

9. Structures and properties

Structured questions

1. Lithium is a Group I element of the periodic table.

a) A piece of freshly cut lithium was placed in air.

i) Describe what you would observe at the surface of the metal after some time. Explain your answer. (2 marks)

---

ii) Draw an electron diagram of the product formed, showing electrons in the *outermost shells* only. (1 mark)

b) Lithium hydride, LiH, is an ionic compound containing the hydride ion, H<sup>-</sup>. The reaction between the hydride and aluminium chloride produces the ionic compound LiAlH<sub>4</sub>.

i) Draw an electron diagram of the hydride ion, H<sup>-</sup>. (1 mark)

ii) A bond in AlH<sub>4</sub><sup>-</sup> can be represented by H → Al. Name this type of bond and explain how it is formed. (2 marks)

---

---

c) Sodium is another Group I element.

i) In a certain experiment, a piece of sodium was added to a trough of water. State TWO observable changes for the reaction. (2 marks)

---

---

ii) Write a word equation for the reaction of sodium with water. (1 mark)

---

iii) Suggest whether sodium or lithium is more reactive. (1 mark)

---

iv) Draw ONE hazard warning label which should appear on the bottle containing sodium. (1 mark)

d) Describe how the melting point of Group I elements changes as the atomic number increases. (1 mark)

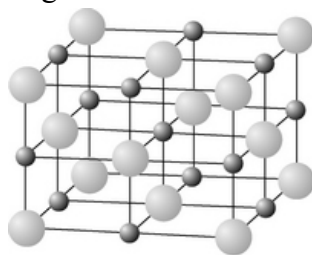
---

2. The melting points and boiling points of four substances at 1 atmospheric pressure are listed in the table below.

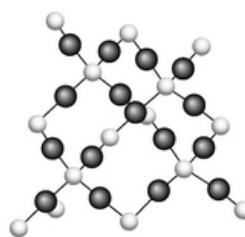
Substance	Melting point ( $^{\circ}\text{C}$ )	Boiling point ( $^{\circ}\text{C}$ )
Argon	-189	-186
Bromine	-7	59
Chlorine	-101	-35
Sulphur	119	445

- a) Which of the above substances exist as a liquid at  $-90^{\circ}\text{C}$  and 1 atmospheric pressure? (1 mark)
- 
- b) What type of attractive forces exists in all the four substances at  $25^{\circ}\text{C}$  and 1 atmospheric pressure? (1 mark)
- 
- c) The four substances are non-metals. Write FOUR typical properties, besides melting and boiling points, of non-metals. (4 marks)
- 
- 
- 
- 
- d) i) Suggest why argon seldom forms compounds. (1 marks)
- 
- ii) State, with explanation, what will happen if a balloon filled with argon is released from the top of a building. (2 marks)
- 
- 
- e) Bromine and chlorine belong to the same group in the periodic table.
- i) Name the group to which they belong. (1 mark)
- 
- ii) Compare the atomic size of bromine and chlorine. Explain whether bromine or chlorine has a larger atomic size. (2 marks)
- 
- 
- f) Chlorine reacts with phosphorus to form phosphorus trichloride.
- i) Draw an electron diagram of phosphorus trichloride, showing electrons in the *outermost shells* only. (1 mark)
- 
- ii) Phosphorus trichloride has a melting point of  $-92^{\circ}\text{C}$  and a boiling point of  $76^{\circ}\text{C}$ .
- (I) Is it a solid, a liquid or a gas at  $25^{\circ}\text{C}$ ? (1 mark)
- 
- (II) Explain why phosphorus trichloride has a low melting point and boiling point. (1 mark)
-

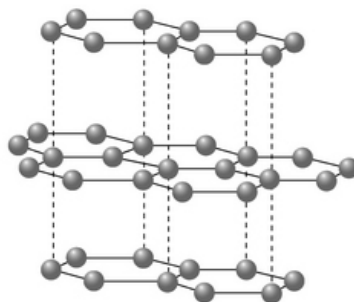
3. The diagrams below show the structures of three solids.



potassium bromide



silicon dioxide



graphite

a) Name the type of bonding between particles in

i) potassium bromide; (1 mark)

ii) silicon dioxide. (1 mark)

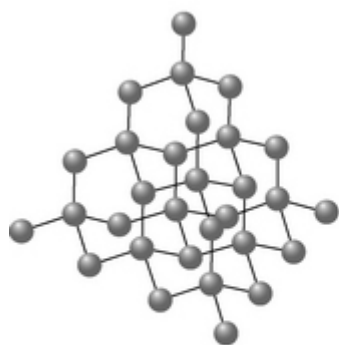
b) Draw an electron diagram of potassium bromide, showing electrons in the *outermost shells* only. (1 mark)

c) Explain why silicon dioxide is a solid with a high melting point while carbon dioxide is a gas at room temperature. (2 marks)

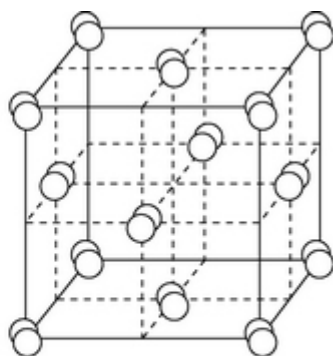
d) Graphite is quite soft and is used in pencils. Explain how its use in pencils depends on the structure of graphite. (2 marks)

e) You are provided with three unlabelled bottles each containing one of the white solids listed below: potassium bromide, silicon dioxide, sugar. Outline physical tests you would use to distinguish the three substances from one another. State also the expected observations. (4 marks)

4. The diagrams below show the structures of two solids, X and Y.



structure of X



structure of Y

( ○ and ● = atoms )

a) Name two substances which have the same structures as X and Y respectively. (2 marks)

b) Name the type of bonding and forces existing between particles in

i) X; and (1 mark)

ii) Y. (2 marks)

c) In terms of the forces between particles, explain why X has a high melting point. (2 marks)

d) i) Suggest ONE use of X. (1 mark)

ii) With reference to its structure, explain why X is suitable for the use suggested in (i). (2 marks)

e) X is an allotrope of a certain element.

i) Explain the meaning of the term 'allotrope'? (2 marks)

ii) Suggest ONE other allotrope of the element. (1 mark)

f) Predict and explain the solubility of Y in non-aqueous solvents. (3 marks)