

Q1. Ionisation energies provide evidence for the arrangement of electrons in atoms.

(a) Complete the electron configuration of the Mg^+ ion.

$1s^2$ (1)

(b) (i) State the meaning of the term *first ionisation energy*.

.....
.....
..... (2)

(ii) Write an equation, including state symbols, to show the reaction that occurs when the **second** ionisation energy of magnesium is measured.

..... (1)

(iii) Explain why the second ionisation energy of magnesium is greater than the first ionisation energy of magnesium.

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.....
..... (1)

(iv) Use your understanding of electron arrangement to complete the table by suggesting a value for the third ionisation energy of magnesium.

	First	Second	Third	Fourth	Fifth
Ionisation energies of magnesium / kJ mol^{-1}	736	1450		10 500	13 629

(1)

- (c) State and explain the general trend in the first ionisation energies of the Period 3 elements sodium to chlorine.

Trend

Explanation

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(3)

- (d) State how the element sulfur deviates from the general trend in first ionisation energies across Period 3. Explain your answer.

How sulfur deviates from the trend

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Explanation

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(3)

- (e) A general trend exists in the first ionisation energies of the Period 2 elements lithium to fluorine. Identify **one** element which deviates from this general trend.

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(1)

(Total 13 marks)

- Q2.** (a) State the meaning of the term *first ionisation energy* of an atom.

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(2)

(b) Complete the electron arrangement for the Mg^{2+} ion.

$1s^2$

(1)

(c) Identify the block in the Periodic Table to which magnesium belongs.

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(1)

(d) Write an equation to illustrate the process occurring when the **second** ionisation energy of magnesium is measured.

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(1)

(e) The Ne atom and the Mg^{2+} ion have the same number of electrons. Give **two** reasons why the first ionisation energy of neon is lower than the third ionisation energy of magnesium.

Reason 1

Reason 2

(2)

(f) There is a general trend in the first ionisation energies of the Period 3 elements, Na – Ar

(i) State and explain this general trend.

Trend

Explanation

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- (ii) Explain why the first ionisation energy of sulphur is lower than would be predicted from the general trend.

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(5)
(Total 12 marks)

Q3. Which one of the following statements is **not** correct?

- A** The first ionisation energy of iron is greater than its second ionisation energy.
- B** The magnitude of the lattice enthalpy of magnesium oxide is greater than that of barium oxide.
- C** The oxidation state of iron in $[\text{Fe}(\text{CN})_6]^{3-}$ is greater than the oxidation state of copper in $[\text{CuCl}_2]^-$
- D** The boiling point of C_3H_8 is lower than that of $\text{CH}_3\text{CH}_2\text{OH}$

(Total 1 mark)

Q4. (a) When aluminium is added to an aqueous solution of copper(II) chloride, CuCl_2 , copper metal and aluminium chloride, AlCl_3 , are formed. Write an equation to represent this reaction.

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(1)

- (b) (i) State the general trend in the first ionisation energy of the Period 3 elements from Na to Ar.

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- (ii) State how, and explain why, the first ionisation energy of aluminium does not follow this general trend.

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(4)

- (c) Give the equation, including state symbols, for the process which represents the second ionisation energy of aluminium.

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(1)

- (d) State and explain the trend in the melting points of the Period 3 metals Na, Mg and Al.

Trend

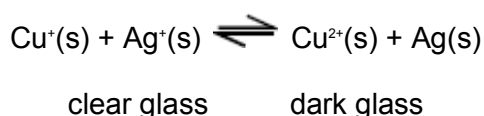
Explanation

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(3)

(Total 9 marks)

Q5. Photochromic glass contains silver ions and copper ions. A simplified version of a redox equilibrium is shown below. In bright sunlight the high energy u.v. light causes silver atoms to form and the glass darkens. When the intensity of the light is reduced the reaction is reversed and the glass lightens.



Which one of the following is a correct electron arrangement?

- A Cu⁺ is [Ar]3d⁹4s¹
- B Cu is [Ar]3d¹⁰4s²
- C Cu²⁺ is [Ar]3d⁸4s¹
- D Cu⁺ is [Ar]3d¹⁰

(Total 1 mark)

Q6. (a) Complete the electronic configuration for the sodium ion, Na⁺

1s² (1)

(b) (i) Write an equation, including state symbols, to represent the process for which the energy change is the second ionisation energy of sodium.

..... (2)

(ii) Explain why the second ionisation energy of sodium is greater than the second ionisation energy of magnesium.

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 (3)

(iii) An element X in Period 3 of the Periodic Table has the following successive ionisation energies.

	First	Second	Third	Fourth
Ionisation energies / kJ mol ⁻¹	577	1820	2740	11600

Deduce the identity of element X.

..... (1)

- (c) State and explain the trend in atomic radius of the Period 3 elements from sodium to chlorine.

Trend

Explanation

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(3)

- (d) Explain why sodium has a lower melting point than magnesium.

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(3)

- (e) Sodium reacts with ammonia to form the compound NaNH_2 which contains the NH_2^- ion. Draw the shape of the NH_2^- ion, including any lone pairs of electrons. Name the shape made by the three atoms in the NH_2^- ion.

Shape of NH_2^-

Name of shape

(2)

- (f) In terms of its electronic configuration, give **one** reason why neon does not form compounds with sodium.

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(1)

(Total 16 marks)