

Q1. Iodine and graphite are both solids. When iodine is heated gently a purple vapour is seen. Graphite will not melt until the temperature reaches 4000 K. Graphite conducts electricity but iodine is a very poor conductor of electricity.

(a) State the type of crystal structure for each of iodine and graphite.

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(2)

(b) Describe the structure of and bonding in graphite and explain why the melting point of graphite is very high.

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(4)

(c) Explain why iodine vaporises when heated gently.

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(2)

(d) State why iodine is a very poor conductor of electricity.

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(1)
(Total 9 marks)

Q2. The table below shows the boiling points of some hydrogen compounds formed by Group 6 elements.

| | H ₂ O | H ₂ S | H ₂ Se | H ₂ Te |
|-------------------|------------------|------------------|-------------------|-------------------|
| Boiling point / K | 373 | 212 | 232 | 271 |
| | | | | |

(a) State the strongest type of intermolecular force in water and in hydrogen sulfide (H₂S).

Water

Hydrogen sulfide

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(2)

(b) Draw a diagram to show how two molecules of water are attracted to each other by the type of intermolecular force you stated in part (a). Include partial charges and all lone pairs of electrons in your diagram.

(3)

(c) Explain why the boiling point of water is much higher than the boiling point of hydrogen sulfide.

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(1)

(d) Explain why the boiling points increase from H_2S to H_2Te

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(2)

(e) When H^+ ions react with H_2O molecules, H_3O^+ ions are formed.

Name the type of bond formed when H^+ ions react with H_2O molecules.
Explain how this type of bond is formed in the H_3O^+ ion.

Type of bond

Explanation

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(2)

(f) Sodium sulfide (Na_2S) has a melting point of 1223 K.
Predict the type of bonding in sodium sulfide and explain why its melting point is high.

Type of bonding

Explanation

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(3)

(Total 13 marks)

Q3. (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)