

1 This question is about the fluorides  $\text{BF}_3$ ,  $\text{NF}_3$ ,  $\text{OF}_2$  and  $\text{O}_2\text{F}_2$ .

(a) (i) For  $\text{BF}_3$ , name the shape of the molecule and give the FBF bond angle.

(2)

Shape.....

Bond angle.....

\*(ii) For the  $\text{NF}_3$  molecule, draw the shape you would expect and suggest the FNF bond angle. Explain why the molecule has this shape and bond angle.

(4)

Shape

Bond angle.....

Explanation.....

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(iii) Draw a diagram to show the bonding in the single product of the reaction between  $\text{BF}_3$  and  $\text{NF}_3$ .

Identify the type of bond that forms between these two molecules.

(2)

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(b) (i) What is the oxidation number of oxygen in  $\text{OF}_2$ ?

(1)

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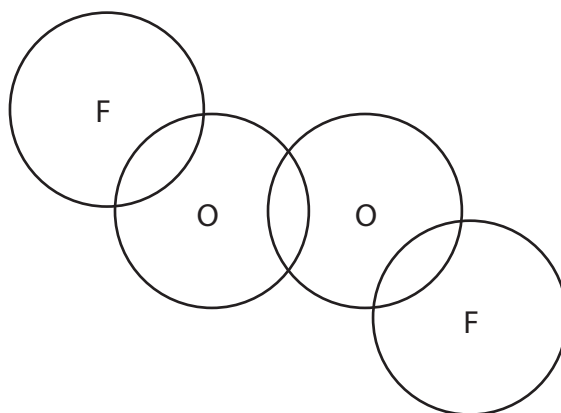
(ii) When water reacts with  $\text{OF}_2$ , oxygen is one of the products. Suggest an equation for this reaction.

State symbols are not required.

(1)

(c) Complete the diagram with dots and crosses to show the outer shell electrons in the  $\text{O}_2\text{F}_2$  molecule.

(1)



**(Total for Question = 11 marks)**

2 This question is about ethanethiol,  $\text{CH}_3\text{CH}_2\text{SH}$ . Thiols are like alcohols, but the oxygen atom has been replaced by a sulfur atom. They react in a similar way to alcohols.

(a) (i) Draw a dot and cross diagram for ethanethiol, showing outer electrons only.

(2)

(ii) Give the value for the CSH bond angle in ethanethiol. Justify your answer.

(3)

CSH angle .....

Justification .....

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(b) There are hydrogen bonds between ethanol molecules but not between ethanethiol molecules.

(i) Explain why the bond angle around the hydrogen atom involved in a hydrogen bond is  $180^\circ$ .

(2)

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(ii) Explain why there are no hydrogen bonds between ethanethiol molecules.

(1)

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(c) (i) Describe the formation of London forces.

(2)

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(ii) Explain why the London forces in ethanethiol are stronger than those in ethanol.

(1)

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(d) The reaction of sodium with ethanethiol,  $\text{CH}_3\text{CH}_2\text{SH}$ , is similar to its reaction with ethanol.

(i) Suggest one observation you would make when sodium is added to ethanethiol.

(1)

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(ii) Suggest a balanced equation for this reaction. State symbols are **not** required.

(1)

(e) Ethanol can be made from bromoethane by reaction with aqueous potassium hydroxide, KOH(aq), under suitable conditions.

(i) Write the equation for this reaction. State symbols are **not** required.

(1)

(ii) State the type and mechanism of this reaction.

(2)

Type .....

Mechanism .....

(iii) Suggest the formula of a suitable chemical to make ethanethiol from bromoethane.

(1)

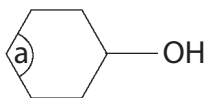
(f) When ethanethiol undergoes complete combustion in air, a gas is produced which is not formed on the complete combustion of ethanol. Identify the gas and suggest why it is damaging to the environment.

(2)

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**(Total for Question 19 marks)**

3 The skeletal formula of cyclohexanol is shown below.



(a) (i) The actual bond angles differ from the angles in the two dimensional diagram shown.

What is the angle of the C—C—C bond labelled **a**?

(1)

Angle .....

\*(ii) What is the angle of the C—O—H bond? Justify your answer, explaining why the size of the angle is different from the angle in (i).

(3)

Angle .....

Explanation .....

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(b) (i) Suggest what you would expect to **see** when cyclohexanol reacts with sodium.

(2)

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(ii) Phosphorus(V) chloride (phosphorus pentachloride) is used to test for the presence of an —OH group. Write the equation for the reaction of cyclohexanol with phosphorus(V) chloride.

(2)

(iii) Give the chemical test you could use to identify the gas produced, and the observation you would make.

(1)

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(iv) Cyclohexanol reacts with hot acidified potassium dichromate(VI) solution.

Give the skeletal formula of the organic product of this reaction.

(1)

(v) What colour change would you observe as this reaction takes place?

(1)

From ..... to .....

(c) The mass spectrum of cyclohexanol has a prominent peak at mass / charge ratio 82. Suggest the molecular formula of the fragment which causes this peak.

(1)

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**(Total for Question = 12 marks)**