01 A compound of potassium has the formula $K_2Cr_2O_7$.

(a) How many elements are there in this compound ?

(b) How many atoms are there in this compound ?

(c) Give the formula of each of the ions in this compound.

(a) Three elements

(b) 2 potassium atoms

2 chromium atoms

7 oxygen atoms

Total: 11 atoms

(c) In a compound, potassium always exists as an ion K^+.

Two K^+ ions produce a total charge of +2.

The negative ion must carry a charge of –2, i.e. $Cr_2O_7^{2-}$.

The ions are the potassium ion, K^+ and the dichromate (VI) ion, $Cr_2O_7^{2-}$.

02 The relative atomic mass of beryllium is 9 and the relative atomic mass of titanium is 48.

(a) How many times is an atom of beryllium heavier than an atom of carbon - 12 ?

(b) How many times is an atom of titanium heavier than an atom of carbon -12 ?

(c) How many times is an atom of titanium heavier than an atom of beryllium ?

(a) $$\frac{\text{Mass of 1 atom of beryllium}}{\text{Mass of 1 atom of carbon - 12}} = \frac{9}{12} = 0.75$$

(b) $$\frac{\text{Mass of 1 atom of titanium}}{\text{Mass of 1 atom of carbon - 12}} = \frac{48}{12} = 4$$

(c) $$\frac{\text{Mass of 1 atom of titanium}}{\text{Mass of 1 atom of beryllium}} = \frac{48}{9} = 5.33$$

03 Calculate the number of moles of each element present in 1.00 g of each of the following substances:

(a) $Na_3Al F_6$

(b) $CuSO_4 5H_2O$

(a) Relative formula mass of $Na_3Al F_6$

$= 3(23.0) + 27.0 + 6(19.0)$

$= 210.0$

Molar mass of $Na_3Al F_6 = 210.0$ g mol^{-1}

Number of moles of $Na_3Al F_6$ = (mass)/(molar mass)

$= 1.00/210.0$

$= 4.8 \times 10^{-3}$ mol

1 mole of $Na_3Al F_6$ contains 3 moles of Na atoms, 1 mole of Al atoms and 6 moles of F atoms.

Number of moles of Na atoms $= 3(4.8 \times 10^{-3})$

$= 0.014$ mol

Number of moles of Al atoms $= 4.8 \times 10^{-3}$ mol

Number of moles of F atoms $= 6(4.8 \times 10^{-3})$

$= 0.029$ mol

(b) Relative formula mass of $CuSO_4.5H_2O$

= 63.5 + 32.1 + 9(16.0) +10(1.0)

= 249.6

Molar mass of $CuSO_4.5H_2O$ = 249.6 g mol^{-1}

Number of moles of $CuSO_4.5H_2O$ = (mass)/(molar mass)

= 1.00/249.6

= 4.0×10^{-3} mol

1 mole of $CuSO_4.5H_2O$ contains 1 mole of Cu atoms,

1 mole of S atoms, 9 moles of O atoms and 10 moles of H atoms.

Number of moles of Cu atoms = 4.0×10^{-3} mol

Number of moles of S atoms = 4.0×10^{-3} mol

Number of moles of O atoms = $9(4.0 \times 10^{-3})$

= 0.036 mol

Number of moles of H atoms = $10(4.0 \times 10^{-3})$

= 0.040 mol

04 Determine the mass (in grams) of the following:

(a) One molecule of water

(b) 10 moles of $Fe(NO_3)_3$

(a) Relative molecular mass of $H_2O = 2(1.0) + 16.0 = 18.0$

Molar mass of H_2O = 18.0 g mol^{-1}

Number of moles of H_2O molecules

$$= \frac{\text{no. of molecules}}{6.0 \times 10^{23}}$$

$$= \frac{1}{6.0 \times 10^{23}} \text{ mol}$$

Mass of 1 molecule of H_2O = (mole) × (molar mass)

$$= \frac{1}{6.0 \times 10^{23}} \text{mol} \times 18.0 \text{ g mol}^{-1}$$

$$= 3.0 \times 10^{-23} \text{ g}$$

(b) Relative formula mass of $Fe(NO_3)_3$

= 55.8 + 3(14.0) + 9(16.0)

= 241.8

Molar mass of $Fe(NO_3)_3$ = 241.8 g mol^{-1}

Mass of 10 moles of $Fe(NO_3)_3$ = (mole) × (molar mass)

= (10 mol) × (241.8 g mol^{-1})

= 2418 g

05 Calculate the percentage by mass of each element in sodium phosphate, Na_3PO_4.

(a) Percentage by mass of Sodium

(b) Percentage by mass of Phosphorous

(c) Percentage by mass of Oxygen

Relative molecular mass of

$Na_3PO_4 = 3(23.0) + 31.0 + 4(16.0) = 164$

Molar mass of $Na_3PO_4 = 164\ g\ mol^{-1}$

(a) % of Na:

Relative atomic mass of Na = 23.0

Molar mass of Na = $23.0\ g\ mol^{-1}$

1 mole of Na_3PO_4 contains 3 moles of Na.

Mass of 3 moles of Na atoms

= (mole) × (molar mass)

= $(3\ mol) \times (23.0\ g\ mol^{-1})$

= 69.0 g

Percentage of Na

= [(mass of Na)/(molar mass)] × 100

= [69.0/164)] × 100

= 42.1%

(b) % of P:

Relative atomic mass of P = 31.0

Molar mass of P = 31.0 g mol^{-1}

1 mole of Na_3PO_4 contains 1 mole of P.

Mass of 1 mole of P atoms = (mole) × (molar mass)

= (1 mol) × (31.0 g mol^{-1})

= 31.0 g

Percentage of P = [(mass of P)/(molar mass)] × 100

= [31.0/164] × 100

= 18.9%

(c) % of O:

Relative atomic mass of O = 16.0

Molar mass of O = 16.0 g mol^{-1}

1 mole of Na_3PO_4 contains 4 moles of O.

Mass of 4 moles of O atoms = (mole) × (molar mass)

= (4 mol) × (16.0 g mol^{-1})

= 64.0 g

Percentage of O = [(mass of O)/(molar mass)] × 100

= [64.0/164] × 100

= 39.0%