CHEMISTRY

Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Answer **all** questions provided on the Question Paper.
The use of an approved scientific calculator is expected, where appropriate.

The number of marks is given in brackets [ ] at the end of each question, or part question.

This document consists a total of **6** printed pages.

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1 Magnesium is essential in our bodies. For example, magnesium is needed to regulate our muscle movements.

(a) Magnesium exists as the Mg^{2+} ion most of the times in our body.

(i) Write down the number of electrons, protons and full electronic configuration of the Mg^{2+} ion. [1]

(ii) State how the mass of a Mg^{2+} ion is distributed. [1]

(iii) The Mg^{2+} ion exists as predominantly 2 isotopes. In 1 human body, it is found that 73.4% of the Mg^{2+} ions exist as $^{24}Mg^{2+}$, while the rest exists as $^{25}Mg^{2+}$. Calculate the relative mass of Mg^{2+} ions in the body, to 2 decimal places. [1]

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(b) Magnesium is located in Period 3 of the Periodic Table.

The *first ionisation energies* of each element in Period 3 follow a certain trend.

(i) Explain what is meant by *first ionisation energy*. Include an equation in your answer. [2]

(ii) Draw a graph of the first ionisation energy against consecutive elements in Period 3 only. Numerical values are **not** needed.

Include an explanation, **below** your graph, for:

- The general trend of the first ionisation energy of elements across Period 3
- Any anomalies

Your graph should also illustrate these trends. [6]

(iii) Another element in Period 3 has the following ionisation energies.

I.E. represents ionisation energy.

I.E.	1st	2nd	3rd	4th	5th	6th	7th	8th
log (I.E.)	6.28	7.03	7.39	7.67	8.06	8.23	9.29	9.43

Deduce the identity of this element. [2]

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[Total: 13]

2 Mercury lamps used to light our streets. Some mercury was vapourised in a lamp. A filament then discharged electrons of enough energy to knock out electrons in lower energy level orbitals in mercury. Electrons from higher energy orbitals will then lose energy, filling up the vacant lower energy orbitals. In this process, a photon carrying an energy that is exactly the difference between the higher and lower energy level orbitals is emitted. A photon is what makes us able to see light of different colours.

(a) In this process, mercury may be ionised too. Mercury is in Group 12.

(i) State whether zinc has a lower or higher first ionisation energy than cadmium, both of which are Group 12 metals, explaining your answer. [2]

(ii) Compare the first ionisation energies of platinum, gold and mercury, explaining your answer. [2]

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(b) Mercury is in Period 6 of the Periodic Table.

Sketch, on **separate** axes, **all** the orbitals in the 5d subshell. [2]

(c) A mercury lamp typically emits green light. When analysed further, 3 main wavelengths of visible light, 404.7 nm, 435.8 nm, 546.1 nm were found.

The relationship between the energy of a photon, E, expressed in eV (electron volts), and the wavelength, λ, expressed in nm, is given below.

$$E = \frac{1240}{\lambda}$$

No other wavelengths of light (within the visible spectrum), was found to be emitted.

(i) Suggest why the observation of only discrete wavelengths of light being emitted proves that the energy levels of an orbital and subshell are discrete. [1]

(ii) A mercury lamp has a power of 40 J s^{-1}. Assuming that only photons of 404.7 nm, 435.8 nm, 546.1 nm were emitted, and rate of emission of photons of all wavelengths are the same, calculate the number of photons emitted by the lamp in 1 second. [3]

[1 eV = 1.60×10^{-19} J]

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[Total: 10]