

Section 8.3 Concentrations of Solutions
Solutions for Practice Problems
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1. Practice Problem (page 373)

A pharmacist adds 20.0 mL of distilled water to 30.0 g of a powdered medicine. The volume of the solution formed is 25.0 mL. What is the percent (m/v) concentration of the solution?

What Is Required?

You need to calculate the percent (m/v) concentration of a solution.

What Is Given?

You know the mass of the powdered medicine solute: 30.0 g

You know the volume of the solution: 25.0 mL

Plan Your Strategy

Write the formula for percent (m/v) concentration.

Substitute the given data into the expression to calculate the concentration.

Act on Your Strategy

$$\begin{aligned}\text{percent (m/v)} &= \frac{\text{mass of solute [in grams]}}{\text{volume of solution [in millilitres]}} \times 100\% \\ &= \frac{30.0 \text{ g}}{25.0 \text{ mL}} \times 100\% \\ &= 1.20 \times 10^2\%\end{aligned}$$

The concentration of the solution is $1.20 \times 10^2\%$ (m/v).

Check Your Solution

Since the mass of solute is greater than the volume of solution, it is reasonable to have a percent (m/v) concentration greater than 100%. The answer correctly shows three significant digits.

2. Practice Problem (page 373)

A solution contains 21.4 g of sodium nitrate, $\text{NaNO}_3(\text{s})$, dissolved in 250 mL of solution. Find the percent (m/v) concentration of the solution.

What Is Required?

You need to calculate the percent (m/v) concentration of a solution.

5. Practice Problem (page 373)

A chemist measured 25.00 g of water and bubbled hydrogen chloride gas into the water. The resulting solution had a mass of 26.68 g and a volume of 25.2 mL. Determine the percent (m/v) concentration of the solution.

What Is Required?

You need to calculate the percent (m/v) concentration of a solution.

What Is Given?

You know the mass of the hydrogen chloride solution, HCl(aq): 26.68 g

You know the mass of the solvent: 25.00 g

You know the volume of the solution: 25.2 mL

Plan Your Strategy

Calculate the mass of solute by subtracting the mass of solvent from the mass of solution.

Write the formula for percent (m/v) concentration.

Substitute the given data into the expression to calculate the concentration.

Act on Your Strategy

$$\text{mass of solute} = \text{mass of solution} - \text{mass of solvent}$$

$$= 26.68 \text{ g} - 25.00 \text{ g}$$

$$= 1.68 \text{ g}$$

$$\begin{aligned}\text{percent (m/v)} &= \frac{\text{mass of solute [in grams]}}{\text{volume of solution [in millilitres]}} \times 100\% \\ &= \frac{1.68 \text{ g}}{25.2 \text{ mL}} \times 100\% \\ &= 6.67\%\end{aligned}$$

The concentration of the solution is 6.67% (m/v).

Check Your Solution

Estimating, the mass of solute is about $\frac{1}{15}$ the volume of the solution. The

concentration in percent (m/v) expressed as a fraction is $\frac{7}{100}$, or about $\frac{1}{15}$.

This agrees with the calculated value and the answer correctly shows three significant digits.

- Substitution to calculate the mass of KCl(s) solute, m_{KCl} :

$$m_{\text{KCl}} = \frac{0.03\% \frac{\text{g}}{\text{mL}} \times 300 \text{ mL}}{100\%}$$

$$= 0.09 \text{ g}$$

The mass of potassium chloride is 0.09 g.

- Substitution to calculate the mass of CaCl₂(s) solute, m_{CaCl_2} :

$$m_{\text{CaCl}_2} = \frac{0.033\% \frac{\text{g}}{\text{mL}} \times 300 \text{ mL}}{100\%}$$

$$= 0.099 \text{ g}$$

The mass of calcium chloride is 0.099 g.

Check Your Solution

Estimating by expressing each mass as a percentage of the volume:

$$\text{NaCl(aq): } \frac{2.6 \text{ g}}{300 \text{ mL}} \times 100\% = 0.9\% \text{ (m/v)}$$

$$\text{KCl(aq): } \frac{0.09 \text{ g}}{300 \text{ mL}} \times 100\% = 0.03\% \text{ (m/v)}$$

$$\text{CaCl}_2\text{(aq): } \frac{0.099 \text{ g}}{300 \text{ mL}} \times 100\% = 0.033\% \text{ (m/v)}$$

The answers show the correct number of significant digits.

9. Practice Problem (page 373)

What volume of 5.0% (m/v) solution of sodium chloride, NaCl(aq), can be made using 40 g of NaCl(s)?

What Is Required?

You need to calculate the volume of a NaCl(aq) solution.

What Is Given?

You know the concentration of the solution: 5.0% (m/v)

You know the mass of the solute: 40 g

Plan Your Strategy

Write the formula for percent (m/v) concentration.

Rearrange the formula to solve for the volume of solution.

Substitute the data into the expression to calculate the volume of the sodium chloride solution, V .

Act on Your Strategy

Formula for percent (m/v) concentration:

$$\text{percent (m/v)} = \frac{\text{mass of solute [in grams]}}{\text{volume of solution [in millilitres]}} \times 100\%$$

Rearranged formula to solve for the volume of solution:

$$\text{percent (m/v)} = \frac{\text{mass of solute [in grams]}}{\text{volume of solution [in millilitres]}} \times 100\%$$

$$\text{percent (m/v)} \times \text{volume of solution [in millilitres]} = \text{mass of solute [in grams]} \times 100\%$$

$$\text{volume of solution [in millilitres]} = \frac{\text{mass of solute [in grams]}}{\text{percent (m/v)}} \times 100\%$$

Substitution to calculate the volume of the sodium chloride solution, v :

$$v = \frac{40 \cancel{\text{g}}}{\frac{5.0\% \cancel{\text{g}}}{\text{mL}}} \times 100\% \\ = 800 \text{ mL}$$

The volume of the solution is 800 ml.

Check Your Solution

Using the calculated value for the volume of solution, express the mass as a percentage of the volume:

$$\frac{40 \text{ g}}{800 \text{ mL}} \times 100\% = 5.0\% \text{ (m/v)}$$

The answer agrees with the given data and correctly shows two significant digits.

10. Practice Problem (page 373)

How would you prepare 400 mL of a 3.5% (m/v) solution of sodium acetate?

What Is Required?

You need to calculate the mass of sodium acetate and describe how to prepare a solution.