

- 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.

- How many times is an atom of beryllium heavier than an atom of carbon - 12 ?
- How many times is an atom of titanium heavier than an atom of carbon -12 ?
- How many times is an atom of titanium heavier than an atom of beryllium ?

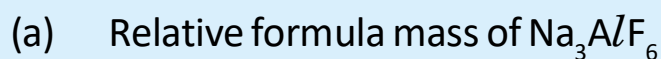
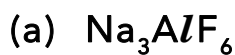
$$(a) \frac{\text{Mass of 1 atom of beryllium}}{\text{Mass of 1 atom of carbon - 12}} = \frac{9}{12} = 0.75$$

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

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

03

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



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

$$= 210.0$$

$$\text{Molar mass of } \text{Na}_3\text{AlF}_6 = 210.0 \text{ g mol}^{-1}$$

$$\text{Number of moles of } \text{Na}_3\text{AlF}_6 = (\text{mass})/(\text{molar mass})$$

$$= 1.00/210.0$$

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

1 mole of Na_3AlF_6 contains 3 moles of Na atoms, 1 mole of Al atoms and 6 moles of F atoms.

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

$$= 0.014 \text{ mol}$$

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

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

$$= 0.029 \text{ mol}$$

(b) Relative formula mass of $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$

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

$$= 249.6$$

$$\text{Molar mass of } \text{CuSO}_4 \cdot 5\text{H}_2\text{O} = 249.6 \text{ g mol}^{-1}$$

Number of moles of $\text{CuSO}_4 \cdot 5\text{H}_2\text{O} = (\text{mass})/(\text{molar mass})$

$$= 1.00/249.6$$

$$= 4.0 \times 10^{-3} \text{ mol}$$

1 mole of $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ contains 1 mole of Cu atoms, 1 mole of S atoms, 9 moles of O atoms and 10 moles of H atoms.

$$\text{Number of moles of Cu atoms} = 4.0 \times 10^{-3} \text{ mol}$$

$$\text{Number of moles of S atoms} = 4.0 \times 10^{-3} \text{ mol}$$

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

$$= 0.036 \text{ mol}$$

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

$$= 0.040 \text{ mol}$$

- 04** Determine the mass (in grams) of the following:
- (a) One molecule of water
(b) 10 moles of $\text{Fe}(\text{NO}_3)_3$

(a) Relative molecular mass of $\text{H}_2\text{O} = 2(1.0) + 16.0 = 18.0$

Molar mass of $\text{H}_2\text{O} = 18.0 \text{ g mol}^{-1}$

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 $\text{H}_2\text{O} = (\text{mole}) \times (\text{molar mass})$

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

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

(b) Relative formula mass of $\text{Fe}(\text{NO}_3)_3$

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

$$= 241.8$$

Molar mass of $\text{Fe}(\text{NO}_3)_3 = 241.8 \text{ g mol}^{-1}$

Mass of 10 moles of $\text{Fe}(\text{NO}_3)_3 = (\text{mole}) \times (\text{molar mass})$

$$= (10 \text{ mol}) \times (241.8 \text{ g mol}^{-1})$$

$$= 2418 \text{ g}$$

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

- Percentage by mass of Sodium
- Percentage by mass of Phosphorous
- Percentage by mass of Oxygen

Relative molecular mass of

$$\text{Na}_3\text{PO}_4 = 3(23.0) + 31.0 + 4(16.0) = 164$$

$$\text{Molar mass of } \text{Na}_3\text{PO}_4 = 164 \text{ g mol}^{-1}$$

(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

$$= (\text{mole}) \times (\text{molar mass})$$

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

$$= 69.0 \text{ g}$$

Percentage of Na

$$= \left[\frac{\text{mass of Na}}{\text{molar mass}} \right] \times 100$$

$$= \left[\frac{69.0}{164} \right] \times 100$$

$$= 42.1\%$$

(b) % of P:

Relative atomic mass of P = 31.0

Molar mass of P = 31.0 g mol⁻¹

1 mole of Na₃PO₄ 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 Na₃PO₄ 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%