Mole

1.) If 1.0 mol of unknown gas X contains 3.0×10^{23} molecules at a certain temperature and pressure, how many molecules are present in 5.0 mol of oxygen gas at the same temperature and pressure?
Answer – 5.0 mol × 3.0×10^{23} molecules/mol = **1.5×10^{24} molecules**

2.) Calculate the molar mass of each of the following.
a.) NO → 1 × 14.01 + 1 × 16.00 = **30.01 g/mol**
b.) H_2O → 2 × 1.01 + 1 × 16.00 = **18.02 g/mol**
c.) NH_3 → 1 × 14.01 + 3 × 1.01 = **17.04 g/mol**
d.) CO_2 → 1 × 12.01 + 2 × 16.00 = **44.01 g/mol**
e.) CH_4 → 1 × 12.01 + 4 × 1.01 = **16.05 g/mol**
f.) $AgNO_3$ → 1 × 107.87 + 1 × 14.01 + 3 × 16.00 = **169.88 g/mol**
g.) $Ca(OH)_2$ → 1 × 40.08 + 2 × 16.00 + 2 × 1.01 = **74.10 g/mol**
h.) $Al(NO_3)_3$ → 1 × 26.98 + 3 × 14.01 + 9 × 16.00 = **213.0 g/mol**
i.) $FeCl_3$ → 1 × 55.85 + 3 × 35.45 = **162.20 g/mol**
j.) SnC_2O_4 → 1 × 118.71 + 2 × 12.01 + 4 × 16.00 = **206.73 g/mol**
k.) $Sn(C_2O_4)_2$ → 1 × 118.71 + 4 × 12.01 + 8 × 16.00 = **294.75 g/mol**
l.) $(NH_4)_3PO_4$ = **149.12 g/mol**
m.) CH_3COOH = **60.06 g/mol**
n.) $CH_3CH_2CH_2CH_3$ = **58.14 g/mol**
o.) $Ni(H_2O)_2(NH_3)_4Cl_2$ = **233.79 g/mol**
p.) $Al_2(SO_4)_3$ = **342.10 g/mol**

3.) Calculate the molar mass of each of the following.
a.) $Co_3(AsO_4)_2 \cdot 8H_2O$ → 3 × 58.93 + 2 × 74.92 + 8 × 16.00 + 16 × 1.01 + 8 × 16.00 = **598.80 g/mol**
b.) $Pb(C_2H_3O_2)_2 \cdot 3H_2O$ → 1 × 207.20 + 4 × 12.01 + 6 × 1.01 + 4 × 16.00 + 6 × 1.01 + 3 × 16.00 = **379.40 g/mol**
c.) $MgSO_4 \cdot 7H_2O$ → 1 × 24.31 + 1 × 32.06 + 4 × 16.00 + 14 × 1.01 + 7 × 16.00 = **246.50 g/mol**
d.) $KAl(SO_4)_2 \cdot 12H_2O$ → 1 × 39.01 + 1 × 26.98 + 2 × 32.06 + 8 × 16.00 + 24 × 1.01 + 12 × 16.00 = **474.40 g/mol**

More mole

1a.) 0.473 mol $SO2$

1b.) 0.0125 mol $HNO3$

1c.) 0.00574 mole $Ca(OH)2$

1d.) $7.06 * 10^{-12}$ $Fe2O3$

1e.) **23.8 mol NaOH**

1f.) **0.00112 mol**

1g.) **91.3 mol**

1h.) **0.00536 mol**

2a.)
Volume = 0.235 mol × 22.4 L/mol = **5.26 L**

2b.)
Volume = 9.36 mol × 22.4 L/mol = **210 L**

2c.) **56000 L**

3a.)
Molar mass of CO_2 = 44.01 g/mol
Mass = 0.125 mol × 44.01 g/mol = **5.50 g**

3b.)
Molar mass of $FeCl_3$ = 162.2 g/mol
Mass = 5.48 mol × 162.2 g/mol = **889 g**

3c.) **0.0177 g**

3d.)
Molar mass of $Ni(OH)_2$ = 92.71 g/mol
Mass = 15.4 mol × 92.71 g/mol = **1,430 g**

4a.)
$Na_2B_4O_7 \cdot 10H_2O$ = 2(22.99) + 4(10.81) + 7(16.00) + 10[2(1.01) + 16.00] = **381.4 g/mol**

4b.)
$3.1 * 10^{28}$ g

4c.) 212 g

4d.)
5.5 x 10^{-7}

4e.) 344.5g/ mol

4f.)8.07 *10^{23}

5.)
Mass = 1.18×10^{-22} g
Compare with molar masses:
SO_3 = 80.06 g/mol ⇒ per molecule = $80.06 \div 6.022\times10^{23} = 1.33\times10^{-22}$ g
CH_4 = $16.05 \div 6.022\times10^{23} = 2.67\times10^{-23}$ g
NF_3 = $71.00 \div 6.022\times10^{23} = 1.18\times10^{-22}$ g
C_2H_2 = $26.04 \div 6.022\times10^{23} = 4.32\times10^{-23}$ g
Answer: NF_3 (closest match)

6a.)
2 mol of chickens × 6.022×10^{23} chickens/mol × 2 drumsticks/chicken = **2.41×10^{24} drumsticks**

6b.)
Each chicken has 2 drumsticks, 2 wings, and 2 thighs = 6 pieces total
2 mol × 6.022×10^{23} × 6 = **7.23×10^{24} total pieces**

Percent Composition

1.) Calculate the percentage composition of the following.

a.) C_2H_6 $= 30.08 \frac{g}{mol}$

Answer - $C = 24.02\ g$ $H = 2.02\ g$

$C\ \frac{24.02\ g}{30.08\ g} \times 100 = 79.85\ \%$

$H\ \frac{6.06\ g}{30.08\ g} \times 100 = 20.1\ \%$

b.) $FeCl_2$ $= 126.76 \frac{g}{mol}$

Answer - $Fe = 55.85\ g$ $Cl = 70.90\ g$

$Fe\ \frac{55.85\ g}{126.76\ g} \times 100 = 44.06\ \%$

$H\ \frac{70.90\ g}{126.76\ g} \times 100 = 55.93\ \%$

c.) $FeCl_3$ $= 162.21 \frac{g}{mol}$

Answer - $Fe = 55.85\ g$ $Cl = 106.35\ g$

$Fe\ \frac{55.85\ g}{162.21\ g} \times 100 = 34.43\ \%$

$H\ \frac{106.35\ g}{162.21\ g} \times 100 = 65.56\ \%$

d.) $C_2H_4O_2$ $= 60.06 \frac{g}{mol}$

Answer - $C = 24.02\ g$ $H = 4.04\ g$ $O = 32.00\ g$

$C\ \frac{24.02\ g}{60.06\ g} \times 100 = 39.99\ \%$ $H\ \frac{4.04\ g}{60.06\ g} \times 100 = 6.73\ \%$

$O\ \frac{32.00\ g}{60.06\ g} \times 100 = 53.28\ \%$

e.) $CaCO_3$ $= 100.09 \frac{g}{mol}$

Answer - $C = 24.02\ g$ $Ca = 40.08\ g$ $O = 48.00\ g$

$C\ \frac{12.01\ g}{100.09\ g} \times 100 = 12.00\ \%$ $Ca\ \frac{40.00\ g}{100.09\ g} \times 100 = 40.04\ \%$

$O\ \frac{48.00\ g}{100.09\ g} \times 100 = 47.96\ \%$

f.) $NaOH$ $= 40.00 \frac{g}{mol}$

Answer - $Na = 22.99\ g$ $H = 1.01\ g$ $O = 16.00\ g$

$Na\ \frac{22.99\ g}{40.00\ g} \times 100 = 57.48\ \%$ $H\ \frac{1.01\ g}{40.00\ g} \times 100 = 2.53\ \%$

$O\ \frac{16.00\ g}{40.00\ g} \times 100 = 40.00\ \%$

g.) $CaCl_2 \cdot 2H_2O$ $= 147.02 \frac{g}{mol}$ $Ca = 40.08\ g$

Answer - $Cl = 70.90\ g$ $H = 4.04\ g$ $O = 32.00\ g$

$Ca\ \frac{40.08\ g}{147.02\ g} \times 100 = 27.26\ \%$ $Cl\ \frac{70.89\ g}{147.02\ g} \times 100 = 47.67\ \%$

$H\ \frac{4.04\ g}{147.02\ g} \times 100 = 2.75\ \%$ $O\ \frac{32.00\ g}{147.02\ g} \times 100 = 21.77\ \%$

h.) $(NH_4)_3PO_4$ $= 149.12 \frac{g}{mol}$ $N = 42.03\ g$

Answer - $P = 30.97\ g$ $H = 12.12\ g$ $O = 64.00\ g$

$N\ \frac{42.03\ g}{149.12\ g} \times 100 = 28.19\ \%$ $P\ \frac{30.97\ g}{149.12\ g} \times 100 = 20.77\ \%$

$H\ \frac{12.12\ g}{149.12\ g} \times 100 = 8.13\ \%$ $O\ \frac{64.00\ g}{149.12\ g} \times 100 = 42.92\ \%$

i.) $Ag(NH_3)_2Cl$ $= 177.40 \frac{g}{mol}$ $Ag = 107.87\ g$

Answer - $Cl = 35.45\ g$ $H = 6.06\ g$ $N = 28.02\ g$

$Ag\ \frac{107.87\ g}{177.40\ g} \times 100 = 60.806\ \%$ $Cl\ \frac{35.45\ g}{177.40\ g} \times 100 = 19.98\ \%$

$H\ \frac{6.06\ g}{177.40\ g} \times 100 = 3.42\ \%$ $N\ \frac{28.02\ g}{177.40\ g} \times 100 = 15.79\ \%$

Empirical Formula

1.) Find the empirical formula for the following compounds.

a.) 15.9% B and 84.1% F

Answer - $15.9\ g\ B \times \frac{1\ mol\ B}{10.81\ g\ B} = 1.47\ mol\ B$ $84.1\ g\ F \times \frac{1\ mol\ F}{19.00\ g\ F} = 4.43\ mol\ F$

$\frac{1.47\ B}{1.47} = 1\ B$ $\frac{4.43\ F}{1.47} = 3.01\ F$ BF_3

b.) 87.5% Si and 12.5% H

Answer - $87.5\ g\ Si \times \frac{1\ mol\ Si}{28.09\ g\ Si} = 3.11\ mol\ Si$ $12.5\ g\ H \times \frac{1\ mol\ H}{1.01\ g\ H} = 12.38\ mol\ H$

$\frac{3.11\ Si}{3.11} = 1\ Si$ $\frac{12.38\ H}{3.11} = 3.98\ H$ SiH_4

c.) 43.7% P and 56.5% O

Answer - $43.7\ g\ P \times \frac{1\ mol\ P}{30.97\ g\ P} = 1.41\ mol\ P$ $56.5\ g\ O \times \frac{1\ mol\ O}{16.00\ g\ O} = 3.53\ mol\ O$

$\frac{1.41\ P}{1.41} = 1 \times 2 = P$ $\frac{3.53\ O}{1.41} = 2.5 \times 2 = 5\ O$ P_2O_5

d.) 77.9% I and 22.1% O

Answer - $77.9\ g\ I \times \frac{1\ mol\ I}{126.91\ g\ I} = 0.614\ mol\ I$ $22.1\ g\ O \times \frac{1\ mol\ O}{16.00\ g\ O} = 1.38\ mol\ O$

$\frac{0.614\ I}{0.614} = 1 \times 4 = I$ $\frac{1.38\ O}{0.614} = 2.25 \times 4 = 8.99\ O$ I_4O_9

e.) 77.7% Fe and 22.3% O

Answer - $77.7\ g\ Fe \times \frac{1\ mol\ Fe}{55.85\ g\ Fe} = 1.39\ mol\ Fe$ $22.3\ g\ O \times \frac{1\ mol\ O}{16.00\ g\ O} = 1.39\ mol\ O$

$\frac{1.39\ O}{1.39} = 1\ Fe$ $\frac{1.39\ Fe}{1.39} = 1\ Fe$ FeO

f.) 70.0% Fe and 30.0% O

Answer - $70.0\ g\ Fe \times \frac{1\ mol\ Fe}{55.85\ g\ Fe} = 1.25\ mol\ Fe$ $30.0\ g\ O \times \frac{1\ mol\ O}{16.00\ g\ O} = 1.88\ mol\ O$

$\frac{1.25\ Fe}{1.25} = 1 \times 2 = 2\ Fe$ $\frac{1.88\ O}{1.25} = 1.5 \times 2 = 3\ O$ Fe_2O_3

Molecular Formula

1. C_3H_6
2. N_2O_4
3. $C_{10}H_{22}$
4. CO
5. Si_2F_6
6. B_2H_6
7. C_3H_6
8. O_3