Q1.

A student does a series of reactions with aqueous solutions of some potassium halides (**P**, **Q** and **R**) of equal concentration. Each solution contains a different halide ion (chloride, bromide or iodide).

The student adds 3 drops of bromine water to 3 drops of each aqueous solution of potassium halide. The student also adds 3 drops of the bromine water to 3 drops of water.

Table 1 shows the student's observations.

Table 1

	Observation when 3 drops of bromine water are added
Solution P	Orange solution
Solution Q	Brown solution
Solution R	Orange solution
Water	Orange solution

(a) Identify the halide ion present in **Q**.

Give the ionic equation for the reaction that occurs when bromine water is added to **Q**.

Halide ion in **Q**

_____

Ionic equation

_____

(2)

(b) Explain, in terms of oxidising ability, why the observations from these reactions do **not** allow the student to identify the halide ion present in **P** and the halide ion present in **R**.

_____

_____

_____

_____

(2)

(c) The student does a second experiment to determine the halide ion in each of **P** and **R**.

The student adds a few drops of aqueous silver nitrate solution to 2 cm^3 of each potassium halide solution.

Table 2 shows the student's observations.

Table 2

	Student's Observation
P	Precipitate formed
R	Precipitate formed

Describe a further chemical test that the student can complete on the precipitates formed to identify the halide ion present in **P** and the halide ion present in **R**.

Describe how the observations from this test can be used to identify the halide ion present in **P** and the halide ion present in **R**.

_____

_____

_____

_____

_____

_____

(3)

(Total 7 marks)

Q2.

A student is provided with separate unlabelled samples of four different solutions for analysis.

The four solutions are known to be ammonium nitrate, potassium sulfate, sodium carbonate and magnesium nitrate, but the student does not know which sample is which.

Outline a series of test-tube reactions that the student can use to identify each of these solutions.

Include:

- the expected observations
- ionic equations for any reactions.

(Total 6 marks)

Q3.

This question is about chlorine.

(a) Give an equation to show how chlorine forms an acidic solution in water.

_____

(1)

(b) Give an equation for the reaction between chlorine and cold, dilute aqueous sodium hydroxide.

_____

(1)

(c) In acidic conditions, ClO_3^- ions oxidise Cl^- ions to form Cl_2

Deduce a half-equation for the oxidation of Cl^- to Cl_2

Deduce a half-equation for the reduction of ClO_3^- to Cl_2

Deduce the overall equation for this reaction.

Half-equation for the oxidation of Cl^- to Cl_2

_____

Half-equation for the reduction of ClO_3^- to Cl_2

_____

Overall equation

_____

(3)

(d) Give the equation for the reaction of solid sodium chloride with concentrated sulfuric acid.

State the role of the chloride ions in this reaction.

Equation

_____

Role _____

(2)

(e) Draw the shape of the Cl_3^- ion.
Include any lone pairs of electrons that influence the shape.

(1)

(f) Chlorine forms an ion with the Group 3 element thallium (Tl).

State and explain the bond angle in $TlCl_2^+$

Bond angle _____

Explanation _____

_____

_____

_____

(2)

(Total 10 marks)

Q4.

This question is about halogens and halide ions.

(a) Explain why the electronegativity of the halogens decreases down the group.

_____

_____

_____

_____

(2)

Concentrated sulfuric acid reacts with solid sodium chloride and with solid sodium bromide.

(b) State **one** similarity in, and **one** difference between, these reactions.

Similarity _____

_____

Difference _____

_____

(2)

(c) Solid sodium iodide reacts with concentrated sulfuric acid to form hydrogen sulfide.

Give a half-equation to show the oxidation of iodide ions.

Give a half-equation to show the reduction of concentrated sulfuric acid to hydrogen sulfide.

Use your half-equations to deduce an overall equation for this reaction.

Half-equation 1

_____

Half-equation 2

_____

Overall equation

_____

(3)

(Total 7 marks)

Q5.

Iodide ions can be oxidised to iodine using oxidising agents such as iodate(V) ions (IO_3^-) and concentrated sulfuric acid.

(a) State, in terms of electrons, the meaning of the term oxidising agent.

_____

_____

(1)

In acidic solution, IO_3^- ions oxidise iodide ions to iodine.

$$IO_3^- + 5\ I^- + 6\ H^+ \rightarrow 3\ I_2 + 3\ H_2O$$

(b) Give a half-equation for the oxidation of iodide ions to iodine.

Deduce the half-equation to show the reduction process in this reaction.

Oxidation half-equation

_____

Reduction half-equation

_____

(2)

(c) When iodide ions are oxidised using concentrated sulfuric acid, sulfur dioxide, a yellow solid and a foul-smelling gas are all formed.

Give an equation to show the reaction between iodide ions and concentrated sulfuric acid to form the yellow solid.

Identify the foul-smelling gas.

Equation

_____

Identity of foul-smelling gas _____

(2)

(Total 5 marks)

Q6.

A student does two test-tube reactions on four colourless solutions (**A**, **B**, **C** and **D**).

The table below shows the student's observations.

Solution	**Test 1** Add $Na_2CO_3(s)$	**Test 2** Add acidified $AgNO_3(aq)$
A	Effervescence	No visible change
B	Effervescence	White precipitate
C	No visible change	No visible change
D	No visible change	Very pale yellow precipitate

(a) Identify the gas formed in **Test 1**.

Describe a further test to confirm the identity of this gas.

Identity of gas _____

Test

_____

_____

(2)

(b) Explain how the observations from **Test 1** and **Test 2** can be used to show that solution **B** contains hydrochloric acid.

_____

_____

_____

_____

(2)

(c) Describe a series of tests that the student can use to show that solution **C** contains ammonium sulfate.

(4)

(d) The student does an additional experiment to show that solution **D** contains a mixture of halide ions. One of the halide ions is chloride.

Method:

Step 1 Add an excess of $AgNO_3(aq)$ to 10.0 cm^3 of solution **D**.
Step 2 Filter, wash, dry and weigh the precipitate.
Step 3 Add an excess of dilute ammonia to the dry precipitate.
Step 4 Filter, wash, dry and weigh the solid that remains.

Explain how the masses recorded during this experiment can be used to show that solution **D** contains a mixture of halide ions.

(2)

(Total 10 marks)

Q7.

This question is about some elements in Group 7 and their compounds.

(a) Chlorine is added to some drinking water supplies to decrease the risk of people suffering from diseases such as cholera.

State why the amount of chlorine added must be controlled.

_____

_____

(1)

(b) Give an equation for the reaction of chlorine with water to form a solution containing **two** acids.

Explain, with reference to electrons, why this is a redox reaction.

Equation

_____

Explanation _____

_____

_____

_____

(2)

(c) A student bubbles chlorine gas through a solution of sodium iodide.

State the observation the student would make.

Give an ionic equation for the reaction.

Observation _____

Ionic equation

_____

(2)

(d) The student adds a few drops of concentrated sulfuric acid to a small amount of solid sodium iodide.

Two gaseous sulfur-containing products are formed.

Give an equation for the formation of each of these sulfur-containing products.

State the role of sulfuric acid in the formation of these products.

Equation 1

_____

Equation 2

_____

Role _____

(3)

(e) The student adds a few drops of acidified silver nitrate solution to a solution of an unknown **impure** sodium halide.
The student observes bubbles of gas and a colourless solution.
The student bubbles the gas through calcium hydroxide solution and a white precipitate forms.

Deduce the identity of the sodium halide.

Suggest the identity of the gas.

Give an ionic equation for the formation of this gas from the impurity.

Identity of sodium halide _____

Identity of gas _____

Ionic equation

_____

(3)

(f) The ClF_2^+ ion contains two different Group 7 elements.

Use your understanding of the electron pair repulsion theory to draw the shape of this ion.

Include any lone pairs of electrons that influence the shape.

Explain why the ion has the shape you have drawn.

Suggest a value for the bond angle in the ion.

Shape

Explanation _____

_____

_____

Bond angle _____

(3)

(g) Magnesium is used in the extraction of titanium from titanium(IV) chloride.

Give an equation for this reaction.

_____

(1)

(Total 15 marks)