Section B Short answer (15 marks)

Section B consists of five questions. Write your answers in the spaces provided. You are advised to spend 20 minutes on this section.

1 Determine the percentage composition of iron(II) sulfate. (3 marks)

2 Respiration can be represented by the following equation:

$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O + \text{energy}$$

a Calculate the molecular mass of glucose. (1 mark)

b How many moles of carbon dioxide are produced per mole of glucose? (1 mark)

c How many particles of water are produced per mole of oxygen? (1 mark)

3 Hydrogen sulfide gas reacts with oxygen gas to form sulfur dioxide gas and water according to the equation:

$$\_\_\_\_\_\ H_2S + \_\_\_\_\_\ O_2 \longrightarrow \_\_\_\_\_\ SO_2 + \_\_\_\_\_\ H_2O$$

a Balance the equation by writing the correct coefficients in the spaces above. (1 mark)

b Calculate the mass of sulfur dioxide produced from 1.0 kg of hydrogen sulfide. (2 marks)

4 An unknown substance has the following percentage composition by mass: 49.5% C, 5.2% H, 16.6% O, 28.8% N.

a Determine the empirical formula of this compound. (2 marks)

b If the molar mass of the compound is 194.19 g mol^{-1}, determine the molecular formula. (1 mark)

5 A piece of zinc metal of mass 0.73 g is added to 1.3 g of hydrochloric acid. The following reaction takes place.

$$Zn(s) + 2HCl(aq) \longrightarrow ZnCl_2(aq) + H_2(g)$$

a Calculate the moles of each reactant present before the reaction takes place. (1 mark)

b One reactant is in excess (there is too much of it). Identify which reactant is in excess and by how many moles. (1 mark)

c Calculate the mass of hydrogen gas produced in this reaction. (1 mark)

End of test (30 marks)

Section B Short answer (15 marks)

Section B consists of five questions. Write your answers in the spaces provided. You are advised to spend 20 minutes on this section.

1 Determine the percentage composition of iron(II) sulfate. (3 marks)

Answer: $FeSO_4$

Mass of Fe = 55.85

Mass of S = 32.07

Mass of O = 16.00 × 4

Formula mass = 55.85 + 32.07 + (16.00 × 4) = 151.92

$$\%Fe = \frac{55.85}{151.92} \times 100 = 36.8\%$$

$$\%S = \frac{32.07}{151.92} \times 100 = 21.1\%$$

$$\%O = \frac{64.00}{151.92} \times 100 = 42.1\%$$

2 Respiration can be represented by the following equation:

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + \text{energy}$$

a Calculate the molecular mass of glucose. (1 mark)

Answer: $C_6H_{12}O_6$

$= (6 \times 12.01) + 12(1.008) + 6(16.00)$

$= 180.16$

b How many moles of carbon dioxide are produced per mole of glucose? (1 mark)

Answer: 6

c How many particles of water are produced per mole of oxygen? (1 mark)

Answer: 1 mole of water per 1 mole of oxygen. This means there are 6.02×10^{23} molecules of water produced per mole of oxygen.

3 Hydrogen sulfide gas reacts with oxygen gas to form sulfur dioxide gas and water according to the equation:

$$\_\_\_\_\_H_2S + \_\_\_\_\_O_2 \rightarrow \_\_\_\_\_SO_2 + \_\_\_\_\_H_2O$$

a Balance the equation by writing the correct coefficients in the spaces above. (1 mark)

Answer: $\mathbf{2}H_2S + \mathbf{3}O_2 \rightarrow \mathbf{2}SO_2 + \mathbf{2}H_2O$

b Calculate the mass of sulfur dioxide produced from 1.0 kg of hydrogen sulfide. (2 marks)

Answer: 1 kg = 1000 g of H_2S

$$n = \frac{m}{M}$$

$$n\mathrm{H_2S} = n\mathrm{SO_2} = \frac{1000}{[(2 \times 1.008) + 32.07]}$$

$$n = 29.337...$$

$$m\mathrm{SO_2} = n \times M$$

$$= 29.337... \times 64.07$$

$$= 1879.62...$$

$$= 1.88 \text{ kg } \mathrm{SO_2}$$

4 An unknown substance has the following percentage composition by mass: 49.5% C, 5.2% H, 16.6% O, 28.8% N.

a Determine the empirical formula of this compound. (2 marks)

Answer: Mass (in 100 g): C = 49.5 g, H = 5.2 g, O = 16.6 g, N = 28.8 g

$$n\mathrm{C} = \frac{49.5}{12.01} = 4.12$$

$$n\mathrm{H} = \frac{5.2}{1.008} = 5.1587$$

$$n\mathrm{O} = \frac{16.6}{16.00} = 1.0375$$

$$n\mathrm{N} = \frac{28.8}{14.01} = 2.0557$$

$$\mathrm{C} = \frac{4.12}{1.0375} = 3.97 = 4$$

$$\mathrm{H} = \frac{5.1587}{1.0375} = 4.97 = 5$$

$$\mathrm{O} = \frac{1.0375}{1.0375} = 1$$

$$\mathrm{N} = \frac{2.0557}{1.0375} = 1.98 = 2$$

$C_4H_5ON_2$

b If the molar mass of the compound is 194.19 $gmol^{-1}$, determine the molecular formula. (1 mark)

Answer: (4 × 12) + (5 × 1) + (2 × 14) + (1 × 16.00) = 97

$$\frac{194.19}{97} = 2$$

$C_8H_{10}O_2N_4$

5 A piece of zinc metal of mass 0.73 g is added to 1.3 g of hydrochloric acid. The following reaction takes place.

$$Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$$

a Calculate the moles of each reactant present before the reaction takes place. (1 mark)

Answer: $n\text{Zn} = \dfrac{0.73}{65.39}$

$= 0.1116...$ mol

$n\text{HCl} = \dfrac{1.3}{(1.008 + 35.45)}$

$= 0.035\,66...$ mol

b One reactant is in excess (there is too much of it). Identify which reactant is in excess and by how many moles. (1 mark)

Answer: Zn:HCl = 1:2 Only need $\dfrac{0.03...}{2}$ mol of Zn. Zn is in excess by

$0.1116 - \left(\dfrac{0.03...}{2}\right) = 0.094$ mol

c Calculate the mass of hydrogen gas produced in this reaction. (1 mark)

Answer:

$m\text{H}_2 = \text{n} \times \text{M}$

$= \left(\dfrac{0.03566}{2}\right) \times (2 \times 1.008)$

$= 0.0359...$

$= 0.036$ g H_2 gas

End of test (30 marks)