Water of Crystallisation

Complete Study Card · Class 10 Chemistry

What is Water of Crystallisation?

Water of crystallisation is the **fixed number of water molecules** associated with one formula unit of a crystalline salt. These molecules are part of the crystal structure and give the salt its colour and shape.

Salts with water of crystallisation are **hydrated salts**. On strong heating they become **anhydrous** (waterless), often changing colour.

Tip: *The dot '·' in CuSO4·5H2O means 'associated with'. The number before H2O = water molecules per formula unit.*

Hydrated Salts — Reference Table

Common Name	Chemical Name	Formula	Water Molecules	Colour
Blue Vitriol (Bluestone)	Copper Sulphate pentahydrate	CuSO4 · 5H2O	5	Blue
Washing Soda	Sodium Carbonate decahydrate	Na2CO3 · 10H2O	10	Colourless / White
Gypsum	Calcium Sulphate dihydrate	CaSO4 · 2H2O	2	White
Plaster of Paris (POP)	Calcium Sulphate hemihydrate	CaSO4 · 1/2 H2O	1/2	White powder
Green Vitriol (Copperas)	Ferrous Sulphate heptahydrate	FeSO4 · 7H2O	7	Light Green
White Vitriol	Zinc Sulphate heptahydrate	ZnSO4 · 7H2O	7	Colourless
Epsom Salt	Magnesium Sulphate heptahydrate	MgSO4 · 7H2O	7	Colourless
Borax	Sodium Tetraborate decahydrate	Na2B4O7 · 10H2O	10	White
Alum	Potassium Alum dodecahydrate	KAl(SO4)2 · 12H2O	12	Colourless

What Happens on Heating Hydrated Salts?

Hydrated Salt	Reaction on Heating	Observation
Blue Vitriol CuSO4 · 5H2O	CuSO4 · 5H2O →(heat)→ CuSO4 + 5H2O	Blue → White (Reversible — add water to restore blue)
Green Vitriol FeSO4 · 7H2O	2FeSO4 →(heat)→ Fe2O3 + SO2 + SO3	Green → Reddish-brown (Irreversible)
Washing Soda Na2CO3 · 10H2O	Na2CO3 · 10H2O →(heat)→ Na2CO3 + 10H2O	White crystals → White powder

Hydrated Salt	Reaction on Heating	Observation
Gypsum $CaSO_4 \cdot 2H_2O$	$CaSO_4 \cdot 2H_2O \xrightarrow{(120\ C)} CaSO_4 \cdot 1/2\ H_2O + 3/2\ H_2O$	Gypsum → Plaster of Paris

Gypsum vs Plaster of Paris — Key Differences

Property	Gypsum	Plaster of Paris (POP)
Chemical name	Calcium Sulphate dihydrate	Calcium Sulphate hemihydrate
Formula	$CaSO_4 \cdot 2H_2O$	$CaSO_4 \cdot 1/2\ H_2O$
Water molecules	2 per formula unit	1/2 per formula unit
Obtained by	Found naturally / POP + water	Heating Gypsum at 120 C
Uses	Making POP, fertilisers	Casts, statues, bone fracture support
Sets hard?	Already hard crystal	Sets hard when water is added (Exothermic)

Setting Reaction of Plaster of Paris

When water is added to POP it rehydrates and sets hard as Gypsum (exothermic):

$CaSO_4 \cdot 1/2\ H_2O + 3/2\ H_2O \rightarrow CaSO_4 \cdot 2H_2O + Heat$

(Plaster of Paris → Gypsum — hard solid)

Tip: *Board Tips: • Blue vitriol test: Add water to white $CuSO_4$ → turns blue again (reversible test). • $FeSO_4$ heating is irreversible (forms Fe_2O_3). • POP must NOT be stored in moist places — it absorbs moisture and sets prematurely. • The 1/2 water in POP means 1 water molecule is shared between 2 formula units.*