IONIC CHEMISTRY

1. (a) A white solid **T** was heated with sodium hydroxide solution, an alkaline gas **X** was formed. Identify the cation in **T**

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   (b) When an aqueous solution of **T** was treated with lead(II) nitrate solution, a bright yellow precipitate was formed. Identify the anion in **T**.

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   (c) Write the ionic equation for the reaction leading to the formation of;

   i. Gas **X** in (a)

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   ……

   ii. The yellow precipitate in (b)

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   (d) Chlorine was bubbled through an aqueous solution of **T**.

   i. State what was observed.

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   ……

   ii. Write an ionic equation for the reaction that took place.

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   (**Uneb** 2010 p**2** Qtn.3)

2. (a) Aqueous ammonia solution was added to aluminium sulphate solution.

   i. State what was observed.

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ii. Write the equation for the reaction that took place.

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(b) Dilute sodium hydroxide solution was added drop wise until in excess to the product in (a).

i. State what was observed.

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ii. Explain your observation in (b) (i)

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(**Uneb** 2010 p**2** Qtn.7)

3. (a) State what would be observed if dilute ammonia solution was added drop wise until in excess to the aqueous solutions of;

i. Zinc sulphate.

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ii. Aluminium nitrate.

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iii. Copper(II) sulphate.

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iv. Magnesium nitrate.

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(b) Write ionic equation(s) for the reaction in (a) (iii)

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(Uneb 2009 p2 Qtn.9)

4. When aqueous ammonia was added drop wise to a solution containing zinc sulphate, a white precipitate, **Q**, was formed. **Q** dissolved in excess aqueous ammonia to form a colourless solution.

   a) Write ;

      i. An ionic equation for the reaction leading to the formation of **Q**.

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      ……

      ii. The formula of the cation present in the colourless solution.

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      ……

   b)

      i. Name a reagent that can be used to identify the sulphate ions in solution.

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      ii. State what would be observed when the reagent you have named in (b) (i) is used.

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      (Uneb 2008 p2 Qtn.9)

5. (a) Sodium carbonate solution was added to an aqueous solution of hydrogen chloride.

   i. State what was observed.

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ii. Write the equation for the reaction that took place.

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(b) 2-3 drops of lead(II) nitrate was added to the resultant solution in (a)

i. State what was observed.

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ii. Write an ionic equation for the reaction that took place.

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(**Uneb** 2007 p**2** Qtn.9)

6. When ammonia solution is added drop wise until in excess to copper(II) sulphate solution, a blue precipitate is formed. The precipitate dissolves in excess ammonia to form a deep blue solution. Explain these observations.

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Uneb 2007 p**2** Qtn.12

7. Ammonium chloride was placed in a dry test tube and heated while holding at the mouth of a test tube a glass rod containing a drop of lead(II) nitrate solution.

a) State what was observed;

i. In the test tube.

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ii. On the glass rod.

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……

b) Write an ionic equation for reaction that took place on the glass rod.

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c)

i. Name a reagent that can be used to test for the second product which was not tested for when lead(II) nitrate was used.

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ii. State what would be observed if the reagent named in (c) (i) was used.

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Uneb 2006 p**2** Qtn.1

8. (a) Lead(II) nitrate solution was added to aqueous solution of sodium iodide.

i. State what was observed.

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ii. Write an ionic equation for the reaction that took place.

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(b) Lead(II) nitrate crystals were heated strongly

i. State what was observed.

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…

ii. Write the equation for the reaction that took place.

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……

Uneb 2006 p**2** Qtn.2

9. (a) State what would be observed if sodium carbonate solution was added to;

   i. Aqueous calcium hydroxide.

   ……

   ii. Dilute sulphuric acid.

   ……

   (b) Write ionic equations for the reactions in (a) (i) and (a) (ii)

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Uneb 2005 p**2** Qtn.3

10. The table below shows some tests that were carried out on a certain substance ,Z, and the observation made were recorded in the table below.

Test	Observation
1. Solid **Z** was heated.	A colourless gas that turned calcium hydroxide solution to a white precipitate.
2. Aqueous sodium hydroxide was added to aqueous solution of **Z**	No apparent change.
3. Dilute hydrochloric acid was added to a solution of **Z**	Effervescence and a gas that formed a white precipitate with calcium hydroxide solution evolved.
4. (i) Aqueous magnesium chloride was added to solution of **Z**	No apparent change.
(i) Resultant solution from 4.(i) was heated.	White precipitate formed.

   a) What deduction can you make concerning the solubility of the hydroxide of the metal ion in Z?

- The hydroxide of the metal ion in Z is very soluble in water.

b) State the;

i. Likely anions present in Z

- Carbonate ion
- Hydrogen carbonate ion

ii. Anion actually present in Z.

- Hydrogen carbonate ion.

c) (i) Identify the white precipitate in test 4(ii)

- Magnesium carbonate.

(ii) Write an equation to show the reaction resulting in the formation of the substance you have identified in (c) (i)

- $Mg(HCO_3)_2(aq) \longrightarrow MgCO_3(s) + H_2O(l) + CO_2(g)$

11. (a) Lead(II) nitrate was heated until there was no further change.

i. State what was observed.

- ✓ White crystals made a crackling sound, melted and effervescenced, giving off reddish brown fumes.
- ✓ A reddish brown solid residue when hot and turned yellow on cooling was left.

ii. Write equation for the reaction that took place.

$2Pb(NO_3)_2(s) \longrightarrow 2PbO(s) + 4NO_2(g) + O_2(g)$

(b) Dilute hydrochloric acid was added to a solution of lead(II) nitrate and the resultant mixture warmed.

i. State what was observed.

- ✓ A white precipitate soluble on warming and recrystallizes on cooling.

ii. What can you deduce from your observation?

- ✓ Lead(II) chloride is insoluble in cold water but soluble in warm (hot) water.

  Or

- ✓ The solubility of lead(II) chloride in water increases with increase in temperature.

12. (a) Write equation to show the reaction between copper(II) hydroxide and dilute nitric acid.

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(b) Aqueous ammonia solution was added drop wise to a sample of copper(II) hydroxide until ammonia was in excess.

i. State what was observed.

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ii. Write the formula of the final product

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(Uneb 2002 p2 Qtn.7)

13. State the reagents that can be used to distinguish between each of the following pairs of ions and in each case, state what would be observation and write ionic equation for the reaction if each ion is treated with the reagent;

a) $Pb^{2+}(aq)$ and $Al^{3+}(aq)$

Reagent(s)	**Observation** and equation
• Dilute hydrochloric acid and warm.	With $Pb^{2+}(aq)$; white precipitate soluble on warming and recrystallizes on cooling. $Pb^{2+}(aq) + 2Cl^{-}(aq) \rightleftharpoons PbCl_2(s)$ With $Al^{3+}(aq)$; No observable

	change
• Potassium iodide solution.	With $Pb^{2+}(aq)$; a yellow precipitate would be formed. $Pb^{2+}(aq) + 2I^{-}(aq) \longrightarrow PbI_2(s)$ With $Al^{3+}(aq)$; there would be no observable change.
• Dilute sulphuric acid.	With $Pb^{2+}(aq)$; a white precipitate would be formed. $Pb^{2+}(aq) + SO_4^{2-}(aq) \longrightarrow PbSO_4(aq)$ With $Pb^{2+}(aq)$; there would be no observable change.

b) $SO_4^{2-}(aq)$ and $CO_3^{2-}(aq)$

Reagent(s)	**Observation** and equation.
• Barium nitrate solution followed by dilute nitric acid.	With $SO_4^{2-}(aq)$; White precipitate insoluble in the acid. $Ba^{2+}(aq) + SO_4^{2-}(aq) \longrightarrow BaSO_4(s)$ With $CO_3^{2-}(aq)$; White precipitate is formed dissolves in the acid with effervescence of a colourless gas forming a colourless solution. $Ba^{2+}(aq) + CO_3^{2-}(aq) \longrightarrow BaCO_3(s)$ $BaCO_3(s) + 2HNO_3(aq) \longrightarrow Ba(NO_3)_2(aq) + H_2O(l) + CO_2(g)$

14. (a) A solution of sodium carbonate was added to a solution of calcium ions.

i. State what was observed.

✓ A white precipitate was formed.

ii. Write equation for the reaction that took place.

- ✓ $Ca^{2+}(aq) + CO_3^{2-}(aq) \longrightarrow CaCO_3(s)$

  Or

- ✓ $Ca^{2+}(aq) + Na_2CO_3(aq) \longrightarrow CaCO_3(s) + 2Na^+(aq)$

(b) Dilute hydrochloric acid was added to the mixture in (a) above.

i. State what was observed.

- ✓ The white solid in the mixture dissolved with effervescence of a colourless gas forming a colourless solution.

ii. Write equation for the reaction.

- ✓ $CaCO_3(s) + 2HCl(aq) \longrightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$

15. (a) The table below shows the results of tests carried out on an aqueous solution of a salt. Study the table and answer the questions that follow.

Tests	Observation
i. With dilute sodium hydroxide solution.	White precipitate soluble in excess alkali.
ii. With aqueous ammonia.	White precipitate insoluble in excess ammonia solution.
iii. With aqueous potassium iodide.	A bright yellow precipitate.

i. Identify the cation.

- ✓ Lead(II) ion.

ii. Write an ionic equation for the reaction in test (ii) in the table.

- ✓ $Pb^{2+}(aq) + 2OH^-(aq) \longrightarrow Pb(OH)_2(s)$

iii. Explain the explanation in test (ii)

- ✓ Lead(II) ions combine with the hydroxide ions from ammonia solution forming insoluble lead(II) hydroxide which is a white precipitate.

(b) Write the equation for the reaction in test (iii) in the table and state another reagent besides aqueous potassium iodide that would give the same observation as in test (iii) of the table.

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1. a) A green crystalline inorganic compound **M** was heated in a test tube, misty fumes which turned anhydrous copper(II) sulphate blue and turned acidified orange potassium(VI) green. A reddish-brown residue was left.

   i) State two gases evolved. (1mark)

   ……
   ……
   …

   ii) Why did acidified potassium dichromate(VI) turn green. ($1\frac{1}{2}$ marks)

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   ……
   …

   iii) Suggest the identity for the residue. ($\frac{1}{2}$ mark)

   ……
   ……

   b) Dilute sulphuric acid was added to aqueous solution of **Q** followed by sodium hydroxide solution. It was observed that there was no observable change with acid but a greenish precipitate was formed on adding the alkali.

   i) Name the greenish precipitate formed. ($\frac{1}{2}$ mark)

   ……
   ……

   ii) Write the equation for the formation of the greenish precipitate.

   ($1\frac{1}{2}$ marks)

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……

C) A few drops of concentrated nitric acid were added to aqueous solution of **Q**. It was observed that the solution turned yellowish. On adding sodium hydroxide, a brown precipitate was formed.

i) Why did the solution turn yellow? (1mark)

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……

ii) Name the brown precipitate. ($\frac{1}{2}$ mark)

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2. Excess lead (II) oxide was added to warm dilute nitric acid and the mixture was stirred. After filtering, the mixture was cooled and a solution of sodium chloride was added to the filtrate.

(a) Write an equation for the reaction between lead (II) oxide and nitric acid.

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(b) State what was observed when sodium chloride solution was added to the filtrate.

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(c) Write an equation for the reaction in (b).

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(d) Describe what happens when the mixture in (b) is heated.

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3. Table 1 shows some tests which were carried out on a green solid, **P** and the

observations that were made.

Table I

Test	Observations
(i) **P** was heated until there was no further change	A colourless liquid condensed on the cooler part of the test tube. A colourless gas which turned aqueous potassium dichromate (VI) green was given out and a reddish brown residue **R** was left.
(ii) Chlorine gas was bubbled through an aqueous solution of **P**	Solution turned from green to yellow.

(a) Identify substances **P** and **R**.

P ……

R ……

(b) Name a substance that could be used to test for colourless liquid.

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(c) Write an equation for the reaction that took place in test (i).

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(d) Explain the reactions that took place in test (ii).

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4. (a)Name one reagent that can be used to differentiate between each of the following pairs of cations. In each case state what would be observed if each cation

is reacted with the reagent.

(i) $Al^{3+}(aq)$ and $Pb^{2+}(aq)$

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(ii) $Cu^{2+}(aq)$ and $Zn^{2+}(aq)$

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(iii) $NH_4^+(aq)$ and $Ca^{2+}(aq)$

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(b) Name one reagent that reacts with $CO_3^{2-}(aq)$ and $SO_4^{2-}(aq)$ to show similar observation and another one which can be used to distinguish the two anions. In each case state the observation.

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5. (a)Copper (II)) carbonate was heated strongly until there was no further change.

(i) State what was observed.

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(ii) Write an equation for the reaction.

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(iii) Name one reagent which can be used to identify the gaseous

product.

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(b) Excess dilute sulphuric acid was added to the residue in (a) and the mixture warmed.

(i) State what was observed.

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(ii) Write an equation for the reaction.

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(c) To the product in (b) was added dilute sodium hydroxide solution drop wise until in excess.

(i) State what was observed.

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(ii) Write an equation for the reaction.

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6. Zinc powder was added to a solution of copper sulphate in a test tube. A brown solid and a colourless solution were formed.

(a) (i) Identify the brown solid.

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(ii) Write an equation for the formation of the brown solid.

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(b) (i) Identify the colourless solution.

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(ii) Write an equation for the formation of the colourless solution.

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(iii) Write an overall equation for the reaction between zinc powder and copper sulphate.

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(iv) What reaction has taken place?

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7. An aqueous ammonia was added to aluminium sulphate solution.

(a) (i) State what was observed. ***(½ mark)***

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(ii) Write the reaction for the reaction that took place. ***(1½ marks)***

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(b) Dilute sodium hydroxide solution was added drop-wise until in excess to the product in (a).

(i) State what was observed. ***(01 mark)***

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(ii) Explain your observation in (b) (i) . ***(02 marks)***

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8. Anhydrous Iron (II) sulphate was heated strongly.

a) State what was observed (1mark)

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b) Write the equation for the reaction. (1½ marks)

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c) i) Name the reagent that can be used to identify one of the gaseous product.

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ii) State what would be observed when the gaseous product was treated with the reagent named in (c) (i) (1 mark)

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d) Write equation of reaction between the gaseous product in c (i) and hydrogen Sulphide. (1½ marks)

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9. a) Define the term ion (1 marks)

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b) Write ionic equations for the following chemical reactions:

i) Zinc metal with hydrochloric acid. (1½ marks)

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ii) Copper (II) oxide with dilute sulphuric acid. (1½ marks)

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……iii) Copper (II) sulphate with aqueous sodium carbonate. (1 marks)

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10. (a)Zinc carbonate was strongly heated is a hard glass test-tube until there is no further

change.

i) State what is observed. (1½ marks)

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ii) Write the equation for the reaction that took place. (1½ marks)

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b) The residue formed in (a) above was added to dilute sulphuric acid and heated.

i) State what is observed. (1mark)

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……

ii) Write equation for the reaction. (1mark)

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11. Excess ammonia solution was added to a solution containing a mixture of copper(II) ions and lead(II) ions and the resultant mixture filtered.

a) State the colour of the;

i) Residue.

……

ii) Filtrate.

……

b) Write;

i) The formula of the cation in the filtrate.

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……

ii) Equation for the reaction that resulted into the formation of the residue.

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c) If the experiment above was repeated using excess sodium hydroxide solution instead of ammonia and the resultant mixture filtered, state the colour of the;

i) Filtrate.

……

ii) Residue.

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(**Jjeb** 2018 p**2** Qtn.4)

12. The table below shows some tests carried out on a solution of salt Z and the observations that were made.

Test number	**Test**	**Observation**
I.	Sodium hydroxide solution was added drop-wise to aqueous **Z** until in excess.	A white precipitate soluble in excess sodium hydroxide.
II.	Ammonia solution was added drop-wise to aqueous **Z** until in excess.	A white precipitate insoluble in excess ammonia.
III.	Dilute hydrochloric acid was added to aqueous **Z** and the mixture warmed.	A white precipitate soluble on warming.

Use the observations from the table to answer the following questions.

a) (i) Identify the cation in **Z**.

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(ii) Write the ionic equation for the reaction in test III.

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b) Briefly describe how the cation in **Z** can be confirmed.

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(**Uneb** 2018 p2 Qtn.5)

13. Aluminium sulphate crystals were dissolved in distilled water; the resultant solution divided into two parts and treated as below.

I. To the first part was added three drops of lead(II) nitrate solution followed by dilute nitric acid.

II. To the second part was added dilute ammonia solution drop-wise until in excess.

State what was observed in each case and write ionic equation for the reaction that took place.

a) (I)

Observation

……

……

Equation

……

……

b) (II)

Observation

……

……

Equation

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14. (a) Crystals of copper(II) sulphate were strongly heated in a hard glass tube until no further change.

    i) Write equation(s) for the reaction(s) that took place.

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    ……

    ……..

    ii) State one use of copper(II) sulphate in the laboratory.

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    ……..

(b) Sodium hydroxide solution was added drop-wise to an aqueous solution of copper(II) sulphate.

i) State what was observed.

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ii) Write the equation for the reaction that took place.

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(d) The product in (b) was treated with excess dilute ammonia solution.

i) State what was observed.

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ii) Write the formula of the species responsible present in the final mixture.

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15. The following tests were carried out on an aqueous solution of substance **P**.

Tests	Observation
Aqueous ammonia solution was added drop-wise until in excess.	White precipitate soluble in excess.
Aqueous sodium hydroxide was added drop-wise until in excess.	White precipitate soluble in excess.
Dilute hydrochloric acid was added.	No observable change.
Barium chloride followed by hydrochloric acid was added.	White precipitate insoluble in the acid.

a) Identify the cation and anion in **P**.

i) Cation.

……

ii) Anion.

……

b) Write ionic equations to show the reaction between **P** and

i) Aqueous ammonia.

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ii) Acidified barium chloride.

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16. (a) Ammonium hydroxide solution was added drop-wise to an aqueous aluminium nitrate solution until in excess.

i) State what was observed.

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ii) Write the equation for the reaction that took place.

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(b) If dilute sodium hydroxide solution was then added to drop-wise until in excess to the product in (a) above.

i) State the likely observation.

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ii) Give a brief explanation for your observation in (b) (i)

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17. Ammonium sulphate was dissolved in water to form an aqueous solution. The resultant solution was divided into 3 parts.

(a) To the first part was added sodium hydroxide solution and the mixture warmed.

i) State what was observed.

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ii) Write an ionic equation for the reaction that took place.

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(b) To the second part was added lead(II) nitrate solution.

i) State what was observed.

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ii) Write an ionic equation for the reaction that took place

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(c) State what would be observed if the litmus was added to the third part.

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18. (a) State what is observed when aqueous hydrogen chloride is added to

i) Sodium carbonate solution.

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ii) Lead(II) nitrate solution.

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(b) Write the equation for the reaction between a concentrated solution of hydrogen chloride and potassium manganate(VII) crystals.

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(c) The gaseous product in (b) was bubbled into potassium iodide solution.

i) State what was observed.

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ii) Write the equation for the reaction.

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19. (a) State what is observed and write equation(s) for the reaction that takes place when aqueous sodium hydroxide solution is added drop wise until in excess to

i) Copper(II) chloride solution.

Observation

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Equation(s)

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ii) Zinc sulphate solution.

Observation

……

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Equation(s)

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iii) Iron(II) sulphate solution.

observation

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Equation(s)

……

……

iv) Aluminium sulphate solution.

observation

……

……

…

Equation(s)

……

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…

(b) (i) Name a reagent that can be used to distinguish between aluminium ions and lead(II) ions in solution and state what is observed in each case when the ions are separately treated with the reagent.

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(ii) Write the equation for the reaction in (b)(i) above.

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20. When burning calcium was lowered into a gas jar of nitrogen and drops of water added to the product, a gas **E,** was evolved, leaving a moist solid residue, **G**. Both **E** and **G** turned red litmus paper blue.

(a) Write the equation for the reaction leading to the formation of **E** and **G**

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(b) Explain why **E** and **G** turned red litmus paper blue.

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21. A sample of pure dry colourless gas, **D,** reacted with hot iron wire to produce equimolar amounts of gas, **W,** and a green solid residue, **Z. W** burnt in air with an explosion. **Z** dissolved in water to give a green solution, which reacted with acidified silver nitrate solution giving a white precipitate.

(a) State any deductions that can be made concerning **Z**

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……

(b) Write the formula of

i) **W** ……

ii) **Z** …….

(c) Comment on the composition of **D**

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…

(d) When excess dilute sodium hydroxide solution was added to aqueous **Z**, a green precipitate, which turned reddish-brown on standing in air, was formed

i) Identify the green precipitate.

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ii) Give a reason for the colour change of the precipitate.

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(e) Write an ionic equation for the reaction leading to the formation of the white precipitate when the green solution reacted with acidified silver nitrate solution.

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22. During a practical experiment, lead(II) nitrate solution was added to solution Y of

unknown composition. A white precipitate was formed.

(a) Identify the anions that were probably present in solution Y

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(b) Name one reagent that can be used to distinguish between the anions identified in (a) above.

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(c) State what would be observed when solution Y is separately treated with the reagent in (b)

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(Wakissha p.2 Qtn.8 2019)

23. An analysis on the crystalline substance X was carried out as shown below in the table.

	TEST	**OBSERVATION**
(i)	Addition of sodium hydroxide solution drop wise until in excess.	White precipitate soluble in excess forming a colourless solution.
(ii)	Addition of ammonia solution drop wise until in excess.	White precipitate insoluble in excess.
(iii)	Addition of 5 drops of dilute hydrochloric acid.	No observable change.

(a) Name three cations that could be suspected in test (i) above.

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…

(b) Name the cation that could be present in test (ii) above.

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(c)

i. Name one reagent that can be used to identify the actual cation in X

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ii. State what is observed when the reagent is used.

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24. Name one reagent which could be used to distinguish between members of each of the following pairs of ions and in each case state what would be observed if the reagent you have named was treated separately with each member of the pair.

Pair of ions	**Reagent**	**Observation**
(a) $SO_4^{2-}(aq)$ and $SO_3^{2-}(aq)$		
(b)$Al^{3+}(aq)$ and $Pb^{2+}(aq)$		
(c) $I^-(aq)$ and $Cl^-(aq)$		

25.