

Mole Review

Chemistry 11 **ADVANCED**

1. Calculate the number of moles in each of the following.

a) 125 mL of hydrogen gas at STP

$$\frac{0.125 \text{ L}}{22.4 \text{ L/mol}} = 0.00558 \text{ mol} \quad \text{or} \quad \underline{5.58 \times 10^{-3} \text{ mol}}$$

b) 1.26×10^{24} molecules of carbon dioxide

$$\frac{1.26 \times 10^{24}}{6.022 \times 10^{23}} = \underline{2.09 \text{ mol}}$$

c) 12.6 g water

$$\frac{12.6 \text{ g}}{18.01528 \text{ g/mol}} = \underline{0.699 \text{ mol}}$$

d) 12.6 g sodium chloride

$$\frac{12.6 \text{ g}}{58.442 \text{ g/mol}} = \underline{0.216 \text{ mol}}$$

2. Calculate the mass of each of the following.

a) 1.95×10^{22} molecules of sucrose, $\text{C}_{12}\text{H}_{22}\text{O}_{11}$

$$\left(\frac{1.95 \times 10^{22}}{6.022 \times 10^{23}} \right) (342.30008 \text{ g/mol}) = \underline{11.1 \text{ g}}$$

b) 2.50 L of propane, C_3H_8 , at STP

$$\left(\frac{2.50 \text{ L}}{22.4 \text{ L/mol}} \right) (44.09652 \text{ g/mol}) = \underline{4.92 \text{ g}}$$

c) 0.780 mol $\text{Ca}(\text{CN})_2$

$$(0.780 \text{ mol}) (92.1134 \text{ g/mol}) = \underline{71.8 \text{ g}}$$

3. Determine the number of atoms in each of the following.

a) 1 molecule of $C_{17}H_{19}NO_3$

40 atoms

b) 2.85 mol of Ag

$$(2.85 \text{ mol})(6.022 \times 10^{23}) = \underline{1.72 \times 10^{24} \text{ atoms}}$$

c) 0.875 L of carbon dioxide at STP

$$\left(\frac{0.875 \text{ L}}{22.4 \text{ L/mol}}\right)(6.022 \times 10^{23})(3 \text{ atoms/molecule}) = \underline{7.06 \times 10^{22} \text{ atoms}}$$

d) 12.9 g of $CaCO_3$

$$\left(\frac{12.9 \text{ g}}{100.0872 \text{ g/mol}}\right)(6.022 \times 10^{23})(5 \text{ atoms/molecule}) = \underline{3.88 \times 10^{23} \text{ atoms}}$$

e) 12.9 g of $Fe(NO_3)_3$

$$\left(\frac{12.9 \text{ g}}{241.8617 \text{ g/mol}}\right)(6.022 \times 10^{23})(13 \text{ atoms/molecule}) = \underline{4.18 \times 10^{23} \text{ atoms}}$$

4. Determine the volume of the following gases at STP.

a) 12.5 g of carbon dioxide

$$\left(\frac{12.5 \text{ g}}{44.0098 \text{ g/mol}}\right)(22.4 \text{ L/mol}) = \underline{6.36 \text{ L}}$$

b) 2.15 mol of propane

$$(2.15 \text{ mol})(22.4 \text{ L/mol}) = \underline{48.2 \text{ L}}$$

c) 6.88×10^{20} atoms of helium

$$\left(\frac{6.88 \times 10^{20}}{6.022 \times 10^{23}}\right)(22.4 \text{ L/mol}) = \underline{0.0256 \text{ L}}$$

d) 125 g of sulfur trioxide

$$\left(\frac{125 \text{ g}}{80.0642 \text{ g/mol}} \right) (22.4 \text{ L/mol}) = 35.0 \text{ L}$$

5. What volume of 0.125 M CaCl_2 can be made from 15.0 g?

$$\frac{15.0 \text{ g}}{110.984 \text{ g/mol}} = 0.135 \text{ mol} \quad V = \frac{n}{C} = \frac{0.135 \text{ mol}}{0.125 \text{ mol/L}} = 1.08 \text{ L}$$

6. What is the molarity of 325 g of NaHCO_3 dissolved in 2500.0 mL of solution?

$$\frac{325 \text{ g}}{84.0069 \text{ g/mol}} = 3.87 \text{ mol} \quad C = \frac{n}{V} = \frac{3.87 \text{ mol}}{2.5000 \text{ L}} = 1.55 \text{ mol/L}$$

7. What volume of 14.0 M nitric acid would be required to make 750.0 mL of 0.100 M nitric acid?

$$C_1 V_1 = C_2 V_2$$

$$V_1 = \frac{C_2 V_2}{C_1} = \frac{(0.100 \text{ M})(0.7500 \text{ L})}{(14.0 \text{ M})} = 0.00536 \text{ L} \quad \text{or } 5.36 \text{ mL}$$

8. What is the molarity of a solution that contains 36.1 g of MgCl_2 in 895 mL of solution.

$$\frac{36.1 \text{ g}}{95.211 \text{ g/mol}} = 0.379 \text{ mol} \quad C = \frac{n}{V} = \frac{0.379 \text{ mol}}{0.895 \text{ L}} = 0.424 \text{ mol/L}$$

9. You need to prepare 2.50 L of a 0.125 M solution of hydrochloric acid, but the only solution available is 12.0 M. What volume of the 12.0 M solution must be diluted?

$$C_1 V_1 = C_2 V_2$$

$$V_2 = \frac{C_1 V_1}{C_2} = \frac{(0.125 \text{ M})(2.50 \text{ L})}{(12.0 \text{ M})} = 0.0260 \text{ L} \quad \text{or } 26.0 \text{ mL}$$

10. What mass of sodium sulfate is required to prepare 750.0 mL of a 0.275 M solution?

$$n = C \cdot V = (0.275 \text{ mol/L})(0.7500 \text{ L}) = 0.206 \text{ mol}$$
$$(0.206 \text{ mol})(142.04314 \text{ g/mol}) = 29.3 \text{ g}$$

*11. 225.0 mL of 0.500 M nitric acid is added to 100.0 mL of 2.00 M nitric acid. What is the molarity of the mixture?

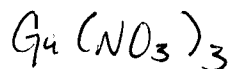
$$C_{AB} = \frac{C_A V_A + C_B V_B}{V_A + V_B} = \frac{(0.500 \text{ M})(225.0 \text{ mL}) + (2.00 \text{ M})(100.0 \text{ mL})}{225.0 \text{ mL} + 100.0 \text{ mL}}$$
$$= \frac{112.5 + 200}{325.0} = \frac{312.5}{325.0} = 0.962 \text{ M}$$

*12. Two solutions are mixed together. The first solution is 250.0 mL of 0.450 M hydrochloric acid. The second solution consists of 600.0 mL of 2.800 M hydrochloric acid. What is the concentration of the solution that is obtained when the two are mixed together?

$$C_{AB} = \frac{C_A V_A + C_B V_B}{V_A + V_B} = \frac{(0.450 \text{ M})(250.0 \text{ mL}) + (2.800 \text{ M})(600.0 \text{ mL})}{250.0 \text{ mL} + 600.0 \text{ mL}}$$
$$= \frac{112.5 \text{ mmol} + 1680 \text{ mmol}}{850.0 \text{ mL}}$$
$$= \frac{179.25 \text{ mmol}}{850.0 \text{ mL}} = 2.11 \text{ mol/L}$$

13. Determine the percentage composition of each element in gallium nitrate.

$$\% \text{ Ga} = \frac{69.72}{255.7347}$$
$$= 27.266 \%$$
$$\% \text{ N} = \frac{3(14.0067)}{255.7347}$$
$$= 16.43 \%$$
$$\% \text{ O} = \frac{9(15.9994)}{255.7347}$$
$$= 56.31 \%$$



14. The density of a gaseous compound is 1.964 g/L at STP. Calculate the molar mass of this gas.

$$\frac{\text{mass}}{\text{mol mass}} = \frac{\text{vol}}{\text{mol vol}} \quad \frac{1.964 \text{ g}}{\text{mol mass}} = \frac{1000 \text{ L}}{22.4 \text{ L/mol}} \quad \text{mol mass} = 44.0 \text{ g/mol}$$

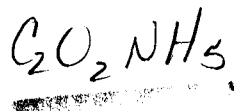
15. Determine the empirical formula of the compound with the following percentage composition: 32.00% carbon, 42.66% oxygen, 18.67% nitrogen & 6.67% hydrogen

$$\begin{array}{l} \frac{32.00 \text{ g C}}{12.011 \text{ g/mol}} \\ \frac{42.66 \text{ g O}}{15.9994 \text{ g/mol}} \\ \frac{18.67 \text{ g N}}{14.0067 \text{ g/mol}} \\ \frac{6.67 \text{ g H}}{1.00794 \text{ g/mol}} \end{array}$$

$$\begin{array}{l} \frac{2.664224 \text{ mol}}{1.332934} \\ \frac{2.666350}{1.332934} \\ \frac{1.332934}{1.332934} \\ \frac{6.617457}{1.332934} \end{array}$$

$$1.999 \quad : \quad 2.00 \quad : \quad 1 \quad : \quad 4.965$$

$$2 : 2 : 1 : 5$$



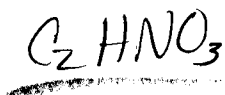
16. Determine the empirical formula of the compound with the following percentage composition: 27.59% carbon, 1.15% hydrogen, 16.09% nitrogen & 55.17% oxygen

$$\begin{array}{l} \frac{27.59 \text{ g C}}{12.011} \\ \frac{1.15 \text{ g H}}{1.00794} \\ \frac{16.09 \text{ g N}}{14.0067} \\ \frac{55.17 \text{ g O}}{15.9994} \end{array}$$

$$\begin{array}{l} \frac{2.297061}{1.140940} \\ \frac{1.140940}{1.140940} \\ \frac{1.1487359}{1.14940} \\ \frac{3.448254}{1.140940} \end{array}$$

$$1.9996 \quad 1 \quad 1.007 \quad 3.022$$

$$2 : 1 : 1 : 3$$

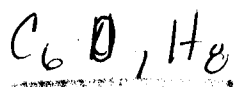


17. An organic compound contains 37.5% carbon, 58.3% oxygen and 4.20% hydrogen. The substance has a molar mass of 192.10 g/mol. Determine the molecular formula of this compound.

$$\frac{72.0375 \text{ g C}}{12.011} = 5.998$$

$$\frac{111.9943 \text{ g O}}{15.9994} = 6.9999$$

$$\frac{8.0682 \text{ g H}}{1.00794} = 8.005$$



18. Determine the molecular formula of methyl butanoate, a compound that smells like apples. Its percent composition is 58.8% carbon, 9.8% hydrogen and 31.4% oxygen. In the gaseous state, 782 mL has a mass of 3.56 g.

$$\frac{3.56 \text{ g}}{\text{mol mass}} = \frac{0.782 \text{ L}}{22.4 \text{ mol}}$$

$$\text{mol mass} = 101.97 \text{ g/mol}$$

$$\frac{59.96 \text{ g C}}{12.011} = 4.992$$

$$\frac{9.993 \text{ g H}}{1.00794} = 9.9177$$

$$\frac{32.01447 \text{ g O}}{15.9994} = 2.001$$

$$4.992$$

$$9.9177$$

$$2.001$$

