

M1. (a) Iodine has more electrons / iodine is bigger (atom or molecule) / iodine has bigger  $M_r$  / bigger surface area

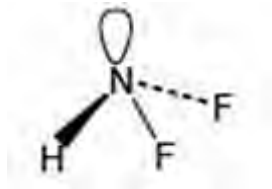
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Stronger / more van der Waals forces / vdw / London / temporarily induced dipole / dispersion forces between molecules

1

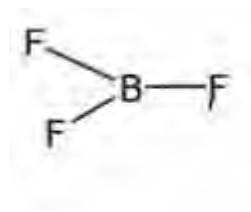
*Stronger VdW intermolecular forces = M2  
If stated VdW between atoms lose M2*

(b) (i)



*Mark is for 3 bp and 1 lp attached to N (irrespective of shape)*

1



*Mark is for 3 bp and 0 lp attached to B (irrespective of shape)*

1

$\text{NHF}_2$  shape - pyramidal / trigonal pyramid  
*Accept tetrahedral / triangular pyramid*

1

$\text{BF}_3$  shape - trigonal planar  
*Not triangular or triangular planar*

1

(ii)  $107^\circ$

*Allow  $106-108^\circ$*

1

(c) Hydrogen bonds  
*Allow H-Bonds*  
*Not just Hydrogen*  
*Apply list principle eg Hydrogen bonding and dipole-dipole = 0*  
1

(d) Coordinate / dative covalent / dative  
*If covalent mark on*  
*If ionic / metallic CE = 0*  
1

Lone pair / both electrons / 2 electrons on N(HF<sub>2</sub>) donated (to BF<sub>3</sub>)  
*Direction of donation needed here*  
1

[10]

**M2.** (a) Water or H<sub>2</sub>O or molecules (in ice) are held further apart  
(than in liquid water)/(more) space/gaps/holes in structure/Water  
or H<sub>2</sub>O or molecules (in ice) are more spread out  
*Allow water (liquid) is more compact/less space/gaps/holes*  
*CE if holes filled with air, O<sub>2</sub> etc*  
*CE if macromolecule*  
*CE if atoms further apart (since ambiguous)*  
*Ignore spaces filled with H<sub>2</sub>O*  
*Ignore reference to H bonds*  
*Allow better tessellation in liquid water*  
1

(b) (i) Hydrogen bonding  
*Allow H bonds*  
*Do not allow 'hydrogen' only but mark on*  
1

(ii) Van der Waals'/VdW

*Allow London forces, dispersion forces, temporary induced dipole forces*

1

- (iii) Hydrogen bonding is stronger (than van der Waals forces)/IMF in ice stronger (than IMF in methane)/H bonds take more energy to break

*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

1

(trigonal) pyramid(al)/(distorted) tetrahedral

*do not insist on the + sign*

*Allow triangular pyramid*

*Not square pyramid*

*Ignore bond angles in structure*

*M2 independent of M1*

1

- (ii) 107°

*Allow range 106 – 108°*

*Ignore °(C)*

1

- (iii) NH<sub>3</sub>/ammonia

*Contradictions (eg NH<sub>4</sub>, ammonia) CE = 0*

1

- (d) 3

*Allow three/III/3 lone pairs/3lp/3 lone pairs of electrons*

1

[9]

- M3.** (a) (i) Covalent;  
*If not covalent CE = 0.*  
*If blank, mark on.* 1
- Shared pair of electrons (one from each atom);  
*Not shared electrons.* 1
- (ii) Hydrogen bonds / H bonds;  
*Not just hydrogen.* 1
- Van der Waals/London/dispersion forces/temporary induced dipole; 1
- (b) Showing all the lone pairs on both molecules;  
*Allow showing both lone pairs on the O involved in the H-bond.* 1
- Showing the partial charges on O and H on both molecules;  
*Allow showing both partial charges on the O and H of the other molecule involved in the H bond.* 1
- Showing the Hydrogen bond from the lone pair on O of one molecule to the delta + on the H of the other molecule; 1
- (c) (i)  $C_2H_6OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$ ;  
*Accept multiples.*  
*Allow  $C_2H_6O$ .* 1
- (ii) CO is (produced which is) toxic/ poisonous/C (may be produced) which is toxic/ C is a respiratory irritant/ C (particles) exacerbate asthma/C causes global dimming/ smog;  
*Must relate to C or CO.*  
*Any mention of  $SO_2$ ,  $NO_2$  or other pollutants CE = 0.* 1
- (iii) More fuel needed (which costs more)/Wastes fuel/

less fuel burnt (so need more to buy more)/engine gets sooty so  
need to pay for engine to be cleaned/Have to fit catalytic converter;

*Not just costs more.*

*Not engine gets sooty unless qualified.*

1

- (d) (i) (React) with CaO/ calcium oxide/quicklime/lime;  
*Accept CaCO<sub>3</sub>/ calcium carbonate/limestone.*  
*Not chalk.*

1

All the sulfur dioxide may not react with the CaO or CaCO<sub>3</sub> /  
may not have time to react/ incomplete reaction;

*Accept incomplete reaction.*

1

- (ii) Occupies a (much) smaller volume;  
*Not easier to store or transport.*

1

[13]

- M4.** (a) Hydrogen/H bonds  
*Not just hydrogen*

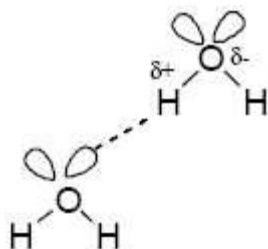
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van der Waals/vdw/dipole-dipole/London/temporarily induced  
dipole/dispersion forces

*Not just dipole*

1

(b)



*M1 for partial charges as indicated in diagram (correct minimum)*

*M2 for all four lone pairs*

*M3 for H bond from the lp to the H ( $\delta^+$ ) on the other molecule*

*Lone pair on hydrogen CE = 0*

*OHO CE = 0*

*If only one molecule of water shown*

*CE = 0*

3

- (c) Hydrogen bonds/IMF (in water) stronger

**OR**

IMF/VDW/dipole-dipole forces (in H<sub>2</sub>S) are weaker

**OR**

H bonding is the strongest IMF

*Ignore energy references*

*Comparison must be stated or implied*

1

- (d) Atoms/molecules get larger/more shells/more electrons/more surface area

*Not heavier/greater Mr*

1

therefore increased Van der Waals/IMF forces

*Ignore references to dipole-dipole forces*

1

- (e) Dative (covalent)/coordinate

*If not dative/coordinate CE = 0/2*

*If covalent or blank read on*

1

(Lone) pair/both electrons/two electrons on O(H<sub>2</sub>) donated (to H<sup>+</sup>)

OR pair/both electrons come from O(H<sub>2</sub>)

*Explanation of a coordinate bond specific to oxygen or water required*

*Not just H<sup>+</sup> attracted to lone pair since that is nearer to a H bond*

1

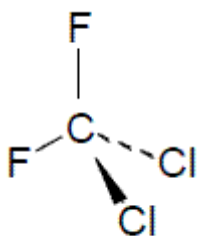
- (f) ionic 1
- if not ionic CE = 0*
- oppositely charged ions/+ and – ions or particles  
*atoms or molecules loses M2 and M3* 1
- ions attract strongly OR strong/many (ionic) bonds must be broken  
*S- loses M2*  
*Reference to IMF loses M2 and M3* 1

[13]

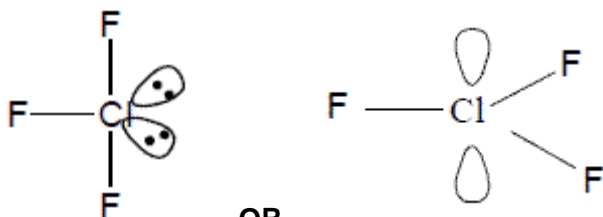
- M5.** (a) (i) shared pair of electrons  
*Can have one electron from each atom contributes to the bond*  
*Not both electrons from one atom* 1

- (ii)  $\frac{1}{2} \text{Cl}_2 + \frac{3}{2} \text{F}_2 \rightarrow \text{ClF}_3$  1
- Only*  
*Ignore state symbols even if wrong*

(b)



1



OR

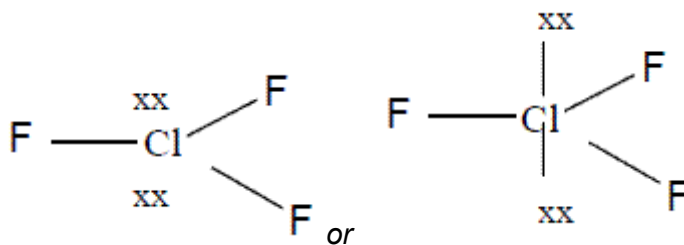
Allow any structure with 4 bp

In  $CClF_2$ , watch for Cl in centre- it must be C

Ignore wrong bond angles

Representations of lone pairs allowed are the two examples shown with or without the electrons in the lobe.

Also they can show the lone pair for either structure by two crosses/dots or a line with two crosses/dots on it e.g.



Or a structure with 3 bp and 2 lp

1

(c) Dipole – dipole

Allow van der Waals/vdw/London/dispersion/temporary dipole – induced dipole

Not dipole alone

1

(d) (i) Coordinate/dative (covalent)

If wrong CE = 0/3 but if 'covalent' or left top line blank, mark on.

1

(Lone) pair of electrons/both electrons (on F<sup>-</sup>)

CE if lone pair is from B

1

Donated from F/fluoride or donated to the BF<sub>3</sub>

Must have the – sign on the F ie F<sup>-</sup>

Ignore F<sup>+</sup>

M3 dependent on M2

1

(ii) 109° to 109.5°

1



(e)  $\frac{238 \times 100}{438}$

*For 1 mark allow 238 as numerator and 438 as denominator or correct strings*

1

= 54.3%

*2 marks if correct answer to 3 sig figs.  
54% or greater than 3 sig figs = 1 mark*

1

[11]