

1 This question is about ions and compounds containing hydrogen.

(a) Lithium aluminium hydride, LiAlH_4 , contains the AlH_4^- ion.

Draw a 'dot-and-cross' diagram to show the bonding in an AlH_4^- ion.

Show outer electrons only.

[1]

(b) Nitrogen forms NH_4^+ and NH_2^- ions.

Predict the name of the shape of, and H–N–H bond angle in, NH_4^+ and NH_2^- .

Ion	Name of shape	H–N–H bond angle
NH_4^+		
NH_2^-		

[2]

- (c) Nitrogen, phosphorus and arsenic are in Group 15 (5) of the periodic table.

The boiling points of their hydrides are shown below.

Element	Hydride	Boiling point/°C
N	NH ₃	–33
P	PH ₃	–88
As	AsH ₃	–55

- (i) Explain why the boiling point of PH₃ is lower than the boiling point of NH₃.

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- (ii) Explain why the boiling point of PH₃ is lower than the boiling point of AsH₃.

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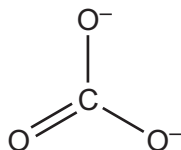
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..... [2]

2(a) Sodium carbonate, Na_2CO_3 , is a base used in washing soda.

Na_2CO_3 contains the carbonate ion, CO_3^{2-} , shown below.



Draw the '*dot-and-cross*' diagram for the carbonate ion.

Show outer electrons only and use different symbols for electrons from C and O, and any 'extra' electrons.

[2]

- 3** Which set of elements in the solid state contain a simple molecular lattice, a giant covalent lattice and a giant metallic lattice?
- A** S, Si, Al
- B** P, Si, C
- C** S, P, Si
- D** Mg, P, S

Your answer

[1]

4(a)

Draw a 'dot-and-cross' diagram for MgBr_2 .

Show outer electron shells only.

[2]

4(b)* **Table 16.1** shows some physical properties of magnesium, bromine and magnesium bromide.

Substance	Melting point/°C	Electrical conductivity	
		Solid	Liquid
Magnesium	711	Good	Good
Bromine	−7	Poor	Poor
Magnesium bromide	650	Poor	Good

Table 16.1

Explain the physical properties shown in **Table 16.1** using your knowledge of structure and bonding. **[6]**

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Additional answer space if required

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- 5 Which statement describes electronegativity?
- A** A measure of the reactivity of an element.
 - B** The ability of an atom to attract an electron to become a 1– ion.
 - C** The attraction of a bonded atom for the electrons in a covalent bond.
 - D** The attraction of an atom for a lone pair of electrons.

Your answer

[1]

6 Which statement(s) about a molecule of Cl-N=O is/are correct?

1: It is a polar molecule.

2: It contains 6 lone pairs of electrons.

3: It has a bond angle of 180° .

A 1, 2 and 3

B Only 1 and 2

C Only 2 and 3

D Only 1

Your answer

☐

[1]

7(a) Magnesium has metallic bonding and is a good conductor of electricity.

Describe, with the aid of a labelled diagram, the metallic bonding in magnesium and explain why magnesium conducts electricity.

Include the correct charges on the particles in your diagram.

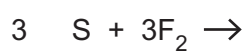
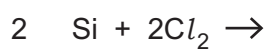
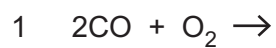
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..... **[3]**

- 8 The three reactions below each form one product only.

Which reaction(s) form(s) a product with non-polar molecules?



- A** 1, 2 and 3
B Only 1 and 2
C Only 2 and 3
D Only 1

Your answer

[1]

9 Which compound has polar molecules?

A HCN

B BCl_3

C CO_2

D C_2F_4

Your answer

[1]

10 Which substance(s) has/have induced dipole–dipole interactions (London forces) in the solid state?

1 C_2H_6

2 H_2O

3 Si

A 1, 2 and 3

B Only 1 and 2

C Only 2 and 3

D Only 1

Your answer

[1]

11 Water has the anomalous properties below.

- Water has relatively high melting and boiling points.
- Ice is less dense than water.

Which statement explains these anomalous properties?

- A** The covalent bonding within water molecules.
- B** The hydrogen bonding between water molecules.
- C** The induced dipole–dipole interactions (London forces) between water molecules.
- D** The ionic bonding between water molecules.

Your answer

[1]

12(a) SO_2 and SO_3 both have molecules with sulfur in the centre and bond angles of approximately 120° .

(i) Explain why the bond angles in SO_3 are 120° .

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(ii) Explain why both SO_2 and SO_3 have polar bonds, but only SO_2 has polar molecules.

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- 13 The table below shows the boiling points of some hydrogen halides.

Hydrogen halide	Boiling point/K
HCl	188
HBr	206
HI	238

What is the best explanation for the trend in boiling points from HCl to HI?

- A** The strength of the covalent bonds increases.
- B** The strength of the hydrogen bonds increases.
- C** The strength of the induced dipole–dipole interactions (London forces) increases.
- D** The strength of the permanent dipole–dipole interactions increases.

Your answer

[1]

14(a)* The hydrides of silicon, phosphorus and sulfur have simple molecular structures, but their molecules have different shapes.

Explain why molecules of SiH_4 , PH_3 and H_2S have different shapes.

Your answer should include 'dot-and-cross' diagrams (outer shells only), the names of the shapes and an explanation of why the bond angles are different.

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Additional answer space if required.

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