VIII. The Mole (Chapter 6)

1. Calculate the number of moles in:

a) 80. grams of zinc, Zn. g Zn → mole Zn

$$80.\ g\ Zn \times \frac{1\ mole\ Zn}{65.41\ g\ Zn} = 1.2231\ mole\ Zn = \boxed{1.2\ mole\ Zn}$$

b) .58 grams of lead, Pb. g Pb → mole Pb

$$0.58\ g\ Pb \times \frac{1\ mole\ Pb}{207.2\ g\ Pb} = 0.002799\ mole\ Pb = \boxed{0.0028\ mole\ Pb}$$

c) 3.47×10^{-5} grams of vanadium, V. g V → mole V

$$3.47 \times 10^{-5}\ g\ V \times \frac{1\ mole\ V}{50.9415\ g\ V} = 6.8117 \times 10^{-7}\ mole\ V = \boxed{6.81 \times 10^{-7}\ mole\ V}$$

2. Calculate the number of atoms in:

a) .23 mole copper, Cu. mole Cu → atom Cu

$$0.23\ mole\ Cu \times \frac{6.022 \times 10^{23}\ atoms\ Cu}{1\ mole\ Cu} = 1.3851 \times 10^{23}\ atoms\ Cu = \boxed{1.4 \times 10^{23}\ atoms\ Cu}$$

b) .23 mole gold, Au. mole Au → atom Au

$$0.23\ mole\ Au \times \frac{6.022 \times 10^{23}\ atoms\ Au}{1\ mole\ Au} = 1.385 \times 10^{23}\ atoms\ Au = \boxed{1.4 \times 10^{23}\ atoms\ Au}$$

c) 7.76×10^{-3} mole neon, Ne. mole Ne → atoms Ne

$$7.76 \times 10^{-3}\ mole\ Ne \times \frac{6.022 \times 10^{23}\ atoms\ Ne}{1\ mole\ Ne} = 4.6730 \times 10^{21}\ atoms\ Ne = \boxed{4.67 \times 10^{21}\ atoms\ Ne}$$

3. Calculate the number of atoms in:

a) 7.8×10^{4} grams of bromine, Br. g Br → mole Br → atom Br

$$7.8 \times 10^{4}\ g\ Br \times \frac{1\ mole\ Br}{79.904\ g\ Br} \times \frac{6.022 \times 10^{23}\ atoms\ Br}{1\ mole\ Br} = 5.8785 \times 10^{26}\ atoms\ Br$$

$$= \boxed{5.9 \times 10^{26}\ atoms\ Br}$$

b) 4.5×10^{-5} grams of krypton, Kr g Kr → mole Kr → atoms Kr

$$4.5 \times 10^{-5}\ g\ Kr \times \frac{1\ mole\ Kr}{83.80\ g\ Kr} \times \frac{6.022 \times 10^{23}\ atoms\ Kr}{1\ mole\ Kr} = 3.2377 \times 10^{17}\ atoms\ Kr$$

$$= \boxed{3.2 \times 10^{17}\ atoms\ Kr}$$

4. Calculate the number of grams in:

a) 9.7×10^{41} atoms of lithium, Li. ~~g~~ atoms Li → mole Li → g Li

$$9.7\times10^{41}\text{ atoms Li}\times\frac{1\text{ mole Li}}{6.022\times10^{23}\text{ atoms Li}}\times\frac{6.941\text{ g Li}}{1\text{ mole Li}}=1.1\,\underline{1}803\times10^{19}\text{ g Li}$$

$$=\boxed{1.1\times10^{19}\text{ g Li}}$$

b) 5.8×10^{-4} mole calcium, Ca. mole Ca → g Ca

$$5.8\times10^{-4}\text{ mole Ca}\times\frac{40.078\text{ g Ca}}{1\text{ mole Ca}}=0.023\,\underline{2}45\text{ g Ca}=\boxed{0.023\text{ g Ca}}$$

5. Calculate the number of :

a) molecules of sucrose, $C_{12}H_{22}O_{11}$, in 2.1×10^{-8} moles of sucrose. Moles Sucrose → Molecule Sucrose

$$2.1\times10^{-8}\text{ moles }C_{12}H_{22}O_{11}\times\frac{6.022\times10^{23}\text{ molecule }C_{12}H_{22}O_{11}}{1\text{ mole }C_{12}H_{22}O_{11}}=1.\underline{2}6462\times10^{16}\text{ molecules}$$

$$=\boxed{1.3\times10^{16}\text{ molecules }C_{12}H_{22}O_{11}}$$

b) molecules in 3.87×10^{4} grams of water, H_2O. g H_2O → moles H_2O → molecules H_2O

$$3.87\times10^{4}\text{ g }H_2O\times\frac{1\text{ mole }H_2O}{18.01528\text{ g }H_2O}\times\frac{6.022\times10^{23}\text{ molecules }H_2O}{1\text{ mole }H_2O}=1.29\,\underline{3}63\text{ mol}\times10^{27}\text{ molecules}$$

$$=\boxed{1.29\times10^{27}\text{ molecules }H_2O}$$

c) moles of methane in 4.7×10^{27} molecules of methane, CH_4. Molecules CH_4 → Moles CH_4

$$4.7\times10^{27}\text{ molecules }CH_4\times\frac{1\text{ mole }CH_4}{6.022\times10^{23}\text{ molecules }CH_4}=7.\underline{8}04716\times10^{3}\text{ mole }CH_4$$

$$=\boxed{7.8\times10^{3}\text{ mole }CH_4}$$

d) grams of C in 17.3 grams of nonane, C_9H_{20}. g C_9H_{20} → mole C_9H_{20} → mole C → g C

$$17.3\text{ g }C_9H_{20}\times\frac{1\text{ mole }C_9H_{20}}{128.2578\text{ g }C_9H_{20}}\times\frac{9\text{ mole C}}{1\text{ mole }C_9H_{20}}\times\frac{12.011\text{ g C}}{1\text{ mole C}}=14.\underline{5}809\text{ g C}$$

$$=\boxed{14.6\text{ g C}}$$

e) atoms of O in .00517 grams of glucose, $C_6H_{12}O_6$. g $C_6H_{12}O_6$ → mole $C_6H_{12}O_6$ → mole O → atom O

$$0.00517\text{ g }C_6H_{12}O_6\times\frac{1\text{ mole }C_6H_{12}O_6}{180.1572\text{ g }C_6H_{12}O_6}\times\frac{6\text{ mole O}}{1\text{ mole }C_6H_{12}O_6}\times\frac{6.022\times10^{23}\text{ atoms O}}{1\text{ mole O}}=1.0\,\underline{3}689\times10^{20}\text{ atoms O}$$

$$=\boxed{1.04\times10^{20}\text{ atoms O}}$$

f) atoms of H in 5.6×10^{4} moles of sucrose, $C_{12}H_{22}O_{11}$. mole $C_{12}H_{22}O_{11}$ → mole H → atom H

$$5.6\times10^{4}\text{ moles }C_{12}H_{22}O_{11}\times\frac{22\text{ mole H}}{1\text{ mole }C_{12}H_{22}O_{11}}\times\frac{6.022\times10^{23}\text{ atoms H}}{1\text{ mole H}}=7.\underline{4}191\times10^{29}\text{ atoms H}$$

$$=\boxed{7.4\times10^{29}\text{ atoms H}}$$

6. Calculate the number of: (Note- $CuCO_3$ is an ionic compound, so we do not refer to molecules of $CuCO_3$. Instead, you can refer to a "formula unit" of $CuCO_3$.)

a) grams of Cu in 47.3 grams of $CuCO_3$. $g CuCO_3 \rightarrow mole\ CuCO_3 \rightarrow mole\ Cu \rightarrow g\ Cu$

$$47.3\ g\ CuCO_3 \times \frac{1\ mole\ CuCO_3}{123.5552\ g\ CuCO_3} \times \frac{1\ mole\ Cu}{1\ mole\ CuCO_3} \times \frac{63.546\ g\ Cu}{1\ mole\ Cu} = 24.32699\ g\ Cu$$

$$= \boxed{24.3\ g\ Cu}$$

b) moles of Cu in 47.3 grams of $CuCO_3$. $g CuCO_3 \rightarrow mole\ CuCO_3 \rightarrow Moles\ Cu$

$$47.3\ g\ CuCO_3 \times \frac{1\ mole\ CuCO_3}{123.5552\ g\ CuCO_3} \times \frac{1\ mole\ Cu}{1\ mole\ CuCO_3} = 0.3828248\ mole\ Cu$$

$$= \boxed{0.383\ mole\ Cu}$$

c) moles of Cl in 2.17 moles of $AlCl_3$. $mole\ AlCl_3 \rightarrow mole\ Cl$

$$2.17\ moles\ AlCl_3 \times \frac{3\ mole\ Cl}{1\ mole\ AlCl_3} = \boxed{6.51\ mole\ Cl}$$

d) grams of Cl in 2.17 moles of $AlCl_3$. $mole\ AlCl_3 \rightarrow mole\ Cl \rightarrow g\ Cl$

$$2.17\ mole\ AlCl_3 \times \frac{3\ mole\ Cl}{1\ mole\ AlCl_3} \times \frac{35.453\ g\ Cl}{1\ mole\ Cl} = 230.799\ g\ Cl$$

$$= \boxed{231\ g\ Cl}$$

e) grams of H in .015 grams of H_3PO_4. $g H_3PO_4 \rightarrow mole\ H_3PO_4 \rightarrow Mole\ H \rightarrow g\ H$

$$0.015\ g\ H_3PO_4 \times \frac{1\ mole\ H_3PO_4}{90.99522\ g\ H_3PO_4} \times \frac{3\ mole\ H}{1\ mole\ H_3PO_4} \times \frac{1.00794\ g\ H}{1\ mole\ H} = 4.9846 \times 10^{-4}\ g\ H$$

$$= \boxed{5.0 \times 10^{-4}\ g\ H}$$

f) atoms of O in 2.007 grams of H_3PO_4. $g H_3PO_4 \rightarrow mole\ H_3PO_4 \rightarrow mole\ O \rightarrow atoms\ O$

$$2.007\ g\ H_3PO_4 \times \frac{1\ mole\ H_3PO_4}{90.99522\ g\ H_3PO_4} \times \frac{4\ mole\ O}{1\ mole\ H_3PO_4} \times \frac{6.022 \times 10^{23}\ atoms\ O}{1\ mole\ O} = 5.312857 \times 10^{22}\ atoms\ O$$

$$= \boxed{5.313 \times 10^{22}\ atoms\ O}$$