- 1 The H–O–H bond angle in an oxonium ion, H_3O^+ , is approximately **A** 104.5°
 - **B** 104.3
 - **C** 109.5°
 - **D** 120°

(Total for Question 1 = 1 mark)

2 The bond angles within a molecule of tetrachloromethane result from repulsion between

A atoms.

- **B** bonded pairs of electrons.
- **C** atomic nuclei.
- D lone pairs of electrons.

(Total for Question 2 = 1 mark)

- 3 The term **electronegativity** is best described as the ability of an atom to **A** attract the electrons within a covalent bond.
 - **B** repel the electrons within a covalent bond.
 - **C** attract the electrons within an ionic bond.
 - **D** repel the electrons within an ionic bond.

(Total for Question 3 = 1 mark)

- 4 Graphite is made up of hexagonal rings of carbon atoms in a layered arrangement. The carbon atoms in the same layer are 0.14 nm apart. What is the distance between adjacent layers of carbon atoms?
 - **A** 0.04 nm
 - **B** 0.13 nm
 - **C** 0.15 nm
 - **D** 0.34 nm

(Total for Question 18 = 1 mark)

- 5 Some ionic solids, such as sodium chloride, are soluble in water because **A** there are only weak ionic bonds within the lattice.
 - B there are strong London forces created on dissolving.
 - C the ions are strongly hydrated by the water molecules.
 - **D** strong hydrogen bonds are formed with the water molecules.

(Total for Question 19 = 1 mark)

6 The table below gives the boiling temperatures of some alcohols.

Alcohol	Boiling temperature / °C
Ethanol	78
Propan-1-ol	97
Butan-1-ol	117

From the data in the table, the boiling temperature of hexan-1-ol is most likely to be

A 138°C **B** 148°C

- C 158°C D 168°C (Total for Question 12 = 1 mark)
- 7 An experiment to determine the effect of an electrostatic force on a jet of liquid is carried out using the apparatus as shown.



Which of the following liquids would **not** be significantly deflected by the electrostatic force applied?

- A CH₃OH
- B CCl₄
- C CHCl₃
- \mathbf{D} H₂O

(Total for Question 13 = 1 mark)

Although they have similar relative molecular masses, the boiling temperatures of pentane (36°C) and butan-1-ol (117°C) are significantly different. The reason for this is that, in comparison with pentane,
 A the intermolecular forces between the alcohol molecules are much stronger.

B the covalent bonds in the alcohol are stronger.

C there are more covalent bonds in the alcohol and so it requires more energy to break all of them.

D the molecular shape of the alcohol allows it to form stronger interactions between molecules.

(Total for Question 14 = 1 mark)

- Compounds such as sodium chloride dissolve in water because the ions interact with the water molecules. The interactions are
 A dipole dipole
 - A dipole-dipole.
 - B ion-dipole.
 - **C** hydrogen bonds.
 - **D** London forces.

(Total for Question 15 = 1 mark)

10 Potassium bromate(V), KBrO₃, is a primary standard, meaning that it can be obtained as a pure substance and used to accurately determine the concentrations of solutions of other chemicals, such as sodium thiosulfate, $Na_2S_2O_3$.

(a) (i) Complete the dot and cross diagram for the bromate(V) ion. Show only the outer shell electrons.

In this ion, the bromine expands its outer shell to accommodate 12 electrons. Use \mathbf{x} for bromine electrons and o for oxygen electrons. The symbol * on the diagram represents the extra electron which gives the ion its charge.





(ii) Suggest how elements in Period 3 and higher can accommodate more than eight electrons in their outer shell.

(1)



11 Which of the following are properties of the liquid, 1-bromobutane?

		Solubility in water	Effect of a charged rod on a stream of the liquid
×	A	soluble	stream diverted
Х	В	soluble	stream unaffected
Ň	с	insoluble	stream diverted
X	D	insoluble	stream unaffected

(Total for Question 1 = 1 mark)

- 12 (a) The strongest intermolecular forces in liquid ammonia are(1)
 - A covalent bonds.
 - B hydrogen bonds.
 - C London forces.
 - D permanent dipole-dipole forces.

(b) The graph below shows the boiling temperatures for the Group 5

hydrides. Select the most likely boiling temperature for ammonia.

(1)



- C
- D

(Total for Question 2 = 2 marks)

13 Which of the following isomers of C6H14 has the **lowest** boiling temperature?



(Total for Question 6 = 1 mark)

- 14 Which of the following compounds has the **highest** boiling temperature? Mr = relative molecular mass
 - A cyclopentane Mr = 70
 - **B** pentane Mr = 72
 - **C** butan-1-ol Mr = 74
 - **D** ethane-1,2-diol Mr = 62

(Total for Question 7 = 1 mark)

15 Microwave energy can only be used for heating reactions involving polar reactants.

Which of the following reactions **cannot** be heated with microwave energy? **A** $C_5H_{12} + CI_2 \rightarrow C_5H_{11}CI + HCI$

- **B** C₂H₅OH + HBr \rightarrow C₂H₅Br + H₂O
- **C** C₂H₅I + KOH → C₂H₅OH + KI

D CH₃CHO + $\frac{1}{2}O_2 \rightarrow$ CH₃COOH

(Total for Question 10 = 1 mark)

- 16 Diamond, buckminsterfullerene and graphite are all forms of carbon. A significant difference between buckminsterfullerene and the other two forms is that only buckminsterfullerene
 - A has good electrical conductivity.
 - B has a precise molecular formula.
 - **C** is tough and rigid.

D has some carbon atoms with only three covalent bonds.

(Total for Question 14 = 1 mark)

- 17 Sulfur can combine with fluorine to form a number of different compounds, some of which are shown below. From the diagrams given, which compound will **not** be polar?
 - A Disulfur difluoride, S₂F₂



B Sulfur difluoride, SF₂



C Sulfur tetrafluoride, SF₄



D Sulfur hexafluoride, SF₆



- 18 Which of the following species has the smallest bond angle?
 - A CO₂
 - **B** H₂O
 - C SO₃
 - **D** H₃O+

(Total for Question 11 = 1 mark)

- 19 Which of the following bonds is likely to be the most polar?
 - A H–F
 - **B** P–O
 - C N–Cl
 - D C-S

(Total for Question 12 = 1 mark)

- 20 Which of the following has the longest bond length?
 - B H-CI
 - **C** 0=0

D N=N (Total for Question 19 = 1 mark)

- 21 Which of these molecules is polar?
 - A CO2
 - B NH₃
 - C CCI4
 - D CH4

(Total for Question 1 = 1 mark)

- 22 Which of these species has bond angles equal to 90°?
 - ☑ A BeF^{2−}₄
 - B SiCl₄
 - C NH₄⁺
 - \square **D** SF₆

(Total for Question 2 = 1 mark)

- 23 Which of these species does **not** have a trigonal pyramidal shape?
 - A BF3
 - B NH₃
 - C H₃O⁺
 - D PH₃

(Total for Question 3 = 1 mark)

24 Which of the following molecules has the greatest number of lone pairs of electrons?



25 This diagram represents a square planar structure:



Which of these species has this square planar shape?

- 🛛 🗛 SF4
- B NH⁺₄
- C XeF₄

(Total for Question 5 = 1 mark)

- 26
- A Hydrogen bromide, HBr
- B Hydrogen sulfide, H₂S
- C Silane, SiH₄
- D Ammonia, NH₃

Which of the following compounds has hydrogen bonding in the liquid state?

- 27 Which of the following elements has the greatest attraction for bond pairs of electrons in a covalent bond?
 - 🖸 A Beryllium
 - Boron
 - C Bromine
 - D Chlorine

(Total for Question 7 = 1 mark)

- 28 In a molecule of hydrogen, the two hydrogen atoms are held together by
 - A a hydrogen bond.
 - **B** a polar covalent bond.
 - C a non-polar covalent bond.
 - **D** London forces.

(Total for Question 8 = 1 mark)

How many molecular ion peaks are in the mass spectrum of 1,2-dichloroethane? Assume the only isotopes present are ¹H, ¹²C, ³⁵Cl and ³⁷Cl.

- A 4
- **B** 3
- C 2
- 🖸 D 1

(Total for Question 1 = 1 mark)

- 30 In water, hexan-1-ol is less soluble than ethanol. The best explanation for this is that
 - A hexan-1-ol molecules cannot form hydrogen bonds with water molecules but ethanol molecules can.
 - **B** carbon-carbon bonds are stronger in hexan-1-ol than in ethanol.
 - C London forces between hexan-1-ol molecules are stronger than between ethanol molecules.
 - D permanent dipole forces are stronger in hexan-1-ol than in ethanol.

(Total for Question 11 = 1 mark)

31	As Group 7 is descended, the boiling temperatures of the hydrogen halides, from	HF to HI,
	A decrease then increase.	
	B decrease.	
	C increase then decrease.	
	D increase.	
32	(Total for Question 12 = 1 13 This question is about three chlorine compounds: BCl ₃ , NCl ₃ and Cl ₂ O ₇ . (a) For BCl ₃ , give the shape of the molecule and give the CIBCI bond angle.	(2)
	Shape	
	Bond angle	(4)
	Bond angle	
	Explanation	

33 What are the shapes of the BF₃ and PH₃ molecules?

		BF ₃	PH ₃
	A	pyramidal	pyramidal
\times	B	pyramidal	trigonal planar
2	С	trigonal planar	pyramidal
\times	D	trigonal planar	trigonal planar

(Total for Question 1 = 1 mark)

34 What are the C—C—C bond angles in diamond and graphite?

		Diamond	Graphite
X	A	109.5°	109.5°
X	в	109.5°	120°
X	c	120°	109.5°
Ň	D	120°	120°

(Total for Question 2 = 1 mark)

35 Which describes the polarity of the C—Cl bond and the polarity of the molecule trichloromethane, CHCl₃?

	Polarity of C—Cl bond	Polarity of molecule
A	non-polar	non-polar
B	non-polar	polar
🖂 C	polar	non-polar
🖸 D	polar	polar

(Total for Question 3 = 1 mark)

- 36 Which isomer, with the formula C_7H_{16} , will have the **lowest** boiling temperature?
 - A CH₃CH₂CH₂CH₂CH₂CH₂CH₂CH₃
 - **B** (CH₃)₂CHCH₂CH₂CH₂CH₃
 - $\Box C CH_3CH_2C(CH_3)_2CH_2CH_3$
 - $\square D (CH_3)_2 CHC(CH_3)_3$

(Total for Question 4 = 1 mark)

37 What is the empirical formula of a bromoalkane containing, by mass, 22.0% carbon, 4.6% hydrogen and 73.4% bromine?

(Relative atomic masses: C = 12, H = 1, Br = 80)

- A C₃H₇Br
- B C₂H₅Br
- C C₂H₃Br
- D CH₃Br

(Total	for	Junction	12 - 1	mark
local		lacouoli	13 - 1	mark/

- 38 This question concerns the halogens and some of their compounds.
 - (a) A halogen dissolves in water to form a yellow solution, and in cyclohexane to form a purple solution.

Name the halogen.

(b) Oxygen difluoride, OF₂, is produced in the reaction between fluorine and cold, dilute sodium hydroxide solution.

 $2F_2 \quad + \quad 2OH^- \quad \rightarrow \quad OF_2 \quad + \quad 2F^- \quad + \quad H_2O$

Give the oxidation numbers of fluorine and oxygen in all of the species in the equation above and use them to explain why this is a redox reaction.

(3)

(1)

(c) Chlorine oxidises thiosulfate ions, S₂O₃²⁻, to sulfate(VI) ions.

The ionic half-equations for the reaction are

$$Cl_2 + 2e^- \rightarrow 2Cl^-$$

 $S_2O_3^{2-} + 5H_2O \rightarrow 2SO_4^{2-} + 10H^+ + 8e^-$

Write the overall equation for the reaction.

(1)

(d) The boiling temperatures of the hydrogen halides are shown.

Hydrogen halide	Boiling temperature / K
HF	293
HCl	188
HBr	206
HI	238

*(i) London forces are present in all of these compounds.

Describe how these forces arise.

(2)

(ii) State why the London forces are greater in hydrogen iodide than in hydrogen	bromide (1)
(iii) Explain why the boiling temperature of hydrogen fluoride is higher than that of hydrogen chloride.	(2)
(e) In the solid state, phosphorus(V) chloride exists as [PCl₄] ⁺ and [PCl ₆] ⁻ ions. Predict the shapes of these ions. Fully justify your answers.	
Shape [PCl4] ⁺ Shape [PCl6] ⁻	(-)

(Total for Question 22 = 14 marks)