Mixtures, Hydrates, and Purity Student Worksheet | `g10_u01_w02`

I can: use frozen masses and mass data to model hydrate composition, mixture fraction, and purity while stating the assumption behind each inference.
Frozen values: H 1.008, C 12.011, O 15.999, Na 22.990, Mg 24.305, S 32.060, Cl 35.450, Ca 40.078, Si 28.085, Co 58.933, Cu 63.546. Values are from `audits/atomic_masses_v2024.1.json`. All scenarios are paper data cards; no heating, dissolution, collection, or chemical procedure is requested.

1. Find the molar mass of $CuSO_4 \cdot 5H_2O$. Separate the anhydrous salt and five-water contributions.

2. How many grams of water are represented in 0.500 mol $CuSO_4 \cdot 5H_2O$?

3. Calculate the percent water by mass in $CuSO_4 \cdot 5H_2O$.

4. A 12.48 g data-card sample is modeled as pure $CuSO_4 \cdot 5H_2O$. Predict grams of anhydrous $CuSO_4$ and grams of water.

5. A model record lists an 8.00 g hydrate sample and a 5.11 g anhydrous residue. Calculate percent mass loss. Does that support the percent water in item 3 if the only loss is water?

6. An unknown is modeled as $CoCl_2 \cdot xH_2O$. A 10.00 g data-card sample leaves 6.40 g anhydrous $CoCl_2$. Find x.

7. A 20.0 g mixture of NaCl and SiO_2 is modeled so that a separation data card leaves 7.50 g insoluble SiO_2. Find mass percent of each component.

8. A 25.0 g limestone model contains $CaCO_3$ and inert SiO_2. A supplied mass-balance card assigns 4.40 g CO_2 to its $CaCO_3$ component. Find grams and percent $CaCO_3$.

9. An 18.0 g limestone model gives 3.96 g CO_2 by the same stated ratio. Find percent $CaCO_3$.

10. A 12.0 g MgO sample would contain 7.23 g Mg if pure. A composition card reports 6.51 g Mg and states impurities contain no Mg. Find percent MgO and name the key assumption.

11. A 6.00 g metal sample is 80.0% Mg by a supplied purity card. Use $2Mg + O_2 \rightarrow 2MgO$ to predict grams of MgO if oxygen is excess.

12. Theoretical MgO from item 11 is compared with a 7.20 g collected-mass card. Calculate percent yield relative to the stated pure-Mg amount.

13. A 15.0 g mixture is 40.0% $CaCO_3$ and 60.0% inert SiO_2. Predict grams CO_2 from its $CaCO_3$ component.

14. A 10.0 g mixture gives a model-assigned 1.76 g CO_2. Infer percent $CaCO_3$, assuming only $CaCO_3$ accounts for that card's CO_2.

15. For $Na_2CO_3 \cdot 10H_2O$, use a 14.31 g data-card sample to predict grams anhydrous Na_2CO_3 and grams water.

16. Use item 15 to determine the mole ratio water:Na_2CO_3. Explain why that ratio, not the mass ratio, identifies the hydrate number.

17. A 5.00 g purity card assigns 3.80 g of a sample to Na_2CO_3. Calculate percent purity.

18. Use $Na_2CO_3 \rightarrow CO_2$ as a stated one-to-one mole model. From item 17's Na_2CO_3 mass, predict grams CO_2.

19. An unknown $MgSO_4 \cdot xH_2O$ card lists 12.30 g hydrate and 6.00 g anhydrous $MgSO_4$. Find x.

20. A model claims an 8.00 g sample is 90.0% one target substance because a mass analysis assigns 7.20 g to it. Verify the percentage and state one alternate explanation or measurement boundary that should be checked before calling it a final purity result.