

Y13 Chemistry HT HL

Part 1 – 4 hours UpLearn: Prioritise according to advanced information (top = most important / paper)

Part 2 – Exam style questions (below)

Q1.

The first ionisation energies of the elements in Period 2 change as the atomic number increases.

Explain the pattern in the first ionisation energies of the elements from lithium to neon.

(Total 6 marks)

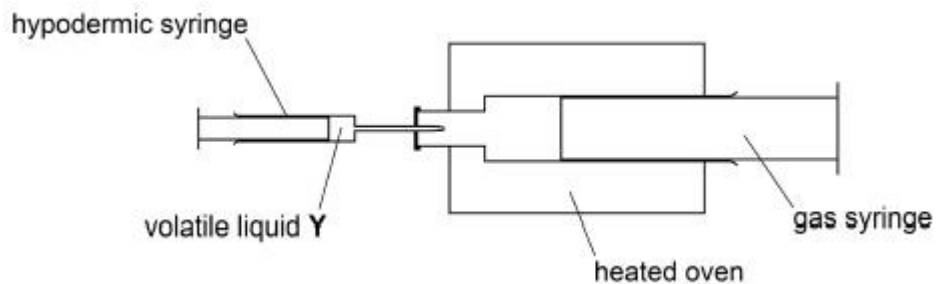
Q2.

A student determined the relative molecular mass, M_r , of an unknown volatile liquid Y in an experiment as shown in the diagram.

The student used a hypodermic syringe to inject a sample of liquid Y into a gas syringe in an oven.

At the temperature of the oven, liquid Y vaporised.

The student's results are shown in the table.



Mass of hypodermic syringe and liquid Y before injection	10.91 g
Mass of hypodermic syringe and liquid Y after injection	10.70 g
Oven temperature	98.1 °C
Atmospheric pressure	102 kPa
Increase in volume in gas syringe after injection of Y	85.0 cm ³

(a) Define the term relative molecular mass (M_r).

Use the experimental results in the table to determine the relative molecular mass of Y.

The gas constant $R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$

(5)

- (b) Some of the liquid injected did not evaporate because it dripped into the gas syringe nozzle outside the oven.

Explain how this would affect the value of the M_r of Y calculated from the experimental results.

(2)

(Total 7 marks)

Q3.

Halogenoalkanes such as 1,1,2-trichloro-1,2,2-trifluoroethane were used as coolants in refrigerators until the late 1980s. Their use was then banned and alternative coolants were used instead.

- (a) Draw the displayed formula of 1,1,2-trichloro-1,2,2-trifluoroethane.

(1)

- (b) 1,1,2-Trichloro-1,2,2-trifluoroethane was banned for use as a refrigerant because it damaged the ozone layer.

Write **three** equations to show how this compound is involved in damaging the ozone layer.

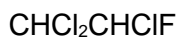
(3)

- (c) State the role of chlorine atoms in the reactions in part (b).

(1)

- (d) Inevitably, some coolant escapes from refrigerators.

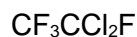
Deduce which of the following coolants, **A**, **B** or **C**, would cause least environmental damage to the atmosphere.



A



B



C

Coolant _____

(1)

- (e) Give the IUPAC name of compound **B** in part (d).

(1)

- (f) The boiling point of iodomethane (CH_3I) is higher than that of fluoromethane (CH_3F) even though the electronegativity of iodine is less than that of fluorine.

Explain why iodomethane has the higher boiling point by considering the forces that act between CH_3I molecules and comparing these forces with the forces between the CH_3F molecules.

(3)

(Total 10 marks)

Q4.

This question is about compounds that contain fluorine.

- (a) Sodium fluoride contains sodium ions (Na^+) and fluoride ions (F^-).
 Na^+ and F^- have the same electron configuration.

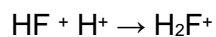
Explain why a fluoride ion is larger than a sodium ion.

(2)

- (b) Explain, in terms of structure and bonding, why the melting point of sodium fluoride is high.

(2)

- (c) The ion H_2F^+ is formed when hydrogen fluoride gains a proton as shown in the equation



Name the type of bond formed when HF reacts with H^+
Explain how this bond is formed.

Type of bond _____

Explanation _____

(2)

- (d) Fluoroantimonic acid contains two ions, SbF_6^- and H_2F^+

Draw the shape of the SbF_6^- ion and the shape of the H_2F^+ ion. Include any lone pairs that influence the shape.

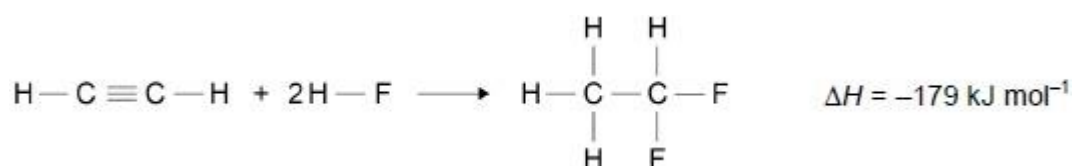
Name the shape of each ion.

SbF_6^-	H_2F^+
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Shape		
Name of shape		

(4)

- (e) Hydrogen fluoride reacts with ethyne (C_2H_2) as shown in the equation. All compounds are in the gaseous state.



The table shows some mean bond enthalpy data.

Bond	C-H	$C \equiv C$	H-F	C-C
Mean bond enthalpy / kJ mol^{-1}	412	837	562	348

Use the data in the table above to calculate a value for the bond enthalpy of a C-F bond in the product.

C-F bond enthalpy _____ kJ mol^{-1}

(3)
(Total 13 marks)

Mark schemes

Q1.

This question is marked using Levels of Response.	
<p>Level 3: ALL Stages with matching justifications</p> <p>All stages are covered and the explanation of each stage is generally correct and virtually complete.</p> <p>Answer is well structured with no repetition or irrelevant points. Accurate and clear expression of ideas with no errors in use of technical terms.</p>	5-6 marks
<p>Level 2: TWO Stages with matching justifications OR THREE Stages with incomplete justifications.</p> <p>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.</p> <p>Answer shows some attempt at structure Ideas are expressed with reasonable clarity with, perhaps, some repetition or some irrelevant points.</p> <p>Some minor errors in use of technical terms.</p>	3-4 marks
<p>Level 1: ONE Stage with matching justification OR TWO Stages with incomplete justifications</p> <p>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.</p> <p>Answer includes isolated statements but these are not presented in a logical order or show confused reasoning.</p> <p>Answer may contain valid points which are not clearly linked to an argument structure. Errors in the use of technical terms.</p>	1-2 marks
Insufficient correct chemistry to gain a mark.	0 marks

Indicative Chemistry Content

Stage 1: General Trend (Li → Ne)

- 1a. 1st IE increases
- 1b. More protons/increased nuclear charge
- 1c. Electrons in same energy level / shell
- 1d. No extra/similar shielding
- 1e. Stronger attraction between nucleus and outer e OR outer e closer to nucleus (ignore radius decreases)

Stage 2: Deviation Be → B

- 2a. B lower than Be
- 2b. Outer electron in (2)p

2c. higher in energy than (2)s

If Al vs Mg then do not award 2a or 2b

Stage 3: Deviation N → O

3a. O lower than N

3b. 2 electrons in (2)p need to pair

3c. pairing causes repulsion (do not award if it is clear reference to repulsion is in s orbital)

If S vs P then do not award 3a or 3b

[6]

Q2.

(a) The sum of $\frac{\text{(weighted) average masses of atoms in formula}}{1/12 \text{ mass of an atom of } ^{12}\text{C}}$
 $\frac{\text{Average mass of one molecule}}{1/12 \text{ mass of an atom of } ^{12}\text{C}}$

1

Method 1

Method 2

Mass of Y = 0.21g

Mass of Y = 0.21g

If incorrect lose M5 also, unless AE

1

$$M_r = \frac{mRT}{pV}$$

$$n = \frac{pV}{RT} \text{ and } M_r = \frac{m}{n}$$

Can be implied in calculations

1

$$M_r = \frac{0.21 \times 8.31 \times 371.1}{102000 \times 85 \times 10^{-6}}$$

$$n = \frac{102000 \times 85 \times 10^{-6}}{8.31 \times 371.1} (= 2.81 \times 10^{-3})$$

M4 – awarded for all 3 unit conversions

1

$$M_r = 74.7$$

$$M_r = 74.7$$

Allow 75

1

(b) Lower volume recorded

Allow

(Evaporated) mass of gas is less than the recorded mass of liquid / 0.21g (or converse)

1

M_r would be greater (than the real M_r)

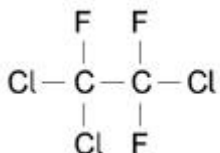
Ignore other references to mass

1

[7]

Q3.

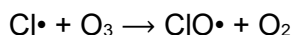
(a)



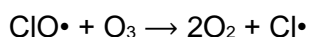
1

(b) Initiation: $\text{CCl}_2\text{FCF}_2\text{Cl} \rightarrow \text{Cl}\cdot + \text{CCl}_2\text{FCF}_2\cdot$ Allow initiation equations where more than one $\text{Cl}\cdot$ is formed

1



1



1

(c) Acts as a catalyst

1

(d) B

1

(e) 1,1,1,2-tetrafluoroethane

1

(f) Iodine is bigger than fluorine so the van der Waals forces between CH_3I molecules are stronger than those between CH_3F molecules

1

The dipole-dipole forces between CH_3F molecules are stronger than those between CH_3I molecules*Or vice versa*

1

The van der Waals forces are stronger than the dipole-dipole forces so these dominate

1

[10]**Q4.**(a) Fluoride ion has (two) fewer protons/lower nuclear charge*Do not allow fluorine, but allow fluorine ion.**Any reference to different numbers of electrons in the ions loses M1*

1

Weaker attraction between nucleus and (outer) electrons

*Allow answers in terms of sodium ion but must be explicit.**Ignore references to atomic radius*

1

- (b) (Electrostatic) forces of attraction between oppositely charged ions/ Na^+ and F^-

Mention of IMF, covalent, macromolecular, metallic, electronegativity of ions loses both marks

1

Lots of energy needed to overcome/break forces

Allow strong ionic bonding

Allow strong forces/bonds of attraction (need to be broken)

1

- (c) Type of Bond: Coordinate bond / dative (covalent) bond

If just covalent, then do not award M1 but mark on

1

Explanation: A (lone) pair of electrons is donated from F

Allow both electrons (in the shared pair) come from F

1

- (d)

Shape		
Name of shape	Octahedral	Bent / V-shaped / angular

Lone pairs on H_2F^+ are essential (can be shown in lobes)

Ignore missing charges

Mark independently

4

- (e) $\Delta H = \Sigma \Delta H(\text{Bonds broken}) - \Sigma \Delta H(\text{Bonds Formed})$

Allow M1 if 2785 and 1996 seen (or allow M1 if 1961 and 1172 seen)

$$-179 = 2(412) + 837 + 2(562) - [348 + 4(412) + 2(\text{C}-\text{F})]$$

1

$$-179 = 2785 - (1996 + 2(\text{C}-\text{F}))$$

$$2(\text{C}-\text{F}) = 968$$

M3 consequential on any M2 if it is clear that M2 is for 2(C-F)

1

$$\text{C}-\text{F} = 484$$

-484 scores 2

1

[13]