

## SOLUTION

### 1 ANALYZE

**Given:** chemical formula,  $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$   
molar mass of  $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$   
**Unknown:** mass percentage of  $\text{H}_2\text{O}$

### 2 PLAN

chemical formula  $\longrightarrow$  mass  $\text{H}_2\text{O}$  per mole of  $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$   $\longrightarrow$  % water

The mass of water per mole of sodium carbonate decahydrate must first be found. This value is then divided by the mass of one mole of  $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$ .

### 3 COMPUTE

One mole of  $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$  contains 10 mol  $\text{H}_2\text{O}$ . Recall from page 239 that the molar mass of  $\text{H}_2\text{O}$  is 18.02 g/mol. The mass of 10 mol  $\text{H}_2\text{O}$  is calculated as follows.

$$10 \text{ mol } \text{H}_2\text{O} \times \frac{18.02 \text{ g } \text{H}_2\text{O}}{1 \text{ mol } \text{H}_2\text{O}} = 180.2 \text{ g } \text{H}_2\text{O}$$

$$\text{mass of } \text{H}_2\text{O} \text{ per mole of } \text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O} = 180.2 \text{ g}$$

The molar mass of  $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$  is 286.19 g/mol, so we know that 1 mol of the hydrate has a mass of 286.19 g. The mass percentage of 10 mol  $\text{H}_2\text{O}$  in 1 mol  $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$  can now be calculated.

$$\text{mass percentage of } \text{H}_2\text{O} \text{ in } \text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O} = \frac{180.2 \text{ g } \text{H}_2\text{O}}{286.19 \text{ g } \text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}} \times 100 = 62.97\% \text{ } \text{H}_2\text{O}$$

### 4 EVALUATE

Checking shows that the arithmetic is correct and that units cancel as desired.

## PRACTICE

Answers in Appendix E

- Find the percentage compositions of the following:
  - $\text{PbCl}_2$
  - $\text{Ba}(\text{NO}_3)_2$
- Find the mass percentage of water in  $\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$ .
- Magnesium hydroxide is 54.87% oxygen by mass. How many grams of oxygen are in 175 g of the compound? How many moles of oxygen is this?

### extension

Go to [go.hrw.com](http://go.hrw.com) for more practice problems that ask you to calculate percentage composition.



Keyword: HC6FRMX

## SECTION REVIEW

- Determine both the formula mass and molar mass of ammonium carbonate,  $(\text{NH}_4)_2\text{CO}_3$ .
- How many moles of atoms of each element are there in one mole of  $(\text{NH}_4)_2\text{CO}_3$ ?
- What is the mass in grams of 3.25 mol  $\text{Fe}_2(\text{SO}_4)_3$ ?
- How many molecules of aspirin,  $\text{C}_9\text{H}_8\text{O}_4$ , are there in a 100.0 mg tablet of aspirin?

- Calculate the percentage composition of  $(\text{NH}_4)_2\text{CO}_3$ .

### Critical Thinking

- RELATING IDEAS** A sample of hydrated copper(II) sulfate ( $\text{CuSO}_4 \cdot n\text{H}_2\text{O}$ ) is heated to  $150^\circ\text{C}$  and produces 103.74 g anhydrous copper(II) sulfate and 58.55 g water. How many moles of water molecules are present in 1.0 mol of hydrated copper(II) sulfate?