**Atomic Structure - Homework 2**

**1.** (a) Complete the table below to show the relative masses and charges of a proton, a neutron and an electron.

|  |  |  |
| --- | --- | --- |
|  | Relative mass | Relative charge |
| Proton |  |  |
| Electron |  |  |
| Neutron |  |  |

(3)

(b) Describe the process by which particles are ionised in a mass spectrometer.

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(2)

(c) Give two reasons why particles must be ionised before being analysed in a mass spectrometer.

*Reason 1* .....................................................................................................................

*Reason 2* .....................................................................................................................

(2)

(d) A sample of boron contains 20% by mass of 10B and 80% by mass of 11B.  
Calculate the relative atomic mass of boron in this sample.

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(2)

(e) Compound **X** contains only boron and hydrogen. The percentage by mass of boron in **X** is 81.2%. In the mass spectrum of **X** the peak at the largest value of *m/z* occurs at 54.

(i) Use the percentage by mass data to calculate the empirical formula of **X**.

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(ii) Deduce the molecular formula of **X**.

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(4)

(Total 13 marks)

**2.** (a) The diagramin **Figure 1** shows the behaviour of the three fundamental particles when passed through an electric field.



**Figure 1**

(i) Identify the particles represented by **A**, **B**, and **C**.

**A** ....................................................... **B** ...........................................................

**C** .......................................................

(1)

(ii) Explain the shapes and directions of the paths traced by the fundamental particles as they pass through the electric field.

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(3)

(b) **Figure 2** is a simplified diagram of a mass spectrometer.



**Figure 2**

(i) State and explain the purpose of the part of the mass spectrometer labelled **P**.

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(2)

(ii) State the purpose of the *electric field,* ofthe *magnet* and of the part labelled **Q.**

*Electric field* .....................................................................................................

*Magnet* .............................................................................................................

*Part* **Q** ..............................................................................................................

(3)

(c) Explain what is meant by the term *molar gas volume.*

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(2)

(d) The equation below represents the thermal decomposition of KClO3.

2KClO3(s)  2KCl(s) + 3O2(g)

(i) Calculate the mass of oxygen which could be produced by the complete decomposition of 1.47 g of KClO3.

(2)

(ii) Calculate the mass of KClO3 required to produce 1.00 dm3 (at 20 °C and 101.3 kPa) of oxygen.

molar gas volume = 24000 cm3 mol–1 at 20 °C and 101.3 kPa

(3)

(Total 16 marks)

**3.** (a) Describe, in terms of charge and mass, the properties of protons, neutrons and electrons. Explain fully how these particles are arranged in an atom of 14N.

(6)

(b) Account for the existence of isotopes.

(2)

(c) Isotopes can be separated in a mass spectrometer. Show how this is possible by describing the various parts of a mass spectrometer and by discussing the principles of operation of each part.

(14)

(d) The mass spectrum of an element has peaks with relative intensity and *m*/*z* values shown in the table below.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *m/z* | 80 | 82 | 83 | 84 | 86 |
| Relative intensity | 1 | 5 | 5 | 25 | 8 |

Identify this element and calculate its accurate relative atomic mass

(4)

(e) The mass spectrum of a compound has a molecular ion peak at *m*/*z* = 168.   
Elemental analysis shows it to contain 42.9% carbon, 2.4% hydrogen and 16.7% nitrogen by mass. The remainder is oxygen.

Calculate the empirical and molecular formulae of this compound

(4)

(Total 30 marks)

**............. Out of 59 (Grade )**