Molarity Problems

FORMULAS

**Molarity:** \( M = \frac{\text{moles of solute}}{\text{litres of solution}} \) (mol/L)

**Dilution problems:** \( M_1V_1 = M_2V_2 \)

**Molar mass:** \( n = \frac{m}{MW} \), where \( n \) = number of moles

- \( m = \text{mass} \)
- \( MW = \text{molecular weight} \) (g/mol)

**Example 1:** Determine the molarity of 3.72 moles of NaBr in 575 mL of solution.

**Solution:**

\[
[\text{NaBr}] = \frac{3.72 \text{ mol}}{0.575 \text{ L}} = 6.47 \text{ mol/L}
\]

**Example 2:** How many millilitres of concentrated H\(_2\)SO\(_4\) (16.0 M) is required to prepare 250 mL of 6.00 M H\(_2\)SO\(_4\) solution?

**Solution:**

desired: \( M_1 = 6.00 \text{ M}; \ V_1 = 250 \text{ mL} \)

on hand: \( M_2 = 16.0 \text{ M}; \ V_2 = ? \)

\[
V_2 = \frac{M_1V_1}{M_2} = \frac{(6.00 \text{ M})(250 \text{ mL})}{16.0 \text{ M}} = 93.8 \text{ mL H}_2\text{SO}_4
\]

**Example 3:** 15.32 mL of 0.5250 M HCl is required to titrate 17.50 mL of a NaOH solution. Determine the concentration of the NaOH solution.

**Solution:**

Because we have a titration, we need the formula equation for the reaction:

\[
\text{HCl} + \text{NaOH} \rightarrow \text{NaCl} + \text{H}_2\text{O}
\]

moles of acid: \( 0.5250 \text{ mol/L} \times (15.32 \times 10^{-3} \text{ L}) = 8.043 \times 10^{-3} \text{ mol HCl} \)

8.043 \times 10^{-3} \text{ mol HCl reacts with} \ 8.043 \times 10^{-3} \text{ mol NaOH}

concentration (molarity): \( \frac{8.043 \times 10^{-3} \text{ mol NaOH}}{1.750 \times 10^{-2} \text{ L NaOH}} = 0.4596 \text{ mol/L} \)

EXERCISES

A. Determine the molarity of a solution containing 2.58 mol NaCl in 455 mL of solution.

B. Determine the number of moles of KOH present in 95.0 mL of 0.255 M solution.

C. 12.5 g of Na\(_2\)CO\(_3\) is dissolved in water to make 325 mL of solution. What is the concentration?

D. What volume of 0.500 M BaCl\(_2\) will contain 16.2 g BaCl\(_2\)?
E. How many grams of BaCl₂ will be required to prepare 185 mL of 0.675 M solution?

F. Determine the concentration of the following solutions when mixed:
   1) 150 mL 0.550 M HCl + 250 mL H₂O
   2) 100 mL 0.500 M HCl + 100 mL 0.750 M HCl
   3) 300 mL 0.500 M HCl + 200 mL 0.750 M HCl

G. What volume of concentrated H₂SO₄ (18.0 M) is required to prepare 550 mL of 4.00 M H₂SO₄ solution?

H. How much water must be added to 625 mL of solution containing 27.2 g H₂SO₄ to make the final solution 0.325 M?

I. Consider the reaction:
   \[ \text{BaCl}_2 + \text{K}_2\text{CrO}_4 \rightarrow \text{BaCrO}_4 \downarrow + 2 \text{KCl} \]
   1) How many grams of barium chromate can be obtained from 75.0 mL of 0.150 M BaCl₂ solution?
   2) What volume of 0.500 M K₂CrO₄ solution is required to react with the 75.0 mL of 0.150 M BaCl₂ solution?

J. 15.3 mL of 0.100 M NaOH is required to titrate 15.0 mL of a HCl solution. Determine the concentration of the HCl solution.

K. What volume of 0.325 M NaOH is required to titrate 25.7 mL of 0.462 M HCl?

L. Consider the reaction:
   \[ \text{H}_2\text{SO}_4 + 2 \text{NaOH} \rightarrow \text{Na}_2\text{SO}_4 + 2 \text{H}_2\text{O} \]
   1) 15.2 mL of 0.425 M NaOH solution is required to neutralize 25.0 mL of H₂SO₄. Determine the concentration of the sulphuric acid solution.
   2) What volume of 0.425 M NaOH is required to neutralize 12.5 mL of 0.275 M H₂SO₄?

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**SOLUTIONS**

A. 5.67 M   B. 2.42 × 10⁻² mol   C. 0.363 M   D. 156 mL   E. 26.0 g
F. (1) 0.206 M   (2) 0.625 M   (3) 0.600 M   G. 122 mL   H. 228 mL
I. (1) 2.85 g   (2) 22.5 mL   J. 0.102 M   K. 36.5 mL   L. (1) 0.129 M   (2) 16.2 mL