Mark schemes

Q1.

(a) The (relative) ability of an atom to attract electron density in a covalent bond

OR

the (relative) ability of an atom to attract the pair of electrons in a covalent bond.

1

(b) Chlorine has a higher electronegativity (than carbon)

OR

Carbon has a lower electronegativity (than chlorine)

allow carbon and chlorine have different electronegativities

So the electron density is unsymmetrical/so chlorine becomes δ- and carbon becomes δ+

2

(c) CCl_4 is (a) symmetrical (molecule)/is tetrahedral/there is an even distribution of electron density

So the dipoles cancel out

Ignore no dipole moment

Do not allow the polar bonds cancel out/partial charges cancel

2

(d) (Random) movement of electrons (in one molecule creates a dipole)/a temporary dipole is formed (in one molecule)/an imbalance in electron density (in one molecule)

Induces a dipole in another molecule

(These temporary) dipoles in different molecules attract/(temporary) attraction between δ+ and δ- in different molecules

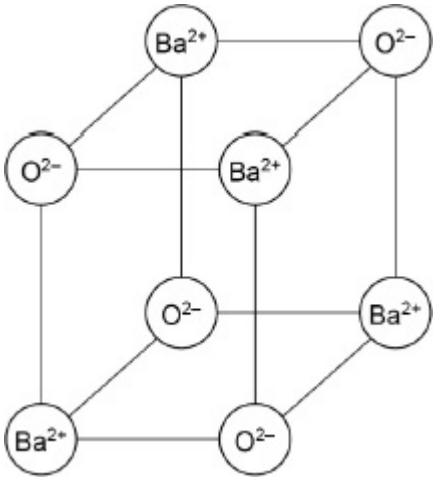
Allow M3 from a diagram

3

(e) Alternating ions with correct charges on ions

Cubic 3D arrangement with minimum of 8 particles

Diagram



2

[10]

Q2.

M1: SF_6 is octahedral (either in words or as a structure)

M2: SF_6 bond angle is 90°

M3: SF_6 all the bond pairs repel equally

M4: SF_3^+ is (trigonal) pyramidal (either in words or as a structure)
(Allow tetrahedral)

M5: SF_3^+ bond angle is 103-107°

M6: SF_3^+ lone pair-bond pair repulsion is greater than bond pair-bond pair repulsion (so bond angle is reduced)

[6]

Q3.

This question is marked using levels of response. Refer to the Mark Scheme Instructions for Examiners for guidance on how to mark this question.	
Level 3 **5-6 marks**	All stages are covered and the explanation of each stage is generally correct and virtually complete. Answer is well structured with no repetition or irrelevant points. Accurate and clear expression of ideas with no errors in use of technical terms.
Level 2 **3-4 marks**	All stages are covered but the explanation of each stage may be incomplete or may contain inaccuracies OR two stages are covered and the explanations are generally correct and virtually complete. Answer shows some attempt at structure. Ideas are expressed with reasonable clarity with, perhaps, some repetition or some irrelevant points. Some minor errors in use of technical terms.
Level 1 **1-2 marks**	Two stages are covered but the explanation of each stage may be incomplete or may contain inaccuracies, OR only one stage is covered but the explanation is generally correct and virtually complete. Answer includes isolated statements but these are not presented in a logical order or show some confusion. Answer may contain valid points which are not clearly linked to an argument structure. Errors in the use of technical terms.
Level 0 **0 marks**	Insufficient correct chemistry to gain a mark.

Stage 1: Name of each shape

1a: CF_4 = Tetrahedral

1b: XeF_4 = Square Planar

Stage 2: Explanation of shape / bond angle in CF_4

2a: four bonding pairs (and zero lone pairs)

2b: electron pairs repel each other to be as far apart as possible / electron pairs repel each other equally

2c: so bond angle is 109.5°

Stage 3: Explanation of shape / bond angle in XeF_4

3a: four bonding pairs

3b: two lone pairs

3c: so bond angle is 90°

3d: lone pairs repel more than bonding pairs,

3e: so lp as far apart as possible / so lone pairs are opposite each other / 180° apart

[6]

Q4.

(a) Cl is more electronegative (than C) **or**

C and Cl have different electronegativities

Allow idea that electrons (in bond) are not shared equally

1

(b) idea that dipole moments (or dipoles) cancel out (due to symmetry)

Allow polar bonds / polarities cancelling out

1

(c) **M1** van der Waals' forces between molecules in CCl_4 stronger than (combined van der Waals' and) dipole-dipole forces between molecules in CH_2Cl_2

M2 as CCl_4 has (many) more electrons than CH_2Cl_2

***M1** must refer to the forces being between molecules at some point*

*NOT **M1** for any reference to bond breaking*

*NOT **M1** for any reference to incorrect intermolecular forces*

Allow London forces or temporary (induced) dipole-dipole forces for van der Waals' forces

*For **M2**, allow CCl_4 has higher mass or higher M_r or bigger than CH_2Cl_2*

2

(d) **M1** attraction between O lone pair

M2 and δ+ H of OH on another molecule

no marks if answer indicates that the hydrogen bond is the O-H bond within a molecule

Marks could be awarded from a suitable diagram

2

[6]

Q5.

(a) **M1** energy transferred = 2.4 x 100 (= 240 kJ / 240000 J)

***M1 IGNORE** sign*

M2 amount of water vaporised = $\frac{103}{18}$ (= 5.72 mol)

M3 $\Delta H_{vap} = \frac{\text{M1 in kJ}}{\text{M2}}$ = (+)41.9 / 42.0 (kJ mol^{-1})

***ALLOW** ecf in **M3** (if q = mcΔT used for incorrect **M1** then a value **in kJ** could score ecf in **M3**)*

***ALLOW** 41.9 to 42.11 to two or more sig figs*

***M3 NOT** if negative*

Correct answer = 3 marks

3

(b) **M1** O **AND** N more electronegative than C and/or H (so all have polar bonds)

M2 CH_3CH_2OH and CH_3OCH_3 both v-shaped/non-linear/bent **AND** $CH_3CH_2NH_2$ (trigonal) pyramidal

M3 shapes are not symmetrical (so molecules are polar)

M4 O more electronegative than N (so ethylamine is least polar)

***ALLOW** 'different electronegativities' PLUS diagrams labelled δ+ and δ-*

ALLOW** angular for v-shaped in **M2

*Diagrams from **M2** do not require lone pairs*

***ALLOW M3** if diagrams in **M2** show asymmetry*

*Correct diagrams of the three shapes gives **M2** and **M3***

4

(c) **M1** hydrogen bonding in CH_3CH_2OH and $CH_3CH_2NH_2$ **AND** (permanent) dipole-dipole forces in CH_3OCH_3

M2 hydrogen bonding stronger (than other (intermolecular) forces)

M3 hydrogen bonding stronger in CH_3CH_2OH than in $CH_3CH_2NH_2$

IGNORE *van der Waals' / temporary/induced dipole-dipole forces*

M1 NOT *any reference to breaking covalent bonds*

M3 ALLOW *reference to O being more/most electronegative (than N) OR ethanol has greater dipole moment / more polar than ethylamine*

If none of M1, M2 or M3 have been awarded:

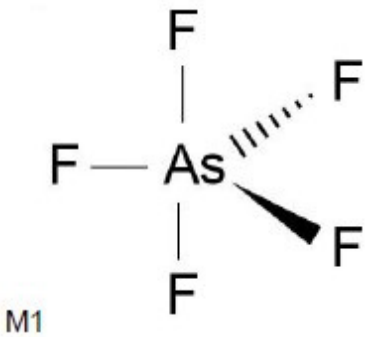
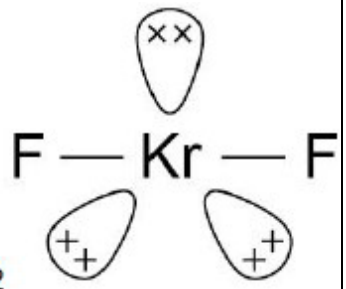
ALLOW *one mark for an indication that higher boiling point = stronger intermolecular forces but*

NOT *if reference to breaking covalent bonds*

3

[10]

Q6.

	AsF_5	**KrF_2**
Diagram of shape	 M1	 M2
Bond angle(s)	M3: 90 and 120	

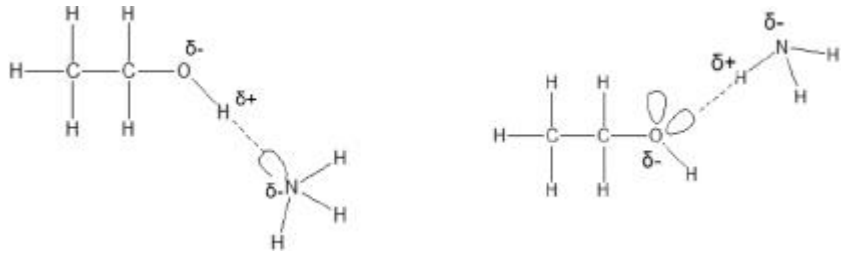
KrF_2 must show lone pairs (either as lobes or crosses/dots) and must be linear.

Ignore any lone pairs on fluorine.

[3]

Q7.

(a)



M1 – lone pairs and partial charges (δ−, δ+, δ−) on atoms involved in the hydrogen bond

1

M2 – dotted line between lone pair on N/O to correct H

1

M3 – linear O–H·····N / linear N–H···O

1

Ignore partial charges on C-H

(b) The (relative) tendency of an atom to attract a pair of electrons/ the electrons/ electron density in a covalent bond

Allow

Nucleus instead of atom

Power of an atom to attract a bonding/shared pair of electrons

Power of an atom to withdraw electron density from a covalent bond

Not lone pair / element

1

(c) H and O

O−H

1

(d) M1 the molecule is completely symmetrical / the molecule is tetrahedral / there is an even distribution of electron density

1

M2 the dipoles cancel out

1

Do not allow

The polar bonds cancel out / no dipole moment / partial charges cancel

(e) M1 CBr_4 has van der Waals' forces between molecules

1

M2 $CHBr_3$ has van der Waals' forces and dipole-dipole intermolecular forces

1

M3 The van der Waals' between CBr_4 molecules are stronger than the dipole-dipole and van der Waals' forces between $CHBr_3$ (because it has a larger mass/more electrons/larger electron cloud)
OR
The intermolecular forces between CBr_4 molecules are stronger than the intermolecular forces between $CHBr_3$

M3 cannot be awarded if mention of breaking bonds

1

[10]