THE CHEMISTRY OF GEMSTONE COLOURS

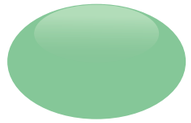
Gemstone colours stem from their chemical structures, which absorb different wavelengths of light. Their hardness is measured on the Mohs hardness scale (1-10).

PEARL

Formula: $CaCO_3$

Mohs hardness: 2.5–4.5

Produced in soft tissue of shelled molluscs. The thinner the layers of the pearl, the finer the lustre.

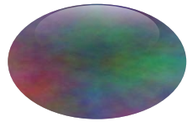


TURQUOISE

Formula: $Al_6(PO_4)_4(OH)_8.4H_2O$

Mohs hardness: 5.0–6.0

Colour caused by the presence of copper ions coordinated to the hydroxide ions and water.

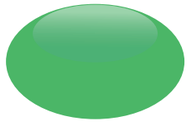


OPAL

Formula: $SiO_2.nH_2O$

Mohs hardness: 5.5–6.0

'Play of colours' caused by interference and diffraction of light passing through structure.



JADE

Formula: $NaAlSi_2O_6$

Mohs hardness: 6.5–7.0

Colour from chromium and iron impurities. The mineral nephrite is also referred to as jade.

PERIDOT

Formula: Mg_2SiO_4

Mohs hardness: 6.5–7.0

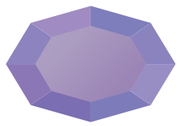
Colour caused by iron 2+ ions replacing magnesium ions in some locations in the structure.

GARNET

Formula: $Mg_3Al_2(SiO_4)_3$

Mohs hardness: 6.5–7.5

Colour caused by iron 2+ ions replacing magnesium ions in some locations in the structure.



AMETHYST

Formula: SiO_2

Mohs hardness: 7.0

Colour caused by irradiation of iron 3+ ions in place of silicon in some locations in the structure.

CITRINE

Formula: SiO_2

Mohs hardness: 7.0

The yellow colour of citrine is due to the presence of either aluminium or iron impurities.

TOURMALINE

Formula: $Na_3Li_3Al_6(BO_3)_3(SiO_3)_6F_4$

Mohs hardness: 7.0–7.5

Colour due to manganese ions replacing lithium and aluminium ions in some sites.

ZIRCON

Formula: $ZrSiO_4$

Mohs hardness: 7.5

Many colours depending on impurities. Colourless forms are popular diamond substitutes.

AQUAMARINE

Formula: $Be_3Al_2(SiO_3)_6$

Mohs hardness: 7.5–8.0

Colour caused by iron 2+/3+ ions replacing aluminium ions in some locations in the structure.

EMERALD

Formula: $Be_3Al_2(SiO_3)_6$

Mohs hardness: 7.5–8.0

Colour caused by chromium ions replacing aluminium in some locations in the structure.

SPINEL

Formula: $MgAl_2O_4$

Mohs hardness: 7.5–8.0

A variety of colours are possible, caused by impurities such as iron, chromium and nickel.

TOPAZ

Formula: $Al_2SiO_4(F,OH)_2$

Mohs hardness: 8.0

Pure topaz is colourless; blue & brown varieties are caused by atomic level imperfections.

ALEXANDRITE

Formula: Al_2BeO_4

Mohs hardness: 8.5

Colour caused by chromium ions replacing aluminium in some sites. Colour varies in different light.

RUBY

Formula: Al_2O_3

Mohs hardness: 9.0

Colour caused by chromium ions replacing aluminium ions in some locations in the structure.

SAPPHIRE

Formula: Al_2O_3

Mohs hardness: 9.0

Colour caused by titanium and iron ions replacing aluminium ions in some locations in the structure.

DIAMOND

Formula: C_n

Mohs hardness: 10

Colourless; can be faintly coloured by the trapping of nitrogen or boron atoms in the crystal.