

UG SEM-V MJC-8 (T) Co-Ordination Chemistry)

Simple Definition of Double Salt

A **double salt** is a compound formed when two different salts crystallize together from a saturated solution in a fixed molecular ratio. They are stable only in the solid, crystalline state.

The most important characteristic of a double salt is its **behaviour in solution**.

When dissolved in water, a double salt **completely dissociates** into the simple ions of its constituent salts. It **loses its identity** and behaves exactly like a mixture of the two separate salts.

In short: Solid State → Fixed Ratio; Aqueous Solution → Simple Ions

1. **Dissociation in Water:** This is the defining property. The double salt breaks down into its component ions.
2. **Fixed Composition:** In the crystalline solid, the ions are present in a simple, fixed ratio (e.g., 1:1:2 for $\text{KAl}(\text{SO}_4)_2$).
3. **Properties are Additive:** The chemical properties of a double salt in an aqueous solution are the sum of the properties of its individual ions.
4. **Ionic Bonding:** The bonding within a double salt is primarily ionic.

Common Example: Potash Alum

- **Formula:** $\text{KAl}(\text{SO}_4)_2 \cdot 12 \text{H}_2\text{O}$ (Potassium Aluminium Sulfate)
- **Behavior:**
 - **In Solid State:** It exists as a well-defined crystal containing K^+ , Al^{3+} , SO_4^{2-} , and water of crystallization in a fixed 1:1:2:12 ratio.
 - **In Aqueous Solution:** It dissociates completely:
$$\text{KAl}(\text{SO}_4)_2 \rightarrow \text{K}^+(\text{aq}) + \text{Al}^{3+}(\text{aq}) + 2 \text{SO}_4^{2-}(\text{aq})$$
- **Proof of Identity Loss:** The aqueous solution will give positive chemical tests for:
 - **Potassium ions (K^+)** (e.g., a lilac flame test).
 - **Aluminium ions (Al^{3+})** (e.g., a white gelatinous precipitate with NaOH).
 - **Sulfate ions (SO_4^{2-})** (e.g., a white precipitate with BaCl_2).

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Contrast with Coordination Compounds

It is essential to difference a double salt from a **coordination compound**.

	Double Salt	Coordination Compound
Behavior in Solution	Completely dissociates into simple ions.	Partially dissociates; the complex ion retains its identity.
Identity in Solution	Lost. Behaves like a mixture of simple ions.	Retained. The complex has unique properties.
Example	$(\text{NH}_4)_2\text{SO}_4 \cdot \text{FeSO}_4 \cdot 6\text{H}_2\text{O}$ (NH_4) ₂ SO ₄ ·FeSO ₄ ·6H ₂ O (Mohr's Salt)	$[\text{Cu}(\text{NH}_3)_4]\text{SO}_4$ [Cu(NH ₃) ₄] ²⁺ SO ₄ ²⁻ (Tetraamminecopper(II) sulfate)
Aqueous Ions	$\text{NH}_4^+, \text{Fe}^{2+}, \text{SO}_4^{2-}$	$[\text{Cu}(\text{NH}_3)_4]^{2+}, \text{SO}_4^{2-}$ (No free Cu ²⁺ ions)

Other Common Examples of Double Salts

- **Carnallite:** $\text{KCl} \cdot \text{MgCl}_2 \cdot 6\text{H}_2\text{O}$
- **Mohr's Salt:** $(\text{NH}_4)_2\text{SO}_4 \cdot \text{FeSO}_4 \cdot 6\text{H}_2\text{O}$