

“A solid compound containing water molecules combined in a definite ratio as an integral part of the crystal”

HYDRATES

What is a Hydrate?

- Any salt that has water chemically bonded to the ions in the crystal structure is a hydrate or hydrated crystal.
 - Copper(II) sulfate is a hydrate.
 - Hydrated copper(II) sulfate is deep blue in color.



What does the Chemical Formula of A Hydrate Look Like?

- $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$
- $\text{FeSO}_4 \cdot 6\text{H}_2\text{O}$
- $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$
- $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$
- The number in front of the water not only indicate how many molecules of water are attached this also represents the number of MOLES of water present in the hydrate

How are Names of Hydrates Written?

- $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$
 - barium chloride dihydrate
- $\text{FeSO}_4 \cdot 6\text{H}_2\text{O}$
 - iron(II) sulfate hexahydrate
- $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$
 - sodium carbonate decahydrate
- $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$
 - copper(II) sulfate pentahydrate

What prefixes are used?

0.5	hemi	7	hepta
1	mono	8	octa
2	di	9	nona
3	tri	10	deca
4	tetra	11	undeca
5	penta	12	dodeca
6	hexa	13	triskaideca

How can the water be removed?

- Heat the crystal. The water is loosely bound, and will come away as water vapor.
- Put the crystal in contact with or near a desiccant, maybe in a desiccator.



What is the compound called after the water has been removed?

- Anhydride (noun)
 - The light blue powder is the anhydride.
- Anhydrous (adjective)
 - Anhydrous copper(II) sulfate is left in the test tube after heating.



How is a hydrate formed?

- A substance that absorbs water from the air is said to be hygroscopic.



How to find the formula of a Hydrate

- To determine the water content of an ionic hydrate sample, we measure the mass of the sample before and after heating.
- Based on the analysis, we can express the water content of the hydrate

Determine number of moles

- Mass of anhydrous portion = mass of substance left after heating
- Figure out how many moles there are of water and of anhydrous portion
- Divide number of moles of water by the number of moles of anhydrous portion – this gives you the number of moles of hydration

Finding Moles of Water of Hydration

- Number of moles of waters of hydration = moles of water/ moles of anhydrous compound

Writing the formula

- Once we have determined the number of moles of the water of hydration, we can write the chemical formula for the anhydrous compound, followed by a raised dot, followed by the number of waters of hydration obtained by calculation.

- **Example #1:** A **15.67 g** sample of a hydrate of **magnesium carbonate** was heated, without decomposing the carbonate, to drive off the water. The **mass was reduced to 7.58 g**. What is the formula of the hydrate?
- **Solution:**
- **1) Mass of water removed: $15.67 - 7.58 = 8.09$ g of water**
- **2) Calc moles of MgCO_3 and water:**
- **$\text{MgCO}_3 \Rightarrow 7.58 \text{ g} / 84.313 \text{ g/mol} = 0.0899 \text{ mol}$**
 $\text{H}_2\text{O} \Rightarrow 8.09 \text{ g} / 18.015 \text{ g/mol} = 0.449 \text{ mol}$
- **3) Find a whole number molar ratio:**
- **$\text{MgCO}_3 \Rightarrow 0.0899 \text{ mol} / 0.0899 \text{ mol} = 1$**
 $\text{H}_2\text{O} \Rightarrow 0.449 \text{ mol} / 0.0899 \text{ mol} = 5$
 $5\text{MgCO}_3 \cdot 5\text{H}_2\text{O}$