Mole Review - Answers

Chemistry 11

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

a) 125 mL of hydrogen gas at STP

$$\text{mol} = \frac{0.125\ \text{L}}{22.4\ \text{L/mol}} = 0.00558\ \text{mol}$$

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

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

c) 15.8 mL of sulfur trioxide at STP

$$\frac{0.0158\ \text{L}}{22.4\ \text{L/mol}} = 7.05 \times 10^{-4}\ \text{mol}$$

d) 2.65 g of copper(II) sulfate pentahydrate

$$\frac{2.65\ \text{g}\ CuSO_4 \cdot 5H_2O}{249.686\ \text{g/mol}} = 0.0106\ \text{mol}$$

e) 12.6 g water

$$\frac{12.6\ \text{g}\ H_2O}{18.01528\ \text{g/mol}} = 0.699\ \text{mol}$$

f) 12.6 g sodium chloride

$$\frac{12.6\ \text{g}\ NaCl}{58.44277\ \text{g/mol}} = 0.216\ \text{mol}$$

g) 2.86×10^{-3} g scandium acetate

$$\frac{2.86 \times 10^{-3}\ \text{g}\ Sc(C_2H_3O_2)_3}{222.08976\ \text{g/mol}} = 1.29 \times 10^{-5}\ \text{mol}$$

h) 4.57×10^{17} atoms platinum

$$\frac{4.57 \times 10^{17}}{6.022 \times 10^{23}} = 7.59 \times 10^{-7}\ \text{mol}$$

2. Calculate the mass of each of the following.

a) 1.95×10^{22} molecules of sucrose, $C_{12}H_{22}O_{11}$

$\frac{1.95 \times 10^{22}}{6.022 \times 10^{23}} = 0.0324 \text{ mol}$

$(0.0324 \text{ mol})(342.30008 \text{ g/mol}) = 11.1 \text{ g}$

b) 2.50 L of propane, C_3H_8, at STP

$\frac{2.50 \text{ L}}{22.4 \text{ L/mol}} = 0.112 \text{ mol}$

$(0.112 \text{ mol})(44.096\,52 \text{ g/mol}) = 4.92 \text{ g}$

c) 0.780 mol $Ca(CN)_2$

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

d) 9.57×10^{17} atoms platinum

$\frac{9.57 \times 10^{17}}{6.022 \times 10^{23}} = 1.59 \times 10^{-6} \text{ mol}$

$(1.59 \cdot 10^{-6} \text{ mol})(195.08 \text{ g/mol}) = 3.10 \times 10^{-4} \text{ g}$

e) 36.5 mL of chlorine at STP

$\frac{0.0365 \text{ L}}{22.4 \text{ L/mol}} = 0.00163 \text{ mol}$

$(0.00163 \text{ mol})(70.906 \text{ g/mol}) = 0.116 \text{ g}$

f) 5.68×10^{27} molecules zinc nitrate

$\frac{5.68 \cdot 10^{27}}{6.022 \times 10^{23}} = 9430 \text{ mol}$ $Zn(NO_3)_2$

$(9430 \text{ mol})(189.3898 \text{ g/mol}) = 1790000 \text{ g}$

g) 35.7 L of ozone (O_3)

$\frac{35.7 \text{ L}}{22.4 \text{ L/mol}} = 1.59 \text{ mol}$

$(1.59 \text{ mol})(47.9982 \text{ g/mol}) = 76.5 \text{ g}$

h) 0.145 mol cupric sulfate pentahydrate

$(0.145 \text{ mol})(249.686 \text{ g/mol}) = 36.2 \text{ g}$

$CuSO_4 \cdot 5H_2O$

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

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

(1 molecule)(40 atoms/molecule) = 40 atoms

b) 2.85 mol of Ag

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

c) 0.875 L of carbon dioxide at STP

$\frac{0.875\ L}{22.4\ L/mol} = 0.0391\ mol$

$(0.0391\ mol)(6.022 \times 10^{23}) = 2.35 \times 10^{22}$ molecules

$\times 3 = 7.06 \times 10^{22}$ atoms

d) 17.0 g of copper(II) sulfate pentahydrate $CuSO_4 \cdot 5H_2O$

$\frac{17.0\ g}{249.686\ g/mol} = 0.0681\ mol$

$(0.0681\ mol)(6.022 \times 10^{23}) = 4.10 \times 10^{22}$ molecules

$\times 21 = 8.61 \times 10^{23}$ atoms

e) 12.9 g of $CaCO_3$

$\frac{12.9\ g}{100.0862\ g/mol} = 0.129\ mol$

$(0.129\ mol)(6.022 \times 10^{23}) = 7.76 \times 10^{22}$ molecules

$\times 5 = 3.88 \times 10^{23}$ atoms

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

$\frac{12.9\ g}{241.8617\ g/mol} = 0.0533\ mol$

$(0.0533\ mol)(6.022 \times 10^{23}) = 3.21 \times 10^{22}$ molecules

$\times 13 = 4.18 \times 10^{23}$ atoms

g) 2.86×10^{-3} g scandium acetate

$\frac{2.86 \cdot 10^{-3}}{222.089766\ g/mol} = 1.29 \times 10^{-5}\ mol$

$(1.29 \cdot 10^{-5}\ mol)(6.022 \times 10^{23}) = 7.75 \times 10^{18}$ molecules

$\times 22 = 1.71 \times 10^{20}$ atoms

h) 15.7 L of ozone (O_3)

$\frac{15.7\ L}{22.4\ L/mol} = 0.701\ mol$

$(0.701\ mol)(6.022 \times 10^{23}) = 4.22 \times 10^{23}$ molecules

$\times 3 = 1.27 \times 10^{24}$ atoms

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

a) 12.5 g of carbon dioxide

$\frac{12.5\text{g } CO_2}{44.0098\text{ g/mol}} = 0.284\text{ mol}$

$(0.284\text{ mol})(22.4\text{ L/mol}) = 6.36\text{ L}$

b) 2.15 mol of propane (C_3H_8)

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

c) 9.57×10^{17} atoms argon

$\frac{9.57 \times 10^{17}\text{ Ar}}{6.022 \times 10^{23}} = 1.59 \times 10^{-6}\text{ mol}$

$(1.59 \cdot 10^{-6}\text{ mol})(22.4\text{ L/mol}) = 3.56 \times 10^{-5}\text{ L}$

d) 345 g of krypton

$\frac{345\text{ g Kr}}{83.80\text{ g/mol}} = 4.12\text{ mol}$

$(4.12\text{ mol})(22.4\text{ L/mol}) = 92.2\text{ L}$

e) 6.88×10^{20} atoms of helium

$\frac{6.88 \times 10^{20}\text{ He}}{6.022 \times 10^{23}} = 0.00114\text{ mol}$

$(0.00114\text{ mol})(22.4\text{ L/mol}) = 0.0256\text{ L}$

f) 125 g of sulfur trioxide

$\frac{125\text{g } SO_3}{80.063\text{ g/mol}} = 1.56\text{ mol}$ ~~0.976 mol~~ ~~128.0624 g/mol~~

$(1.56\text{ mol})(22.4\text{ L/mol}) = 34.97\text{ L} = 35.0\text{ L}$ ~~21.9 L~~

g) 1.95×10^{22} molecules of carbon monoxide

$\frac{1.95 \times 10^{22}}{6.022 \times 10^{23}} = 0.0324\text{ mol}$

$(0.0324\text{ mol})(22.4\text{ L/mol}) = 0.725\text{ L}$

h) 5.68×10^{27} atoms xenon

$\frac{5.68 \times 10^{27}}{6.022 \times 10^{23}} = 9430\text{ mol}$

$(9430\text{ mol})(22.4\text{ L/mol}) = 211000\text{ L}$

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

$$\frac{15.0\ g\ CaCl_2}{110.984\ g/mol} = 0.135\ mol \qquad V = \frac{n}{C} = \frac{0.135\ mol}{0.125\ mol/L}$$

$$= 1.08\ L$$

b) Determine the volume of 4.50 M silver nitrate that can be made from 100.0 g of silver nitrate.

$$\frac{100.0\ g}{169.8731\ g/mol} \qquad V = \frac{n}{C} = \frac{0.589\ mol}{4.50\ mol/L}$$

$$= 0.589\ mol \qquad = 0.131\ L$$

c) What is the volume of a 0.875 mol/L solution that contains 18.6 g of ferrous sulfate heptahydrate? $FeSO_4 \cdot 7H_2O$

$$\frac{18.6\ g}{278.01756\ g/mol} \qquad V = \frac{n}{C} = \frac{0.0669\ mol}{0.875\ mol/L}$$

$$= 0.0669\ mol \qquad = 0.0765\ L$$

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

$$\frac{325\ g}{84.00691\ g/mol} \qquad C = \frac{n}{V} = \frac{3.87\ mol}{2.5000\ L} = 1.55\ mol/L$$

$$= 3.87\ mol$$

b) Determine the concentration of 56.0 g of cadmium nitrate in 400.0 mL of solution.

$$\frac{56.0\ g}{236.4198\ g/mol} = 0.237\ mol \qquad C = \frac{n}{V} = \frac{0.237\ mol}{0.4000\ L} = 0.592\ mol/L$$

c) What is the molarity of 167 g of ammonium sulfate in 950.0 mL of solution? $(NH_4)_2SO_4$

$$\frac{167\ g}{132.14052\ g/mol} \qquad C = \frac{n}{V} = \frac{1.26\ mol}{0.9500\ L} = 1.33\ mol/L$$

$$1.26\ mol$$

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

$C_1V_1 = C_2V_2 \qquad V_1 = \frac{C_2V_2}{C_1} = \frac{(0.100\ mol/L)(0.7500\ L)}{(14.0\ mol/L)}$

$= 0.00536\ L \quad or \quad 5.36\ mL$

b) What volume of 18.0 M sulphuric acid is required to prepare 2.50 L of 0.200 M sulphuric acid?

$V_1 = \frac{C_2V_2}{C_1} = \frac{(0.200\ mol/L)(2.50\ L)}{(18.0\ mol/L)}$

$= 0.0278\ L$

c) What is the concentration when 20.0 mL of 12.0 M hydrochloric acid is diluted to a final volume of 1.00 L?

$C_2 = \frac{C_1V_1}{V_2} = \frac{(12.0\ mol/L)(0.0200\ L)}{(1.00\ L)}$

$= 0.240\ mol/L$

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

$mol = \frac{36.1\ g}{95.211\ g/mol}$

$= 0.379\ mol$

$C = \frac{n}{V} = \frac{0.379\ mol}{0.895\ L}$

$= 0.424\ mol/L$

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?

$V_2 = \frac{C_1V_1}{C_2} = \frac{(0.125\ mol/L)(2.50\ L)}{(12.0\ mol/L)}$

$= 0.0260\ L$

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

$n = C \cdot V$
$= (0.275\ mol/L)(0.7500\ L)$
$= 0.206\ mol$

$mass = (0.206\ mol)(142.04314\ g/mol)$
$= 29.3\ g$

11. 225.0 mL (A) of 0.500 M nitric acid is added to 100.0 mL (B) of 2.00 M nitric acid. What is the molarity of the mixture?

$mol\ A = C \cdot V$
$= (0.500\ M)(0.2250\ L)$
$= 0.1125\ mol$

$mol\ B = C \cdot V$
$= (2.00\ M)(0.1000\ L)$
$= 0.200\ mol$

$C = \frac{total\ mol}{total\ vol}$
$= \frac{0.1125 + 0.200}{0.225 + 0.100}$
$= \frac{0.3125}{0.325}$
$0.962\ mol/L \Leftarrow$

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

$mol\ A = C \cdot V$
$= (0.450\ M)(0.2500\ L)$
$= 0.1125\ mol$

$mol\ B = C \cdot V$
$= (2.800\ M)(0.6000\ L)$
$= 1.68\ mol$

$C = \frac{total\ mol}{total\ vol}$
$= \frac{0.1125\ mol + 1.68\ mol}{0.2500\ L + 0.6000\ L}$
$= \frac{1.7925\ mol}{0.850\ L} = 2.11\ mol/L$

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

$Ga(NO_3)_3$

$\%\ Ga = \frac{69.72}{255.7347} \times 100$
$27.26\ \%\ Ga$

$\%\ N = \frac{3(14.0067) \times 100}{255.7347}$
$16.43\ \%\ N$

$\%\ O = \frac{9(15.9994) \times 100}{255.7347}$
$53.61\ \%\ O$