1 When aqueous solutions of barium chloride and potassium sulfate are mixed, a white precipitate forms. The ionic equation for the reaction is

☐ **A** $K^+(aq) + Cl^-(aq) \rightarrow KCl(s)$

☐ **B** $K^{2+}(aq) + 2Cl^-(aq) \rightarrow KCl_2(s)$

☐ **C** $Ba^+(aq) + SO_4^-(aq) \rightarrow BaSO_4(s)$

☐ **D** $Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$

1 mark)

2)

How many molecules are present in 16 g of oxygen gas, $O_2(g)$?

[Avogadro constant = 6×10^{23} mol^{-1}]

☐ **A** 96×10^{23}

☐ **B** 12×10^{23}

☐ **C** 6×10^{23}

☐ **D** 3×10^{23}

1 mark)

3)

An isotope of an element, atomic number z, has mass number 2z + 4. How many neutrons are in the nucleus of the element?

☐ **A** z + 4

☐ **B** z + 2

☐ **C** z

☐ **D** 4

1 mark)

4)

The Avogadro constant is 6.0×10^{23} mol^{-1}. The number of **atoms** in 1 mol of dinitrogen tetroxide, N_2O_4, is

☐ **A** 3.6×10^{24}

☐ **B** 1.8×10^{24}

☐ **C** 6.0×10^{23}

☐ **D** 1.0×10^{23}

1 mark)

5)

A sample of swimming pool water contains 0.482 parts per million (ppm) of chlorine. This is equal to a percentage of

☐ **A** 0.000482

☐ **B** 0.0000482

☐ **C** 0.00000482

☐ **D** 0.000000482

1 mark)

6)
Bromine has two isotopes with relative isotopic masses 79 and 81. Which of the following values for mass/charge ratio could correspond to a peak in the mass spectrum of bromine, Br_2? You should assume the ions detected have a single positive charge.

☐ **A** 79.9

☐ **B** 80

☐ **C** 159

☐ **D** 160

1 mark)

7)
The first five ionization energies of an element, **X**, are shown in the table.

Ionization energy	1st	2nd	3rd	4th	5th
Value / kJ mol^{-1}	631	1235	2389	7089	8844

What is the mostly likely formula of the oxide that forms when **X** burns in oxygen?

☐ **A** X_2O

☐ **B** XO

☐ **C** X_2O_3

☐ **D** XO_2

1 mark)

8)
Which of the following has the largest ionic radius?

☐ **A** S^{2-}

☐ **B** Cl^-

☐ **C** K^+

☐ **D** Ca^{2+}

1 mark)

9)
Which of the following is a major effect caused by increased carbon dioxide levels arising from the burning of fossil fuels?

☐ **A** Melting of polar ice caps.

☐ **B** Damage to the ozone layer.

☐ **C** Increased acid rain.

☐ **D** Increased skin cancer.

1 mark)

10)
Which of the following compounds shows geometric (*E-Z* or *cis-trans*) isomerism?

☐ **A** but-1-ene

☐ **B** 2-methylbut-1-ene

☐ **C** but-2-ene

☐ **D** 2-methylbut-2-ene

= 1 mark)

Section B

11)

(a) Define the term **relative isotopic mass**.

(2)

(b) Naturally occurring chlorine contains 75.53% of ^{35}Cl and 24.47% of ^{37}Cl.

(i) Calculate the relative atomic mass of chlorine to **four** significant figures.

(2)

(ii) Two of the peaks in the mass spectrum of chlorine, Cl_2, are at *m/e* 70 and 74. Identify the species giving rise to these peaks.

(2)

70 .....

74 .....

(iii) What is the *m/e* value of the other peak that you would expect to see in this region of the mass spectrum and the identity of the species giving rise to it?

(2)

12)

(a) (i) An alkaline solution is produced when barium reacts with cold water. Write the equation for this reaction, including all state symbols.

(2)

(ii) The reaction in (a)(i) is a redox reaction. State the initial and final oxidation number of any element that changes its oxidation number.

(2)

(b) Dilute hydrochloric acid is added to the solution produced in (a)(i). Write the equation for the reaction which occurs. State symbols are **not** required.

(1)

(c) Dilute sulfuric acid is added to another sample of the solution produced in (a)(i). How would the appearance of the resulting mixture differ from the mixture produced in (b)? Explain this difference.

(2)

Appearance .....

Explanation .....

(d) (i) Two white powders are known to be barium carbonate and magnesium carbonate.

How could you distinguish between the two powders by heating them? [No practical details are required.]

Include the equation for the action of heat on one of these carbonates. State symbols are not required.

(2)

Equation:

(ii) Suggest another test, other than heating or the use of an acid, which could be used to distinguish between magnesium carbonate and barium carbonate. State the results for both compounds.

(2)

Test .....

Result with magnesium carbonate .....

.....

Result with barium carbonate .....

13)

The boiling temperatures of fluorine and two of its compounds are given below.

Substance	F_2	CH_3F	HF
T_b/K	85	195	293

(a) A molecule of F_2 has 18 electrons.

Which intermolecular force depends to a large extent on the number of electrons in the molecule?

(1)

(b) Calculate the number of electrons in a molecule of CH_3F.

(1)

(c) Explain why the boiling temperature of CH_3F is greater than that of F_2, referring to the intermolecular forces present.

(1)

(d) Explain why the boiling temperature of HF is the highest in the series.

(2)

(e) Explain why the values of the boiling temperatures for Cl_2, CH_3Cl and HCl do not follow the same trend as F_2, CH_3F and HF.

(1)

14)

The boiling temperatures of some hydrides are given below.

Compound	Boiling temperature / K
HF	293
HCl	188
HBr	206
HI	238
H_2O	373

*(a) Explain, by comparing the forces involved, why HI has a higher boiling temperature than HBr.

(3)

*(b) Explain, by comparing the types of forces involved, why HF has a higher boiling temperature than HCl.

(3)

(c) Suggest why H_2O has a higher boiling temperature than HF.

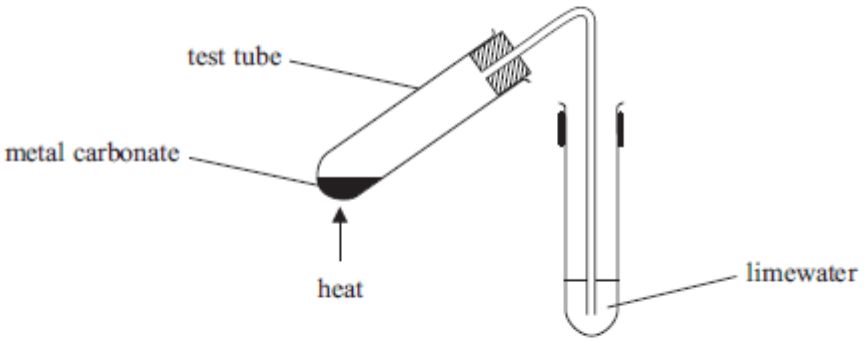
(1)

15)

The carbonates of Group 2 in the Periodic Table decompose on heating to form the corresponding metal oxide and carbon dioxide. A general equation for the reaction is

$$MCO_3(s) \rightarrow MO(s) + CO_2(g)$$

The thermal stability of these carbonates can be compared in the laboratory using the apparatus in the diagram below. The test tube on the left contains a sample of a metal carbonate and the tube on the right contains limewater.



(a) (i) State the measurement that you would make in this experiment.

(1)

(ii) Suggest **three** ways to make sure that, when carrying out this experiment, the thermal stabilities of the different carbonates are compared fairly.

(3)

(b) (i) State the trend in the thermal stability of the metal carbonates as the group is descended.

(1)

*(ii) Explain this trend in stability.

(3)