Section A

1 Which of the following bond angles occur in a molecule of ethanol, C_2H_5OH?

- ☐ **A** 90° and 180°
- ☐ **B** 104.5° and 180°
- ☐ **C** 104.5° and 109.5°
- ☐ **D** 109.5° and 120°

(Total for Question 1 = 1 mark)

2 Which of the following molecules is linear?

- ☐ **A** Carbon dioxide, CO_2
- ☐ **B** Sulfur dioxide, SO_2
- ☐ **C** Water, H_2O
- ☐ **D** Methanal, HCHO

(Total for Question 2 = 1 mark)

3 Which of the following molecules contains polar bonds but is **not** a polar molecule?

- ☐ **A** Chlorine, Cl_2
- ☐ **B** Hydrogen chloride, HCl
- ☐ **C** Trichloromethane, $CHCl_3$
- ☐ **D** Tetrachloromethane, CCl_4

(Total for Question 3 = 1 mark)

4 Which of the following has dipole-dipole interactions between its molecules, but no hydrogen bonding?

- ☐ **A** Methane, CH_4
- ☐ **B** Methanol, CH_3OH
- ☐ **C** Ammonia, NH_3
- ☐ **D** Hydrogen iodide, HI

(Total for Question 4 = 1 mark)

5 Which list below shows the compounds in order of **increasing** boiling temperature?

- ☐ **A** CH_4, HCl, HF
- ☐ **B** HF, CH_4, HCl
- ☐ **C** HCl, HF, CH_4
- ☐ **D** HF, HCl, CH_4

(Total for Question 5 = 1 mark)

6)

Which of the following could **not** be an element in Group 2?

- ☐ **A** An element with an oxide which forms a solution of pH 10.
- ☐ **B** An element with an insoluble sulfate.
- ☐ **C** An element with a chloride which is liquid at room temperature.
- ☐ **D** An element with a carbonate which decomposes on heating.

1 mark)

7)

Chlorides of Group 1 elements produce coloured flames when

- ☐ **A** electrons become excited to a higher energy level.
- ☐ **B** excited electrons move from a higher to a lower energy level.
- ☐ **C** an outer electron leaves the atom.
- ☐ **D** electrons move between the negative and positive ions.

1 mark)

8)

This question is about the following compounds.

A Barium carbonate

B Lithium nitrate

C Potassium bromide

D Potassium nitrate

(a) Which compound gives a green colour in a flame test?

(1)

- ☐ **A**
- ☐ **B**
- ☐ **C**
- ☐ **D**

(b) Which compound gives a lilac colour in a flame test and does **not** decompose on heating?

(1)

- ☐ **A**
- ☐ **B**
- ☐ **C**
- ☐ **D**

2 marks)

9)

Which of the following trends occurs going down the elements in Group 2?

- ☐ **A** The solubility of the hydroxides increases.
- ☐ **B** The first ionization energy increases.
- ☐ **C** The solubility of the sulfates increases.
- ☐ **D** The stability of the carbonates to heat decreases.

1 mark)

10)

Which of the following is **not** a true statement about hydrogen iodide?

- ☐ **A** It forms steamy fumes in moist air.
- ☐ **B** It dissolves in water to form an acidic solution.
- ☐ **C** It forms a cream precipitate with silver nitrate solution.
- ☐ **D** It forms dense white smoke with ammonia.

1 mark)

11)

Chemical reactions may involve

A oxidation

B reduction

C no change in oxidation number

D disproportionation

Which of the terms above best describes what happens to the **chlorine** in the following reactions?

(a) $Cl_2(g) + H_2O(l) \rightarrow HCl(aq) + HOCl(aq)$

(1)

☐ **A**

☐ **B**

☐ **C**

☐ **D**

(b) $Cl_2(g) + 2Na(s) \rightarrow 2NaCl(s)$

(1)

☐ **A**

☐ **B**

☐ **C**

☐ **D**

(c) $NaCl(s) + H_2SO_4(l) \rightarrow HCl(g) + NaHSO_4(s)$

(1)

☐ **A**

☐ **B**

☐ **C**

☐ **D**

3 marks)

Section B

12)

(a) State how the following processes are achieved in a mass spectrometer.

(i) Ionization of the sample.

(1)

(ii) Acceleration of the ions.

(1)

(iii) Deflection of the ions.

(1)

(b) State how you could find the molecular mass of a substance from its mass spectrum.

(1)

(c) Living things take up the radioactive isotope carbon-14 from the atmosphere. In recent years a particular linen cloth was shown, using mass spectrometry, to have been made from flax grown in the early 14th century. Suggest how mass spectrometry can be used to estimate the age of the cloth.

(2)

13)

The melting temperatures of the elements of Period 3 are given in the table below. Use these values to answer the questions that follow.

Element	Na	Mg	Al	Si	P (white)	S (monoclinic)	Cl	Ar
Melting temperature / K	371	922	933	1683	317	392	172	84

(a) Explain why the melting temperature of sodium is very much less than that of magnesium.

(3)

(b) Explain why the melting temperature of silicon is very much greater than that of white phosphorus.

(3)

14)

(a) Briefly describe an experiment, with a diagram of the apparatus you would use, which shows that there are oppositely charged ions in copper(II) chromate(VI), $CuCrO_4$. Describe what you would expect to see.

Formula of ion	Colour
$Cu^{2+}(aq)$	blue
$CrO_4^{2-}(aq)$	yellow

(4)

(b) The ions in an ionic lattice are held together by an **overall** force of attraction.

(i) Describe the forces of attraction in an ionic lattice.

(1)

(ii) Suggest **two** forces of repulsion which exist in an ionic lattice.

(2)

C) N/A

(d) The lattice composed of the ions Mg^{2+} and O^{2-} is stronger than a lattice composed of the ions Mg^{+} and O^{-}.

(i) Explain, in terms of the charges on the ions and the size of the cations, why this is so.

(2)

(ii) Suggest how the lattice energy of $Mg^{2+}O^{2-}$ would differ from that of $Mg^{+}O^{-}$.

(1)

15)

This question is about the element chlorine (atomic number = 17).

(a) Complete the electronic structure of chlorine.

(1)

$1s^2\ 2s^2$ .....

(b) Chlorine forms compounds with magnesium and with carbon.

(i) Draw a dot and cross diagram to show the electronic structure of the compound magnesium chloride (only the outer electrons need be shown).
Include the charges present.

(2)

(ii) Draw a dot and cross diagram to show the electronic structure of the compound tetrachloromethane (only the outer electrons need be shown).

(2)