

Atomic structure – A2 Chemistry P1 & P3

1. No.1

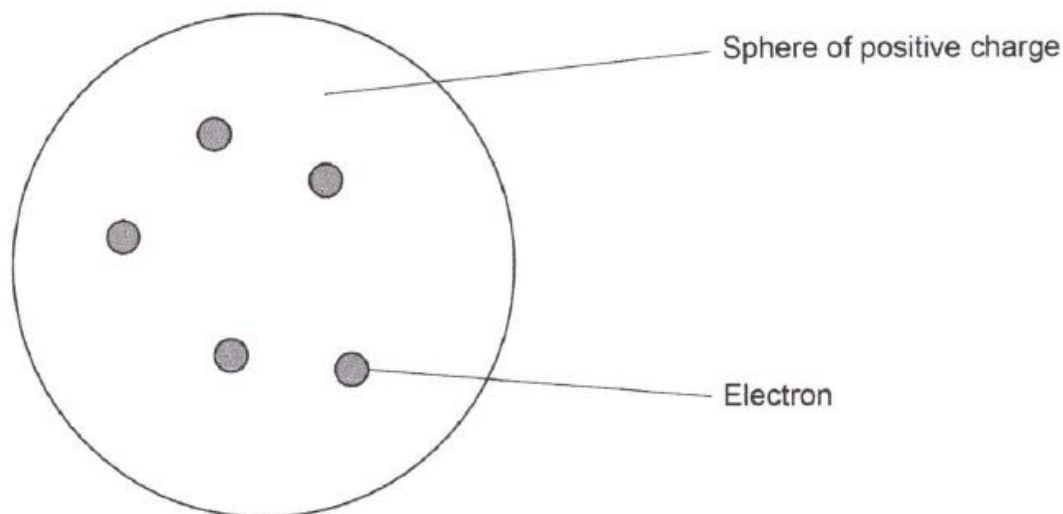
0 1

This question is about atomic structure.

0 1. 1

In 1897 JJ Thomson discovered the electron. He suggested that atoms were positively charged spheres with electrons embedded within them.

Figure 1 represents an atom using Thomson's model.

Figure 1

Suggest the identity of this atom.

Give **two** differences between the modern model of an atom and the Thomson model of an atom.

[3 marks]

Identity Boron.

Difference 1 In modern model, protons are at the centre of the atom while in Thomson they are spread evenly in the atom.

Difference 2 In modern model electron are in shells while in Thomson model there are no energy shells.

0 1 . 2

Tellurium has a relative atomic mass of 127.6
Iodine has a relative atomic mass of 126.9

Define relative atomic mass.

Suggest **one** property of tellurium that justifies its position before iodine in the modern Periodic Table.

[3 marks]

Definition The average mass of one atom of an element compared with 1/12 mass of an atom of carbon 12.

Justification Tellurium has atomic number $Z = 52$ Iodine has atomic number $Z = 53$. Elements are ordered by increasing proton number so tellurium comes before iodine.

0 1 . 3

A sample of tellurium is analysed in a time of flight (TOF) mass spectrometer using electron impact ionisation.

Give an equation, including state symbols, for this ionisation.

[1 mark]



0 1 . 4

In the TOF mass spectrometer an ion of an isotope of tellurium, with mass number y , travels along a 1.25 m flight tube with a kinetic energy of 1.88×10^{-12} J

The ion takes 3.00×10^{-7} s to reach the detector.

$$KE = \frac{1}{2} mv^2$$

KE = kinetic energy / J

m = mass / kg

v = speed / m s^{-1}

Calculate the mass, in g, of 1 mole of these tellurium ions.

Use your answer to suggest the mass number y of the tellurium isotope.

The Avogadro constant, $L = 6.022 \times 10^{23} \text{ mol}^{-1}$

[5 marks]

Flight tube length $d = 1.25 \text{ m}$ time $t = 3.00 \times 10^{-7}$ K.E. = 1.88×10^{-12} J.

$$\text{Speed } v = \frac{d}{t} = \frac{1.25}{3.00 \times 10^{-7}} = 4.166666667 \times 10^6 \text{ m s}^{-1} \\ \approx 4.17 \times 10^6 \text{ m/s.}$$

$$\text{Mass:} \\ m = \frac{2KE}{v^2} = \frac{2 \times 1.88 \times 10^{-12}}{(4.17 \times 10^6)^2} = 2.1657599999 \times 10^{-25} \text{ kg.}$$

$$\frac{\text{Mass of 1 mole in ions}}{\text{Mass per mole (g)}} = m \times N_A \times 1000.$$

$$= 2.1657599999 \times 10^{-25} \times 6.022 \times 10^{23} \times 1000.$$

$$= 130.4220672 \text{ g} \approx 130.4 \text{ g.}$$

Mass of 1 mole is 130.4 g.

The isotope mass to the nearest integer is 130.

Mass 130.4 g

Mass number y 130.

0 1 . 5

Tellurium has several other isotopes.
Two of these isotopes are ^{126}Te and ^{124}Te
A different sample of tellurium is analysed using a TOF mass spectrometer.

Which statement about kinetic energy (KE) is correct?

[1 mark]

Tick (✓) **one** box.

The KE of $^{126}\text{Te}^+$ is greater than the KE of $^{124}\text{Te}^+$

☐

The KE of $^{126}\text{Te}^+$ is the same as the KE of $^{124}\text{Te}^+$

☒

The KE of $^{126}\text{Te}^+$ is less than the KE of $^{124}\text{Te}^+$

☐

2. No.6

Which row contains two species with different numbers of electrons?

[1 mark]

A NH_3 and HF

☐

$\text{N } 7 + 3\text{H } 3 = 10$ $\text{H } 1 + \text{F } 9 = 10$

B CO_3^{2-} and NO_3^-

☐

$\text{C } 6 + 3 \times 8 + 2 = 32$ $7 + 24 + 1 = 32$

C H_3O^+ and HF_2^+

☒

$3 \times 1 + 8 + 1 = 12$ $(1 + 2 \times 9 - 1) = 18$

D CH_4 and NH_2^-

☐

$6 + 4 = 10$ $7 + 2 + 1 = 10$