

AQA A-LEVEL CHEMISTRY • 7405

CHEMISTRY



EXAM QUESTION PACK

3.2.3 GROUP 7, THE HALOGENS

SCORE

/281

PERCENTAGE

%

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Q1.

Which statement is correct about the reaction between concentrated sulfuric acid and solid sodium bromide?

- A** Bromide ions are reduced.
- B** Hydrogen bromide and sulfur are formed.
- C** Sulfuric acid acts as an oxidising agent.
- D** Bromine and hydrogen sulfide are formed.

☐

(Total 1 mark)

Q2.

Separate unlabelled solid samples of three anhydrous sodium compounds are provided for a student to identify.

These compounds are known to be sodium carbonate, sodium fluoride and sodium chloride but it is not known which sample is which.

Outline a logical sequence of test-tube reactions that the student could carry out to identify each of these compounds.

Include the observations the student would expect to make.

Give equations, including **state symbols**, for any reactions that would take place.

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(Total 6 marks)

Q3.

An aqueous solution **Y** is known to contain one type of group 2 metal ion and one type of negative ion.

Aqueous solutions of sulfuric acid and magnesium nitrate are added to separate samples of solution **Y**. The observations are shown in the table.

Solution added	Observation with solution Y
Sulfuric acid	A white precipitate forms
Magnesium nitrate	A white precipitate forms

- (a) Suggest the identity of the group 2 metal ion present in solution **Y**.

Write an ionic equation, including state symbols, for the reaction that takes place when sulfuric acid is added to solution **Y**.

Group 2 metal ion _____

Ionic equation _____

(2)

- (b) Suggest the identity of the negative ion present in solution **Y**.

Write an ionic equation, including state symbols, for the reaction that takes place when magnesium nitrate is added to solution **Y**.

Negative ion _____

Ionic equation _____

(2)

(Total 4 marks)

Q4.

Which is the best technique to remove the silver chloride that forms when aqueous solutions of silver nitrate and sodium chloride react?

- | | | |
|----------|--------------|--------------------------|
| A | Refluxing | ☐ |
| B | Evaporation | ☐ |
| C | Filtration | ☐ |
| D | Distillation | ☐ |

(Total 1 mark)

Q5.

Which statement about astatine is correct?

- | | | |
|----------|---|--------------------------|
| A | Astatine has a greater electronegativity than bromine | ☐ |
| B | Astatine is a better oxidising agent than bromine | ☐ |
| C | Astatine has a greater boiling point than bromine | ☐ |

- D Astatine has a greater first ionisation energy than bromine



(Total 1 mark)

Q6.

Which species is **not** produced by a redox reaction between solid sodium iodide and concentrated sulfuric acid?

- A Na_2SO_4 ☐
- B H_2S ☐
- C S ☐
- D SO_2 ☐

(Total 1 mark)

Q7.

This question is about silver iodide.

- (a) Define the term enthalpy of lattice formation.

(2)

- (b) Some enthalpy change data are shown in the table.

	Enthalpy change / kJ mol^{-1}
$\text{AgI(s)} \rightarrow \text{Ag}^+(\text{aq}) + \text{I}^-(\text{aq})$	+112
$\text{Ag}^+(\text{g}) \rightarrow \text{Ag}^+(\text{aq})$	-464
$\text{I}^-(\text{g}) \rightarrow \text{I}^-(\text{aq})$	-293

Use the data in the table to calculate the enthalpy of lattice formation of silver iodide.

Enthalpy of lattice formation = _____ kJ mol^{-1}

(2)

- (c) A calculation of the enthalpy of lattice formation of silver iodide based on a perfect ionic model gives a smaller numerical value than the value calculated in part (b)

Explain this difference.

(2)

- (d) Identify a reagent that could be used to indicate the presence of iodide ions in an aqueous solution and describe the observation made.

Reagent _____

Observation _____

(2)

(Total 8 marks)

Q8.

Concentrated sulfuric acid reacts with alkenes, alcohols and sodium halides.

- (a) Name the mechanism for the reaction of concentrated sulfuric acid with an alkene.

(1)

- (b) Outline the mechanism for the reaction of concentrated sulfuric acid with propene to show the formation of the major product.

(4)

- (c) Draw the structure of the minor product of the reaction between concentrated sulfuric acid and propene.

(1)

- (d) Explain why the product shown in your answer to part (b) is the major product.

(2)

- (e) Butan-2-ol reacts with concentrated sulfuric acid to form a mixture of three isomeric alkenes. Two of the alkenes are stereoisomers.

Draw the skeletal formula of each of the three isomeric alkenes formed by the reaction of butan-2-ol with concentrated sulfuric acid.

Give the full IUPAC name of each isomer.

Skeletal formula	Name

(3)

- (f) A by-product of the reaction of butan-2-ol with concentrated sulfuric acid has the molecular formula C_4H_8O

Name this by-product, identify the role of the sulfuric acid in its formation and suggest the name of a method that could be used to separate the products of this reaction.

By-product _____

Role of sulfuric acid _____

Name of separation method

(3)

- (g) Concentrated sulfuric acid reacts with solid sodium chloride.

Give the observation you would make in this reaction.

State the role of the sulfuric acid.

Observation with sodium chloride _____

Role of sulfuric acid _____

(2)

- (h) Concentrated sulfuric acid reacts with solid sodium iodide, to produce several products.

Observations made during this reaction include the formation of a black solid, a yellow solid and a gas with the smell of bad eggs.

Identify the product responsible for each observation.

Black solid _____

Yellow solid _____

Gas _____

(3)

(Total 19 marks)

Q9.

A student was given a 50.0 g sample of solid silver chloride contaminated with solid silver carbonate.

The student suggested the following method to obtain the maximum amount of pure dry silver chloride from the sample:

1. Tip the solid into a boiling tube.
2. Add dilute nitric acid.
3. Allow the remaining solid to settle.

4. Decant off the liquid.

5. Leave the sample to dry on a shelf.

Identify any faults or omissions in the method suggested by the student.

Suggest improvements to the method, using commonly available laboratory equipment.

The following chemicals are also available:

distilled water, dilute solutions of NaOH, NH₃, HCl, H₂SO₄

(Total 6 marks)

Q10.

This question is about elements in Group 7 of the Periodic Table and their compounds.

- (a) Bromine (Br₂), strontium chloride (SrCl₂) and iodine monochloride (ICl) all have similar M_r values.

Suggest, with reasons, the order of melting points for these three substances.

(6)

- (b) Write an equation for the reaction of chlorine with cold water.

State a reason why chlorine is added to drinking water, and suggest a disadvantage of treating water in this way.

Equation

Reason _____

Disadvantage _____

(3)

- (c) Bromine reacts with phosphorus to form phosphorus tribromide.

Write an equation for this reaction and draw the shape of the phosphorus tribromide molecule formed.

Suggest the bond angle in phosphorus tribromide.

Equation

Shape

Bond angle _____

(3)

- (d) Phosphorus pentabromide in the solid state consists of PBr_4^+ and Br^- ions.

Draw the shape of the PBr_4^+ ion and suggest its bond angle.

Shape

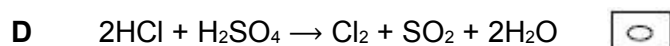
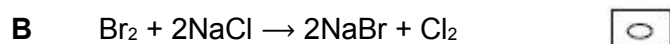
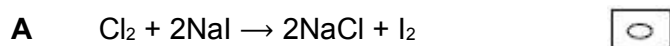
Bond angle _____

(2)

(Total 14 marks)

Q11.

Which equation represents a reaction that does take place?



(Total 1 mark)

Q12.

Which species is the best oxidising agent?



(Total 1 mark)

Q13.

The following tests were carried out to identify an unknown green salt **Y**.

An aqueous solution of **Y** gave a cream precipitate of compound **A** when reacted with silver nitrate solution.

Compound **A** gave a colourless solution when reacted with concentrated ammonia solution.

Another aqueous solution of **Y** gave a green precipitate **B** when reacted with sodium carbonate solution.

The green precipitate **B** was filtered and dried and then reacted with sulfuric acid to give a pale green solution containing compound **C** and a colourless gas **D**.

- (a) Identify by name or formula the compounds **A**, **B**, **C**, **D** and **Y**.

Identity of **A** _____

Identity of **B** _____

Identity of **C** _____

Identity of **D** _____

Identity of **Y** _____

(5)

- (b) Write the simplest ionic equation for the reaction of silver nitrate solution with the anion that is present in compound **Y**.

(1)

- (c) Write the simplest ionic equation for the reaction that occurs between the green precipitate **B** and sulfuric acid.

(1)

(Total 7 marks)

Q14.

This question is about the chemical properties of chlorine, sodium chloride and sodium bromide.

- (a) Sodium bromide reacts with concentrated sulfuric acid in a different way from sodium chloride.

Write an equation for this reaction of sodium bromide and explain why bromide ions react differently from chloride ions.

Equation _____

Explanation _____

(3)

- (b) A colourless solution contains a mixture of sodium chloride and sodium bromide.

Using aqueous silver nitrate and any other reagents of your choice, develop a procedure to prepare a pure sample of silver bromide from this mixture. Explain each step in the procedure and illustrate your explanations with equations, where appropriate.

(6)

- (c) Write an ionic equation for the reaction between chlorine and cold dilute sodium hydroxide solution.
Give the oxidation state of chlorine in each of the chlorine-containing ions formed.

(2)

(Total 11 marks)

Q15.

Which of these substances reacts most rapidly to produce a silver halide precipitate with acidified silver nitrate?

- | | | |
|----------|------------------------|-----------------------|
| A | CH_3Br | ☐ |
| B | CH_3Cl | ☐ |
| C | CH_3F | ☐ |
| D | CH_3I | ☐ |

(Total 1 mark)

Q16.

A Grignard reagent is a compound in which magnesium is bonded to an alkyl group (R)

and a halogen (X). It can be represented by the formula RMgX .

A Grignard reagent is formed by the reaction of magnesium metal with a haloalkane using dry ethoxyethane as a solvent. Ethoxyethane has a boiling point of $35\text{ }^{\circ}\text{C}$, forms a dense vapour and is highly flammable.

- (a) Give **one** reason why a hot water bath is used rather than direct heating with a Bunsen burner when preparing the Grignard reagent.

_____ (1)

- (b) Grignard reagents react with water.

Suggest **one** reason why the ethoxyethane protects the Grignard reagent from reacting with water vapour in the air.

_____ (1)

- (c) A Grignard reagent can be used to introduce an extra carbon atom into an organic molecule.
For example, propanone (CH_3COCH_3) reacts with CH_3MgBr in a two-stage process to form 2-methylpropan-2-ol, $(\text{CH}_3)_3\text{COH}$. The isomer 2-methylpropan-1-ol is not formed in this process.

Suggest a suitable reagent and the associated observations that could be used to distinguish between 2-methylpropan-2-ol and its isomer 2-methylpropan-1-ol.

Reagent _____

Observation with 2-methylpropan-2-ol _____

Observation with 2-methylpropan-1-ol _____

(3)

- (d) At the end of the preparation of the alcohol, the bromine from the Grignard reagent remains as the bromide ion.
Suggest reagents and observations to confirm that this halide ion is Br^- and not I^-

(4)
(Total 9 marks)

Q17.

Silver cyanide can be precipitated from sodium cyanide solution by adding an excess of silver nitrate solution.

Describe how you would obtain a pure dry sample of silver cyanide from this mixture.

(Total 3 marks)

Q18.

A student oxidised a solution of hydrochloric acid with a few drops of sodium chlorate(I) solution. The reaction mixture effervesced and turned pale green. The gas formed bleached universal indicator paper.

- (a) Write a half-equation for the oxidation of chloride ions.

(1)

- (b) Write a half-equation for the reduction of chlorate(I) ions to chlorine in acidic conditions.

(1)

- (c) Write an overall equation for the redox reaction of chlorate(I) ions with hydrochloric acid.

(1)

- (d) A solution of sodium chlorate(I) was added to a colourless solution of potassium iodide.
Suggest what is observed.

Explain the reaction that leads to this observation.

(3)
(Total 6 marks)

Q19.

The halogens are the elements in Group 7.

- (a) The electronegativities of the halogens are shown in the table.

Halogen	Fluorine	Chlorine	Bromine	Iodine
Electronegativity	4.0	3.0	2.8	2.5

Explain the trend in electronegativities shown by the halogens.

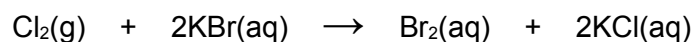
(2)

- (b) The halogens can all behave as oxidising agents in reactions.

- (i) Explain, in terms of electron transfer, the meaning of the term oxidising agent.

(1)

- (ii) An equation for the reaction that takes place when chlorine gas is bubbled through aqueous potassium bromide is shown.



Explain, with reference to the oxidation states, why this is a redox reaction.

(1)

(c) Solid sodium halides react with concentrated sulfuric acid.

- (i) A sample of solid sodium iodide is reacted with concentrated sulfuric acid. A black solid forms and hydrogen sulfide gas is produced.

Write a half-equation for the reaction of sulfuric acid to form hydrogen sulfide.

(1)

- (ii) Write a half-equation for the formation of the black solid.

(1)

- (iii) Use your answers to parts (c) (i) and (c) (ii) to write an overall equation for the reaction of sodium iodide with concentrated sulfuric acid.

(1)

- (iv) Give the role of sulfuric acid in its reaction with sodium iodide.

Tick (✓) **one** box.

Acid

☐

Oxidising agent

☐

Reducing agent

☐

Electrophile

☐

(1)

- (v) Write an equation for the reaction of concentrated sulfuric acid with solid sodium fluoride.

(1)

- (vi) Suggest **one** reason why the reaction of sodium fluoride with concentrated sulfuric acid is different from the reaction with sodium iodide.

(1)

(d) Chlorine reacts with water to form an equilibrium mixture containing hydrochloric acid and chloric(I) acid.

- (i) Write an equation for the formation of this equilibrium mixture.

(1)

- (ii) Household bleach contains sodium chlorate(I) and sodium chloride. State and explain, with reference to your equation in part (d)(i), why it is dangerous to acidify an aqueous mixture of sodium chlorate(I) and sodium chloride.

(2)

(Total 13 marks)

Q20.

The following pairs of compounds can be distinguished by simple test-tube reactions.

For each pair of compounds, give a reagent (or combination of reagents) that, when added separately to each compound, could be used to distinguish between them. State what is observed in each case.

- (a) Butan-2-ol and 2-methylpropan-2-ol

Reagent _____

Observation with butan-2-ol

Observation with 2-methylpropan-2-ol

(3)

- (b) Propane and propene

Reagent _____

Observation with propane

Observation with propene

(3)

- (c) Aqueous silver nitrate and aqueous sodium nitrate

Reagent _____

Observation with aqueous silver nitrate

Observation with aqueous sodium nitrate

(3)

- (d) Aqueous magnesium chloride and aqueous barium chloride

Reagent _____

Observation with aqueous magnesium chloride

Observation with aqueous barium chloride

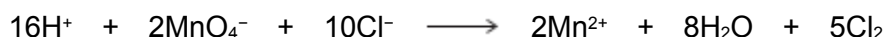
(3)

(Total 12 marks)

Q21.

Chlorine is an important industrial chemical.

- (a) Chlorine is formed when KMnO_4 reacts with hydrochloric acid.
The ionic equation for this redox reaction is



- (i) Deduce the half-equation for the oxidation of chloride ions to chlorine.

(1)

- (ii) Give the oxidation state of manganese in the MnO_4^- ion.

(1)

- (iii) Deduce the half-equation for the reduction of the MnO_4^- ions in acidified solution to manganese(II) ions and water.

(1)

- (b) Chlorine behaves as an oxidising agent in the extraction of bromine from seawater. In this process, chlorine gas is bubbled through a solution containing bromide ions.

(i) Write the **simplest ionic** equation for the reaction of chlorine with bromide ions.

(1)

(ii) Give **one** observation that would be made during this reaction.

(1)

(iii) In terms of electrons, state the meaning of the term **oxidising agent**.

(1)

- (c) In sunlight, chlorine can also oxidise water slowly to form oxygen.

Write an equation for this reaction.

Give the oxidation state of chlorine in the chlorine-containing species that is formed.

Equation

Oxidation state of chlorine in the species formed _____
(2)

- (d) Explain why chlorine has a lower boiling point than bromine.

(2)

(Total 10 marks)

Q22.

- (a) Strontium chloride is used in toothpaste for sensitive teeth. Both strontium carbonate and strontium sulfate are white solids that are insoluble in

water.

- (i) Write an equation for the reaction between strontium chloride solution and sodium sulfate solution.
Include state symbols in your equation.

(1)

- (ii) Strontium carbonate reacts with nitric acid to produce a solution of strontium nitrate.
Strontium sulfate does not react with nitric acid.

Describe briefly how you could obtain strontium sulfate from a mixture of strontium carbonate and strontium sulfate.

You are **not** required to describe the purification of the strontium sulfate.

(2)

- (b) A solution of magnesium sulfate is sometimes given as first aid to someone who has swallowed barium chloride.

Explain why drinking magnesium sulfate solution is effective in the treatment of barium poisoning.

(1)

- (c) Medicines for the treatment of nervous disorders often contain calcium bromide. Silver nitrate, acidified with dilute nitric acid, can be used together with another reagent to test for the presence of bromide ions in a solution of a medicine.

Describe briefly how you would carry out this test and state what you would observe.

(3)

(Total 7 marks)

Q23.

- (a) Anhydrous strontium chloride is not used in toothpaste because it absorbs water from the atmosphere. The hexahydrate, $\text{SrCl}_2 \cdot 6\text{H}_2\text{O}$, is preferred.

A chemist was asked to determine the purity of a sample of strontium chloride hexahydrate. The chemist weighed out 2.25 g of the sample and added it to 100 cm³ of water. The mixture was warmed and stirred for several minutes to dissolve all of the strontium chloride in the sample. The mixture was then filtered into a conical flask. An excess of silver nitrate solution was added to the flask and the contents swirled for 1 minute to make sure that the precipitation was complete.

The silver chloride precipitate was separated from the mixture by filtration. The precipitate was washed several times with deionised water and dried carefully. The chemist weighed the dry precipitate and recorded a mass of 1.55 g.

- (i) Calculate the amount, in moles, of AgCl in 1.55 g of silver chloride ($M_r = 143.4$).

(1)

- (ii) The equation for the reaction between strontium chloride and silver nitrate is



Use your answer from part (i) and this equation to calculate the amount, in moles, of SrCl_2 needed to form 1.55 g of silver chloride.

(1)

- (iii) Use data from the Periodic Table to calculate the M_r of strontium chloride hexahydrate. Give your answer to 1 decimal place.

(1)

- (iv) Use your answers from parts (a)(ii) and (a)(iii) to calculate the percentage by mass of strontium chloride hexahydrate in the sample. Show your working. Give your answer to the appropriate precision.

(2)

- (v) Several steps in the practical procedure were designed to ensure an accurate value for the percentage by mass of strontium chloride hexahydrate in the sample.

- 1 Explain why the solution of strontium chloride was filtered to remove insoluble impurities before the addition of silver nitrate.

(1)

- 2 Explain why the precipitate of silver chloride was washed several times with deionised water.

(1)

- (b) Magnesium hydroxide and magnesium carbonate are used to reduce acidity in the stomach. Magnesium hydroxide can be prepared by the reaction of solutions of magnesium chloride and sodium hydroxide.

- (i) Write the **simplest ionic** equation for the reaction that occurs between magnesium chloride and sodium hydroxide.
Include state symbols in your equation.

(1)

- (ii) Other than cost, explain one advantage of using magnesium hydroxide rather than magnesium carbonate to reduce acidity in the stomach.

(1)

- (c) Calcium ethanoate, $(\text{CH}_3\text{COO})_2\text{Ca}$, is used in the treatment of kidney disease. Thermal decomposition of calcium ethanoate under certain conditions gives propanone and **one** other product.

Write an equation for the thermal decomposition of calcium ethanoate.

(1)

- (d) Salts containing the chromate(VI) ion are usually yellow in colour.
Calcium chromate(VI) is soluble in water.
Strontium chromate(VI) is insoluble in water, but will dissolve in a solution of ethanoic acid.
Barium chromate(VI) is insoluble in water and is also insoluble in a solution of ethanoic acid.

Describe a series of tests using solutions of sodium chromate(VI) and ethanoic acid that would allow you to distinguish between separate solutions of calcium chloride, strontium chloride and barium chloride.
State what you would observe in each test.

(3)

- (e) The strontium salt of ranelic acid is used to promote bone growth. Analysis of a pure sample of ranelic acid showed that it contained 42.09% of carbon, 2.92% of hydrogen, 8.18% of nitrogen, 37.42% of oxygen and 9.39% of sulfur by mass.

Use these data to calculate the empirical formula of ranelic acid.
Show your working.

(2)

(Total 15 marks)

Q24.

- (a) Chlorine displaces iodine from aqueous potassium iodide.

- (i) Write the **simplest ionic** equation for this reaction.

(1)

- (ii) Give **one** observation that you would make when this reaction occurs.

(1)

- (b) In bright sunlight, chlorine reacts with water to form oxygen as one of the products. Write an equation for this reaction.

(1)

- (c) Explain why chlorine has a lower boiling point than bromine.

(2)
(Total 5 marks)

Q25.

The following pairs of compounds can be distinguished by simple test-tube reactions.

For each pair, give a suitable reagent that could be added separately to each compound to distinguish between them.

Describe what you would observe in each case.

- (a) AgBr(s) and AgI(s)

Reagent _____

Observation with AgBr(s) _____

Observation with AgI(s) _____

(3)

- (b) HCl(aq) and HNO₃(aq)

Reagent _____

Observation with HCl(aq) _____

Observation with HNO₃(aq) _____

(3)

- (c) Cyclohexane and cyclohexene

Reagent _____

Observation with cyclohexane _____

Observation with cyclohexene _____

(3)

(d) Butanal and butanone

Reagent _____

Observation with butanal _____

Observation with butanone _____

(3)

(Total 12 marks)

Q26.

Aldehydes can be prepared from acyl chlorides.

State how an aldehyde could be tested to show whether it is contaminated with traces of unreacted acyl chloride.

State what you would observe.

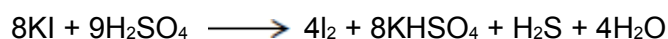
Test _____

Observation _____

(Total 2 marks)

Q27.

Concentrated sulfuric acid reacts with solid potassium iodide as shown in the equation.



Give **two** observations that you would make when this reaction occurs.

In terms of electrons, state what happens to the iodide ions in this reaction.

State the **change** in oxidation state of sulfur that occurs during this formation of H_2S and deduce the half-equation for the conversion of H_2SO_4 into H_2S

(Total 5 marks)

Q28.

Chlorine is a powerful oxidising agent.

- (a) Write the **simplest ionic** equation for the reaction between chlorine and aqueous potassium bromide.

State what is observed when this reaction occurs.

(2)

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

Give a major use for the solution that is formed by this reaction.

Give the IUPAC name of the chlorine-containing compound formed in this reaction in which chlorine has an oxidation state of +1.

(3)

- (c) Write an equation for the equilibrium reaction that occurs when chlorine gas reacts with cold water.

Give **one** reason why chlorine is used for the treatment of drinking water even though the gas is very toxic.

(2)

- (d) State how you could test a sample of water to show that it contains chloride ions.

In your answer, give a reagent, **one** observation and the **simplest ionic** equation for the reaction with the reagent.

(3)

(Total 10 marks)

Q29.

A student investigated the chemistry of the halogens and the halide ions.

- (a) In the first two tests, the student made the following observations.

Test	Observation
1. Add chlorine water to aqueous potassium iodide solution.	The colourless solution turned a brown colour.
2. Add silver nitrate solution to aqueous potassium chloride solution.	The colourless solution produced a white precipitate.

- (i) Identify the species responsible for the brown colour in Test 1.

Write the **simplest ionic** equation for the reaction that has taken place in Test 1.

State the type of reaction that has taken place in Test 1.

(3)

- (ii) Name the species responsible for the white precipitate in Test 2.

Write the **simplest ionic** equation for the reaction that has taken place in Test 2.

State what would be observed when an excess of dilute ammonia solution is added to the white precipitate obtained in Test 2.

(3)

- (b) In two further tests, the student made the following observations.

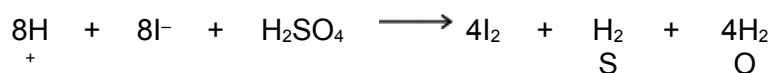
Test	Observation
3. Add concentrated sulfuric acid to solid potassium chloride.	The white solid produced misty white fumes which turned blue litmus paper to red.
4. Add concentrated sulfuric acid to solid potassium iodide.	The white solid turned black. A gas was released that smelled of rotten eggs. A yellow solid was formed.

- (i) Write the **simplest ionic** equation for the reaction that has taken place in Test 3.

Identify the species responsible for the misty white fumes produced in Test 3.

(2)

- (ii) The student had read in a textbook that the equation for one of the reactions in Test 4 is as follows.



Write the **two** half-equations for this reaction.

State the role of the sulfuric acid and identify the yellow solid that is also observed in Test 4.

(4)

- (iii) The student knew that bromine can be used for killing microorganisms in swimming pool water.
The following equilibrium is established when bromine is added to cold water.



Use Le Chatelier's principle to explain why this equilibrium moves to the right when sodium hydroxide solution is added to a solution containing dissolved bromine.

Deduce why bromine can be used for killing microorganisms in swimming pool water, even though bromine is toxic.

(3)

(Total 15 marks)

Q30.

Iodine reacts with concentrated nitric acid to produce nitrogen dioxide (NO_2).

- (a) (i) Give the oxidation state of iodine in each of the following.

I_2 _____

HIO_3 _____

(2)

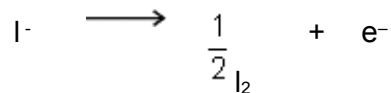
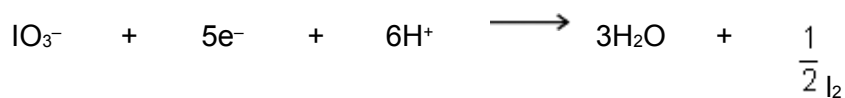
- (ii) Complete the balancing of the following equation.



(1)

- (b) In industry, iodine is produced from the NaIO_3 that remains after sodium nitrate has been crystallised from the mineral Chile saltpetre.

The final stage involves the reaction between NaIO_3 and NaI in acidic solution. Half-equations for the redox processes are given below.



Use these half-equations to deduce an overall ionic equation for the production of iodine by this process. Identify the oxidising agent.

Overall ionic equation

The oxidising agent _____

(2)

- (c) When concentrated sulfuric acid is added to potassium iodide, solid sulfur and a black solid are formed.

- (i) Identify the black solid.

(1)

- (ii) Deduce the half-equation for the formation of sulfur from concentrated sulfuric acid.

(1)

- (d) When iodide ions react with concentrated sulfuric acid in a different redox reaction, the oxidation state of sulfur changes from +6 to -2. The reduction product of this reaction is a poisonous gas that has an unpleasant smell. Identify this gas.

(1)

- (e) A yellow precipitate is formed when silver nitrate solution, acidified with dilute nitric acid, is added to an aqueous solution containing iodide ions.

- (ii) Write the **simplest ionic** equation for the formation of the yellow precipitate.

_____ (1)

- (ii) State what is observed when concentrated ammonia solution is added to this precipitate.

_____ (1)

- (iii) State why the silver nitrate is acidified when testing for iodide ions.

_____ (1)

- (f) Consider the following reaction in which iodide ions behave as reducing agents.



- (i) In terms of electrons, state the meaning of the term *reducing agent*.

_____ (1)

- (ii) Write a half-equation for the conversion of chlorine into chloride ions.

_____ (1)

- (iii) Suggest why iodide ions are stronger reducing agents than chloride ions.

_____ (2)

(Total 15 marks)

Q31.

Fluorine and iodine are elements in Group 7 of the Periodic Table.

- (a) Explain why iodine has a higher melting point than fluorine.

(2)

- (b) (i) Draw the shape of the NHF_2 molecule and the shape of the BF_3 molecule.
Include any lone pairs of electrons that influence the shape. In each case name the shape.

Shape of NHF_2

Shape of BF_3

Name of shape of NHF_2 _____

Name of shape of BF_3 _____

(4)

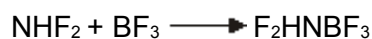
- (ii) Suggest a value for the F—N—F bond angle in NHF_2

(1)

- (c) State the strongest type of intermolecular force in a sample of NHF_2

(1)

- (d) A molecule of NHF_2 reacts with a molecule of BF_3 as shown in the following equation.



State the type of bond formed between the N atom and the B atom in F_2HNBF_3 .

Explain how this bond is formed.

Name of type of bond _____

How bond is formed _____

(2)

Q32.

- (a) Give the **formula** of a Group 2 metal hydroxide used in agriculture.

_____ (1)

- (b) Identify a sodium halide that does **not** undergo a redox reaction when added as a solid to concentrated sulfuric acid.

_____ (1)

- (c) Chlorine gas reacts with cold dilute sodium hydroxide solution to form sodium chloride and another chlorine-containing compound, **X**.

Give the **formula** of **X**.

_____ (1)

- (d) Give the **formula** of the substance responsible for the orange colour when chlorine gas is bubbled through an aqueous solution of sodium bromide.

_____ (1)

- (e) Solid sodium iodide undergoes a redox reaction with concentrated sulfuric acid.

Give the **formula** for each of the following in this reaction.

Formula of the solid reduction product _____

Formula of the oxidation product _____

(2)

- (f) Draw the structure of each of the following organic compounds.

- (i) The hydrocarbon that is a chain isomer of methylpropene, but does **not** exhibit E–Z stereoisomerism.

(1)

- (ii) The alcohol that is a position isomer of butan-2-ol.

(1)

- (iii) The hydrocarbon that has a peak, due to its molecular ion, at $m/z = 44$ in its mass spectrum.

(1)

- (iv) The bromoalkane that reacts with sodium cyanide to produce propanenitrile.

(1)

(Total 10 marks)

Q33.

- (a) Some scientists thought that the waste water from a waste disposal factory contained **two** sodium halides.

They tested a sample of the waste water.

They added three reagents, one after the other, to the same test tube containing the waste water.

The table below shows their results.

Reagent added	Observations
1. Silver nitrate solution (acidified with dilute nitric acid)	A cream precipitate formed
2. Dilute ammonia solution	A yellow precipitate remained
3. Concentrated ammonia solution	The yellow precipitate did not dissolve

- (i) Identify the yellow precipitate that did **not** dissolve in concentrated ammonia solution.
Write the **simplest** ionic equation for the formation of this precipitate from silver ions and the correct halide ion.

Identify the other sodium halide that must be present in this mixture of two sodium halides.

(3)

- (ii) Give **one** reason why the silver nitrate solution was acidified before it was used in this test.

(1)

- (iii) The method that the scientists used could **not** detect one type of halide ion. Identify this halide ion.
Give **one** reason for your answer.

(2)

- (b) The scientists thought that the waste water also contained dissolved barium ions. An aqueous solution of sodium sulfate can be used to test for the presence of dissolved barium ions.

Write the **simplest** ionic equation for the reaction between barium ions and sulfate ions to form barium sulfate.

State what is observed in this reaction.

Give a use for barium sulfate in medicine and explain why this use is possible, given that solutions containing barium ions are poisonous.

(4)

- (c) The scientists also analysed the exhaust gases from an incinerator used to destroy waste poly(ethene).
Mass spectrometry showed that there was a trace gas with a precise $M_r = 28.03176$ in the exhaust gases from the incinerator.

The table below contains some precise relative atomic mass data.

Atom	Precise relative atomic mass
^{12}C	12.00000
^1H	1.00794
^{16}O	15.99491

Use the data to show that the trace gas is ethene. Show your working.

Suggest why both ethene and carbon monoxide might have been identified as the trace gas if the scientists had used relative atomic masses to a precision of only one decimal place.

Write an equation for the incomplete combustion of ethene to form carbon monoxide and water only.

Ethene is used to make poly(ethene).

Draw the displayed formula for the repeating unit of poly(ethene).

Name this type of polymer.

(5)

(Total 15 marks)

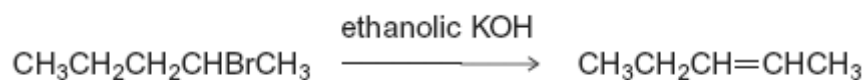
Q34.

Organic reaction mechanisms help chemists to understand how the reactions of organic compounds occur.

The following conversions illustrate a number of different types of reaction mechanism.

- (a) When 2-bromopentane reacts with ethanolic KOH, two structurally isomeric alkenes are formed.

- (i) Name and outline a mechanism for the conversion of 2-bromopentane into pent-2-ene as shown below.

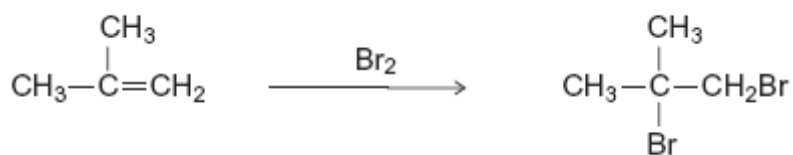


(4)

- (ii) Draw the structure of the other structurally isomeric alkene produced when 2-bromopentane reacts with ethanolic KOH.

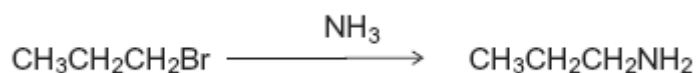
(1)

- (b) Name and outline a mechanism for the following conversion.



(5)

(c) Name and outline a mechanism for the following conversion.



(5)

(Total 15 marks)

Q35.

Copper(II) sulfate solution, together with copper(II) carbonate (CuCO_3) powder, can be used to determine the identity of three solutions **A**, **B** and **C**. The three solutions are known to be hydrochloric acid, barium chloride, and sodium chloride.

In **Experiment 1** a small amount of copper(II) carbonate powder was added to each of the three solutions.

In **Experiment 2** a dropping pipette was used to add 2 cm^3 of copper(II) sulfate solution to each of the three solutions.

The results of these experiments are shown in the table below.

Experiment 1 Addition of copper(II) carbonate powder	Experiment 2 Addition of copper(II) sulfate solution
---	---

Solution A	no visible change	white precipitate
Solution B	no visible change	no visible change
Solution C	effervescence (bubbles of gas)	no visible change

- (a) Use the observations in the table to deduce which of the solutions, **A**, **B** or **C** is hydrochloric acid _____
barium chloride _____
(2)
- (b) Explain why a precipitate was formed when copper(II) sulfate solution was added to solution **A**.
Write an equation for the reaction that occurred.
Explanation _____

Equation _____
(2)
- (c) Suggest the identity for the colourless gas produced when copper(II) carbonate powder was added to solution **C**.

(1)
- (d) Identify the two reagents that could be used in a test to confirm that the solutions contained chloride ions, **not** bromide ions. State what would be observed on addition of each reagent.
Reagent 1 _____
Observation 1 _____

Reagent 2 _____
Observation 2 _____

(4)
- (e) Copper(II) sulfate is toxic. Suggest **one** safety precaution you would take to minimise this hazard when wiping up a spillage of copper(II) sulfate solution.

(1)

(Total 10 marks)

Mark schemes

Q1.
c

[1]

Q2.

Marks awarded for this answer will be determined by the quality of written communication as well as the standard of the scientific response. Examiners should apply a 'best-fit' approach to the marking. Additional tests limits to lower mark within a level. This would include, for example, adding silver nitrate to the already identified sodium carbonate. Use of hydrochloric acid with silver nitrate also limits to lower mark within a level as this would not be a logical sequence/method that would work.	
Level 3 5-6 marks	All stages are covered and each stage is generally correct and virtually complete. Answer is communicated coherently and shows a logical progression from Stage 1 to Stages 2 and 3 to identify all three compounds in a logical sequence with results and equations for all compounds stated. Covers 2 tests with matching observations, conclusions and equations
Level 2 3-4 marks	All stages are covered but stage(s) may be incomplete or may contain inaccuracies OR two stages are covered and are generally correct and virtually complete. Answer is communicated mainly coherently and shows a logical progression from Stage 1 to Stages 2 and 3. Covers 2 compounds Isolated tests on named compounds – max LEVEL 2
Level 1 1-2 marks	Two stages are covered but stage(s) may be incomplete or may contain inaccuracies OR only one stage is covered but is generally correct and virtually complete. Answer includes isolated statements but these are not presented in a logical order.

Indicative Chemistry Content

Stage 1 Suggested tests

1a Add named acid to all 3

1b Add water / make into a solution

1c Add AgNO₃

Ignore addition of NH_3 / Ignore additional test for CO_2 produced

Stage 2 Expected observations - conclusions

2a Na_2CO_3 will fizz with acid

2b NaCl gives white ppt with AgNO_3

2c NaF shows no (visible) change / no ppt

Additional incorrect observations loses point

Stage 3 Equations – state symbols must match method

3a $\text{Na}_2\text{CO}_3 + 2\text{HNO}_3 \rightarrow 2\text{NaNO}_3 + \text{CO}_2 + \text{H}_2\text{O}$... or ionic

3b $\text{AgNO}_3 + \text{NaCl} \rightarrow \text{AgCl} + \text{NaNO}_3$

... or ionic

3c correct state symbols

[6]

Q3.

(a) Ba^{2+} OR Sr^{2+}

1

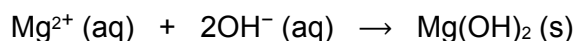
Award M1 if barium named in M1 then used Ba^{2+} in the equation



1

(b) OH^-

Award M1 if hydroxide named in M1 then used OH^- in the equation



1

1

[4]

Q4.

C

[1]

Q5.

C

[1]

Q6.

A

[1]

Q7.

(a) Enthalpy change or heat energy change when 1 mol of solid ionic compound/substance or 1 mol of ionic lattice

1

is formed from its gaseous ions.

1

Allow: enthalpy change for:

$M^+ (g) + X^- (g) \rightarrow MX (s)$ or $Ag^+ (g) + I^- (g) \rightarrow AgI (s)$
CE=0/2 if describing wrong process (e.g. ΔH of lattice dissociation or ΔH of formation / or heat energy required)
Ignore heat energy released

- (b) lattice dissociation energy = $(112 + 464 + 293) = + 869 \text{ (kJ mol}^{-1}\text{)}$

1

lattice formation energy = $- 869 \text{ (kJ mol}^{-1}\text{)}$

$(+)869 = 1 \text{ mark}$

1

- (c) AgI contains covalent character

CE=0/2 if atoms/molecules

For M1, allow the following:

*not completely ionic / ions not spherical / ions distorted /
 some covalent bonding*

1

Forces / bonds (holding the lattice together) are stronger

Ignore covalent bonds stronger (than ionic bonds)

Ignore electronegativity

Ignore references to energy

1

- (d) $AgNO_3$
yellow ppt

Ignore ammonia/acidified/nitric acid/sulfuric acid

1

or

Cl_2 or Br_2

brown solution/black ppt

*M2 dependent on correct M1 but mark on from Ag^+ or
 Tollens*

1

[8]

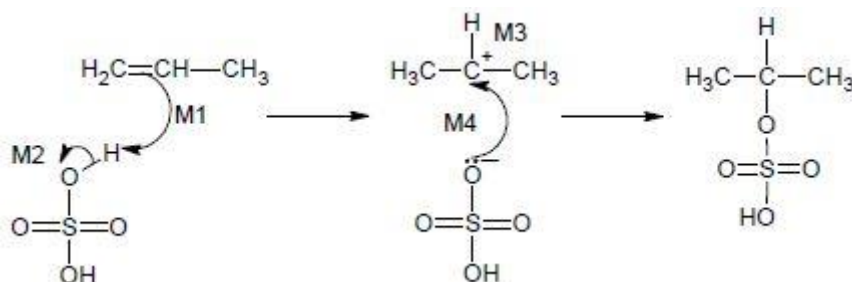
Q8.

- (a) electrophilic addition

ALLOW phonetic e.g. electrophylic, electrophillic

1

- (b)



M1: must show an arrow from $=$ of $C=C$ towards the H atom of the H-O bond or HO that is part of H-O-S... on a compound with molecular formula H_2SO_4

M1 could have arrow to H^+ in which case **M2** would be for an independent H–O bond break on a compound with formula H_2SO_4

ALLOW CH_3-C^+ etc for carbocation

No need for hydrogensulfate to be displayed

*If H_2O used as electrophile – max **M3** ONLY*

M2: must use an arrow to show the breaking of the H–O bond

***M2** ignore partial charges unless wrong*

M3: is for the correct carbocation structure

*NOT **M3** if primary carbocation shown.*

M4: must show an arrow from a lone pair of electrons on the correct oxygen of the negatively charged ion towards the positively charged carbon atom

***M4** NOT HSO_4*

credit as shown (or $^-:OSO_2OH$)

or as $:OSO_3H$ – in which case negative charge can be shown anywhere

*ecf from H_2SO_3 in **M1***

NB: The arrows are double-headed

***IGNORE** subsequent use of water to hydrolyse hydrogensulfate*

4

(c) minor product = $CH_3CH_2CH_2OSO_3H$

ecf from 1° in (b) for $CH_3CH(OSO_3H)CH_3$

ecf from alcohol as product in (b)

ecf from side chain such as $-OHSO_3$ or $-HSO_4$ in (b)

1

(d) (major) product formed via more stable carbocation OR secondary carbocation more stable (than primary)

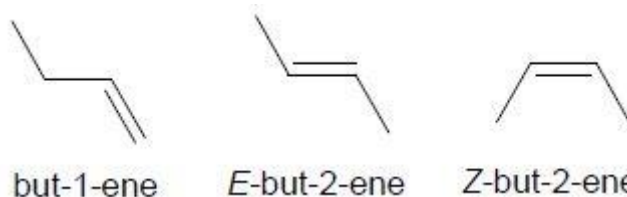
1

Due to electron-releasing character / (positive) inductive effect of two alkyl / methyl groups (as opposed to one)

1

ALLOW 'more' alkyl groups in place of 'two' alkyl groups

(e)



*matching name **and** formula for each mark*

One 'salvage' mark available for 3 correct structures or 3 correct names if no other mark awarded

*use of **trans** **and** **cis** can score 1/2 for the two but-2-ene structures*

3

(f) butanone

ALLOW butan-2-one

1

oxidising agent	
<i>ALLOW electron acceptor but NOT electron pair acceptor</i>	1
(fractional) distillation	
<i>ALLOW gas <u>chromatography</u></i>	1
(g) white / misty / steamy fumes	
<i>NOT gas evolved / effervescence</i>	1
acid/proton donor	1
(h) iodine / I ₂	
<i>IGNORE state symbols</i>	1
sulfur / S / S ₈	
<i>If name and formula given they must both be right</i>	1
hydrogen sulfide / H ₂ S	1
	[19]

Q9.

This question is marked using levels of response. Refer to the Mark Scheme Instructions for Examiners for guidance on how to mark this question.

Level 3

All stages are covered and the explanation of each stage is generally correct and virtually complete.

Stage 2 is supported by correct equations.

Answer communicates the whole process coherently and shows a logical progression from stage 1 to stage 2 and then stage 3. The steps in stage 3 are in a logical order.

5-6 marks

Level 2

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.

Answer is mainly coherent and shows a progression through the stages. Some steps in each stage may be out of order and incomplete.

3-4 marks

Level 1

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.

Answer includes some isolated statements, but these are not presented in a logical order or show confused reasoning.

1-2 marks

Level 0

Insufficient correct chemistry to warrant a mark.

0 marks

Indicative Chemistry content

Stage 1 Apparatus

- Boiling tube likely to be too small for 50.0 g solid plus acid
- Use a (large / medium / 250 ml) beaker instead

Stage 2 AgCl Prep

- HNO_3 will form soluble AgNO_3 so max AgCl not obtained
- Use HCl instead
- Method doesn't say how much acid should be used
Or
Use excess acid / Add acid until no more bubbles evolved

Stage 3 Making pure dry solid

- Decanting means solid wet / contaminated with HNO_3 / acid or decanting means some solid lost
- Instead use filter and then wash with distilled water (and then dry)

[6]

Q10.

- (a) $\text{SrCl}_2 > \text{ICI} > \text{Br}_2$

If wrong can award 1 for one in the correct 'position'

2

SrCl_2 strong ionic bonds / (strong electrostatic attraction between opposite ions)

1

Lattice so many strong bonds to overcome

1

ICI has dipole-dipole between molecules – weaker than ionic bonds

1

Br_2 has van der Waals forces between molecules – much weaker

Accept London / dispersion / induced dipole forces

1

- (b) $\text{Cl}_2 + \text{H}_2\text{O} \rightleftharpoons \text{HCl} + \text{HClO}$

OR $2\text{Cl}_2 + 2\text{H}_2\text{O} \rightleftharpoons \text{O}_2 + 4\text{HCl}$

OR $\text{Cl}_2 + \text{H}_2\text{O} \rightleftharpoons 2\text{H}^+ + \text{Cl}^- + \text{ClO}^-$

1

Kills bacteria

1

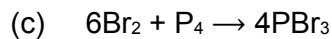
Wasteful as most potable water not used for drinking - used in washing clothes etc

OR Some people suffer eye irritation / Some people find the taste unpleasant

OR can react with organic compounds to produce harmful substances

Allow 'it is potentially toxic as it can be if over concentrated'

1



Accept 4P for P₄

1

Pyramidal shown in a diagram (but the name of the shape isn't needed)

1

100–108°

Actual value is 101° (hence larger range of values allowed)

1

(d) Tetrahedral shown in a diagram (but the name of the shape isn't needed)

1

109.5°

Accept 109° or 109°28'

1

[14]

Q11.

A

[1]

Q12.

A

[1]

Q13.

(a) **A** Silver bromide / AgBr

1

B Iron(II) carbonate / FeCO₃

1

C Iron(II) sulphate / FeSO₄

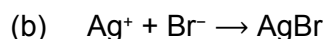
1

D Carbon dioxide / CO₂

1

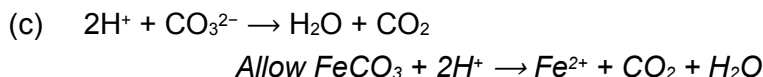
Y Iron(II) bromide / FeBr₂

1



Allow equation if state symbols missing but penalise if state symbols are incorrect

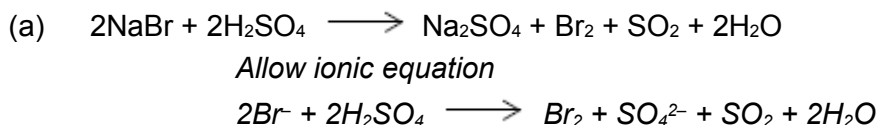
1



1

[7]

Q14.



1

Br^- ions are bigger than Cl^- ions

1

Therefore Br^- ions more easily oxidised / lose an electron more easily (than Cl^- ions)

1

- (b) This question is marked using levels of response. Refer to the Mark Scheme Instructions for Examiners for guidance on how to mark this question.

Level 3

All stages are covered and the explanation of each stage is generally correct and virtually complete. Stages 1 and 2 are supported by correct equations.

Answer communicates the whole process coherently and shows a logical progression from stage 1 to stage 2 and then stage 3. The steps in stage 3 are in a logical order.

5–6 marks

Level 2

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.

Answer is mainly coherent and shows a progression through the stages. Some steps in each stage may be out of order and incomplete.

3–4 marks

Level 1

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.

Answer includes some isolated statements, but these are not presented in a logical order or show confused reasoning.

1–2 marks

Level 0

Insufficient correct chemistry to warrant a mark.

0 marks

Indicative chemistry content

Stage 1: formation of precipitates

- Add silver nitrate
- to form precipitates of AgCl and AgBr
- $\text{AgNO}_3 + \text{NaCl} \rightarrow \text{AgCl} + \text{NaNO}_3$
- $\text{AgNO}_3 + \text{NaBr} \rightarrow \text{AgBr} + \text{NaNO}_3$

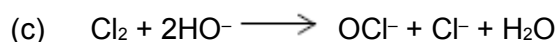
Stage 2: selective dissolving of AgCl

- Add excess of dilute ammonia to the mixture of precipitates
- the silver chloride precipitate dissolves
- $\text{AgCl} + 2\text{NH}_3 \rightarrow \text{Ag}(\text{NH}_3)_2^+ + \text{Cl}^-$

Stage 3: separation and purification of AgBr

- Filter off the remaining silver bromide precipitate
- Wash to remove soluble compounds
- Dry to remove water

6



1

OCl⁻ is +1

Cl⁻ is -1

Both required for the mark

1

[11]

Q15.

D

[1]

Q16.

- (a) Ethoxyethane is flammable

Accept "to avoid igniting ethoxyethane vapour".

1

- (b) Ethoxyethane (vapour) forms a protective layer

Water and ethoxyethane are immiscible.

Do not allow 'ethoxyethane is dense' without further qualification.

1

- (c) Acidified potassium dichromate(VI)/K₂Cr₂O₇ **M1**

*If incomplete, lose **M1** but mark on. If incorrect CE = 0/3.*

Accept acidified sodium dichromate / Na₂Cr₂O₇

1

Observation with 2-methylpropan-2-ol – no colour change **M2**

Accept "stays orange".

1

Observation with 2-methylpropan-1-ol – (orange to) green **M3**

Accept chemically correct alternatives.

1

- (d) i. (Acidified) silver nitrate (solution)
Allow a chemically correct alternative reagent.
 1
- ii. Cream / off-white precipitate
Allow this alternative with correct observation.
 1
- Dilute ammonia solution **OR** Conc ammonia solution
Allow this alternative with correct confirmatory reagent or procedure.
 1
- some ppt dissolves or ppt dissolves
Allow this alternative with correct confirmatory result.
*Do not allow full marks for alternatives without **both** a test and a confirmation.*
 1 [9]

Q17.

- Filter
Must be in this order
 1
- Wash (the residue) with water
 1
- Dry by pressing between filter paper or in air
Allow other suitable methods for drying. If heat is mentioned, method of gentle heating must be specified. Heat, alone, is not sufficient
 1 [3]

Q18.

- (a) $2\text{Cl}^- \rightarrow \text{Cl}_2 + 2\text{e}^{(-)}$
Allow $2\text{Cl}^- - 2\text{e}^{(-)} \rightarrow \text{Cl}_2$
Allow correct equation forming ClO^- but not Cl^+
 1
- (b) $2\text{ClO}^- + 4\text{H}^+ + 2\text{e}^- \rightarrow \text{Cl}_2 + 2\text{H}_2\text{O}$
Allow HClO in correctly balanced equation
 1
- (c) $\text{ClO}^- + \text{Cl}^- + 2\text{H}^+ \rightarrow \text{Cl}_2 + \text{H}_2\text{O}$
allow $\text{HClO} + \text{HCl} + \rightarrow \text{Cl}_2 + \text{H}_2\text{O}$
 1
- (d) Goes brown (or shades of brown)
Allow black ppt/solid but NOT black solution or purple
 1

Due to iodine or I_3^-

Correct $\frac{1}{2}$ equation scores M2 and M3

1

Because I^- oxidised

1

[6]

Q19.

- (a) Increasing atomic radius / shielding / number of shells / size (down group) or reverse argument

NOT 'molecules'

1

Decreasing attraction of nucleus/protons for shared (electron) pair / bond electrons

NOT if attraction for single electron implied

1

- (b) (i) Electron acceptor / species that accepts electrons / species that gains electrons

NOT electron pair

NOT just 'gain of electrons'

1

- (ii) Chlorine 0 to -1 / oxidation state/number of chlorine decreases
AND

Bromine -1 to 0 / oxidation state/number of bromine increases

Penalise if oxidised for chlorine and/or reduced for bromine

Credit oxidation states if labelled on equation

1

- (c) (i) $H_2SO_4 + 8H^+ + 8e^- \rightarrow H_2S + 4H_2O$

ALLOW $SO_4^{2-} + 10H^+ + 8e^- \rightarrow H_2S + 4H_2O$

ALLOW fractions/multiples

IGNORE state symbols

1

- (ii) $2I^- \rightarrow I_2 + 2e^-$

ALLOW fractions/multiples

IGNORE state symbols

ALLOW $2I^- - 2e^- \rightarrow I_2$

1

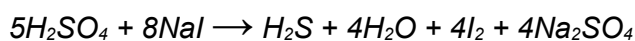
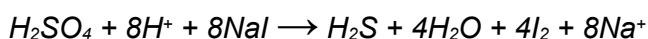
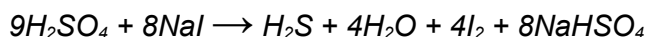
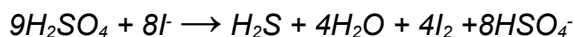
- (iii) $H_2SO_4 + 8H^+ + 8I^- \rightarrow H_2S + 4H_2O + 4I_2$

ALLOW

$H_2SO_4 + 8HI \rightarrow H_2S + 4H_2O + 4I_2$

$SO_4^{2-} + 2H^+ + 8HI \rightarrow H_2S + 4H_2O + 4I_2$

$SO_4^{2-} + 10H^+ + 8I^- \rightarrow H_2S + 4H_2O + 4I_2$



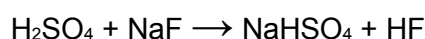
1

(iv) 'Oxidising agent' box ticked

1

(v) $\text{H}_2\text{SO}_4 + 2\text{NaF} \rightarrow \text{Na}_2\text{SO}_4 + 2\text{HF}$

OR



1

(vi) Fluoride less powerful reducing agent (than iodide)

OR

Fluoride less easily oxidised than iodide

Or reverse argument in either case

NOT general group VII trend statement

NOT fluorine/F or iodine/I

Must be comparative

1

(d) (i) $\text{Cl}_2 + \text{H}_2\text{O} \rightleftharpoons 2\text{H}^+ + \text{Cl}^- + \text{ClO}^-/\text{HCl} + \text{HOCl}$

ALLOW $\rightarrow$ for $\rightleftharpoons$

1

(ii) Equilibrium shifts/moves left

1

(Producing) chlorine (which) is toxic/poisonous

Mark independently

1

[13]

Q20.

(a) **M1** acidified potassium dichromate or $\text{K}_2\text{Cr}_2\text{O}_7 / \text{H}_2\text{SO}_4$

OR $\text{K}_2\text{Cr}_2\text{O}_7 / \text{H}^+$ **OR** acidified $\text{K}_2\text{Cr}_2\text{O}_7$

M2 (orange to) green solution **OR** goes green

M3 (solution) remains orange or no reaction or no (observed) change

If no reagent or incorrect reagent in **M1**, **CE = 0** and no marks for **M1**, **M2** or **M3**

If incomplete / inaccurate attempt at reagent e.g.

"dichromate" or "dichromate(IV)" or incorrect formula or no acid, **penalise M1 only and mark on**

For **M2** ignore dichromate described as "yellow" or "red"

For **M3** ignore "nothing (happens)" or "no observation"

Alternative using $\text{KMnO}_4 / \text{H}_2\text{SO}_4$

M1 acidified potassium manganate(VII) / potassium permanganate or $\text{KMnO}_4 / \text{H}_2\text{SO}_4$

OR $\text{KMnO}_4 / \text{H}^+$ **OR** acidified KMnO_4

M2 colourless solution **OR** goes colourless

M3 (solution) remains purple or no reaction or no (observed) change

For M1

If incomplete / inaccurate attempt at reagent e.g.

*“manganate” or “manganate(IV)” or incorrect formula or no acid, **penalise M1 only and mark on***

*Credit alkaline KMnO_4 for possible full marks but **M2** gives brown precipitate or solution goes green*

3

(b) **M1** (Shake with) Br_2 **OR** bromine (water) **OR** bromine (in CCl_4 / organic solvent)

M2 (stays) orange / red / yellow / brown / the same

OR no reaction **OR** no (observed) change

M3 decolourised / goes colourless / loses its colour / orange to colourless

*If no reagent or incorrect reagent in **M1**, **CE = 0** and no marks for **M1**, **M2** or **M3***

*If incomplete / inaccurate attempt at reagent (e.g. Br), **penalise M1 only and mark on***

*No credit for combustion observations; **CE = 0***

*For **M2** in every case*

Ignore “nothing (happens)”

Ignore “no observation”

Ignore “clear”

OR as alternatives

Use $\text{KMnO}_4 / \text{H}_2\text{SO}_4$

M1 acidified potassium manganate(VII) / potassium permanganate **OR** $\text{KMnO}_4 / \text{H}_2\text{SO}_4$

OR $\text{KMnO}_4 / \text{H}^+$ **OR** acidified KMnO_4

M2 (stays) purple or no reaction or no (observed) change

M3 decolourised / goes colourless / loses its colour

Use iodine

M1 iodine or I_2 / KI or iodine solution

M2 no change

M3 decolourised / goes colourless / loses its colour

Use concentrated sulfuric acid

M1 concentrated H₂SO₄

M2 no change

M3 brown

For M1, it must be a whole reagent and / or correct formula

For M1 penalise incorrect attempt at correct formula, but mark M2 and M3

With potassium manganate(VII)

If incomplete / inaccurate attempt at reagent e.g.

“manganate” or “manganate(IV)” or incorrect formula or no acid, penalise M1 only and mark on

Credit alkaline / neutral KMnO₄ for possible full marks but M3 gives brown precipitate or solution goes green

Apply similar guidance for errors in the formula of iodine or concentrated sulfuric acid reagent as those used for other reagents.

3

(c) **M1** Any soluble chloride including hydrochloric acid (ignore concentration)

M2 white precipitate or white solid / white suspension

M3 remains colourless or no reaction or no (observed) change or no precipitate or clear solution or it remains clear

OR as an alternative

M1 Any soluble iodide including HI

M2 yellow precipitate or yellow solid / yellow suspension

M3 remains colourless or no reaction or no (observed) change or no precipitate or clear solution or it remains clear

OR as an alternative

M1 Any soluble bromide including HBr

M2 cream precipitate or cream solid / cream suspension

M3 remains colourless or no reaction or no (observed) change or no precipitate or clear solution or it remains clear

OR as an alternative

M1 NaOH or KOH or any soluble carbonate

M2 brown precipitate or brown solid / brown suspension with NaOH / KOH
(white precipitate / solid / suspension with carbonate)

M3 remains colourless or no reaction or no (observed) change or no precipitate or clear solution or it remains clear

If no reagent or incorrect reagent or insoluble chloride in M1,

CE = 0 and no marks for **M1**, **M2** or **M3**

Allow chlorine water

If incomplete reagent (e.g. chloride ions) or inaccurate attempt at formula of chosen chloride, or chlorine, **penalise M1 only and mark on**

For **M2** require the word “white” and some reference to a solid. Ignore “cloudy solution” OR “suspension” (similarly for the alternatives)

For **M3**

Ignore “nothing (happens)”

Ignore “no observation”

Ignore “clear” on its own

Ignore “dissolves”

3

- (d) **M1** Any soluble sulfate including (dilute or aqueous) sulfuric acid

M2 remains colourless or no reaction or no (observed) change or no precipitate or clear solution or it remains clear

M3 white precipitate or white solid / white suspension

If no reagent or incorrect reagent or insoluble sulfate in **M1**, **CE = 0** and no marks for **M1**, **M2** or **M3**

Accept MgSO_4 and CaSO_4 but not barium, lead or silver sulfates

If concentrated sulfuric acid or incomplete reagent (e.g. sulfate ions) or inaccurate attempt at formula of chosen sulfate, **penalise M1 only and mark on**

For **M3** (or **M2** in the alternative) require the word “white” and some reference to a solid.

Ignore “cloudy solution” OR “suspension”

For **M2** (or **M3** in the alternative)

Ignore “nothing (happens)”

Ignore “no observation”

Ignore “clear” on its own

Ignore “dissolves”

OR as an alternative

M1 NaOH or KOH

M2 white precipitate or white solid / white suspension

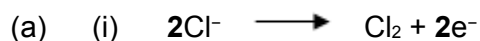
M3 remains colourless or no reaction or no (observed) change or no precipitate or clear solution or it remains clear

If incomplete reagent (e.g. hydroxide ions) or inaccurate attempt at formula of chosen hydroxide, **penalise M1 only and mark on**

If **M1** uses NH_3 (dilute or concentrated) **penalise M1 only and mark on**

3

[12]

Q21.

Ignore state symbols

Credit loss of electrons from LHS

Credit multiples

Do not penalise absence of charge on electron

1



Allow Mn^{+7} and $7+$

1



Ignore state symbols

Credit loss of electrons from RHS

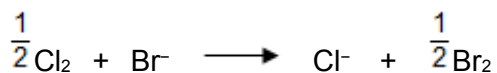
Credit multiples

Do not penalise absence of charge on electron

1



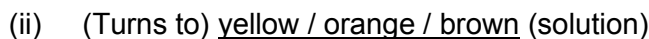
OR



One of these two equations only

Ignore state symbols

1



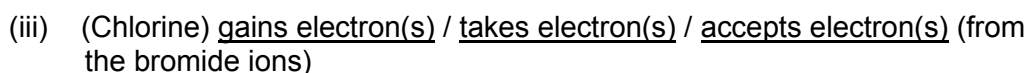
Penalise "red / reddish" as the only colour

Accept "red-brown" and "red-orange"

Ignore "liquid"

Penalise reference to a product that is a gas or a precipitate

1



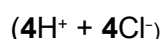
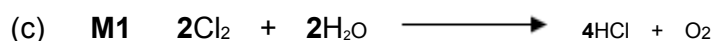
OR



Penalise "electron pair acceptor"

Not simply "causes loss of electrons"

1



Ignore state symbols

Credit multiples

M2 consequential on HCl or Cl⁻ which **must** be the only chlorine-containing product in the (un)balanced equation.
For **M2** allow Cl⁻¹ or Cl¹⁻ but **not** Cl⁻

2

(d) **M1 The relative size (of the molecules / atoms)**

Chlorine is smaller than bromine **OR** has fewer electrons / electron shells
For **M1** ignore whether it refers to molecules or atoms.

OR It is smaller / It has a smaller atomic radius / it is a smaller molecule / atom (or converse)

CE=0 for the clip for reference to (halide) ions or incorrect statements about relative size
Ignore molecular mass and M_r

M2 How size of the intermolecular force affects energy needed

Ignore shielding

The forces between chlorine / Cl₂ molecules are weaker (than the forces between bromine / Br₂ molecules)
(or converse for bromine)

OR chlorine / Cl₂ has weaker / fewer / less (VdW) intermolecular forces / forces between molecules
(or converse for bromine)

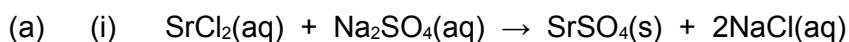
QoL in M2 for clear reference to the difference in size of the force between molecules. Reference to Van der Waals forces alone is not enough.

Penalise **M2** if (covalent) bonds are broken

2

[10]

Q22.



Allow multiples, including fractions.

Allow ionic equations.

Lose this mark if any of the state symbols are missing or incorrect.

1

(ii) Add nitric acid to the mixture (until in excess)

Do not allow any suggestion that the solution is an emetic.

1

Filter (to isolate strontium sulfate)

1

(b) Insoluble barium sulfate is formed

Allow 'removes barium ions as a precipitate'.

1

(c) Add silver nitrate, then dilute ammonia (solution) **M1**

Do not allow answers which imply silver nitrate and ammonia are added at the same time.

Allow 'add silver nitrate, then concentrated ammonia (solution)'.

Can score **M1** in the answer for **M3**

1

Cream precipitate **M2**

Allow 'off white precipitate'.

1

No visible change or precipitate dissolves slightly in dilute ammonia **M3**

Allow 'soluble / colourless solution / precipitate dissolves in concentrated ammonia'.

Allow 3 marks for:

Add dilute ammonia (solution), then silver nitrate **M1**

No visible change **M2**

Cream / off white precipitate with silver nitrate **M3**

1

[7]

Q23.

- (a) (i) 1.08×10^{-2}

Do not penalise precision but must be to at least 2 significant figures.

Do not accept 1×10^{-2}

1

- (ii) $5.4(0) \times 10^{-3}$

Allow (i) / 2

Do not penalise precision but must be to at least 2 significant figures.

1

- (iii) 266.6

Lose this mark if answer not given to 1 decimal place.

1

- (iv) mass = $5.4(0) \times 10^{-3} \times 266.6 = 1.44$ g **M1**

Allow (ii) $\times$ (iii).

1

percentage = $1.44 \times 100 / 2.25 = 64.0$ **M2**

Allow consequential answer from **M1**

Lose this mark if answer not given to 3 significant figures.

Correct answer with no working scores **M2** only.

1

- (v) 1 Would give an incorrect / too large mass (of silver chloride)
Do not allow 'to get an accurate result' without qualification.

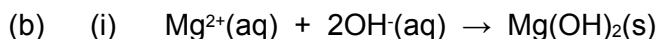
1

- 2 To remove soluble impurities / excess silver nitrate (solution) / strontium nitrate (solution)

Do not allow 'to remove impurities'.

Do not allow 'to remove excess strontium chloride solution'.

1



Allow $\text{Mg}^{2+}(\text{aq}) + 2\text{OH}^{-}(\text{aq}) \rightarrow \text{Mg}^{2+}(\text{OH})_2(\text{s})$

Allow multiples, including fractions.

Lose mark if state symbols are missing or incorrect.

Lose mark if incorrect charge on an ion.

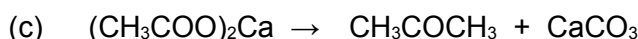
1

- (ii) Does not produce CO_2 / gas which distends stomach / does not produce wind / does not increase pressure in stomach

Allow 'prevents flatulence' and 'prevents burping'.

Do not allow 'gas' without qualification.

1



Allow multiples.

Allow propanone as $\text{C}_3\text{H}_6\text{O}$

Allow $(\text{CH}_3\text{COO})_2\text{Ca}^{2+} \rightarrow \text{CH}_3\text{COCH}_3 + \text{Ca}^{2+}\text{CO}_3^{2-}$

1

- (d) Ca (salt) - no visible change with sodium chromate(VI) **M1**

Allow 'yellow solution formed' or 'no ppt. forms'.

Allow **M1** and **M2** in any order.

1

Sr and Ba (salts) give (yellow) precipitate with sodium chromate(VI) **M2**

Lose this mark if precipitate has an incorrect colour.

1

Sr precipitate (chromate(VI)) dissolves in ethanoic acid / Ba precipitate (chromate(VI)) does not dissolve in ethanoic acid **M3**

If ethanoic acid is added first, allow access to **M1** and **M3**.

1

- (e) C 42.09 / 12, H 2.92 / 1, N 8.18 / 14, O 37.42 / 16 and S 9.39 / 32.1

Accept any other correct method of working.

If relative atomic mass has been divided by the percentage composition is used then CE = 0 / 2

1

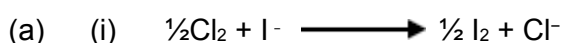


Correct answer with no working scores 1 mark only.

1

[15]

Q24.



Only these two equations.

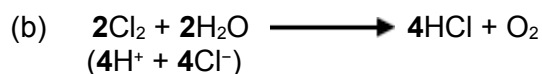
OR



- (ii) (Solution turns from colourless to) brown / red-brown solution

Allow grey / black solid.

Ignore "purple".



Credit multiples.

- (c) **M1 The relative size (of the molecules / atoms)**

Chlorine is smaller than bromine OR has fewer electrons / electron shells

OR It is smaller / It has a smaller atomic radius / it is a smaller molecule / or has smaller M_r

(or converse for bromine)

Ignore general Group 7 statements.

*For **M1** ignore whether it refers to molecules or atoms.*

M2 How size of the intermolecular force affects energy needed

The forces between chlorine / Cl_2 molecules are weaker (than the forces between bromine / Br_2 molecules leading to less energy needed to separate the molecules)

(or converse for bromine)

OR chlorine / Cl_2 has weaker / less / fewer forces between molecules **OR**

chlorine / Cl_2 has weaker / less / fewer intermolecular forces

(or converse for bromine)

CE=0 for reference to (halide) ions.

QoL for clear reference to the difference in size of the force between molecules.

*Penalise **M2** if (covalent) bonds are broken.*

Q25.

- (a) **M1** concentrated sulfuric acid OR c(onc) H_2SO_4

*If no reagent or incorrect reagent in **M1**, **CE= 0** and no marks for **M2** or **M3***

M2 (cream solid) turns orange

OR orange / red / brown fumes / gas / vapour

*If dilute sulfuric acid **OR** "aq" (alone) **CE=0***

M3 (yellow solid) turns black

OR purple fumes / gas / vapour

OR correct reference to H_2S observation (eg bad egg smell)

*If H_2SO_4 / sulfuric acid given but not stated whether dilute or concentrated, penalise **M1** and mark on for **M2** and **M3***

*If incorrect formula for the acid, penalise **M1** but mark **M2** and **M3***

OR as an alternative

M1 concentrated ammonia **OR** c(onc) NH₃

*If NH₃ / ammonia / aq ammonia given, but not stated as concentrated **OR** if dilute ammonia given, penalise **M1** but mark on for **M2** and **M3***

*Ignore "partially" and ignore "clear" in **M2***

M2 (cream solid) dissolves / solution formed

M3 precipitate remains / does not dissolve / insoluble

OR no reaction / no change / (yellow solid) turns to white solid

*If incorrect formula for ammonia, penalise **M1** but mark **M2** and **M3***

*In **M3** for ammonia.*

ignore "nothing (happens)".

ignore "no observation".

3

(b) M1 AgNO₃ **OR** silver nitrate **OR** any soluble silver salt

*If no reagent **OR** incorrect reagent in **M1**, **CE= 0** and no marks for **M2 OR M3***

M2 white precipitate or white solid / white suspension

*An insoluble silver salt **OR** Tollens' **OR** Ag **OR** ammoniacal silver nitrate or HCl / AgNO₃ **CE= 0** for the clip.*

M3 remains colourless **OR** no reaction **OR** no (observed) change **OR** no precipitate

*For **M1***

*Credit acidified (**OR** HNO₃) silver nitrate for **M1** and mark on.*

If silver ions or incorrect formula for silver nitrate, penalise

M1** but mark **M2** and **M3

Credit alternative test for nitrate ions

*For **M2***

*Ignore "cloudy solution" **OR** "suspension".*

*For **M3***

Ignore "nothing (happens)".

Ignore "no observation".

Ignore "clear".

Ignore "dissolves".

3

(c) M1 Br₂ **OR** bromine (water) **OR** bromine (in CCl₄ / organic solvent)

*If no reagent or incorrect reagent in **M1**, **CE= 0** and no marks for **M2** or **M3***

Either Order

M2 (stays) Orange / red / yellow / brown / the same

OR no reaction **OR** no (observed) change

OR reference to colour going to cyclohexane layer

*No credit for combustion observations; **CE=0***

*For **M2** in every case.*

Ignore "nothing (happens)".

Ignore "no observation".

Ignore "clear".

M3 decolourised / goes colourless / loses its colour

With bromine (water)

For M1, it must be a whole reagent and / or correct formula.

If oxidation state given in name, it must be correct.

For M1 penalise incorrect formula, but mark **M2** and **M3**

OR as an alternative

Use KMnO₄/H₂SO₄

M1 acidified potassium manganate(VII) or KMnO₄/H₂SO₄

OR KMnO₄/ H⁺ **OR** acidified KMnO₄

M2 (stays) purple or no reaction or no (observed) change

With potassium manganate(VII)

For M1

M3 purple to colourless solution **OR** goes colourless

If “manganate” or “manganate(IV)” or incorrect formula or no acid, penalise **M1** but mark **M2** and **M3**

Credit alternative test using **iodine** (for **M1**)

M2 (brown) to purple or accept no change, M3 colourless

Credit alternative test using concentrated H₂ SO₄

M2 no change, M3 brown

Credit alkaline / neutral KMnO₄ for possible full marks but **M3** gives brown precipitate or solution goes green.

3

- (d) M1 Tollens' (reagent) OR ammoniacal silver nitrate OR a description of making Tollens'
(Ignore either AgNO₃ or [Ag(NH₃)₂]⁺ or “the silver mirror test” on their own, but mark M2 and M3)

M2 silver mirror

OR black solid / precipitate (Ignore silver precipitate)

M3 (stays) colourless or no reaction or no (observed) change

If no reagent or incorrect reagent in **M1**, **CE= 0** and no marks for **M2** or **M3**

For M3 in every case

Ignore “nothing (happens)”.

Ignore “no observation”.

Alternative using Fehling's (solution)

M1 Fehling's (solution) or Benedict's solution

(Ignore Cu²⁺(aq) or CuSO₄ on their own, but mark M2 and M3)

M2 Red solid / precipitate (Credit Orange or brown solid)

M3 (stays) blue or no reaction or no (observed) change

With potassium dichromate(VI)

For M1

If “dichromate” or “(potassium) dichromate(IV)” or incorrect formula or no acid, penalise **M1** but mark **M2** and **M3**

Alternative using K₂Cr₂O₇/H₂ SO₄

M1 acidified potassium dichromate or K₂Cr₂O₇/H₂SO₄

OR K₂Cr₂O₇/H⁺ **OR** acidified K₂Cr₂O₇

M2 (Orange to) green solution OR goes green

M3 (stays) Orange or no reaction or no (observed) change

For M3

Ignore dichromate described as “yellow” or “red”.

With potassium manganate(VII)

For M1

If “manganate” or “(potassium manganate(IV))” or incorrect formula or no acid, penalise M1 but mark M2 and M3

Alternative using $\text{KMnO}_4 / \text{H}_2\text{SO}_4$

M1 acidified potassium manganate(VII) or $\text{KMnO}_4 / \text{H}_2\text{SO}_4$

OR $\text{KMnO}_4 / \text{H}^+$ **OR** acidified KMnO_4

M2 purple to colourless solution OR goes colourless

M3 (stays) purple or no reaction or no (observed) change

*Credit alkaline / neutral KMnO_4 for possible full marks but **M2** gives brown precipitate or solution goes green.*

3

[12]

Q26.

Test

silver nitrate (solution) **(M1)**

Allow an alternative soluble silver salt eg fluoride, sulfate.

Do not allow ‘silver ions’ but can access second mark.

Incorrect formula loses this mark but can access second mark.

*Do not allow ‘silver’ or an insoluble silver salt and **cannot** access second mark.*

Ignore references to acidification of the silver nitrate.

If an acid is specified it should be nitric acid, but allow sulfuric acid in this case as there are no metal ions present.

If hydrochloric acid is used, CE = 0 / 2.

Do not allow ‘add water’.

1

Observation

white precipitate **(M2)**

Ignore ‘cloudy’.

Do not allow ‘white fumes’ or ‘effervescence’.

Do not allow this mark if test reagent is incorrect or missing.

*Allow named indicator paper or named indicator solution for **M1**.*

*Allow correct colour change for **M2**.*

1

[2]

Q27.

M1 and M2 (either order)

Any two from

- purple vapour / gas
- (white solid goes to) black or black / grey or black / purple solid

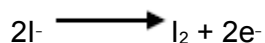
- bad egg smell or words to this effect
Ignore misty white fumes
Ignore yellow solid
Ignore purple solid
Ignore "goes (dark) brown"

M3

Or multiples for possible equation in M3

The iodide ion(s) / they lose (an) electron(s)

OR

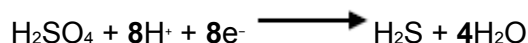


M4

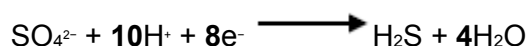
Accept "changes by - 8"

Oxidation state of S changes from +6 to -2 or changes by 8

M5

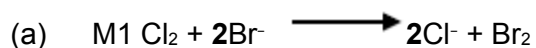


OR



[5]

Q28.



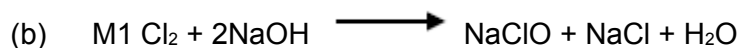
Accept a correct equation using $\frac{1}{2} \text{Cl}_2$ but no other multiples

M2 solution goes orange / yellow (from colourless)

Ignore reference to brown colour

Penalise incorrect observations eg fumes, precipitates

2



(NaOCl)

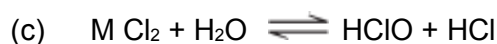
Or a correct ionic equation

Ignore reference to "swimming pools" and to "disinfectant"

M2 bleach or kills bacteria / bacteriacide / micro-organisms / microbes

M3 sodium chlorate(I) ONLY

3



(HOCl)

*Equilibrium symbol **required** in M1*

Accept ionic RHS

M2

The (health) benefit outweighs the risk or wtte

OR

a clear statement that once it has done its job, little of it remains

OR

used in (very) dilute concentrations / small amounts / low doses

2

- (d) M1 Silver nitrate OR AgNO_3 (with or without nitric acid)

For **M1**

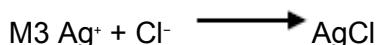
If only the formula is written then it must be correct

If both the formula and the name are written then ignore incorrect attempt at the formula, but penalise an incorrect name

M2 (depends on M1)

white precipitate / white solid

*If the reagent is incomplete eg Ag^+ ions, penalise **M1** and mark on*



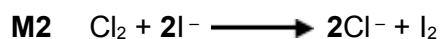
*Penalise both **M1** and **M2** for alkaline AgNO_3 **OR** for the use of HCl to acidify the silver nitrate **OR** for Tollens' reagent*

3

[10]

Q29.

- (a) (i) **M1** iodine **OR** I_2 OR I_3^-
Ignore state symbols
*Credit **M1** for "iodine solution"*



OR



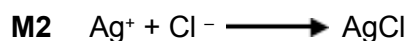
Penalise multiples in M2 except those shown

M2 accept correct use of I_3^-

M3 redox or reduction-oxidation or displacement

3

- (ii) **M1** (the white precipitate is) silver chloride
M1 must be named and for this mark ignore incorrect formula



*For **M2** ignore state symbols*

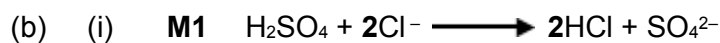
Penalise multiples

M3 (white) precipitate / it dissolves

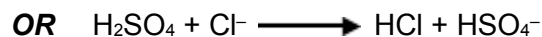
OR colourless solution

Ignore references to "clear" alone

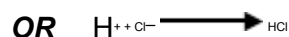
3



For M1 ignore state symbols



Penalise multiples for equations and apply the list principle



M2 hydrogen chloride **OR** HCl **OR** hydrochloric acid

2

(ii) **M1 and M2 in either order**

For M1 and M2, ignore state symbols and credit multiples

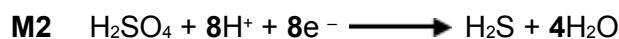


OR

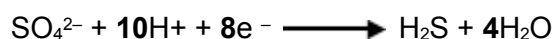


Do not penalise absence of charge on the electron

Credit electrons shown correctly on the other side of each equation



OR



Additional equations should not contradict

M3 oxidising agent / oxidises the iodide (ions)

OR

electron acceptor

M4 sulfur **OR** S **OR** S₂ **OR** S₈ **OR** sulphur

4

(iii) **M1** The NaOH / OH⁻ / (sodium) hydroxide reacts with / neutralises the H⁺ / acid / HBr (lowering its concentration)

OR a correct neutralisation equation for H⁺ or HBr with NaOH or with hydroxide ion

Ignore reference to NaOH reacting with bromide ions

Ignore reference to NaOH reacting with HBrO alone

M2 Requires a correct statement for M1

The (position of) equilibrium moves / shifts(from L to R)

- to replace the H⁺ / acid / HBr that has been removed / lost
- **OR** to increase the H⁺ / acid / HBr concentration
- **OR** to make more H⁺ / acid / HBr / product(s)
- **OR** to oppose the loss of H⁺ / loss of product(s)
- **OR** to oppose the decrease in concentration of product(s)
In M2, answers must refer to the (position of) equilibrium shifts / moves and is not enough to state simply that it / the system / the reaction shifts to oppose the change.

M3 The (health) benefit outweighs the risk or wtte

OR

a clear statement that once it has done its job, little of it remains

OR

used in (very) dilute concentrations / small amounts / low doses

3

[15]

Q30.

(a) (i) **M1** 0

M2 (+) 5

Accept Roman V for M2

2



Accept multiples

1



For M1, ignore state symbols

Credit multiples

Accept $2\frac{1}{2}\text{I}_2 + \frac{1}{2}\text{I}_2$ as alternative to 3I_2

Electrons must be cancelled

M2 NaIO_3 **OR** IO_3^- **OR** iodate ions **OR** iodate(V) ions etc.

For M2 Do not penalise an incorrect name for the correct oxidising agent that is written in addition to the formula.

Accept "the iodine in iodate ions" but NOT "iodine" alone

Accept "the iodine / I in iodate ions" but NOT "iodine" alone

2

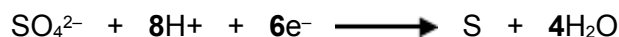
(c) (i) Iodine **OR** I_2

Insist on correct name or formula

1



Ignore state symbols



Credit multiples

Do not penalise absence of charge on the electron

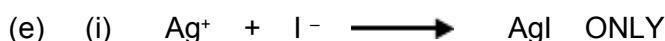
1

(d) hydrogen sulfide

OR H_2S

OR hydrogen sulphide

1



Ignore state symbols

No multiples

1

(ii) The (yellow) precipitate / solid / it does not dissolve / is insoluble
ignore "nothing (happens)"

OR turns to a white solid

ignore "no observation"

OR stays the same

OR no (visible/ observable) change

OR no effect / no reaction

1

(iii) The silver nitrate is acidified to

- react with / remove (an)ions that would interfere with the test
Ignore reference to "false positive"
- prevent the formation of other silver precipitates / insoluble silver compounds that would interfere with the test
Do not penalise an incorrect formula for an ion that is written in addition to the name.
- remove (other) ions that react with the silver nitrate
- react with / remove carbonate / hydroxide / sulfite (ions)
If only the formula of the ion is given, it must be correct

1

(f) (i) An electron donor

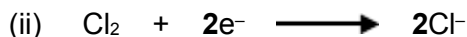
Penalise "electron pair donor"

OR (readily) donates / loses / releases / gives (away) electron(s)

Penalise "loss of electrons" alone

Accept "electron donator"

1



Ignore state symbols

Do not penalise absence of charge on electron

Credit $\text{Cl}_2 \longrightarrow 2\text{Cl}^- - 2\text{e}^-$

Credit multiples

1

- (iii) For M1 and M2, iodide ions are stronger reducing agents than chloride ions, because

Ignore general statements about Group VII trends or about halogen molecules or atoms. Answers must be specific

M1 Relative size of ions

*CE=0 for the clip if "iodine ions / chlorine ions" **QoL***

Iodide ions / they are larger / have more electron levels(shells) (than chloride ions) / larger atomic / ionic radius

*CE=0 for the clip if "iodide ions are bigger molecules / atoms" **QoL***

OR electron to be lost/outer shell/level (of the iodide ion) is further the nucleus

OR iodide ion(s) / they have greater / more shielding

Insist on iodide ions in M1 and M2 or the use of it / they / them, in the correct context (or chloride ions in the converse argument)

OR converse for chloride ion

M2 Strength of attraction for electron(s)

Must be comparative in both M1 and M2

The electron(s) lost /outer shell/level electron from (an) iodide ion(s) less strongly held by the nucleus compared with that lost from a chloride ion

OR converse for a chloride ion

2

[15]

Q31.

- (a) Iodine has more electrons / iodine is bigger (atom or molecule) / iodine has bigger M_r / bigger surface area

1

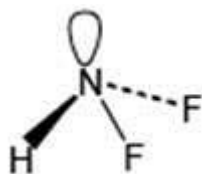
Stronger / more van der Waals forces / vdw / London / temporarily induced dipole / dispersion forces between molecules

1

Stronger VdW intermolecular forces = M2

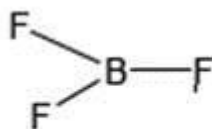
If stated VdW between atoms lose M2

- (b) (i)



Mark is for 3 bp and 1 lp attached to N (irrespective of shape)

1



Mark is for 3 bp and 0 lp attached to B (irrespective of shape)

1

NHF₂ shape - pyramidal / trigonal pyramid
Accept tetrahedral / triangular pyramid

1

BF₃ shape - trigonal planar
Not triangular or triangular planar

1

(ii) 107°
Allow 106-108°

1

(c) Hydrogen bonds
Allow H-Bonds
Not just Hydrogen
Apply list principle eg Hydrogen bonding and dipole-dipole = 0

1

(d) Coordinate / dative covalent / dative
If covalent mark on
If ionic / metallic CE = 0

1

Lone pair / both electrons/ 2 electrons on N(HF₂) donated (to BF₃)
Direction of donation needed here

1

[10]

Q32.

(a) Ca(OH)₂ OR Mg(OH)₂
Ignore name
Could be ionic

1

(b) NaF or sodium fluoride

OR

NaCl or sodium chloride

Either formula or name can score

Do not penalise the spelling “fluoride”

When both formula and name are written,

- penalise contradictions*
- if the attempt at the correct **formula** is incorrect, ignore it and credit **correct name** for the mark unless contradictory*
- if the attempt at the correct name is incorrect, ignore it and credit **correct formula** for the mark unless contradictory*

1

(c) NaClO OR NaOCl

Ignore name (even when incorrect)

The correct formula must be clearly identified if an equation is written

1

(d) Br₂ (ONLY)

Only the correct formula scores;

penalise lower case “b”, penalise upper case “R”, penalise superscript

Ignore name

The correct formula must be clearly identified if an equation is written

1

(e) M1 S OR S₈ OR S₂

M2 I₂ (ONLY)

Ignore names

penalise lower case “i” for iodine,

penalise superscripted numbers

Mark independently

The correct formula must be clearly identified in each case if an equation is written

2

(f) (i) CH₃CH₂CH=CH₂

Structure of but-1-ene. Ignore name

Credit “sticks” for C-H bonds

1

(ii) CH₃CH₂CH₂CH₂OH

Structure of butan-1-ol. Ignore name

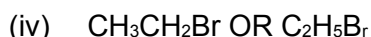
Credit “sticks” for C-H bonds

1

(iii) CH₃CH₂CH₃

Structure of propane. Ignore name
 Ignore calculations and molecular formula
 Credit “sticks” for C-H bonds
 Ignore the molecular ion

1



Structure of bromoethane.
 Ignore name and structure of nitrile
 Credit “sticks” for C-H bonds

1

[10]

Q33.

- (a) (i) **M1** (yellow precipitate is) silver iodide OR AgI (which may be awarded from the equation)

M2 $\text{Ag}^+ + \text{I}^- \rightarrow \text{AgI}$ (Also scores M1 unless contradicted)

M3 sodium chloride OR NaCl

For M2

Accept multiples

Ignore state symbols

Allow crossed out nitrate ions, but penalise if not crossed out

3

- (ii) The silver nitrate is acidified to

- react with / remove ions that would interfere with the test
- prevent the formation of other silver precipitates / insoluble silver compounds that would interfere with the test
- remove (other) ions that react with the silver nitrate
- react with / remove carbonate / hydroxide / sulfite (ions)
 Ignore reference to “false positive”

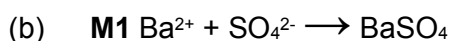
1

- (iii) **M1 and M2 in either order**

M1 Fluoride (ion) OR F⁻

- M2**
- Silver fluoride / AgF is soluble / dissolves (in water)
 - no precipitate would form / no visible / observable change
 Do not penalise the spelling “fluoride”,
 Penalise “fluride” once only
 Mark M1 and M2 independently

2



(or the ions together)

M2 white precipitate / white solid / white suspension

M3 Barium meal or (internal) X-ray or to block X-rays

M4 BaSO₄ / barium sulfate is insoluble (and therefore not toxic)

For M1, ignore state symbols

Allow crossed out sodium ions, but penalise if not crossed out

For M2, ignore “milky”

If BaSO₃ OR BaS used in M1 and M4, penalise once only

For M3 Ignore radio-tracing

For M4 NOT barium ions

NOT barium

NOT barium meal

NOT “It” unless clearly BaSO₄

4

(c) **M1** 2(12.00000) + 4(1.00794) = 28.03176

M2 Ethene and CO or “they” have an imprecise **M_r** of 28.0 / 28

OR

Ethene and CO or “they” have the same M_r to one d.p.

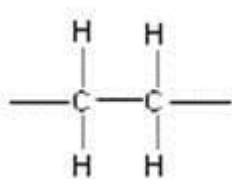
OR

These may be shown by two clear, simple sums identifying both compounds

M3 $\text{C}_2\text{H}_4 + 2\text{O}_2 \rightarrow 2\text{CO} + 2\text{H}_2\text{O}$

(H₂C=CH₂)

M4 Displayed formula



M5 Type of polymer = Addition (polymer)

M1 must show working using 5 d.p. for hydrogen

Penalise “similar” or “close to”, if this refers to the imprecise value in M2, since this does not mean “the same”

For M3, accept CH₂=CH₂ OR CH₂CH₂

For M4, all bonds must be drawn out including those on either side of the unit.

Penalise “sticks”

*Ignore brackets around **correct** repeating unit but penalise*

“n”

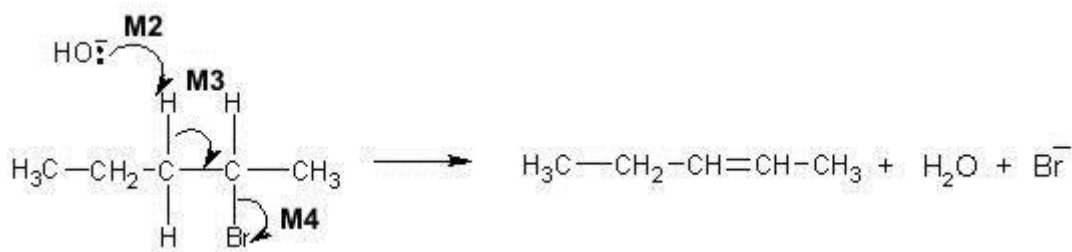
Penalise “additional”

5

[15]

Q34.

(a) (i) **M1** Elimination



M2 must show an arrow from the lone pair on the oxygen of a negatively charged hydroxide ion to a correct H atom

M3 must show an arrow from a C-H bond adjacent to the C-Br bond towards the appropriate C-C bond.
Only award if a reasonable attempt has been made at the attack on the H atom of the appropriate adjacent C-H

M4 is independent provided it is from their original molecule

Award full marks for an E1 mechanism in which **M3** is on the correct carbocation.

N.B. These are double-headed arrows

For M1, accept “Base elimination” but no other prefix.

Penalise **M2** if covalent KOH

Penalise **M4** for formal charge on C of C-Br or incorrect partial charges on C-Br

Ignore other partial charges

Penalise once only in any part of the mechanism for a line and two dots to show a bond.

Max any 2 of 3 marks for the mechanism for wrong reactant (or wrong product if shown).

Accept the correct use of “sticks” for the molecule except for the C-H being attacked

4

(ii) **Structure for pent-1-ene**

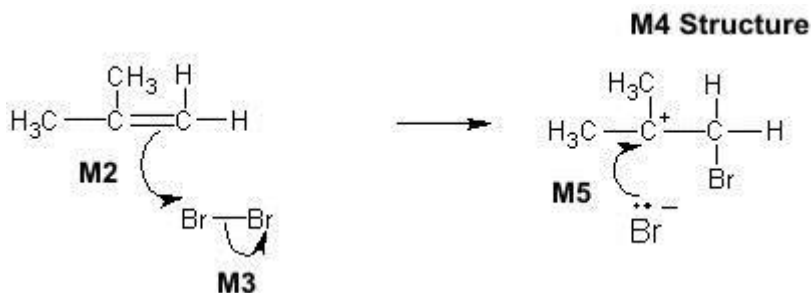


Penalise C_5H_7

Accept correct “sticks”

1

(b) **M1** Electrophilic addition



M2 must show an arrow from the double bond towards the Br atom of the Br-Br molecule

M3 must show the breaking of the Br-Br bond.

M4 is for the structure of the tertiary carbocation with Br on the correct carbon atom.

M5 must show an arrow from the lone pair of electrons on the negatively charged bromide ion towards the positively charged carbon atom.

N.B. These are double-headed arrows

For M1, both words required.

For the mechanism

M2 Ignore partial negative charge on the double bond.

M3 Penalise partial charges on Br-Br bond if wrong way and penalise formal charges

Penalise once only in any part of the mechanism for a line and two dots to show a bond

Max any 3 of 4 marks for the mechanism for

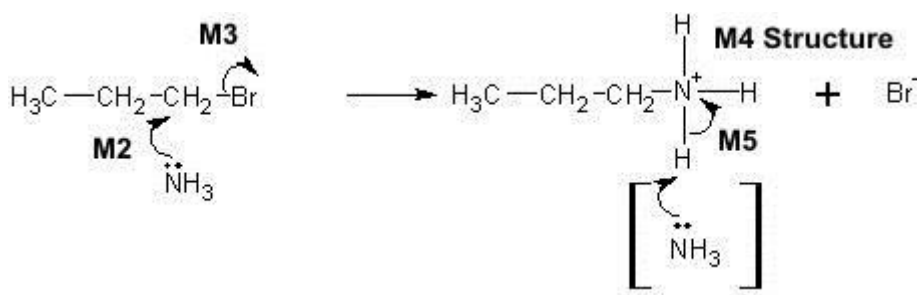
wrong organic reactant or wrong organic product (if shown) or primary carbocation.

If HBr is used, max 2 marks for their mechanism

Accept the correct use of "sticks"

5

(c) **M1 Nucleophilic substitution**



M2 must show an arrow from the lone pair of electrons on the nitrogen atom of an ammonia molecule to the C atom.

M3 must show the movement of a pair of electrons from the C-Br bond to the Br atom. **M3** is independent provided it is from their original molecule

M4 is for the structure of the alkylammonium ion, which could be a condensed formula. A positive charge must be shown on/or close to, the N atom.

M5 is for an arrow from the N-H bond to the N atom.

Award full marks for an S_N1 mechanism in which M2 is the attack of the ammonia on the intermediate carbocation.

N.B. These are double-headed arrows

For M1, both words required.

Penalise M2 if NH₃ is negatively charged.

Penalise M3 for formal charge on C or incorrect partial charges

The second mole of ammonia is not essential for M5; therefore ignore any species here.

Penalise once only for a line and two dots to show a bond.

*Max any 3 of 4 marks **for the mechanism** for wrong organic reactant (or wrong organic product if shown)*

Accept the correct use of "sticks"

5

[15]

Q35.

- (a) Hydrochloric acid = **C**

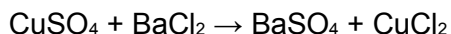
1

Barium chloride = **A**

1

- (b) Barium sulfate is insoluble

1



Accept multiples.

Accept ionic equation.

Do not penalise lack of state symbols, but if used they must be correct.

1

- (c) CO₂ / Carbon dioxide

1

- (d) Reagent 1 silver nitrate (solution)

Ignore lack of reference to acidifying prior to addition of silver nitrate solution.

1

Observation 1 White precipitate

1

Reagent 2 (dilute) ammonia solution / aqueous ammonia

*Do not accept addition of **ammonia** only.*

1

Observation 2 (Colourless) solution

Allow ppt dissolves.

Do not allow 'goes colourless' or 'goes clear'.

Chlorine and no visible change or solution does not become orange scores M3 and M4.

1

- (e) Gloves / wash hands after use

Ignore 'eye protection'.

Do not accept 'do not ingest the chemicals', 'wipe up spillages', 'use a fume cupboard', 'wear a lab coat' (list principle).

1

[10]

Examiner reports

Q1.

Many students (47.6%) got this correct although a significant number thought that bromide ions were reduced in the reaction of sodium bromide with concentrated sulfuric acid.

Q2.

Students found this challenging and did not always express their ideas clearly. Many approached this question as if they already knew which compound was which. A good number did not appreciate that the compounds were solids and so they should make them into solutions. The best students realised that acid should be added first to identify the sodium carbonate and that this solid can then be discarded from further tests. A large number of students realised that silver nitrate would be the best reagent that could be used to determine which solid was sodium chloride and which was sodium fluoride. Additional use of ammonia solution was not necessary in this case. Equations were well written, although did not often include state symbols as required. A high number of students felt that concentrated sulfuric could be used to determine which solid was which despite the fact that all three solids would give very similar observations. The question discriminated particularly well.

Q3.

- (a) The correct ion was identified quite often but the equation was much less well answered.
- (b) Even good students struggled with this question. The context of the ion test was the reverse of the common way of asking the question and, as such, poorly understood.

Q4.

63.6% of students gained this mark. This proved to be a relatively easy practical question requiring little application of knowledge.

Q5.

This mark was gained by 71.7% of students, showing that this is one of the easier physical property trends to remember.

Q6.

Only 42.2% of students selected the correct answer. Perhaps many students did not appreciate that a range of sulfur-based products are formed in the reaction.

Q7.

- (a) The definition was only given by the best students. Some students gave definitions of other enthalpy changes, particularly the enthalpy of formation of a substance. Many students missed the idea that a solid was being formed and some thought that the solid ionic lattice was formed from one mole of gaseous ions.
- (b) Many students were uncertain about the sign of the enthalpy change for lattice formation and $+869 \text{ kJ mol}^{-1}$ was a common wrong answer.

- (c) Many students understood that the lattice was not perfectly ionic and had some covalent character. Linking the covalent character with stronger bonding eluded all but the strongest students.
- (d) The reagent silver nitrate was well known, and this was generally followed by the correct colour of the precipitate. Some students used a more reactive halogen as the reagent and this was given full credit; however, observations for this were less well known.

Q8.

- (a) 78% of students gained this mark.
- (b) With nearly 40% of students scoring full marks, this question illustrated that the skill of representing mechanisms is good. When confusion arose it generally involved attempts to show mechanisms involving water and producing the alcohol, when the final product in this case should be propyl hydrogensulfate. The most common omissions were the curly arrow to show breaking of the H-O bond in H_2SO_4 and/or the negative charge on the HSO_4^- ion. The bonding/order of atoms in H_2SO_4 was also sometimes confused, with structures such as $\text{H}-\text{O}-\text{HSO}_3$ seen.
- (c) Most students who showed a secondary carbocation structure in part (b), were able correctly to show the structure of a primary carbocation here. If a primary ion structure had been shown in (b), 'ecf' was allowed for those (relatively few) students.
- (d) Most students gained the first mark here, but only 17% achieved full marks. A simple statement that a secondary carbocation is more stable than a primary was sufficient for the first mark (although many students mistakenly referred to the greater stability of the final product instead). For the second mark, the explanation needed to make clear that the positive inductive effect was greater in the secondary carbocation due to it having **more** alkyl groups attached to the C^+ .
- (e) This was another question that proved trickier than expected, with a roughly even split between 0, 1, 2 and 3 marks. 'Butan' or 'bute' were often seen as incorrect stems of names and a very common error was for the same isomer of but-2-ene to be drawn twice, with one named as *Z*-but-2-ene and the other as *E*-but-2-ene.
- (f) Butanal was a common wrong answer for the by-product and the fact that sulfuric acid acts as an oxidising agent was not well recognised.
- (g) Although the oxidising ability of concentrated sulfuric acid did not seem to be recognised often in part (f), it was often, incorrectly, suggested here, with most students concentrating on this aspect and failing to recognise that sulfuric acid does not oxidise a chloride ion.
- (h) Over 30% of students gained full marks here, but there was also quite a lot of confusion between the products, with carbon suggested as the black solid; iodine, SO_2 or H_2S as the yellow solid; and SO_2 commonly suggested as the gas smelling of bad eggs.

Q16.

The question on Grignard Reagents was challenging and many were unable to use their practical experience to think through the context. Part (a) was fairly well done but (b) proved more problematic with poor expression often losing the mark. In (c), there was a common mistake in using Tollens' or Fehling's reagent to distinguish the alcohols. Part (d) required some careful structuring to achieve full marks and the context of the question

(comparing bromide and iodide only) was often ignored. The omission of the concentration of the ammonia solution used for the confirmatory test was a common fault.

Q17.

Many answered this question well but a common error was to describe in detail a recrystallisation.

Q18.

This question was answered poorly. Even the half equation in (a) was usually not answered correctly and the more challenging equations in (b) and (c) were only seen from the better students. In (d) the explanation that iodide ions are oxidised wasn't seen very often but a reasonable proportion of students scored some marks on this question.

Q19.

In a definition of electronegativity students must make it clear that they are referring to the attraction between the nucleus and the shared pair of bond electrons. Most students were awarded the first mark but many answers were too vague in their references to gain the second mark. Most of the rest of this question was well answered although there were some issues with balancing charges in the redox equations.

Very few students showed the acids formed in part (d)(i) as being dissociated and this, in turn, seemed to make part (d)(ii) harder than expected because many students failed to spot that addition of acid would shift the equilibrium to the left and so produce toxic chlorine gas. Although there was no specific reference to Le Chatelier in the question (which would have given a more specific clue) the stem of part (d) did refer to an equilibrium mixture and this was intended to point students in the right direction.

Q20.

This was a high demand question, since it requires application of chemistry from the specification and a failure to provide a suitable test reagent leads to the loss of three marks in each part. The number of possible answers to distinguish silver nitrate in part (c) was considerable and partial credit was awarded for test reagents that were unsuitable for test-tube tests, but which led to correct chemical observations. Less than one third of students scored all three marks on part (c) and part (d), whereas three quarters scored full marks on part (b).

Q21.

This was a relatively straightforward start to the paper, but the usual errors were made in balancing equations. The idea of oxidation state is relatively well understood. In part (d), students demonstrated a lack of clarity in what happens during the process of boiling, often alluding to bond breakage and rarely referring to the forces between molecules.

Q22.

- (a) (i) In this part, it was disappointing to note that there were many instances of missing or incorrect state symbols that were missed or ignored by the marker.
- (ii) The logic required in this part again required a careful and sequenced expression of ideas that some found challenging.

The information and test in part (b) and (c) were well known and usually well expressed

with occasional confusion regarding the concentration of the ammonia solution used.

Q23.

- (a) The calculations in parts (i) to (iv) of this part were generally well done although there was some confusion regarding the number of significant figures (both in answers and the marking) and with some lower-scoring students experiencing difficulties in part (iv). However, the ideas underlying part (v) gave a greater challenge and many partial answers were seen (and sometimes incorrectly credited).
- (b) In part (b) and (c) were well answered in the main with the usual caveat about state symbols. The formula of propanone was generally well known either as the molecular or structural formula.
- (c) In part (b) and (c) were well answered in the main with the usual caveat about state symbols. The formula of propanone was generally well known either as the molecular or structural formula.
- (d) The ideas in this part were found to be quite challenging to all but the highest-scoring students and a great deal of confusion was seen regarding colours, solutions and precipitates. In the marking, it is important to appreciate that to gain partial marks the procedure described must be chemically correct; M3 could not be awarded unless there is some correct work up to this point. Answers were often jumbled and contradictory. Many students failed to add sodium chromate solution at the start and so could not gain any marks. Where this addition was done, some students mentioned the formation of a precipitate with the calcium ion solution that then dissolved on addition of water. Many students did not appreciate that the substances were already in solution at the start of the procedure.
- (e) As usual, the empirical formula in this part was well done with a few arithmetic errors only.

Q24.

As with a number of other equations on the paper, rather too many of those given in parts (a)(i) and (b) were unbalanced. The observation in part (a)(ii) was answered well and over 80% of all students scored at least one mark in part (c).

Q25.

This type of question demands that students have a good grasp of observational chemistry from the specification. No marks can be awarded in any of the four parts if a suitable test reagent is not known. This limited the marks for some students. No marks are awarded in the observation sections if the response is "nothing" or "no observation". The least well answered part was part (b) with just over half of all students scoring no marks and only approximately a quarter scoring full marks. By contrast the best answered part was part (d) with only very few students scoring no marks and almost two-thirds of all students scoring full marks.

Q26.

In this Question, a number of students spoiled their answer by including sodium hydroxide in the test reagent. The use of water was occasionally allowed even though it was specifically disallowed in the Marking Guidelines.

Q27.

This question discriminated well with 52% gaining at least 3 marks and most students recording observations associated with the reaction (required by the question), rather than from other reactions that may be occurring at the same time. The remainder of the question was answered well although some were confused about what was happening to iodide ions in terms of electrons.

Q28.

The chemistry of Group 7 is never answered particularly well. This question was no exception and errors were seen both in the equations and in the observations and explanations. Part (a) was the least well-answered with only 13% gaining both marks. Even in part (d), only 75% of the students gained any of the 3 marks. Students need to be advised to learn the key information from this area of the specification and then to read the full question with care in every case.

Q29.

Parts (a) and (b)(i) required interpretation of inorganic results from what should be familiar chemistry. Those who had learned this area of the specification fared well, although some lost marks from failing to read (and then answer) the full question. The ability of students to work out half-equations in redox processes such as those in part (b)(ii) has improved and this question discriminated well with the better students scoring full marks and many of the weaker students still scoring something.

The question in part (b)(iii) has been asked previously in a slightly different form. It was demanding then and remained so on this occasion, with relatively few students able to recognise the fact that sodium hydroxide will react with the H^+ ions and the position of equilibrium will move from left to right to oppose the decrease in concentration of those ions.

Q30.

Many very good answers were seen throughout this question. In part (b), the oxidising agent was not well answered by some. In parts (c), (d) and (e), the answers requiring observations suggest that not all students have had the chance either to see or to perform these simple experiments. Part (f) was well answered with the correct use of chemical names and terminology.

Q31.

Many candidates answered part (a) well but there were a significant number who did not make it clear that the van der Waals forces were between the molecules. Part (b)(i) differentiated well. There were many examples of the wrong number of lone pairs in both molecules and a frequent occurrence of bi-pyramids in candidates' answers. The angle in part (b)(ii) generated a range of values although the answer to part (c) was given correctly by a majority of candidates. Part (d) was generally well done although several candidates gave the wrong direction for the donation of the lone pair.

Q32.

This question covered a wide range of the specification content. Halogen chemistry is not well-known by students and even when they may know some chemistry they can miss the mark by being unable to write the correct formula. Indicative of this was part (e) with only 18% scoring both marks and 56% scoring zero. The organic structures in part (f) were answered better, although part (f)(i) proved demanding and only 26% obtained this mark.

Q33.

Inorganic chemistry is a weakness for many candidates and this question proved challenging for some. Not surprisingly sodium bromide was a common incorrect response in part (a)(i).

Only the better candidates knew the reason for acidifying the silver nitrate solution in part (a)(ii) but the inability of this reagent to detect fluoride ions in part (a)(iii) was reasonably well known. Part (b) was a good discriminator; the relatively easy equation and observation marks eluded some. In part (c) most candidates could use the data to arrive at the correct precise Mr value but were less effective in explaining that the Mr values are the same when using one decimal place. The equation for complete combustion of ethene was done well but neither the displayed formula for the repeating unit nor the type of polymer scored highly.

Q34.

Putting three mechanisms together proved to be very discriminating. Weaker candidates were able to score some marks and the best candidates scored all 15. There is always a concern that in these longer Section B questions, candidates might forget to record the name of a mechanism and there was some evidence of that happening here. Partial credit was given in part (a)(i) for a mechanism that used an incorrect starting or finishing compound with much of the focus concentrated on the curly arrows. This guiding principle was applied to good effect in parts (b) and (c). In part (c), centres need to appreciate that full marks will only be awarded in a mechanism of this type if the positive charge on the intermediate is placed on the N atom and not on or adjacent to a hydrogen atom.

Q35.

In part (a) only the highest-scoring candidates scored both marks. Weaker candidates seemed to be guessing.

In this part (b) was, perhaps, the most demanding question of all. Many candidates could not equate the appearance of a precipitate with insolubility, and even the better candidates could not write a correct equation for a very familiar reaction.

The better candidates scored full marks in this part (d). A few lost a mark because they were vague about the concentration of the ammonia solution to be used. A surprising number got the tests the wrong way around, losing two marks. Centres are reminded that if a candidate chooses an incorrect test reagent the mark for the observation can also not be awarded.

The above notes are intended for the small minority of centres experiencing difficulty in meeting the coursework criteria. They must not be allowed to detract unduly from the very healthy overall picture. Given the pressures on centres to deliver the teaching programme, this was once again a very positive and encouraging session. Centres are again warmly commended for the trouble taken to assemble a sample which proved to be easy to moderate. Their efforts continue to be much appreciated by the moderator team.