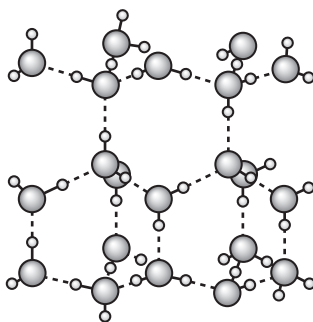


Section A

Answer **all** questions in the spaces provided.

1 Water can be found as ice, water and steam.

1 (a) The following diagram shows the arrangement of some of the water molecules in a crystal of ice.



With reference to the structure shown above give **one** reason why ice is less dense than water.

.....

.....

.....

(1 mark)

1 (b) Water and methane have similar relative molecular masses and both contain the element hydrogen.
The table below gives some information about water and methane.

	H ₂ O	CH ₄
M_r	18.0	16.0
Melting point / K	273	91

1 (b) (i) State the strongest type of intermolecular force holding the water molecules together in the ice crystal.

.....

(1 mark)

1 (b) (ii) State the strongest type of intermolecular force in methane.

.....

(1 mark)



1 (b) (iii) Give **one** reason why the melting point of ice is higher than the melting point of methane.

.....
.....
.....

(1 mark)

1 (c) A molecule of H_2O can react with an H^+ ion to form an H_3O^+ ion.

1 (c) (i) Draw and name the shape of the H_3O^+ ion. Include any lone pairs of electrons.

Shape of the H_3O^+ ion

Name of shape.....
(2 marks)

1 (c) (ii) Suggest a value for the bond angle in the H_3O^+ ion.

.....
(1 mark)

1 (c) (iii) Identify **one** molecule with the same number of atoms, the same number of electrons and the same shape as the H_3O^+ ion.

.....
(1 mark)

1 (d) Water can also form the hydroxide ion.
State the number of lone pairs of electrons in the hydroxide ion.

.....
(1 mark)

9

Turn over ►



Question	Marking Guidance	Mark	Comments
1(a)	<u>Water</u> or <u>H₂O</u> or <u>molecules</u> (in ice) are held <u>further apart</u> (than in liquid water)/(more) <u>space/gaps/holes</u> in structure/ <u>Water</u> or <u>H₂O</u> or <u>molecules</u> (in ice) are more spread out	1	Allow water (liquid) is more compact / less space/gaps/holes CE if holes filled with air, O ₂ etc CE if macromolecule CE if <u>atoms</u> further apart (since ambiguous) Ignore spaces filled with H ₂ O Ignore reference to H bonds Allow better tessellation in liquid water
1(b)(i)	Hydrogen bonding	1	Allow H bonds Do not allow 'hydrogen' only but mark on
1(b)(ii)	Van der Waals' / VdW	1	Allow London forces, dispersion forces, temporary induced dipole forces
1(b)(iii)	Hydrogen bonding is <u>stronger</u> (than van der Waals forces) / IMF in ice stronger (than IMF in methane)/ H bonds take more energy to break	1	Not H Bonds are strong (needs comparison) If (b)(i) OR (ii) is incorrect, cannot award (b)(iii) If (b)(i) and /or (ii) is blank, can score (b)(iii)

1(c)(i)	Structure showing 3 bonds to H and 1 lone pair (trigonal) pyramid(al) /(distorted) tetrahedral	1 1	do not insist on the + sign Allow triangular pyramid Not square pyramid Ignore bond angles in structure M2 independent of M1
1(c)(ii)	107°	1	Allow range 106 - 108° Ignore ° (C)
1(c)(iii)	NH ₃ /ammonia	1	Contradictions (eg NH ₄ ammonia) CE = 0
1(d)	3	1	Allow three/ III/ 3 lone pairs/ 3lp/ 3 lone pairs of electrons