KIRINYAGA CENTRAL SUB-COUNTY JOINT EXAMINATION - 2015

Kenya Certificate of Secondary Education
CHEMISTRY
PAPER 1
(THEORY)
JULY/AUGUST, 2015
TIME: 2 HOURS

INSTRUCTIONS TO CANDIDATES:
(i) Write your name and index number in the spaces provided above.
(ii) Sign and write the date of examination in the spaces provided above.
(iii) Answer ALL the questions in the spaces provided.
(iv) Mathematical tables and silent electronic calculators may be used.
(v) All working must be clearly shown where necessary.
(vi) Candidates should check the question paper to ascertain that all the pages are printed as indicated and that no questions are missing.

For Examiner’s Use Only

<table>
<thead>
<tr>
<th>Questions</th>
<th>Maximum Score</th>
<th>Candidate’s Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – 30</td>
<td>80</td>
<td></td>
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</tbody>
</table>

This paper consists of 12 printed pages. Candidates should check to ascertain that all the pages are printed as indicated and that no questions are missing.
1. Element A and B with atomic numbers 12 and 17 respectively react together.
   (a) Write the electronic configurations of each.

   A ________________________________________________________ (1 mark)

   B ________________________________________________________ (1 mark)

   (b) Write the formula of the compound formed between A and B.

2. When a compound X was heated, a brown gas and a black residue were produced. Give the formula of:
   (i) the brown gas. _________________________________________ (1 mark)

   (ii) the black residue. ________________________________________ (1 mark)

3. 20cm³ of a dibasic acid required 25cm³ of 0.1M NaOH for complete neutralization.
   (a) How many moles of sodium hydroxide reacted with the dibasic acid? (1 mark)

   ______________________________________________________________________

   (b) Calculate the concentration of the dibasic acid in moles per litre. (2 marks)

   ______________________________________________________________________

   ______________________________________________________________________

   ______________________________________________________________________

4. The set-up was used to prepare carbon (IV) oxide and investigate its properties.

   (a) Write an equation for the reaction in vessel B. (1 mark)
(b) What is the role of sodium hydroxide solution in the set-up? (1 mark)

_____________________________________________________________________

(c) What would be observed if a burning splint is introduced at jet C? (1 mark)

_____________________________________________________________________

5. Write down the property of concentrated sulphuric (VI) acid shown in the following reactions.
   (a) $\text{H}_2\text{C}_2\text{O}_4.2\text{H}_2\text{O(S)} \xrightarrow{\text{H}_2\text{SO}_4(l)} 2\text{H}_2\text{O(l)} + \text{CO}_2(g) + \text{CO}_2(g)$

   Property ____________________________________________ (1 mark)

   (b) $\text{C(S)} + 2\text{H}_2\text{SO}_4(S) \rightarrow \text{CO}_2(g) + 2\text{H}_2\text{O(l)} + 2\text{SO}_2(g)$

   Property ____________________________________________ (1 mark)

6. When 25cm³ of 0.5M HCl is added to 25cm³ of 0.5M NaOH the temperature of the solution rose from 23°C to 26°C. Given that the density of the solution is 1gcm⁻³ and its specific heat capacity is 4.2Jg⁻¹K⁻¹.
   (a) Determine the amount of heat evolved that caused the temperature rise. (1 mark)

   _______________________________________________________________________

   (b) Work out the molar enthalpy of neutralization for this reaction. (2 marks)

   _______________________________________________________________________

   _______________________________________________________________________

   _______________________________________________________________________

   _______________________________________________________________________

7. The empirical formula of a compound is CH₂ and its molecular mass is 42.
   (a) What is the molecular formula of this compound? (1 mark)

   _______________________________________________________________________

   _______________________________________________________________________

   _______________________________________________________________________

   _______________________________________________________________________

   (b) To which group of hydrocarbons does the compound above belong? (1 mark)

   _______________________________________________________________________
Chemistry Paper 1

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(c) Draw the structural formula of the fourth member of this series and give its IUPAC name. (1 mark)

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_____________________________________________________________________
________________________________________ ____________________________

8. The set-up below shows how gas A was prepared and reacted with heated magnesium.

(a) Give a reason why it is not advisable to heat magnesium before heating ammonium nitrite. (1 mark)

_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________

(b) (i) Identify gas A. (1 mark)

(b) (ii) Write a chemical equation for the reaction between gas A and magnesium. (1 mark)

_____________________________________________________________________

9. In the down’s process (used for extraction of sodium) a certain salt is added to lower the melting point of sodium chloride from 800°C to about 600°C.

(i) Identify the salt added. (1 mark)
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(ii) Why is it necessary to lower the temperature? (1 mark)

______________________________________________________________________

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______________________________________________________________________

(iii) Give one use of sodium. (1 mark)

______________________________________________________________________

______________________________________________________________________

10. Consider the following reaction at equilibrium.

\[ \text{PCl}_5(g) \rightleftharpoons \text{PCl}_3(g) + \text{Cl}_2(g) \]

Complete the table below to show the effect of different factors on the position of equilibrium. (3 marks)

<table>
<thead>
<tr>
<th>Factor</th>
<th>Effect on the equilibrium position</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i) Decrease pressure</td>
<td></td>
</tr>
<tr>
<td>(ii) Remove chlorine</td>
<td></td>
</tr>
<tr>
<td>(iii) Adding helium gas to the mixture</td>
<td></td>
</tr>
</tbody>
</table>

11. (a) State Graham’s Law of diffusion. (1 mark)

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

(b) 100cm³ of sulphur (IV) oxide takes 20 seconds to diffuse through a porous plate. What volume of oxygen gas would diffuse through the same plate in 30 seconds under similar conditions. (S = 32, O = 16). (2 marks)

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________
12. Element X contains isotopes with mass number 16 and 18 respectively existing in the ratio 1:3 calculate the relative atomic mass of X. (2 marks)

13. The structures shown below represents two cleansing agents A and B.

\[
\text{RCOO}^+\text{Na}^+ \quad \text{R} \quad \text{OSO}_3^+\text{Na}^+ \\
\text{A} \quad \text{B}
\]

(a) Identify the cleansing agent B. (1 mark)

(b) Which cleansing agent would be more suitable for washing in water containing magnesium sulphate? Explain. (2 marks)

14. Study the reaction scheme below and answer the questions that follow.

\[
\text{Al}_2(\text{SO}_4)_3(\text{aq}) + \text{Little NaOH} \rightarrow \text{White precipitate} \quad \text{Excess NaOH}_{(aq)} \rightarrow \text{Colourless solution Q}
\]

(a) Write an ionic equation for the formation of the white precipitate. (1 mark)

(b) Write the formula of the complex ion present in the colourless solution Q. (1 mark)

15. Study the table below and use it to answer the questions that follow.

<table>
<thead>
<tr>
<th>Solution</th>
<th>PH</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>3.5</td>
</tr>
</tbody>
</table>
(i) In which of the solution will phenolphthalein indicator be colourless. (1 mark)

(ii) Which of the solutions could be used to relieve heartburn? Explain. (2 marks)

16. Starting with dilute sulphuric (VI) acid, dilute nitric (V) acid and lead (II) carbonate powder, describe how you can prepare a dry sample of lead (II) sulphate. (3 marks)

17. (a) 384g of radioactive element was reduced to 48g in 540 days. Determine the half-life of X. (2 marks)

(b) Give one use of radioactive isotopes in industries. (1 mark)

18. The diagram below is a set-up of apparatus used to react ammonia gas with iron (IV) chloride solution.
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(a) State the observation made in the beaker after a few minutes. (1 mark)

(b) Explain why the funnel is used to deliver the ammonia into the solution. (1 mark)

19. (a) A mass of 40g of a saturated solution of potassium chlorate at 25°C yields 14g of potassium chlorate when evaporated to dryness. Calculate the solubility of potassium chlorate at 25°C. (2 marks)

(b) State one advantage of hard water. (1 mark)

20. Dry hydrogen chloride gas was passed over heated iron wool as shown below.
(a) State the observation made in the combustion tube at the end of the experiment. (1mk)

(b) Write the equation for the reaction taking place:
(i) In the combustion tube. (1 mark)

Chemistry Paper 1
Leading to production of the blue flame. (1 mark)

21. A dry cell is constructed using the following substances. Zinc metal, graphite rod, ammonium chloride paste and manganese (IV) oxide mixed with carbon powder.

(a) State the roles of:
(i) ammonium chloride paste. (1 mark)

(b) Given that:
\[ 2NH_4^{+}(aq) + 2e^- \rightarrow 2NH_3(g) + H_2(g) \quad E^\theta = 0.74V \]
and \[ Zn^{2+}(aq) + 2e^- \rightarrow Zn(s) \quad E^\theta = -0.76V \]

Calculate the e m f of the cell given zinc forms the negative electrode. (1 mark)

22. 1.26g of lead powder were dissolved in excess nitric (VI) acid to form lead nitrate solution. All the lead nitrate solution was reacted with sodium sulphate solution.

(a) Write an ionic equation for the reaction between lead nitrate and sodium sulphate solutions. (1 mark)
(b) Determine the mass of lead salt formed in  
(a) above (Pb = 207, S = 32, O = 16).  (2 marks)  
_________________________________________________________________  
_________________________________________________________________  
_________________________________________________________________  

Chemistry Paper I  
Kirinyaga Central  
23. The figure below shows a burning splint that was put across the middle of a non-luminous flame. Explain the results.  
(2 marks)  

24. The following chromatogram was obtained in an experiment to investigate the components present in certain dyes.  

(a) Which two dyes when mixed would produce A?  
(1 mark)  

(b) Which dye is pure?  
(1 mark)  

(c) Indicate on the diagram the solvent front.  
(1 mark)  

25. (a) Draw a dot (.)/cross (X) diagram to show bonding in Cl₂O.  (Cl = 17, O = 8).  (1 mark)
(b) In terms of structure and bonding explain why the component Cl₂O has a very low melting and boiling point. (2 marks)

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______________________________________________________________________
______________________________________________________________________
______________________________________________________________________

Chemistry Paper 1
26. Solid J reacts with cold water but solid K does not. L reduces the oxide of M but does not reduce the oxide of K. Arrange the elements in order of reactivity starting with the most reactive. (2 marks)

____________________________________________________________________________
____________________________________________________________________________

27. The figure below shows a set-up used in electrolysis of lead iodide.

(a) Why is heating necessary? (1 mark)

______________________________________________________________________
______________________________________________________________________
(b) Write the equation of the reaction that occurs at the cathode. (1 mark)

______________________________________________________________________
______________________________________________________________________
(c) At which electrode does reduction occurs. (1 mark)
28. 3.22g of hydrated sodium sulphate, Na$_2$SO$_4$.XH$_2$O were heated to a constant mass of 1.42g. Determine the value of X in the formula. (Na = 23.0, S = 32.0, O = 16.0, H = 1). (3 marks)

Chemistry Paper 1

29. The curve shown below was obtained when solid naphthalene was heated to boiling.

![Graph](attachment:image.png)

(a) Explain in molecular terms the changes occurring in portions.
   (i) AB.
   (1 mark)

(b) What is the significance of portion BC?
   (1 mark)
30. Use the equation below to answer the questions that follow.

\[ \text{Cr}_2\text{O}_7^{2-}\text{(aq)} + \text{OH}^-\text{(aq)} \rightarrow 2\text{CrO}_4^{2-}\text{(aq)} + 2\text{H}_2\text{O}\text{(l)} \]

Using oxidation numbers show where reduction has taken place. (2 marks)

____________________________________________________________________________

____________________________________________________________________________

____________________________________________________________________________

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KIRINYAGA CENTRAL SUB-COUNTY JOINT EXAMINATION - 2015

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<th>Candidate’s Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<td></td>
<td></td>
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<tr>
<td>2</td>
<td>9</td>
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<td>13</td>
<td></td>
<td></td>
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<td>7</td>
<td>11</td>
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<tr>
<td>Total Score</td>
<td>80</td>
<td></td>
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</tbody>
</table>

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(a) Study the table below and answer the questions that follow.

<table>
<thead>
<tr>
<th>Element</th>
<th>Atomic radius (nm)</th>
<th>Ionic radius (nm)</th>
<th>Formula of oxide</th>
<th>Melting point of oxide (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.364</td>
<td>0.421</td>
<td>$A_2O$</td>
<td>-119</td>
</tr>
<tr>
<td>B</td>
<td>0.830</td>
<td>0.711</td>
<td>$BO_2$</td>
<td>837</td>
</tr>
<tr>
<td>E</td>
<td>0.592</td>
<td>0.485</td>
<td>$E_2O_3$</td>
<td>1466</td>
</tr>
<tr>
<td>G</td>
<td>0.381</td>
<td>0.446</td>
<td>$G_2O_5$</td>
<td>242</td>
</tr>
<tr>
<td>J</td>
<td>0.762</td>
<td>0.676</td>
<td>$JO$</td>
<td>1054</td>
</tr>
</tbody>
</table>

(i) Which elements are non-metals? Give a reason. (3 marks)

________________________________________________________________________

________________________________________________________________________

(ii) Explain why the melting point of the oxide of $E$ is higher than that of the oxide of $G$. (2 marks)

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

(iii) Give two elements that would react vigorously with each other. Explain your answer. (2 marks)

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

(b) Study the information below and answer the questions that follow. The letters do not represent the actual symbols of the elements.

<table>
<thead>
<tr>
<th>Element</th>
<th>Electronic Configuration</th>
<th>Ionization energy KJ/mol</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1st I.E</td>
</tr>
<tr>
<td>X</td>
<td>2.2</td>
<td>900</td>
</tr>
<tr>
<td>Y</td>
<td>2.8.2</td>
<td>736</td>
</tr>
<tr>
<td>Z</td>
<td>2.8.8.2</td>
<td>590</td>
</tr>
</tbody>
</table>
(i) What chemical family does the elements $X$, $Y$ and $Z$ belongs? (1 mark)

(ii) What is ionization energy? (1 mark)

(iii) The 2$^{nd}$ ionization energy is higher than the 1$^{st}$ ionization energy of each element. Explain. (1 mark)

(iv) When a piece of element $Z$ is placed in cold water, it sinks to the bottom and effervescence of a colourless gas that burns explosively is produced. Use a simple diagram to illustrate how this gas can be collected during this experiment. (2 marks)

2. Study the flow chart below starting from iron metal and answer the questions that follow.
(a) Identify gases.

D

L

V

(b) Identify the following substances.

(i) Compound B

(ii) Compound T

(iii) Solid A

(iv) Solid Y

(v) Solid X

(c) What name is given to the reaction in Step 2? ____________________ (1 mark)

(d) State the colour of solid X. ________________________________ (1 mark)

(e) Write balanced equations for the reactions that occurred in

Step 1.

______________________________ (1 mark)

Step 5.

______________________________ (1 mark)

(f) What property of hydrogen peroxide (H_2O_2) is indicated in Step 7? (1 mark)

3. (a) One mole of heptane was thermally cracked, two hydrocarbons Q and P were formed. Q was an alkene molecule with three carbon atoms.

(i) Give the molecular formula of.

I Q ____________________________ (1 mark)

II P ____________________________ (1 mark)

(ii) Write the structural formula of Q. (1 mark)
Name the compound formed when Q undergoes self addition reaction. (1 mark)

State one disadvantage of using the product named in a(iii) above. (1 mark)

Cracking can also be achieved using less amount of heat in the presence of a catalyst. Name one catalyst that is often used. (1 mark)

An organic compound J has the following percentage by mass, carbon 64.86%, hydrogen 13.51% and the rest is oxygen. The relative molecular mass of the compound is 74. (C = 12, O = 16, H = 1)

Work out the molecular formula of compound J. (3 marks)

To which homologous series does compound J belong? (1 mark)

Write a balanced chemical equation for the reaction that occurs when compound J reacts with sodium metal. (1 mark)

Name the type of reaction indicated in b(iii) above. (1 mark)
(v) Name the organic compound formed when $J$ reacts with excess acidified potassium managanate (VII).

(1 mark)

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**Chemistry Paper 2**

4. 2.5g of a pure metal carbonate $MCO_3$ was reacted with excess 2M nitric (V) acid. The volume of carbon (IV) oxide evolved was measured and recorded at 10 second intervals. The results were recorded as shown in the table below.

<table>
<thead>
<tr>
<th>Volume of gas (cm$^3$)</th>
<th>0</th>
<th>90</th>
<th>150</th>
<th>210</th>
<th>280</th>
<th>340</th>
<th>390</th>
<th>450</th>
<th>480</th>
<th>480</th>
<th>480</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time (seconds)</td>
<td>0</td>
<td>10</td>
<td>20</td>
<td>30</td>
<td>40</td>
<td>50</td>
<td>60</td>
<td>70</td>
<td>80</td>
<td>90</td>
<td>100</td>
</tr>
</tbody>
</table>

(a) (i) On the grid provided, plot a graph of volume (vertical axis) against time – Label it curve A. (3 marks)
(ii) From your graph determine the rate of reaction between 25 seconds and 40 seconds. (2 marks)

On the same axes, sketch a curve that would be obtained if the same experiment was repeated using excess 1M nitric (V) acid. Label it curve B. (1 mark)

(iv) Give that carbon (IV) oxide was measured at room temperature and pressure, work out the relative atomic mass of metal M. (Molar gas volume at r.t.p = 24dm³, C = 12, O = 16). (3 marks)

(b) When bromine is dissolved in water the equilibrium shown below is established.

\[
Br_{(aq)}^2 + H_2O_{(l)} \rightleftharpoons Br_{(aq)}^- + OB_{(aq)}^- + 2H_{(aq)}^+
\]

(Yellow) (Colourless)

State and explain the observation that would be made if aqueous sodium hydroxide was added to the equilibrium mixture. (2 marks)

5. (a) Use the standard electrode potentials for elements A, B, C, D and F given below to answer the questions that follow.

\[
A_{(aq)}^{2+} + 2e^- \rightleftharpoons A_{(s)} \quad E^0 (\text{Volts}) -2.90
\]
\[
\begin{align*}
B_{(aq)}^{2+} + 2e^- &\rightleftharpoons B_{(S)} & -2.38 \\
C^+_{(aq)} + e^- &\rightleftharpoons \frac{1}{2}C_{2(\ell)} & 0.00 \\
D_{(aq)}^{2+} + 2e^- &\rightleftharpoons D_{(S)} & +0.34 \\
\frac{1}{2}F_{2(\ell)} + e^- &\rightleftharpoons F_{(aq)} & +2.87 \\
\end{align*}
\]

**Chemistry Paper 2**

(i) Which element is likely to be hydrogen? Give a reason for your answer. (2 marks)

(ii) What is \(E^0\) of the strongest reducing agent? (1 mark)

(iii) Calculate the e.m.f of the cell that would be formed when half cells of B and D are combined. (1 mark)

(b) Aqueous copper (II) sulphate was electrolysed using the set up below.
(i) When the switch was closed a gas was produced only at electrode B. Which electrode is the anode? (1 mark)

(ii) Write the half equation for the reaction occurring at electrode B. (1 mark)

(iii) What happens to the PH of the electrolyte during electrolysis? Explain. (2marks)

(iv) If carbon electrodes were replaced with copper electrodes in the cell above, write the equation of the reaction that would occur at the anode. (1 mark)

(c) During electrolysis of aqueous copper (II) sulphate using copper electrodes a current of 0.2 amperes was passed through the cell for 5 hours. Determine the change in mass of the cathode that occurred as a result of the electrolysis process. (Cu = 64, IF = 96500 coulombs). (3 marks)

6. (a) State Hess’s law. (1 mark)
(b) Use the following information to answer the questions that follow:

\[
\begin{align*}
C(S) + O_2(g) &\rightarrow CO_2(g) \quad \Delta H = -393 \text{KJ/mol} \\
H_2(g) + \frac{1}{2}O_2(g) &\rightarrow H_2O(g) \quad \Delta H = -296 \text{KJ/mol} \\
C_4H_{10} + \frac{13}{2}O_2(g) &\rightarrow 4CO_2(g) + 5H_2O \quad \Delta H = -2877 \text{KJ/mol}
\end{align*}
\]

Chemistry Paper 2

(i) Draw an energy cycle diagram relating heat of formation and combustion of butane.

(ii) Calculate the heat of formation of butane.

(c) Distinguish between hydration energy and lattice energy.

(d) The diagram below shows an energy level diagram for the formation of magnesium chloride. Study it and answer the questions that follow.
(i) State the enthalpy changes represented by

A ____________________________________________________ (½ mark)

B _____________________________________________________ (½ mark)

C _____________________________________________________ (½ mark)

(ii) What is the relationship between $\Delta H_A$, $\Delta H_B$ and $\Delta H_C$. (½ mark)

_________________________________________________________________

(e) Define heat value of a fuel. (1 mark)

_________________________________________________________________

_________________________________________________________________

(ii) Give two reasons why wood and charcoal are chosen for domestic heating. (2 marks)

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7. The flow chart below shows the large scale manufacture of ammonia gas and some ammonium compounds. Study it and answer the questions that follow.

[Diagram of the flow chart with nodes labeled: Dry hydrogen gas, Dry nitrogen gas, Purifiers, Compressors]
(a) What are the sources of the following raw materials?
   (i) Hydrogen gas. (1 mark)

   _______________________________________________________________________

   (ii) Nitrogen gas. (1 mark)

   _______________________________________________________________________

(b) What optimum conditions are needed during the manufacture of ammonia in the
   (i) Compressor. (1 mark)

   _______________________________________________________________________

   (ii) Catalytic chamber. (1 mark)

   _______________________________________________________________________

(c) Why should the gas be passed through the compressor. (1 mark)

   _______________________________________________________________________

   _______________________________________________________________________

(d) Write an equation for the reaction that occurs in Step 1. (1 mark)

   _______________________________________________________________________

   _______________________________________________________________________

(e) Write the formula of the compound B. (1 mark)

   _______________________________________________________________________

(f) Calculate the percentage of nitrogen in compound A. (2 marks)
(g) What observation would be made if compound C was added to a sample suspected to contain copper (II) ions dropwise then in excess? (2 marks)
1. You are provided with:
   • Solution A, Dilute hydrochloric acid.
   • Solution B, made by dissolving 0.5g of sodium hydroxide in water and made to 250cm³ of solution.
   • Solid C, Magnesium ribbon.
   • Phenolphthalein indicator.

   You are required to:
   (i) Standardize solution A.
   (ii) Determine the rate of reaction between solution A and magnesium.

**PROCEDURE I:**

(i) Measure exactly 10cm³ of solution A using a burette and transfer into a 250ml volumetric flask. Top up to the mark using distilled water. Label this solution D.

(ii) Drain the remaining solution A in the burette, rinse the burette thoroughly and fill the burette with solution D.

(iii) Pipette 25cm³ of solution B into a conical flask. Add three drops of phenolphthalein indicator.

(iv) Titrate solution D with solution B. Record your results in the table below. Repeat procedures (i) to (iv) to complete the table.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final burette reading (cm³)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial burette reading (cm³)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volume of base, solution A used (cm³)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(a) Calculate the average volume of solution D used. (1 mark)

(b) Calculate:
   (i) Number of moles of solution B reading. (1½ marks)
   (ii) Number of moles of solution D in 250cm³ of solution. (1½ marks)
   (iii) Molarity of solution A. (1 mark)
PROCEDURE II:

(i) Cut solid C into equal pieces, each 2cm long.

(ii) Using a burette, measure 12cm³ of solution A, into a clean boiling tube.

(iii) Drop one piece of solid C into the boiling tube containing solution A and start the stopwatch immediately. Stop the stopwatch when all solid C has just reacted. Record your results in the table below.

(iv) Repeat steps (ii) and (iii) above using 10cm³, 8cm³, 6cm³ and 4cm³ of solution A. Top up each with distilled water to make12cm³ of solution and complete the table below.

<table>
<thead>
<tr>
<th>Volume of Solution A (cm³)</th>
<th>Volume of distilled water (cm³)</th>
<th>Concentration of solution A (moles/l)</th>
<th>Time(s)</th>
<th>( \frac{I}{t} (S^{-1}) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(a) Plot a graph of \( \frac{I}{t} \) (y-axis) against the concentration of solution A.

(b) From the graph, determine the time taken for the reaction to reach completion when 1.5 moles of solution A are used. (2 marks)

(c) Comment on the shape of the graph. (1 mark)

2. You are provided with solid Q. Carry out the tests below and record your observations and inferences in the spaces provided.

(a) Strongly heat a spatula-end full of solid Q in a dry test tube.

<table>
<thead>
<tr>
<th>Observation</th>
<th>Inference</th>
</tr>
</thead>
</table>

(1mk) (1mk)

(b) (i) Place the remaining solid Q in a boiling tube. Add 10cm³ of distilled water. Divide the solution into five portions.

<table>
<thead>
<tr>
<th>Observation</th>
<th>Inference</th>
</tr>
</thead>
</table>

(½mk) (½mk)
(ii) To the first portion, add aqueous lead (II) nitrate solution.

<table>
<thead>
<tr>
<th>Observation</th>
<th>Inference</th>
</tr>
</thead>
<tbody>
<tr>
<td>(½mk)</td>
<td>(½mk)</td>
</tr>
</tbody>
</table>

(iii) To the second portion, add dilute nitric (V) acid, followed by barium nitrate solution.

<table>
<thead>
<tr>
<th>Observation</th>
<th>Inference</th>
</tr>
</thead>
<tbody>
<tr>
<td>(½mk)</td>
<td>(½mk)</td>
</tr>
</tbody>
</table>

(iv) To the third portion add a few drops of sodium hydroxide until in excess.

<table>
<thead>
<tr>
<th>Observation</th>
<th>Inference</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1mk)</td>
<td>(1mk)</td>
</tr>
</tbody>
</table>

(v) To the fourth portion, add a few drops of aqueous ammonia until it is excess.

<table>
<thead>
<tr>
<th>Observation</th>
<th>Inference</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1mk)</td>
<td>(½mk)</td>
</tr>
</tbody>
</table>

(vi) To the fifth portion, add a few drops of hydrochloric acid. Warm the contents.

<table>
<thead>
<tr>
<th>Observation</th>
<th>Inference</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1mk)</td>
<td>(½mk)</td>
</tr>
</tbody>
</table>

3. You are provided with solid R. Carry out the tests below and record your observations and inferences.

(a) Place a spatula-end full of solid R in a dry boiling tube and add about 10cm³ of distilled water. Shake thoroughly and heat to boil. Divide the solution into five portions.

<table>
<thead>
<tr>
<th>Observation</th>
<th>Inference</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1mk)</td>
<td>(½mk)</td>
</tr>
</tbody>
</table>
(b) (i) Test the first portion with the universal indicator solution provided.

<table>
<thead>
<tr>
<th>Observation</th>
<th>Inference</th>
</tr>
</thead>
<tbody>
<tr>
<td>(½mk)</td>
<td>(1mk)</td>
</tr>
</tbody>
</table>

(ii) To the second portion, add a few drops of acidified potassium manganate (VII) solution.

<table>
<thead>
<tr>
<th>Observation</th>
<th>Inference</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1mk)</td>
<td>(1mk)</td>
</tr>
</tbody>
</table>

(iii) To the third portion, add a few drops of bromine water.

<table>
<thead>
<tr>
<th>Observation</th>
<th>Inference</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1mk)</td>
<td>(1mk)</td>
</tr>
</tbody>
</table>

(iv) To the fourth portion, add half spatula of sodium hydrogen carbonate.

<table>
<thead>
<tr>
<th>Observation</th>
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</tr>
</thead>
<tbody>
<tr>
<td>(½mk)</td>
<td>(½mk)</td>
</tr>
</tbody>
</table>

(v) To the fifth portion in a boiling tube, add 5cm³ of ethanol followed by a few drops of concentrated sulphuric (VI) acid. Warm the mixture.

<table>
<thead>
<tr>
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<th>Inference</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1mk)</td>
<td>(½mk)</td>
</tr>
</tbody>
</table>