What a TGA Graph is?

TGA (Thermogravimetric Analysis) measures how the **mass (weight)** of a samples changes as it is heated. On a TGA graph:

- The **x-axis** is **Temperature (°C or °K)** — as the sample is heated.
- The **y-axis** is **% Mass Remaining** (or mass loss) — how much weight the sample retains/losses at each temperature.

Example of **Thermogravimetric Analysis (TGA) of copper(II) sulfate ($CuSO_4$)** or **copper(II) sulfate pentahydrate ($CuSO_4 \cdot 5H_2O$)**.

Purpose:

To determine:

- Water of hydration
- Thermal stability
- Decomposition temperatures

Sample:

Copper(II) sulfate pentahydrate
Molecular weight calculation:

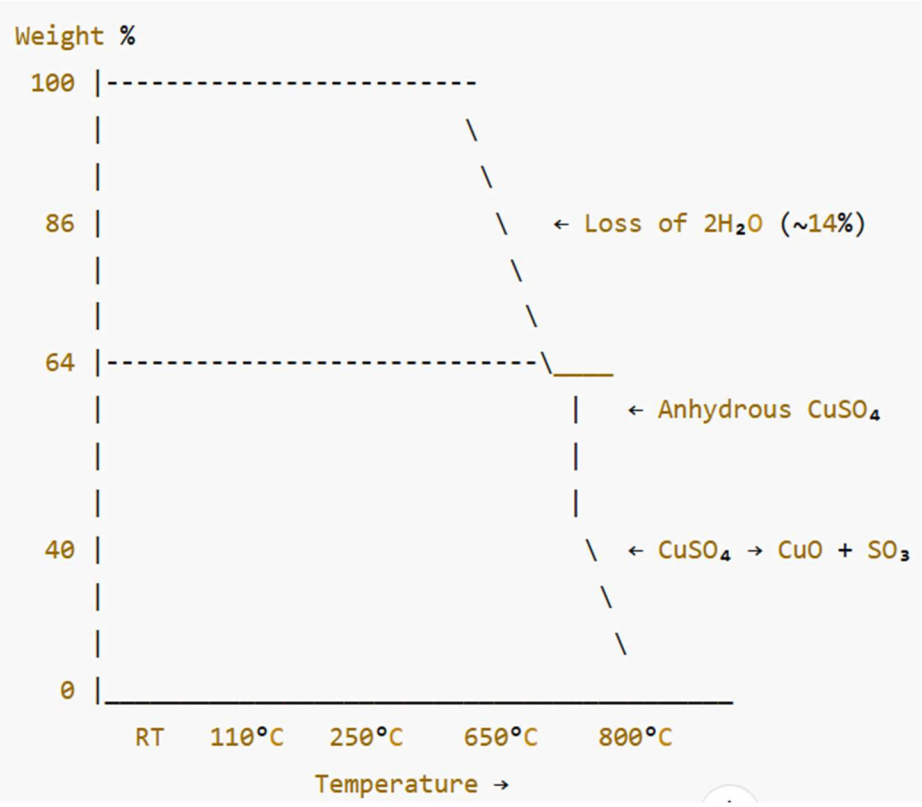
Cu = 63.5
S = 32
O_4 = 64
$5H_2O$ = 90
Total=249.5 g/mol
Formula: $CuSO_4 \cdot 5H_2O$
Molar mass: 249.7 g/mol

What Happens During Heating?

When heated from room temperature to ~800°C, $CuSO_4 \cdot 5H_2O$ undergoes **stepwise mass loss**.

TGA Observations

When heated from room temperature to 800°C, the TGA curve shows **three major steps**:



- **Step 1: 30–110°C:** Loss of 2 water molecules

  $CuSO_4.5H_2O \rightarrow CuSO_4.3H_2O + 2H_2O$

  Weight loss: $\frac{36}{249.5.} \times 100 = 14.40\%$

- **Step 2: 110–250°C**

  Loss of remaining 3 water molecules

  $CuSO_4.3H_2O \rightarrow CuSO_4 + 3H_2O$

  Weight loss: $\frac{54}{249.5.} \times 100 = 21.60\%$

Total dehydration loss:

$$14.26\ (\boldsymbol{step-1}) + 21.60(\boldsymbol{step-2}) = 36\%$$

Residue formed: **Anhydrous $CuSO_4$**

Step 3: 650–800°C

Decomposition of anhydrous salt

$$CuSO_4 \rightarrow CuO + SO_3\uparrow$$

SO_3 molecular weight = 80 g

$$\text{Weight loss: } \frac{80}{249.5.} \times 100 \approx 32\%$$

Final residue: **CuO**

TGA Curve Summary

Temperature Range	Event	Mass Change
30–110°C	Loss of 2 H_2O	Partial drop
110–250°C	Loss of remaining 3 H_2O	Total ~36% loss
650–800°C	$CuSO_4 \rightarrow CuO$	Final mass ~32%

What the TGA Graph Shows

- Initial plateau (stable solid)
- Stepwise downward slopes (water loss)
- Stable region (anhydrous $CuSO_4$)
- Sharp drop at high temperature (SO_3 release)
- Final plateau (CuO residue)

Observations

- Confirms **5 water molecules of hydration**
- Shows dehydration occurs in multiple stages
- Demonstrates thermal decomposition temperature
- Final solid residue is **black CuO**
