Solution Stoichiometry

Chem Worksheet 15-6

Name Answer Key

(CV = n)

concentration (mol/L) × volume (L) = moles

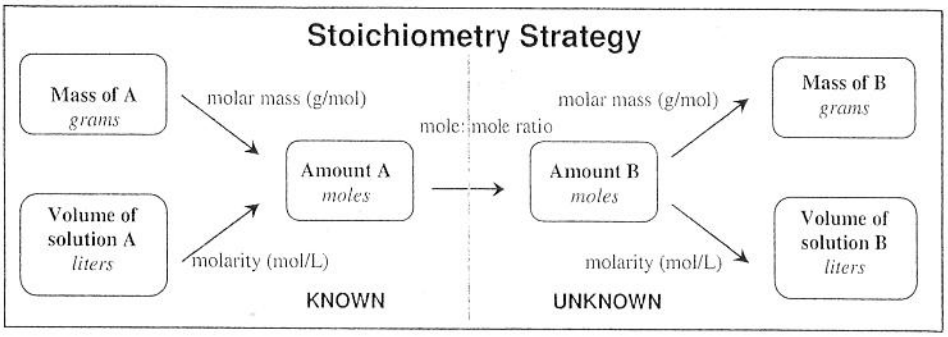
The **molarity** of a solution is a ratio of the moles of solute per liters of solution. The units for molarity are written as mol/L or *M*. This measurement is used to perform stoichiometric calculations. The strategy used for solving these solution stoichiometry problems is to set up the problem so that the units cancel.

USEFUL EQUATIONS

$$\text{molarity} = \frac{\text{mol solute}}{\text{L solution}} \qquad 1\text{ L} = 1000\text{ mL}$$

When the volume of a solution is multiplied by the molarity of a solution the resulting units are moles. A balanced equation allows us to convert from moles of a known substance to moles of an unknown. Finally, the moles of an unknown substance can be converted into grams, liters of solution, molarity, or other units.

mole box!



* g → moles for (solids) using mm

* C·V → moles if you have a soln & not a solid!

Example

How many grams of solid calcium hydroxide, $Ca(OH)_2$, are required to react with 350 mL of 0.40 *M* HCl?

$$\_\_HCl + \_\_Ca(OH)_2 \rightarrow \_\_CaCl_2 + \_\_H_2O$$

- balance the equation: $2\,HCl + \_\_Ca(OH)_2 \rightarrow \_\_CaCl_2 + 2\,H_2O$

- convert mL to L: $\frac{350\ \text{mL HCl}}{1} \times \frac{1\text{ L}}{1000\ \text{mL}} = 0.350\text{ L HCl}$

- write the 'given' and 'unknown' units: $\frac{350\text{ L HCl}}{1} \times \text{———} \times \text{———} \times \text{———} = \text{grams } Ca(OH)_2$

- fill in factors and solve: $\frac{0.350\ \text{L HCl}}{1} \times \frac{0.40\ \text{mol HCl}}{1\ \text{L HCl}} \times \frac{1\ \text{mol Ca(OH)}_2}{2\ \text{mol HCl}} \times \frac{74.10\text{ g Ca(OH)}}{1\ \text{mol Ca(OH)}_2} = 5.19\text{ grams Ca(OH)}_2$

Answer the following questions. Show all work and report answers with units.

1. How many grams of aluminum are required to react with 35 mL of 2.0 *M* hydrochloric acid, HCl?
   $6\,HCl + 2\,Al \rightarrow 2\,AlCl_3 + 3\,H_2$
2. How many grams of sodium can be reacted with 750 mL of a 6.0 *M* solution of sulfuric acid, H_2SO_4?
   $2\,Na + \_\_H_2SO_4 \rightarrow \_\_Na_2SO_4 + \_\_H_2$
3. If 45 mL of a 1.5 *M* $AgNO_3$ is added to KCl how many grams of AgCl can be formed?
   $\_\_AgNO_3 + \_\_KCl \rightarrow \_\_AgCl + \_\_KNO_3$
4. How many liters of a 0.75 *M* solution of $Ca(NO_3)_2$ will be required to react with 148 g of Na_2CO_3?
   $\_\_Ca(NO_3)_2 + \_\_Na_2CO_3 \rightarrow \_\_CaCO_3 + 2\,NaNO_3$
5. How many liters of a 3.0 *M* H_3PO_4 solution are required to react with 4.5 g of zinc?
   $2\,H_3PO_4 + 3\,Zn \rightarrow \_\_Zn_3(PO_4)_2 + 3\,H_2$
6. How many milliliters of 0.10 *M* $Pb(NO_3)_2$ are required to react with 75 mL of 0.20 *M* NaI?
   $\_\_Pb(NO_3)_2 + 2\,NaI \rightarrow \_\_PbI_2 + 2\,NaNO_3$
7. How many grams of solid $BaSO_4$ will form when Na_2SO_4 reacts with 25 mL of 0.50 *M* $Ba(NO_3)_2$?
   $\_\_Ba(NO_3)_2 + \_\_Na_2SO_4 \rightarrow \_\_BaSO_4 + 2\,NaNO_3$
8. If 525 mL of 0.80 *M* HCl solution is neutralized with 315 mL of $Sr(OH)_2$ solution what is the molarity of the $Sr(OH)_2$?
   $2\,HCl + \_\_Sr(OH)_2 \rightarrow \_\_SrCl_2 + 2\,H_2O$

Answer Key

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1)

$$35\text{mL} \times \frac{1\text{L}}{1000\text{mL}} \times \frac{2.0\text{mol HCl}}{1\text{L}} \times \frac{2\text{mol Al}}{6\text{mol HCl}} \times \frac{27\text{g Al}}{1\text{mol Al}} = 0.63\text{g Al}$$

2)

$$750\text{mL} \times \frac{1\text{L}}{1000\text{mL}} \times \frac{6.0\text{mol } H_2SO_4}{1\text{L}} \times \frac{2\text{mol Na}}{1\text{mol } H_2SO_4} \times \frac{23\text{g Na}}{1\text{mol Na}} = (210\text{g}) \; 207\text{g Na}$$

3)

$$45\text{mL} \times \frac{1\text{L}}{1000\text{mL}} \times \frac{1.5\text{mol AgNO}_3}{1\text{L}} \times \frac{1\text{mol AgCl}}{1\text{mol AgNO}_3} \times \frac{142.5\text{g}}{1\text{mol AgCl}} = 9.6\text{g AgCl}$$

(107 + 35.5 = 142.5 g/mol)

4)

$$148\text{g } Na_2CO_3 \times \frac{1\text{mol } Na_2CO_3}{106\text{g}} \times \frac{1\text{mol } Ca(NO_3)_2}{1\text{mol } Na_2CO_3} \times \frac{1\text{L } Ca(NO_3)_2}{0.75\text{mol}} = 1.9\text{L } Ca(NO_3)_2$$

5)

$$4.5\text{g Zn} \times \frac{1\text{mol Zn}}{63.55\text{g}} \times \frac{2\text{mol } H_3PO_4}{3\text{mol Zn}} \times \frac{1\text{L } H_3PO_4}{3.0\text{ mol}} = 0.016\text{L } H_3PO_4$$

6)

$$75\text{mL} \times \frac{1\text{L}}{1000\text{mL}} \times \frac{0.20\text{mol NaI}}{1\text{L}} \times \frac{1\text{mol Pb(NO}_3)_2}{2\text{mol NaI}} \times \frac{1\text{L Pb(NO}_3)_2}{0.10\text{mol}} = 0.075 \; Pb(NO_3)_2$$

7)

$$25\text{mL} \times \frac{1\text{L}}{1000\text{mL}} \times \frac{0.50\text{mol Ba(NO}_3)_2}{1\text{L}} \times \frac{1\text{mol BaSO}_4}{1\text{mol Ba(NO}_3)_2} \times \frac{229\text{g}}{1\text{mol BaSO}_4} = 2.9\text{g BaSO}_4$$

(137 + 32 + 16 × 4 = 64)

8) looking for molarity
looking for $\frac{mol}{1L}$!

volume but nothing with it

$$\frac{1L}{1000mL} \times 525mL \times \frac{0.80\ mol\ HCl}{1L} \times \frac{1\ mol\ Sr(OH)_2}{2\ mol\ HCl} \times \frac{1}{315mL\ Sr(OH)_2} \times \frac{1000mL}{1L} =$$

only units left over = $\frac{mol}{L}$

$= 0.67\ \frac{mol}{L}$ $Sr(OH)_2$

make sure to write down the units of what is wanted!