1. (a) By referring to electrons, explain the meaning of the term *oxidising agent*.

.....

(1)

(b) For the element **X** in the ionic compound **MX**, explain the meaning of the term *oxidation state*.

.....

(1)

(c) Complete the table below by deducing the oxidation state of each of the stated elements in the given ion or compound.

	Oxidation state
Carbon in CO_3^{2-}	
Phosphorus in PCl_4^{+}	
Nitrogen in Mg_3N_2	

(3)

(d) In acidified aqueous solution, nitrate ions, NO_3^-, react with copper metal forming nitrogen monoxide, NO, and copper(II) ions.

(i) Write a half-equation for the oxidation of copper to copper(II) ions.

.....

(ii) Write a half-equation for the reduction, in an acidified solution, of nitrate ions to nitrogen monoxide.

.....

(iii) Write an overall equation for this reaction.

.....

(3)

(Total 8 marks)

5. (a) The following is an equation for a redox reaction.

$$2NO + 12H^+ + 10I^- \rightarrow 2NH_4^+ + 2H_2O + 5I_2$$

(i) Define *oxidation* in terms of electrons.

.....

(ii) Deduce the oxidation state of nitrogen in NO and of nitrogen in NH_4^+

Oxidation state of nitrogen in NO .....

Oxidation state of nitrogen in NH_4^+ .....

(iii) Identify the species formed by oxidation in this reaction.....

(4)

(b) When chlorine gas is bubbled into an aqueous solution of sulphur dioxide, hydrogen ions, sulphate ions and chloride ions are formed.

(i) Write a half-equation for the formation of chloride ions from chlorine.

.....

(ii) Write a half-equation for the formation of hydrogen ions and sulphate ions from sulphur dioxide and water.

.....

(iii) Hence, deduce an overall equation for the reaction which occurs when chlorine is bubbled into aqueous sulphur dioxide.

.....

(3)
(Total 7 marks)

6. (a) In terms of electrons, what happens to an oxidising agent during a redox reaction?

.....

(1)

(b) Consider the following redox reaction.

$SO_2(aq) + 2H_2O(l) + 2Ag^+(aq) \rightarrow 2Ag(s) + (aq) + 4H^+(aq)$

(i) Identify the oxidising agent and the reducing agent in this reaction.

Oxidising agent .....

Reducing agent .....

(ii) Write a half-equation to show how sulphur dioxide is converted into sulphate ions in aqueous solution.

.....

(3)

(c) Fe^{2+} ions are oxidised to Fe^{3+} ions by ClO_3^- ions in acidic conditions. The ClO_3^- ions are reduced to Cl^- ions.

(i) Write a half-equation for the oxidation of Fe^{2+} ions in this reaction.

.....

(ii) Deduce the oxidation state of chlorine in ClO_3^- ions.

.....

(iii) Write a half-equation for the reduction of ClO_3^- ions to Cl^- ions in acidic conditions.

.....

(iv) Hence, write an overall equation for the reaction.

.....

(4)

(Total 8 marks)

7. (a) In acidic conditions, hydrogen peroxide, H_2O_2, oxidises iodide ions to iodine. The hydrogen peroxide is reduced to water. In H_2O_2, oxygen has an oxidation state of –1.

(i) Construct a half-equation for the reduction of hydrogen peroxide to water in acidic conditions.

.....

(ii) Construct a half-equation for the oxidation of I^- ions to iodine.

.....

(iii) Construct an equation for the overall reaction.

.....

(3)

(Total 12 marks)

8. Chlorine and bromine are both oxidising agents.

(a) Define an *oxidising agent* in terms of electrons.

.....

(1)

(b) In aqueous solution, bromine oxidises sulphur dioxide, SO_2, to sulphate ions, SO_4^{2-}

(i) Deduce the oxidation state of sulphur in SO_2 and in

SO_2 .....

SO_4^{2-} .....

(ii) Deduce a half-equation for the reduction of bromine in aqueous solution.

.....

(iii) Deduce a half-equation for the oxidation of SO_2 in aqueous solution forming and H^+ ions.

.....

(iv) Use these two half-equations to construct an overall equation for the reaction between aqueous bromine and sulphur dioxide.

.....

(5)

(c) Write an equation for the reaction of chlorine with water. Below each of the chlorine-containing products in your equation, write the oxidation state of chlorine in that product.

.....

.....

(3)

(d) Give a reason why chlorine is not formed when solid potassium chloride reacts with concentrated sulphuric acid.

.....

(1)

(e) Write an equation for the reaction between solid potassium chloride and concentrated sulphuric acid.

.....

(1)

(f) Solid potassium bromide undergoes a redox reaction with concentrated sulphuric acid.

(i) Give the oxidation product formed from potassium bromide.

.....

(ii) Give the reduction product formed from sulphuric acid.

.....

(2)

(Total 13 marks)

9. (a) State the trend in the boiling points of the halogens from fluorine to iodine and explain this trend.

Trend .....

Explanation .....

.....

.....

(4)

(b) Each of the following reactions may be used to identify bromide ions. For each reaction, state what you would observe and, where indicated, write an appropriate equation.

(i) The reaction of aqueous bromide ions with chlorine gas

Observation .....

Equation .....

(ii) The reaction of aqueous bromide ions with aqueous silver nitrate followed by the addition of concentrated aqueous ammonia

Observation with aqueous silver nitrate .....

Equation .....

Observation with concentrated aqueous ammonia .....

.....

(iii) The reaction of solid potassium bromide with concentrated sulphuric acid

Observation 1 .....

Observation 2 .....

(7)

(c) Write an equation for the redox reaction that occurs when potassium bromide reacts with concentrated sulphuric acid.

.....

(2)

(Total 13 marks)

10. (a) Describe and explain the trend in the boiling points of the elements down Group VII from fluorine to iodine.

(4)

(b) Describe what you would observe when aqueous silver nitrate, followed by dilute aqueous ammonia, is added to separate aqueous solutions of sodium chloride and sodium bromide.

(4)

(c) State the trend in the oxidising abilities of the elements down Group VII from chlorine to iodine.
Explain how this trend can be shown by displacement reactions between halogens and halide ions in aqueous solutions.
Illustrate your answer with appropriate observations and equations.

(7)

(Total 15 marks)

11. (a) Explain, by referring to electrons, the meaning of the terms *reduction* and *reducing agent*.

(2)

(b) Iodide ions can reduce sulphuric acid to three different products.

(i) Name the **three** reduction products and give the oxidation state of sulphur in each of these products.

(ii) Describe how observations of the reaction between solid potassium iodide and concentrated sulphuric acid can be used to indicate the presence of any **two** of these reduction products.

(iii) Write half-equations to show how two of these products are formed by reduction of sulphuric acid.

(10)

(c) Write an equation for the reaction that occurs when chlorine is added to cold water. State whether or not the water is oxidised and explain your answer.

(3)
(Total 15 marks)

12. (a) State the trend in electronegativity of the elements down Group VII. Explain this trend.

Trend .....

Explanation .....

.....

.....

(3)

(b) (i) State the trend in reducing ability of the halide ions down Group VII.

.....

(ii) Give an example of a reagent which could be used to show that the reducing ability of bromide ions is different from that of chloride ions.

.....

(2)

(c) The addition of silver nitrate solution followed by dilute aqueous ammonia can be used as a test to distinguish between chloride and bromide ions. For each ion, state what you would observe if an aqueous solution containing the ion was tested in this way.

Observations with chloride ions .....

.....

Observations with bromide ions .....

.....

(4)

(d) Write an equation for the reaction between chlorine and cold, dilute aqueous sodium hydroxide. Give two uses of the resulting solution.

Equation .....

Use 1 .....

Use 2 .....

(3)

(Total 12 marks)

13. (a) Identify the halogen that is the strongest oxidising agent.

.....

(1)

(b) Give the formula of the halide ion that is the strongest reducing agent.

.....

(1)

(c) Describe what you would observe in each case when aqueous silver nitrate is added separately to dilute aqueous sodium fluoride and to dilute aqueous sodium iodide. Write an equation, including state symbols, for the reaction between aqueous sodium iodide and aqueous silver nitrate.

Observation with NaF(aq) .....

Observation with NaI(aq) .....

Equation .....

(3)

(d) Describe what you would observe when concentrated sulphuric acid is added to solid sodium chloride. Write an equation for the reaction that occurs.

Observation .....

Equation .....

(2)

(e) Describe two observations that you would make when concentrated sulphuric acid is added to solid sodium iodide. Write an equation for a reaction that occurs in which iodide ions are oxidised by the sulphuric acid.

Observation 1 .....

Observation 2 .....

Equation .....

.....

.....

(4)

(f) Describe the colour change that you would observe when an aqueous solution of iodine, to which starch solution has been added, reacts with an excess of $Na_2S_2O_3$. Write an equation for the reaction that occurs between iodine and $Na_2S_2O_3$.

Observation .....

Equation .....

(3)
(Total 14 marks)

14.

(a) State and explain the trend in electronegativity down Group VII from fluorine to iodine.

Trend .....

Explanation .....

.....

.....

(3)

(b) State what you would observe when chlorine gas is bubbled into an aqueous solution of potassium iodide. Write an equation for the reaction that occurs.

Observation .....

Equation .....

(2)

(c) Identify **two** sulphur-containing reduction products formed when concentrated sulphuric acid oxidises iodide ions. For each reduction product, write a half-equation to illustrate its formation from sulphuric acid.

Reduction product 1 .....

Half-equation .....

Reduction product 2 .....

Half-equation .....

(4)

(d) Write an equation for the reaction between chlorine gas and dilute aqueous sodium hydroxide. Name the **two** chlorine-containing products of this reaction and give the oxidation state of chlorine in each of these products.

Equation .....

Name of product 1 .....

Oxidation state of chlorine in product 1 .....

Name of product 2 .....

Oxidation state of chlorine in product 2 .....

(5)

(Total 14 marks)

16.

(a) State and explain the trend in electronegativity down Group VII from fluorine to iodine.

Trend .....

Explanation .....

.....

(3)

17. (a) Concentrated sulphuric acid can be reduced by some solid sodium halides to H_2S

(i) Give the oxidation state of sulphur in H_2S

.....

(ii) Give **one** solid sodium halide which will reduce concentrated sulphuric acid, forming H_2S

.....

(iii) State **one** way in which the presence of H_2S could be recognised.

.....

(iv) Write a half-equation for the formation of H_2S from sulphuric acid.

.....

(4)

(b) A different solid sodium halide reacts with concentrated sulphuric acid without reduction forming a halogen-containing product **X**.

(i) Suggest an identity for **X**.

.....

(ii) Identify the solid sodium halide which produces **X**.

.....

(iii) State the role of sulphuric acid in the formation of **X**.

.....

(iv) Write an equation for the reaction with concentrated sulphuric acid in which **X** is formed.

.....

(4)
(Total 8 marks)

18. (a) State and explain the trend in the electronegativities of the halogens from fluorine to iodine.

Trend. .....

Explanation. .....

.....

(3)

(b) When either solid potassium bromide or solid potassium iodide reacts with concentrated sulphuric acid, a mixture of gases is evolved. In each case, one of the gases is produced by oxidation.

(i) Give the formula of the oxidation product formed in each reaction and state how this product would be observed.

Oxidation product using KBr(s). .....

Observation. .....

Oxidation product using KI(s). .....

Observation. .....

(ii) State all the reduction products formed in these reactions and state which are formed in the reaction with KI, but **not** in the reaction with KBr.

Reduction products. .....

.....

Product(s) formed only with KI(s). .....

.....

(iii) Identify the other gaseous products formed in these reactions. State the type of reaction by which they are produced.

Other products. .....

.....

Reaction type. .....

.....

(11)
(Total 14 marks)

19. (i) Explain the trends in first ionisation energy and electronegativity down Group II.

(ii) Discuss two ways in which beryllium is an atypical member of Group II.

(Total 10 marks)

20. (a) When using silver nitrate to test for the presence of chloride ions in an aqueous solution, it is important to add another reagent to prevent interference by any carbonate ions which would form a white precipitate of Ag_2CO_3

(i) Identify this other reagent.

.....

(ii) Write an equation to show how this other reagent reacts with sodium carbonate.

.....

(2)

(b) The presence of some halide ions in solution can be detected using aqueous silver nitrate and aqueous ammonia.

(i) Identify a halide ion which, on addition of aqueous silver nitrate, forms a precipitate that is insoluble in concentrated aqueous ammonia.

.....

(ii) Identify a halide ion which cannot be detected using these reagents.

.....

(2)

(c) A mixture of two precipitates, **P** and **Q**, was formed by adding aqueous silver nitrate to a solution containing two different halide ions. Precipitate **P** dissolved on addition of an excess of dilute aqueous ammonia. The remaining precipitate, **Q**, was filtered off.

(i) Identify the halide ion in **P**.

.....

(ii) Precipitate **Q** was soluble in concentrated aqueous ammonia. Identify the halide ion in **Q**.

.....

(2)
(Total 6 marks)

21. (a) State what you would observe on adding aqueous chlorine to separate aqueous solutions of sodium bromide and sodium iodide. Write equations for the reactions occurring.

(4)

(b) State what you would observe on adding concentrated sulphuric acid to separate solid samples of sodium bromide and sodium iodide. In each case, identify all the reduction products. Using half-equations, construct an overall ionic equation for the oxidation of bromide ions by concentrated sulphuric acid.

(9)
(Total 13 marks)

24. Describe how you could distinguish between separate solutions of sodium fluoride, sodium chloride, sodium bromide and sodium iodide using separate solutions of silver nitrate and ammonia.

Predict the effect of concentrated ammonia solution on silver astatide, AgAt, and explain your answer.

(Total 9 marks)

25. (a) State the trend in oxidising power of the halogens chlorine, bromine and iodine.

.....

(1)

(b) State what would be observed if aqueous bromine were to be added separately to samples of aqueous potassium chloride and aqueous potassium iodide. Write an ionic equation for any reaction occurring.

Observation with aqueous KCl .....

Observation with aqueous KI .....

Ionic equation .....

(3)

(c) When chlorine is dissolved in cold water a pale-green solution, chlorine water, is formed. A piece of universal indicator paper, dipped into chlorine water, first turns red and then becomes white.

(i) Give the formula of the species responsible for the green colour of chlorine water.

.....

(ii) Write an equation for the reaction between chlorine and cold water.

.....

(iii) Explain the colour changes observed when universal indicator paper is dipped into chlorine water.

.....

.....

(4)

(d) Write an equation for the reaction that occurs when chlorine is bubbled into cold, dilute aqueous sodium hydroxide.

.....

(1)
(Total 9 marks)

26. (a) A white solid, **A**, gives a brick red colour in a flame test.

When aqueous silver nitrate is added to an aqueous solution of **A**, a precipitate **B** is formed. **B** is insoluble in concentrated aqueous ammonia.

When aqueous chlorine is added to aqueous **A**, a brown solution containing element **C** is formed.

Aqueous starch is added to the brown solution and a blue-black colouration appears.

The blue-black solution turns colourless when an aqueous solution of **D** is added. This reaction may be used in a titration to find the concentration of element **C**.

(i) Suggest the names or formulae for the substances represented by A, B, C and D.

A .....

B .....

C .....

D .....

(4)

(ii) Write an equation for the reaction between **A** and aqueous silver nitrate.

.....

(1)

(b) The table below gives the solubilities of two Group 2 sulphates at 293 K. The units of solubility are g solute in 100 g water.

Compound	**Solubility**
$MgSO_4$	33
$BaSO_4$	0.00024

(i) State **two** factors which influence the solubilities of $MgSO_4$ and $BaSO_4$ at 293 K. Hence explain the different solubilities of $MgSO_4$ and $BaSO_4$.

.....

.....

.....

.....

.....

(3)

(ii) When aqueous magnesium sulphate is added to aqueous barium hydroxide, a white precipitate is formed. Write an ionic equation, including state symbols, for the reaction that involves barium ions.

.....

(2)

(c) When concentrated sulphuric acid is added to each of the solid sodium halides NaCl and NaBr, a displacement reaction occurs and a hydrogen halide is formed. With NaBr, a further reaction takes place. This involves redox.

(i) Write an equation for the reaction which leads to the formation of HCl.

.....

(1)

(ii) HBr can reduce sulphuric acid to form a gaseous product which contains sulphur. Give the formula of the sulphur containing compound that is produced and state the oxidation number of sulphur in the compound.

Compound ..... *Oxidation number* .....

(2)

(iii) Complete and balance the equation for the redox reaction which occurs between hydrogen bromide and sulphuric acid.

HBr + $H_2SO_4 \rightarrow$

(2)

(iv) State what you would observe when concentrated sulphuric acid is added to sodium bromide.

.....

(1)

(Total 16 marks)

27. (a) Explain, with reference to electron transfer, what is meant by the term *oxidising agent.*

.....

.....

(1)

(b) State and explain the trend in oxidising power of the halogens fluorine to iodine.

Trend .....

Explanation .....

.....

.....

.....

(3)

(c) A redox reaction occurs when an aqueous solution of potassium iodide is mixed with an aqueous solution of chlorine.

(i) State the colours of the original separate solutions and the colour of the mixture.

Colour of aqueous potassium iodide .....

Colour of aqueous chlorine .....

Colour of the mixture .....

(2)

(ii) Write an equation for the reaction.

.....

(1)

(iii) Identify the reducing agent in this reaction.

.....

(1)

(iv) Write half-equations (ion-electron equations) to show the reaction of the oxidising agent and the reaction of the reducing agent.

Half-equation for the oxidising agent

.....

Half equation for the reducing agent

.....

(2)

(d) In the presence of a strong acid, the IO_3^- ion is a powerful oxidising agent. The half-equation (ion-electron equation) for this process is shown below.

$$IO_3^-(aq) + 6H^+(aq) + 5e^- \rightarrow \tfrac{1}{2} I_2(aq) + 3H_2O(1)$$

Under acidic conditions, IO_3^- will oxidise iodide ions to iodine.

(i) Deduce the oxidation numbers of iodine in IO_3^-, I^- and I_2.

Oxidation number of iodine in IO_3^- .....

Oxidation number of iodine in I^- .....

Oxidation number of iodine in I_2 .....

(3)

(ii) Write an ionic equation to show the reaction between aqueous solutions of KIO_3 and KI under acidic conditions.

.....

(2)

(Total 15 marks)

28. (a) Explain why the boiling temperatures of the halogens increase down Group VII from fluorine to iodine

(2)

(b) State how, and explain why, the reducing powers of the halide ions change down Group VII from fluoride to astatide.

(4)

(c) Use your knowledge of the reactions of solid sodium chloride, bromide and iodide to predict the gaseous products formed when concentrated sulphuric acid is warmed with solid sodium astatide. Identify the role of the astatide ion in the formation of each gaseous product and write equations for the reactions occurring.

(9)
(Total 15 marks)

29. (a) State and explain the trend in electronegativity of the halogens down Group VII.

Trend.....

Explanation.....

.....

.....

(4)

(b) State and explain the trend in boiling points of the halogens down Group VII.

Trend.....

Explanation.....

.....

.....

(3)
(Total 7 marks)

30. (a) (i) Give the meaning of the term *electronegativity*.

.....

.....

(ii) Explain why the electronegativity of the halogen atoms decreases from fluorine to iodine.

.....

.....

(3)

(b) How, if at all, does the decrease in electronegativity from fluorine to iodine affect the polarity of the bond between two identical halogen atoms in a halogen molecule? Explain your answer.

Effect on bond polarity .....

Explanation .....

.....

(2)

(c) When concentrated sulphuric acid is added to separate samples of solid sodium bromide or sodium iodide and warmed, a mixture of gases is evolved. Some of these are reduction products of sulphuric acid.

(i) Give the formula of each gaseous reduction product of sulphuric acid formed using these two halides.

Gaseous reduction product(s) of H_2SO_4 using NaBr

.....

Gaseous reduction product(s) of H_2SO_4 using NaI

.....

(ii) What other gases are evolved in these reactions? How if at all could they be recognised?

.....

.....

.....

.....

.....

(9)
(Total 14 marks)

31. (a) The following are the reduction products formed when solid sodium iodide is heated with concentrated sulphuric acid:

S H_2S SO_2

(i) In which of these products has the sulphur from sulphuric acid undergone **least** reduction?

.....

(ii) In which of these products has the sulphur sulphuric acid undergone **most** reduction?

.....

(2)

(b) (i) Write a half-equation for the conversion of HI into I_2

.....

(ii) Write a half-equation for the conversion of H_2SO_4 into H_2S in the presence of H^+ ions.

.....

(iii) Write a half-equation for the conversion of H_2SO_4 into SO_2 in the presence of H^+ ions.

.....

(iv) Use your answers to parts (i), (ii) and (iii) above to construct an overall equation for the simultaneous formation of one mole of H_2S and one mole of SO_2 in the reaction of HI with H_2SO_4

.....

.....

.....

.....

(5)

(c) Write an ionic equation for the reaction which occurs when chlorine gas is bubbled into cold dilute sodium hydroxide and give a commercial use for the product of this reaction.

Equation.....

Commercial use.....

(2)
(Total 9 marks)

32. (a) (i) State and explain the trend in oxidising ability of the elements down Group VII from chlorine to iodine.

(ii) Explain how an aqueous solution of chlorine can be used to differentiate between separate aqueous solutions of sodium chloride, sodium bromide and sodium iodide. State what would be observed in each experiment and write equations for the reactions which occur.

(13)

(b) A commercial bleach contains sodium chlorate(I). A 10.0 cm^3 sample of this bleach was diluted to 250 cm^3 in a volumetric flask. When a 25.0 cm^3 portion of the solution produced was added to an excess of acidified potassium iodide, iodine was produced. On titration, this iodine reacted exactly with 23.0 cm^3 of 0.100 M sodium thiosulphate.

(i) Write equations for the reaction of the chlorate(I) ion with iodide ions in the presence of H^+ ions and for the reaction of iodine with sodium thiosulphate and describe what you see at the end point of the titration. Name a suitable indicator for this reaction.

(ii) Calculate the concentration of sodium chlorate(I) in the original solution in mol dm^{-3}.

(17)
(Total 30 marks)

33. (a) How can the addition of an aqueous solution of chlorine be used to distinguish between aqueous solutions of sodium bromide and sodium iodide?
State any observations you would make and write equations for the reactions occurring.

(4)

(b) How can reactions with concentrated sulphuric acid be used to distinguish between solid samples of sodium bromide and sodium iodide?
State the observations you would make and give all the oxidation and reduction products formed in both reactions. Using half-equations, construct an overall equation for **one** of these redox reactions.

(11)
(Total 15 marks)

34. (a) (i) State the trend in the boiling points of the halogens from fluorine to iodine.

.....

(ii) Explain this trend.

.....

.....

(iii) Give the physical states of chlorine, bromine, and iodine at room temperature, and deduce the likely physical state of astatine at room temperature.

.....

.....

.....

(5)

(b) (i) Define *reducing agent* in terms of electron transfer.

.....

(ii) State and explain the trend in reducing power of the halide ions down Group VII.

Trend in reducing power .....

Explanation .....

.....

(iii) Justify your answer to part (ii) above by considering changes in the oxidation state of sulphur in reactions of concentrated sulphuric acid with sodium bromide and with sodium iodide.

.....

.....

.....

.....

(7)

(c) When chlorine is bubbled into cold, dilute aqueous sodium hydroxide, an equilibrium is established.

(i) Write an ionic equation for the equilibrium reaction between chlorine and hydroxide ions.

.....

(ii) Show that this is a redox reaction by considering the oxidation states of the chlorine-containing species in the equilibrium mixture.

.....

.....

.....

(iii) Identify the oxidising agent in the forward direction of the equilibrium and the reducing agent in the backward direction of the equilibrium.

Oxidising agent in forward direction .....

Reducing agent in backward direction .....

(6)
(Total 18 marks)

35. (a) State and explain the trend in the electronegativity of the halogens down Group VII.

Trend.....

Explanation.....

.....

.....

.....

(3)

(b) State and explain the trend in boiling temperatures of the halogens down Group VII.

Trend.....

Explanation.....

.....

.....

.....

(3)

(c) The relative molecular masses of bromine, Br_2, and iodine monochloride, ICl, are almost the same, yet their boiling temperatures are quite different. Account for this difference in boiling temperature.

.....

.....

.....

.....

.....

(4)

(Total 10 marks)

36. The composition of a mixture of two solid sodium halides was investigated in two separate experiments.

Experiment (1)

When a large excess of chlorine gas was bubbled through a concentrated solution of the mixture, orange-brown fumes and a black precipitate were produced.

Experiment (2)

0.545 g of the solid mixture was dissolved in water and an excess of silver nitrate solution was added. The mass of the mixture of silver halide precipitates formed was 0.902g. After washing the mixture of precipitates with an excess of concentrated aqueous ammonia the mass of the final precipitate was 0.564g.

Write equations for each of the reactions occurring in these experiments and explain how these results enable you to identify the halide ions present. Use the information given above to calculate the percentage by mass of each halide ion present in the solid mixture.

(Total 15 marks)

37. (a) State the meaning of the term *oxidising agent*

.....

(1)

(b) When solid potassium manganate(VII) is heated, it decomposes according to the equation below.

$$2KMnO_4 \rightarrow K_2MnO_4 + MnO_2 + O_2$$

Explain, in terms of the oxidation states, why this is a redox reaction.

.....

.....

.....

(3)

(c) Chlorate(I) ions are produced when chlorine is dissolved in cold water.

(i) Write an equation for this reaction.

.....

(ii) The concentration of chlorate(I) ions in the aqueous chlorine solution can be increased by the addition of sodium hydroxide. Explain this observation and write an equation to show the effect of the sodium hydroxide.

Explanation.....

.....

Equation.....

(4)
(Total 8 marks)

38.

(b) How would you distinguish between separate solutions of sodium chloride, sodium bromide and sodium iodide using solutions of silver nitrate and ammonia?

(6)
(Total 15 marks)

39. This question concerns the chemistry of the Group II metals Mg to Ba.
An aqueous solution of a Group II metal chloride, **X**Cl_2, forms a white precipitate when dilute aqueous sodium hydroxide is added. A separate sample of the solution of **X**Cl_2 does **not** form a

precipitate when dilute aqueous sodium sulphate is added.

An aqueous solution of a different Group II metal chloride, **Y**Cl_2, does **not** form a precipitate when dilute aqueous sodium hydroxide is added. A separate sample of the solution of **Y**Cl_2 forms a white precipitate when dilute aqueous sodium sulphate is added.

Suggest identities for the Group II metals **X** and **Y**. Write equations, including state symbols, for the reactions which occur.

(Total 6 marks)

40. (i) For the elements Mg–Ba, state how the solubilities of the hydroxides and the solubilities of the sulphates change down Group II.

(ii) Describe a test to show the presence of sulphate ions in an aqueous solution.
Give the results of this test when performed on separate aqueous solutions of magnesium chloride and magnesium sulphate. Write equations for any reactions occurring.

(iii) State the trend in the reactivity of the Group II elements Mg–Ba with water.

Write an equation for the reaction of barium with water.

(Total 11 marks)

41. Define the term *electronegativity* and explain why the electronegativity values of the Group II elements Be–Ba decrease down the group.

(Total 4 marks)

42. (a) There is a trend in the reactivity of the Group II metals, Be–Ba, with water. State this trend and give the conditions under which magnesium reacts rapidly with water.
Write an equation to represent this reaction.

Trend Be to Ba …….....……..

Conditions .....….....……..

Equation .....……

(3)

(b) Describe what you would observe when a few drops of aqueous sodium hydroxide are added to aqueous beryllium chloride, followed by a large excess of aqueous sodium hydroxide. Write equations for the two reactions which occur.

Observation when a few drops are added .....……

.....……

Equation ….….....……

Observation with excess …….....……

.....….....……

Equation ….....……

(4)
(Total 7 marks)

44. (a) A small sample of barium metal was added to water in a flask. When the reaction had ceased, the contents of the flask were treated with a small amount of dilute aqueous sodium sulphate.

Describe all that you would observe and write equations, with state symbols, for the reactions that occur.

(8)

(b) Dilute sodium hydroxide solution was added dropwise until in excess to separate dilute aqueous solutions of beryllium chloride, magnesium chloride and barium chloride.

Describe what you would observe in each case and account for your observations.

(8)

(c) (i) A naturally occurring compound of calcium contains by mass 23.29% of calcium,18.64% of sulphur and 2.32% of hydrogen, the remainder being oxygen.

Determine the empirical formula of this compound.

(ii) For any compound, what is the relationship between empirical and molecular formula? What additional information is required to determine a molecular formula from an empirical formula?

(5)
(Total 21 marks)

45. (a) When calcium and barium are added separately to water, similar reactions occur.

(i) Describe **two** observations that can be made when calcium reacts with water.

1st observation .....

.....

2nd observation .....

.....

(2)

(ii) For the two observations you have given in (a)(i), describe the differences that are found when barium reacts with water.

Difference for 1st observation .....

.....

Difference for 2nd observation .....

.....

(2)

(iii) Write an equation for the reaction of calcium with water.

.....

(1)

(b) Bleaching powder is manufactured by reacting chlorine with solid calcium hydroxide. When bleaching powder, which contains ClO^- ions, is added to excess acidified aqueous potassium iodide, iodine is liberated and chloride ions are formed. The aqueous iodine can be titrated with aqueous sodium thiosulphate, using a suitable indicator.

(i) Give the name of a suitable indicator for use in this titration.

.....

(1)

(ii) Describe the point in the titration at which the indicator is added.

.....

(1)

(iii) State the colour change that occurs in the indicator at the end point of the titration.

.....

(2)

(iv) State the oxidation number of **chlorine** in ClO^- and in Cl^-.

Oxidation number in ClO^- .....

Oxidation number in Cl^- .....

(1)

(v) State the oxidation number of **iodine** in I^- and in I_2.

Oxidation number in I^- .....

Oxidation number in I_2 .....

(1)

(vi) Write an ionic equation for the reaction of bleaching powder with acidified potassium iodide.

.....

.....

.....

(1)

(Total 12 marks)

46. (a) In terms of structure and bonding, describe and explain fully the difference between the melting points of the Period 3 elements aluminium, silicon and phosphorus.

(12)

(b) Describe and explain the difference between the electrical conductivities of the elements aluminium, silicon and phosphorus.

(4)

(c) State appropriate conditions under which magnesium and calcium react with water. Give equations for the reactions and describe what you would observe.

(7)

(d) "Beryllium is an atypical element in Group II." Justify this statement by comparing the reactions of beryllium hydroxide and magnesium hydroxide with hydrochloric acid and also with sodium hydroxide. Write equations to illustrate your answer.

(7)
(Total 30 marks)

48. (i) Complete the electronic configuration of a calcium atom.

$1s^2$.....

(1)

(ii) Describe the bonding present in solid calcium.

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.....

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(4)
(Total 5 marks)