Chemistry 20 - Science 10 Review - Stoichiometric Calculations; The Mole

Name: KEY

Ensure that you show all of your work, including the formulas used and substitution of numerical values. Record each answer with units and pay attention to the appropriate number of significant digits.

You may find the following formula useful: m = Mn

1. Write the chemical formula and then calculate the molar mass of each of the following elements and compounds.

a. Elemental phosphorus

$P_{4(s)}$

$M_{P_4} = 4 \times M_P = 4 \times 30.97 = \boxed{123.88\ g/mol}$

b. Elemental sulfur.

$S_{8(s)}$

$M_{S_8} = 8 \times M_S = 8 \times 32.07 = \boxed{256.56\ g/mol}$

c. Magnesium chloride.

$MgCl_{2(s)}$ $M_{MgCl_2} = M_{Mg} + 2M_{Cl} = 24.31 + 2 \times 35.45$

$= \boxed{95.21\ g/mol}$

d. Osmium nitride.

Os_3N_4 $M_{Os_3N_4} = 3M_{Os} + 4M_N = 3 \times 190.23 + 4 \times 14.01$

$= \boxed{626.73\ g/mol}$

e. Vanadium (V) hydrogen oxalate.

$V(HOOCCOO)_5$ $M_{Total} = M_V + 5M_{HOOCCOO} = 50.94 + 5 \times 89.07$

$= \boxed{496.29\ g/mol}$

$M_{HOOCCOO} = M_H + 4M_O + 2M_C = 1.01 + 4 \times 16.01 + 2 \times 12.01 = 89.07$

f. Zirconium permanganate

$Zr(MnO_4)_4$ $M_T = M_{Zr} + 4M_{MnO_4} = 91.22 + 4 \times 118.94$

$= \boxed{566.98\ g/mol}$

$M_{MnO_4} = M_{Mn} + 4M_{Oxy} = 54.94 + 4 \times 16.00 = 118.94\ g/mol$

g. Ammonium benzoate

$NH_4C_6H_5COO$ $M_T = M_N + 9M_H + 7M_C + 2M_{Oxy}$

$= 14.01 + 9 \times 1.01 + 7 \times 12.01 + 2 \times 16$

$= \boxed{139.17\ g/mol}$

h. Lanthanum iodate

$La(IO_3)_3$ $M_{Total} = M_{La} + 3M_I + 9M_{Oxy}$

$= 138.91 + 3 \times 126.90 + 9 \times 16$

$= \boxed{663.61\ g/mol}$

i. Actinium peroxide

$Ac_2(O_2)_3$ $M_{Total} = 2M_{Ac} + 6M_{Oxy}$

$= 2 \times 227 + 6 \times 16.00$

$= \boxed{550\ g/mol}$

j. Tungsten dichromate

$W(Cr_2O_7)_3$ $M_{Total} = M_W + 6M_{Cr} + 21M_{Oxy}$

$= 183.84 + 6 \times 52.00 + 21 \times 16.00$

$= \boxed{831.84\ g/mol}$

k. Praseodymium thiocyanate

$Pr(SCN)_3$ $M_{Total} = M_{Pr} + 3M_S + 3M_C + 3M_N$

$= 140.91 + 3 \times 32.07 + 3 \times 12.01 + 3 \times 14.01$

$= \boxed{315.18\ g/mol}$

l. Zinc sulfide.

ZnS $M_{Total} = M_{Zn} + M_S$

$= 65.41 + 32.07$

$= \boxed{97.48\ g/mol}$

m. Copper (I) perchlorate

$CuClO_4$ $M_{Total} = M_{Cu} + M_{Cl} + 4M_{Oxy}$

$= 63.55 + 35.45 + 4 \times 16.00$

$= \boxed{163.00\ g/mol}$

2. Calculate the number of moles of each of the following entities.

a. 3.6 grams of elemental phosphorus. $M_P = 123.88\ g/mol$

$n = \frac{m}{M} = \frac{3.6g}{123.88g/mol} = 0.029\ mol$ or $29\ mmol$ or $2.9\times10^{-2}\ mol$

b. 14.8 grams of elemental sulfur. $M_{S_8} = 256.56\ g/mol$

$n = \frac{m}{M} = \frac{14.8g}{256.56g/mol} = 0.0577\ mol$ or $57.7\ mmol$ or $5.77\times10^{-2}\ mol$

c. 32.6 grams of magnesium chloride. $M_{MgCl_2} = 95.21\ g/mol$

$n = \frac{m}{M} = \frac{32.6g}{95.21g/mol} = 0.342\ mol$ or $3.42\times10^{-1}\ mol$ or $342\ mmol$

d. 3.1 grams of osmium nitride. $M = 626.73\ g/mol$

$n = \frac{m}{M} = \frac{3.1g}{626.73g/mol} = 0.0049\ mol$ $4.9\ mmol$ $4.9\times10^{-3}\ mol$

e. 2.12 grams of vanadium (V) hydrogen oxalate. $M = 496.29\ g/mol$

$n = \frac{m}{M} = \frac{2.12g}{496.29g/mol} = 0.00427\ mol$ $4.27\ mmol$ $4.27\times10^{-3}\ mol$

f. 7.89 grams of ~~zirconium~~ permanganate. $M = 566.98\ g/mol$

$n = \frac{m}{M} = \frac{7.89g}{566.98g/mol} = 0.0139\ mol$ $13.9\ mmol$ $1.39\times10^{-2}\ mol$

3. Calculate the mass of each of the following entities.

a. 3.2 moles of elemental phosphorus.

$m = M_n = 123.88\ g/mol \times 3.2\ mol = 396.416g = 4.0\times10^{2}g$ $0.40kg$

b. 0.18 moles of elemental sulfur.

$m = M_n = 256.56 \times 0.18 = 46g$

c. 2.34 moles of magnesium chloride.

$m = M_n = 95.21 \times 2.34 = 223g$

d. 4.5 moles of osmium nitride.

$m = M_n = 626.73 \times 4.5 = 2820g = 2.8kg$ or $2.8\times10^{3}g$

e. 5.0 moles of vanadium (V) hydrogen oxalate.

$m = M_n = 496.29 \times 5.0 = 2481g = 2.5kg$ or $2.5\times10^{3}g$

f. 0.011 moles of zirconium permanganate.

$m = M_n = 566.98 \times 0.011 = 6.2g$

g. 1.34 moles of ammonium benzoate. $M = 139.17\ g/mol$

$m = 139.17 \times 1.34 = 186g$

h. 0.0023 moles of lanthanum iodate. $M = 663.61\ g/mol$

$m = 663.61 \times 0.0023 = 1.5g$

$M = \frac{m}{n} = \frac{0.080g}{0.0025mol}$

elemental oxygen (O_2) $M = 32\ g/mol$

Challenge Problem:

A sample of an unknown element has a mass of 0.080 grams. A particle counter reveals that this sample contains 1.5055×10^{21} particles. What is the identity of the unknown element?

$m = 0.080g$ $n = (1.5055\times10^{21}) \div (6.022\times10^{23}\ particles/mol) = 0.0025mol$