.

Setting edge; an alternative name for the girdle.

Shagreen; a material sometimes used as a covering to cigarette cases, lighters, mirrors, brushes and small boxes, etc. Originally made from the skin of the wild ass, which even now, with that of the horse and camel, provides much of the material. Shagreen is now generally derived from the skins of certain sharks and ray fishes. The material is dyed to

suitable colour, generally green, blue, red and black.

Shatter marks; see *Fire marks.*

Shattuckite; $2CuSiO_3H_2O$; R.I. about 1·80; S.G. about 3·8; H. 3½ to 4; Monoclinic (massive); Blue; U.S.A. Its status as a mineral species has been disputed.

Sheen; a shimmering effect, due to reflection of light from a position inside the stone, in contradistinction to lustre (q.v.) which is a surface reflection.

Shell-marble; a marble consisting mainly of fossil shells.

Shipley colorimeter; an instrument for the colour grading of diamonds.

"Siam aquamarine"; a misnomer for the heat-treated bluish green zircon.

"Siberian ruby"; a misnomer for rubellite. See *Tourmaline.*

Siberite; a name used for violet tourmaline.

Siderite; blue quartz. The name is properly used for the iron carbonate and some meteorites. Its use in the quartz context should be dropped.

Silica glass; SiO_2; R.I. 1·46; S.G. 2·21; H. 6; Amorphous; Colour, pale greenish yellow; Locality, Libyan Desert. A celestial origin is suggested by some authors, others regard it as sandstone fused by intense heat of basaltic intrusions. See also *Quartz glass.*

Silicates; formerly thought of as salts of various silicic acids. Now considered as compounds in which the structure is largely determined by the silicon-oxygen linkages which form the framework of the crystals. Examples are; *Beryl,* $3BeO, Al_2O_3, 6SiO_2$; *Spodumene,* $Li_2O, Al_2O_3, 4SiO_2$; *Zircon,* ZrO_2, SiO_2.

Silk; the whitish sheen seen in some corundums and due to the presence of vast numbers of microscopically small canals reflecting the light. "Pseudo-silk" is understood to be due to microscopic acicular crystals of titanic iron and is often observed in stones from Thailand.

Sillimanite; see *Fibrolite.*

Simetite; Sicilian amber, see *Amber.*

Silver; Ag. S.G. pure 10·5, standard 10·31; a lustrous white metal, malleable and ductile used in jewellery and for orna-

mental and utility articles. Standard silver has 925 parts of pure silver with 75 parts of alloy to the 1,000.

Silver Cape; a classification of diamond colour.

Sine of angle; the ratio between the side opposite that angle and the hypotenuse. The hypotenuse being the side opposite the right angle of a right angled triangle.

Sinhalite; $Mg(Al,Fe)BO_4$; R.I. 1·67–1·71; S.G. 3·47 to 3·49; H. 6½; Orthorhombic; Yellow and brown; Ceylon, Burma. A stone known for years as brown peridot and not discovered as a new mineral until 1952.

"Sira"; trade name for an abrasive, made of aluminium oxide artificially manufactured.

Skew facets: see *Cross facets.*

Skiagram; an X-ray shadow photograph produced by radiations which have passed through the substance under examination. It depends upon the differing degrees of transparency of the various parts of the substance and is the method used in medical diagnosis. The method is used for the detection of cultured pearls.

Skill facets; are the eight small triangular facets around the girdle edge of the crown in the brilliant-cut. They are adjacent to the cross or skew facets. The combined 16 facets, the eight cross and the eight skill, are often collectively known as break facets, half facets or halves.

Slate; an argillaceous sedimentary rock of greyish colour. It is used for the so-called "black marble", which early in this century was utilised for clock cases. S.G. 2·81 to 2·86.

"Slocum stone"; an opal imitation, made from glass.

Smaltite; $CoAs_3$. A cubic (massive) tin-white to steel grey mineral with a hardness of 5½ and a density varying between 6·0 to 6·3. Occasionally cut. Canada and Europe, etc.

Smaragdite; jade-like form of hornblende. Density about 3·2. See *Hornblende.*

"Smaryll"; the name applied to a composite stone made up of two pieces of pale emerald or beryl with a colouring layer between. A modification of the "soudé emerald".

Smithsonite; $ZnCO_3$; R.I. 1·62–1·85; S.G. 4·3–4·65; H. 5;

Trigonal; Colours, yellow, green, and blue; Localities, Greece, Sardinia and New Mexico. The green variety is sometimes marketed under the name of "Bonamite".

Smoky quartz; dark greyish-brown transparent quartz.

Snell's law; see page 131.

"Snow-flake jade"; see *Jade matrix.*

Soapstone; see *Steatite.*

Sodalite; a deep blue complex silicate mineral crystallising in the cubic system. R.I. 1·48; S.G. 2·2 to 2·4; H. 5½ to 6; Locality, Canada.

Sodium carbonate; $Na_2CO_3 10H_2O$; a flux used in blowpipe analysis.

Sonstadt's solution; see page 121.

"Soochow jade"; a misleading term for bowenite serpentine.

Soudé emerald; a composite stone made to represent the emerald. It is constructed with a crown and pavilion of rock crystal (or pale beryl) with a layer of green glass or gelatine across the plane of the girdle. A modern version has two pieces of synthetic white spinel with the coloured layer between. These are made in all colours. They are sometimes called *soudé sur spinelle.*

Sources of gemstones; see page 191.

Sousmansite; possibly a variety of wardite (q.v.).

"South African jade"; see "*Transvaal jade*".

"Spanish emerald"; a misnomer for green glass.

"Spanish topaz"; a misnomer for orange-brown quartz. Often amethyst or morion which has been treated by heat.

Sparklite; a name which has been applied in the U.S.A. to the colourless (fired) zircon.

Specific gravity; see page 120.

Specific gravity bottle (Pyknometer); a small flask fitted with a ground glass stopper pierced lengthwise with a capillary opening so that the bottle can be filled to a definite mark. It is used for the determination of the density of liquids, powders and small fragments by the direct weighing method.

Spectra; plural of spectrum (q.v.).

Spectrograph; an instrument arranged for the production of spectra as in a spectroscope, but having a camera fitted in place of the telescope of the latter instrument so that a plate exposed in it will record, after development, the spectral lines (in bright line emission spectra) or the sections and bands preferentially absorbed (absorption spectra). Quartz prisms and lenses are used in order to obtain results in the ultra-violet region.

Spectrolite; labradorite feldspar found in Finland.

Spectrometer; an instrument used for the measurement of the spectrum. There are various types which may either allow the wave-length to be read off directly or to be arrived at by computation. The most usual types used in gemmological work are the direct vision direct reading types (Beck), and the table instruments consisting of a fixed collimating tube, to parallelise the light, and fitted with an adjustable slit; a graduated circular table upon which the crystal or stone is mounted, and lastly a telescope which may be moved round the table and to which a vernier is attached in order accurately to measure the angles. This is the instrument generally used in determining refractive index by the method of minimum deviation.

Spectroscope; an instrument which analyses a ray of light into the spectrum colours, and may be one of two types:

(1) the prism type, where dispersion is effected by the different refringence of the glass prism for rays of different wave-length (colour).

(2) diffraction grating type, where a grating of many fine parallel lines performs a similar function by a process of interference the effects being viewed by a lens system (a short telescope).

Spectrum, Absorption; the field seen in a spectroscope (or photograph, if spectrograph is used) when a source of white light from an incandescent solid is viewed by the instrument after suffering absorption by transmission through or reflection from a gemstone or other medium. Owing to the absorption of light by the medium being examined, dark bands or lines indicating the wave-lengths absorbed, may be seen

across the otherwise continuous spectrum. This often gives useful information of a diagnostic nature. See page 150.

Spectrum, Emission; the field seen in a spectroscope (or photograph if spectrograph is used) when a source of light is examined by the instrument. It may be one of three kinds:

(1) **Bright Line;** a number of sharp and bright vertical lines, and are the spectra of glowing vapours of elements. These spectra serve to identify the elements present in a substance (Spectrum analysis). See page 158.

(2) **Continuous;** the familiar rainbow colours, a continuous graduation of light passing imperceptibly through red to violet. It is produced by incandescent solids.

(3) **Swan;** a fluted or banded formation of bright lines, each of which appears to be sharp towards the side of longer wave-length and to fade away on the opposite side (actually a group of very fine lines comparatively far apart on one side and crowded closer and closer together towards the other until they are so dense that they appear one line at the head); produced by the incandescent vapours of compounds.

Specular iron ore; a variety of hematite (q.v.) occurring in rhombohedral crystals. Black in colour, and with a metallic splendent lustre.

Speed of light; is approximately 186,000 miles per second in air (300,000 kilometres per second). To find the speed of light in any other medium it is necessary to divide 186,000 by the refractive index of the medium.

Spessartine (Spessartite); the manganese aluminium garnet. See *Garnet*. The form spessartite has also been used by petrologists for a certain type of rock.

Sphalerite; ZnS, R.I. 2·3o–2·37; S.G. 4·08–4·10; H. 3·5–4; Cubic; Colour, almost black through browns to yellow. Mineralogical name for zinc blende and blende. Gem quality material from Picos de Europa, Spain. High dispersion 0·156.

Sphene (Titanite); $CaTiSiO_5$; R.I. 1·888–1·917 to 1·914–2·053; S.G. 3·45 to 3·56; H. 5 to 5½; Monoclinic; Colours, yellow,

green, brown and grey; Localities, Switzerland, Mexico and Burma.

Spherulites (Spherules); Rounded aggregates or rosettes of very fine needle-like crystals radiating from a common centre producing ball-like inclusions which are circles when cut across and polished. An example is orbicular jasper.

Spinel; $MgAl_2O_4$; R.I. 1·714 to 1·736; S.G. 3·58 to 3·75 (intermediate Mg-Zn type may reach 4·06); H.8; Cubic; Colours, deep red, rose red and pink, orange-yellow (Rubicelle), purple, blue, grass-green (Chlorospinel), dark green to black (Ceylonite or Pleonaste, S.G. 4 or above); Localities, Ceylon, Burma, Thailand, U.S.A., etc. See *Gahnospinel.*

Spodumene; $LiAl(SiO_3)_2$; R.I. 1·660–1·675 to 1·664–1·679; S.G. 3·17 to 3·23; H. 6 to 7; Monoclinic; Colours, yellow, yellowish-green, ice-green, grass-green (Hiddenite) and lilac-pink (Kunzite); Localities, U.S.A., Brazil and Madagascar.

Stag horn; see *Deer horn.*

Stained chalcedony; see *Artificial treatment of gemstones,* page 182.

Stained jasper; see *Artificial treatment of gemstones,* page 178.

Stalactite; a tapered column of mineral matter found pendant from the roof of a cavern and which has been deposited by dripping water.

Stalagmitic formation; a cavern formation the opposite to a stalactite. It may cover the floor of the cavern or may rise as a column from the floor underneath a stalactite. In some cases the two may join to produce a column.

Star-cut; see page 188.

Star facets; the name applied to the eight triangular facets which surround the table in the brilliant-cut.

"Starilian"; trade name for strontium titanate.

"Starlite"; name proposed, in U.S.A., for the blue zircon (heat treated).

Star stones; see *Asterias.*

Staurolite; $HFeAl_5Si_2O_{13}$; R.I. 1·74–1·75 to 1·75–1·76; S.G. 3·4 to 3·8; H. 7 to 7½; Rhombic; Colour, reddish-brown; Localities, Switzerland and South America. Twinned

crystals often in the form of a cross (Cross stone or Fairy stone).

Steatite (Soapstone); $H_2Mg_3Si_4O_{12}$; R.I. 1·54–1·59; S.G. 2·6 to 2·8; H. 1. may be higher owing to impurities; Monoclinic; Colours, yellow, brown and reddish. Used for carvings.

Step-cut; see pages 185, 189, 191.

Stibiotantalite; $SbO_2(Ta,Nb)_2O_6$; R.I. 2·39–2·46; S.G. 7·4; H. 5½ to 6; Orthorhombic; Brownish-yellow; U.S.A.

Stichtite; $Mg_6Cr_2(OH)_{16}CO_3.4H_2O$; R.I. mean 1·53; S.G. 2·15; H. 2½; Trigonal (massive); Rose red to lilac; South Africa, Canada and Tasmania.

Strass; a term originally used for a special type of highly dispersive flint glass used for imitation gemstones. Widely, but incorrectly used for all types of glass used as imitations.

Streak; may be defined as the colour of the powder of a mineral and may be quite different from that of the mineral in mass. It is generally observed by rubbing the mineral upon a plate of unglazed porcelain termed a streak-plate. Streak marks treated with acid reagents are the standard type of test for determining the quality of precious metals, particularly gold.

Stressed figured amber; cloudy amber which has during the process of clarification with rape seed oil developed stress cracks which look like nasturtium leaves. These are sometimes coloured by staining.

Striae; small channels or thread-like lines, roughly parallel, seen on the surface of crystals or in the internal structure of stones, and may be described as follows:

Cooling striae; the whorl formation seen in glasses, due to irregularities in mixing.

Crystal striations; the fine lines seen on the surface of crystals.

Curved striae; the curved or "onion" type of structure characteristic of synthetic gemstones.

Straight striae; the straight lines seen in the inside of natural stones.

Strontium titanate; $SrTiO_3$; R.I. 2·41; S.G. 5·13; H. 6; colourless. A synthetically produced stone which has no

counterpart in nature. It is produced by the flame-fusion process (Verneuil process). Trade names are "Fabulite" and "Starilian". The stone has cubic crystallization and is therefore singly refractive.

"Styrian jade"; a misnomer for pseudophite.

Sunstone; see *Feldspar*.

Surface tension; the tension of the surface film of a liquid due to the cohesion of its particles, as seen in the bubble or drop. The drop may be modified by the nature of the substance upon which it forms.

Swirl marks; the irregular striations observed in badly annealed glass. It may be likened to the effect seen when treacle is stirred.

Swiss-cut; a modified form of the brilliant cut for small diamonds, the table being surrounded with eight star facets only. See page 190.

"Swiss jade"; a misnomer for jasper (an impure quartz) stained green to represent jade.

"Swiss lapis"; a misnomer for jasper (an impure quartz) stained blue to represent lapis-lazuli.

"Symerald"; the name applied to the modern version of the emerald-coated beryl. See *Emerita*, which was an earlier name for the stone.

Symmetry, Axis of; the axis upon which a crystal on being rotated comes to occupy the same position in space more than once in a complete turn.

Symmetry, Centre of; when like faces, edges, etc., of a crystal are arranged in pairs in corresponding positions and on opposite sides of a central point.

Symmetry, Planes of; a plane which will divide a crystal into two similar and similarly-placed halves. Such a plane will divide a crystal into two parts so that one part is the mirror-image of the other.

"Synthetic alexandrite"; a misnomer still applied to the synthetic corundum or spinel which has a greenish colour in daylight and a reddish colour in artificial light, and is made to represent the true chrysoberyl alexandrite. Actual synthetic alexandrite is now manufactured.

"Synthetic doublet"; a reported composite stone consisting of a piece of synthetic red spinel or corundum and a piece of blue synthetic corundum cemented together along a vertical division making a pseudo parti-coloured stone. The method has an application for the representation of college and army colours.

"Synthetic" (garnet, tourmaline, etc.); a prefix used for synthetic corundums and spinels made in colours similar to that named, *e.g.*, "*Synthetic emerald*" may be synthetic green corundum or similar coloured spinel. These terms are definitely misnomers. It should be remembered that there is a true synthetic emerald.

Synthetic stones; see page 170.

Syrian garnet; a name for almandine garnet from Syria. See *Garnet* (Almandine).

Taaffeite; $Be_4Mg_4Al_{16}O_{32}$; R.I. 1·72; S.G. 3·60; H. 8; Hexagonal; Mauve; Ceylon; very rare.

Tabby extinction; a blotchy extinction effect, caused by strain and seen in some synthetic spinel and glass.

Table; the name applied to the large central facet on the crown in the brilliant-cut and trap-cut stones.

Talc; the hydrated magnesium silicate of which soapstone is the massive variety. One of the softest minerals, it is the standard of 1 on the Mohs scale. See *Steatite*.

Tanzanite; the name given to the transparent blue zoisite.

Tecali marble; a green marble from Tecali, Pueblo, Mexico, which simulates jade.

Tektite; a general name for glassy objects which have reached the Earth's surface after passage through the atmosphere: *e.g.* moldavites, australites and indochinites.

Television stone; see *Ulexite*.

Templet; alternative name for the bezel facet.

Tetrabromoethane; the modern chemical name for acetylene tetrabromide (q.v.).

Tetragonal (Dimetric); one of the crystal systems. See page 114.

Tetrahedron; the crystal form bounded by four equilateral triangles and belonging to the cubic system (the tetrahedron is the geometrical solid with the smallest number of faces).

Thermoluminescence; a secondary light generated by certain substances when they are heated with invisible infra-red rays.

Thetis' hair stone; see *Needle stone.*

Thomsonite; a zeolite; $2(Ca,Na_2)Al_2(SiO_4)_2.5H_2O$; R.I. 1·497–1·625; S.G. 2·3 to 2·4; H. 5 to 5½; Rhombic; Colours, white, red, green and yellow (mottled); Locality, U.S.A.

Three-point; see *Diamond point.*

Thulite; a variety of zoisite.

Tiger's-eye; a silica pseudomorph after crocidolite. See *Quartz.*

Tin-cut; the term applied to moulded glass imitation stones (pastes) which have had the facets polished on a lap.

Tinstone; alternative name for *Cassiterite.*

"Titania"; trade name for synthetic rutile.

Titanite; see *Sphene.*

Toluene (Toluol); C_7H_8; a hydrocarbon liquid used for the dilution of methylene iodide and bromoform in the preparation of heavy liquids; as an immersion liquid in certain refractive index tests and, owing to its low surface tension, in place of water in direct weighing method for determining density. R.I. = 1·49; S.G. = 0·88.

Topaz; $Al_2(OH,F)_2SiO_4$; R.I. 1·607–1·619 to 1·629–1·637; S.G. 3·50 to 3·60; H. 8; Rhombic; Colours, yellow, blue, green and pink (generally heat treated); Localities, Brazil, Siberia, Ceylon, British Isles (rare) and U.S.A.

Topaz, Brazilian; name applied to the true yellow topaz. See *Topaz.*

Topazolite; yellow andradite. See *Garnet.*

"Topaz, Oriental"; a misnomer for yellow corundum.

"Topaz, Scottish"; a misnomer for yellow quartz.

"Topaz, Synthetic"; a misnomer for synthetic corundum or spinel of a colour resembling a topaz colour. Mostly applied to the yellow.

Tortoise-shell; the horny shell of the carapace of the Hawks-bill Turtle (*Chelone imbricata*); R.I. 1·55 to 1·56; S.G. 1·26 to 1·35; Colours, mottled dark and light browns and yellows; Localities, Celebes, New Guinea, China, India, Africa and Australia. Tortoiseshell may be distinguished from "plastic" imitations by microscopic examination; the dark patches in

the real material are seen to contain swarms of spherical reddish particles, whereas in the imitations the edges of the dark areas are more defined and lack the dot-like structure.

Total reflection; the name applied to the phenomenon which occurs when a ray of light travelling through a denser medium to a rarer medium at an angle greater than the critical angle suffers complete reflection back through the denser medium. See *Critical angle of total reflection.*

Total reflectometers; see *Reflectometers.*

Touchstone; black and unglazed Wedgwood pottery, or basanite (q.v.), a velvet-black variety of quartz, used in the testing of precious metals by applying acids to the streaks made on the touchstone.

Tourmalinated quartz; rock crystal with included crystals of, usually black, tourmaline.

Tourmaline; a complex boro-silicate; R.I. 1·616–1·634 to 1·630–1·652; S.G. 3·00 to 3·15; H. 7 to 7½; Trigonal; Colours, colourless (Achroite), red and pink (Rubellite), green, blue, yellow-green, honey-yellow, pale-coloured (Elbaite), violet (Siberite), dark blue (Indicolite), brown (Dravite), black (Schorl); Localities, U.S.A., Ceylon, Madagascar, Germany, Brazil and Russia.

"Tourmaline, Synthetic"; a misnomer for synthetic spinel or corundum made in a colour to resemble tourmaline. It is generally the green colour to which the name is applied.

Transparency or Diaphaneity; the term used to describe the amount of light transmitted through a substance. Degrees of transparency are classed according to the amount of light which penetrates the substance:

Transparent; an object viewed through them shows outlines clear and distinct, *e.g.*, most gemstones.

Semi-transparent; the outlines of an object viewed through them would be blurred but a considerable amount of light can penetrate the stone.

Translucent; some light passes through but no object can be seen through the stone.

Semi-translucent; light is only transmitted through the edges.

Opaque; allows no light to pass through.

"Transvaal jade"; the light-green massive grossular garnet found in the Transvaal, South Africa, and used as a substitute for jade, has had this misnomer applied to it. Another misnomer for this material is South African jade. S.G. about 3·47; R.I. 1·73; H. 6½.

Trap-cut; name applied to the style of cutting which consists of a table facet and a series of facets, each similarly disposed so that the contour of each runs parallel to that of the table. Also known as step-cut. See *Baguette-cut* and *Cuts of stones*, pages 185, 189, 191.

Trapeze; the name applied to a stone cut in the form of a trapezoid (two parallel sides and two inclined). See *Cuts of stones*, page 186.

Trapiche emerald; an emerald crystal in which radially arranged albite separates clear emerald segments but producing a single crystal. The clear emerald parts are cut as gemstones.

Treated opal; black dyed opal.

Tremolite; Monoclinic; R.I. mean 1·61; S.G. 2·98; H. 5½ to 6½; An end member of one amphibole series of minerals, the other end member being actinolite (q.v.). The pale colours of nephrite are felted fibres of tremolite. The mineral also produces greenish chatoyant stones (Canada); and a pink variety, called hexagonite (U.S.A.).

Triangle; the name applied to a trap-cut stone with an outline in the form of a triangle, generally an equilateral triangle. See pages 185, 186.

Triboluminescence; the phenomenon exhibited by certain minerals when they are rubbed or scratched, of showing a luminosity.

Triclinic; one of the crystal systems. See page 114.

Trigonal (Rhombohedral) system; sub-division of the hexagonal system of crystallisation in which the principal axis is one of threefold instead of sixfold symmetry. Considered by some authorities as a separate system.

Trimetric system; alternative name for the rhombic system.

Triplet; a composite stone. See pages 177, 178.

Triplex opals; a composite stone consisting of an opal doublet

which has a covering dome of rock crystal cemented over the face of the opal. It is actually a triplet.

Tripoli; a very fine-grained silica from Missouri and Oklahoma used as a polishing agent.

"Tsavorite"; a misleading name given to the green vanadian grossular garnet from the Tsavo district of Kenya.

Tugtupite; a cyclamen-red ornamental mineral found in Greenland. It is near sodalite in composition and has a density near 2·36 and a refractive index of 1·50. The hardness is 6.

"Tully" Memorial Medal; a medal to commemorate B. J. Tully, awarded annually to the candidate submitting the best papers in the Fellowship Examination of the Gemmological Association of Great Britain which, in the opinion of the Council and Examiners, are of sufficiently high standard to merit the award.

Tumbling; a method used for the production of baroque shaped stones by churning them with abrasive and then with polishing compounds in a rotating drum. Used extensively by amateurs.

Turpentine; an oil having a value in certain refractive index tests. R.I. 1·47.

Turquoise; a basic phosphate of aluminium and some copper and iron; R.I. 1·61 to 1·65; S.G. 2·6 to 2·85; H. 6; Triclinic; Colours, blue and green; Localities, Iran, Egypt, Turkestan and U.S.A.

Turquoise matrix; turquoise cut so that it includes some of the matrix it is found with: a brown limonite.

Turquoise, Viennese; see *Viennese turquoise.*

Twin crystals; two or more crystals of the same species which have intergrown together but always with reference to definite laws. They are often characterised by having re-entrant angles, and are of three general types:

(1) **Contact twins;** where two halves of a crystal are in reverse order, so that if one half is rotated through half a circle about the plane of joining (perpendicular to the twinning axis) the form of the normal crystal is obtained.

(2) **Interpenetrant twins;** where two crystals have grown so

that they penetrate one another, often producing cross and star forms.

(3) **Polysynthetic or repeated twins;** are composed of a number of contact twins producing very thin plates, each crystal being arranged in reverse order to its neighbour. Sometimes called lamellar twinning.

Two-point; see *Diamond point.*

Ugrandite series; the name applied to the isomorphous series of garnets which contain the uvarovite/grossularite/andradite group.

Uintahite; another name for bitumen.

Ulexite; $NaCaB_5O_9.8H_2O$; Mean R.I. 1·51; S.G. 1·65 to 2·0; H. 1 to 2; Monoclinic (fibrous massive). Not a gemstone but of interest in that the fibres are so straight that, when cut as thick plates with the fibres at right angles to the cut, print can be read through the stone. It is because of this that the stone is called "Television stone".

Ultra-violet light; the invisible rays, in wave-length beyond the visible violet, having a range of between 1,000 and 3,800 Ångström units (100 and 380 nanometres). They are known best by the facility with which they affect a photographic plate and by the effect certain substances have of emitting a visible light when they are irradiated with ultra-violet rays (Fluorescence). Between 3,800 Å and 3,000 Å (380 nm and 300 nm) the rays are usually known as long-wave ultra-violet light; between 3,000 Å and 2,000 Å (300 nm and 200 nm) they are known as short-wave rays.

Ultra-violet lamps; lamps used to produce ultra-violet light particularly for use in exciting luminescence in materials. They may be one of three types:

(1) Electrically excited high pressure mercury vapour in a quartz glass tube with the powerful visible light filtered out with a suitable filter (Wood's glass filter). The main ultra-violet rays produced by such a lamp are about 365 nanometres. These are known as long-wave lamps.

(2) Electrically excited low pressure mercury vapour in a quartz, or special glass, envelope. The weak visible light and the long-wave ultra-violet rays are as far as possible

filtered out by a suitable filter. Major radiation produced by this lamp is in the short-wave region at 253·7 nm.

(3) The fluorescent tube lamp. The lamp consists of a short-wave ultra-violet generator as in (2) but enclosed in an ordinary glass envelope upon the inside of which is sprayed a compound which "fluoresces" in the long-wave ultra-violet light with a range between 410 and 320 nanometres so that the lamp emits further into the visible violet than does the high-pressure long-wave lamp. This lamp may be best for distinction between natural and synthetic emeralds.

Unakite; a granite-like rock consisting of a mixture of pink feldspar and green epidote and some quartz. The R.I. varies according to the mineral part from 1·52 for the feldspar, 1·55 for the quartz and 1·76 for the epidote. S.G. varies from 2·88 to 3·2. Mottled pink and green. U.S.A.

Uniaxial; the term used to describe the optical character of anisotropic crystals which have one direction of single refraction; confined to crystals of the tetragonal, trigonal and hexagonal crystal systems.

Unit cell; the unit of crystal structure which is the smallest part of a crystal which can still possess the characteristic properties of the crystal.

Units of weights; see page 229.

Univalve molluscs; pearl producing shellfish which have a shell in one piece, and not a shell in two halves as in the oysters and mussels. The abalone (*Haliotidae*) and the giant conch are examples of univalves.

"Uralian emerald"; a misnomer for the green demantoid garnet. See *Garnet* (Andradite).

Utahlite; alternative name for variscite.

Uvarovite; see *Garnet*.

Valency; the combining power of an element; measured by the number of atoms of hydrogen with which it can combine or which it can replace. Thus chlorine combines with one atom of hydrogen and is, therefore, univalent, calcium replaces two atoms and is, therefore, divalent, and so on. Several elements have different valencies in different compounds,

e.g., iron is divalent as in the compounds FeO, or trivalent as in the compound Fe_2O_3. The valencies of the commoner elements are given on page 212.

"Vallum diamond"; a misnomer for rock crystal.

Variscite; $AlPO_4 2H_2O$; R.I. mean 1·57; S.G. 2·52 to 2·60; H. 4 to 5; Rhombic; Colours, apple-green, blue-green; Locality, U.S.A. Sometimes called Utahlite.

Vaseline; a hydrocarbon jelly useful for protective covering of refractometer dense glasses when the instrument is not in use. At a pinch this jelly could be used as an immersion "fluid" for small peelings in refractive index tests. The R.I. is near 1·50.

Vegetable ivory; see *Ivory, Vegetable.*

Velocity of light; see *Speed of light.*

Venus' (Thetis') hair stone; see *Needle stone.*

Verd antique; see *Serpentine.*

Verdite; a massive deep green micaceous rock used as an ornamental stone; R.I. 1·58; S.G. 2·8 to 3·0; H. 3; South Africa and U.S.A.

Verneuil process; the method devised by the French chemist Verneuil, for the production of synthetic corundum and spinel, by use of the oxy-hydrogen furnace.

Vesuvianite; see *Idocrase.*

"Victoria-stone"; an artificial chatoyant stone made in various colours in Japan.

"Vienna turquoise"; a misnomer for a glass imitation turquoise.

"Viennese turquoise"; an artificial turquoise produced from precipitated aluminium phosphate coloured by copper oleate. The powder being consolidated by hydraulic pressure into solid form. The material has similar hardness, S.G. and R.I. to true turquoise, but does not decrepitate when heated with the blowpipe flame.

Violane; massive violet-blue diopside.

Volcanic glass; see *Moldavite, Obsidian* and *Tektite.*

Vulcanite; crude rubber treated with sulphur by heat; S.G. 1·15 to 1·20 (Ebonite 1·2 to 1·8).

Walker balance; a balance on the principle of the steel-yard used for determining the specific gravity of fairly large mineral specimens. The specimen is suspended and moved along the beam until it counter-balances the constant weight. The reading on the graduated beam, at the point the specimen is suspended is recorded (reading A). The specimen is immersed in water and again counterpoised and the second reading taken (reading B). Formula: B divided by B minus A, gives the specific gravity.

Walrus ivory; an ivory obtained from the canine teeth of the walrus (*Odobaenus rosmarus*).

Wardite; $Na_4CaAl_{12}(PO_4)_8(OH)_{18}6H_2O$; R.I. (mean) 1·59; S.G. 2·81; H. 5; Light green or bluish-green with vitreous lustre. Occurs in nodules of variscite at Utah, U.S.A. Sousmansite may be identical with wardite.

Wart pearls; another name for Blister pearls (q.v.).

"Water chrysolite"; a misnomer for *Moldavite.*

"Water sapphire"; a misnomer for *Iolite* (Cordierite).

Wave-length; the distance between the crests, or troughs, of two successive waves. In the case of the longer waves of the electro-magnetic spectrum, the wireless waves, they are measured in metres; while in the shorter waves of light, ultra-violet rays, X-rays, etc., they are measured in Nanometres and Ångström units (q.q.v.). See also *Electro-magnetic spectrum.*

Weight, Units of; see page 229.

Westphal balance; a type of steelyard balance fitted with a sinker at the end of the graduated arm. It is used for the determination of the relative density of heavy liquids. By the substitution of a suitable clip and pan in place of the sinker, the specific gravity of small gemstones may be determined. The clip is immersed in water and weights placed on the graduated arm until the beam is counterpoised (reading A), this is repeated with the stone in the pan (reading B), and then with the stone in the clip immersed in water (reading C). Formula B minus A divided by B minus C gives the specific gravity.

West's solution; a highly refractive liquid (R.I. 2·05); consists of white phosphorus + sulphur + methylene iodide; $P:S:CH_2I_2$ in the proportions 8:1:1.

Whewellite; $CaC_2O_4.H_2O$; R.I. 1·49–1·65; S.G. 2·23; H. 2½; Monoclinic; Colourless; Central Europe and France.

White gold; gold alloyed with silver, nickel, platinum or palladium will produce a white alloy. More than 50% of the first two metals are required in order to produce the white colour, hence the alloy is limited to 9 carat quality. 30% of platinum or 25% of palladium is required to produce white gold of 18 carat quality. White gold is used to simulate platinum as a setting for precious stones.

White light; light consisting of all colours (wave-lengths). Sometimes known as *mixed light*.

White opal; opal showing flashes of colour against a pale background. See *Opal*.

Willemite; Zn_2SiO_4; R.I. 1·693–1·712; S.G. 3·89 to 4·18; H. 5 to 6; Trigonal; Colours, yellow, green, brown and reddish; Locality, U.S.A.

Williamsite; see Serpentine.

Witherite; $BaCO_3$; R.I. 1·532–1·680; S.G. 4·27 to 4·35; H. 3½; Orthorhombic; Colour white; Localities, England, Japan, U.S.A. and Canada.

Wollastonite; $CaSiO_3$; R.I. 1·61–1·63; S.G. 2·8 to 2·9; H. 4½ to 5; Monoclinic; Colour, white; Localities, Finland, Rumania and Mexico.

Wonderstone; see *Nevada wonderstone* and *Pyrophyllite*.

Wood opal; see *Opal*.

Wulfenite; $PbMoO_4$; R.I. 2·304–2·403; S.G. 6·7 to 7; H. 3; Tetragonal; Colours, orange, yellow, green, grey and white; Localities, Australia, Zaire, Central Europe, Mexico and U.S.A.

Wyoming jade; nephrite from Wyoming, U.S.A., but the name is sometimes used for jade matrix.

Xalostocite; is an ornamental stone consisting of crystals of pink grossular garnet in white marble. Also known as Rosolite and Landerite.

Xanthite; name applied to a yellowish-brown variety of idocrase from New York State.

X-rays; the electro-magnetic radiations discovered by Röntgen in 1895 (hence sometimes called Röntgen rays) and well known for their property of penetrating opaque substances to a varying amount. They have a very short wave-length (mean about 1 Ångström, 0·1 nanometres), so short that Max von Laue, in 1912, experimented and found that the atomic structure of crystals acted as a diffraction grating for these rays and laid the foundation of crystal analysis by X-rays, work which has been followed up by Sir William Bragg and his son, Sir Lawrence Bragg. The X-ray method of pearl testing is based upon crystal diffraction, and depends upon the radial structure of the crystals of aragonite in true pearls as against the parallel arrangement of the crystals in the mother-of-pearl comprising the nucleus of cultured pearls. The spot diffraction photographs obtained by this method are termed "Lauegrams".

The differential penetrating power of the rays to certain substances is used, not only for assisting in identification of gemstones, but for the determination of pearls by revealing the fine structures of real pearls and the bead of cultured pearls. Both freshwater and cultured pearls fluoresce under X-rays and this gives some help in identification. Much synthetic ruby phosphoresces under X-rays while the real ruby does not. This is a valuable aid in the case of awkward synthetic rubies.

X-rays, Transparency to; see page 166.

Xylene (Xylol); a liquid hydrocarbon; R.I. = 1·49. See page 134.

YAG see *Yttrium aluminium garnet.*

Yellow gold; the usual colour of gold. The alloying metals being silver and copper in the proportion of roughly three to two.

Yellow ground; the name given to the top layers of the "blue ground" or kimberlite, filling the diamond pipes of South Africa, the yellow colour being due to the oxidation of the iron content.

Yellow pearls; pearls of a yellow colour obtained from the *Margaritifera carcharium* found along the coast of Shark Bay, Western Australia.

Yttrium aluminium garnet; $Y_3Al_5O_{12}$; R.I. 1·83; S.G. 4·6; H. 8. a synthetically produced crystal with a garnet structure. It is produced in a number of colours and colourless. Known as YAG, the stones are marketed as "Diamonair".

Yttrium aluminate; $YA10_3$; R.I. 1·938–1·955; S.G. 5·35; H. 8; Orthorhombic; Colours, red, pink, violet, etc.

Zerfass emerald; synthetic emerald grown by the firm of Zerfass of Germany.

Zinc blende; see *Sphalerite.*

Zincite; ZnO; R.I. 2·013–2·029; S.G. 5·43 to 5·7; H. 4 to 4½; Hexagonal; Colour, red; Locality, New Jersey, U.S.A.

Zircon; $ZrSiO_4$; two distinct types:

Normal (High) type R.I. 1·925–1·983 to 1·933–1·992; S.G. 4·60 to 4·70, usually 4·69; fully crystalline, tetragonal; Colours, honey yellow, light green, blue and red. The heat treated stones (colourless, golden-yellow and blue in colour) are of this type.

Metamict (Low) type; Composed of nearly amorphous SiO_2 and ZrO_2 due to "metamictic" decomposition of the "normal" zircon. R.I. 1·79 to 1·84; S.G. 3·95 to 4·10; Nearly singly refracting; Colours, leaf-green to dirty brownish green.

Between these two types there are found stones intermediate in character due to a partial decomposition of the "normal" type. They may display a marked banded or zonal structure. Either the "low" or "intermediate" types will return to the "normal" type on prolonged heating. Localities, Ceylon, Vietnam, Thailand (Siam), Brazil, Australia, Russia and France. Low and intermediate types are common from Ceylon. The hardness of normal zircon is 7½ and of the low type 6½.

Zircon-cut; see pages 185, 187.

Zirconia, Cubic; an artificially produced gem material. R.I. 2·18; S.G. about 5·7; H. 8·5; Dispersion 0·066; Cubic. Closely resembles diamond when cut.

Zonite; jasper from Arizona.

Zoisite; $Ca_2Al_2(AlOH)(SiO_4)_3$; S.G. 3·35; H. Crystals $8\frac{1}{2}$, massive material 6 to $6\frac{1}{2}$; R.I. 1·692–1·700; Rhombic; Blue, and sometimes green, yellow, pink or brown, which, on heat treatment usually turn blue. Found in Tanzania and hence the stones are called tanzanite. A massive pink zoisite found in Norway is called thulite (S.G. 3·10), and a massive green variety containing large opaque ruby crystals (Anyolite) is found in Tanzania.

PART TWO

Tables and Useful Data

The Crystal Systems

Cubic; Crystals are referred to three axes which are equal and at right angles to one another. There are nine planes of symmetry and three tetragonal, four trigonal and six digonal axes of symmetry (13 in all).

Tetragonal; Crystals are referred to three axes which intersect at right angles, but which have the vertical axis either longer or shorter than the lateral axes, which equal one another. There are five planes of symmetry and one tetragonal and four digonal axes of symmetry.

Hexagonal; Crystals are referred to four axes, three of which are equal, horizontal, and intersect at 60 degrees; the fourth axis is perpendicular to the other three and may be either longer or shorter than them. There are seven planes of symmetry and seven axes of symmetry (1 hexagonal and 6 digonal).

Trigonal (or Rhombohedral); Can be referred to the four crystal axes as in the hexagonal system, but this system has lower symmetry. There being only four planes of symmetry and one trigonal and three digonal axes of symmetry.

Orthorhombic; Crystals are referred to three axes of unequal length but at right angles to each other. There are three planes of symmetry and three axes of symmetry.

Monoclinic; Crystals are referred to three axes of unequal length, two of which intersect each other at an oblique angle, while the third is perpendicular to them. There is one plane of symmetry and one digonal axis of symmetry.

Triclinic; Crystals are referred to three axes, all of which are of unequal length and are all inclined to one another. This system has no symmetry planes or axes.

GEMSTONES IN ORDER OF CRYSTAL SYSTEMS

Cubic

Analcite
Chromite
Cobaltite
Cuprite
Diamond
Fluorite (Fluorspar)
Gahnite
Garnet
Gold
Haüyne
Lazurite (Lapis-lazuli)
Leucite
Microlite
Periclase
Pollucite
Pyrites
Rhodizite
Smaltite
Sodalite
Sphalerite
Spinel
Strontium titanate
Yttrium alumium garnet

Tetragonal

Anatase
Apophylite
Cassiterite
Idocrase (Vesuvianite)
Melinophane
Rutile
Scapolite
Scheelite
Wardite (?)
Wulfenite
Zircon

Hexagonal

Apatite
Beryl
Cancrinite
Niccolite
Painite
Taaffeite
Zincite

Trigonal

Benitoite
Calcite (Marble)
Corundum
Dioptase
Friedelite
Hematite
Lithium niobate
Magnesite
Phenakite
Proustite
Quartz
Rhodochrosite
Smithsonite
Stichtite
Tourmaline
Willemite

Orthorhombic

Andalusite
Anglesite
Aragonite
Barite
Beryllonite
Boracite
Bronzite
Brookite
Celestine
Cerussite
Chrysoberyl
Danburite
Dumortierite
Enstatite
Fibrolite (Sillimanite)
Hambergite
Hypersthene
Iolite
Kornerupine
Marcasite
Natrolite
Peridot
Prehnite
Pyrophyllite
Sinhalite
Staurolite
Stibiotantalite
Thomsonite
Topaz
Variscite
Witherite
Zoisite

Monoclinic

Augelite
Azurite
Bayldonite
Beryllonite
Brazilianite
Chondrodite
Colemanite
Crocoite
Datolite
Diopside
Durangite
Epidote
Euclase
Gypsum
Herderite
Howlite (?)
Jadeite
Lazulite
Lepidolite
Malachite
Meerschaum (Sepiolite)
Mesolite
Nephrite
Orthoclase Feldspar
Pectolite
Petalite
Serpentine
Shattuckite
Sphene (Titanite)
Spodumene
Talc (Soapstone)
Tremolite
Ulexite
Whewellite
Wollastonite

Triclinic

Amblygonite
Axinite
Labradorite, Microcline and Oligoclase Feldspars
Kyanite
Rhodonite
Turquoise

Amorphous

Albertite
Amber
Bakelite
Billitonite
Bitumen
Casein
Celluloid
Chrysocolla (apparently)
Copal resin
Ekanite
Glass
Ivory
Jet
Moldavite
Obsidian
Odontolite
Opal
Silica-glass
Tortoise-shell
Vegetable ivory
Vulcanite

PHYSICAL PROPERTIES

Cleavage is the tendency of a crystallised mineral to break along certain definite directions producing more or less smooth surfaces.

The following have "strong" cleavage: Diamond, Euclase, Fluorspar, Feldspar, Sphene, Spodumene, Topaz, Fibrolite, Calcite and Hambergite.

Hardness is the power a substance possesses to resist abrasion (scratching) when a pointed fragment of another substance is drawn across it.

The mineral scale of Mohs is used in determining the hardness of gemstones. This scale (printed below) depends on the fact that a harder material will scratch one that is softer. Ten minerals were selected, each of which will scratch any with lower number in the scale and will not scratch one higher in the scale. The numbers in the scale do not denote equal degrees of hardness for the difference in hardness

between 9 (corundum) and 10 (diamond) is much greater than between 9 and 8.

The Brinell scale is added as a comparison, owing to its employment in the hardness determination of metals and plastics. This scale depends upon the area of an indentation made in the material when a steel ball (or a diamond sphere), usually 2 mm. in diameter, is subjected to a pressure of, generally, 3,000 kilograms. The pressure in kilograms, making the impression, is divided by the area of the impression expressed in square millimetres. The answer is called the Brinell hardness number.

Scales of Hardness

	Mohs	*Brinell*
Talc	1	3
Gypsum	2	12
Calcite	3	53
Fluorspar	4	64
Apatite	5	137
Feldspar	6	147
Quartz	7	178
Topaz	8	304
Corundum	9	667
Diamond	10	

Finger nail	about $2\frac{1}{2}$	Mohs's Scale
Copper coin	,, 3	
Window glass	,, $5\frac{1}{2}$	
Knife blade	,, 6	
Steel file	,, $6\frac{1}{2}$	

GEMSTONES IN ORDER OF HARDNESS (*Mohs's Scale*)

1 Talc; Ulexite.

$1\frac{1}{2}$ to 2 Pyrophyllite; Soapstone.

2 Gypsum.

2 to $2\frac{1}{2}$ Amber; Bitumen (Uintahite); Casein; Celluloid; Meerschaum (Sepiolite); Pseudophite (Styrian Jade).

2 to 3 Bone; Vegetable Ivory.
2 to 4 Chrysocolla.
2½ Albertite; Dentine Ivory; Proustite; Stichtite; Tortoise-shell; Whewellite.
2½ to 3 Bakelite; Crocoite; Gold; Wulfenite.
2½ to 3½ Pearl.
2½ to 5 Serpentine.
3 Calcite; Anglesite; Barytes; Verdite.
3 to 3½ Aragonite.
3½ Azurite; Celestine; Cerussite; Coral; Howlite; Jet; Lepidolite; Malachite; Witherite.
3½ to 4 Bastite.
4 Cuprite; Fluorspar; Rhodochrosite.
4 to 4½ Zincite.
4 to 5 Bowenite serpentine; Variscite.
4½ Bayldonite; Colemanite.
4½ to 5 Apophyllite; Scheelite; Wollastonite.
5 Apatite; Augelite; Dioptase; Durangite; Herderite; Melinophane; Mesolite; Obsidian; Odontolite; Pectolite; Periclase; Smithsonite; Wardite.
5 to 5½ Analcite; Datolite; Niccolite; Thomsonite; Sphene (Titanite).
5 to 6 Amatrix; Bowenite; Chlorastrolite; Diopside; Glass; Lazulite; Rhodonite; Willemite; Hypersthene.
5 to 6½ Opal.
5 to 7 Kyanite (varies with direction).
5½ Brazilianite; Chromite; Cobaltite; Enstatite; Lazurite (Lapis-lazuli); Leucite; Microlite; Moldavite; Natrolite; Smaltite.
5½ to 6 Anatase; Beryllonite; Brookite; Leucite; Sodalite; Stibiotantalite; Tremolite.
5½ to 6½ Hematite.
6 Amblygonite; Cancrinite; Orthoclase; Feldspar; G.G.G.; Lithium niobate; Silica-glass; Strontium titanate; Tugtupite; Turquoise; Zoisite.
6 to 6½ Ekanite; Marcasite; Microcline Feldspar; Petalite; Plagioclase Feldspar; Pyrites; Rutile.
6 to 7 Cassiterite; Epidote; Prehnite; Spodumene.

6½	Benitoite; Chalcedony; Garnet (Demantoid); Idocrase (Californite); Nephrite; Pollucite; Scapolite; Kornerupine; Zircon (low type).
6½ to 7	Chloromelanite; Chondrodite; Garnet (Hessonite); Jadeite; Peridot; Saussurite; Sinhalite; Axinite.
7	Boracite; Danburite; Dumortierite; Quartz; Hambergite.
7¼	Garnet (Pyrope, Spessartine, Rhodolite).
7 to 7½	Andalusite; Iolite; Staurolite; Tourmaline.
7½	Euclase; Fibrolite; Garnet (Almandine and Uvarovite); Painite; Zircon.
7½ to 8	Beryl; Gahnite; Phenakite.
8	Rhodizite; Spinel; Taaffeite; Topaz; YAG.
8½	Chrysoberyl; Zirconia (cubic); Zoisite (Tanzanite).
9	Corundum.
9¼	Carborundum } Synthetic products used as
9½	Boron carbide } abrasives.
10	Diamond; Borazon.

Specific Gravity; The specific gravity of a substance is its weight compared with the weight of an equal volume of pure water at a temperature of 4 degrees Centigrade.

Formula for determining specific gravity by the direct weighing method:

$$\frac{X}{X-Y} \times T = \text{specific gravity.}$$

where X is the weight of the specimen in air, Y the weight of the specimen when immersed in liquid, and T the density of the liquid used (water, ethylene dibromide or toluol) at the temperature of the experiment.

Temperature correction tables on pages 32–235.

Heavy liquids used in comparative methods (a stone will float in a liquid of greater density and will sink in one less dense).

1. Salt solution: 10 level teaspoonfuls of common salt in a ½ pint tumbler of water gives a solution having a density of between 1·12 and 1·14; this is a useful test for amber.
2. Bromoform: Density = 2·90 which can be lowered by dilution with toluol.
3. Acetylene tetrabromide: Density = 2·95 which is lowered by dilution with toluol.
4. Sonstadt's solution (a saturated solution of potassium mercuric iodide in water). Density = 3·18 which is lowered by dilution with water.
5. Klein's solution (cadmium boro-tungstate in water). Density = 3·28 which is lowered by dilution with water.
6. Methylene Iodide (CH_2I_2). Density = 3·32 which is lowered by dilution with either benzene or toluol.
7. Rohrbach's solution (barium mercuric iodide in water). Density = 3·58.
8. Methylene iodide, with dissolved iodine and iodoform. Density = 3·6.
9. Clerici's solution (thallium malonate and formate in water). Density up to 4·15 at room temperatures. May be diluted with water to lower density.
10. Retger's salt (thallium silver nitrate), is a solid at ordinary room temperature, and for use must be heated in a water bath to 75 degrees Centigrade, when it melts to a yellow liquid having a density of 4·6, and may be reduced to a lower density by dilution with water.

Tables of Specific Gravities

It was found that the table of specific gravity as published in the first edition was, owing to its completeness, somewhat unwieldy when this constant was required to be ascertained for the more important gemstones. Therefore, in this edition the main table is prefaced by a smaller table giving the mean values for those stones which are more usual in jewellery.

SPECIFIC GRAVITY OF THE MORE IMPORTANT GEM MATERIALS

These are mean figures only. For fuller data the main table should be consulted.

Polystyrene	1·05
Amber	1·08
Perspex	1·18
Bakelite (synthetic resin)	1·26
Tortoiseshell	1·29
Casein (plastic material)	1·33
Celluloid	1·38
Vegetable ivory	1·40
Dentine ivory	1·85
Bone	2·00
Fire opal	2·00
Opal	2·1
Obsidian	2·4
Moonstone	2·57
Chalcedony	2·6
Quartz	2·65
Coral	2·68
Beryl (*Aquamarine and yellow*)	2·69
„ (*Emerald*)	2·71
„ (*Pink*)	2·80
Pearl (*Oriental*)	2·71
„ (*Cultured*)	2·75
Turquoise (*American*)	2·6
„ (*Persian and Egyptian*)	2·8
Lapis-lazuli	2·8
Pink pearl (*Conch pearl*)	2·85
Nephrite (*Jade, part*)	3·00
Tourmaline	3·05
Andalusite	3·15
Fluorspar	3·18
Spodumene	3·18
Jadeite (*Jade, part*)	3·33
Peridot	3·34

Sinhalite	3·46
Diamond	3·52
Topaz (*Pink and yellow*)	3·53
„ (*Colourless and blue*)	3·56
Sphene	3·53
Spinel (*Natural*)	3·60
„ (*Synthetic*)	3·63
Garnet (*Hessonite*)	3·65
Chrysoberyl	3·72
Garnet (*Pyrope*)	3·75
„ (*Demantoid*)	3·84
„ (*Almandine*)	3·97
Corundum (*Ruby and sapphires*)	3·99
Zircon (*Low type=green*)	4·00
Synthetic rutile	4·25
Zircon (*Intermediate type*)	4·4
„ (*High type*)	4·69
Strontium titanate	5·13

Main Table of Specific Gravities

The heavy liquids are included in the following table in *italic* type.

Amber	1·03 to 1.10
Copal Resin	1·03 to 1.10
Bitumen (Uintahite)	1·035 to 1.07
Polystyrene	1·05
Albertite	1·097
Meerschaum (Sepiolite)	1·10 to 1·20
Jet	1·10 to 1·40
most usually	1·20 to 1·30
Salt Solution—see headnote	1·12 to 1·14
Vulcanite	1·15 to 1·20
Perspex and Diakon plastics	1·18 to 1·19
Bakelite	1·25 to 2·00
Clear types	1·25 to 1·30
Glycerol (*Glycerine*) (at 20 degrees C.)	1·26
Tortoise-shell	1·26 to 1·35

Cellulose acetate (safety celluloid)	1·29	to 1·80
Clear types	1·29	to 1·40
Casein	1·32	to 1·39
Usually	1·32	to 1·34
Cellulose nitrate (Celluloid)	1·36	to 1·80
Usually	1·36	to 1·42
Vegetable ivory	1·38	to 1·42
Deer horn	1·60	to 1·85
Ulexite	1·65	to 2·00
Dentine ivory	1·70	to 1·98
Elephant and Mammoth	1·70	to 1·85
Hippo., Walrus and Narwhal	1·85	to 1·98
Bone	1·70	to 2·10
Usually	1·94	to 2·10
Opal	1·95	to 2·20
Fire opal	1·97	to 2·06
Chrysocolla	2·10	to 2·20
Stichtite	2·15	to 2·20
Dibromoethane (*Ethylene dibromide*)	2·19	
Natrolite	2·20	to 2·25
Sodalite	2·2	to 2·4
Silica-glass	2·21	
Gypsum	2·20	to 2·40
Alabaster	2·30	to 2·33
Analcite	2·22	to 2·29
Whewellite	2·23	
Mesolite	2·29	
Porcelain	2·3	
Thomsonite	2·3	to 2·4
Apophyllite	2·30	to 2·50
Obsidian	2·3	to 2·5
Moldavite	2·3	to 2·5
Hambergite	2·35	
Tugtupite	2·36	
Petalite	2·39	to 2·46
Lazurite	2·40	
Pearl	2·40	to 2·78
Fine pearl	2·07	to 2·75

Blue pearl	2·40	to 2·65
Black clam pearl	2·20	to 2·66
Australian pearl	2·72	to 2·78
Cultured pearl	2·70	to 2·78
Colemanite	2·42	
Cancrinite	2·42	to 2·50
Leucite	2·45	to 2·50
Serpentine	2·50	to 2·65
Lapis-lazuli	2·50	to 2·90
Included pyrites may bring S.G. to over 3·0		
Variscite	2·4	to 2·6
Feldspar	2·54	to 2·72
Yellow orthoclase	2·56	to 2·57
Moonstone	2·55	to 2·58
Sunstone	2·62	to 2·65
Microcline (Amazon stone)	2·54	to 2·57
Labradorite	2·70	to 2·72
Elaeolite	2·55	to 2·65
Iolite	2·57	to 2·66
Howlite	2·58	
Bowenite serpentine	2·58	to 2·62
Marble	2·58	to 2·75
Pseudophite (Styrian Jade)	2·60	to 2·85
Bastite	2·6	
Slate	2·6	to 2·7
Coral	2·6	to 2·7
Williamsite serpentine	2·61	
Chalcedony (Crypto-cryst. Quartz)	2·60	to 2·65
Scapolite	2·60	to 2·71
Yellow	2·70	
Pink	2·61	to 2·65
Blue	2·63	
Sunstone feldspar	2·62	to 2·65
Turquoise	2·6	to 2·85
American usually	2·6	
Persian and Egyptian usually	2·8	
Quartz (Crystalline)	2·651	
Beryl	2·65	to 2·85

Colourless (Goshenite)	2·69 to 2·70
Yellow (Golden beryl)	2·69 to 2·70
Grass-green (Emerald)	2·65 to 2·76
Pink (Morganite)	2·75 to 2·85
Pale Green (Aquamarine)	2·68 to 2·73
Blue (Aquamarine)	2·69 to 2·73
Synthetic emerald	2·66 to 2·71
Augelite	near 2·7
Steatite	2·7 to 2·8
Soapstone (massive)	2·20 to 2·80
Labradorite	2·70 to 2·72
Calcite	2·71
Marble	2·58 to 2·75
Pectolite	2·74 to 2·88
Pyrophyllite	about 2·8
Beryllonite	2·80 to 2·85
Wollastonite	2·8 to 2·9
Lepidolite	2·8 to 2·9
Prehnite	2·80 to 2·95
Usually	2·88 to 2·94
Verdite	2·80 to 2·99
Wardite	2·81
Pink pearl	2·84 to 2·89
Pollucite	2·85 to 2·94
Unakite	2·85 to 3·20
Bromoform	2·90
Datolite	2·90 to 3·00
Nephrite (Jade, part)	2·90 to 3·02
Carbonado	2·9 to 3·5
Aragonite	2·93
Brazilianite	2·94
Tetrabromoethane (*Acetylene Tetrabromide*)	2·95
Phenakite	2·95 to 3·0
Boracite	2·96
Tremolite	2·98
Danburite	3·00
Herderite	3·00
Melinophane	3·00

Magnesite	3·00 to 3·12
Tourmaline	3·00 to 3·12
Colourless (Achroite)	3·08 to 3·12
Green	3·04 to 3·10
Blue	3·09 to 3·11
Brown	3·05 to 3·09
Pink	3·00 to 3·05
Red	3·02 to 3·06
Yellow	3·08 to 3·10
Black	3·10 to 3·12
Odontolite (Bone turquoise)	3·00 to 3·25
Amblygonite	3·015 to 3·033
Friedelite	3·07
Chondrodite	3·1
Euclase	3·10
Lazulite	3·1
Andalusite	3·10 to 3·20
Apatite	3·15 to 3·22
Carborundum	3·17
Fluorspar	3·17 to 3·19
Spodumene	3·17 to 3·23
Sonstadt's Solution	3·18
Saussurite	about 3·2
Chlorastrolite	3·2
Diopside	3·20 to 3·34
Californite (Idocrase)	3·25 to 3·32
Fibrolite (Sillimanite)	3·25
Enstatite	3·25 to 3·30
Zoisite (Thulite)	3·10
Epidote	3·25 to 3·50
Dumortierite	3·26 to 3·36
Kornerupine	3·27 to 3·32
Axinite	3·27 to 3·29
Klein's Solution	3·28
Ekanite	3·28
Dioptase	3·3
Jadeite	3·3 to 3·5
Peridot	3·34

Garnet	3·30	to 4·20
Grossularite	3·30	to 3·72
Uvarovite	3·41	to 3·52
Hessonite	3·55	to 3·67
Pyrope	3·68	to 3·80
Rhodolite	3·84	
Andradite	3·80	to 3·90
Demantoid	3·83	to 3·85
Almandine	3·80	to 4·20
Spessartine	3·90	to 4·20
Di-iodomethane (*Methylene Iodide*)	3·32	
Hypersthene	3·3	to 3·4
Zoisite (Tanzanite)	3·35	
Idocrase	3·35	to 3·45
Clinoenstatite	3·37	
Chloromelanite	3·4	
Rhodizite	3·40	
Rhodonite	3·40	to 3·70
Usually	3·6	to 3·7
Staurolite	3·4	to 3·80
Rhodochrosite	3·45	to 3·70
Usually	3·50	to 3·65
Sinhalite	3·47	to 3·49
Diamond	3·51	to 3·52
Topaz	3·50	to 3·60
Colourless	3·55	to 3·5
Yellow	3·53	to 3·58
Brown	3·50	to 3·60
Pink	3·50	to 3·54
Blue	3·55	to 3·60
Sphene (Titanite)	3·52	to 3·54
Periclase	3·55	to 3·60
Rohrbach's Solution	3·58	
Methylene + Iodine + Iodoform	3·60	
Taaffeite	3·60	
Kyanite	3·65	to 3·69
Hessonite (Garnet)	3·55	to 3·67
Spinel	3·58	to 3·75

Blue	3·60	to 3·75
Pink	3·58	to 3·61
Purple	3·58	to 3·64
Red	3·58	to 3·64
Ceylonite	3·63	to 3·90
Gahnospinel	may reach	4·06
Synthetic	3·61	to 3·65
Benitoite	3·64	to 3·65
Pyrope (Garnet)	3·68	to 3·80
Chrysoberyl	3·68	to 3·78
Malachite	3·74	to 3·95
Azurite	3·77	to 3·89
Shattuckite	near	3·8
Andradite	3·80	to 3·90
Demantoid	3·83	to 3·85
Anatase	3·82	to 3·95
Rhodolite (Garnet)	3·84	
Almandine (Garnet)	3·80	to 4·20
Brookite	3·87	to 4·08
Willemite	3·89	to 4·18
Zircon	3·95	to 4·72
(Low type) (Green)	3·95	to 4·10
(Normal type) (Blue)	4·65	to 4·70
(Brown)	4·65	to 4·70
(Red)	4·65	to 4·70
(Orange Yellow)	4·65	to 4·70
Intermediate type	4·1	to 4·6
Corundum	3·96	to 4·05
Red (Burma Ruby)	3·97	to 4·01
(Siam Ruby)	3·99	to 4·05
Purple	3·97	to 4·01
Pink	3·97	to 4·00
Blue	3·97	to 4·01
Green	3·99	to 4·01
Colourless	3·99	to 4·00
Yellow	3·96	to 4·01
Synthetics	3·98	to 4·00

Celestine	3·97	to 4·00
Durangite	3·97	to 4·07
Spessartine (Garnet)	3·90	to 4·20
Painite	4·01	
Calcium titanate	4·05	
Sphalerite (Blende)	4·08	to 4·10
Clerici's Solution	4·15	
Rutile	4·20	to 4·30
Synthetic	4·25	
Witherite	4·27	to 4·36
Chromite	4·3	to 4·6
Smithsonite	4·3	to 4·65
Bayldonite	4·35	
Gahnite	4·40	
Barytes	4·47	
Yttrium aluminium garnet (YAG)	4·58	
Retger's Salt	4·6	
Lithium niobate	4·64	
Marcasite	4·8	
Pyrites	4·84	to 5·10
Hematite	4·95	to 5·3
Strontium titanate	5·13	
Zincite	5·43	to 5·7
Microlite	5·5	
Proustite	5·57	to 5·64
Zirconia (Cubic)	5·7	
Cuprite	5·85	to 6·15
Barium titanate	5·90	
Scheelite	5·90	to 6·10
Crocoite	5·90	to 6·10
Smaltite	6·0	to 6·3
Cobaltite	6·0	to 6·4
Anglesite	6·30	to 6·39
Cerussite	6·5	
Wulfenite	6·7	to 7·0
Cassiterite	6·8	to 7·1
G.G.G.	7·05	
Niccolite	7·3	to 7·6

Stibiotantalite	7·4
Stainless steel	7·9
Silver—Standard	10·31
Fine (pure)	10·5
Gold— 9 carat	11·4
15 carat	14·0
18 carat	15·4
22 carat	17·7
Fine (pure)	19·32
Palladium	11·4
Ruthenium	12·3
Rhodium	12·44
Platinum	21·5
Iridium	22·41
Osmium	22·5

REFRACTIVE INDEX

Snell's Law

(*a*) When a ray of light passes from one medium into another the sine of the angle of incidence bears to the sine of the angle of refraction a definite ratio which depends only upon the two media in contact and the nature (colour) of the light.

(*b*) The incident ray, the normal at the point of incidence and the refracted ray are all in the same plane.

When light is passing from air into a given medium the ratio:

$$\frac{\sin(\text{angle of incidence})}{\sin(\text{angle of refraction})}$$

is known as the refractive index of the medium in question (for *sine of an angle* see page 94).

Methods of determining refractive index

(*a*) Refractometer; a calibrated instrument for the direct reading of refractive index.

(*b*) Immersion Method: when a specimen is immersed in a liquid having a similar refractive index the relief is low, *i.e.*, the edges tend to disappear. The specimen is im-

mersed in one liquid after another until one is found in which it most completely disappears, it is then known that the specimen must have a refractive index near to that of the liquid.

(*c*) Becke's method: when a specimen is immersed in a liquid of known refractive index and viewed by a microscope, and the microscope tube is raised from the position of exact focus, a white line is seen at the margin of specimen and liquid, which travels into the medium of higher refraction. Hence, whether the index of the specimen is higher or lower than the liquid of known index, or between two such liquids, may be easily determined. (Mainly suitable for small fragments.)

(*d*) Direct measurement by microscope: a specimen with parallel surfaces is placed on a microscope slide on the stage of a measuring or petrological microscope with calibrated fine adjustment in such a way that the top and bottom faces of the specimen are two parallel planes. The top is focused and a reading made, then the microscope is focused on the lower face of the specimen as seen through the top face, the difference in the readings giving the apparent depth of the specimen. Then by pushing the glass slide along and focusing the microscope on its surface, the difference between this reading and the reading of the top face gives the real depth of the specimen. The simple calculation:

$$\frac{\text{real depth}}{\text{apparent depth}}$$

gives the refractive index for isotropic stones and the ordinary ray in uniaxial stones.

(*e*) Minimum deviation: by the use of a spectrometer or goniometer. The stone is first set on the table of the instrument with two facets acting as a prism with the apex pointing towards the collimating tube so that the illuminated slit is reflected off both faces forming the

prism. The telescope is moved until the cross-wires are aligned with the reflections of the slit and the difference of two readings gives twice the angle A of the prism. The table bearing the stone is now rotated so that the ray from the collimating tube passes across the prism faces previously measured. The signal will now be bent out of straight, due to refraction, and be coloured, due to dispersion (unless monochromatic light is used). Signal is read when the telescope cross-wires are aligned on the yellow at the position of minimum deviation. The table bearing the stone is now rotated so that a corresponding measurement may be taken on the opposite side, this combined angle being divided by two which gives the angle D. Then by the following calculation the refractive index is found.

$$\text{R.I.} = \frac{\sin \frac{1}{2}(A+D)}{\sin \frac{1}{2} A}$$

Example:

Circle reading for reflection from first prism face	353°	22½′
Circle reading for reflection from second prism face	233°	36′
Difference	119°	46½′
This figure divided by 2 gives the angle A of the prism	59°	53¼′
First measurement of minimum deviation	343°	43′
Second measurement of minimum deviation	247°	7½′
	96°	35½′
Divide by 2 to obtain angle of minimum deviation D	48°	17¾′

Thus we have:

$$\text{R.I.} = \frac{\text{Sin } \frac{1}{2}(\text{A}+\text{D})}{\text{Sin } \frac{1}{2}\text{A}} = \frac{\text{Sin } \frac{1}{2}(108°11')}{\text{Sin } \frac{1}{2}(59°53\frac{1}{4}')} = \frac{\text{Sin } 54{\cdot}5\frac{1}{2}'}{\text{Sin } 29{\cdot}56\frac{5}{8}'}$$

Using logarithms:

$$\text{R.I.} = \text{antilog } (90847—69825) = 1{\cdot}6227$$

A list of liquids (with their refractive indices) suitable for approximate immersion and Becke line tests are tabled under. Liquids are also included in the main table of refractive indices of gem materials.

A list of suitable liquids for use in approximate immersion, Becke line and shadow methods for Refractive Index Determinations

Slight differences in the purity of these oils and liquids occur in the commercial state and it is advisable to check the values on a refractometer if accurate work is contemplated.

Water	1·33
Alcohol	1·36
Amyl acetate	1·37
Petroleum	1·45
Turpentine	1·47
Olive Oil	1·47
Glycerol (Glycerine)	1·47
Castor Oil	1·48
Xylene	1·49
Toluene	1·49
Cedar Wood Oil	1·51
Chlorobenzene (Monochlorbenzol)	1·53
Canada Balsam	1·53
Clove Oil	1·54
Dibromoethane (Ethylene dibromide)	1·54
Nitrobenzene	1·55

Bromotoluene	1·55
Dimethylaniline	1·56
Benzyl benzoate	1·57
Orthotoluidine	1·57
Aniline	1·58
Cinnamon Oil	1·59
Bromoform	1·59
Cassia Oil	1·60
Iodobenzene	1·62
Monochlornaphthalene	1·63
Tetrabromoethane (Acetylene tetrabromide)	1·63
Monobromonaphthalene	1·66
Iodo naphthalene	1·70
Di-iodomethane (Methylene Iodide)	1·74
Di-iodomethane (Methylene Iodide) and Sulphur	1·78
Di-iodomethane (Methylene Iodide), S. and C_2I_4	1·81
Phenyldi-iodoarsine	1·85
West's Solution	2·05

TABLE OF OPTICAL PROPERTIES

Singly refracting or isotropic	Amorphous substances and cubic crystals		one index of refraction, n
Doubly refracting or anisotropic	Hexagonal, Trigonal, Tetragonal	Uniaxial	two indices of refraction, ω and ϵ positive, ω less than ϵ. negative, ϵ less than ω.
	Rhombic, Monoclinic, Triclinic	Biaxial	three indices of refraction, α, β and γ. positive, $\alpha\beta$—γ. negative, α—$\beta\gamma$.

i.e. When the intermediate index of refraction β is nearer to α = positive, when nearer to γ = negative.

It is possible to ascertain on a refractometer whether a gem of the uniaxial group is positive or negative by noting which shadow edge moves on rotation of the stone. In some biaxial stones it is possible to obtain this information by similar means.

Consistent with the tables for specific gravity, the main table of refractive indices is prefaced with a smaller table giving the mean values for the most important gem species.

THE REFRACTIVE INDICES OF THE MORE IMPORTANT GEM SPECIES

	Refractive Index		Bi-refringence
Fluorspar	1·43		—
Opal	1·45		—
Feldspar	1·53	1·54	·005
Quartz	1·54	1·55	·009
Synthetic emerald	1·56	1·56	·003
Beryl	1·57	1·58	·006
Topaz	1·62	1·63	·008
Tourmaline	1·62	1·64	·018
Andalusite	1·63	1·64	·010
Spodumene	1·66	1·68	·015
Peridot	1·65	1·69	·038
Spinel	1·72		—
Chrysoberyl	1·74	1·75	·009
Hessonite Garnet	1·74		—
Pyrope Garnet	1·75		—
Corundum	1·76	1·77	·008
Spessartine Garnet	1·80		—
Almandine Garnet	1·81		—
Demantoid Garnet	1·89		—
Sphene	1·90	2·20	·115
Zircon	1·93	1·99	·059
Strontium titanate	2·41		—
Diamond	2·42		—
Synthetic rutile	2·62	2·90	·287

Pyrope garnet intermixes by isomorphous replacement with almandine garnet; thus a series of garnets having a refractive index of any value between 1·75 and 1·81 may be found.

Glass (paste stones) may have any refractive index, but are usually between 1·50 and 1·70; thus, as there are few singly refractive natural stones between these values, a stone giving a singly refractive reading between these values should give suspicion that it is a paste.

MAIN TABLE OF GEMSTONES

In the order of their Refractive Indices for yellow light, with their optical character, birefringence, etc.

N.B.—The word "to" between figures implies variation in range; "–" shows the greatest and least readings in doubly-retracting stones; names of liquids are printed in *italics*.

	Refractive Indices	Birefr.	Optic Sign	Isotropic Uniaxial or Biaxial
Water	1·333	—	—	I
Alcohol	1·36	—	—	I
Amyl acetate	1·37	—	—	I
Fluorspar	1·43	—	—	I
Opal	1·44 to 1·47	—	—	I
„ Fire	1·453 to 1·455	—	—	I
Petroleum	1·45	—	—	I
Silica Glass	1·46	—	—	I
Turpentine	1·47	—	—	I
Glycerol	1·47	—	—	I
Olive Oil	1·47	—	—	I
Castor Oil	1·48	—	—	I
Natrolite	1·480–1·493	0·013	Pos.	B
Moldavite	1·48–1·50	—	—	I
Calcite	1·486–1·658	0·172	Neg.	U
Analcite	1·487	—	—	I
Toluene	1·49	—	—	I
Xylene	1·49	—	—	I
Celluloids—				
Cellulose acetate	1·490 to 1·505	—	—	I
Cellulose nitrate	1·495 to 1·51	—	—	I
Thomsonite	1·497–1·525	0·028	Pos.	B
Whewellite	1·49–1·65	0·160	Pos.	B
Benzene	1·50	—	—	I

	Refractive Indices	Birefr.	Optic Sign	Isotropic Uniaxial or Biaxial
Obsidian	1·50	—	—	I
Lazurite	1·50	—	—	I
Tugtupite	mean 1·50	0·006	Pos.	U
Mesolite	mean 1·50	—	—	B
Chrysocolla	about 1·50	0·011	Pos.	U
Serpentine	mean 1·50 to 1·57	—	—	B
Petalite	1·505–1·519	0·014	Pos.	B
Pollucite	1·51	—	—	I
Cedar Wood Oil	1·51	—	—	I
Leucite	1·51	—	—	I
Ulexite	mean 1·51	—	—	B
Cancrinite	mean 1·51	0·022	Neg.	U
Magnesite	1·515–1·717	0·202	Neg.	U
Feldspar—				
Moonstone and Orthoclase	1·52–1·53 to 1·53–1·54	0·008	Neg.	B
Sunstone	1·54–1·55	0·01	Neg.	B
Microcline	1·52–1·53	0·008	Neg.	B
Labradorite	1·56–1·57	0·01	Pos.	B
Gypsum	1·52–1·53	0·01	Pos.	B
Apophyllite	about 1–53	—	—	U
Canada Balsam	1·53	—	—	I
Chlorobenzene	1·53	—	—	I
Stichtite	mean 1·53	0·027	Neg.	U
Aragonite	1·531–1·686	0·155	Neg.	B
Witherite	1·532–1·680	0·148	Neg.	B
Elaeolite	1·538–1·542	0·004	Neg.	U
Iolite	1·53–1·54 to 1·54–1·55	0·01	Neg.	B
Steatite (Soapstone)	1·54–1·59	0·05	Neg.	B
Amber	1·54	—	—	I
Clove Oil	1·54	—	—	I
Vegetable Ivory	1·54	—	—	I
Dentine Ivory	1·54	—	—	I

	Refractive Indices	Birefr.	Optic Sign	Isotropic Uniaxial or Biaxial
Bone	about 1·54	—	—	I
Scapolite—				
Pink and Yellow	1·548–1·570	0·022	Neg.	U
Blue	1·544–1·560	0·016	Neg.	U
Bakelites	1·54 to 1·70	—	—	I
Usually	1·62 to 1·66	—	—	I
Quartz	1·543–1·552 to 1·545–1·554	0·009	Pos.	U
Nitrobenzene	1·55	—	—	I
Bromotoluene	1·55	—	—	I
Albertite	1·55	—	—	I
Meerschaum	mean 1·55	—	—	B
Lepidolite	mean 1·55	—	—	B
Beryllonite	1·552–1·564 to 1·554–1·566	0·012	Neg.	B
Casein	1·55 to 1·56	—	—	I
Tortoise-shell	1·55 to 1·56	—	—	I
Hambergite	1·55–1·62	0·07	Pos.	B
Dimethylaniline	1·56	—	—	I
Bowenite	mean 1·56	—	—	B
Labradorite—				
(Feldspar)	1·56–1·57	0·01	Pos.	B
Beryl—				
Emerald	1·560–1·565 to 1·587–1·593	varies		
Aquamarine	1·570–1·575 to 1·580–1·586	0·005 to 0·009	Neg.	U
Yellow	1·568–1·573			
Pink	1·580–1·588 to 1·590–1·599			
Benzyl benzoate	1·57	—	—	I
Orthotoluidine	1·57	—	—	I
Pyrophyllite	mean 1·57	—	—	B
Variscite	mean 1·57	—	Neg.	B
Augelite	1·574–1·588	0·014	Pos.	B

	Refractive Indices	Birefr.	Optic Sign	Isotropic Uniaxial or Biaxial
Pseudophite . .	1·576–1·579	0·003	P–N	B
Aniline . . .	1·58	—	—	I
Verdite . . .	mean 1·58	—	—	—
Colemanite . .	1·586–1·614	0·028	Pos.	B
Bromoform . .	1·59	—	—	I
Cinnamon Oil . .	1·59	—	—	I
Polystyrene . .	1·59	—	—	I
Howlite . . .	mean 1·59	—	—	—
Wardite . . .	mean 1·59	—	—	—
Melinophane . .	1·593–1·612	0·019	Neg.	U
Herderite . . .	1·594–1·624	0·030	Neg.	B
Pectolite . . .	1·595–1·633	0·038	Pos.	B
Rhodochrosite . .	1·597–1·817 to 1·605–1·826	0·22	Neg.	U
Brazilianite . .	1·598–1·617	0·019	Pos.	B
Cassia Oil . . .	1·60	—	—	I
Ekanite . . .	1·60	—	—	I
Tremolite . . .	1·60–1·62	0·020	Neg.	B
Vulcanite . . .	1·60 to 1·63	—	—	I
Nephrite . . .	1·60–1·63 to 1·62–1·65	0·03	Neg.	B
Topaz—				
Blue & white .	1·61–1·62	0·010	Pos.	B
Brown & pink .	1·63–1·64	0·008	Pos.	B
Wollastonite . .	1·61–1·63	0·015	Neg.	B
Amblygonite . .	1·611–1·637	0·026	Pos.	B
Chondrodite . .	1·61–1·64	0·032	Pos.	B
Prehnite . . .	1·61–1·64	0·03	Pos.	B
Turquoise . . .	1·61 to 1·65	—	—	B
Tourmaline . .	1·616–1·634 to 1·630–1·652	0·014 to 0·021	Neg.	U
Iodobenzene . .	1·62	—	—	I
Smithsonite . .	1·62–1·85	0·23	Neg.	U
Celestine . . .	1·62–1·63	0·010	Pos.	B

	Refractive Indices	Birefr.	Optic Sign	Isotropic Uniaxial or Biaxial
Datolite	1·625–1·669	0·044	Neg.	B
Carbon disulphide	1·63	—	—	I
Monochlornaphthalene	1·63	—	—	I
Tetrabromoethane	1·633	—	—	I
Lazulite	mean 1·63	0·036	Neg.	B
Danburite	1·630–1·636	0·006	Neg.	B
Andalusite	1·634–1·644 to 1·641–1·648	0·007 to 0·011	Neg.	B
Apatite	1·63–1·64 to 1·64–1·65	0·004	Neg.	U
Friedelite	1·63–1·66	0·030	Neg.	U
Barytes	1·636–1·648	0·012	Pos.	B
Jet	1·64 to 1·68	—	—	I
Dioptase	1·644–1·697 to 1·658–1·709	0·053	Pos.	U
Peridot	1·650–1·688 to 1·668–1·706	0·038	Pos.	B
Jadeite	mean 1·65 to 1·68	0·02	Pos.	B
Euclase	1·652–1·672	0·020	Pos.	B
Fibrolite	1·658–1·678	0·020	Pos.	B
Spodumene	1·660–1·675 to 1·664–1·679	0·015	Pos.	B
Malachite	1·65–1·90	0·25	Neg.	B
Phenakite	1·654–1·670	0·016	Pos.	U
Enstatite	1·663–1·673	0·010	Pos.	B
Monobromonaphthalene	1·66	—	—	I
Boracite	1·66 to 1·67	—	—	I
Kornerupine	1·665–1·678	0·013	Neg.	B
Durangite	1·66–1·71	0·050	Neg.	B
Axinite	1·674–1·684	0·01	Neg.	B
Hypersthene	1·67–1·68 to 1·69–1·70	0·01	Pos.	B

	Refractive Indices	Birefr.	Optic Sign	Isotropic Uniaxial or Biaxial
Diopside	1·67–1·70	0·03	Pos.	B
Sinhalite	1·67–1·71	0·038	Neg.	B
Dumortierite	1·678–1·689	0·011	Neg.	B
Rhodizite	1·69	—	—	I
Willemite	1·693–1·712	0·019	Pos.	U
Zoisite	1·692–1·700	0·008	Pos.	B
Idocrase	1·702–1·706 to 1·726–1·732	0·004	Pos.	U
Iodo naphthalene	1·704	—	—	—
Kyanite	1·715–1·732	0·017	Neg.	B
Rhodonite	1·71–1·73 to 1·72–1·75	0·02	Pos.	B
Taaffeite	1·717–1·721	0·004	Neg.	U
Spinel	1·714 to 1·736			
Gahnospinel	1·73 to 1·75			
Ceylonite	1·77–1·80	—	—	I
Synthetics	1·725 to 1·728			
Clinozoisite	1·724–1·734	0·010	Pos.	B
Periclase	1·73	—	—	I
Epidote	1·736–1·770	0·034	Pos.	B
Pyrope Garnet	1·74 to 1·75			
Theoretical figure	1·70	—	—	I
Hessonite Garnet	1·742–1·748	—	—	I
Di-iodomethane	1·742	—	—	I
Staurolite	1·74–1·75 to 1·75–1·76	0·01	Pos.	B
Chrysoberyl	1·742–1·749 to 1·750–1·757	0·009	Pos.	B
Shattuckite	1·752–1·815	—	—	—
Benitoite	1·757–1·804	0·047	Pos.	U
Corundum	1·759–1·767 to 1·770–1·779	0·008	Neg.	U
Azurite	1·730–1·838	0·11	Pos.	B
Rhodolite Garnet	1·76	—	—	I

	Refractive Indices	Birefr.	Optic Sign	Isotropic Uniaxial or Biaxial
Almandine Garnet	1·75 to 1·82	—	—	I
Painite	1·787–1·816	0·029	Neg.	U
Di-iodomethane and Sulphur	1·79	—	—	I
Spessartine Garnet	1·79 to 1.81	—	—	I
Cerussite	1·804–2·078	0·274	Neg.	B
Gahnite	1·805	—	—	I
Di-iodomethane, S and C_2I_4	1·81	—	—	I
Andradite Garnet	1·82 to 1·89	—	—	I
Demantoid Garnet	1·88 to 1·89			
YAG	1·83	—	—	I
Phenyldi-iodoarsine	1·85	—	—	I
Uvarovite Garnet	1·84 to 1·85	—	—	I
Zircon—				
Green (Low type)	1·79 to 1·84		Practically	I
White (Normal type)	1·925–1·984			
Blue	1·925–1·984			
Brown	1·92–1·98 to 1·93–1·99	0·059	Pos.	U
Yellow	1·923–1·967 to 1·931–1·993			
Red	1·923–1·967 to 1·931–1·993			

Intermediate types vary between the *low* and the *normal* types.

Anglesite	1·877–1·894	0·017	Pos.	B
Sphene (Titanite)	1·885–1·990 to 1·915–2·050	0·105 to 0·135	Pos.	B
Scheelite	1·918–1·934	0·016	Pos.	U
Microlite	1·93	—	—	I
Bayldonite	1·95–1·99	0·04	Pos.	B
Cassiterite	2·003–2·101	0·098	Pos.	U
Zincite	2·013–2·029	0·016	Pos.	U
G.G.G.	2·02	—	—	I

	Refractive Indices	Birefr.	Optic Sign	Isotropic Uniaxial or Biaxial
West's Solution	2·05	—	—	I
Zirconia (Cubic)	2·18	—	—	I
Lithium niobate	2·21–2·30	0·09	?	U
Wulfenite	2·304–2·402	0·098	Neg.	U
Crocoite	3·21–2·66	0·35	Pos.	B
Sphalerite	2·368 to 2·371	—	—	I
Stibiotantalite	2·39–2·46	0·07	Pos.	B
Calcium titanate	2·40	—	—	I
Barium titanate	2·40	—	—	I
Strontium titanate	2·41	—	—	I
Diamond	2·417 to 2·420	—	—	I
Anatase	2·493–2·554	0·06	Neg.	U
Brookite	2·583–2·705	0·122	Pos.	B
Rutile	2·616–2·903	0·287	Pos.	U
Proustite	2·7–3·0	0·3	Neg.	U
Cuprite	2·85	—	—	I
Hematite	2·94–3·22	0·28	Neg.	U

Dispersion; the power of a transparent medium to separate the spectrum colours, the figures given being (usually) the result of the subtraction of the figures of refractive index for the red ray ("B" line at 6867Å.) from the figures of the refractive index for the violet ray ("G" line at 4308 Å.).

Following is a table of the dispersion of gemstones measured between the "B" and "G" lines of the solar spectrum.

Fluorspar	0·007	Beryl	0·014
Calcite e ray	0·008	Topaz	0·014
„ o ray	0·017	Smithsonite o ray	0·014
Silica Glass	0·010	„ e ray	0·031
Beryllonite	0·010	Hambergite	0·015
Leucite	0·010	Phenakite	0·015
Cancrinite	0·010	Chrysoberyl	0·015
Kyanite	0·011	Fibrolite	0·015

Pollucite	0·012	Spessartine Garnet	0·027
Feldspar	0·012	Willemite	0·027
Quartz	0·013	YAG	0·028
Apatite	0·013	Dioptase o ray	0·028
Brazilianite	0·014	,, e ray	0·036
Scapolite	0·017	Epidote	0·030
Corundum	0·018	G.G.G.	0·038
Kornerupine	0·018	Zircon	0·038
Sinhalite	0·018	Flint Glass	0·041
Idocrase	0·019	Diamond	0·044
Peridot	0·020	Anglesite	0·044
Spinel (natural and synthetic)	0·020	Benitoite	0·044
Kyanite	0·020	Sphene	0·051
Pyrope Garnet	0·022	Demantoid Garnet	0·057
Staurolite	0·023	Zirconia (Cubic)	0·066
Almandine Garnet	0·027	Cassiterite	0·071
Andalusite	0·016	Lithium niobate	0·120
Danburite	0·017	Sphalerite	0·156
Iolite	0·017	Strontium titanate	0·19
Tourmaline	0·017	Anatase o ray	0·213
Spodumene	0·017	,, e ray	0·259
Hessonite Garnet	0·027	Rutile	0·28
Euclase	0·016		
Danburite	0·016		
Datolite	0·016		
Crown Glass	0·016		

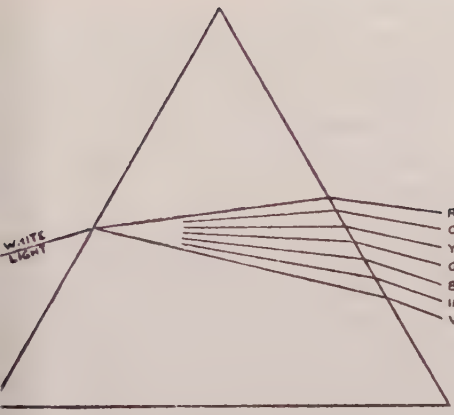


Diagram showing dispersion of a ray of white light into its spectrum colours in passing through glass prism

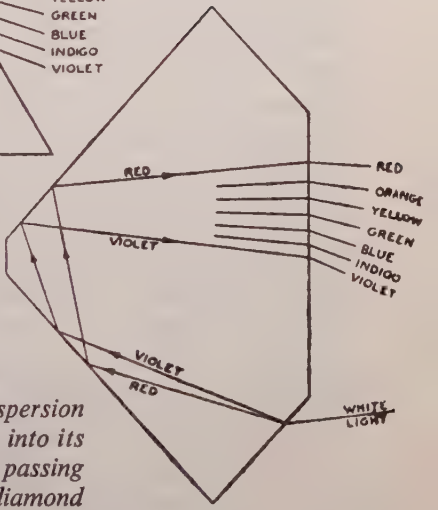


Diagram showing dispersion of a ray of white light into its spectrum colours in passing through brilliant-cut diamond

Pleochroism; the differential selective absorption of the ordinary ray and the extraordinary ray in uniaxial stones (dichroism), or of the three rays corresponding to the three principal vibration directions in biaxial stones (trichroism).

This phenomenon, which is observed with a dichroscope, enabling the two colours (or two of the three colours at a time in biaxial stones) to be viewed side by side, is not possible in amorphous materials or in any mineral crystallising in the cubic system.

A LIST OF THE PLEOCHROIC COLOURS OF THE PRINCIPAL GEMSTONES

Anatase (distinct) . .	pale blue or yellowish; dark blue or orange.
Andalusite (strong) . .	yellow; green; red.
Apatite (weak except in Burma stones)	
Yellow (Asparagus stone) . . .	golden yellow; greenish yellow.
Blue green (Moroxite)	pale yellow; sapphire-blue.
Axinite (strong) . .	violet; brown; green.
Benitoite (strong) . .	colourless; greenish to indigo-blue.
Beryl (distinct)	
Green (Emerald) . .	yellowish green; bluish green.
Greenish Blue . . (Aquamarine) . .	colourless to pale yellowish green; pale bluish green.
Blue (Aquamarine) .	colourless; sky-blue.
Pink (Morganite). .	pale rose; bluish rose.
Yellow (Heliodor) .	pale yellow; pale greenish yellow.
Violet	violet; colourless.
Chrysoberyl (strong in deep colours)	
Yellow	colourless; pale yellow; lemon yellow.
Cat's-eye . . .	reddish yellow; greenish yellow; green.
Green (Alexandrite)—	
Natural light . .	emerald-green; yellowish; columbine red.
Artificial light . .	emerald-green; reddish yellow; red.
Corundum (strong)	
Red (Ruby) . . .	pale yellowish red; deep red.
Blue (Sapphire) . .	pale greenish blue; deep blue.
Green	yellowish green; green.
Violet	yellowish red; violet red.
Yellow	imperceptible.

Corundum, Synthetic (*Alexandrite type*)	
In natural light . .	pale brownish green; deep mauve.
In artificial light . .	brownish yellow; deep mauve.
Other synthetic corundums show dichroic tints in general agreement with the natural corundums of similar colour.	
Danburite (very weak) .	pale yellow; very pale yellow; pale yellow.
Dioptase (weak) . .	dark green; light green.
Enstatite (distinct) . .	green; yellowish green; brownish green.
Epidote (strong) . .	green; yellowish green; yellow.
Euclase (distinct) . .	colourless; pale green; green.
Fibrolite (distinct) . .	colourless; pale yellow; sapphire-blue.
Iolite (strong) . . .	pale blue; pale yellow; dark violet-blue.
Kyanite (distinct) . .	pale blue; blue; dark blue.
Peridot (distinct) . .	yellow-green; green.
Quartz (weak)	
Yellow (Citrine) . .	yellow; slightly paler yellow.
Violet (Amethyst) .	purple; reddish purple.
Smoky quartz . .	brown; reddish-brown.
Rose quartz . . .	pink; pale pink.
Heat treated amethyst "topaz" colour. .	imperceptible.
Sphene (*Titanite*) (strong)	colourless; yellow; reddish yellow.
Spodumene (strong)	
Pink (Kunzite) . .	colourless; pink; violet.
Green (Hiddenite) .	bluish green; grass-green; yellowish green.
Yellow	pale yellow; deep yellow; yellow.
Staurolite (distinct) . .	red; brown; yellow.

Topaz (distinct)	
Yellow	honey-yellow; straw-yellow; pinkish yellow.
Blue	colourless; pale pink; blue.
Pink	colourless; very pale pink; pink.
Green	pale green; bluish green; colourless.
Tourmaline (strong)	
Red (Rubellite) . .	pink; dark red.
Blue (Indicolite) . .	light blue; dark blue.
Green	pale green; dark green.
Brown	yellowish brown; deep brown.
Zircon (weak except in blue)	
Red	columbine red; clove brown.
Blue	colourless; sky-blue.
Green	brownish green; green.
Yellow	brownish yellow; honey-yellow.
Brown	yellowish brown; reddish brown.
Zoisite (strong)	
Blue	blue; purple; sage green.

Absorption Spectra; when a source of white light is examined through a spectroscope, a continuous band of colour is seen, passing from red through orange, yellow, green, blue to violet, that is in order of diminishing wave-lengths, in fact, the well-known Newtonian spectrum.

When the light examined has first passed through a coloured stone, parts of the spectrum corresponding to those wave-lengths preferentially absorbed by the stone will appear less bright than the other parts. In some cases this is clearly seen as dark lines and bands. These absorption spectra as they are called, may often give a convincing diagnostic test.

In the following table, and the relating coloured plates, of the principal absorption spectra, the intention has been to give such information on the more prominent bands which would be the most useful for diagnostic purposes, thus these tables may ignore some of the weaker bands which can sometimes be seen; make no mention of the difference between the spectra of the ordinary ray and that of the extraordinary

ray observed in some stones; and give no indication of the *apparent* difference in the appearance of the spectra of similar stones which is due to the differences in the intensity of the absorption with deep coloured material, well exemplified by some almandine garnets.

Note:—*The coloured plates (in the picture section) of the absorption spectra are drawn as they would be seen through a diffraction grating spectroscope, that is with uniform dispersion. A prism spectroscope shows the red end bunched and the violet end more open.*

SPECTRA OF GEMSTONES AFFORDING USEFUL TESTS

Note:—*The units in this text are retained as Ångströms (Å.). In many future texts, the nanometre (nm) may be used. The conversion is that 1 nanometre equals 10 Ångströms; so 6,830Å.=683Nm.*

Apatite.

The yellowish-green variety shows a distinctive spectrum consisting of a group of sharp lines fairly close together in the yellow and a group of sharp lines in the blue-green. Seen in most calcium minerals and in Crookes' glass. These are due to didymium.

Beryl.

Emerald: sharp lines in the red at 6830 Å. and 6805 Å. (a wide doublet), 6620 Å. and 6460 Å., with a rather hazy absorption in the orange-yellow (6300 Å. to 5800 Å.). The synthetic emerald shows a similar absorption spectrum to the natural emerald. This spectrum is due to chromium.

Aquamarine: The bands shown by this variety of beryl are not very distinctive. There is a broad band in the violet at 4270 Å. and a diffuse band in the blue-violet at 4560 Å., both being weak and not easily seen. The extraordinary ray which may be isolated by the use of a polaroid disc allows these bands to be seen more strongly, and there may be also seen a narrow absorption line in the green at 5370 Å.

Other colours of Beryl: do not show a characteristic spectrum suitable for diagnosis.

Chrysoberyl.

Alexandrite: shows a strong doublet at 6805 Å. and 6785 Å., a weak line at 6510 Å. and a moderate line at 6450 Å., completed with a rather hazy absorption in the yellow. The three lines in the blue, at 4765 Å. and 4750 Å. (close doublet) and at 4685 Å., so well seen in ruby, are often present. Spectrum is due to chromium.

Yellow: shows a single band in the blue-violet at 4450 Å. Spectrum is due to ferric iron.

Corundum.

Ruby and Synthetic Ruby: a strong doublet at 6942 and 6928 Å. (This pair of lines, which may be said to be centred at 6935 Å., may not be resolved into two lines by the aid of an ordinary hand spectroscope. An important point is that they may often be observed not as an absorption but as a fluorescence line. They are particularly well observed in the fluorescent condition when the stone is examined in scattered light). A moderately strong line at 6590 Å., a broad absorption from 6200 Å. to 5400 Å. (that is from the orange to the centre of the green), three lines in the blue at 4765 and 4750 Å. (a close doublet which under ordinary conditions of observation are seen as one strong line) and at 4685 Å. There is a general absorption of the violet. This absorption spectrum is due to chromium.

Green and Blue Sapphire: the principal bands are at 4710 Å., 4600 Å., and a particularly persistent band at 4500 Å. In the case of the green sapphire the two bands at 4600 and 4500 Å. may appear as a single band of great intensity. In the case of the blue sapphire only the 4500 Å. band may be seen, but almost always, even if only faintly as a fine line. (This line has some importance in gem distinction, as, if seen, the stone must be natural since the synthetic counterpart does not show any bands in the blue.) There is an absorption of the red and orange, and sometimes a partial absorption of the yellow, particularly

in blue sapphires of fine colour. This absorption spectrum is due to ferric iron.

Synthetic Blue and Green Sapphires: do not show the bands in the blue.

Pink Sapphires (natural and synthetic): spectra similar to that of ruby with the bright fluorescence line at 6935 Å. always present, the lines in the blue "window" (the doublet centred at 4755 Å. and the line at 4680 Å.) may not be seen. The absorption spectrum is due to chromium.

Golden-yellow Australian Sapphires: bands at 4710 Å., 4600 Å. and 4500 Å., similar to green sapphire. Spectrum is due to ferric iron.

Orange-coloured Synthetic Sapphires: a spectrum similar to ruby with the bright doublet at 6935 Å., the lines in blue may not be seen. Spectrum is mainly due to chromium.

Purple Sapphires (Natural and Synthetic): a spectrum similar to that of ruby.

"Alexandrite type" Synthetic Sapphire: a broad absorption in the orange and yellow, absorption in the violet, but no characteristic fine lines in the red. A narrow line at 4750 Å., in the blue, is seen which is useful for distinction. The bright red fluorescence line in the deep red is often present. This spectrum is due to vanadium.

Brown and most Yellow Synthetic Sapphires: do not exhibit a characteristic absorption spectrum.

Diamond.

In general two different series of absorption bands may be seen in diamond. The most usual type of spectrum is that mostly observed in the "Cape" series of stones and which show a bluish or mauve fluorescent colour under ultra-violet rays. These bands are: a strong band at 4155 Å. (the most persistent), a moderately strong band at 4780 Å. with weaker bands at about 4650 Å., 4520 Å., 4350 Å. and 4230 Å. Diamonds which show a strong yellow or orange-yellow fluoresence generally show the 4155 Å. band, but very weakly. Those diamonds which show a green fluores-

cence (they generally have a brown, greenish-yellow or green body colour, and are somewhat rare) show a spectrum with a band at 5040 Å., with weaker bands at 4900 Å., 5370 Å., and 5120 Å., in that order of intensity.

A strong source of light is required for the observation of the absorption bands in diamond, as, except in the case of the 5040 Å. *band, they are near the limit of visibility. The inclusion of the weaker bands is purely for the sake of completeness in the case of a most important gemstone.*

In yellow and brown diamonds, if a narrow line be seen at 5940 Å. in the orange part of the spectrum, this indicates that the stone has been artificially coloured by particle bombardment and subsequently annealed to a yellow colour.

Enstatite.

A sharp narrow band at 5060 Å.

Epidote.

Bands at 4750 Å. and 4550 Å. in the blue may be observed if the absorption in the blue is not too intense. This spectrum is due to ferric iron.

Garnet.

Almandine: spectrum is characterised by three heavy broad bands centred at 5760 Å., 5270 Å. and 5050 Å. (These two later bands merge into one in the deeper coloured material.) A fourth band at 4620 Å. of only half the strength of the other three is nearly always observed. Other bands are at 6170 Å.(in the orange), and 4760 Å., 4380 Å. and 4270 Å., which are weak bands in the blue and violet. Spectrum is due to ferrous iron.

Rhodolite: as for Almandine.

Pyrope-Almandine series: as for Almandine.

Pyrope (lower ranges reaching to nearly pure Pyrope): shows a spectrum reminiscent of that for "ruby spinel" with the exception that the broad absorption is centred near 5750 Å., instead of at 5400 Å. as in spinel. There are no

traces of bright fluorescence lines although the spectrum is due to chromium.

Demantoid: has a characteristic sharp cut-off in the violet at 4430 Å., which in the paler stones may appear as a band allowing some very deep violet to be seen (this is really the Fe band of Andradite). Spectrum is due to ferric iron. Although demantoid owes its colour to chromium the characteristic lines in red are not usually observed.

Jadeite.

Shows a strong narrow band at 4370 Å. which is present in most colours of this material, particularly in the pale mauve shade. The emerald green colour shows the chromium bands ill-defined at 6915 Å., 6550 Å. and 6300 Å.

Peridot.

Has three rather broad bands in the blue at 4970 Å., 4740 Å., and 4530 Å. The spectrum is due to ferrous iron.

Spinel.

Red: sharp lines in the red at 6855 Å. and 6840 Å. (a moderately strong doublet), a weak band at 6560 Å. and a strong absorption in the yellow-green (5950 Å. to 4900 Å.). In the paler rose-red and pink colours the spectrum may be characterised by a series of bright red fluorescence lines, five in number, of which the two strongest, 6870 Å. and 6750 Å., form a clearly separated pair. This spectrum is due to chromium.

Some synthetic red spinels show a fluorescent spectrum reminiscent more of that of ruby than the "organ pipe" lines of natural red spinel.

Blue: shows a band in the orange at 6300 Å. of moderate strength, a somewhat stronger and narrower band at 4800 Å. and a strong broad band at 4590 Å. This spectrum is due to ferrous iron.

Synthetic Dark Blue (sapphire-blue colours): three heavy broad bands as follows: in orange centred at 6350 Å., in yellow centred at 5800 Å., in green centred at 5400 Å.,

the first two being about twice the width of the last. Spectrum is due to cobalt.

Synthetic Light Blue ("Aquamarine" and "Zircon" types): show the three bands as in the dark blue shades, with sometimes a bright red fluorescence line in the deep red, rather similar to ruby. This is best seen in scattered light.

Synthetic Yellow ("Chrysolite" type): two lines in the blue-violet at 4450 Å. (slightly blurred) and at 4220 Å. (very sharp). Spectrum is due to manganese.

Synthetic Greenish-Blue ("Aquamarine" and "Zircon" type): show a spectrum being a combination of that for the blue and that for the yellow. Due to cobalt and manganese.

"Alexandrite" type Synthetic Spinel: a spectrum characterised by three bands due to cobalt. The line at 4750 Å., seen in the similar type of corundum, is not observed in this spinel type.

Spodumene.

Two bands in the violet at 4380 Å. and 4320 Å. These are seen in the yellow-green spodumene, are masked in the hiddenite variety by the strong general absorption in the blue, and are not seen in kunzite.

Tourmaline.

Blue and Green: shows a sharp band like a thick pencil line in the blue-green at 4980 Å. The red is strongly absorbed to about 6400 Å.

Red and Pink: a broad absorption band in the green with bands at 4580 and 4510 Å. in the blue. This spectrum is very weak and is not a good aid to identification.

Turquoise.

Two bands at about 4300 Å. and 4200 Å. which are very difficult to observe as they lie in the general obscurity of the violet. Light reflected from turquoise may show these lines.

Zircon.

Is characterised by a number of sharp lines of which the most prominent is one at 6535 Å., and can be usually seen in any zircon. Other lines at 6910 Å., 6830 Å., 6625 Å., 6210 Å., 6150 Å., 5895 Å., 5625 Å., 5275 Å., 5160 Å., 4840 Å. and 4325 Å. may be observed. As many as twenty bands may be observed in some zircons (generally green) with a small spectroscope.

The low type dull green zircon (S.G. 3·98 to 4·20) sometimes shows a peculiar spectrum of the line at 6535 Å. smudged out on the side of lower wave-length, or reminiscent of the Swan spectra of chemical compounds. The spectrum of zircon is ascribed to uranium.

Paste Stones.

Vary in their absorption spectra according to their colour. Most of the sapphire blue coloured pastes show the three bands due to cobalt. This spectrum, however, differs slightly from that shown by synthetic blue spinel in that the centre band is here the narrower band and the outer bands are farther away from the centre band than in the synthetic spinel.

Red pastes often show a broad absorption in the yellow green which is narrower than the broad absorption of ruby. This spectrum may be due to selenium. Some pink pastes are coloured by didymium and show the rare earth lines similar to yellow apatite.

The Light Spectrum (10Å.=1nm)

Ultra-violet	1000 to 3800	Ångström	units
Violet	3800 to 4400	„	„
Blue	4400 to 4900	„	„
Blue-green	4900 to 5100	„	„
Green	5100 to 5500	„	„
Yellow-green	5500 to 5750	„	„
Yellow	5750 to 5900	„	„
Orange	5900 to 6300	„	„
Red	6300 to 7000	„	„

Deep-red . . . 7000 to 7900 „ „
Infra-red . . . 7900 to 10,000,000 Ångström units.

An Ångström unit is one ten-millionth of a millimetre. One Ångström equals 0·0000001 millimetre.

The Major Fraunhofer Lines (10Å.=1 nm)

A	oxygen	7593·8	Ångström units.
B	oxygen	6867·2	„ „
C	hydrogen	6563	„ „
D1	sodium	5895·9	„ „
D2	sodium	5890·0	„ „
E	iron	5269·5	„ „
F	hydrogen	4861·5	„ „
G	iron	4307·9	„ „
H	calcium	3968·5	„ „
K	calcium	3933·7	„ „

The Principal Emission Lines Useful for Calibration

Flame

Lithium	red	6707·9	Ångström units.
Sodium	yellow	5895·9	„ „
Sodium	yellow	5890·0	„ „
Thallium	green	5350·5	„ „
Strontium	blue	4607·3	„ „
Calcium	blue-indigo	4226·7	„ „
Potassium	violet	4044·1	„ „

Arc

Cadmium	red	6438·4696	Ångström units.
Lithium	orange	6103·6	„ „
Copper	green	5218·2	„ „
Copper	green	5153·3	„ „
Copper	green	5105·6	„ „
Barium	blue-green	4934·1	„ „
Barium	blue	4554·0	„ „

(The Cadmium red line is the International Standard Wave-length).

The mercury lines obtained from a mercury-vapour electric discharge lamp provide a fruitful source, and the more powerful of these lines can be picked up underlying the continuous spectrum of fluorescent lighting tubes.

Mercury spectrum (10Å. = 1nm)

6234 Å (orange)
6152 Å (orange)
5790 Å (yellow)
5770 Å (yellow)
5461 Å (green)
4359 Å (blue)
4348 Å (blue)
4078 Å (violet)
4047 Å (violet)

COLOUR FILTER

The colour filters which transmit a band of red and a band of green light, and which were primarily intended as a test for the Emerald as against certain other gems and counterfeits, have been found to have other uses in gem discrimination.

The undermentioned list gives the residual colour seen when the stones are viewed through the "Beryloscope", "Chelsea" colour filter, or any filter operating on the same principle.

Green stones—

Alexandrite	= red, brighter in artificial light.
Aquamarine	= shows distinctively green.
Demantoid Garnet	= reddish.
Doublets	= green.
Emerald	= red or pink (the deeper the green of the stone the stronger the red colour.)

Synthetic emeralds show a very strong red through the filter, so stones showing a strong red should be suspect. Unaccountably some emeralds, particularly those from South Africa and India do not show the red colour through the filter.

Enstatite	= green.
Fluorspar	= reddish.
Hiddenite	= dirty green or slight pink.
Pastes	= green.
Peridot	= green.
Sapphire	= green.
Stained Chalcedony	= red.

Note:—The pale apple-green Stained Chalcedony resembling Chrysoprase does *not* show red.

Synthetic Corundum (Alexandrite type)	= red in natural and artificial light.
Synthetic Green Sapphire	= red.
Synthetic Green Spinel	= green, or in certain modern types; red.
Tourmaline	= green.
Zircon	= reddish.

Red stones—

Garnets	= dark red, no fluorescence.
Pastes and Doublets	= as for Garnets.
Ruby (Natural and Synthetic)	= strong fluorescent red.
Spinel	= as above but less strong.

Blue stones—

Aquamarine	= shows distinctively green.
Doublets	= as for pastes.
Natural Blue Spinel	= reddish.
Pastes Dark Blues	= red.
Light Blues	= greenish.
Sapphires	= blackish.
Synthetic Dark Blue Spinel	= red.
Synthetic Light Blue Spinel	= orange.
Synthetic "Zircon type" Spinel	= orange to red.
Zircon	= greenish.

Note:—The blue sapphire, which shows a purple colour when viewed in artificial light (due to an inter-mixture of blue sapphire and red ruby), usually shows *red* under the colour filter.

GEM AND ORNAMENTAL STONES LISTED ACCORDING TO COLOUR

Stones are transparent or translucent unless otherwise stated.

Colourless—

Amblygonite
Analcite
Anglesite
Apatite
Apophyllite
Augelite
Barytes
Beryl (Goshenite)
Beryllonite
Celestine
Colemanite
Corundum (White Sapphire)
Danburite
Datolite
Diamond
Diopside
Euclase
Feldspar (Moonstone)
Fluorspar
Garnet (rare)
G.G.G.
Hambergite
Leucite
Lithium niobate
Magnesite
Periclase
Petalite
Phenakite
Pollucite
Quartz (Rock Crystal)
Scheelite (Syn)
Spinel (Synthetic)
Spodumene
Strontium titanate
Topaz
Tourmaline (Achroite)
Whewellite
YAG
Zircon (heat treated)
Zirconia (Cubic)

Yellow and Orange—

Amber
Amblygonite
Anglesite
Apatite
Axinite
Barytes
Beryl (Heliodor)
Beryllonite
Brazilianite
Cancrinite
Cassiterite
Chalcedony
Chondrodite
Chrysoberyl
Copal resin

Corundum (Yellow Sapphire)
Danburite
Datolite (opaque)
Diamond
Fluorspar
Fibrolite
Garnet (Hessonite, Topazolite, Spessartine)
Idocrase
Jadeite
Lithium niobate
Marble
Melinophane
Opal (Fire Opal)
Orthoclase Feldspar
Phenakite
Quartz (Citrine)
Rhodizite
Rutile (Syn)
Scapolite
Scheelite
Sepiolite (Meerschaum) (opaque)
Silica glass
Sinhalite
Smithsonite (opaque)
Sphalerite (Bleude)
Sphene
Spinel
Spodumene
Staurolite (opaque)
Stibiotantalite
Thomsonite (opaque)
Topaz
Tourmaline
Willemite
Wulfenite
YAG
Zircon

Brown—
Amber
Anatase
Andalusite
Axinite
Barytes
Beryl
Brookite
Cassiterite
Chalcedony
Chondrodite
Datolite (opaque)
Diamond
Epidote
Fluorspar
Garnet (Hessonite)
Hypersthene (opaque)
Idocrase
Jadeite
Kornerupine
Marble
Microlite
Moldavite
Obsidian
Orthoclase feldspar
Pearl
Peridot
Prehnite
Quartz
Rhodochrosite
Rutile (Syn)
Scheelite
Sinhalite
Soapstone
Sphalerite (Blende)
Sphene
Staurolite (opaque)

Stibiotantalite
Thomsonite (opaque)
Tourmaline
Willemite
YAG
Zircon

Red and Pink—
Amber
Andalusite
Barytes
Beryl (Morganite)
Cassiterite
Chalcedony
Chondrodite
Coral (opaque)
Corundum (Ruby and Pink Sapphire)
Crocoite
Cuprite
Danburite
Datolite (opaque)
Diamond (rare)
Durangite
Epidote
Fluorspar
Friedelite
Garnet (Pyrope, Almandine, Spessartine, Hessonite)
Jadeite
Marble
Microlite
Opal (Fire Opal)
Painite
Pearl
Phenakite
Quartz (Rose Quartz, Cornelian and Jasper)
Rhodochrosite (translucent)
Rhodonite (opaque)
Rutile
Scapolite (opalescent)
Smithsonite
Spinel ("Balas Ruby" and "Ruby Spinel")
Spodumene (Kunzite)
Staurolite (opaque)
Stichtite (opaque)
Thomsonite (opaque)
Topaz ("fired")
Tourmaline (Rubellite)
Tremolite
Tugtupite
Willemite
Wulfenite
Zincite
Zircon (Jacinth)
Zoisite (Thulite) (opaque)

Purple and Violet—
Apatite
Axinite
Charoite
Corundum (Violet Sapphire)
Diopside (Violane) (opaque)
Dumortierite
Fibrolite
Fluorspar
Garnet (Almandine and Rhodolite)
Jadeite
Lepidolite
Quartz (Amethyst)

Scapolite
Spinel ("Almandine")
Spodumene (Kunzite)
Stichtite
Taaffeite
Tourmaline
Zircon

Blue—
Anatase
Anglesite
Apatite
Azurite (opaque)
Barytes
Benitoite
Beryl (Aquamarine)
Celestine
Cerussite
Chalcedony
Chrysocolla (opaque)
Corundum (Sapphire)
Diamond (rare)
Diopside (Violane) (opaque)
Dumortierite (opaque)
Euclase
Fibrolite
Fluorspar
Idocrase
Iolite
Jadeite
Kyanite
Lazulite (opaque)
Lazurite (Lapis-lazuli) (opaque)
Odontolite (opaque)
Pearl
Quartz (Siderite)
Rutile (Syn)
Scapolite (Cat's-eye)
Shattuckite
Smithsonite (opaque)
Sodalite (opaque)
Spinel
Topaz
Tourmaline (Indicolite)
Turquoise (opaque)
Wardite (opaque)
Zircon
Zoisite

Green—
Andalusite
Anglesite
Apatite
Bastite (opaque)
Bayldonite
Beryl (Emerald and Aquamarine)
Boracite
Cerussite
Chalcedony
Chlorastrolite (opaque)
Chrysoberyl
Chrysocolla (opaque)
Corundum (Green Sapphire)
Datolite (opaque)
Diamond (rarely)
Diopside
Dioptase
Enstatite
Epidote
Euclase
Feldspar (Amazon stone)

Fibrolite
Fluorspar
Gahnite
Garnet (Demantoid and Uvarovite)
Garnet (Grossular, "Transvaal Jade")
Idocrase
Jadeite (translucent to opaque)
Kornerupine
Kyanite
Malachite (opaque)
Marble
Maw-sit-sit
Moldavite
Nephrite (semi-opaque to opaque)
Ophicalcite
Peridot
Prehnite
Pseudophite (opaque)
Pyrophyllite
Quartz (Prasiolite, Prase and Plasma)
Rhodizite
Serpentine (opaque)
Smaragdite
Smithsonite (opaque)
Soapstone
Sphene (Titanite)
Spinel (Chlorospinel)
Spodumene (Hiddenite)
Thomsonite (opaque)
Topaz
Tourmaline
Tremolite
Turquoise (opaque)
Variscite (opaque)
Wardite (opaque)
Willemite
Wulfenite
YAG
Zircon

White—
Alabaster
Amber
Barytes
Bone (opaque)
Cerussite
Colemanite
Coral (opaque)
Datolite (opaque)
Garnet (Grossular)
Gypsum (Satin-spar)
Howlite
Ivory (opaque)
Jadeite (semi-opaque)
Marble
Meerschaum (opaque)
Mesolite
Milky Quartz
Nephrite (opaque)
Opal
Pearl
Scapolite
Thomsonite (opaque)
Ulexite
Vegetable Ivory (opaque)
Witherite
Wollastonite
Wulfenite

Grey—
Apophyllite

Cerussite
Diamond
Herderite
Labradorite
Marble
Obsidian
Opal
Pectolite
Pyrophyllite
Quartz (Chalcedony)

Black—
Amber
Anatase
Cassiterite
Chromite
Chalcedony (Onyx)
Coral
Diamond
Garnet (Melanite)
Jadeite
Jet
Marble
Obsidian
Opal
Pearl
Quartz (Morion)
Rutile
Spinel (Ceylonite)
Tourmaline (Schorl)

opaque

Metallic Colours—

White	Cobaltite
White to grey	Smaltite
Golden yellow	Gold
Brass yellow	Pyrites
Grey yellow	Marcasite
Brilliant black	Hematite; Psilomelane
Grey white	Platinum; Palladium and Rhodium
White	Silver

THE TRANSPARENCY OF GEMSTONES TO X-RAYS

The degree of transparency to X-rays may, in some cases, have a diagnostic value, as, for instance, the separation of diamond from zircon, topaz from lead glass, etc. In general it is found that the higher the atomic weight of the constituent elements comprising the stone, the more opaque is that stone to the rays. In the following table, from the work of C. Doelter, this is more or less borne out with the exception of beryl, which should in theory have a far greater transparency to the rays.

TABLE OF TRANSPARENCY TO X-RAYS

Opaque	Almandine Garnet Beryl Epidote Hematite Lithium niobate Magnetite Pyrites Rutile YAG Zircon
Partly opaque	Calcite Gypsum Tourmaline Turquoise
Slightly transparent . . .	Fluorspar Hessonite Garnet Spinel
Partly transparent . . .	Feldspar (Labradorite and Moonstone) Quartz Topaz
Semi-transparent . . .	Andalusite Chrysoberyl Kyanite Opal
Almost transparent . . .	Corundum
Entirely transparent . . .	Amber Copal Diamond Jet

Lead glass imitation gemstones are opaque to the rays.

THE FLUORESCENT COLOURS OF GEMSTONES UNDER ULTRA-VIOLET LIGHT

Depending as it generally does on the inclusion of a minor impurity in the material, fluorescence may vary widely in the same variety of gemstone, hence, except in certain well-defined cases, the fluorescent colours will not give much help in gem distinction.

It must be realized that there are two distinct ranges of ultra-violet rays. The most generally used are the long-wave rays which lie between the range of 3000 Å. to 4000 Å. These are mainly obtained from a medium pressure mercury-vapour electric discharge lamp which gives a maximum emission at 3650 Å. and the strong visible light given off from this lamp is filtered out by interposing a Wood's glass filter which allows only the range 3000 Å. to 3900 Å. to pass (10Å.=1 nm).

The short-wave radiation, that between 2000 Å. and 3000 Å., is usually produced by a low pressure mercury-vapour lamp which gives a strong emission at 2537 Å. The weak visible light and the long-wave ultra-violet rays being, as far as possible filtered out by a special glass filter. Such a filter is the Chance glass OX7.

There is a third type of lamp which supplies long-wave rays up to 4100 Å. This lamp operates on the same principle as the fluorescent lamps now extensively used for lighting, except that the powder coating inside the tube emits long-wave ultra-violet light and not a strong visible light.

Each lamp has its use, for the response of a substance may differ with each type of radiation. The type of lamp giving the emission in the case of the stones listed is indicated in each case.

A short table of gem materials which, in general, show a pronounced fluorescence colour, is appended.

Diamond . . .	Three main types of colour:—blue green and yellow. The blue (generally a violet-blue or "lilac") is the most common. Best by long-wave

	ultra-violet. Blue fluorescing diamonds generally show a yellow phosphorescence and this may be more apparent after irradiation with short-wave ultra-violet rays.
Ruby	A glowing red. The synthetic counterpart shows the same effect. (All radiations.)
Synthetic Green Sapphire	Generally shows a green glow under the short-wave lamp.
Natural Yellow Corundum (Ceylon) . .	An orange fluorescence. Best long-wave.
Pink, Orange, Mauve and Purple colours of Synthetic Corundum.	A red fluorescence. Best long-wave.
Red Spinel . . .	A glowing red. All radiations.
Greenish-Blue Synthetic Spinel	A red fluorescence. Long-wave. Bluish-white. Short-wave.
Yellowish-Green and Yellowish-Blue Synthetic Spinel . .	A bright apple-green. This is due to manganese and some pastes of various colours show this apple-green fluorescence colour owing to the same cause. All wavelengths.
Colourless Synthetic Spinel . . .	Practically inert under long-wave lamp but bright bluish-white under the short-wave lamp. Synthetic white sapphire also does not glow under the long-wave lamp but only gives a dull deep blue glow under the short-wave lamp.
Deep Green Synthetic Spinel . . .	A plum-red fluorescence. Long-wave. Greenish-white. Short-wave.
"*Alexandrite Type*" *Synthetic Spinel* .	A dull red fluorescence. Long-wave. *Note:*—The "Alexandrite type" synthetic corundum appears to be inert under ultra-violet rays.

Emerald . . .	Under the long-wave lamp emeralds may show either a green glow or a red glow. Synthetic emeralds emit a strong red glow which may be useful as an indication. The best lamp for this is the long-wave fluorescence lamp emitting up to 4100 Å.
Kunzite	An orange fluorescence. Long-wave.
Fluorspar, except "Blue John" . . .	A violet fluorescence. Long-wave.
Benitoite . . .	This blue stone which so much resembles sapphire may be identified by the fact that it is inert under long-wave ultra-violet light but glows with a strong bluish light under the rays from the short-wave lamp.
Scheelite . . .	Is inert under the long-wave lamp but shows a blue glow under the short-wave ultra-violet rays.
Zircon	Usually shows a mustard-coloured glow under the long-wave lamp.
Pearl	A sky-blue fluorescence.
Amber	A powder-blue "bloom".
Ivory	A bluish fluorescence. A similar fluorescence is given by bone. Some plastic imitations of ivory show a mustard-yellow fluorescence.

MANUFACTURED GEMS

Synthetic Corundum and Spinel

Synthetic gems having a similar chemical composition to natural corundum and spinel and which in physical and optical

properties approximate to these gems, are made in an oxy-coal-gas furnace (Verneuil process).

Synthetic corundums have practically the same physical properties as their natural counterparts; discrimination between natural and synthetic is always possible, however, by means of the characteristic internal markings peculiar to each type, consequent upon their very different method of growth.

Natural rubies very frequently contain the extremely fine rod-like inclusions intersecting at 60° known as "silk" (see note on synthetic star stones given later in the text) and also angular crystalline inclusions pale in colour and showing low relief.

Particularly in Burma stones "treacly" swirl marks may be noticed. Siam rubies often contain circular feathers containing a round black inclusion. Long "needle" or lath-shaped inclusions and "twin planes" (straight lines running across the stone) are seen in Siam rubies.

In natural sapphires the colour is usually unevenly distributed in the form of alternating bands of darker and paler colour which are always rigidly straight being parallel to the faces of the hexagonal prism in the original sapphire crystal. In some stones two or more sets of these colour-bands are seen to meet at 120°. Natural sapphires also frequently contain "feathers" consisting of small crystal or liquid inclusions, closely spaced and more or less in one plane, somewhat resembling a thumb-print. There are many other internal markings characteristic of natural stones often differing slightly according to the locality from which the stone came.

Synthetic corundum, on the other hand, does not contain crystal inclusions or "silk", except in the synthetic star stones, and the synthetic stones of the corundum family seldom contain "feathers" or straight bands of colour. Their own characteristic markings consist of small gas bubbles, often clustered together in groups, and either spherical, elongated oval, or tadpole-shaped. On account of their low refractive index these show high relief. In synthetic sapphires there is uneven distribution of colour following the curved outlines of the original

boule, forming curved bands of colour. In synthetic ruby, curved lines are also seen, more closely-spaced than in the sapphires, but entirely characteristic. Some of the above signs can often be observed either with the naked eye or with a pocket lens skilfully used. Observation is much facilitated, however, if the stone be immersed in a liquid of high R.I. such as monobromonaphthalene or methylene iodide in a small glass cell. The distribution of colour and characteristic inclusions or markings can then be clearly seen and in difficult cases examination under a microscope will reveal the presence of minute bubbles or crystal structures (according to whether the stone is synthetic or natural) which are too small to be seen with a pocket lens.

Since the end of the Second World War synthetic star corundums have been made in red (ruby), blue (sapphire) and in other colours. These stones show a type of "silk" crossing at 60° which are needles of fine rutile and to these needles the star effect is due. Besides this "silk" the synthetic star stones show the typical curved colour bands and gas bubbles characteristic of synthetic corundum. The stars are very sharp and the colour of the stones are usually a more pronounced red or blue than usually seen in natural star stones.

In the case of synthetic spinels there are no curved bands of colour, and bubbles are rather few and hard to find, but as these stones are marketed in colours not intended to simulate natural spinel but other species such as aquamarine, blue zircon and sapphire, the physical constants of which differ widely from those of the material used, there should be no need to go any further than a refractometer test. Indeed the characteristic effects seen under the Chelsea colour filter, and the lack of dichroism and the typical anomalous double refraction (tabby extinction) refraction, are usually sufficient indications in themselves.

In addition, synthetic spinels, owing to a slightly greater aluminium content than in natural spinel, show a higher index of refraction than is shown by natural stones:—1·728 for the synthetic as against 1·718 for the natural spinel.

Below can be found a list of the principal types of synthetic corundum and spinel now on the market.

Synthetic Corundums

Colourless may imitate: Diamond, Natural White Sapphire, Zircon (heat treated), White Topaz, Rock Crystal.

Reds may imitate: Almandine Garnet, Pyrope Garnet, Natural Ruby, Spinel ("Ruby Spinel" and "Balas Ruby"), Natural Star Ruby.

Pinks may imitate: Natural Pink Sapphire, Tourmaline (Rubellite), Rose Beryl (Morganite), Topaz ("fired").

Lilac and Mauves may imitate: Quartz (Amethyst), Natural Violet Sapphire, Spodumene (Kunzite).

Purples may imitate: Natural Purple Sapphire, Quartz (Amethyst), Garnet (Almandine), Spinel ("Almandine").

Yellows may imitate: Natural Yellow Sapphire, Quartz (Citrine), Topaz, Feldspar (Orthoclase), Beryl (Heliodor).

Orange and Orange Red colours may imitate: Natural Orange Sapphire, Padparadschah Sapphire, Fire Opal, Topaz, Zircon (Jacinth), Garnet (Hessonite), Quartz, Golden Beryl, Danburite.

Blues may imitate: Natural Sapphire, Tourmaline (Indicolite), Spinel, Natural Star Sapphire.

Greens may imitate: Chrysoberyl (Alexandrite), Natural Green Sapphire, Beryl (Emerald and Aquamarine), Peridot, Demantoid Garnet, Tourmaline.

Browns may imitate: Topaz (Brazilian), Quartz, Zircon, Garnet (Hessonite), Tourmaline.

Synthetic Spinels

Colourless may imitate: As list for Colourless Synthetic Corundum.

Pale Blues may imitate: Beryl (Aquamarine), Topaz, Zircon.

Dark Blues may imitate: Sapphire, Tourmaline, Spinel.

Yellows may imitate: Chrysoberyl, Peridot, Tourmaline, Feldspar (Orthoclase).

Pinks may imitate: Topaz (heat treated), Pink Sapphire, Tourmaline (Rubellite), Rose Beryl (Morganite).

Greens may imitate: Tourmaline, Green Sapphire, Peridot, Beryl (Aquamarine and Emerald), Demantoid Garnet, Chrysoberyl (Alexandrite).

Synthetic Chrysoberyl

Cut stones have been marketed since the early 1970s. They have good colour change, but are often paler than natural stones. Their physical properties are similar to those of natural stones; but their inclusions are typical of flux melt production.

Synthetic Emerald

The commercial production of synthetic emerald is carried out in America and elsewhere. The stones are of good colour and they contain natural looking feathers as they are made most probably by a fused melt process. These feathers are made up of liquid-filled cavities and are characterised by their "veil-like" appearance as though they were curtains waving in the wind. Moreover, the specific gravity of synthetic emerald, about 2·66, is markedly lower than for the natural stones. The refractive indices and the birefringence are again perceptibly lower: 1·560–1·565 and ·001 to ·004 respectively. Some recent production has constants similar to those of natural emerald. Further, the synthetic shows an intenser absorption spectrum, dichroism and fluorescence under ultra-violet light than the natural, and probably shows a stronger red colour under the Chelsea colour filter. Synthetic emerald is now made in Germany, France, Austria, U.S.A., etc.

Synthetic Quartz

This has been produced in blue, brown and, more recently, violet (for amethysts). There is also a colourless variety which is grown hydrothermally for use in oscillators.

Synthetic Rutile

A post-war development made on a modified Verneuil furnace, rutile (TiO_2) is made in a number of colours. The

most usual is a pale straw yellow, but yellows, browns and red colours have been produced. There is also a blue colour, but owing to their liability to chip, they are rarely marketed. The synthetic rutile has a density of 4·25 and refractive indices of 2·62–2·90. The hardness is about 6½. The large double refraction and the exceptional "fire" (six times greater than that of diamond) identifies the stone by sight.

Strontium Titanate (Fabulite)

Another post-war development, this stone may be said to be the nearest in appearance to diamond. It is water white in colour; is singly refractive and has a refractive index of 2·41. The density is 5·13 and the hardness about 6.

Yttrium Aluminium Garnet ("Diamonair")

A synthetically produced stone made colourless and in a number of colours. Singly refractive with refractive index of 1·83 and the density 4·58 and a hardness of 8.

G.G.G. (Gadolinium gallium garnet)

This, and various other synthetic "garnets", have been made in various colours. They often contain rare earths as essential constituents or as dopants. These garnets may show spectacular colours under ultra-violet light; e.g. G.G.G. goes bright orange-pink.

Lithium Niobate ("Linobate")

Grown as colourless, yellow or brown crystals the stones have a hardness of about 5½; a density of 4·64 and refractive indices of 2·21–2·30.

Synthetic Turquoise and Lapis-lazuli

Both these materials are manufactured by Gilson. The turquoise lacks the fine white spots found in much natural turquoise; any large lump without these spots should be viewed with suspicion. Much natural lapis-lazuli contains calcite which is not commonly encountered in the synthetic equivalent.

Synthetic Periclase ("Lavernite")

The synthetic magnesium oxide mineral has been made

synthetically and sold commercially. It is colourless and has a density 3·6; a refractive index of 1·73 and a hardness of about 5.

Cubic Zirconia

This is produced by the skull-melting process. It provides a very good imitation of diamond; R.I. 2·18; S.G. about 5·7; H. 8·5; dispersion 0·066.

Synthetic Diamond

Since 1955 synthetic diamond has been produced, but only in sufficient size to allow its employment as grinding and polishing powder. Gem quality synthetic diamond, although made in 1970, has no significance in the field of gemstones as yet.

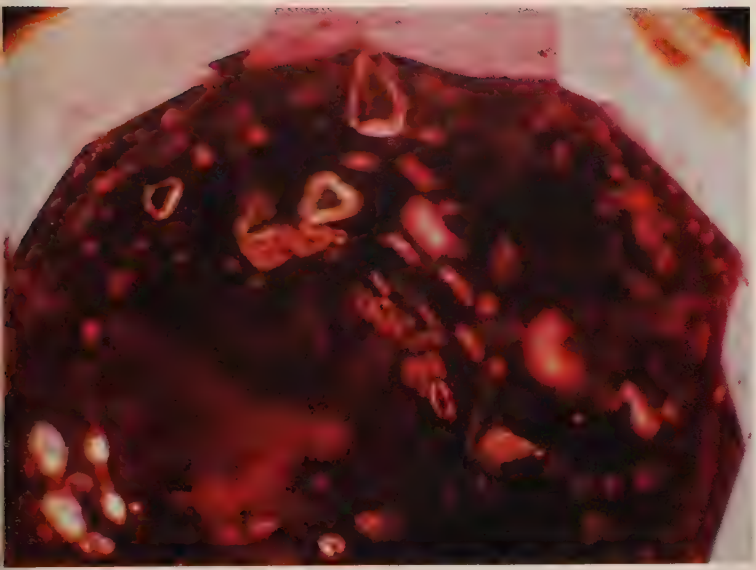
Synthetic Opal

A commercially viable synthetic opal of very convincing appearance in both black and white, has been made by P. Gilson of France. Distinction is possible (1979) by the crenulate margins to the "grains". However the "fish-scale" or "lizard-skin" effect seen in earlier specimens is not now so prominent.

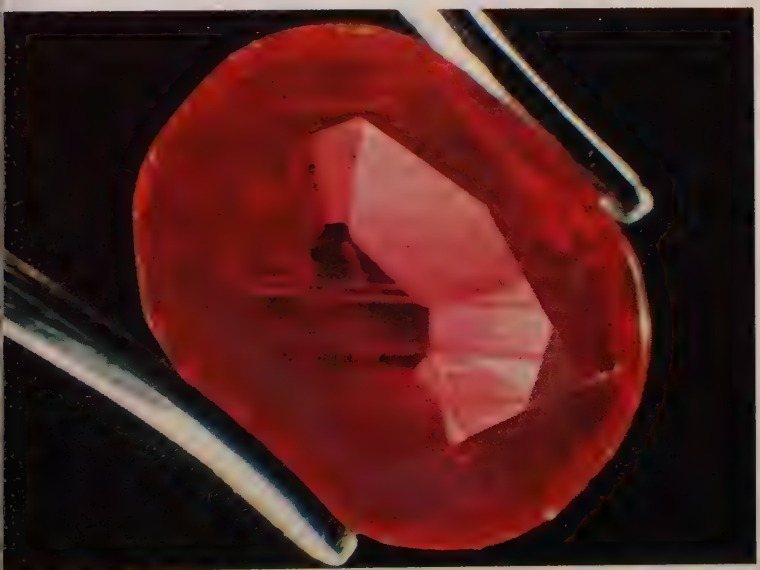
Composite Stones are stones constructed of two or more pieces of material, which may or may not be genuine crystal or even of crystal of the stone simulated. They are described as follows:

True Doublets are two pieces of genuine stone (say two pieces of sapphire) cemented together to form a larger stone of much greater apparent value. The crown is usually made of one piece and the pavilion another, the cement join being along the girdle. Stones most usually treated are: Diamond, Ruby and Sapphire.

False Doublets are made similarly to the True Doublets with the exception that the pavilion is made of glass or an inferior stone. Or in many cases the crown of the stone is composed of red garnet and the pavilion of a suitably coloured glass. These are made to represent Diamond, Ruby, Sapphire and Emerald.



orroded crystal inclusions in Burma ruby.

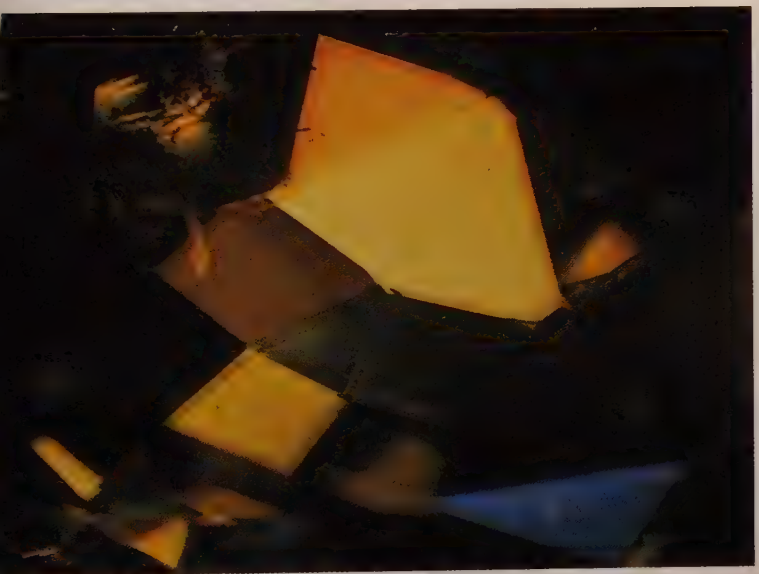


uby doublet showing straight bands in natural crown, and curved bands in synthetic base.

Ceylon sapphire showing feathers and fine rutile needles.

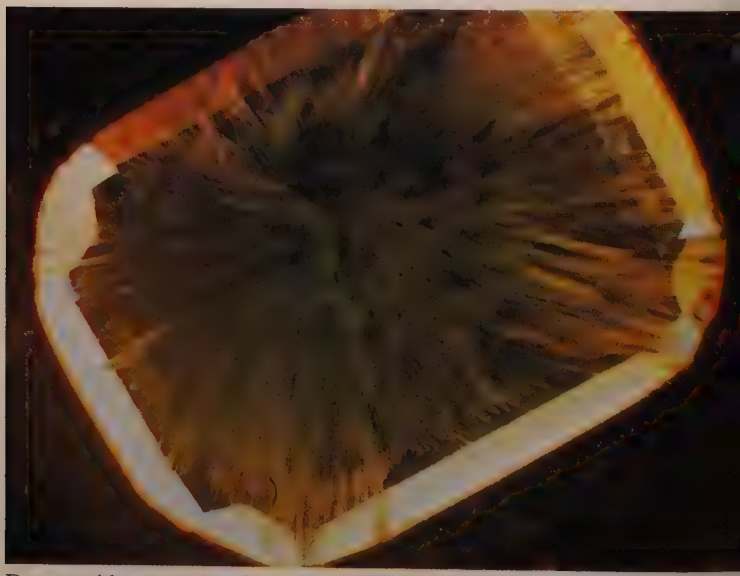
Hexagonal zoning in Cambodian sapphire.

train phenomena ('water lilies') in peridot from Arizona.

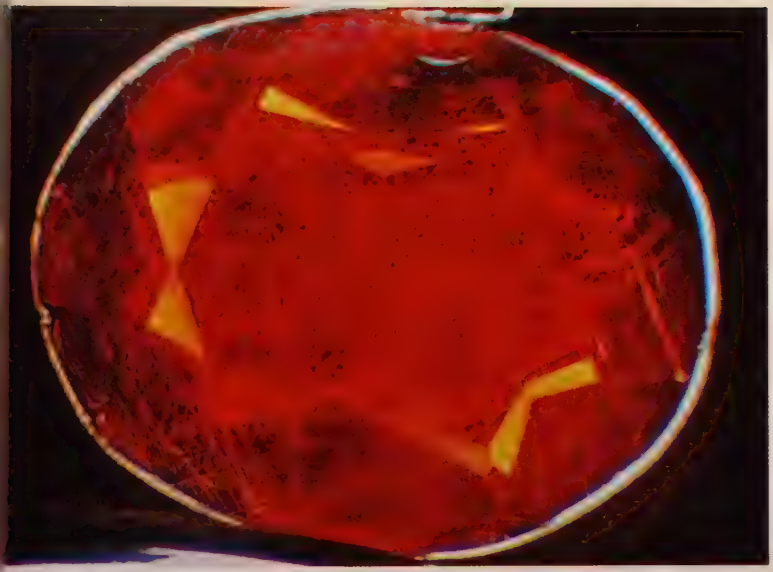


Zircon showing doubling of the back facets.

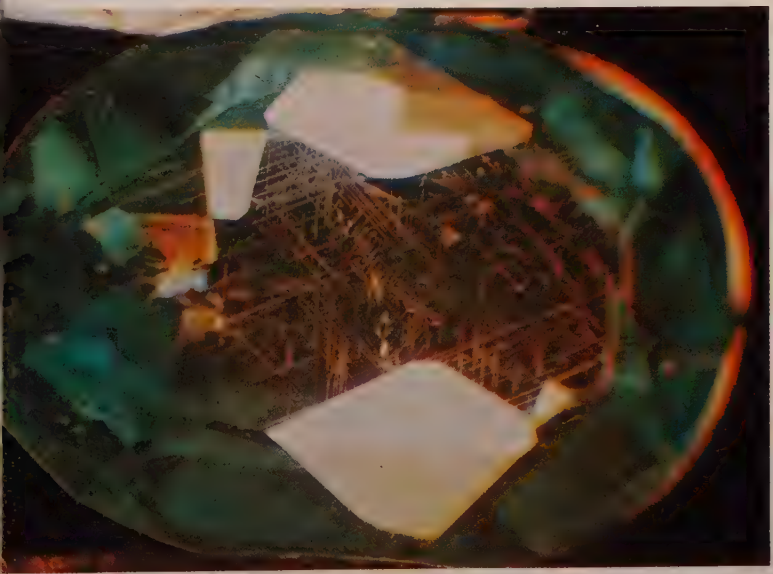
Hessonite garnet showing 'treacly character' and granular inclusions.



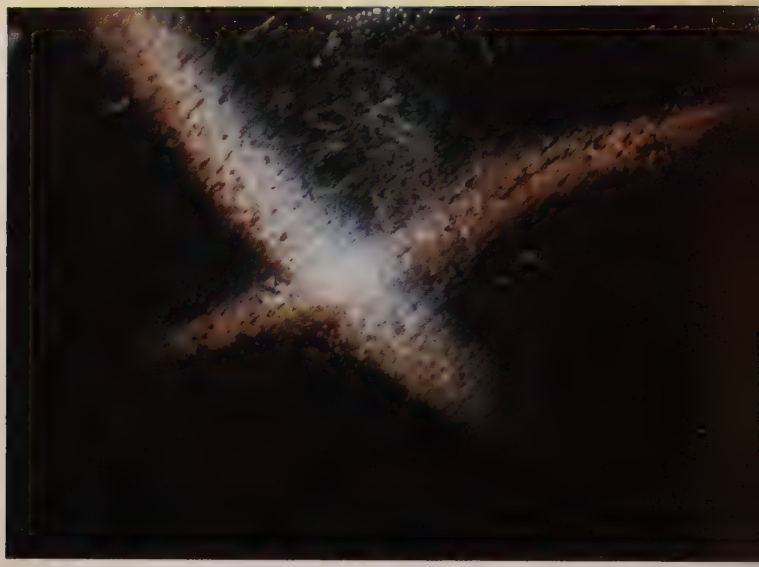
Demantoid garnet showing asbestos ('byssolite') fibres.



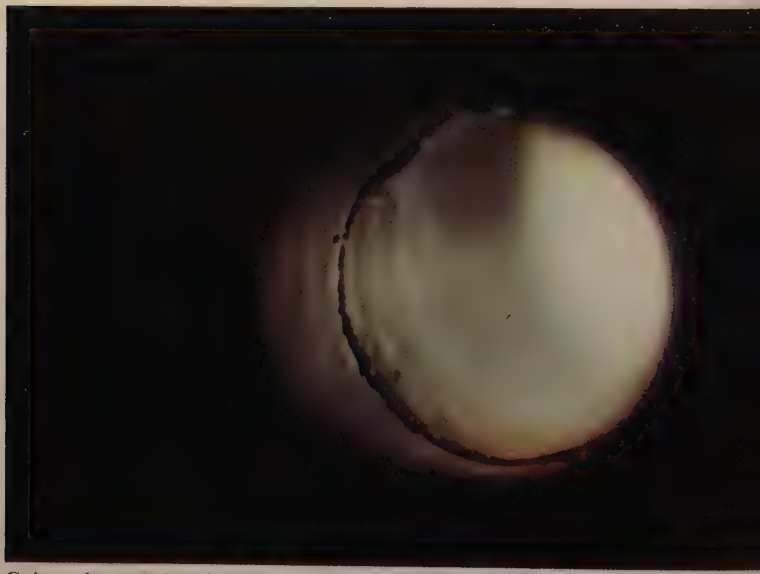
Orientated hornblende needles in almandine garnet.



Garnet-topped doublet of pinkish garnet top with included needles and blue/green glass base. Note the lustre difference of garnet/glass on the bright facet.



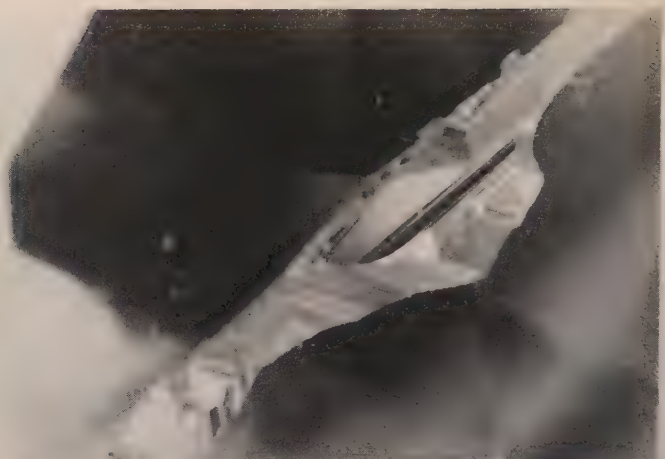
Diopside showing magnetic needles causing asterism.



Cultured pearl showing discontinuity within the drill hole.

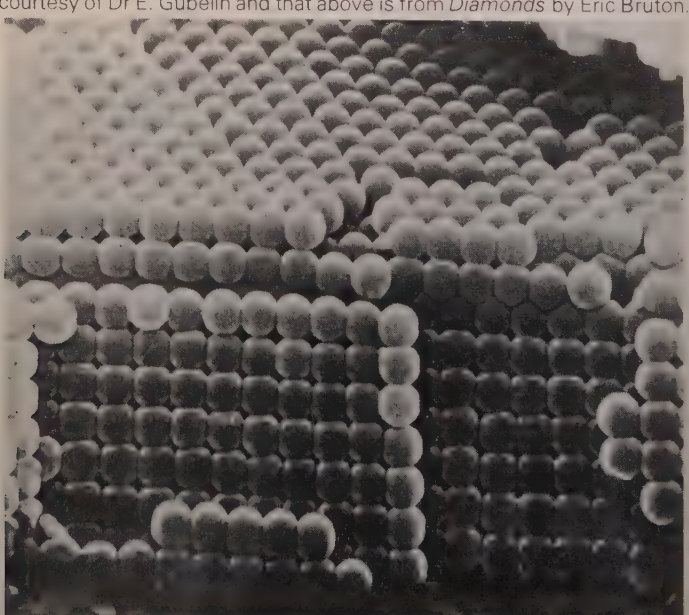
Colour banding in citrine quartz.

Gilson synthetic black opal with a mosaic showing crenellated margins and 'fish-scale' effect.



Magnified view of a large natural on the girdle of a diamond.

All colour illustrations were kindly supplied by the Institute of Geological Sciences, London, except for those of the citrine and cultured pearl, for which the publishers are indebted to the Association Française de Gemmologie and Mr Alan Hodgkinson. The illustration below is reproduced by courtesy of Dr E. Gübelin and that above is from *Diamonds* by Eric Bruton.



The structure of opal seen at a magnification of 17,500 via an electron microscope. The rows of tiny spheres are responsible for the interference colours which appear when white light falls on the gem.

Note: Diamond Doublets have been found constructed with a top of real diamond and a base of either synthetic white spinel or corundum, white topaz, rock crystal or glass. Even if set, such a stone may easily be detected by the reflection of the table facet from the plane of junction of the two parts when the stone is viewed at an angle. Further, the stone is found to be "seen through" when viewed at an angle of 45°, feathery "inclusions" due to disintegration of the cement may be seen if the stone is old.

Triplets are similarly constructed stones, but made in three pieces. Generally a section of base material to give the desired colour is cemented in the middle across the setting edge.

Soudé Type Stones

There are four types of such composite stones:

(1) A crown consisting of a piece of rock crystal which is cemented by the aid of coloured gelatine to a base also of clear rock crystal. They were mostly made in a green colour to imitate the emerald, but other colours were made. The green types showed a red colour through the Chelsea colour filter, and the two pieces of rock crystal used were often selected for the natural inclusions they had. The green gelatine was unstable to light and turned yellow so this type was discontinued.

(2) Similar to the above being made with two pieces of rock crystal, but the green, and the stones were mostly green to imitate the emerald, consisted of a layer of sintered glass. The colour of these soudé emeralds showed green through the Chelsea colour filter. Both these types (1 and 2) if immersed in water and looked at sideways will show the top and bottom to be colourless with the line of colour along the girdle.

(3) Similar to type (2) but instead of using two pieces of rock crystal, two pieces of synthetic colourless spinel are used. They are now made in all colours. The short-wave ultra-

violet lamp will cause the synthetic spinel to glow with a bluish-white light. Owing to the higher refraction of synthetic spinel to quartz it is better to use some liquid with a higher refractive index than water for the immersion test.

(4) Similar to the above but constructed with two pieces of pale emerald or beryl. Marketed under the name "Smaryll".

Recently an imitation composite stone has been placed upon the market, intended to imitate the greyish-blue star sapphire, and is constructed of a piece of star rose quartz cut in the necessary direction below which is blue glass with a metallic mirror on its lower surface and finally a piece of stained blue chalcedony forming the back of the stone.

They have also been produced by "sputtering" a coloured metal mirror on to the back of a suitable piece of star rose quartz.

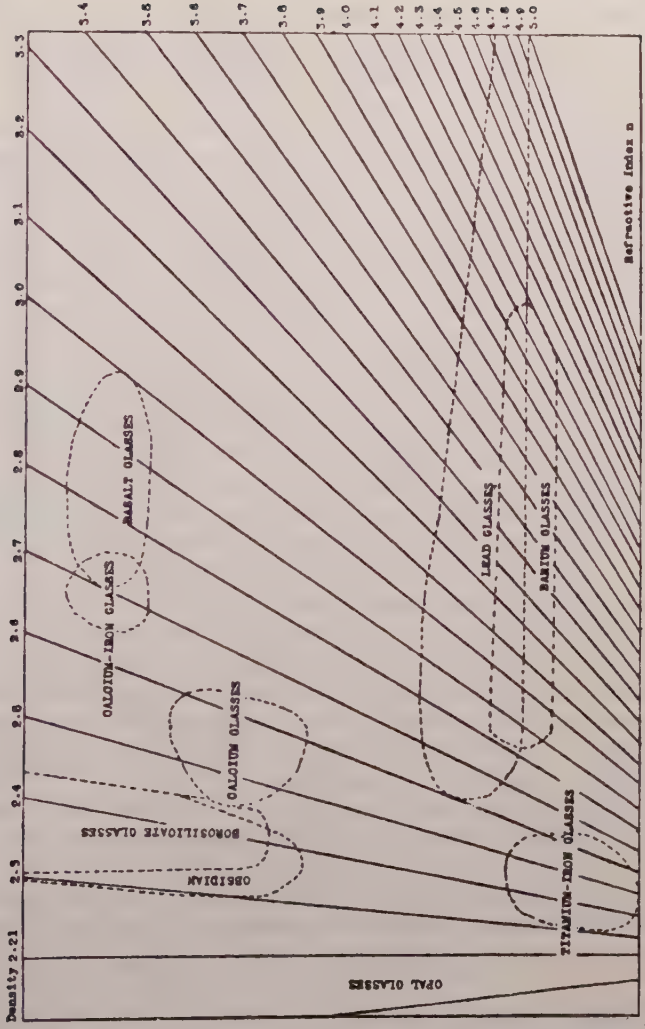
Opal Doublets

These are made by cementing a thin slice of colourful precious opal on to a piece of common opal, black onyx, or a black glass called *opalite*. Some opal doublets have been further embellished with a dome of rock crystal covering the front of the opal. These are known as "Triplex opals".

It has been recorded that an imitation of opal has been made by cementing a thin section of mother-of-pearl between two rounded and polished pieces of glass.

Jadeite Triplets

These are made by cementing together three pieces of white jadeite with a green jelly-like cement. There is a centre cabochon and two hollow cabochons which complete the top and base. Easy to detect when unset, if in a setting the join is hidden and the stone is most deceptive. An abnormal absorption spectrum of bands in the red indicate the nature of the stone. These absorption bands are due to the organic dyestuff used.



A chart for determining the composition of glass imitation gems. After Bannister.

Glass (Pastes or Strass). Glass is a mixture of silicates with sometimes the addition of lead oxide or thallium oxide to increase the dispersion, and is coloured by adding small amounts of metallic oxides.

Glass may have any specific gravity between 2·00 to 6·00 and similarly the refractive index varies from 1·44 to 1·90, and in general these figures bear some relation to each other. It is indeed possible, by using the graph devised by Dr. F. A. Bannister, to ascertain with some degree of certainty, the chemical constitution of a glass, simply by taking the specific gravity and refractive index of the specimen and plotting on the graph. See page 175.

Glass may be detected by its softness, generally less than 6 (there is a case-hardened paste which has a hardness about 7, but this is rare): the physical and optical constants which rarely agree with those of the stone simulated and the fact that it is isotropic while the stone it resembles is anisotropic. It is also possible to detect by microscopic examination when peculiar whorls of "cooling striae" and also air-bubbles are seen. A remarkable opal simulant—the "Slocum Stone"—has been produced recently from glass.

THE PLASTICS

No modern work on gemmology would be complete without reference to "The Plastics", those rigid products so prominent in commerce and industry, which are becoming increasingly popular as a medium for gem simulation

Divided into two main groups, the *thermo-plastic* type and the *thermo-setting* type, which respectively are those which become plastic on the application of heat, relatively rigid at ordinary temperatures but become plastic again when re-heated; and those moulded by high pressures and high temperatures, and once formed do not again become plastic.

Thermo-plastic Types

Cellulose nitrate (*Celluloid*): a thermo-plastic material made from a nitro-cellulose base. Made in various colours and transparency, the material is used as an imitation of ivory and to some extent amber. R.I. 1·495 to 1·51; S.G. 1·36 to

1·80 (in clear types 1·36 to 1·42); H. about 1½. Celluloid is softened by amyl-acetate or acetone, or a mixture of these two liquids. Celluloid is inflammable; if a peeling is taken, using a knife blade, and is introduced into a flame it will burn easily.

Cellulose acetate (*Safety celluloid*): a thermo-plastic material made from cellulose and acetic acid. This material has similar applications to those of celluloid. R.I. 1·490 to 1·505; S.G. 1·26 to 1·80 (usually 1·29 to 1·40); H. 1½. Like the ordinary celluloid, the safety celluloid softens with amyl-acetate and acetone.

Methylmethacrylate resin (*Perspex*): a synthetic resin of low density and thermo-plastic properties which may be produced in any shade of colour from colourless to black. This *acrylic resin*, as it is sometimes called, is used for producing imitation stones for costume jewellery and for the beads of imitation pearls. R.I. 1·50; S.G. 1·18; H. 2. It is attacked by acetone.

An alternative name for this material is *Diakon*.

Polystyrene (*Polystyrol*): A thermo-plastic material, marketed as *Distrene*, it is a polymerisation product of vinyl benzene. R.I. 1·59 to 1·67; S.G. 1·05; H. 2¼. The material dissolves in benzene or toluene. Like Perspex it is used for costume jewellery and for the beads of imitation pearls.

Thermo-setting Types

Phenol formaldehyde (*Bakelite*): a resin formed by the interaction of phenol (carbolic acid) and formaldehyde. R.I. 1·54 to 1·70 (usually 1·62 to 1·66); S.G. 1·25 to 2·00 (usually 1·25 to 1·30); H. 2¼. Used particularly for simulation of amber and, in the cast form known as "Catalin", for imitation cut gems of all colours. Cresol is sometimes used in the place of phenol.

Urea formaldehyde (*Bakelite*): a polymerisation product of formaldehyde with urea, or its sulphur analogue—thiourea, producing a material taking delicate shades of colour and of great translucency. R.I. 1·55 to 1·62; S.G. 1·45 to 1·55

(usually about 1·50); H. 2½. Sometimes known as the *amino resin*, this material is marketed under the names "Beetle" and "Scarab".

Casein: a formalised product of the casein of milk, producing a horn-like substance which may be machined into various designs. R.I. 1·54 to 1·56; S.G. 1·32 to 1·39 (usually constant at 1·33); H. 2½. Variously known as "Galalith", "Lactoid", "Erinoid", the material makes an excellent imitation of tortoiseshell, and to some extent of amber and ivory.

THE ARTIFICIAL TREATMENT OF GEMSTONES

Certain gem and ornamental stones are amenable to treatment, which alters the colour to one more attractive, by such means as moderate heat, staining, and the effects of radium emanations.

Heat treatment: Yellow topaz to pink ("fired" topaz); Brown zircon to colourless ("Jargoon" or "Matura Diamond"); Brown topaz to colourless; Brown zircon (probably at a different temperature) to blue (Starlite); Violet corundum to rose red; Yellow corundum to colourless; Pale green beryl to sky-blue (Aquamarine); Violet quartz (amethyst) to yellow; some amethyst turns to green on heating; Dark smoky quartz to yellow and orange-yellow; Zoisite to sapphire blue.

Staining: Chalcedony (Agate) to black (Black onyx) by sugar solution acted on by sulphuric acid; to yellow by hydrochloric acid; to red by ferrous sulphate; to blue by ferric ferrocyanide; to apple-green by nickel solutions; to emerald-green by chromium solutions.

Various other tints may be imparted by the use of organic dyes, but these fade on exposure to light.

Jasper and Hornstone change to blue simulating lapis-lazuli by the introduction of dye ("German lapis" or "Swiss lapis") or stained green to produce "Swiss jade".

Alabaster is stained with dye to pale tints.

Turquoise and Opal have their colour intensified by staining.

White jadeite has been stained to give an Imperial jade colour, and white howlite has been stained blue to resemble turquoise.

Cases are on record where yellowish diamonds have had a film of blue or violet dye rubbed over the back facets in order to correct the colour, likewise pale emeralds, pink topazes and rubies have been so treated with stain to increase the depth of colour.

Atomic bombardment: Diamonds, usually "off coloured" "Cape" stones have had their colour altered by bombardment with particles of atomic size. There are four methods used.

(1) By emanations from radium salts. The diamonds turn green. The colour, which is only skin deep, is permanent. The stones, however, become and remain radioactive, and this radioactivity provides a test.
(2) By high speed atomic particles shot out from an "atom smasher" such as a cyclotron. The colour induced is green, but by subsequent heat treatment brown and yellow colours are induced. The colour is only skin deep. Tests are not easy, but the yellow and brown stones usually show an absorption line at 5940 Å.
(3) By neutrons shot out from an atomic reactor (atomic pile). The effects are similar to those induced by cyclotron but the stone is coloured throughout.
(4) By high speed electrons obtained from a Van de Graaf generator. The colour induced is either aquamarine blue or greenish blue. The colour is only skin deep. Tests depend upon the fact that all known natural blue diamonds tested are electroconductive, that is they pass an electric current. The electron treated stones do not.

Some other stones will colour by means of atomic bombardment but the resulting colours are insufficiently attractive to be of value. Pink beryl has been irradiated to produce a deep blue "Maxixe-type" beryl, but the colour fades rapidly upon exposure to a strong light.

Some stones will colour after bombardment with X-rays. Yellow sapphire will go to a lovely topaz colour and kunzite

will turn green under this treatment. The stones soon revert to their original colour so the treatment is not commercially attractive.

Imitation Pearls

(1) Spheres of faintly opalescent glass are covered inside with parchment size which before drying is sprayed with pearl essence (Essence-d'orient, made from fish scales), and the bead is finished by being filled with wax.

(2) A solid glass bead upon the outside of which many coats of pearl essence are baked with subsequent burnishing. The density of the hollow wax-filled type of imitation pearl has been found to be usually less than 1·55 and rarely above that value. The solid glass bead type has a density much greater: the general range being 2·85 to 3·25, but some recent types have been found with values as low as 2·3. These are apparently made from crown glass and two typical values are 2·33 and 2·53. Mother-of-pearl has been used for the beads instead of glass, and so have the plastics "Perspex" and "Polystyrene". The latter are too light in weight so that the beads do not hang well.

FORMS USED IN THE FASHIONING OF GEMSTONES

Cabochon-cuts; have a domed top of either high or low curvature, and a base which may be anything from a repetition of the top to one which is hollowed out. The plan of such a stone being either circular or elliptical. Used for emeralds, rubies, sapphires, opals, turquoise, star stones, cat's-eyes and others.

Rose-cut; has a flat base with triangular facets, either 12 or 24, terminating in a point. Used for small diamonds and pyrope garnets.

Brilliant-cut; the modern cut for diamond, having 58 facets, 33 above the girdle (the crown) and 25 below (the pavilion). Certain definite proportions are essential for this cut, especially so in diamond. The angle between the crown facets and the girdle must be between 35 and 37 degrees, and similarly that between the girdle and the pavilions must be 40 degrees. In an ideal stone the depth of the crown should be one-third the total depth of the stone, and the width of the table should not exceed

four-ninths the total width of the stone. A stone which is too flat shows a "fish-eye" effect and one which is too deep a blackish glassy or "lumpy" appearance. Marquise and Pendeloque Brilliants are brilliant cuts on a modified outline.

Zircon-cut; similar to the brilliant cut with the addition of a set of facets on the pavilion reaching from the culet half-way up the back facets.

Briolette; an oval or pear-shaped diamond having its entire surface cut in triangular or rectangular facets.

Step, Trap or Emerald-cut; the stone is cut on a plan outline of a square, oblong or baguette and has a series of rectangular facets arranged parallel to the girdle.

Scissors, or Cross-cut; similar to the step-cut with the exception that the side facets are made up of four or more triangular facets.

Other shapes of outline based on the step-cut fashioning are *Kite, Lozenge, Triangle, Obus, etc.* Used for emerald, diamond and various coloured stones.

Seal-cut; similar to step-cut but with a very low crown and a wide table.

Mixed-cut; has a brilliant-cut crown and a step-cut base. Used for various coloured stones.

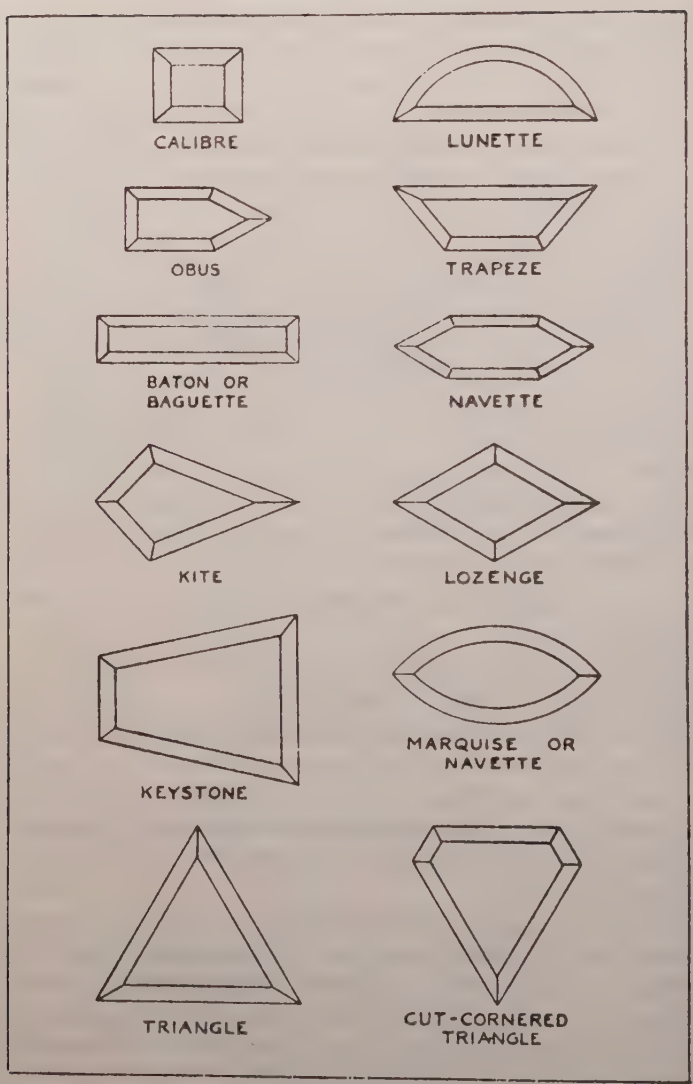
Fancy cuts; as recently used are modifications of the step-cut with fancy geometrical outline.

Cameo; is a stone with a raised carved image, generally used on stones or shells having horizontal banding of different colours so that the background can be a different colour from the carved figures.

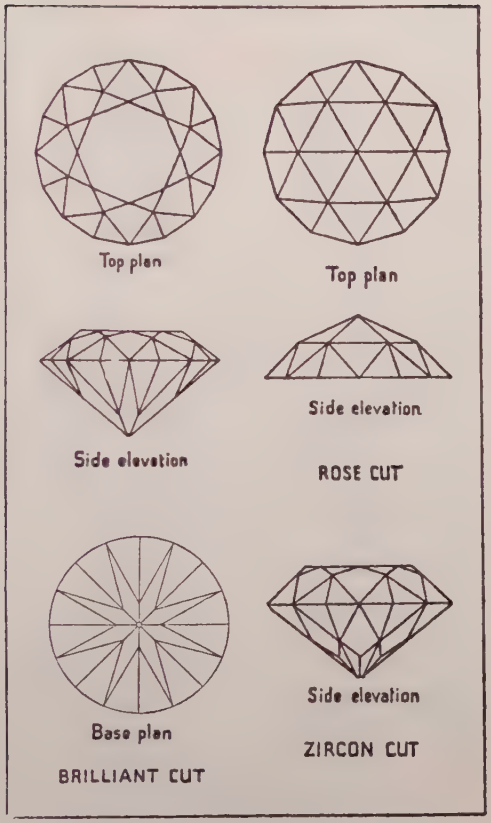
Intaglio; the reverse to cameo, that is, the design is engraved into the stone so that it can act as a seal. Usually used on stones of one colour and not those having a banded structure.

Curvette; is a cameo engraved so that the design has a hollowed background and the edge of the stone is raised as much as the central design.

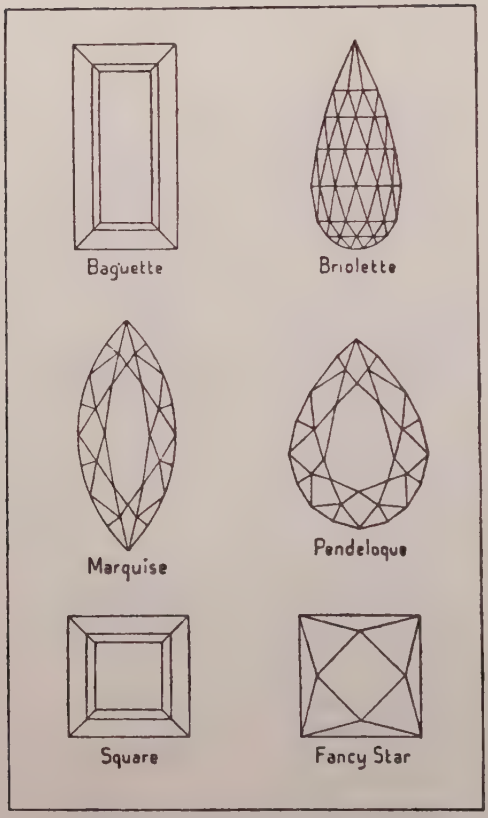
Cont. on page 191



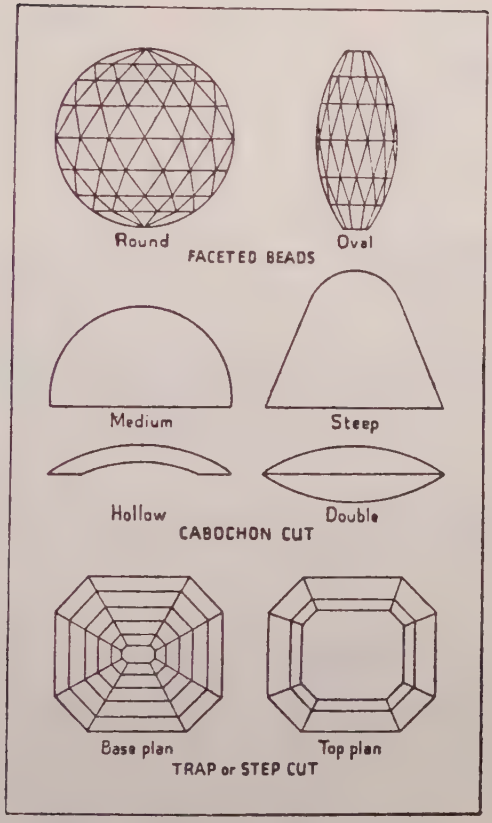
Outlines of cuts



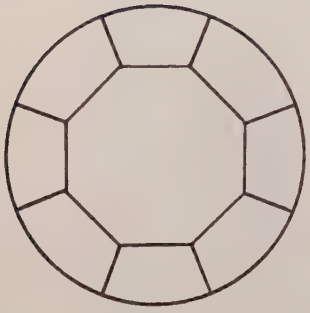
Conventional styles of gem cutting

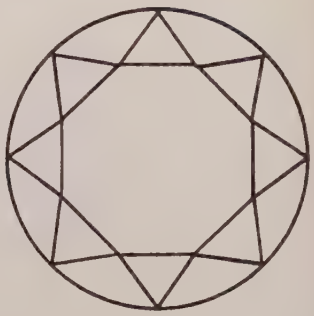


Conventional styles of gem cutting

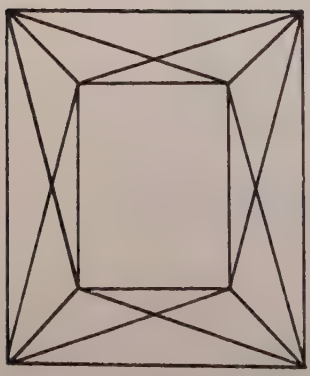


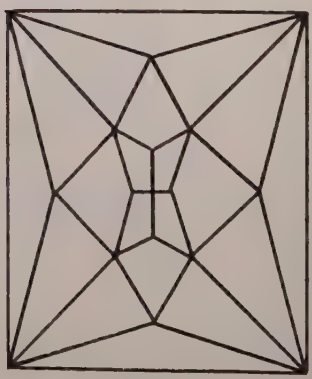
Conventional styles of gem cutting



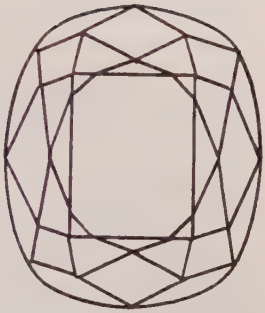


Eight-cut (left) and *Swiss-cut* (right) modification of the Brilliant-cut with a smaller number of facets. These are used for small diamonds.





The Scissors, or Cross-cut



Left; an oblong step-cut or trap-cut stone.

Right; a conventional cushion-shaped stone.

The stone dealers, specially those dealing in synthetic stones, now prefer to call the old cushion shape the *Antique-cut*, and the oblong trap-cut as the *Cushion-cut*.

LIST OF GEMSTONES SHOWING THEIR PRINCIPAL SOURCES

The more important sources are shown in heavy type.

Amber: British Isles, **Burma,** Denmark, **U.S.S.R.,** Finland, Holland, **Italy** (Sicily), Lithuania, N. America, **Rumania,** Sweden, **Poland, Dominican Republic.**

Amblygonite: Brazil.

Analcite: Czechoslovakia, Italy, Japan.

Anatase: Brazil, England, France, Germany, Switzerland, U.S.A.

Andalusite: **Brazil, Ceylon,** Russia, Spain.

Anglesite: Scotland, U.S.A.

Apatite: Burma, Ceylon, Czechoslovakia, Germany, India, Mexico, U.S.A. (in the State of Maine), Canada.

Apophyllite: Germany, India.

Augelite: Bolivia, U.S.A.

Axinite: British Isles, Canada, France, Tasmania, U.S.A. (California, New York and Pennsylvania), Mexico (Baja California).

Azurite: Zaire, British Isles, France, U.S.A. (in the State of Arizona).

Barytes: World-wide occurrence.

Bastite: Burma, Germany.

Bayldonite: Cornwall (England), S.W. Africa.

Benitoite: U.S.A. (in the State of California).

Beryl: (*emerald*) Brazil, **Colombia,** Egypt, India, New South Wales, Norway, Pakistan, **Rhodesia, Russia, Transvaal, Zambia.** (*Aquamarine*) Argentine, **Brazil,** British Isles, China, France, India, **Madagascar,** New South Wales, **Russia, South West Africa,** Tanzania, Transvaal, U.S.A. (in States of California, Connecticut and Maine), Western Australia. (*Morganite*) **Brazil, Madagascar, U.S.A.** (in the State of California). (*Heliodor*) **Brazil,** Ceylon, **Madagascar,** Russia, **South West Africa.**

Beryllonite: U.S.A. (in the State of Maine).

Boracite: Germany, U.S.A.

Brazilianite: Brazil (Minas Geraes), U.S.A.

Brookite: France, Switzerland, U.S.A.

Cancrinite: Canada.

Cassiterite: Bolivia, British Isles, Czechoslovakia, Indonesia, Germany, Malaysia, Mexico, Tasmania.

Celestine: **England,** U.S.A.

Cerussite: World-wide occurrence.

Chalcedony: **Brazil, India, Madagascar, Uruguay.** Material has a world-wide occurrence.

Charoite: U.S.S.R.

Chlorastrolite: U.S.A. and Canada (around Lake Superior).

Chondrodite: Sweden, U.S.A.

Chromite: New Zealand, Turkey, U.S.A. (in the States of Maryland and Pennsylvania), Rhodesia.

Chrysoberyl: (*alexandrite*) **Ceylon,** Rhodesia, **Russia,** (*Cat's-eye*) **Ceylon,** (*Yellow*) **Brazil, Ceylon, Madagascar,** Rhodesia, U.S.A. (in the States of Connecticut and New York). (*Colourless*) Burma.

Chrysocolla: Canada, Chile, Russia, U.S.A. (in the States of Arizona, Lake Superior district and Nevada), Israel.

Cobaltite: British Isles, Canada, Norway.

Colemanite: U.S.A.

Copal Resin: New Zealand, Africa (many states).

Coral: Australia (Northern shores), Japanese waters, **Mediterranean** (worked in Italy), Persian Gulf, (*black*) Hawaii.

Corundum: (*ruby*) **Burma,** Ceylon, Finland, India, **Thailand, Tanzania,** U.S.A. (in the State of North Carolina). (*Sapphire*) Angola, Zaire, **Burma, Ceylon,** China, Colombia, **India,** Vietnam, Madagascar, New South Wales, Queensland, Malawi, Kenya, Rhodesia, **Thailand,** Tanzania, Victoria, U.S.A. (in the State of Montana).

Cultured Pearls: **Japanese Waters,** Malay Archipelago, N.W. Australia.

Cuprite: Widespread occurrence.

Danburite: Burma, Japan, Madagascar, U.S.A. (in the State of Connecticut), Mexico.

Datolite: British Isles, Germany, U.S.A. (in the Lake Superior district).

Diamond: **Angola,** Botswana, Central African Empire, Zaire, **Brazil, Guyana,** Indonesia (Borneo), **Ghana,** India, Ivory Coast, Lesotho, New South Wales, Rhodesia, **Russia, Sierra Leone, South Africa, South West Africa,** Tanzania, U.S.A. (in the States of California, Virginia and Arkansas), Venezuela.

Diopside: Austria, Brazil, Burma, Italy, Madagascar, South Africa, U.S.A. (in the State of New York).

Dioptase: Argentina, Chile, Zaire, Rumania, Russia, South West Africa.

Dumortierite: France, India, Madagascar, Norway, South West Africa, U.S.A. (in the States of Arizona, California and Nevada).

Durangite: Mexico.

Ekanite: Ceylon.

Enstatite: Burma, South Africa.

Epidote: Alaska, Austria, France, Italy, Kenya, Norway.

Euclase: Brazil, India, Russia, Tanzania.

Feldspar: (*moonstone*) **Burma, Ceylon,** Madagascar, India, Tanzania, (*Yellow orthoclase*) Madagascar, (*Labradorite*) **Canada (Newfoundland),** Russia. (*Amazonite*) U.S.A. (in the State of Colorado). (*Sunstone*) Canada, Russia, Norway, U.S.A. (in the State of California). (*Adularia*) Switzerland.

Fibrolite: Burma, Ceylon.

Fluorspar: British Isles (*including the Blue John variety*), Germany, Norway, South West Africa, U.S.A.

Friedelite: France, Sweden, U.S.A.

Gahnite: Many localities.

Garnet: (*Hessonite*) Brazil, **Ceylon,** Russia. (*Xalostockite*) Mexico. (*Massive grossular*) Transvaal. (*Pyrope*) Argentine, **Australia,** Brazil, **Czechoslovakia,** Madagascar, Mexico, Rhodesia, **South Africa,** Tanzania, U.S.A. (in the States of Arizona and Colorado). (*Rhodolite*) U.S.A. (in the State of North Carolina). (*Almandine*) Australia, Austria, **Brazil, Ceylon, India,** Madagascar, Tanzania, Uruguay, U.S.A. (*Spessartine*) Brazil, Ceylon, New South Wales, U.S.A. (in the State of Nevada). (*Demantoid*) **Russia.** (*Topazolite*) Italy, Switzerland. (*Uvarovite*) Finland, Germany, India, Russia, Spain.

Hambergite: Madagascar.

Hematite: British Isles, Germany, Norway, Spain, Sweden, U.S.A.

Herderite: Germany (Saxony), U.S.A.

Howlite: California.

Idocrase: Austria, Canada, Italy, Russia, Switzerland. (*Californite*) U.S.A. (in the State of California), Switzerland. (*Cyprine*) Norway. (*Xanthite*) U.S.A. (in the State of New York).

Iolite: Burma, Ceylon, India, Madagascar.

Ivory: (*Elephant*) **Africa,** Burma, India, Thailand (Siam). (*Fossil*) Russia. (*Hippopotamus*) Africa. (*Walrus*) Canada, Norway, Russia. (*Narwhal*) Canada, Norway, North Atlantic. (*Boar*) Africa, India. (*Cachelot whale*) North Atlantic.

Jadeite: **Burma.** (*Chloromelanite*) Mexico, U.S.A.

Jeremyjevite: South West Africa.

Jet: **British Isles, Spain,** Turkey.

Kornerupine: Ceylon, Burma, Greenland, Madagascar, Tanzania.

Kyanite: India, Kenya, Switzerland, U.S.A. (in the State of Montana).

Lapis-lazuli: **Afghanistan,** Burma, **Chile, Russia,** U.S.A. (in the State of California).

Lazulite: Austria, Brazil, Sweden, U.S.A. (in the State of North Carolina).

Lepidolite: Madagascar, Russia, U.S.A.

Leucite: Italy.

Malachite: Zaire, Russia, South Australia, Chile.

Meerschaum: Turkey.

Moldavite: Czechoslovakia.

Natrolite: Norway, Scotland.

Nephrite: Canada, China, **New Zealand,** Poland, Rhodesia, **Russia,** Tibet, U.S.A.

Niccolite: Canada, Europe, U.S.A.

Obsidian: Iceland, Italy, Mexico, U.S.A.

Odontolite: France.

Operculum: Indonesia, Malaysia.

Opal: Czechoslovakia, Honduras, Mexico, **New South Wales,**

Queensland, South and Western Australia, Brazil. (*Fire Opal*) **Mexico,** Western Australia. (*Water Opal*) **Mexico,** U.S.A.

Painite: Burma.

Pearl: **Australia** (north and west coasts), Burma (Mergui archipelago), **Ceylon** (Gulf of Manaar), East Indies (Borneo and New Guinea), Japan, Malaysia, **Bahrein,** U.S.A. (Gulf of Mexico and Gulf of California), Venezuela. (*Conch and clam pearls*) Gulf of Mexico and Gulf of California. (*Freshwater pearls*) Rivers of the British Isles and North America. (*Cultured pearls*) Japan, Malaysia, North West Australia, Pacific Islands.

Pectolite: Italy, Scotland, U.S.A.

Peridot: Brazil, Burma, **Egypt** (Isle of St. John in the Red Sea), Hawaii, Norway, Queensland, U.S.A.

Petalite: Sweden, U.S.A., Rhodesia.

Phenakite: Brazil, Russia, Tanzania, U.S.A. (in the State of Maine).

Pollucite: Elba, U.S.A. (in the State of Maine), Sweden.

Prehnite: China, France, South Africa, U.S.A.

Proustite: Chile, Europe, France, Mexico, U.S.A.

Pseudophite: Austria, Italy, Norway.

Quartz: (*Rock Crystal*) **Brazil,** France, Hungary, India, Italy, **Japan,** Madagascar, Switzerland, U.S.A. (*Amethyst*) **Brazil, Uruguay,** Ceylon, India, Japan, Madagascar, **Russia.** (*Cairngorm*) Brazil, British Isles, China, Spain, U.S.A. (in the State of Colorado). (*Citrine*) Brazil, Madagascar. (*Rose Quartz*) Brazil, Germany, India, Japan, Madagascar, Russia, South West Africa, U.S.A. (in the State of Maine). (*Quartz cat's-eyes*) Ceylon, Germany. (*Crocidolite*) Austria, South Africa. (*Aventurine*) India, Spain.

Rhodizite: Madagascar, Russia.

Rhodochrosite: Argentina, Germany, U.S.A., South Africa.

Rhodonite: Australia, India, Russia, U.S.A.

Rutile: France, Italy, Madagascar, Norway, Sweden, Russia, Switzerland, U.S.A.

Saussurite: Switzerland.

Scapolite: Brazil, Burma, Madagascar, Canada, Tanzania.

Scheelite: Mexico, U.S.A.

Serpentine: British Isles, Canada, Italy, Norway, U.S.A. (*Serpentine has widespread occurrence throughout the world*).

Silica Glass: Libya.

Sinhalite: Ceylon, Burma.

Smaltite: Canada, Europe.

Smithsonite: Greece, South West Africa, U.S.A. (in the State of New Mexico).

Sodalite: Canada, Russia, S.W. Africa, U.S.A.

Sphene: Austria, Canada, Switzerland, U.S.A. (in the States of Maine and Pennsylvania), Mexico.

Spinel: Afghanistan, **Burma, Ceylon, Thailand,** U.S.A. (in the State of Montana).

Spodumene: (*Hiddenite*) Brazil, U.S.A. (in the State of North Carolina). (*Kunzite*) Madagascar, U.S.A. (in the State of California). (*Yellow*) Brazil, Madagascar.

Staurolite: Afghanistan, Russia, Switzerland, U.S.A.

Stibiotantalite: U.S.A.

Stichtite: Canada, South Africa, Tasmania.

Taaffeite: Ceylon.

Thomsonite: U.S.A. (in the State of Colorado and the Lake Superior district).

Topaz: **Brazil,** British Isles, Burma, **Ceylon,** Germany, Japan, Madagascar, New South Wales, Nigeria, Rhodesia, **Russia, South West Africa,** Tasmania, U.S.A. (in the States of California, Colorado, New Hampshire and Utah).

Tortoise-shell: Australia, China, Indonesia, India, New Guinea, Indian Ocean area.

Tourmaline: **Brazil,** Burma, **Ceylon,** India, Madagascar, Rhodesia, Russia, South West Africa, Switzerland, Thailand,

Tanzania, **U.S.A.** (in the States of California, Connecticut and Maine).

Tremolite: Canada.

Tugtupite: Greenland.

Turquoise: **Egypt, Iran** (Persia), Tibet, U.S.A. (in the States of Arizona, California, Colorado, New Mexico, Nevada and Texas).

Ulexite: California.

Unakite: U.S.A.

Variscite: U.S.A. (in the State of Utah).

Verdite: South Africa, U.S.A.

Violane: Italy.

Vegetable Ivory: (*Corozo nut*) Colombia, Ecuador, Peru. (*Doom palm nut*) Nigeria, Somalia, Sudan, Tanzania.

Wardite: U.S.A. (in the State of Utah).

Whewellite: Europe.

Willemite: U.S.A. (in the State of New Jersey).

Witherite: Canada, England, Japan, U.S.A.

Wollastonite: Finland, Mexico, Rumania.

Wulfenite: Australia, Zaire, Europe, Mexico, U.S.A.

Zincite: U.S.A. (in the State of New Jersey).

Zircon: **Burma, Ceylon,** France, **Vietnam,** Madagascar, New South Wales, Russia, **Thailand.**

Zoisite: Norway, Tanzania.

GEMSTONES OCCURRING IN THE PRINCIPAL COUNTRIES

Note: *restricted space prevents these lists from being exhaustive. Academic occurrences are often omitted.*

Europe

Austria: Datolite, diopside, emerald, epidote, garnet (almandine), idocrase, lazulite, pseudophite, quartz, sphene, topaz.

British Isles: Agate, alabaster, amber, anatase, anglesite, axinite, azurite, bayldonite, beryl, cassiterite, cobaltite, datolite, fluorspar, hematite, jet, malachite, marble, natrolite, pearl (freshwater), pectolite, quartz, serpentine, topaz, witherite.

Czechoslovakia: Analcite, apatite, cassiterite, garnet (pyrope), moldavite, opal.

Denmark: Amber.

Estonia (U.S.S.R.): Amber.

Finland: Amber, corundum (ruby), garnet (uvarovite), wollastonite.

France: Anatase, axinite, azurite, chiastolite, dumortierite, epidote, friedelite, jadeite (chloromelanite), malachite, odontolite, pollucite, prehnite, proustite, quartz, rutile, zircon.

Germany: Agate, apatite, azurite, bastite, cassiterite, fluorspar, garnet (uvarovite), hematite, quartz, rhodochrosite, sanidine.

Greece: Smithsonite.

Holland: Amber.

Hungary: Opal, quartz, rhodochrosite.

Italy: Amber, coral, chondrodite, diopside, epidote, friedelite, garnet (topazolite), obsidian, petalite, quartz, rutile.

Lithuania (U.S.S.R.): Amber.

Norway: Beryl (emerald), cobaltite, corundum, dumortierite, epidote, feldspar (sunstone), hematite, idocrase (cyprine), ivory (narwhale and walrus), peridot, pseudophite, rutile, serpentine, thulite.

Poland: Amber, chrysoprase, nephrite.

Rumania: Amber.

Spain: Andalusite, apatite, aragonite, garnet (uvarovite), hematite, jet, quartz, sphalerite.

Sweden: Amber, hematite, lazulite.

Switzerland: Analcite, anatase, feldspar (adularia), epidote, garnet (topazolite), idocrase, kyanite, leucite, quartz, rutile, saussurite, serpentine, sphene, staurolite, tourmaline.

Asia

Afghanistan: Corundum (ruby), lapis-lazuli, serpentine, spinel, staurolite.

Burma: Apatite, bastite, chrysoberyl, corundum, danburite, diopside, enstatite, feldspar (moonstone), fibrolite, iolite, ivory (elephant), jadeite, lapis-lazuli, pearl (*Mergui Archipeligo*), painite, peridot, scapolite, sinhalite, spinel, topaz, tourmaline, zircon.

China: Beryl, corundum, jadeite (?), nephrite, prehnite, quartz, serpentine (bowenite), tortoise-shell.

India: Apatite, apophyllite, beryl (emerald), chalcedony, corundum (sapphire), diamond, euclase, garnet (almandine and uvarovite), iolite, ivory (elephant and boar), kyanite, quartz, rhodonite, tortoise-shell, tourmaline.

Indonesia: Cassiterite, diamond (*Borneo*), operculum, pearl, tortoise-shell.

Iran (*Persia*): Turquoise.

Japan: Coral, danburite, analcite, pearl (cultured and natural), witherite.

Malaysia: Cassiterite, operculum, pearl (cultured and natural), quartz, tortoise-shell, topaz.

Pakistan: Beryl (emerald), corundum (ruby), garnet (grossular), idocrase.

Russia: Andalusite, beryl (aquamarine and emerald), charoite, chrysoberyl (alexandrite), chrysocolla, diamond, diopside, dioptase, euclase, feldspar (labradorite and sunstone), garnet (demantoid, hessonite and uvarovite), idocrase, ivory (fossil and walrus), lapis-lazuli, malachite, nephrite, phenakite, quartz, rhodizite, rhodonite, rutile, sodalite, staurolite, topaz, tourmaline, zircon.

Sri Lanka (*Ceylon*): Andalusite, apatite, beryl, chrysoberyl, corundum, diopside, ekanite, feldspar (moonstone), fibrolite, garnet (almandine, hessonite and spessartine), iolite, kornerupine, pearl (*Gulf of Manaar*), quartz, sinhalite, spinel, topaz, tourmaline, zircon.

Thailand (*Siam*): Corundum, ivory (elephant), tourmaline, zircon.

Tibet (*China*): Nephrite, turquoise.

Turkey: Chromite, jet, marble, meerschaum, onyx.

Vietnam: Corundum (sapphire), zircon.

Africa

Angola: Corundum, diamond, ivory.

Central African Empire: Diamond, dioptase, ivory.

Ethiopia: Ivory.

Ghana: Diamond, ivory.

Guinea: Diamond, ivory.

Kenya: Corundum (ruby), epidote, garnet, ivory, kyanite.

Libya: Silica glass.

Malagasy, Republic of: Beryl, chalcedony, chrysoberyl, corundum, danburite, diopside, dumortierite, feldspar (moonstone and yellow orthoclase), garnet (almandine and pyrope), hambergite, iolite, kornerupine, quartz, rhodizite, rutile, scapolite, spodumene, topaz, zircon, tourmaline.

Mozambique: Ivory, tourmaline.

Nigeria: Beryl, ivory, topaz, vegetable ivory (doom palm nut).

Rhodesia: Beryl (emerald), chalcedony, chrysoberyl, corundum, diamond, garnet (pyrope), nephrite, topaz, tourmaline.

Sierra Leone: Diamond, ivory.

Somalia: Ivory, vegetable ivory (doom palm nut).

South Africa, Republic of: Beryl (emerald), diamond, diopside, enstatite, garnet (pyrope and massive grossular), prehnite, quartz, rhodochrosite, stichtite, verdite.

South West Africa (*Namibia*): Bayldonite, beryl, diamond, dioptase, dumortierite, quartz, smithsonite, sodalite, topaz, tourmaline.

Sudan: Vegetable ivory (doom palm nut).

Tanzania: Beryl, chrysoberyl (alexandrite), corundum (ruby and sapphire), diamond, euclase, feldspar (moonstone), garnet (almandine and pyrope), ivory, kornerupine, phenakite, tourmaline, vegetable ivory (doom palm nut), zoisite.

Zaire: Azurite, corundum, diamond, ivory, malachite, peridot, wulfenite.

Zambia: Beryl (emerald), garnet, quartz (amethyst).

Americas

Alaska: Nephrite.

Argentina: Beryl, dioptase, garnet (pyrope), rhodochrosite.

Bolivia: Augelite, cassiterite.

Brazil: Amblygonite, anatase, andalusite, beryl (aquamarine and emerald), brazilianite, chalcedony, chrysoberyl, diamond, diopside, euclase, garnet (almandine, hessonite, pyrope, spessartine), lazulite, peridot, phenakite, quartz, scapolite, spodumene, topaz, tourmaline.

Canada: Apatite, axinite, cancrinite, chlorastrolite, chrysocolla, cobaltite, feldspar (labradorite and sunstone), idiocrase, ivory (fossil, narwhal and walrus), niccolite, scapolite, serpentine, sodalite, sphene, tremolite, witherite.

Chile: Chrysocolla, dioptase, lapis-lazuli, malachite, proustite.

Columbia: Beryl (emerald), corundum, vegetable ivory (corozo nut).

Ecuador: Vegetable ivory (corozo nut).

Greenland: Ivory (narwhal and walrus), kornerupine, tugtupite.

Guatemala: Jadeite.

Honduras: Opal.

Mexico: Apatite, axinite, cassiterite, durangite, garnet (grossular and pyrope), jadeite (chloromelanite), obsidian, opal (fire and water), pearl, peridot, proustite, scheelite, wollastonite, wulfenite.

Peru: Vegetable ivory (corozo nut).

Uruguay: Chalcedony, garnet (almandine), quartz.

United States of America: Amber, apatite, augelite, axinite, azurite, benitoite, beryl, beryllonite, boracite, brazilianite, celestine, chlorastrolite, chondrodite, chromite, chrysoberyl, chrysocolla, colemanite, corundum, danburite, datolite. diamond, diopside, dumortierite, feldspar (amazon stone and sunstone), fluorspar, friedelite, garnet (almandine, pyrope, rhodolite spessartine), hematite, herderite, howlite, idocrase (californite), jadeite, kyanite, lapis-lazuli, lazurite, lepidolite, malachite, nephrite, niccolite, obsidian, opal, pearl (clam, conch, freshwater, oyster), peridot, petalite, phenakite, pollucite, prehnite, quartz, rhodonite, rutile, scheelite, serpentine, smithsonite, sodalite, sphene, spinel, spodumene, staurolite, stibiotantalite, thomsonite, topaz, tourmaline, turquoise, ulexite, unakite, variscite, verdite, wardite, willemite, wulfenite, zincite.

Venezuela: Diamond, pearl.

Australasia

New South Wales: Beryl (aquamarine and emerald), corundum, diamond, garnet (spessartine), nephrite, opal, rhodonite, topaz, wulfenite, zircon.

New Zealand: Chromite, kauri gum, nephrite, serpentine (bowenite).

Northern Territory: Pearl.

Queensland: Coral (*Great Barrier Reef*), chrysoprase, corundum, opal, peridot, rhodonite.

South Australia: Malachite, nephrite, opal.

Tasmania: Axinite, cassiterite, stichtite, topaz.

Victoria: Corundum.

Western Australia: Beryl (emerald), pearl (cultured and natural), tektite, tiger's eye.

STREAK

The *streak* of a mineral is the colour of its powder, which may be quite different from that of the mineral in mass. The *streak colour* is best observed by rubbing the specimen under test on a piece of unglazed porcelain or roughened glass called a *streak-plate*.

In general the streak is much lighter than the body colour of the mineral in mass and, except in certain cases, such as hematite, the colour of the streak is hard to determine. It is useful to compare the streak of a suspected mineral with that of a known specimen. The streak of the precious metals, when treated with acid reagents, is used in their determination and estimation of their quality. See *Tests for precious metals*, page 223.

TABLE OF STREAK

Azurite	Blue	*Jet*	Black
Cassiterite	Pale brown	*Malachite*	Green
Cobaltite	Grey-black	*Pyrites*	Green-black
Chromite	Brown	*Rutile*	Pale brown
Gold	Metallic yellow	*Turquoise*	Pale green
Hematite	Red	*Variscite*	Greenish black

Flame Test

The powdered mineral either alone or moistened with hydrochloric, nitric or sulphuric acid, heated on a clean platinum wire may colour the outer part of the blowpipe flame with some definite colour which is characteristic of a metal.

Calcium	Brick-red
Strontium	Crimson
Lithium	Deep crimson
Sodium	Yellow
Potassium	Violet (masked by sodium but can be observed by the use of a blue glass filter)

Barium . .	Yellow-green
Copper . .	Emerald-green with HNO_3; Sky-blue with HCl.
Thallium .	Bright green
Boron . .	Momentary yellow-green with sulphuric acid

Indefinite blue flames are given by lead, arsenic and antimony; and indefinite green flames by zinc, phosphorus and molybdenum. These elements are more satisfactorily detected by other tests.

Micro-Chemical Tests

Methods of chemical investigation requiring only minute portions of the specimen, such as a scraping or peeling are finding increasing value in gemmological diagnosis. Almost any chemical reaction can be carried out on a small scale under the microscope, but to be really effective some easily observed and characteristic reaction is necessary, as in those reactions which give rise to colour change or to crystallised precipitates whose form is so distinctive that they may be recognised.

Short Table of Micro-Chemical Tests

Note.—*Chemical reactions involving the production of hydrofluoric acid should not be attempted under the microscope as these fumes attack the glass of the objective.*

The fumes of the strong acids used in some reactions may attack the brass of the objective. It is suggested that a film of vaseline be smeared over the brasswork to prevent this.

Aluminium. Solutions of aluminium salts in sulphuric acid with caesium sulphate give colourless isotropic octahedra of caesium alum.

Ammonium. To a solution of an ammonium salt is added a drop of sodium phosphate, one of soda and one of magnesium sulphate. Typical crystals of struvite ($NH_4MgPO_46H_2O$) are seen to appear.

Caesium. When aluminium sulphate is added to a caesium salt octahedra of caesium alum are produced.

Calcium. The specimen is dissolved by a drop of hydrochloric acid and on the addition of a drop of sulphuric acid produces radiating groups of needle-shaped crystals of calcium sulphate.

Chloride. A minute trace of chloride in a drop of dilute solution can be detected by the production with silver nitrate of a white precipitate soluble in ammonia. The microscope further shows that the precipitate of silver chloride is redeposited from the ammoniacal solution in colourless isotropic octahedra.

Magnesium. When to a drop of a dilute solution of a magnesium salt containing sal ammoniac and ammonia a drop of sodium phosphate be added, typical crystals of struvite appear.

Nitrate. See under *Miscellaneous chemical tests.*

Phosphate. The specimen is dissolved in a drop of nitric acid and a drop of an aqueous solution of ammonium molybdate added. A bright yellow precipitate of ammonio-phosphomolybdate is formed which, under higher magnification, is resolved into yellow octahedra.

Potassium. Gives yellow octahedra of potassium chloroplatinate (K_2PtCl_6) on the addition of a drop of a solution of platinum tetrachloride to dilute solutions of potassium salts in hydrochloric acid.

Silicon. Silicates are decomposed with hydrofluoric and sulphuric acids in a covered platinum dish, some of the silicon fluoride given off being collected in a drop of water on the underside of the cover. The addition of a sodium salt to this gives a faintly rose-coloured hexagonal plate of sodium fluosilicate (Na_2SiF_6).

Silver. See *Tests for precious metals*, page 223.

Sodium. Uranyl acetate gives with sodium salts yellow isotropic tetrahedra of uranyl sodium acetate.

Miscellaneous Chemical Tests

Carbonate. All carbonates effervesce when touched with warm acid giving off carbon dioxide.

Copper. Dilute solutions of copper compounds in acids become deep blue on the addition of ammonia.

Nitrate. A little nitrate solution is poured into a test tube and an equal volume of strong sulphuric acid added, the liquids mixed and cooled, a *dark brown* film or ring will appear at the surface of contact of a cold solution of ferrous sulphate which is cautiously poured upon the acid liquid without mingling with it. This is a convenient subsidiary test for celluloid, in which case the celluloid can be placed directly into the sulphuric acid which dissolves the celluloid sufficiently to produce the necessary effect. This *brown ring test* for a nitrate may also be carried out as a micro-chemical test.

Sulphur. The powdered material is first fused with sodium carbonate on charcoal, the fused mass placed on a silver coin and moistened produces a black stain. This is the *silver coin test.* Sulphates give a dense white precipitate of barium sulphate on addition of barium chloride to the solution; also after reduction by heating to the sulphide they give the silver coin test as mentioned above.

Titanium. The mineral is heated with sodium carbonate on charcoal, the resulting mass dissolved in sulphuric acid to which has been added an equal quantity of water, the solution is cooled, diluted with water, and a drop of hydrogen peroxide added. The formation of an amber colour indicates the presence of titanium.

Water. Substances which contain water when heated in the closed tube (test tube) give off the water which condenses on the cool part of the tube as colourless drops. These colourless drops may be tested for water by the blue colour produced when added to white anhydrous copper sulphate.

Zinc. Heated on charcoal, zinc minerals give an encrustation which is yellow when hot and white when cold; this

encrustation, moistened with cobalt nitrate and strongly reheated, assumes a fine green colour.

Tests for the distinction between Calcite and Aragonite

(*a*) *Meigen's Test.* The mineral under observation is boiled with cobalt nitrate solution for 15 minutes, and then washed. A pink staining indicates aragonite.

(*b*) *Lietmeier and Frigl's Test.* A solution of manganese sulphate (11·8 gr. $MnSO_4$ $7H_2O$ in 100 c.c. water) is prepared, some solid silver sulphate introduced, the whole heated, cooled and filtered, then one or two drops of dilute caustic soda solution are added, and after one or two hours the precipitate is filtered off and the solution kept in an opaque bottle. For distinguishing between aragonite and calcite, the powder or slice is covered by the solution. Aragonite at once turns grey and finally black, whilst calcite becomes only greyish after more than an hour.

TABLE OF THE CHEMICAL COMPOSITION OF GEM MATERIALS AND PRECIOUS METALS

Elements

Diamond	C
Gold	Au
Palladium	Pd
Platinum	Pt
Silver	Ag

Haloids

Fluorspar	CaF_2

Sulphides

Cobaltite	CoAsS
Marcasite	FeS_2
Proustite	$3Ag_2S\ As_2S_3$
Pyrites	FeS_2
Sphalerite	ZnS

Oxides

Anatase	TiO_2
Brookite	TiO_2
Cassiterite	SnO_2
Chalcedony	SiO_2
Chromite	$FeCr_2O_4$
Crocoite	$PbCrO_4$
Corundum	Al_2O_3
Cuprite	Cu_2O
Hematite	Fe_2O_3
Lithium niobate	$LiNbO_3$
Microlite	$Ca_2Ta_2O_7$
Opal	SiO_2nH_2O
Periclase	MgO
Quartz	SiO_2
Rutile	TiO_2
Scheelite	$CaWO_4$
Strontium titanate	$SrTiO_3$
Zincite	ZnO

Aluminates

Chrysoberyl	$BeAl_2O_4$
Gahnite	$ZnAl_2O_4$
Painite	Ca Boro-silicate aluminate
Spinel	$MgAl_2O_4$
Taaffeite	$Be_4Mg_4Al_{16}O_{32}$
YAG	$Y_3Al_5O_{12}$

Carbonates

Azurite	$2CuCO_3Cu(OH)_2$
Calcite	$CaCO_3$
Cerussite	$PbCO_3$
Magnesite	$MgCO_3$
Malachite	$CuCO_3Cu(OH)_2$
Rhodochrosite	$MnCO_3$
Smithsonite	$ZnCO_3$
Stichtite	$Mg_6Cr_2(OH)_{16}CO_34H_2O$

Silicates

Analcite	$NaAlSi_2O_6H_2O$
Andalusite	Al_2SiO_5
Apophyllite	$KF.Ca_4Si_8O_{12}(OH)_{16}$
Axinite	$HMgCa_2BAl_2(SiO_4)_4$
Benitoite	$BaTiSi_3O_9$
Beryl	$Be_3Al_2(SiO_3)_6$
Cancrinite	A Na,Ca,Al silicate with some CO_2
Charoite	A potassium calcium silicate
Chondrodite	$2Mg_2SiO_4Mg(F,OH)_2$
Chrysocolla	$CuSiO_3nH_2O$
Danburite	$CaB_2Si_2O_8$
Datolite	$Ca(B,OH)SiO_4$
Diopside	$CaMg(SiO_3)_2$
Dioptase	H_2CuSiO_4
Dumortierite	$Al(Al,O)_7(B,OH)(SiO_4)_3$
Enstatite	$(Mg,Fe)SiO_3$
Epidote	$Ca_2(Al,Fe)_2(Al,OH)(SiO_4)_3$
Euclase	$Be(Al,OH)SiO_4$
Feldspar group	
Albite	$NaAlSi_3O_8$
Anorthite	$CaAl_2Si_2O_8$
Microcline	$KAlSi_3O_8$
Orthoclase	$KAlSi_3O_8$
Fibrolite	Al_2SiO_5
Friedelite	$H_7(Mn,Cl)Mn_4Si_4O_{16}$
Garnet group	
Almandine	$Fe_3Al_2(SiO_4)_3$
Andradite	$Ca_3Fe_2(SiO_4)_3$
Grossular	$Ca_3Al_2(SiO_4)_3$
Pyrope	$Mg_3Al_2(SiO_4)_3$
Spessartine	$Mn_3Al_2(SiO_4)_3$
Uvarovite	$Ca_3Cr_2(SiO_4)_3$
Howlite	A silico-borate of calcium
Hypersthene	$(Fe,Mg)SiO_3$
Idocrase	$Ca_6(Al(OH,F))Al_2(SiO_4)_5$
Iolite	$(Mg,Fe)_4Al_8(OH)_2)Si_2O_7)_5$

Jadeite	$NaAl(SiO_3)_2$
Kornerupine	$MgAl_2SiO_6$
Kyanite	Al_2SiO_5
Lepidolite	$H_4K_2Li_2Al_4Si_6O_{22}$
Leucite	$KAl(SiO_3)_2$
Meerschaum	$H_4Mg_2Si_3O_{10}$
Melinophane	$(Ca,Na)_2Be(Si,Al)_2(O,F)_7$
Mesolite	$(Ca,Na)_2Al_2Si_3O_{10}(H_2O)_{2-3}$
Natrolite	$Na_2Al_2Si_3O_{10}2H_2O$
Nephrite	$Ca_2(Mg,Fe)_5(OH)_2(Si_4O_{11})_2$
Pectolite	$HNaCa_2(SiO_3)_3$
Peridot	$(Mg,Fe)_2SiO_4$
Petalite	$Li_2OAl_2O_38SiO_2$
Phenakite	Be_2SiO_4
Pollucite	$H_2Cs_4Al_4(SiO_3)_9$
Prehnite	$H_2Ca_2Al_2(SiO_4)_3$
Pyrophyllite	$H_2Al_2(SiO_3)_4$
Rhodonite	$MnSiO_3$
Scapolite group	
Marialite	$Na_3Al_3Si_9O_{24}NaCl$
Meionite	$Ca_3Al_6Si_6O_{24}CaCO_3$
Serpentine	$Mg_6(OH)_6Si_4O_{11}H_2O$
Sodalite	$3NaAlSiO_4NaCl$
Sphene	$CaTiSiO_5$
Spodumene	$LiAl(SiO_3)_2$
Staurolite	$HFeAl_5Si_2O_{13}$
Steatite	$H_2Mg_3Si_4O_{12}$
Thompsonite	$2(Ca,Na_2)Al_2(SiO_4)_2{\cdot}5H_2O$
Topaz	$Al_2(OH,F)_2SiO_4$
Tourmaline	$(Na,Ca)(Li,Mg,Fe,Al)_9B_3Si_6(O,OH)_{31}$
Tremolite	$CaMg_3Si_4O_{12}$
Willemite	Zn_2SiO_4
Wollastonite	$CaSiO_3$
Zircon	$ZrSiO_4$
Zoisite	$Ca_2Al_2(Al.OH)(SiO_4)_3$

Phosphates, Borates, Sulphates and Arsenates

Amblygonite	$LiAl(F,OH)PO_4$
Anglesite	$PbSO_4$
Apatite	$Ca_5(F,Cl)(PO_4)_3$
Augelite	$2Al_2O_3P_2O_5 3H_2O$
Barytes	$BaSO_4$
Bayldonite	$(Pb,Cu)_3As_2O_8(Pb,Cu)(OH)_2H_2O$
Beryllonite	$NaBePO_4$
Boracite	$Mg_6Cl_2B_{14}O_{26}$
Brazilianite	$Na_2O.3Al_2O_3.2P_2O_5.4H_2O$
Celestine	$SrSO_4$
Colemanite	$Ca_2B_6O_{11}5H_2O$
Durangite	$Na(Al,F)AsO_4$
Gypsum	$CaSO_4.2H_2O$
Herderite	$CaBe(F,OH)PO_4$
Hambergite	$Be_2(OH)BO_3$
Jeremyjevite	$AlBO_3$
Lazulite	$(Fe,Mg)Al_2(OH)_2(PO_4)_2$
Rhodizite	$KAl_2B_3O_8$
Sinhalite	$Mg(Al,Fe)BO_4$
Turquoise	$CuAl_6(PO_4)_4(OH)_8.5H_2O$
Ulexite	$NaCaB_5O_9$
Variscite	$AlPO_4.2H_2O$
Wardite	$Al_2(OH)_3PO_4\frac{1}{2}H_2O$

Tantalate

Stibiotantalite	$SbO_2(Ta,Nb)_2O_6$

Oxalate

Whewellite	$CaC_2O_4H_2O$

VALENCY

The valency of an element is determined by the number of its atoms which will combine with or replace one atom of hydrogen.

The valencies of the commoner elements are tabled below. It will be observed that some elements have different valencies in different compounds, *i.e.*, in the compound FeO iron is divalent and in Fe_2O_3 trivalent.

Monovalent

Bromine	(Br)	Iodine	(I)
Chlorine	(Cl)	Lithium	(Li)
Copper	(Cu)	Mercury	(Hg)
Fluorine	(F)	Potassium	(K)
Gold	(Au)	Silver	(Ag)
Hydrogen	(H)	Sodium	(Na)

Divalent

Barium	(Ba)	Manganese	(Mn)
Beryllium	(Be)	Mercury	(Hg)
Calcium	(Ca)	Nickel	(Ni)
Carbon	(C)	Oxygen	(O)
Chromium	(Cr)	Selenium	(Se)
Cobalt	(Co)	Strontium	(Sr)
Copper	(Cu)	Sulphur	(S)
Iron	(Fe)	Tellurium	(Te)
Lead	(Pb)	Tin	(Sn)
Magnesium	(Mg)	Zinc	(Zn)

Trivalent

Aluminium	(Al)	Gold	(Au)
Antimony	(Sb)	Iron	(Fe)
Arsenic	(As)	Manganese	(Mn)
Bismuth	(Bi)	Nickel	(Ni)
Boron	(B)	Nitrogen	(N)
Chromium	(Cr)	Phosphorus	(P)
Cobalt	(Co)		

Tetravalent

Carbon	(C)	Silicon	(Si)
Germanium	(Ge)	Thorium	(Th)
Hafnium	(Hf)	Tin	(Sn)
Lead	(Pb)	Titanium	(Ti)
Manganese	(Mn)	Zirconium	(Zr)

Pentavalent

Antimony	(Sb)	Nitrogen	(N)
Arsenic	(As)	Phosphorus	(P)
Bismuth	(Bi)	Tantalum	(Ta)

THE CHEMICAL ELEMENTS

Atomic number		*Symbol*	*Atomic weight*
89.	Actinium	Ac	227·05
13.	Aluminium	Al	26·98
95.	Americium	Am	243·0
51.	Antimony	Sb	121·75
18.	Argon	A	39·95
33.	Arsenic	As	74·92
85.	Astatine	At	210·0
56.	Barium	Ba	137·34
97.	Berkelium	Bk	249·0
4.	Beryllium	Be	9·02
83.	Bismuth	Bi	208·98
5.	Boron	B	10·82
35.	Bromine	Br	79·904
48.	Cadmium	Cd	112·41
55.	Caesium	Cs	132·91
20.	Calcium	Ca	40·08
98.	Californium	Cf	251·0
6.	Carbon	C	12·01
58.	Cerium	Ce	140·12
17.	Chlorine	Cl	35·453
24.	Chromium	Cr	51·996
27.	Cobalt	Co	58·94
29.	Copper	Cu	63·55
96.	Curium	Cm	247·0
66.	Dysprosium	Dy	162·5
99.	Einsteinium	Es	254·0
68.	Erbium	Er	167·26
63.	Europium	Eu	151·96
100.	Fermium	Fm	253·0
9.	Fluorine	F	18·998
87.	Francium	Fr	223·0
64.	Gadolinium	Gd	157·25
31.	Gallium	Ga	69·72
32.	Germanium	Ge	72·59
79.	Gold	Au	196·967
72.	Hafnium	Hf	178·49
2.	Helium	He	4·003
67.	Holmium	Ho	164·93
1.	Hydrogen	H	1·008
49.	Indium	In	114·82
53.	Iodine	I	126·93
77.	Iridium	Ir	192·2
26.	Iron	Fe	55·84
36.	Krypton	Kr	83·8
57.	Lanthanum	La	138·9
103.	Lawrencium	Lw	257·0
82.	Lead	Pb	207·2
3.	Lithium	Li	6·94
71.	Lutetium	Lu	174·97
12.	Magnesium	Mg	24·31
25.	Manganese	Mn	54·93
80.	Mercury	Hg	200·59
42.	Molybdenum	Mo	95·94
60.	Neodymium	Nd	144·24
10.	Neon	Ne	20·17
93.	Neptunium	Np	237·0
28.	Nickel	Ni	58·71
41.	Niobium	Nb	92·91
7.	Nitrogen	N	14·007
102.	Nobelium	No	254·0
76.	Osmium	Os	190·2
8.	Oxygen	O	16·00
46.	Palladium	Pd	106·4
15.	Phosphorus	P	30·97
78.	Platinum	Pt	195·09
94.	Plutonium	Pu	244·0
84.	Polonium	Po	209
19.	Potassium	K	39·102
59.	Praseodymium	Pr	140·91
61.	Promethium	Pm	145
91.	Protactinium	Pa	231·0
88.	Radium	Ra	226·0
86.	Radon	Rn	222·0

Atomic number	*Symbol*	*Atomic weight*	*Atomic number*	*Symbol*	*Atomic weight*
75. Rhenium	Re	186·2	65. Terbium	Tb	158·93
45. Rhodium	Rh	102·91	81. Thallium	Tl	204·3
37. Rubidium	Rb	85·48	90. Thorium	Th	232·04
44. Ruthenium	Ru	101·07	69. Thulium	Tm	168·93
62. Samarium	Sm	150·35	50. Tin	Sn	118·69
21. Scandium	Sc	44·96	22. Titanium	Ti	47·90
34. Selenium	Se	78·96	74. Tungsten	W	183·85
14. Silicon	Si	28·086	92. Uranium	U	238·03
47. Silver	Ag	107·87	23. Vanadium	V	50·94
11. Sodium	Na	22·99	54. Xenon	Xe	131·3
38. Strontium	Sr	87·63	70. Ytterbium	Yb	173·04
16. Sulphur	S	32·064	39. Yttrium	Yt	88·905
73. Tantalum	Ta	180·947	30. Zinc	Zn	65·38
43. Technetium	Tc	99	40. Zirconium	Zr	91·22
52. Tellurium	Te	127·61			

MENDELEEFF'S PERIODICAL CLASSIFICATION OF THE ELEMENTS

Until the middle of the 19th Century inorganic chemistry was largely a collection of uncorrelated facts concerning the properties of the 50 odd elements known and their compounds. Certain "families" of elements displaying a similarity in chemical behaviour were recognised but there was no underlying scheme relating all the elements in systematic fashion.

Mendeleeff changed all this. In 1869 he enunciated his periodic classification of the elements based on the order of their atomic weights in which at regular stages elements of similar nature occur and thus form well-defined "groups".

We now know that a more fundamental order than atomic weight is the atomic "number", which represents the surplus positive charge on the nucleus of each element, neutralised by an equal number of planetary electrons in the normal atom.

The fact that the atomic weight order introduced certain anomalies and that many "gaps" existed due to undiscovered elements added greatly to Mendeleeff's task of bringing order out of chaos. He boldly filled the gaps by postulating the missing elements, describing them and their properties in considerable detail. One by one these elements were discovered, many in Mendeleeff's lifetime.

To describe the table in full detail would be to cover the whole field of inorganic chemistry but a few words may be helpful to the student.

Hydrogen, the lightest element, does not belong clearly to any group of elements. Helium, atomic Number 2, heads a group of "noble" gases which are present in our atmosphere and are characterised by a great reluctance to form compounds with other elements. Lithium, the next element, is the lightest of a group of soft metals which combine vigorously with water to form strong caustic alkaline solutions. These, Li, Na, K, Rb and Cs, form an exceptionally well-defined group and are often together in such minerals as tourmaline and beryl. At the other end of the table is found an equally well-defined group known as the halogens (salt formers), comprising the gases fluorine and chlorine, the liquid bromine and the solid iodine. These combine with hydrogen to form powerful mineral acids which combine with the alkalis above to form soluble *salts* of which common salt, sodium chloride (NaCl) is a typical example.

Other relationships between elements in the various groups are not so immediately obvious. In the mineral kingdom the element silicon plays a predominant role, as carbon does in the organic world. This is due to the fact that silicon and oxygen atoms form chains and sheets which are held together very strongly and form stable and resistant compounds in great variety, producing silicate minerals.

THE PERIODIC CLASSIFICATION OF THE ELEMENTS

ç Period	Series	Group O	Group I	Group II	Group III	Group IV
1	1		Hydrogen H = 1·008			
2	2	Helium He = 4·003	Lithium Li = 6·94	Beryllium Be = 9·02	Boron B = 10·82	Carbon C = 12·01
3	3	Neon Ne = 20·18	Sodium Na = 23	Magnesium Mg = 24·3	Aluminium Al = 26·97	Silicon Si = 28·086
4	4	Argon A = 39·94	Potassium K = 39·102	Calcium Ca = 40·08	Scandium Sc = 45·1	Titanium Ti = 47·90
	5		Copper Cu = 63·57	Zinc Zn = 65·38	Gallium Ga = 69·72	Germanium Ge = 72·6
5	6	Krypton Kr = 83·7	Rubidium Rb = 85·4	Strontium Sr = 87·63	Yttrium Yt = 88·904	Zirconium Zr = 91·22
	7		Silver Ag = 107·88	Cadmium Cd = 112·4	Indium In = 114·8	Tin Sn = 118·7
6	8	Xenon Xe = 131·3	Caesium Cs = 132·91	Barium Ba = 137·34	15 Rare Earth elements (139–175)	Hafnium Hf = 178·49
	9		Gold Au = 197	Mercury Hg = 200·59	Thallium Tl = 204·39	Lead Pb = 207·2
7	10	Radon Rn = 222	Francium 223	Radium Ra = 226·05	Actinium Ac = 227·05	Thorium Th = 232·04

THE PERIODIC CLASSIFICATION OF THE ELEMENTS—*Contd.*

Period	Series	Group V	Group VI	Group VII	Group VIII
1					
2	2	Nitrogen N=14·008	Oxygen O=16	Fluorine F=19	
3	3	Phosphorus P=30·98	Sulphur S=32·064	Chlorine Cl=35·453	
4	4	Vanadium V=50·95	Chromium Cr=52	Manganese Mn=54·93	Iron Fe=55·84 Cobalt Co=58·94 Nickel Ni=58·71
	5	Arsenic As=74·91	Selenium Se=78·96	Bromine Br=79·904	
5	6	Niobium Nb=92·91	Molybdenum Mo=96	Technetium Tc=97	Ruthenium Ru=101·7 Rhodium Rh=102·91 Palladium Pd=106·41
	7	Antimony Sb=121·76	Tellurium Te=127·61	Iodine I=126·93	
6	8	Tantalum Ta=180·947	Tungsten W=183·85	Rhenium Re=186·2	Osmium Os=190·2 Iridium Ir=192·2 Platinum Pt=195·09
	9	Bismuth Bi=209	Polonium Po=209	Astatine At=210	
7	10	Protactinium Pa=231·05	Uranium U=238·03		

DAMAGE TO GEMSTONES

Some notes on the recognition and prevention of such damage

Damage to gemstones may be caused by either pressure, heating, radiation, or by chemical attack. The appended list is given for the guidance of manufacturing jewellers to help them in avoiding damage during manufacturing and repairing processes; and to the retail jeweller who may be faced with questions on damage to gemstones by an often irate customer.

Diamond

The most frequent complaint here is the question of flaws, cracks, and occasionally complete parting which occur along the cleavage directions. If the flaw is small but visible then it is extremely difficult to be sure that it has been recently induced or has been in there all the time and overlooked. A too heavily tightening of a claw, or a blow causing pressure on a claw will, if the claw lies along a cleavage direction cause cleavage flaws to develop, and such pressure can occur from many causes, even by rings being caught in a clumsily closed drawer. In many cases one can only conjecture on how it happened. Some caustic alkalis may attack the surface of diamonds, and so can fire, but usually the effect can be remedied by repolishing.

Ruby and sapphire

This species is liable, from the presence of "parting planes", to behave like the cleavage directions in diamond and flaws may be developed in a similar fashion. Heat, if strong enough will induce cracks in these stones, and even moderate heating to, say, 500°C may cause lightening of the colour.

Beryl

Except for emerald, which is well known as a fragile stone, in which pressure and/or heat can cause damage, the beryl family is fairly stable. It could be mentioned that heat may cause some alteration of colour of some beryls when it is remembered that many aquamarines have their colour altered by heat treatment.

Topaz

With its very perfect and fairly easy basal cleavage care must always be taken with this gemstone, for pressure or a blow will tend to induce flaws, or even cause the stone to part in two. The same may be said for *spodumene* (*kunzite*) and some *feldspars.*

Peridot

This gemstone does not have a facile cleavage but there have been cases where the stone has been broken along cleavage directions after a blow. A further danger with peridot is that it is readily attacked by sulphuric acid which destroys the surface polish.

Zircon

The jewellery stones of this species in which damage can occur are the colourless, blue and yellow stones which owe their colour to heat treatment. The danger here is that such stones tend to revert to their initial brown colour if they are irradiated with ultra-violet light. "Sunray lamps" used in the home may do the damage or the use of ultra-violet lamps in testing and even strong sunlight may cause the stones to revert in colour. Careful heating may repair the damage but the effect is to some extent unpredictable.

Quartz

The stones of this species are fairly stable, but in one colour variety, that is the mauve and purple amethyst, very moderate heating can cause loss of colour. There is no rhyme or reason in how a given amethyst will behave, some are fairly stable, but many are not and the risk is great especially as there is no good way of returning the stone to its original colour. Cases of this nature have been known to occur from overheating in a dip bath or by heating by domestic heating appliances. It has been said that exposure to light and heat in a jeweller's shop casement has been known to lighten the colour of some amethysts.

Zoisite

This new gemstone which usually owes its beautiful blue colour to heat treatment is fickle in that it will unaccountably flaw, but damage seems to have been done to such stones by unequal heating during jewellery manufacture and by the action of an ultrasonic cleaner.

Strontium titanite (*Fabulite*)

This is another stone which is known to flaw badly, often so badly as to be useless, after the jewellery in which it is set has been cleaned ultrasonically. Ultrasonic cleaning should not in any circumstance be used with fabulites; nor should any other stone which is subject to weakness.

Turquoise, and other porous stones

Turquoise can be readily damaged by strong acids and this should be remembered when treating turquoise in a dip bath. Most turquoise is waxed and chemical attack from polluted atmosphere and from cosmetics can cause deterioration of the wax with subsequent colour alteration. Degreasing may correct the dirty yellow colour but the resultant colour of the turquoise will be much paler than the original waxed stone, for waxing "wets" the stone giving it a higher colour. Re-waxing may put things to rights, but waxing is a technique requiring some experience. Other porous stones such as the chalcedonies may be adversely affected by chemical attack. Although in general damage to chalcedony is not important as it is not a valuable stone, it could be mentioned that in two reports specimens of sard or cornelian (most probably stained) altered to black from the continuous use of chemicals used in hairdressing.

Pearls

Problems with pearls occur through two factors: the first is the nature of the mineral constituent, aragonite, which is a carbonate and subject to attack by acid. Thus any acid will cause deterioration of the surface of pearls, such as an acid skin, or by the use of acid cosmetics. This produces a barrel-shape to the pearl, or in the case of cultured pearls where the

periphery becomes worn down and leaves only two "caps" of nacreous skin at each end which are then often loose.

The second factor is damage to the surface of the pearls. Pearls kept in a dry atmosphere tend to dry out, for there is a water content in pearls, and this drying may cause cracks to appear on the surface. It may sometimes be corrected by careful heating in rape seed oil, but the process is fraught with danger as even at a low heat of 250°C pearls have been known to burn and turn brown during treatment. Some pearls have been found to turn blackish and this is particularly so with cultured pearls. This has been found to occur through alteration of the organic discontinuation layer which lies between the bead nucleus and the very transparent nacreous outer layer. A few cases have been found to be due to sulphiding of a metallic compound aventituously present in the organic substance.

More common is the impregnation of dirty grease in the layer, grease which has travelled along the string upon which the pearls are strung and by capillary attraction into the layer. It shows through the translucent layers of the nacreous skin making the pearls appear dark coloured. The remedy is to clean the pearls thoroughly by a degreasing solution, but it may take a considerable time to do so. A case of this type which the author investigated was caused by grease from skin creams.

Rather different are the cases where a customer has returned her pearl necklet with the complaint that her pearls are peeling. The answer here is that she has sprayed her hair with setting lotion which has fallen on the pearls, producing a film of lacquer which later tends to peel off.

Many gemstones and minerals are damaged in the post because the packing was inadequate. It cannot be emphasised too strongly that shock-absorbing wrappings are essential when posting all gem materials.

This short resume is written as a guide and must not be thought to be complete, for what may happen to gemstones is anybody's guess. It must be emphasised that the greatest dangers are by acid baths; by heat, and by ultra-sonic cleaners.

ACID TESTS FOR PRECIOUS METALS

Silver

Sterling silver touched with nitric acid shows a greyish-cream spot which is darker and more greenish the lower the quality. A solution of silver nitrate (2 grammes of silver nitrate in 30 c.c. of distilled water acidified with a drop of nitric acid) gives no effect on sterling silver but a brownish stain seen indicates that base metal is present, the darker the stain the more base metal. This test can conveniently be carried out by making a streak with a lunar caustic pencil on the wetted surface of the article to be tested.

If a small scraping of the suspected article is placed on a glass microscope slip, a drop of nitric acid added followed by a drop of hydrochloric acid or a drop of a solution of common salt, a dense white precipitate of silver chloride is formed which microscopically observed is seen as fern-like brownish markings. Ammonia added to this precipitate produces colourless isotropic octahedra (more effectively seen by the higher magnification of a $\frac{1}{4}$ inch objective).

A strong solution of potassium chromate acidified with a few drops of nitric or sulphuric acid, produces, when a drop of this liquid is placed upon the surface to be tested, a bright red stain of silver chromate with fine or standard silver, and only a very faint colouration, or none at all, with other white metals.

Electroplate on copper or nickel silver shows a green stain with nitric acid providing the overlying silver coating has been removed by a file cut or a knife scrape.

Gold

Nitric acid alone or with hydrochloric acid in the proportions of two volumes of the hydrochloric acid to one volume of the nitric acid (aqua regia) is used in the testing of gold.

Nitric acid has little effect on 9 ct. gold and none on the higher qualities, but this acid will show a greenish stain with gold plated, gold filled and rolled gold articles so long as the overlying surface of gold has been removed by filing or

scraping. It may be necessary to cut rather deeply in the case of good rolled gold jewellery.

The quality of the gold is determined by rubbing the article on a touchstone (a piece of black Wedgwood ware or a hard black siliceous stone called *basanite*). The streak so produced is tried with the different acids and an estimate made as to how far the streak disappears. A better estimate can be obtained when the action of the acids on the streak being tested is compared against the streak from a piece of known quality similarly acted upon.

Platinum, palladium and white gold

For testing these metals, the following solution is recommended by Messrs. Johnson Matthey & Co., Ltd.:

Concentrated nitric acid	$\frac{3}{4}$ oz. Troy
Concentrated hydrochloric acid . .	$1\frac{1}{4}$ oz. Troy
Potassium nitrate	1/20 oz. Troy

This mixture is, of course, POISON, but will be made up by any professional chemist.

Its effects on platinum and white gold are as follows:
No colour: platinum of 95 per cent. purity or over.
Bright yellow: 18 ct. white gold containing base metal.
Pale brown: 18 ct. white gold containing palladium.
Medium brown: palladium.

Stainless steel

A liquid which has been suggested as a suitable detector for the stainless steel imitation of platinum, is a saturated solution of ferric chloride ($FeCl_3$), which when applied to stainless steel, attacks the metal immediately, leaving a grey stain which is with difficulty removed. On platinum this solution has no effect.

It should be noted that the light metal aluminium is not affected by nitric acid. The Author came across one incident

Note.—Before applying the acid the surface of the article should be cleaned with methylated spirit, petrol or other grease removing agent.

Where only a small surface is offered the article may be rubbed with touchstone and acid applied to the mark so made.

Always allow a minute for the action to take place and use a piece of clean blotting paper to determine what effect the acid has had.

where this metal, in combination with gold (which masked the lightness in weight) was mistaken for the valuable platinum on account of its failure to react with nitric acid.

CALCULATION OF THE PRICE OF GEMSTONES

Multiply the weight in carats by the price per carat.

Example: It is required to find the value of a topaz weighing 6·37 carats @ £2.25 per carat.

That is 6·37 × 2·25—

$$\begin{array}{r} 6{\cdot}37 \\ 2{\cdot}25 \\ \hline 3185 \\ 1274 \\ 1274 \\ \hline 143325 = £14.33 \end{array}$$

THE "BASE" SYSTEM FOR THE CALCULATION OF THE PRICE OF PEARLS

Find the quality value first. This is called the "base" and is reckoned in units from one unit upwards according to the shape and quality. In the U.K., a *unit* equals 1s. (5p).

The rate of price depends upon the square of the weight in grains.

Hence the value of a pearl of 7 grains at a unit base would be: (7 × 7) units or 49 units.

The value of a pearl of 8·5 grains at a 3 unit base would be:

(1) at a unit base—$(8{\cdot}5)^2$ or 72·25 units.

(2) at a 3 unit base—72·25 × 3 or 216·75

=1,083·75p=£10·84.

Necklets being composed of pearls of different sizes in graduated arrangement are treated somewhat differently. The pearls are weighed in groups, the "base" value fixed and average weight of the pearls in each group found. The price of each group at one unit base is then calculated by multiplying

the average weight by the total weight of the group in grains. The price of a one unit base of each group is then added together and the total multiplied by the base price to obtain the total price of the necklet. This last working is generally set out as a final pearl statement. (It is a trade usage to carry out all calculations to the second place of decimals only, even should the third figure be a 9.)

Example:

Calculate the value of a necklet of pearls in 5 sizes on a 7·5 unit base.

(*a*) 1 pearl weighing 8·20 grains.
(*b*) 4 pearls weighing 20·80 grains.
(*c*) 16 pearls weighing 41·66 grains.
(*d*) 42 pearls weighing 59·64 grains.
(*e*) 66 pearls weighing 52·00 grains.

(*a*) at one unit base = 8·20 × 8·20 which gives 67·24 units.
(*b*) at one unit base = 20·80 × (20·80 ÷ 4), that is 20·80 × 5·20 which gives 108·16 units.
(*c*) at one unit base = 41·66 × (41·66 ÷ 16), that is 41·66 × 2·60 which gives 108·31 units.
(*d*) at one unit base = 59·64 × (59·64 ÷ 42), that is 59·64 × 1·42 which gives 84·68 units.
(*e*) at one unit base = 52·00 × (52·00 ÷ 66), that is 52·00 × 0·78 which gives 40·56 units.

Pearl Statement

1	pearl	8·20	grains	average	8·20	@	1	unit base	67·24 units
4	pearls	20·80	,,	,,	5·20	,,	,,		108·16 ,,
16	,,	41·66	,,	,,	2·60	,,	,,		108·31 ,,
42	,,	59·64	,,	,,	1·42	,,	,,		84·68 ,,
66	,,	52·00	,,	,,	0·78	,,	,,		40·56 ,,
129	,,	182·30	,,	,,		,,	,,		408·95 units

Therefore value of 129 pearls @ base
= 408·95 × 7·5
= 3,067·125 units
but 1 unit = 5p
therefore total value = 3,067·125 × 5 = 15,335p = £153·35.

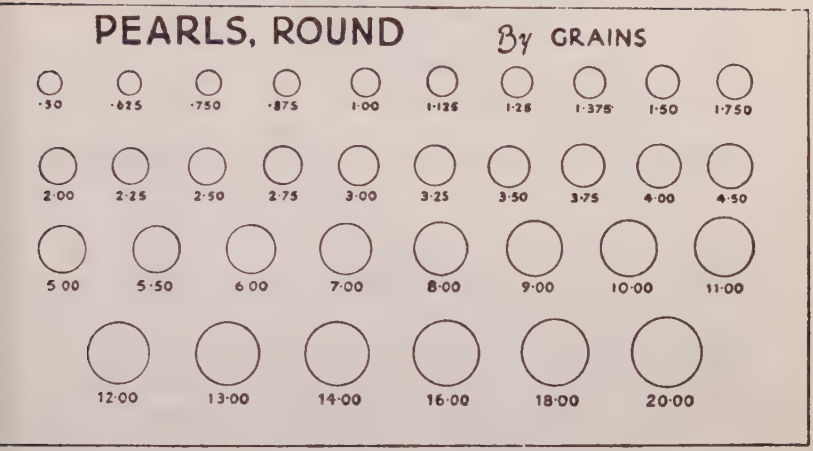


Chart showing approximate diameter of spherical pearls of the weights indicated.

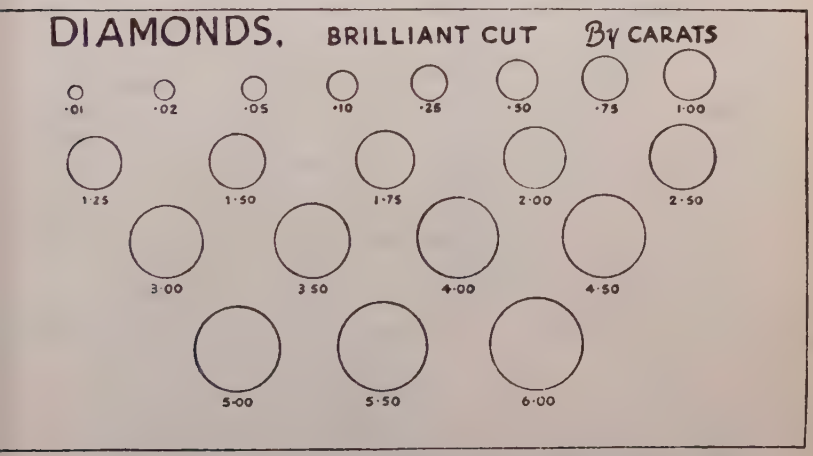


Chart showing approximate girdle diameter of well proportioned diamonds of the weights indicated.

UK	*German RAL Scan. D.N.* (0·5 carats upwards)	*Scan. D.N.* (under 0·5 carats)	*GIA*	*AGS*	*CIBJO*
			D		Exceptional White+
Finest White	River	Rarest White	E	0	Exceptional White
			F	1	Rare White+
Fine White	Top Wesselton	White	G		Rare White
White	Wesselton		H	2	White
				3	
Commercial White	Top Crystal	Tinted White	I	4	Slightly Tinted White
Top Silver Cape	Crystal		J	5	
			K		Tinted White
Silver Cape	Top Cape		L	6	
Light Cape	Cape		M		
			N	7	
		Yellowish	O		
Cape	Light Yellow		P	8	Tinted Colour
			Q		
			R		
Dark Cape	Yellow	Yellow	S–X	9–10	

Comparison of various schemes of diamond colour grading.

UNITS OF WEIGHT

Carat: unit of weight for gemstones equals—
0·200 gramme
3·08647 grains Troy
0·00705478 ounces Avoir

Grain (Pearl): unit of weight for pearls equals 0·25 carat; therefore 4 pearl grains equal 1 carat.

Troy Weight: the weight used in the Jewellery trade for precious metals.
24 grains (gn.) = 1 pennyweight (dwt.)
20 pennyweights = 1 ounce (oz.)
12 ounces = 1 pound (lb.)
The legal weights below one ounce are now the decimal parts.

DECIMAL SUBDIVISIONS OF THE TROY OUNCE WITH THEIR EQUIVALENTS IN PENNYWEIGHTS AND GRAINS

1·000	oz.	equals	20	dwts.			
0·950	,,	,,	19	,,			
0·900	,,	,,	18	,,			
0·850	,,	,,	17	,,			
0·800	,,	,,	16	,,			
0·750	,,	,,	15	,,			
0·700	,,	,,	14	,,			
0·650	,,	,,	13	,,			
0·600	,,	,,	12	,,			
0·550	,,	,,	11	,,			
0·500	,,	,,	10	,,			
0·450	,,	,,	9	,,			
0·400	,,	,,	8	,,			
0·350	,,	,,	7	,,			
0·300	,,	,,	6	,,			
0·250	,,	,,	5	,,			
0·200	,,	,,	4	,,			
0·150	,,	,,	3	,,			
0·100	,,	,,	2	,,			
0·050	,,	,,	1	,,			

0·048	oz.	equals	23	grains			
0·046	,,	,,	22	,,			
0.044	,,	,,	21	,,			
0.042	,,	,,	20	,,			
0.040	,,	,,	19	,,			
0·037	,,	,,	18	,,			
0.035	,,	,,	17	,,			
0·033	,,	,,	16	,,			
0·031	,,	,,	15	,,			
0·029	,,	,,	14	,,			
0·027	,,	,,	13	,,			
0·025	,,	,,	12	,,			
0·023	,,	,,	11	,,			
0·021	,,	,,	10	,,			
0·019	,,	,,	9	,,			
0·016	,,	,,	8	,,			
0·014	,,	,,	7	,,			
0·012	,,	,,	6	,,			
0·010	,,	,,	5	,,			
0·008	,,	,,	4	,,			
0·006	,,	,,	3	,,			
0·004	,,	,,	2	,,			
0·002	,,	,,	1	,,			

N.B.—The grain Troy equals the grain Avoir.
1 ounce Troy equals 480 grains.
1 ounce Avoir. equals 437½ grains.
1 pound Troy equals 5,760 grains.
1 pound Avoir. equals 7,000 grains.
1 pound Avoir. equals 14·5833 ounces Troy.
To convert ounces Avoir. into ounces Troy multiply by 0·91146.
To convert ounces Troy to ounces Avoir. multiply by 1·09714.
To convert pounds Avoir. to ounces Troy multiply by 14·5833.

METRIC WEIGHTS

Milligram (0·001 gram)	=	0·015432 grain
Centigram (0·01 gram)	=	0·154323 grain
Decigram (0·1 gram)	=	1·543235 grains
Gram	=	15·432349 grains
Decagram (10 grams)	=	154·3234488 grains.
Hectogram (100 grams)	=	3·215073 Troy oz.
Kilogram (1000 grams)	=	32·150727 Troy oz.
1 gram	=	5 carats
500 milligrams	=	2·50 ,,
200 ,,	=	1·00 ,,
100 ,,	=	·50 ,,
50 ,,	=	·25 ,,
20 ,,	=	·10 ,,
10 ,,	=	·05 ,,
5 ,,	=	·025 ,,
2 ,,	=	0·10 ,,
1 ,,	=	·005 ,,

1 grain equals 0·0648 gram.

1 ounce Troy equals 31·1035 grams.

1 ounce Avoir. equals 28·3495 grams.

1 pound Avoir. equals 0·45359243 kilograms.

To convert grams to ounces Troy multiply by ·03215.

To convert grams to ounces Avoir. multiply by ·03527.

To convert ounces Troy to grams multiply by 31·1035.

To convert ounces Avoir. to grams multiply by 28·3495.

To convert ounces Troy to metric carats multiply by 155·517.

To convert ounces Avoir. to metric carats multiply by 141·7475.

To convert pennyweights to grams multiply by 1·5552.

To convert grams to pennyweights multiply by 0·643.

To convert pennyweights to metric carats multiply by 7·77.

Cultured pearls are sold by the *momme* which equals 3·75 grams, or 18·75 carats, or 75 grains.

Synthetic stones and pastes are usually sold by size measured in millimetres.

TEMPERATURE CONVERSION TABLE

Cent.	Fahr.	Cent.	Fahr.	Cent.	Fahr.	Cent.	Fahr.
0	32·0	43	109·4	86	186·8	158	316·4
1	33·8	44	111·2	87	188·6	160	320·0
2	35·6	45	113·0	88	190·4	162	323·6
3	37·4	46	114·8	89	192·2	164	327·2
4	39·2	47	116·6	90	194·0	166	330·8
5	41·0	48	118·4	91	195·8	168	334·4
6	42·8	49	120·2	92	197·6	170	338·0
7	44·6	50	122·0	93	199·4	172	341·6
8	46·6	51	123·8	94	201·2	174	345·2
9	48·2	52	125·6	95	203·0	176	348·8
10	50·0	53	127·4	96	204·8	178	352·4
11	51·8	54	129·2	97	206·6	180	356·0
12	53·6	55	131·0	98	208·4	182	359·6
13	55·4	56	132·8	99	210·2	184	363·2
14	57·2	57	134·6	100	212·0	186	366·8
15	59·9	58	136·4	102	215·6	188	370·4
16	60·8	59	138·2	104	219·2	190	374·0
17	62·6	60	140·0	106	222·8	192	377·6
18	64·4	61	141·8	108	226·4	194	381·2
19	66·2	62	143·6	110	230·0	196	384·8
20	68·0	63	145·4	112	233·6	198	388·4
21	69·8	64	147·2	114	237·2	200	392·0
22	71·6	65	149·0	116	240·8	210	410·0
23	73·4	66	150·8	118	244·4	220	428·0
24	75·2	67	152·6	120	248·0	230	446·0
25	77·0	68	154·4	122	251·6	240	464·0
26	78·8	69	156·2	124	255·2	250	482·0
27	80·6	70	158·0	126	258·8	260	500·0
28	82·4	71	159·8	128	262·4	270	518·0
29	84·2	72	161·6	130	266·0	280	536·0
30	86·0	73	163·4	132	269·6	290	554·0
31	87·8	74	165·2	134	273·2	300	572·0
32	89·6	75	167·0	136	276·8	310	590·0
33	91·4	76	168·8	138	280·4	320	608·0
34	93·2	77	170·6	140	284·0	330	626·0
35	95·0	78	172·4	142	287·6	340	644·0
36	96·8	79	174.2	144	291·2	350	662·0
37	98·6	80	176·0	146	294·8	360	680·0
38	100·4	81	177·8	148	298·4	370	698·0
39	102·2	82	179·6	150	302·0	380	716·0
40	104·0	83	181·4	152	305·6	390	735·0
41	105·8	84	183·2	154	309·2	400	752·0
42	107·6	85	185·0	156	312·8	500	932·0

★*Fahrenheit to Centigrade: Subtract* 32, *multiply by* 5, *divide by* 9.

Centigrade to Fahrenheit: Multiply by 9, *divide by* 5, *add* 32.

DENSITY CORRECTION TABLES FOR TOLUENE AND DIBROMOETHANE (ETHYLENE DIBROMIDE)

Note:—*Commercial samples of toluene and more particularly of dibromoethane may vary appreciably in density from the figures given below. For really accurate determinations, therefore, it is wise to purchase a fair quantity (say 500 g.) which can then be calibrated and will last for years if kept in a stoppered bottle.*

A convenient method of calibrating a sample is to carry out a hydrostatic determination with a large piece of pure quartz (say 50 carats) and to work "backwards", assuming the density of quartz to be 2·651. Supposing the density of a sample of toluene 11·3°C. be found on calibration to be 0·8734—a figure corresponding to a temperature of 10·3°C. in the tables, the worker will know that it is necessary to subtract 1°C. from his actual temperature in all figure experiments before referring to the table.

DENSITIES OF TOLUENE FROM 5°C. TO 25°C.

°C.	*Density*	°C.	*Density*
5·0	0·8787	8·0	0·8757
5·1	0·8786	8·1	0·8756
5·2	0·8785	8·2	0·8755
5·3	0·8784	8·3	0·8754
5·4	0·8783	8·4	0·8753
5·5	0·8782	8·5	0·8752
5·6	0·8781	8·6	0·8751
5·7	0·8780	8·7	0·8750
5·8	0·8779	8·8	0·8749
5·9	0·8778	8·9	0·8748
6·0	0·8777	9·0	0·8747
6·1	0·8776	9·1	0·8746
6·2	0·8775	9·2	0·8745
6·3	0·8774	9·3	0·8744
6·4	0·8773	9·4	0·8743
6·5	0·8772	9·5	0·8742
6·6	0·8771	9·6	0·8741
6·7	0·8770	9·7	0·8740
6·8	0·8769	9·8	0·8739
6·9	0·8768	9·9	0·8738
7·0	0·8767	10·0	0·8737
7·1	0·8766	10·1	0·8736
7·2	0·8765	10·2	0·8735
7·3	0·8764	10·3	0·8734
7·4	0·8763	10·4	0·8733
7·5	0·8762	10·5	0·8732
7·6	0·8761	10·6	0·8731
7·7	0·8760	10·7	0·8730
7·8	0·8759	10·8	0·8729
7·9	0·8758	10·9	0·8728

°C.	*Density*	°C.	*Density*
11·0	0·8727	15·6	0·8681
11·1	0·8726	15·7	0·8680
11·2	0·8725	15·8	0·8679
11·3	0·8724	15·9	0·8678
11·4	0·8723	16·0	0·8677
11·5	0·8722	16·1	0·8676
11·6	0·8721	16·2	0·8675
11·7	0·8720	16·3	0·8674
11·8	0·8719	16·4	0·8673
11·9	0·8718	16·5	0·8672
12·0	0·8717	16·6	0·8671
12·1	0·8716	16·7	0·8670
12·2	0·8715	16·8	0·8669
12·3	0·8714	16·9	0·8668
12·4	0·8713	17·0	0·8667
12·5	0·8712	17·1	0·8666
12·6	0·8711	17·2	0·8665
12·7	0·8710	17·3	0·8664
12·8	0·8709	17·4	0·8663
12·9	0·8708	17·5	0·8662
13·0	0·8707	17·6	0·8661
13·1	0·8706	17·7	0·8660
13·2	0·8705	17·8	0·8659
13·3	0·8704	17·9	0·8658
13·4	0·8703	18·0	0·8657
13·5	0·8702	18·1	0·8656
13·6	0·8701	18·2	0·8655
13·7	0·8700	18·3	0·8654
13·8	0·8699	18·4	0·8653
13·9	0·8698	18·5	0·8652
14·0	0·8697	18·6	0·8651
14·1	0·8696	18·7	0·8650
14·2	0·8695	18·8	0·8649
14·3	0·8694	18·9	0·8648
14·4	0·8693	19·0	0·8647
14·5	0·8692	19·1	0·8646
14·6	0·8691	19·2	0·8645
14·7	0·8690	19·3	0·8644
14·8	0·8689	19·4	0·8643
14·9	0·8688	19·5	0·8642
15·0	0·8687	19·6	0·8641
15·1	0·8686	19·7	0·8640
15·2	0·8685	19·8	0·8639
15·3	0·8684	19·9	0·8638
15·4	0·8683	20·0	0·8637
15·5	0·8682	20·1	0·8636

°C.	Density	°C.	Density
20·2	0·8635	22·7	0·8610
20·3	0·8634	22·8	0·8609
20·4	0·8633	22·9	0·8608
20·5	0·8632	23·0	0·8607
20·6	0·8631	23·1	0·8606
20·7	0·8630	23·2	0·8605
20·8	0·8629	23·3	0·8604
20·9	0·8628	23·4	0·8603
21·0	0·8627	23·5	0·8602
21·1	0·8626	23·6	0·8601
21·2	0·8625	23·7	0·8600
21·3	0·8624	23·8	0·8599
21·4	0·8623	23·9	0·8598
21·5	0·8622	24·0	0·8597
21·6	0·8621	24·1	0·8596
21·7	0·8620	24·2	0·8595
21·8	0·8619	24·3	0·8594
21·9	0·8618	24·4	0·8593
22·0	0·8617	24·5	0·8592
22·1	0·8616	24·6	0·8591
22·2	0·8615	24·7	0·8590
22·3	0·8614	24·8	0·8589
22·4	0·8613	24·9	0·8588
22·5	0·8612	25·0	0·8587
22·6	0·8611		

DENSITIES OF DIBROMOETHANE FROM 10°C. TO 20°C.

°C.	Density	°C.	Density
10·0	2·1998	11·8	2·1962
10·1	2·1996	11·9	2·1960
10·2	2·1994	12·0	2·1958
10·3	2·1992	12·1	2·1956
10·4	2·1990	12·2	2·1954
10·5	2·1988	12·3	2·1952
10·6	2·1986	12·4	2·1950
10·7	2·1984	12·5	2·1948
10·8	2·1982	12·6	2·1946
10·9	2·1980	12·7	2·1944
11·0	2·1978	12·8	2·1942
11·1	2·1976	12·9	2·1940
11·2	2·1974	13·0	2·1938
11·3	2·1972	13·1	2·1936
11·4	2·1970	13·2	2·1934
11·5	2·1968	13·3	2·1932
11·6	2·1966	13·4	2·1930
11·7	2·1964	13·5	2·1928

°C	*Density*	°C.	*Density*
13·6	2·1926	16·9	2·1860
13·7	2·1924	17·0	2·1858
13·8	2·1922	17·1	2·1856
13·9	2·1920	17·2	2·1854
14·0	2·1918	17·3	2·1852
14·1	2·1916	17·4	2·1850
14·2	2·1914	17·5	2·1848
14·3	2·1912	17·6	2·1846
14·4	2·1910	17·7	2·1844
14·5	2·1908	17·8	2·1842
14·6	2·1906	17·9	2·1840
14·7	2·1904	18·0	2·1838
14·8	2·1902	18·1	2·1836
14·9	2·1900	18·2	2·1834
15·0	2·1898	18·3	2·1832
15·1	2·1896	18·4	2·1830
15·2	2·1894	18·5	2·1828
15·3	2·1892	18·6	2·1826
15·4	2·1890	18·7	2·1824
15·5	2·1888	18·8	2·1822
15·6	2·1886	18·9	2·1820
15·7	2·1884	19·0	2·1818
15·8	2·1882	19·1	2·1816
15·9	2·1880	19·2	2·1814
16·0	2·1878	19·3	2·1812
16·1	2·1876	19·4	2·1810
16·2	2·1874	19·5	2·1808
16·3	2·1872	19·6	2·1806
16·4	2·1870	19·7	2·1804
16·5	2·1868	19·8	2·1802
16·6	2·1866	19·9	2·1800
16·7	2·1864	20·0	2·1798
16·8	2·1862		

THE RELATION BETWEEN REFRACTIVE INDEX AND DENSITY OF CLERICI'S SOLUTION AND DI-IODOMETHANE (METHYLENE IODIDE) WITH SUITABLE DILUTANTS

If a specimen under test is found to be freely suspended in the liquid the density of that liquid may be ascertained from its index of refraction.

Clerici's solution: Water

R.I.	*Density*	*R.I.*	*Density*
1·500	2·584	1·590	3·348
1·510	2·669	1·600	3·432
1·520	2·753	1·610	3·517
1·530	2·838	1·620	3·601
1·540	2·923	1·630	3·685
1·550	3·008	1·640	3·770
1·560	3·093	1·650	3·854
1·570	3·178	1·660	3·939
1·580	3·263	1·670	4·023

The above table is based on the work of Anderson, Payne and Franklin.

Di-iodomethane (Methylene iodide): Toluene

R.I.	*Density*	*R.I.*	*Density*
1·610	2·007	1·680	2·710
1·620	2·106	1·690	2·809
1·630	2·205	1·700	2·908
1·640	2·304	1·710	3·007
1·650	2·403	1·720	3·106
1·660	2·502	1·730	3·205
1·670	2·601	1·740	3·304

THE GREEK ALPHABET

	Capitals	*Lower case*	*Roman Equivalents*
Alpha	**A**	α	(A)
Beta	**B**	β	(B)
Gamma	Γ	γ	(G)
Delta	Δ	δ	(D)
Epsilon	**E**	ϵ	(E)
Zeta	**Z**	ζ	(Z)
Eta	**H**	η	(E, ē)
Theta	Θ	θ	(Th)
Iota	**I**	ι	(I)
Kappa	**K**	κ	(K)
Lambda	Λ	λ	(L)
Mu	**M**	μ	(M)
Nu	**N**	ν	(N)
Xi	Ξ	ξ	(X)
Omicron	**O**	o	(O)
Pi	Π	π	(P)
Rho	**P**	ρ	(R)
Sigma	Σ	σ,s	(S)
Tau	**T**	τ	(T)
Upsilon	**Y**	υ	(U)
Phi	Φ	ϕ	(Ph)
Chi	**X**	χ	(Ch)
Psi	Ψ	ψ	(Ps)
Omega	Ω	ω	(O, o)

SOME GREEK PREFIXES AND THEIR MEANING

Prefix	*From the Greek*	*Meaning*
Actino-	*Aktinos*	ray
Allo-	*Allos*	other, different
Amphi-	*Amphi*	on both sides
Aniso-	*Anisos*	unequal
Brachy-	*Brachus*	short
Chloro-	*Chloros*	green
Chrom-	*Chroma*	colour
Chrys-	*Chrusos*	gold
Clino-	*Klino*	to slope
Crypto-	*Krupto*	hidden
Cubo-	*Kubos*	cube
Decca-	*Deka*	10
Di-	*Dis*	Double, twice, 2

(*The Latin* Bi- *is often used as a prefix for* 2)

Dodeca-	*Dodeka*	12
Enantio-	*Enantios*	opposite
Endo-	*Endon*	within
Gonio-	*Gonia*	angle
Graph-	*Graphien*	write
Hecto-	*Hekaton*	100
Helio-	*Helios*	the sun
Hema-	*Haima*	blood
Hemi-	*Hemi*	half
Hepta-	*Hepta*	7
Hetero-	*Heteros*	other, different
Hexa-	*Hex*	6
Holo-	*Holos*	whole, entire
Homo-	*Homos*	same
Hydro-	*Hudor*	water
Hypo-	*Hupo*	under
Idio-	*Idios*	one's own, peculiar to
Ido-	*Eidos*	form
Iso-	*Isos*	equal
Kilo-	*Chilioi*	1,000
Litho-	*Lithos*	stone
Macro-	*Makros*	large
Meta-	*Meta*	between with, after
Micro-	*Mikros*	small

(*Is also used to denote millionth parts of the G.G.S. units;* e.g., *micro-farad*=0·000,001 *farad.*)

Mono-	*Monos*	1, sole, only, alone
Morphe-	*Morphe*	form
Myria-	*Murias*	10,000
Neo-	*Neos*	fresh, young, recent
Octa-	*Octo*	8
Ortho-	*Orthos*	right

Prefix	*From the Greek*	*Meaning*
Penta-	*Pente*	5
Pheno-	*Phainos*	shining
Phos-	*Phos*	light
Phot-	*Photos*	
Piezo-	*Piezein*	press
Pseudo-	*Pseudes*	false, spurious
Pyr-	*Pur*	fire
Rhodo-	*Rhodon*	rose
Sider-	*Sideros*	iron
Sphen-	*Sphen*	wedge
Spher-	*Sphaira*	a ball
Tetra-	*Tetrakis*	4
Thermo-	*Thermos*	hot
Tri-	*Tris*	3
Tribo-	*Tribos*	rubbing

WORLD ASSOCIATIONS OF GEMMOLOGISTS

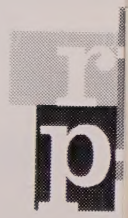
Australia	The Gemmological Association of Australia, Box 75, Broadway 4000, Queensland, Australia.
Belgium	Société Belge de Gemmologie, Rue du Midi, 118, 1000 Bruxelles, Belgium.
Brazil	Associacão Brasileirade Gemologia, Caixa Postal 18154, São Paulo, Brazil.
Canada	The Canadian Gemmological Association, Box 1106, Station Q, Toronto, Ontario, Canada.
Finland	Gemmological Association of Finland, Kulosaaren Puistotie 36 B 16, 00570 Helsinki 57, Finland.
France	Association Française de Gemmologie, 17, Rue Cadet 75009, Paris 9eme, France.
Great Britain	 The Gemmological Association of Great Britain, Saint Dunstans House, 2, Carey Lane, London, E.C.2.

Germany	Deutsche Gemmologische Gesellschaft, D6580- Idar-Oberstein 2, Postfach 2260, Western Germany.
Italy	Instituto Gemoligico Italiano, 20146 Milano, Pinzale Gambaro 7/8, Italy.
Japan	Gemmological Association of All Japan, Tokyo Biho-Kaikan, 1–24 Akashi-cho, Chuo-ku, Tokyo, Japan.
Korea	Gemmological Institute of Korea, 30–7, 3-ka, Namae-munro, Chungku, Seoul, Korea.
Norway	Norges Gemmologiske Selskap, Dronningsgatan, 27, Oslo, Norway.
Rhodesia	The Rhodesian Gem & Mineral Society, P.O. Box 712, Salisbury, Rhodesia.
Spain	Asociacion Española de Gemologia, Paseo de Gracia 64, entlo 2a, Barcelona 7, Spain. Instituto Gemmologico Español, Victor Hugo, 1, 3°, Madrid 4, Spain.
Switzerland	Gemmological Association of Switzerland, Multergasse 20, CH-9000, St Gallen, Switzerland.
United States	Gemological Institute of America, 1660, Stewart Street, P.O. Box 2110, Santa Monica, California 90406, U.S.A.

Robert Webster was originally in the jewelry and pawnbroking trade and won the Fellowship Diploma of the Gemmological Association of Great Britain with distinction in 1934.

In 1946 the same Association awarded him their coveted Research Diploma. In the same year he joined the London Gem Laboratory, then in Hatton Garden, where he remained until he retired in 1971.

He lectured on gemmology to students for many years and was also honorary visiting lecturer to the Detective Training School. He visited mining areas, gem cutting centers and gem laboratories in many parts of the world.



Jacket

Back row: cameo, Australia; drop, Nevada (USA); nodular and banded (2), Australia; doublet.

Front row: doublet, Australia; water opal brooch; Brazilian opal rough; fire opals (3 faceted); water opal, Mexico.

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