



Chemistry I

002

8<sup>th</sup> Nov 2011 8.30am-11.30am

ORDINARY LEVEL NATIONAL EXAMINATIONS 2011

SUBJECT : CHEMISTRY I

TIME : 3 HOURS

INSTRUCTIONS:

- This paper consists of **THREE** Sections A, B and C.
- Answer **ALL** the questions in section A. (55 marks)
- Answer **THREE** questions in section B. (30 marks)
- Answer only **ONE** question in section C. (15 marks)
- **You do not need the Periodic Table.**
- Calculators may be used.

**SECTION A: Attempt all questions.****(55 marks)**

1. Some oxides of period 3 of the periodic table are:  $\text{Na}_2\text{O}$ ,  $\text{Al}_2\text{O}_3$  and  $\text{SO}_3$ .
- (a) From the list choose and write down the formula of an oxide which is:
- (i) Acidic (1 mark)
  - (ii) Basic (1 mark)
  - (iii) Amphoteric (1 mark)
- (b) Write a balanced equation to show the reaction between the basic oxide and water. (2 marks)
2. The following list shows the chemical formulae of some ions:  $\text{Na}^+$ ,  $\text{Al}^{3+}$ ,  $\text{Zn}^{2+}$ ,  $\text{Br}^-$ ,  $\text{PO}_4^{3-}$  and  $\text{O}^{2-}$ . Use the list to write down the chemical formula of:
- (a) Sodium phosphate (1 mark)
  - (b) Aluminium oxide (1 mark)
  - (c) Zinc bromide (1 mark)
3. Silicon (atomic number 14) combines with chlorine (atomic number 17) to form compound A.
- (a) Write the electronic configuration of silicon. (1 mark)
  - (b) Using a "dot" and a "cross" diagram and the symbols Si (silicon) and Cl (chlorine), draw a diagram to show the bonding in the compound formed between Si and Cl. Use electrons in the outer shell only. (2 marks)
  - (c) Would you expect the compound in (b) to conduct electricity when in molten state? Explain your answer. (2 marks)
4.  $\text{C}_5\text{H}_{12}$  is an organic compound which is a member of the homologous series of alkanes.
- (a) What is the name of  $\text{C}_5\text{H}_{12}$ ? (1 mark)
  - (b) Give the formula of an alkane with 7 C atoms. (1 mark)
  - (c) Alkanes are examples of fossil fuels. Explain one environmental problem caused by the burning of alkanes. (2 marks)
5. Magnesium sulphate crystals ( $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ ) were prepared by reacting excess magnesium oxide and sulphuric acid.
- (a) Write an equation for the reaction of magnesium oxide with sulphuric acid to form magnesium sulphate. (2 marks)
  - (b) Why was excess magnesium oxide used? (1 mark)
  - (c) Calculate the percentage of oxygen by mass in the compound  $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$  (Mg = 24, S = 32, O = 16, H = 1)
6. 11.0g of manganese were reacted with oxygen to produce 17.4g of an oxide of manganese.
- (a) Calculate the mass of oxygen in the oxide of manganese. (1 mark)
  - (b) Calculate the number of moles of:
    - (i) Manganese (Mn) atoms (1 mark)
    - (ii) Oxygen (O) atoms, and then (1 mark)
  - (c) Determine the empirical formula of the oxide of manganese. (1 mark)
7. An alcohol has molecular formula  $\text{C}_3\text{H}_8\text{O}$ .
- (a) Write down the formula of the functional group in alcohols. (1 mark)
  - (b) Write down the structural formulae of two possible isomers which are alcohols with molecular formula  $\text{C}_3\text{H}_8\text{O}$ . (2 marks)
  - (c) Give the name of one of the isomers in (b). (1 mark)
8. A concentrated solution of sodium chloride was electrolyzed, using carbon (graphite) electrodes.

- (a) List all the ions present in aqueous sodium chloride by giving their formulae or names. (2 marks)
- (b) What is produced at the cathodes? (1 mark)
- (c) After electrolysis, the remaining solution was tested with red and blue litmus papers. State and explain the expected observations. (2 marks)
9. Chlorine gas was prepared by heating concentrated hydrochloric acid and manganese (IV) oxide ( $\text{MnO}_2$ ). After drying, it was collected by downward delivery.
- (a) Write a balanced equation for the reaction of hydrochloric acid with manganese (IV) oxide to produce chlorine, manganese (II) chloride and water. (2 marks)
- (b) How would you test for chlorine gas? Give the expected observation. (2 marks)
- (c) How is chlorine gas dried? (1 mark)
- (d) Suggest one precaution that would be taken while preparing chlorine gas in the laboratory? (1 mark)
10. The structures of some organic compounds are given below:
- A:  $\text{CH}_3\text{-CH}_2\text{-CH}=\text{CH}_2$       B:  $\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-OH}$
- C:  $\text{CH}_3\text{-CH}_2\text{-COOH}$       D:  $\text{CH}_3\text{-CH}_2\text{-CH}_3$ .
- (a) Which of these compounds is:
- (i) An alkane? (1 mark)
- (ii) A carboxylic acid? (1 mark)
- (iii) An alcohol? (1 mark)
- (b) Which of the compounds would react with sodium carbonate? (1 mark)
- (c) B and C were reacted together. What class of organic compounds is produced by reacting B and C? (1 mark)
11. Separation of some mixtures can be carried out by some methods below: fractional distillation, simple distillation, filtration, and chromatography. Select a method that would be used to separate:
- (a) Components of chlorophyll. (1 mark)
- (b) Kerosene and petrol (gasoline). (1 mark)
- (c) Copper (II) hydroxide from a precipitate of copper (II) hydroxide and water. (1 mark)
- (d) Pure water from sea water. (1 mark)
12. Ammonia ( $\text{NH}_3$ ) is an important chemical used to manufacture other products such as fertilizers and nitric acid.
- (a) Write a balanced equation to show the formation of ammonium nitrate from ammonia and nitric acid. (2 marks)
- (b) State one pollution problem associated with nitrate fertilizers. (1 mark)
- (c) Ammonia salts usually sublime when heated.
- (i) What is meant by sublimation? (1 mark)
- (ii) Write an equation to show the products of heating ammonium chloride. (1 mark)

**SECTION B: Attempt any three questions.**

(30 marks)

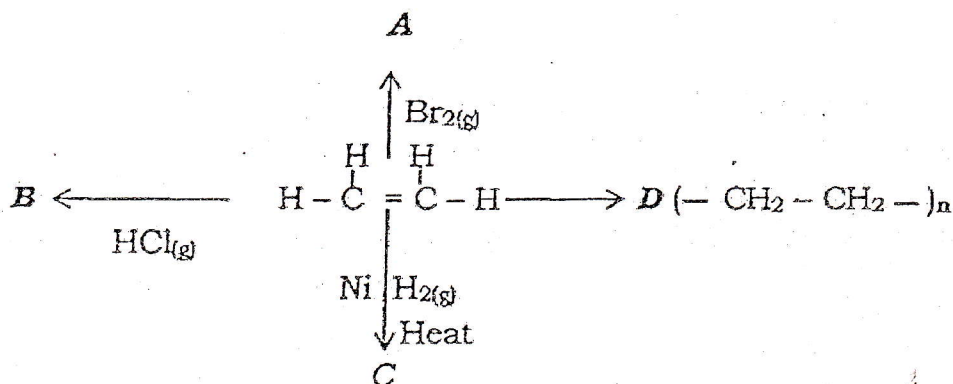
13. Hydrogen peroxide was mixed with manganese (IV) oxide to produce oxygen gas. The gas was collected in several gas jars so that some experiments could be carried out with it.
- (a) What is the role of manganese (IV) oxide ( $\text{MnO}_2$ ) in this experiment? (1 mark)
- (b) How is oxygen gas tested? Describe the test and the expected observation. (2 marks)
- (c) The elements sodium and sulphur were burned separately in gas jars containing oxygen. The product in each gas jar was mixed with water and the mixture shaken. The resulting solution was tested with litmus paper. Write a balanced equation to show:

- (i) How each element reacts with oxygen. (2 marks)  
 (ii) How each product in (i) reacts with water. (4 marks)  
 (d) State the observation made when the product of burning sulphur in oxygen was shaken with water and tested blue litmus paper. (1 mark)

14. Drinking water was suspected to have been contaminated by some salts. It was tested to identify some ions which were suspected to be present. The following tests were carried out: One sample was identified with nitric acid and then barium nitrate was added. A white precipitate was observed. Another sample was mixed with nitric acid and then silver nitrate was added. A white precipitate was observed. A third sample was mixed with sodium hydroxide and there was no observable change.

- (a) Which ion was identified by the test with barium nitrate? Write an ionic equation to show the formation of the white precipitate. (3 marks)  
 (b) Which ion was identified by the test with silver nitrate? Write an ionic equation to show the formation of the white precipitate. (3 marks)  
 (c) Suggest two possible cations which could have been present as shown by the test using sodium hydroxide. (2 marks)  
 (d) Suppose the water contained some ammonium ions. What test would confirm the presence of  $\text{NH}_4^+$  ions? (2 marks)

15. The chart below shows some reactions starting with ethene.



- (a) Give the structure and name of each of the compounds A, B and C. (6 marks)  
 (b) What name is given to the type of reaction that produces compound D? (1 mark)  
 (c) Give the name and the structural formula of the compound  $\text{C}_3\text{H}_6$ . (2 marks)  
 (d) Bromine is used to test for organic compounds which contain  $\text{C} = \text{C}$ . What is observed in this test? (1 mark)

16. Sulphuric acid is manufactured in the contact process according to the steps shown below.

I: Sulphur is burned in air (oxygen).

II: The product is reacted with more air (oxygen) in the presence of a catalyst to form sulphur trioxide.

III: Sulphur trioxide is absorbed in concentrated sulphuric acid and then diluted with water.

- (a) Give a balanced equation for the reaction in step I. (2 marks)  
 (b) Give a balanced equation for the reaction in step II. (2 marks)  
 (c) Name the catalyst used in step II. (1 mark)  
 (d) Briefly explain why sulphur trioxide is not directly reacted with water. (2 marks)  
 (e) Some sulphur dioxide may escape into the atmosphere. Explain an environmental problem this may cause. (2 marks)  
 (f) Give one large scale use of sulphuric acid. (1 mark)

17. A sample of carbon dioxide was prepared and collected for further experiments. The gas was produced by mixing calcium carbonate with hydrochloric acid. It was collected over water.

- (a) Write a balanced equation to show the reaction of calcium carbonate with hydrochloric acid. (2 marks)
- (b) Describe a chemical test for carbon dioxide, by stating the reagent and the expected observation for a positive result. (2 marks)
- (c) Carbon dioxide can be prepared by burning charcoal in air (oxygen). (1 mark)
- (i) Write a balanced equation for the reaction. (1 mark)
- (ii) What might be formed if the charcoal burns in insufficient air (oxygen)? (2 marks)
- (d) State two environmental problem caused by too much carbon dioxide in the atmosphere. (2 marks)
- (e) Carbon dioxide is used in some fire extinguishers. Give two properties of carbon dioxide which enable it to be used as a fire extinguisher. (2 marks)

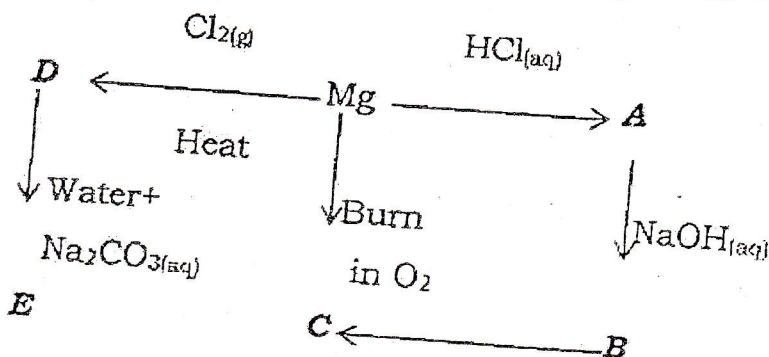
**SECTION C: Attempt only one question.**

**(15 marks)**

18. A titration experiment was carried out to determine the concentration of potassium hydroxide (KOH) and prepare crystals of potassium sulphate. In this experiment, 25cm<sup>3</sup> of KOH were neutralized by 24.50cm<sup>3</sup> of 0.1 mol/dm<sup>3</sup> sulphuric acid, using a suitable indicator.

- (a) Write a balanced equation for the reaction of KOH and H<sub>2</sub>SO<sub>4</sub>. (2 marks)
- (b) Calculate the number of moles of H<sub>2</sub>SO<sub>4</sub>. (2 marks)
- (c) Calculate the number of moles of KOH in 25cm<sup>3</sup>. (2 marks)
- (d) Calculate the concentration of KOH in mol/dm<sup>3</sup>. (2 marks)
- (e) Calculate the mass of KOH that was dissolved in 1dm<sup>3</sup> of solution. (2 marks)
- (K = 39, O = 16, H = 1)
- (f) In order to prepare a sample of crystals of potassium sulphate, 25cm<sup>3</sup> of KOH were mixed with 24.50cm<sup>3</sup> of 0.1mol/dm<sup>3</sup> sulphuric acid without the indicator. Describe in details how a sample of crystals of the salt would be obtained from the solution. (3 marks)
- (g) Rubidium (Rb) is below potassium (K) in group I of the periodic table. How would you compare the reactivity of Rb with K? Explain your reason. (2 marks)

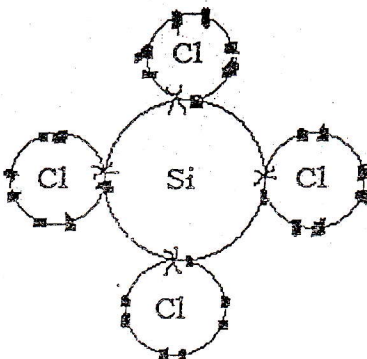
19. The chart below shows some reaction of magnesium and its compounds.



- (a) Identify the compounds **A**, **B**, **C**, **D** and **E** either by names or by the chemical formula. (10 marks)
- (b) In the reaction which produces compound **A**, a gas is produced also. (1 mark)
- (i) Name the gas produced. (2 marks)
- (ii) Describe a chemical test for the gas. (2 marks)
- (c) Write a balanced equation for the reaction of compound **A** with NaOH(aq). (2 marks)

**END.**

SECTION A

<p>1. a) i) Acidic - <math>\text{SO}_3</math>                      ii) Basic - <math>\text{Na}_2\text{O}</math>                      iii) Amphoteric - <math>\text{Al}_2\text{O}_3</math>                      b) <math>\text{Na}_2\text{O}_{(s)} + \text{H}_2\text{O}_{(l)} \longrightarrow 2\text{NaOH}_{(aq)}</math></p>	<p>2. a) <math>\text{Na}_3\text{PO}_4</math>                      b) <math>\text{Al}_2\text{O}_3</math>                      c) <math>\text{ZnBr}_2</math></p>	<p>3. a) 2, 8, 4 or <math>\text{K}^2 \text{L}^8 \text{M}^4</math>                      b)</p>								
<p>4. a) <math>\text{C}_5\text{H}_{12}</math> is pentane                      b) <math>\text{C}_7\text{H}_6</math> or <math>\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3</math>                      c) Air pollution, pollutant gases, global warming, green hour effects, floods, releases <math>\text{CO}_2</math> and <math>\text{CO}</math></p>										
<p>5. a) <math>\text{MgO} + \text{H}_2\text{SO}_4 \longrightarrow \text{MgSO}_4 + \text{H}_2\text{O}</math>                      b) Excess <math>\text{MgO}</math> was used to ensure that the neutralization reaction is complete and also the acid is finished or used up.                      c) M.M of <math>\text{MgSO}_4 \cdot 7\text{H}_2\text{O} = 24 + 32 + 16 \times 4 + (7(2 + 16)) = 246\text{g}</math>                      M.M of oxygen = <math>(16 \times 4 + 16 \times 7) = 176\text{g/mol}</math>                      % of oxygen is <math>\frac{176}{246} \times 100 = 71.5\%</math></p>		<p>c) <math>\text{SiCl}_4</math> cannot conduct electricity because it's a covalent compound, it's a non-electrolyte and it doesn't ionize to set free ions.</p>								
<p>6. a) <math>\text{Mn}_{(s)} + \text{O}_{2(g)} \longrightarrow \text{MnO}_{(s)}</math>                      11g                      17.4g                      Mass of oxygen = <math>17.4 - 11 = 6.4\text{g}</math>                      b) i) <math>\text{Mn} = n = \frac{m}{Mm} = \frac{11}{55} = 0.2</math> moles                      ii) <math>\text{O} = n = \frac{m}{Mm} = \frac{6.4}{16} = 0.4</math> moles</p>	<p>c) Empirical formula:  <table style="margin-left: auto; margin-right: auto;"> <tr> <td>Mn</td> <td>O</td> </tr> <tr> <td>n = 0.2</td> <td>0.4</td> </tr> <tr> <td>Ratio = <math>\frac{0.2}{0.2}</math></td> <td><math>\frac{0.4}{0.2}</math></td> </tr> <tr> <td>1</td> <td>2</td> </tr> </table>                     Empirical formula is <math>\text{MnO}_2</math></p>		Mn	O	n = 0.2	0.4	Ratio = $\frac{0.2}{0.2}$	$\frac{0.4}{0.2}$	1	2
Mn	O									
n = 0.2	0.4									
Ratio = $\frac{0.2}{0.2}$	$\frac{0.4}{0.2}$									
1	2									
<p>7. a)                      b) i) <math>\text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{OH}</math>                      ii) <math>\text{CH}_3 - \underset{\text{O}}{\text{C}} - \text{CH}_3</math>                      c) - Propanol</p>	<p>8. a) <math>\text{Na}^+, \text{Cl}^-, \text{H}^+</math> and <math>\text{OH}^-</math>                      b) Hydrogen gas or <math>\text{H}_2</math>                      c) The red litmus paper turns blue. The blue litmus paper is not affected or changed. Reason: presence of <math>\text{NaOH}</math> which is an alkaline solution</p>									
<p>9. a) <math>4\text{HCl} + \text{MnO}_2 \longrightarrow \text{Cl}_2 + \text{MnCl}_2 + 2\text{H}_2\text{O}</math>                      b) Test for chlorine:                      Turns moist blue litmus paper red and bleaches it.                      - It changes acidified <math>\text{K}_2\text{Cr}_2</math> from orange to green.                      - It changes acidified <math>\text{KmnO}_4</math> purples to colorless.</p>	<p>c) Chlorine gas is dried using concentrated sulphuric acid or an hydrous chloride                      d) The preparation of chlorine in the laboratory should be done in a fume cupboard because it is poisonous.</p>									
<p>10. a) i) D or <math>\text{CH}_3\text{CH}_2\text{CH}_3</math>                      ii) C or <math>\text{CH}_3 - \text{CH}_2 - \text{COOH}</math>                      iii) B or <math>\text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{OH}</math></p>	<p>b) C                      c) Ester or <math>\text{CH}_3 - \text{CH}_2 - \text{COOH}_2 \text{CH}_3</math></p>									

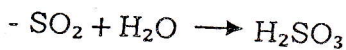
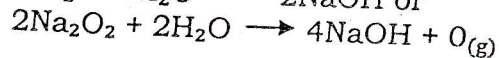
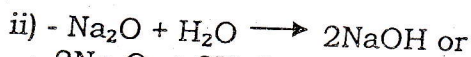
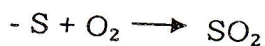
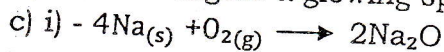
11. a) Chromatography  
 b) Fractional distillation  
 c) Filtration  
 d) Simple distillation

12. a)  $\text{NH}_3 + \text{HNO}_3 \rightarrow \text{NH}_4\text{NO}_3$   
 b) Water pollution, it acidifies soil, eutrophication, problem of respiration of fish  
 c) i) Sublimation as a direct change of state from solid to gas or from gas to solid without passing through the liquid state.  
 ii)  $\text{NH}_4\text{Cl} \xrightleftharpoons{\Delta} \text{NH}_3 + \text{HCl}$

SECTION B.

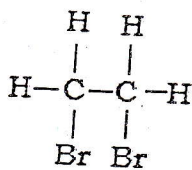
13. a)  $\text{MnO}_2$  is a catalyst ( it speeds up the reaction), it increases the rate of a chemical reaction.

b) Test: It relights a glowing splint



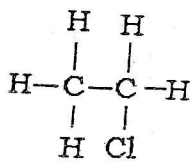
a) Turns blue litmus paper red

15. a) A



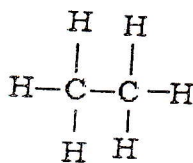
(dibromo ethane)

B

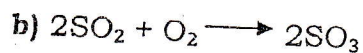
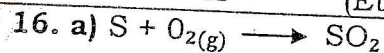


(Chloro ethane)

C

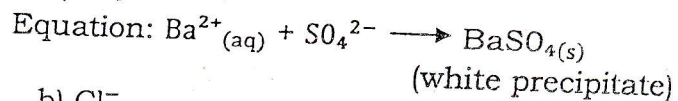


(Ethane)

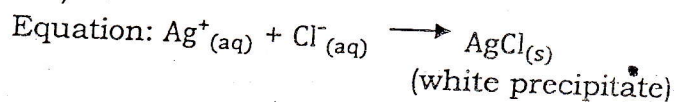


c) The catalyst is  $\text{V}_2\text{O}_5$   
 (vanadium pentoxide)

14. a)  $\text{SO}_4^{2-}$



b)  $\text{Cl}^-$

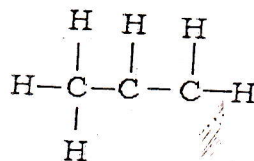


c)  $\text{Na}^+$ ,  $\text{K}^+$  or  $\text{NH}_4^+$ ,  $\text{Li}^+$ ,  $\text{Ca}^{2+}$

d) After addition of  $\text{NaOH}$  to  $\text{NH}_4^+$ , there is a smell of ammonia (which turns red litmus paper blue or with  $\text{HCl}$  gas, it forms dense white fumes)

b) Polymerisation

c)



d) These compounds decolorize bromine water or red bromine loses color (becomes colorless)

16.

d) The reaction is exothermic/produces mist fumes or the reaction is violent/produces a lot of heat

e) Acid rain which infects water and fish, causes green house effect, global warming, respiratory diseases etc

f) Used in car batteries, manufacture of fertilizers, detergents, chemicals, its used as a drying agent, covering metals, used as a dehydrating agent, used as a catalyst etc.

<p>17. a) <math>\text{CaCO}_3 + 2\text{HCl} \rightarrow \text{CaCl}_2 + \text{CO}_2 + \text{H}_2\text{O}</math></p> <p>b) Use of lime water (calcium hydroxide solution)</p> <p>Observation: Lime water turns milky or white precipitate in excess carbon dioxide i.e forms a clear solution.</p> <p>c) i) <math>\text{C}_{(s)} + \text{O}_{2(g)} \rightarrow \text{CO}_{2(g)}</math></p> <p>ii) Carbon monoxide</p>	<p>d) It causes green house effect of global warming, causes bad air (air pollution), floods etc.</p> <p>e) - Its denser than air - It doesn't support combustion/burning - Its not poisonous</p>
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### SECTION C.

<p>18. a) <math>2\text{KOH} + \text{H}_2\text{SO}_4 \rightarrow \text{K}_2\text{SO}_4 + 2\text{H}_2\text{O}</math></p> <p>b) 0.1 moles means that: 1000cm<sup>3</sup> of <math>\text{H}_2\text{SO}_4 \rightarrow 0.1</math> mol of <math>\text{H}_2\text{SO}_4</math></p> <p>1cm<sup>3</sup> of <math>\text{H}_2\text{SO}_4 \rightarrow \left(\frac{0.1}{1000}\right)</math> moles</p> <p>24.5cm<sup>3</sup> of <math>\text{H}_2\text{SO}_4 \rightarrow \left(\frac{0.1}{1000} \times 24.5\right)</math> moles = 0.00245 moles</p> <p>c) 2 moles of KOH <math>\rightarrow</math> 1 mole of <math>\text{H}_2\text{SO}_4</math> from the equation above: <math>2 \times 2.45 \times 10^{-3}</math> = <math>4.9 \times 10^{-3}</math> moles</p>	<p>d) Concentration of KOH. In 25cm<sup>3</sup> of KOH <math>\rightarrow 4.9 \times 10^{-3}</math> moles</p> <p>1cm<sup>3</sup> of KOH <math>\rightarrow \left(\frac{4.9 \times 10^{-3}}{25}\right)</math> moles</p> <p>1000cm<sup>3</sup> of KOH <math>\rightarrow \left(\frac{4.9 \times 10^{-3}}{25} \times 1000\right)</math> = 0.196 moles <math>\therefore</math> Concentration of KOH = 0.196mol/dm<sup>3</sup></p> <p>e) Mm of KOH = 39 + 16 + 1 = 56g Mass = No. of moles <math>\times</math> mm = <math>0.196 \times 56</math> = 10.976g</p>
<p>f) Evaporation then followed by crystallization or evaporate a bit to remove the excess water and leave it covered with pierced paper to crystallize.</p>	<p>g) Rubidium is more reactive than potassium because reactivity of group I metals increases down the group. Or Rubidium is more electro positive than potassium. Or Atomic radius of Rd is greater than atomic radius of K. Number of shells of Rb is greater than number shells of K.</p>
<p>19. a) A = <math>\text{MgCl}_2</math> or Magnesium Chloride B = <math>\text{Mg}(\text{OH})_2</math> or Magnesium hydroxide C = <math>\text{MgO}</math> or Magnesium oxide D = <math>\text{MgCl}_2</math> or Magensium Chloride E = <math>\text{MgCO}_3</math> or Magnesium Carbonate.</p>	<p>b) i) Hydrogne gas or <math>\text{H}_2</math></p> <p>ii) Hydrogen gas is burnt in air and it produces a pop sound.</p> <p>c) <math>\text{MgCl}_2 + 2\text{NaOH} \rightarrow \text{Mg}(\text{OH})_2 + 2\text{NaCl}</math></p>

END