BAHAGIAN PENGURUSAN
SEKOLAH BERASRAMA PENUH DAN SEKOLAH KLUSTER

MODUL PERFECT SCORE
2010

CHEMISTRY

- Set 1
- Set 2
- Set 3
- Set 4
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<td>• Chemicals for Consumers</td>
</tr>
</tbody>
</table>

**Question Validation & Construction Panel**

<p>| | | |</p>
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<th></th>
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<tbody>
<tr>
<td>1</td>
<td>Pn Wan Noor Aifah binti Wan Yusoff</td>
<td>SBPI Gombak</td>
</tr>
<tr>
<td>2</td>
<td>En Che Malik bin Mamat</td>
<td>SBPI BR</td>
</tr>
<tr>
<td>3</td>
<td>En Jong Kak Ying</td>
<td>SMS Kuching</td>
</tr>
<tr>
<td>4</td>
<td>Pn Aishah Peong binti Abdullah</td>
<td>SBPIT</td>
</tr>
<tr>
<td>5</td>
<td>En Ooi Yoong Seang</td>
<td>SMS Muar</td>
</tr>
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</table>
GUIDELINES & ANSWERING TECHNIQUES
1.0 FORMAT OF AN INSTRUMENT OF CHEMISTRY BEGINNING SPM 2003

<table>
<thead>
<tr>
<th>No</th>
<th>Item</th>
<th>Paper 1 (4541/1)</th>
<th>Paper 2 (4541/2)</th>
<th>Paper 3 (4541/3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Type of instrument</td>
<td>Objective test</td>
<td>Subjective test</td>
<td>Written Practical Test</td>
</tr>
<tr>
<td>2</td>
<td>Type of item</td>
<td>Objective item</td>
<td>Section A : Structured Item</td>
<td>Section B : Essay restricted response Item</td>
</tr>
<tr>
<td>3</td>
<td>Number of questions</td>
<td>50 (answers all)</td>
<td>Section A : 6 (answer all)</td>
<td>Section B : 2 (choose one)</td>
</tr>
<tr>
<td>5</td>
<td>Duration of time</td>
<td>1 hour 15 minutes</td>
<td>2 hour 30 minutes</td>
<td>1 hour 30 minutes</td>
</tr>
</tbody>
</table>

2.0 CONSTRUCT REQUIREMENT

<table>
<thead>
<tr>
<th>Construct</th>
<th>Paper 1</th>
<th>Paper 2</th>
<th>Paper 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>20 m (No 1-20)</td>
<td>14</td>
<td>-</td>
</tr>
<tr>
<td>Understanding</td>
<td>15 m (No 21-35)</td>
<td>21</td>
<td>-</td>
</tr>
<tr>
<td>Application</td>
<td>15 m (No 36-50)</td>
<td>29</td>
<td>-</td>
</tr>
<tr>
<td>Analysis</td>
<td>-</td>
<td>21</td>
<td>-</td>
</tr>
<tr>
<td>Synthesizing</td>
<td>-</td>
<td>15</td>
<td>-</td>
</tr>
<tr>
<td>Science process</td>
<td>-</td>
<td>-</td>
<td>50</td>
</tr>
<tr>
<td>Total mark</td>
<td>50</td>
<td>100</td>
<td>50</td>
</tr>
</tbody>
</table>

3.0 TIPS TO SCORE “A” CHEMISTRY

3.1 Master the topics that contain the basic concepts of chemistry:
   1. The structure of the atom
   2. Chemical formulae and equations
   3. Periodic table
   4. Chemical bond

3.2 Familiarize with different types of questions as listed below and complete the previous SPM papers:
   1. Objectives questions (MCQ) (Paper 1)
   2. Structured questions (Paper 2 & 3)
   3. Essays (Paper 2)
   4. Planning an experiment (Paper 3)
   5. Draw and label the diagram
   6. Writing a chemical equation (balanced equation, ionic equation, half equation)

3.3 Try to get:
   ✓ 40 marks above for paper 1
   ✓ 60 marks above for paper 2
   ✓ 40 marks above for paper 3
   (Total = 180/2 = 80, A+ in SPM)

4.0 GUIDELINE FOR ANSWERING PAPER 1

4.1 Paper 1 questions test students on
   1. Knowledge (Number 1-20)
   2. Understanding (Number 21-35)
   3. Application (Number 36-50)

4.2 Score in paper 1 indicates students’ level of understanding in chemistry:
   - Less than 20 – very weak
   - 20 – 25 – weak
   - 26 – 30 – average
   - 31 – 39 – good
   - 40 – 45 – very good
   - 46 – 50 – excellent.

4.3 Answer all SPM objective question (2003 – 2009). Objective questions for each year contain all topics. If your score in paper 1 is 40 and above, you will able to answer questions in paper 2 & 3 easily.
5.0 GUIDELINE FOR ANSWERING PAPER 2 (STRUCTURE AND ESSAY)

5.1 Paper 2 questions test student on
1. Knowledge
2. understanding
3. analyzing
4. synthesizing.

5.2 Steps taken are:
1. Underline the command word and marks allocated for each question.
2. Match the command word to the mark allocated for each question. 1 point is awarded 1 mark.
3. Follow the needs of the question (Refer to the command words, page ……)
4. Unnecessary repetition of the statement in the question is not required.

5.3 Three types of questions which involve experiments in paper 2:
I. Type 1
   Describe an experiment on………………..Include a labeled diagram in your answer
   1. Diagram
   2. Procedure
   3. Observation/example/data/calculation/equation/sketch of graph/conclusion

II. Type 2
   Describe an experiment……………….(The diagram will support your answer.)
   1. No mark is allocated for a diagram
   2. Procedures
   3. Observation/example/calculation/equation/sketch of graph/conclusion

III. Type 3
   Describe a chemical/confirmatory test for………
   1. Procedure
   2. Observation
   3. Conclusion

6.0 GUIDELINE FOR ANSWERING PAPER 3

6.1 Structure Question 1/2 Test The Mastery of 11 Scientific Skills
1. Observing
2. Classifying
3. Inferring
4. Measuring (burette, stopwatch, thermometer, voltmeter)
5. Predicting
6. Communicating( e.g construct table and draw graph)
7. Space-Time Relationship
8. Interpreting Data
9. Defining Operationally
10. Controlling Variables
11. Hypothesizing

Each answer is allocated mark as follows: 3 marks/2 marks/1 mark/0

Score: 11 X 3 = 33

6.2 Question 3 (essay) Test The Mastery of Planning Experiment.
Planning should include the following aspects:
1. Aim of the experiment/Statement of the problem
2. All the variables
3. Statement of the hypothesis
4. List of substances/material and apparatus – should be separated
5. Procedure of the experiment
6. Tabulation of data

Score: (5 X 3) + 2 = 17

- The question normally starts with certain situation related to daily life.
- Problem statement/aim of the experiment/hypothesis and variable can be concluded from the situation given.
- State all the variables
  - Manipulated variable:
  - Responding variable:
  - Constant variable: list down all the fixed variables to ensure the outcome of the responding variable is related only to the manipulated variables.
- Separate the substances and apparatus
- Procedure:
  - All the steps taken in the procedure must include the apparatus used, quantity and type of substance(powder, solution, lumps … etc).
7.0 **THE COMMON COMMAND WORDS IN PAPER 2 & PAPER 3 CHEMISTRY**

- The question normally starts with a command word.
- Students must know the meaning of the command word to make sure that the answer given is according to the question's requirement.
- Match the command word to the mark allocated for each question.

<table>
<thead>
<tr>
<th>Command word</th>
<th>Explanation/example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name/State the name (paper 2 &amp; 3)</td>
<td>Give the name, not the formula. Example: Name the main element added to copper to form bronze. Wrong answer: Sn. Correct answer: Tin</td>
</tr>
<tr>
<td>State (paper 2 &amp; 3)</td>
<td>Write what is observed physically. <em>Example 1</em>: State one observation when magnesium powder is added to hydrochloric acid. <em>Wrong answer</em>: Hydrogen gas is released. <em>Correct answer</em>: Gas bubbles are released.</td>
</tr>
<tr>
<td>State the observation (Paper 2 &amp; 3)</td>
<td>Indicate the change in colour, give the initial and final colour of the substance/chemical. <em>Example 2</em>: What is the colour change of copper(II) sulphate solution? <em>Wrong answer</em>: The solution becomes colourless. <em>Correct answer</em>: The blue colour of the solution becomes colourless</td>
</tr>
<tr>
<td>Explain (Paper 2 &amp; 3)</td>
<td>Give the answer with reasons to explain certain statement/fact/observation/principal. <em>Example 1</em>: Explain why bronze is harder than pure copper. <em>Correct answer</em>: - Copper atoms in pure copper are all the same size and they are arranged in layers that can slide easily when force is applied. - The presence of tin atoms in bronze that are different in size disturb the orderly arrangement of atoms in bronze. - This reduces the layer of atoms from sliding.</td>
</tr>
<tr>
<td>Describe chemical test (Paper 2 &amp; 3)</td>
<td>State the method to conduct the test, observation and conclusion. <em>Example</em>: Describe how to identify the ion present in the solution. <em>Answer</em>: - Pour in 2 cm$^3$ of the solution in a test tube. Add a few drops of sodium hydroxide solution and the test tube is shaken. - A red-brown precipitate formed. - Fe$^{2+}$ ions present.</td>
</tr>
<tr>
<td>Describe gas test. (Paper 2 &amp; 3)</td>
<td>State the method to conduct the test observation and conclusion. <em>Example</em>: Describe the confirmatory test for gas released at the anode (oxygen). <em>Wrong answer</em>: Test with a glowing wooden splinter. <em>Correct answer</em>: - Place a glowing wooden splinter to the mouth of the test tube. - The glowing wooden splinter is lighted up. - Oxygen gas is released.</td>
</tr>
<tr>
<td>Describe an experiment (8 - 10 marks) (Paper 2)</td>
<td>- No mark is awarded for the diagram. The diagram can help students write the steps taken in the procedure. - List of materials 1m - List of apparatus 1m - Procedure (5 - 8 m) - Observation/tabulation of data/calculation/sketch of the graph/chemical equation/ionic equation/conclusion etc. - Any additional details relevant derived from the question.</td>
</tr>
<tr>
<td>Plan an experiment (17 marks) (Paper 3)</td>
<td>Answer the question according the requirement: - Problem statement/Aim of experiment - Hypothesis - Variables</td>
</tr>
</tbody>
</table>
### Describe the process ...
**Describe the structure ....**
**Describe and write equation...**
**Describe how ...**
(Paper 2 & 3)
- List of substances and apparatus
- Procedure
- Tabulation of data

Note: For question 3, unlike PEKA report students only need to answer according to what is stated in the question.
- No mark for the diagram. Diagram can help student writing the steps taken in the procedure.

*Give relevant details derived from the question.*

### Predict
(Paper 2 & 3)
Make a prediction for something that might happen based on facts
*Example: Experiment 1 is repeated using a larger beaker. Predict the increase in temperature*
*Answer: The increase in temperature is lower than experiment 1.*

### Compare
(Paper 2)
Give the **similarities and differences** between two items/ situations

### Differentiate
(Paper 2)
Give differences between two items/situations
*Example: State three differences between ionic and covalent compound.*
*Answer: State three properties of ionic compound and three properties covalent compound*

### Draw a labeled diagram of the apparatus
(Paper 2)
- Functional set up of apparatus
- Complete label
- Shade solid, liquid and gas correctly.
- Draw an arrow and label ‘heat’ if the experiment involves heating

### Draw a diagram to show the bonding formed in the compound
(Paper 2)
(i) Ionic compound – The number of electrons in each shell is correct, 2 electrons in the first shell and 8 electrons in the second and third shell.
  - Show the charge of each particle.
  - Write the symbol of each element at the centre of the ion.
(ii) Covalent compound
  - The number of electrons in each shell is correct, 2 electrons in the first shell and 8 electrons in the second and third shell.
  - The number of atoms sharing pair of electrons is correct.
  - Write the symbol of each element at the center of each atom in the molecule.

### Draw a diagram to show the bonding formed in the compound
(Paper 2)
(i) Ionic compound – The number of electrons in each shell is correct, 2 electrons in the first shell and 8 electrons in the second and third shell.
  - Show the charge of each particle.
  - Write the symbol of each element at the centre of the ion.
(ii) Covalent compound
  - The number of electrons in each shell is correct, 2 electrons in the first shell and 8 electrons in the second and third shell.
  - The number of atoms sharing pair of electrons is correct.
  - Write the symbol of each element at the center of each atom in the molecule.

### Draw a diagram to show the bonding formed in the compound
(Paper 2)
- Functional set up of apparatus
- Complete label
- Shade solid, liquid and gas correctly.
- Draw an arrow and label ‘heat’ if the experiment involves heating

### Write chemical equation
(Paper 2 & 3)
- Write the balanced chemical equation
- Differentiate:
  1. Balanced chemical equation
  2. Ionic equation
  3. Half equation for oxidation
  4. Half equation for reduction

### Calculate
(Paper 2 & 3)
- Show all the steps taken
- Give final answer with unit.

### Classify
(Paper 3)
- Draw table to represent the classification.
### 8.0 THE COMMON DIAGRAM IN CHEMISTRY SPM SYLLABUS

<table>
<thead>
<tr>
<th>The Structure Of Atom</th>
<th>Labelled Diagram for the Setup of Apparatus/ Structural Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Determination of melting and boiling point of naphthalene</td>
<td>Determination Melting Point</td>
</tr>
<tr>
<td>Particle arrangement in solid, liquid and gas</td>
<td>Solid</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Chemical Formulae and Equations</td>
<td>Magnesium oxide</td>
</tr>
<tr>
<td>Determination of empirical formula</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Periodic Table</td>
<td>Reaction between sodium/potassium with oxygen</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Chemical Bond</td>
<td>Reactions between chlorine gas and iron</td>
</tr>
<tr>
<td>The electron arrangement in ionic and covalent compound. * Make sure you can explain the formation of the bonds accurately</td>
<td></td>
</tr>
<tr>
<td>Sodium chloride</td>
<td>Magnesium chloride</td>
</tr>
<tr>
<td>-----------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>Tetrachloromethane</td>
<td>Carbon dioxide</td>
</tr>
</tbody>
</table>

**Electrochemistry**

- Molten Lead (II) bromide
- Copper(II) sulphate solution (Copper electrode)
- Sulphuric Acid, Potassium sulphate, Hydrochloric acid (gas bubbles released)
- Electroplating an iron key
- Purifying an impure metal
<table>
<thead>
<tr>
<th>Voltaic cell</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Simple cell</td>
<td>Daniell cell (porous pot)</td>
</tr>
<tr>
<td>Daniell cell (Salt bridge)</td>
<td></td>
</tr>
<tr>
<td>1. Heating of copper(II) carbonate and confirmatory test for carbon dioxide</td>
<td></td>
</tr>
<tr>
<td><strong>ACID, BASE &amp; SALT</strong></td>
<td></td>
</tr>
<tr>
<td>1. Heating of carbonate compound and confirmatory test for carbon dioxide</td>
<td></td>
</tr>
<tr>
<td>2. Preparation of soluble salt (Method I) – Sodium nitrate</td>
<td></td>
</tr>
<tr>
<td>2. Preparation of soluble salt (Method I &amp; II)</td>
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</tr>
<tr>
<td>3. Preparation of insoluble salt</td>
<td></td>
</tr>
<tr>
<td>3. Preparation of soluble salt (Method II) – Copper(II) sulphate</td>
<td></td>
</tr>
<tr>
<td>4. Preparation of insoluble salt – Lead(II) iodide</td>
<td></td>
</tr>
</tbody>
</table>
**Manufactured Substances in industry**

- Propene: $\text{H} - \text{CH}_3$
- $\text{C} = \text{C}$
- $\text{H} \quad \text{H}$

- Polypropene: $\text{Polypropene}$
- $\text{H} \quad \text{Cl} \quad \text{H} \quad \text{Cl} \quad \text{H}$
- $\text{C} - \text{C} - \text{C} - \text{C} - \text{C}$
- $\text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H}$

- Chloroethane: $\text{H} \quad \text{H} \quad \text{Cl} \quad \text{H} \quad \text{Cl} \quad \text{H}$
- Polivinly chloride (PVC)

**Polymerisation**

**Alloys**

- Arrangement of atoms in a metal and an alloy

**Rate of reaction**

Gas is collected using water displacement for carbon dioxide gas, oxygen and hydrogen.

**Redox**

1. Usage of tube U,
   - **oxidising agent**: a. Chlorine
     - Water
   - b. Bromine
     - Water
   - c. Potassium manganate (VII) acidified

- **Reduction agent**: a. KI
  - b. KBr
  - c. FeSO$_4$
  - *Mark the positive and negative terminal*

2. Rusting of iron

   - Diagram to show the rusting of iron

   - Iron
<table>
<thead>
<tr>
<th>Thermochemistry</th>
<th>Carbon Compound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Determination of Heat Combustion</td>
<td>Alcohol Dehydration</td>
</tr>
<tr>
<td></td>
<td>Oxidation of alcohol and esterification through reflux</td>
</tr>
<tr>
<td></td>
<td>Alcohol Dehydration</td>
</tr>
</tbody>
</table>
CHEMISTRY PERFECT SCORE MODULE

SET 1 2 3 4

1. The Structure of Atom
2. Chemical Formulae and Equations
3. Periodic Table of Elements
4. Chemical Bonds
SET 1
PAPER 2
SECTION A – STRUCTURE QUESTION

1 Table 1 shows four substances and their respective chemical formulae

<table>
<thead>
<tr>
<th>Substance</th>
<th>Chemical Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bromine</td>
<td>Br₂</td>
</tr>
<tr>
<td>Nickel</td>
<td>Ni</td>
</tr>
<tr>
<td>Phenol</td>
<td>C₆H₅OH</td>
</tr>
<tr>
<td>Sodium chloride</td>
<td>NaCl</td>
</tr>
</tbody>
</table>

Table 1

(a) State all substances that exist as molecules.

...........................................................................................................[1 mark]

(b) What is the state of matter for bromine at room temperature?

...........................................................................................................[1 mark]

(c) State the substance that can conduct electricity in solid

...........................................................................................................[1 mark]

(d) Draw the particles arrangement of the substance in (c) at room temperature.

...........................................................................................................[1 mark]

(e) Name the particles present in sodium chloride.

...........................................................................................................[1 mark]

(f) Diagram 1 shows the temperature against time when solid phenol is heated.

...........................................................................................................[1 mark]

(i) State the melting point of phenol.

...........................................................................................................[1 mark]

(ii) Explain why there is no change in temperature from Q to R.
(iii) State how the movement of naphthalene particles changes between R and S during the heating. 

Diagram 2 shows the cooling curve of molten naphthalene beginning from 90°C.

Based on diagram 2, answer the following question.

(a) State the melting point of naphthalene.

(b) State the time when all the liquid naphthalene has frozen.

(c) Why does the temperature of naphthalene remains constant from t₁ to t₂?

(d) (i) What is the type of particles in naphthalene?

(ii) Draw the arrangement of particles of naphthalene at point P and R in the space provided.

(e) State the state of matter for naphthalene at the time
(i) $t_1$ to $t_2$:
……………………………………………………………………………………………………………………………

(ii) $t_2$ to $t_3$:
……………………………………………………………………………………………………………………………

[2 marks]

(f) When naphthalene is heated with direct flame, naphthalene changes from solid to gas. Name the process that occurs.
……………………………………………………………………………………………………………………………

[1 mark]

3 An experiment is carried out to determine the melting point of solid X. Solid X is heated using water bath. The temperature of X is recorded at 30 seconds intervals as shown below

<table>
<thead>
<tr>
<th>Time/second</th>
<th>0</th>
<th>30</th>
<th>60</th>
<th>90</th>
<th>120</th>
<th>150</th>
<th>180</th>
<th>210</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature$^\circ$C</td>
<td>70</td>
<td>77</td>
<td>80</td>
<td>80</td>
<td>80</td>
<td>82</td>
<td>85</td>
<td>95</td>
</tr>
</tbody>
</table>

(a) Draw the set up of the apparatus to carry out this experiment.

[ 2 marks ]

(b) Draw the arrangement of particles in X at $77^\circ$C

[ 1 mark ]
(c) On the graph paper, draw the graph of temperature against time for the heating of X.
(d) (i) Show on your graph, how the melting point of X is determined

(ii) What is meant by melting point?

(e) Explain why there is no change in temperature from 60 second to 120 second.

4 Diagram 4 shows the apparatus set up of an experiment to determine the empirical formula of copper oxide.

(a) What is the meaning of chemical formula?

(b) (i) Name an acid and metal that can be used to prepare hydrogen gas in this experiment.

(ii) Write a balanced chemical equation for the reaction between the acid and the metal in

(b) (i).

(c) State one precautionary step that must be taken before the copper oxide is heated.
(d) Table 4 shows the results of an experiment carried out by a student.

<table>
<thead>
<tr>
<th>Mass of combustion tube + porcelain dish</th>
<th>30.24g</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass of combustion tube + porcelain dish + copper (II) oxide</td>
<td>32.26g</td>
</tr>
<tr>
<td>Mass of combustion tube + porcelain dish + copper</td>
<td>31.86g</td>
</tr>
</tbody>
</table>

Table 4

(i) Calculate the number of moles of copper in this reaction.
[Relative atomic mass : Cu = 64]

(ii) Calculate the number of moles of oxygen in this reaction.
[Relative atomic mass : O = 16]

(iii) Determine the empirical formula of copper oxide.

(e) Name another metal oxide which uses the same method to determine the empirical formula.

(f) M is a reactive metal. How to determine the empirical formula of the oxide of M.

Diagram 5 shows the apparatus set-up to determine the empirical formula of oxide metal M.
Diagram 5

(a)  (i) Name two chemicals used to prepare hydrogen gas in the laboratory.

...............................................................................................................................

[2 marks]

(ii) Write a chemical equation for the reaction in (a)(i).

...............................................................................................................................

[2 marks]

(b) Table 5 shows the result of the experiment:

| Mass of combustion tube + asbestos paper | 39.25 g |
| Mass of combustion tube + asbestos paper + M oxide before heating | 47.95 g |
| Mass of combustion tube + asbestos paper + product after heating | 44.75 g |

Table 5

(i) Determine the empirical formula of M oxide.
[Relative atomic mass of O=16, M=55]

...............................................................................................................................

[4 marks]

(ii) Write a chemical equation for the reduction of M oxide by hydrogen gas.

...............................................................................................................................

[2 marks]

(c) State one precautionary step that must be taken when carrying out the experiment.

...............................................................................................................................

[2 marks]

(d) Can the empirical formula of magnesium oxide be determined by the same method? Explain your answer.

...............................................................................................................................

...............................................................................................................................

...............................................................................................................................

...............................................................................................................................

...............................................................................................................................

...............................................................................................................................

[2 marks]
Diagram 6 shows the apparatus set-up of an experiment to determine the empirical formula of magnesium oxide.

![Diagram 6: Apparatus set-up](Image)

**Result:**
- Mass of crucible + lid $= 24.0$ g
- Mass of crucible + lid + magnesium ribbon $= 26.4$ g
- Mass of crucible + lid + magnesium oxide $= 28.0$ g

(a) What is meant by empirical formula?

........................................................................................................................................................................

[1 mark]

(b) Based on the above results,

(i) calculate the mass of magnesium and the mass of oxygen that have reacted.

........................................................................................................................................................................

[1 mark]

(ii) calculate the mole ratio of magnesium atoms to oxygen atoms.

[Relative Atomic Mass: O=16; Mg=24]

........................................................................................................................................................................

[1 mark]

(iii) determine the empirical formula of magnesium oxide.

........................................................................................................................................................................

[1 mark]

(iv) write the chemical equation for the reaction in the experiment.

........................................................................................................................................................................

[2 marks]

(c) Why the crucible lid is open once in a while during the experiment?

........................................................................................................................................................................

[1 mark]

(d) Metal X is placed below hydrogen in the reactivity series. You are required to carry out an experiment to determine the empirical formula of the oxide of metal X. The apparatus

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provided are combustion tube, glass tube, cork, Bunsen burner, and porcelain dish.

(i) Draw a labeled diagram of the apparatus set-up for the experiment.

[2 marks]

(e) Describe the steps that should be taken to ensure that all the air in the combustion tube has been expelled.

................................................................................................................................................
................................................................................................................................................
................................................................................................................................................
................................................................................................................................................
................................................................................................................................................
[1 mark]

7 Diagram 7 shows the symbols for atom of elements P, Q, and R.

Diagram 7

(a) (i) Write the electron arrangement of atom P.

................................................................................................................................................
[1 mark]

(ii) State the period and the group for element P in the Periodic Table.

Period : ........................................................................................................................................
Group : ........................................................................................................................................[2 marks]

(b) (i) What is the proton number of element Q?

................................................................................................................................................
[1 mark]

(ii) Atom of element Q has a nucleon number of 19. Calculate the number of neutrons in atom Q.
(iii) Write the the standard representation of element P

(b) Element Q and R are located at the same Group in the periodic table of elements. Compare reactivity of element Q and R. Explain your answer

(c) Element P can react with sodium to form a compound
   (i) Name the type of bond in the compound formed between atoms P and sodium.

   (ii) State one physical property of the compound in (c)(i).

(d) Element P can also react with carbon to form a compound. Draw the electron arrangement for the compound formed. [Proton number of C = 12]

8 Table 8 shows the proton numbers of elements X, Y and Z.

<table>
<thead>
<tr>
<th>Elements</th>
<th>Proton Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>12</td>
</tr>
<tr>
<td>Y</td>
<td>8</td>
</tr>
<tr>
<td>Z</td>
<td>6</td>
</tr>
</tbody>
</table>

(a) Write the electron arrangement for atom X

(b) X and Y react to form a compound
   (i) What type of bond holds atom X and Y together?
(ii) What happen to atom X during the formation of the compound with atom Y? Explain why
........................................................................................................................................[2 marks]
(iii) Draw the electron arrangement of the compound formed in (b)(ii)
........................................................................................................................................[2 marks]
(iv) State one physical property of the compound formed
........................................................................................................................................[1 mark]
(c) Y can react with Z to form a compound.
   (i) What is the molecular formula of the compound formed?
........................................................................................................................................[1 mark]
   (ii) What is the relative molecular mass of the compound in c(i).
       [ Given that relative atomic mass Z = 12; Y= 16]
........................................................................................................................................[1 mark]
9 Diagram 9 shows the position of several elements P, Q, R, S, T, U and W in the Periodic Table of Elements

Using the symbols P, Q, R, S, T, U and W, answer the following questions.
(a) State one metal and one non-metal
   Metal:............................................................................................................................[1 marks]
   Non-metal:......................................................................................................................[1 marks]
(b) Write the electron arrangement of atom V.

.................................................................................................................................................... [1 mark]

(c) Which of the elements has the biggest atomic radius?

.................................................................................................................................................... [1 mark]

(d) Compare the electronegativity of elements Q, T, V and U. Explain your answer.

....................................................................................................................................................
....................................................................................................................................................
....................................................................................................................................................
.................................................................................................................................................... [3 marks]

(e) Write the formula of the ion formed by Q.

.................................................................................................................................................... [1 mark]

(f) State the element that is chemically inert. Why?

.................................................................................................................................................... [1 mark]

(g) Write an equation for the reaction between R and U.

.................................................................................................................................................... [2 mark]

(h) State one special characteristic of S.

.................................................................................................................................................... [1 mark]

10 Table 10 shows the elements P, Q, T and U in the Periodic Table of elements. The symbols do not represent the actual symbols of the element.

<table>
<thead>
<tr>
<th>Element</th>
<th>Group</th>
<th>Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Q</td>
<td>17</td>
<td>3</td>
</tr>
<tr>
<td>T</td>
<td>14</td>
<td>2</td>
</tr>
<tr>
<td>U</td>
<td>18</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 10

Answer the following question based on the information given in Table 10,

(a) (i) state the number of valence electron in atom Q

.................................................................................................................................................... [ 1 mark]

(ii) write the electron arrangement of atom Q

.................................................................................................................................................... [ 1 mark]

(b) (i) write the formula of the ion formed from atom P

.................................................................................................................................................... [ 1 mark]

Chemistry Perfect Score Module 2010
(ii) state the element which will form an ionic compound with element P.

......................................................................................................................................................... [1 mark]

(iii) Based on your answer in (b) (ii), write the chemical formula of the compound formed

........................................................................................................................................................................................................................................ [1 mark]

(c) Element U is used to fill weather balloons. Why element U is more suitable than hydrogen for this purpose?

........................................................................................................................................................................................................................................ [1 mark]

(d) Draw the electron arrangement of the compound formed between element T and element Q.

................................................................................................................................................................................................................................................................................................................ [2 marks]

(e) State one physical property of the compound formed in (d)

........................................................................................................................................................................................................................................................................................................ [1 mark]

11 Diagram 11 shows the chemical symbols which represent element P, Q, R and S.

Diagram 11

(a) (i) Write the electron arrangement of atom P.

........................................................................................................................................................................................................................................................................................................ [1 mark]

(ii) State the period and the group for element Q in the Periodic Table.

Period : .................................................................................................................................................................................................

Group : ........................................................................................................................................................................................................................................ [2 marks]

(b) Atoms of P and Q can react to form a compound.

(i) Name the type of bond in the compound formed between atoms P and Q.

........................................................................................................................................................................................................................................................................................................ [1 mark]
(ii) Draw the electron arrangement for the compound formed.

(c) Atoms of R and S can also react to form a compound. Draw the electron arrangement for the compound formed.

(d) Compare one physical property of compound formed in (b) and (c). Explain your answer.

…………………………………………………………………………………………………………
…………………………………………………………………………………………………………
…………………………………………………………………………………………………………
…………………………………………………………………………………………………………
…………………………………………………………………………………………………………

[4 marks]

12 Table 12 shows the melting point, boiling point and electrical conductivity of substances P, Q, R, and T.

<table>
<thead>
<tr>
<th>Substance</th>
<th>Melting point (°C)</th>
<th>Boiling point (°C)</th>
<th>Electrical conductivity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Solid</td>
</tr>
<tr>
<td>P</td>
<td>805</td>
<td>1460</td>
<td>No</td>
</tr>
<tr>
<td>Q</td>
<td>1549</td>
<td>2950</td>
<td>Yes</td>
</tr>
<tr>
<td>R</td>
<td>-210</td>
<td>-153</td>
<td>No</td>
</tr>
<tr>
<td>T</td>
<td>-7</td>
<td>59</td>
<td>No</td>
</tr>
</tbody>
</table>

(a) Which of the substances is a metal?

…………………………………………………………………………………………………………

[1 mark]
(b) (i) State the type of particle in substance P

........................................................................................................................................................................  [1 mark]

(ii) Explain why substance P cannot conduct electricity in solid but can conduct electricity in molten state.

........................................................................................................................................................................  [2 marks]

(c) (i) What is the physical state of R and T at room temperature?

R : ........................................................................................................................................................................  

T : ........................................................................................................................................................................  [2 marks]

(ii) Draw the arrangement of particles in substance T at room temperature.

........................................................................................................................................................................  [1 mark]

(iii) Explain why the melting and boiling points of substance R and T is low?

........................................................................................................................................................................  [1 mark]
13  (a) Diagram 13.1 shows two isotopes of an element X

\[
\begin{array}{c}
\begin{array}{c}
35 \\
17
\end{array}X \\
\begin{array}{c}
37 \\
17
\end{array}X
\end{array}
\]

Diagram 13.1

(i) State the number of neutron in each isotope  
(ii) State two similarities and two differences between the isotopes

(b) Diagram 13.2 shows an atom of element P.

\[
6p + 6n
\]

Diagram 13.2

(i) Describe the atom shown in Diagram 13.2
(ii) Atom of element Q has 7 neutron, which is in the same group with P. Compare atom P with the atom Q

(c) X is a substance which melts at 71°C and boils at 314°C

(i) Sketch a graph of temperature against time when molten X at 100°C is cooled to 60°C.
(ii) Based on the graph in (c)(i), state the physical state of substance X at 71°C and explain the changes in terms of the kinetic energy and the arrangement of particles

14

1 mole of any gas occupies 24 dm³ at room condition.

(a) Explain why 16 g of oxygen occupies the same volume as 22 g of carbon dioxide at room condition.

(b) Caffeine is one of the substances in coffee. Caffeine consists of 0.48 % of carbon, 0.05 % of hydrogen, 0.28 % of nitrogen and 0.16 % of oxygen. The molar mass of caffeine is 194 g mol⁻¹.

Based on the information above, determine the empirical formula and molecular formula of caffeine.
Calculate the percentage of nitrogen by mass in each of the three fertilizers given above and hence determine the best fertilizer a farmer should use for his plants.

15 (a) Diagram 15.1 shows the standard representation for sodium element

![Diagram 15.1](image)

State three information that can be deduced from diagram 15.1

Draw the atomic structure of sodium atom.

(b) Diagram 15.2 shows the empirical formula of glucose:

![Diagram 15.2](image)

(i) What is the meaning of empirical formula?
(ii) The relative molecular mass of glucose is 180, determine the molecular formula of glucose.

(c) (i) An iron chloride compound contains 2.80 g of iron and 5.32 g of chlorine. Determine the empirical formula of the compound.

[Relative atomic mass: Fe = 56, Cl = 35.5]

(ii) Write a chemical equation to represent the reaction between iron and chlorine. Calculate the volume of chlorine gas that react completely with 2.80 g iron.

[1 mole of gas occupied 24 dm³ at room temperature and pressure]

16 (a) What is meant by empirical formula?

(b) A carbon compound contains 92.3% of carbon and 7.7% of hydrogen by mass. The relative molecular mass of this compound is 78. Find the molecular formula of this compound.

[Relative atomic mass: C=12; H=1]

(c) Describe how you could determine the empirical formula of magnesium oxide in the laboratory. Your description should include

- procedure of experiment
- tabulation of result
- calculation of the results obtained

[Relative atomic mass: O=16; Mg=24]
(d) Magnesium can reduce copper oxide to copper. Explain why the empirical formula of the copper oxide cannot be determined by heating the mixture of copper oxide and magnesium powder. [2 marks]

17 Table 17 shows the proton number and nucleon number of atom of elements Q and R.

<table>
<thead>
<tr>
<th>Atom</th>
<th>proton number</th>
<th>nucleon number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q</td>
<td>9</td>
<td>19</td>
</tr>
<tr>
<td>R</td>
<td>6</td>
<td>12</td>
</tr>
</tbody>
</table>

Table 17

(a) (i) Write the electron arrangement of atoms Q and R. [2 marks]

(ii) State the number of neutrons and number of electrons in atom Q. [2 marks]

(b) The reaction between Q and R forms a compound. Describe the formation of the compound.

(c) State the change of the reactivity of Group 1 and Group 17 elements in the Periodic Table of Elements when going down the group. Explain your answer. [8 marks]
18 (a) Diagram 18 shows the electron arrangement of a compound formed from the reaction between element Y and element Z. These letters are not the actual symbols of the elements.

![Diagram 18](image)

(i) Based on diagram 18, write the electron arrangement for atoms of element Y and element Z. Explain the position of element Y in the Periodic Table of the Elements. [6 marks]

(ii) Element Y can react with sodium and sodium hydroxide to form compounds. Write the chemical equation to represent the reaction between

- Y and sodium
- Y and sodium hydroxide

[4 marks]

(b) Table 18 shows the proton number for atoms P, Q and R. These letters are not the actual symbols of the elements.

<table>
<thead>
<tr>
<th>Elements</th>
<th>Proton number</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>11</td>
</tr>
<tr>
<td>Q</td>
<td>17</td>
</tr>
<tr>
<td>R</td>
<td>6</td>
</tr>
</tbody>
</table>

Table 18

By referring to the information in table 18, explain how two compounds can be formed from these elements. The two compounds should have different types of bond. [10 marks]
An experiment is conducted to find out the freezing point of liquid naphthalene. A boiling tube containing molten naphthalene at 95 °C is allowed to cool in a conical flask to room temperature. The temperature of naphthalene is recorded at every half-minute intervals. Diagram 19 shows the reading of the thermometer for this experiment.

(a) Record the temperature in the spaces provided in Diagram 19.

(b) Construct a table to record the time and temperature of the experiment.

(c) (i) Draw a graph of temperature against time.

[3 marks]
(ii) On the graph, mark the freezing point of naphthalene.

(d) (i) What is meant by freezing point?

(ii) Explain why the temperature of naphthalene remains constant from 90th seconds to 150th seconds during the cooling process.
(e) Why is the boiling tube placed in the conical flask during the cooling?

...............................................................................................................................[3 marks]

(f) Diagram below shows the particles arrangement of four substances.

Classify P, Q, R, and S into element and compound.

<table>
<thead>
<tr>
<th>Element</th>
<th>Compound</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

[ 3 marks ]

A student carried out an experiment to determine the empirical formula of magnesium oxide. The step and apparatus set-up of the experiment are shown in Diagram 20.

<table>
<thead>
<tr>
<th>Step</th>
<th>Set-up of apparatus</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Crucible and lid are weighed</td>
<td><img src="image" alt="Crucible and lid set-up" /></td>
</tr>
<tr>
<td>2. Crucible, lid and magnesium ribbon are weight</td>
<td><img src="image" alt="Crucible and weight set-up" /></td>
</tr>
<tr>
<td>3. Magnesium and ribbons heated until the reaction is complete</td>
<td><img src="image" alt="Heating set-up" /></td>
</tr>
<tr>
<td>4. Crucible, lid and magnesium oxide are weighed when cooled</td>
<td><img src="image" alt="Cooling set-up" /></td>
</tr>
</tbody>
</table>
(a) Complete the following table by stating the observations and related inferences in the experiment.

<table>
<thead>
<tr>
<th>Observation</th>
<th>Inferences</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i)</td>
<td>(i)</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>(ii)</td>
<td>(ii)</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(b) Record the reading to two decimal places for

The mass of crucible and lid: ……………g

The mass of crucible, lid and magnesium ribbon: …………… g

The mass of crucible, lid and magnesium oxide when cooled: ………… g

(c) (i) What is the mass of magnesium that has been used?

(ii) What is the mass of oxygen which reacted with magnesium?

(iii) Determine the empirical formula of magnesium oxide.

Use the information that the relative atomic mass, Mg = 24 and O = 16

(d) Based on your answer in (c)(iii), how many moles of magnesium and oxygen atoms have reacted?
An experiment is carried out to investigate the statement above. Table 21 shows the apparatus set up and the observations for the experiment to determine the reactivity of the Group 1 elements based on their reactions with water.

<table>
<thead>
<tr>
<th>Apparatus set-up</th>
<th>Observation towards the metal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lithium</td>
<td>Lithium moves slowly on the surface of the water with a “hiss” sound.</td>
</tr>
<tr>
<td>Potassium</td>
<td>Potassium moves vigorously and randomly on the surface of the water with a “hiss” sound.</td>
</tr>
<tr>
<td>Sodium</td>
<td>Sodium moves quickly and randomly on the surface of the water with a “hiss” sound.</td>
</tr>
</tbody>
</table>

Table 21

(a) State the variables that are involved in the experiment.

<table>
<thead>
<tr>
<th>Name of variables</th>
<th>Action to be taken</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i) Manipulated variable:</td>
<td>(i) The way to manipulate variable:</td>
</tr>
<tr>
<td>......................</td>
<td>......................</td>
</tr>
<tr>
<td>......................</td>
<td>......................</td>
</tr>
<tr>
<td>(ii) Responding variable:</td>
<td>(ii) What to observe in the responding variable:</td>
</tr>
<tr>
<td>......................</td>
<td>......................</td>
</tr>
<tr>
<td>......................</td>
<td>......................</td>
</tr>
<tr>
<td>(iii) Controlled variable:</td>
<td>(iii) The way to maintain the controlled variable:</td>
</tr>
<tr>
<td>......................</td>
<td>......................</td>
</tr>
<tr>
<td>......................</td>
<td>......................</td>
</tr>
</tbody>
</table>

[6 marks]

(b) State one hypothesis for the experiment.

........................................................................................................................................

Chemistry Perfect Score Module 2010
When lithium metal is put in water, it moves very slowly on the surface of the water. When sodium metal is put in water, it moves fast and produces “hiss” sound. When potassium metal is put in water, it moves very fast and produces small explosions.

(c) Based on the observations in the diagram 21, arrange lithium, potassium and sodium in the descending order of reactivity of metals towards water.

Descending order of reactivity of metals towards water.

(d) Solution X was produced from the reaction of sodium with water. Classify the ions that exist in solution X into positive ions and negative ions.

<table>
<thead>
<tr>
<th>Positive Ions</th>
<th>Negative Ions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

PAPER 3

ESSAY

1) 22 When lithium metal is put in water, it moves very slowly on the surface of the water. When sodium metal is put in water, it moves fast and produces “hiss” sound. When potassium metal is put in water, it moves very fast and produces small explosions.

3) 4) 5) 6) Plan an experiment in the laboratory to investigate the reactivity of lithium, sodium and potassium with water. The planning of your experiment must consist of the following:

7) (a) Aim of experiment
(b) Hypothesis

8) (c) All the variables
(d) List of substances and apparatus
(e) Procedure of the experiment
(f) Tabulation of data
1. Electrochemistry
2. Oxidation and Reduction
Diagram 1 shows the set-up of the apparatus to investigate the electrolysis of molten lead(II)bromide. The solid lead(II) bromide is heated until it is completely melted. All the observation are recorded.

(a) What is the meaning of electrolysis?

(b) State the ions present in lead(II) bromide.

(c) State energy change in the process.

(d) In solid, the bulb does not glow, but in molten the bulb glows brightly. Explain.

(e) (i) State the observation at anode.

(ii) Write half-equation for the reaction at anode.

(f) (i) State the name of product formed at cathode.

(ii) What is the process that occurred at cathode.
2. Diagram 2 shows the set-up of an electrolytic cell. Beaker X contains the components of a simple chemical cell whereas electrolysis takes place in Beaker Y.

(a) (i) State the name of the cations present in the solution of Beaker Y.
...............................................................................................................................................................................

(ii) Mark the negative terminal and positive terminal in Beaker X

[1 mark]

(b) (i) What is the colour change of copper(II) sulphate solution?
...............................................................................................................................................................................

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

[1 mark]

(c) (i) What is the product formed at the negative terminal of Beaker X?
...............................................................................................................................................................................

[1 mark]

(ii) Write a half equation for the reaction that occurs at the negative terminal of Beaker X.
...............................................................................................................................................................................

[1 mark]

(d) (i) Name the type of reaction that occurs at the cathode in Beaker Y.
...............................................................................................................................................................................

[1 mark]

(ii) If the zinc plate is replaced by a copper plate, describe what will happen to the voltmeter reading. Explain your answer.
...............................................................................................................................................................................

[2 marks]
Diagram 3 shows the set-up of apparatus to investigate the reaction between potassium iodide solution and chlorine water through the transfer of electrons at a distance.

(a) What is the function of dilute sulphuric acid?
................................................................................................................................. [1 mark]

(b) On the diagram 3, draw the direction of the flow of electrons. .............................. [1 mark]

(c) (i) What is the colour change in the solution around electrode P?
................................................................................................................................. [1 mark]
(ii) Describe a chemical test to determine the product formed in the solution at electrode P.
........................................................................................................................................ [2 marks]

(d) What is the substance that is being oxidised in the experiment? Explain why.
........................................................................................................................................ [2 marks]

(e) Write a half equation for the reaction that occurs at electrode Q.
........................................................................................................................................ [2 marks]

(f) Suggest another reagent that can replace chlorine water.
................................................................................................................................. [1 mark]

(g) What is the change in oxidation number of chlorine in the reaction?
................................................................................................................................. [1 mark]
Table 4 shows the procedures and observations of experiment I, II and III.

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Procedure</th>
<th>Observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Chlorine water is added to iron(II)nitrate solution. The solution is shaken</td>
<td>The green colour of the solution changes to yellow.</td>
</tr>
<tr>
<td>II</td>
<td>Zinc strip is added to copper(II)sulphate solution</td>
<td>Brown solid is deposited on the zinc strip</td>
</tr>
<tr>
<td>III</td>
<td>Mixture of zinc powder and oxide of metal M heated strongly</td>
<td>No changes</td>
</tr>
</tbody>
</table>

Table 4.

(a) Based on experiment I,
   (i) state the name of yellow product formed.

(ii) state the function of chlorine water.

(iii) describe a chemical test that can confirm the product in (b)(i).

(b) Based on experiment II,
   (i) write the ionic equation for the reaction occur.

(ii) state the change in the oxidation number of zinc in the experiment.

(iii) state the type of reaction that has occurred to zinc.

(c) Based on experiment III,
   (i) suggest the name of metal M. Give a reason for your answer.

(ii) if oxide of metal M is replaced by oxide of metal N, a bright glow is observed. Arrange the metal M, N and zinc in descending order of reactivity of metal.
SECTION B

5 (a) Diagram 5.1 shows a voltaic cell. Copper, Cu is situated below metal X in the Electrochemical Series.

![Diagram 5.1](image)

(i) Suggest a metal that is suitable as metal X and a solution that is suitable as solution Y.
(ii) State the positive terminal and the negative terminal of this cell.
(iii) Write half equation for the reaction at the positive terminal and negative terminal.

(b) Diagram 5.2 shows the set up of the apparatus to arrange metals W, X, Y and Z based on the potential difference of the metals.

![Diagram 5.2](image)

Table 5.1 shows the results of the experiment.

<table>
<thead>
<tr>
<th>Pair of metals</th>
<th>Potential difference (V)</th>
<th>Negative terminal</th>
</tr>
</thead>
<tbody>
<tr>
<td>W and X</td>
<td>0.50</td>
<td>X</td>
</tr>
<tr>
<td>X and Y</td>
<td>0.30</td>
<td>Y</td>
</tr>
<tr>
<td>W and Z</td>
<td>1.10</td>
<td>Z</td>
</tr>
</tbody>
</table>

Table 5.2

(i) Arrange metals W, X, Y and Z in descending order in the Electrochemical Series.

(ii) Metals X and Z are used as electrodes in the Diagram 5.2. State which metal acts as positive terminal. Explain your answer and predict the voltage of the cell.

[6 marks]

[1 mark]

[3 marks]
(c) Table 5.2 shows the observation from electrolysis of copper (II)sulphate solution, using different electrodes.

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Electrode</th>
<th>Observation on The CuSO₄ solution</th>
<th>Observation at anode</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Carbon</td>
<td>Blue colour of the solution become fader</td>
<td>Gas bubbles are released</td>
</tr>
<tr>
<td>II</td>
<td>Copper</td>
<td>Blue colour of the solution unchanged</td>
<td>Anode becomes thinner</td>
</tr>
</tbody>
</table>

Table 5.2

Compare experiment I and II. Explain the difference in the observation on the electrolyte and at anode for both experiments. Your explanation must include the substances formed and half equation involved.

6 (a) The following are the equations of two reactions:

| Reaction I | NaOH + HCl → NaCl + H₂O |
| Reaction II | Mg + Zn(NO₃)₂ → Mg(NO₃)₂ + Zn |

Determine which reaction is a redox reaction. Explain your answer in term of oxidation number.

(b) Diagram 6 shows two redox reactions that take place in test tubes P and Q.

(b) Diagram 6 shows two redox reactions that take place in test tubes P and Q.

(c) Table 6 shows the observations of two experiments to determine the position of carbon in the reactivity series of metal.

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Reactants</th>
<th>Observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Carbon + oxide of metal P</td>
<td>A flame spreads to the whole mixture. A brown residue is formed.</td>
</tr>
</tbody>
</table>
II | Carbon + oxide of metal Q | No change  
---|---------------------------|-----------
III | Carbon + oxide of metal R | A glow spreads to the whole mixture. A grey residue is formed.

Table 6

Based on observations in Table 8, arrange the reactivity of metals P, Q, and R in descending order. Explain your answer. Suggest one metal for Q.

[10 marks]

SECTION C

7  
(a) A solution of common salt, sodium chloride, is electrolysed using carbon electrodes. Write a half-equation for the reaction at the cathode.

[2 marks]

(b) Diagram 7 shows two types of cells.

Diagram 7

Compare and contrast cell A and cell B. Include in your answer the observations and half equations for the reactions at the electrodes in both cells.

[8 marks]

(c) A student intends to electroplate an iron ring with a suitable metal to beautify it. Design a laboratory experiment to electroplate the iron ring. Your answer should consist of the following:

- Chemicals required
- Procedures of the experiment.
- A labelled diagram showing the set up of apparatus.
- Chemical equation involved in the reaction.
- Observations.

[10 marks]
8 (a) (i) Explain what is meant by corrosion of metal using a chemical equation. [2 marks]

(ii) Table 8 shows the observation of two experiments to study the effect of metal P and metal Q on the rusting of iron. Rusting of iron is a redox reaction.

<table>
<thead>
<tr>
<th>Experiment</th>
<th>After 1 day</th>
<th>Observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Agar-agar solution with some potassium hexacyanoferrate(III) and phenolphthalein solution added. Iron nail wrapped with metal P</td>
<td>Large amount of dark blue precipitate</td>
</tr>
<tr>
<td>II</td>
<td>Agar-agar solution with some potassium hexacyanoferrate(III) and phenolphthalein solution added. Iron nail wrapped with metal Q</td>
<td>No dark blue precipitate. Solution turns pink.</td>
</tr>
</tbody>
</table>

Table 8

Explain why there is a difference in observation in experiment I and experiment II. Arrange in descending order metals P, iron and Q based on the electropositivity of the metals. [8 marks]

(b) Iron (II) ions can be converted to iron (III) ions and iron (III) ions can be converted back to iron (II) ions.

By using a named metal as a reducing agent and a named halogen as an oxidising agent, describe briefly how you would carry out these two conversions.

Describe a test to show that each conversion has taken place. [10 marks]
The diagram 9 shows the set-up apparatus of the experiment to investigate the effect of metal on rusting of iron, when it is in contact with other metals. Three iron nails coiled with different metals are placed separately into three test tubes W, X and Y, the test tube Z as a control. Each of the test tubes is filled with a agar-agar solution containing a small amount of phenolphthalein and potassium hexacyanoferrate(III) solution. The apparatus is set aside for one day.

\[ \text{Agar-agar solution} \]
\[ + \]
\[ \text{Potassium hexacyanoferrate(III)} \]
\[ + \]
\[ \text{phenolphthalein} \]

Test tube W
Iron nail coiled with magnesium strip

Test tube X
Iron nail coiled with zinc strip

Test tube Y
Iron nail coiled with copper strip

Test tube Z
Iron nail

Diagram 9

Table below shows the result of the experiment is set aside after 1 day.

<table>
<thead>
<tr>
<th>Test tube</th>
<th>W</th>
<th>X</th>
<th>Y</th>
<th>Z</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intensity of blue colour</td>
<td>None</td>
<td>None</td>
<td>Very high</td>
<td>Low</td>
</tr>
<tr>
<td>Pink colouration</td>
<td>Present</td>
<td>Present</td>
<td>Present</td>
<td>Present</td>
</tr>
<tr>
<td>Inference</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(a) State the hypothesis for this experiment.

.................................................................................................................................
.................................................................................................................................
.................................................................................................................................
.................................................................................................................................

[ 3 marks ]

(b) For this experiment, state:
(i) The manipulated variable
.................................................................................................................................

(ii) The responding variable
.................................................................................................................................
(iii) The constant variable

---------------------------------------------------------------------------------------- [3 marks]

(c) Based on the observations, complete the inferences in the table above. [3 marks]

(d) Write half-equation for the oxidation and reduction in the experiment.
Oxidation :

---------------------------------------------------------------------------------------- [3 marks]

Reduction :

---------------------------------------------------------------------------------------- [3 marks]

(e) State the operational definition for the rusting of iron.

---------------------------------------------------------------------------------------- [3 marks]

(f) Based on this experiment classify the metals can provide sacrificial protection and metals that cannot provide sacrificial protection to iron.

---------------------------------------------------------------------------------------- [3 marks]

10. Diagram 10.1 shows the set-up of apparatus for an experiment to determine the order of the metals in the reactivity series.

Potassium manganate (VII) is heated to release oxygen gas which is used to react with metal powder. This experiment is carried out using magnesium powder, zinc powder, lead powder and copper powder to react with oxygen gas respectively.
Table 10.1 shows the observations on the brightness of glow or flame when the metal powders react with oxygen gas.

<table>
<thead>
<tr>
<th>Metal</th>
<th>Observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnesium</td>
<td>Magnesium burns brightly</td>
</tr>
<tr>
<td>Zinc</td>
<td>Zinc burns fairly bright</td>
</tr>
<tr>
<td>Lead</td>
<td>Lead glows brightly</td>
</tr>
<tr>
<td>Copper</td>
<td>Copper glows faintly</td>
</tr>
</tbody>
</table>

Table 10.1

(a) State the hypothesis for the experiment
...........................................................................................................................................
...........................................................................................................................................
........................................................................................................................................... [3 marks]

(b) For this experiment, state:
(i) The manipulated variable
...........................................................................................................................................

(ii) The responding variable
...........................................................................................................................................

(iii) The constant variable
........................................................................................................................................... [3 marks]

(c) State the operational definition for the reactivity of metal.
........................................................................................................................................... [3 marks]

(d) What can be observed to the residue after heating the lead powder?
........................................................................................................................................... [3 marks]

(e) Based on the observation in Table 10.1, state the inference for the reaction between magnesium powder and oxygen gas.
........................................................................................................................................... [3 marks]

(f) Arrange zinc, copper, lead and magnesium in ascending order of reactivity of metal towards oxygen.

_________________ , __________________ , __________________ , __________________ [3 marks]
(g) Predict the position of iron in the reactivity series of metals.

........................................................................................................................................................................ [3 marks]

(h) In this experiment, zinc takes a longer time to start burning compared to magnesium. Explain.

........................................................................................................................................................................ [3 marks]

(i) Classify the metals into more reactive metals than iron and less reactive metals than iron when react with oxygen.

<table>
<thead>
<tr>
<th>More reactive metal than iron</th>
<th>Less reactive metal than iron</th>
</tr>
</thead>
</table>

........................................................................................................................................................................ [3 marks]

(j) Another experiment is carried out to determine the empirical formula of magnesium oxide. Diagram 10.2 shows the results of the experiment.
(i) Record the readings of the experiment with two decimal places.

- Mass of crucible + lid : 
- Mass of crucible + lid + magnesium ribbon : 
- Mass of crucible + lid + magnesium oxide :  

(ii) Based on (i), construct a table to record the readings of the experiment.

11 A more electropositive metal acts as a sacrificial metal which corrodes itself to protect iron from rusting

You are given the iron nails, magnesium ribbon, zinc strip, copper strip and tin strip. Referring to the situation above, plan a laboratory experiment to investigate the effect of other metals on the rusting of iron.

Your planning should include the following aspects:

(a) Statement of the problem
(b) All variables
(c) Statement of the hypothesis
(d) List of materials and apparatus
(e) Procedure of the experiment
(f) Tabulation of data

12 The electrochemical series for zinc, magnesium, copper and iron can be constructed by measuring the potential difference between them

Plan a laboratory experiment to construct the electrochemical series for the metals.

Your planning must include the following items:

(a) Statement of the problem
(b) All the variables
(c) Hypothesis
(d) Lists of materials and apparatus
(e) Procedure
(f) Tabulation of data
CHEMISTRY PERFECT SCORE MODULE

SET 1 2 3 4

1. Acids and Bases
2. Salts
3. Rate od reaction
4. Thermochemistry
CHEMISTRY PERFECT SCORE MODULE

SET 1 2 3 4

5. Acids and Bases
6. Salts
7. Rate of reaction
8. Thermochemistry
An experiment is carried out to investigate neutralisation reaction between 1.0 mol dm\(^{-3}\) of sulphuric acid and 25 cm\(^3\) of sodium hydroxide. A few drops of phenolphthalein are added to the solution. The acid is added slowly to the flask until end point. The result of the experiment is shown in table 1.

<table>
<thead>
<tr>
<th>Titration No</th>
<th>Initial reading of burette (cm(^3))</th>
<th>Final reading of burette (cm(^3))</th>
<th>Volume of acid used (cm(^3))</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>17.30</td>
<td>39.70</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>17.00</td>
<td>39.20</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>17.70</td>
<td>39.70</td>
<td></td>
</tr>
</tbody>
</table>

Table 1

a) What is meant by end point?

...................................................................................................................................................... [1 mark]

b) State the change of colour of phenolphthalein during titration.

...................................................................................................................................................... [1 mark]

c) Fill in the table by calculating the volume of sulphuric acid used in the experiment.

...................................................................................................................................................... [1 mark]

d) Write chemical equation of the reaction in this experiment.

...................................................................................................................................................... [1 mark]

e) (i) Calculate the average volume of sulphuric acid used in the reaction.

...................................................................................................................................................... [1 mark]

(ii) Calculate the number of mol sulphuric acid used in the reaction

...................................................................................................................................................... [1 mark]

f) Draw a labeled diagram to show the set up of apparatus used in the experiment.

...................................................................................................................................................... [2 marks]
An experiment is carried out to determine the concentration of sulphuric acid by titration. A few drops of methyl orange indicator is added to 20.00 cm$^3$ of 0.1 mol dm$^{-3}$ potassium hydroxide solution in a conical flask. Sulphuric acid of unknown concentration is then added. The results obtained are shown in the table 2.

<table>
<thead>
<tr>
<th>Titration</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume of acid added / cm$^3$</td>
<td>5.00</td>
<td>10.00</td>
<td>15.00</td>
<td>20.00</td>
<td>25.00</td>
</tr>
<tr>
<td>Colour of the mixture</td>
<td>Yellow</td>
<td>Orange</td>
<td>Red</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2

(a) What is the colour of methyl orange
   (i) in an acidic solution?

   ........................................... .........................................................

   [1 mark]

   (ii) in an alkaline solution?

   .................................................. ..................................................

   [1 mark]

   (iii) in a neutral solution?

   ........................................................... .................................................

   [1 mark]

(b) What is the volume of sulphuric acid that completely neutralises 20.00 cm$^3$ of 0.1 mol dm$^{-3}$ potassium hydroxide solution?

   ...........................................................................................................

   [1 mark]

(c) Write
   (i) the chemical equation for the reaction.

   ...........................................................................................................

   [1 mark]

   (ii) the ionic equation for the reaction.

   ...........................................................................................................

   [1 mark]

(d) Calculate the molarity of sulphuric acid.

   ...........................................................................................................

   [1 mark]

(e) What is the colour of the mixture when a total of
   (i) 5.00 cm$^3$ of acid is added?

   ...........................................................................................................

   [1 mark]

   (ii) 25.00 cm$^3$ of acid is added?

   ...........................................................................................................

   [1 mark]
What is the expected volume of 0.1 moldm⁻³ hydrochloric acid that neutralises completely 20 cm³ of 0.1 mol dm⁻³ potassium hydroxide solution?

A titration was carried out as shown in Diagram 1. 50 cm³ of 0.2 mol dm⁻³ barium hydroxide is titrated with 1.0 mol dm⁻³ sulphuric acid solution. A few drops of methyl orange indicator is added to the barium hydroxide solution before the titration. Diagram 2 shows a graph of ammeter readings against volume of sulphuric acid added based on the results obtained.

a. Write the balanced chemical equation for the reaction occurring in the beaker.

b. Name the reaction involved in the beaker.

c. State 2 observations in the beaker upon reaching the end-point.

d. Based on Diagram 2,
   i. explain why there is no ammeter reading when x cm³ of sulphuric acid is added
   ii. determine the value of x
e. If the barium hydroxide solution in the above experiment is replaced with potassium hydroxide solution, i. sketch the graph of the ammeter reading against the volume of sulphuric acid added.

ii. explain one difference between the graph obtained in e(i) and the graph as shown in Diagram 2.

4. Diagram 3 below shows laboratory activities in preparation of a salt.

(a) Name the type of reaction in the preparation of salt.

(b) Explain why zinc oxide powder is added in excess.

(c) Write a chemical equation for the reaction that occurs inside the beaker.

(d) Draw the apparatus set-up used to separate the excess zinc oxide powder from the mixture in the diagram above.

(e) Calculate the maximum mass of the salt formed.

[Relative atomic mass: N=14, O=16, Zn=65]
(f) Suggest two substances that can replace zinc oxide in the experiment to obtain the same type of salt.  

[2 marks]

5. 6.0 cm$^3$ of 0.5 mol dm$^{-3}$ silver nitrate solution is poured into 6 different test tubes. Different volume of 1.0 mol dm$^{-3}$ sodium chloride solution are added to each test tube. The mixture is shaken and the height of precipitate formed in each test tube is measured and recorded as shown in the Table 3.

<table>
<thead>
<tr>
<th>Test tube</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume of 0.5 mol dm$^{-3}$ silver nitrate solution (cm$^3$)</td>
<td>6.0</td>
<td>6.0</td>
<td>6.0</td>
<td>6.0</td>
<td>6.0</td>
<td>6.0</td>
</tr>
<tr>
<td>Volume of 1.0 mol dm$^{-3}$ sodium chloride solution (cm$^3$)</td>
<td>1.0</td>
<td>2.0</td>
<td>3.0</td>
<td>4.0</td>
<td>5.0</td>
<td>6.0</td>
</tr>
<tr>
<td>Height of precipitate (cm)</td>
<td>0.5</td>
<td>1.0</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>......</td>
</tr>
</tbody>
</table>

(a) State the name of the precipitate formed.  

[1 mark]

(b) What is the colour of the precipitate?  

[1 mark]

(c) What is the volume of sodium chloride needed to completely react with 6.0 cm$^3$ silver nitrate solution?  

[1 mark]

(d) Calculate  
(i) the number of moles of silver nitrate in the reaction.  

[1 mark]  
(ii) the number of moles of sodium chloride that has completely reacted with 1 mole of silver nitrate.  

[1 mark]

(e) Write the ionic equation for the formation of the precipitate.  

[2 marks]

(f) Predict the height of the precipitate formed in test tube 6.  

[1 mark]
(g) The concentration of sodium chloride solution is changed from 1.0 mol dm\(^{-3}\) to 2.0 mol dm\(^{-3}\) and the other conditions remain the same. Sketch the graph of height of precipitate against the volume of sodium chloride solution.

6 Diagram 4 shows a series of reactions for copper(II) oxide and its other compounds.

```
Diagram 4

Copper(II) oxide \rightarrow \text{heat} \rightarrow \text{Solution W} \rightarrow \text{Lead(II) nitrate solution} \rightarrow \text{Precipitate Y}
```

(a)(i) Name the solution W.

........................................................................................................................................... [1 mark]

(ii) Describe briefly how to prepare a sample of dry salt from solution W.

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...........................................................................................................................................
[3 marks]

(b)(i) What do you observe when dilute sodium hydroxide solution is added drop by drop until in excess into solution W?

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[2 marks]
(ii) Write down the formula of precipitate X.

........................................................................................................................................... [1 mark]

(c) Solution Z is added into solution W until no changes are observed. A dark blue solution is formed. Name the solution Z.

........................................................................................................................................... [1 mark]

(d) When solution W is added into lead(II) nitrate solution in a test tube, precipitate Y and copper(II) nitrate solution are formed.

(i) What is the colour of precipitate Y?

........................................................................................................................................... [1 mark]

(ii) Write down the ionic equation to show the formation of precipitate Y.

........................................................................................................................................... [1 mark]

(iii) How can you separate precipitate Y from copper(II) nitrate solution?

........................................................................................................................................... [1 mark]

7 An experiment was conducted to study the effect of temperature on the rate of reaction between 50 cm$^3$ of sodium thiosulphate solution 0.2 mol dm$^{-3}$ and 5 cm$^3$ of sulphuric acid 1.0 mol dm$^{-3}$ to form a yellow precipitate. Diagram 5 shows the set-up of apparatus for the experiment.

Diagram 5

50 cm$^3$ of sodium thiosulphate solution 0.2 mol dm$^{-3}$ + 5 cm$^3$ of sulphuric acid 1 mol dm$^{-3}$

The experiment was repeated five times at different temperatures. Table 4 shows the temperature and time taken for mark ‘X’ to disappear from view.

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Temperature/$^\circ$C</th>
<th>Time/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>28.0</td>
<td>55</td>
</tr>
<tr>
<td>2</td>
<td>40.0</td>
<td>33</td>
</tr>
<tr>
<td>3</td>
<td>50.0</td>
<td>23</td>
</tr>
<tr>
<td>4</td>
<td>60.0</td>
<td>17</td>
</tr>
<tr>
<td>5</td>
<td>70.0</td>
<td>13</td>
</tr>
</tbody>
</table>

Table 4

(a) Draw a graph of temperature against time for this experiment. [3 marks]
(b) Compare the rate of reaction between Experiment 2 and Experiment 4. Explain your answer by using the Collision Theory.

…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………
[5 marks]

(c) Write the chemical equation for the reaction.

………………………………………………………………………………………………
[1 mark]

(d) Name the yellow precipitate formed.

………………………………………………………………………………………………
[1 mark]

(e) State one other factor that can affect the rate of reaction for this experiment.

………………………………………………………………………………………………
[1 mark]

8 Three experiments were conducted to study the rate of reaction between hydrochloric acid and zinc. Table 5 shows the the mixture of the substances used and time taken to collect 25 cm$^3$ of gas released in each experiment.

<table>
<thead>
<tr>
<th>Expeiment</th>
<th>Mixture of substances used</th>
<th>Time/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>20.0 cm$^3$ hydrochloric acid 1.0 mol dm$^{-3}$ + 2.0 g zinc</td>
<td>50.0</td>
</tr>
<tr>
<td>II</td>
<td>20.0 cm$^3$ hydrochloric acid 1.0 mol dm$^{-3}$ + 2.0 g zinc + 5 drops of copper(II) sulphate solution</td>
<td>32.0</td>
</tr>
<tr>
<td>III</td>
<td>20.0 cm$^3$ sulphuric acid1.0 mol dm$^{-3}$ + 2.0 g zinc</td>
<td>25.0</td>
</tr>
</tbody>
</table>

Table 5

(a) Draw the set-up of apparatus used in this experiment.

[2 marks]

(b) Calculate the average rate of reaction in Experiment II.

[1 mark]

(c) Write the ionic equation for the reaction.

[1 mark]
(d) Compare the rate of reaction between Experiment I and II. 
Explain your answer by using the Collision Theory.

..............................................................................................................................

..............................................................................................................................

..............................................................................................................................

.............................................................................................................................. [4 marks]

(e) Compare the rate of reaction between Experiment I and III. 
Explain your answer by using the Collision Theory.

..............................................................................................................................

..............................................................................................................................

..............................................................................................................................

..............................................................................................................................

.............................................................................................................................. [4 marks]

(f) (i) State the name of the gas collected in the experiments.

.............................................................................................................................. [1 mark]

(ii) Describe one test to confirm the gas collected in (f)(i).

.............................................................................................................................. [2 marks]

An experiment is carried out to determine heat of displacement for the reaction between copper and silver nitrate solution. In this experiment, excess copper powder is added to 50 cm$^3$ of silver nitrate solution 0.5 mol dm$^{-3}$. The heat of displacement in this experiment was -105 kJ mol$^{-1}$. Specific heat capacity of the solution is 4.2 J g$^{-1}$ °C$^{-1}$.

(a) What is meant by heat of displacement?

.............................................................................................................................. [1 mark]

(b) State another observation besides the change in temperature.

.............................................................................................................................. [1 mark]

(c) Based on the information from this experiment, calculate
   (i) the number of moles of silver ions reacted.

.............................................................................................................................. [1 mark]

   (ii) the amount of heat released.

.............................................................................................................................. [1 mark]

   (iii) the change in temperature.

.............................................................................................................................. [2 marks]
(d) State two assumptions made during the calculations.

..........................................................................................................................................
..........................................................................................................................................

[2 marks]

(e) Construct an energy level diagram for the reaction.

..........................................................................................................................................
..........................................................................................................................................

[2 marks]

(f) Polystyrene cup A is used in the above experiment. The experiment is repeated using cup B. Predict the change in temperature. Explain your answer.

Prediction:

..........................................................................................................................................

[1 mark]

Explanation:

..........................................................................................................................................
..........................................................................................................................................
..........................................................................................................................................

[2 marks]

(g) Explain why copper powder used in this experiment is in excess.

..........................................................................................................................................

[1 mark]

(h) If copper powder is replaced with magnesium, predict the change of the magnitude in heat of reaction obtained. Explain your answer.

..........................................................................................................................................
..........................................................................................................................................
..........................................................................................................................................

..........................................................................................................................................

[ 2 marks]

Experiment I is carried out to determine the heat of neutralisation between strong acid and strong alkali. It is found that the heat of neutralisation is \(-57 \text{ kJ mol}^{-1}\). The diagram 6 show the energy level diagram for the reaction between strong acid and strong alkali.

\[ \text{Energy} \]

\[ \text{H}^+(aq) + \text{OH}^-(aq) \rightarrow \text{H}_2\text{O}(l) \]

\[ \Delta H = -57 \text{ kJ mol}^{-1} \]

Diagram 6
a) Name an example of strong acid and a strong alkali.

b) What is meant by “heat of neutralisation” in the experiment?

c) State 2 information about the reaction which can be obtained from the above energy level diagram.

d) In another experiment, experiment II is carried under the same conditions as experiment I, whereby a 50 cm$^3$ of 1 mol dm$^{-3}$ ethanoic acid is added to 50 cm$^3$ of strong alkali with a concentration of 1 mol dm$^{-3}$. The temperature of the mixture increased by 6.5 °C.

(i) Calculate the number of moles of strong alkali used.

(ii) Calculate the heat of neutralization for the reaction between ethanoic acid and strong alkali

[Specific capacity for all solutions is 4.2 Jg$^{-1}$°C$^{-1}$ and the density of all solutions is 1.0 g cm$^{-3}$]

e) (i) Compare the heat of neutralization for Experiment I and Experiment II

(ii) Explain your answer in e(i)

f) If Experiment II is repeated by adding 100 cm$^3$ of 1 mol dm$^{-3}$ ethanoic acid to 100 cm$^3$ strong alkali with concentration 1 mol dm$^{-3}$, the increase in temperature is still 6.5 °C. Explain why.
ESSAY SECTION B

10 (a) What is meant by strong acid? [2 marks]

(b) Two samples of acids are tested and exhibit the same pH value. One sample is 50 cm$^3$ 0.5 moldm$^{-3}$ of sulphuric acid while another sample is 50 cm$^3$ 1.0 moldm$^{-3}$ of hydrochloric acid. Explain why. [4 marks]

(c) Diagram 7 shows hydrogen chloride gas being prepared in the laboratory by adding concentrated sulphuric acid slowly through a thistle funnel to solid sodium chloride. The gas produced is passed thorough water and methylbenzene.

(i) State the observations when aqueous hydrogen chloride solution and hydrogen chloride in methylbenzene are added with the following:
- Universal Indicator
- Zinc powder
- Copper(II) oxide powder [6 marks]

(ii) Based on your answer in c(i), which of the solution is acidic? Explain your answer. [4 marks]

(iii) Diagram 8 shows the apparatus used to study whether aqueous hydrogen chloride solution and hydrogen chloride in methylbenzene are electrolyte or non-electrolyte.

Experiment I

Experiment II

State the observations in experiment I and II. Explain your answer. [4 marks]
11 (a) You are required to prepare a dry sodium nitrate salt. The chemicals supplied are:

- Dilute nitric acid
- Sodium hydroxide solution
- Phenolphthalein

Describe a laboratory activity to prepare the salt. Your answer should include the chemical equation involved. [10 marks]

(b) Describe briefly how you prepare copper(II) chloride salt solution from the chemical substances provided below.

- Copper(II) sulphate solution
- Dilute hydrochloric acid
- Sodium carbonate solution

[6 marks]

(c) Potassium carbonate solution is added into lead(II) nitrate solution to produce solid X and potassium nitrate solution. The mixture is shaken, then filtered. Solid X is heated to produce solid P and gas Q.

(i) Name solid P and state its colour. [2 marks]

(ii) Name gas Q and describe a method to verify its identity. [2 marks]

ESSAY SECTION C

12 (a) Using suitable examples, explain what is meant by

(i) diprotic acid
(ii) strong acid [4 marks]

(b) Explain why sodium hydroxide solution and aqueous ammonia of the same concentration have different pH value. [6 marks]

(c) Describe how to prepare 250 cm\(^3\) of 1.0 mol dm\(^{-3}\) potassium hydroxide starting from solid potassium hydroxide.

Describe how you would prepare 250 cm\(^3\) of 0.1 mol dm\(^{-3}\) potassium hydroxide from the solution. [ Relative atomic mass : H, 1; O, 16; K, 39] [10 marks]

13 (a) An insoluble salt can be prepared by the precipitation reaction. Give an example of an insoluble salt and suggest two solutions to prepare the insoluble salt. Write the ionic equation to represent the precipitation reaction. [4 marks]

(b) Figure below shows an incomplete flow chart of cation and anion tests for salt X.

Use the reagents listed below to confirm that salt solution of X contains Fe\(^{2+}\) ions and SO\(_4^{2-}\) ions.

- Sodium hydroxide solution
- Ammonia solution
- Hydrochloric acid
- Barium chloride solution [6 marks]
(c) Magnesium sulphate is a soluble salt. Describe how to prepare a dry sample of magnesium sulphate in the laboratory.

Your answer should consist of the following:
- Chemicals required
- Procedure of the preparation
- Chemical equation involved in the reaction

14 (a) What is the meaning of activation energy in a chemical reaction?

(b) Describe briefly (i) the Collision Theory, and (ii) the effect of catalyst in a chemical reaction.

(c) Describe one laboratory experiment to study the effect of size on the rate of reaction between calcium carbonate and dilute hydrochloric acid. Include in your answers the following aspects:
- a labelled diagram of the set-up of apparatus
- procedure
- results of the experiment.

(d) Concentration is one of the factors that affects the rate of reaction. Based on the collision theory, explain how concentration affects the rate of reaction.

15 (a) \( \text{Zn(s)} + \text{CuSO}_4(\text{aq}) \rightarrow \text{ZnSO}_4(\text{aq}) + \text{Cu(s)} \quad \Delta H = -152 \text{ kJmol}^{-1} \)

(i) Draw an energy level diagram for the above equation.

(ii) Explain the differences in energy content of reactants as compared to the products.

(b) Table 6 below shows the result of neutralization reactions.

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Neutralization reaction</th>
<th>Heat release (kJ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>NaOH + HCl \rightarrow NaCl + H(_2)O</td>
<td>57</td>
</tr>
<tr>
<td>II</td>
<td>NaOH + CH(_3)COOH \rightarrow CH(_3)COONa + H(_2)O</td>
<td>54</td>
</tr>
<tr>
<td>III</td>
<td>2NaOH + H(_2)SO(_4) \rightarrow Na(_2)SO(_4) + 2H(_2)O</td>
<td>114</td>
</tr>
</tbody>
</table>

Explain why there are differences in heat released between;

(i) Experiment I and Experiment II

(ii) Experiment I and Experiment III

(c) \( \text{Ca}^{2+}(\text{aq}) + \text{CO}_3^{2-}(\text{aq}) \rightarrow \text{CaCO}_3(\text{s}) \quad \Delta H = +12.6 \text{ kJmol}^{-1} \)

Describe a laboratory experiment to determine the heat of reaction for the above reaction, include the following in your answer:
[Relative atomic mass : C=12 ; O=16 ; H=1 ]
- diagram showing the set-up of apparatus
- chemicals required
- procedures of the experiment
- a table to collect the data
- calculation involved
16  (a)  What is the meaning of heat combustion of propanol?  [2 marks]

(b)  (i)  By using a labeled diagram describe an experiment how to determine the heat of combustion of the liquid propanol in the laboratory.  
In your explanation, state together the necessary steps to calculate the heat of combustion of propanol.  [Relative molecular mass of propanol = 60]  [14 marks]

(ii)  State the precaution steps that should be taken during this experiment.  [2 marks]

(c)  Table 16 shows the value of the heat of combustion for methanol and propanol.

<table>
<thead>
<tr>
<th>Alcohol compounds</th>
<th>Heat of combustion/kJ mol⁻¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methanol</td>
<td>-723</td>
</tr>
<tr>
<td>Propanol</td>
<td>-2004</td>
</tr>
</tbody>
</table>

Table 16

Compare the heat of combustion of methanol \((\text{CH}_3\text{OH})\) with the heat of combustion of propanol\((\text{C}_3\text{H}_7\text{OH})\).  Explain your answer.  [2 marks]

PAPER 3

17  Two experiments are carried to study the effect of the size of calcium carbonate on the rate of reaction.  
Experiment I:  1 g of calcium carbonate chips react with 20.0 cm³ of 0.2 mol dm⁻³ hydrochloric acid  
Experiment II:  1 g of calcium carbonate powder react with 20.0 cm³ of 0.2 mol dm⁻³ hydrochloric acid  
The rate of reaction is determined by measuring the volume of of carbon dioxide gas given off against time using the downward displacement of water method.  
The volume of gas released is recorded in Table 8 and Table 9 below.

<table>
<thead>
<tr>
<th>Time / s</th>
<th>0</th>
<th>60</th>
<th>120</th>
<th>180</th>
<th>240</th>
<th>300</th>
<th>360</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burette reading / cm³</td>
<td>50.00</td>
<td>18.00</td>
<td>9.50</td>
<td>8.00</td>
<td>8.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volume of gas / cm³</td>
<td>0.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 17.1

<table>
<thead>
<tr>
<th>Time / s</th>
<th>0</th>
<th>60</th>
<th>120</th>
<th>180</th>
<th>240</th>
<th>300</th>
<th>360</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burette reading / cm³</td>
<td>50.00</td>
<td>22.00</td>
<td>13.50</td>
<td>9.00</td>
<td>8.00</td>
<td>8.00</td>
<td>8.00</td>
</tr>
<tr>
<td>Volume of gas / cm³</td>
<td>0.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 17.2
Diagram 17 shows the burette reading for Experiment I at 60, 120 and 180 seconds.

(a) Record the burette reading and the volume of gas released at 60, 120 and 180 seconds in Table 17.1. [3 marks]

(b) Record the volume of gas released in both experiments in Table 17.1 and Table 17.2. [3 marks]

(c) By using the same axes, draw a graph of the volume of gas released against time for Experiment I and II. [3 marks]

(d) Based on the graph in (c), which experiment has a higher rate of reaction? Explain your answer.

(e) (i) State the variables involved in this experiment.
   Manipulated variable
   Responding variable
   Constant variable
   [3 marks]

   (ii) State the hypothesis for these experiments.

   [3 marks]

(f) Predict the volume of gas released at 420 seconds in Experiment II.

   [3 marks]

(g) Classify the following reaction into fast reaction and slow reaction.

| Rusting, Fermentation, Neutralization, Photosynthesis, Combustion, Precipitation |
| Combustion, Corrosion, Displacement                                           |

[3 marks]
A student performs an experiment to determine the heat displacement of copper. 50 cm$^3$ of copper (II) sulphate solution 0.5 mol dm$^3$ was poured into a polystyrene cup. Initial temperature of the solution was recorded. Then excess zinc powder was added into the copper(II) sulphate solution in the polystyrene cup and stirred as shown in diagram 10.

![Diagram 18.1: Before and After](image)

The initial temperature and maximum temperature were recorded as in diagram 10.2

![Diagram 18.2: Initial and Maximum Temperature](image)

(a) State two observations in this experiment

(b) Refer diagram 18.2, determine the temperature values

Initial temperature .................................................................

Maximum temperature .........................................................

Temperature difference .........................................................

(c) Calculate the heat change in this experiment.

(Heat capacity of solution = 4.2 g$^\circ$C$^{-1}$, Density of solution = 1 g cm$^{-3}$)

(d) Give the inference for this reaction

Chemistry Perfect Score Module 2010
(e) In another experiment, excess zinc powder was poured into 50 cm$^3$ copper(I l) sulphate solution 1 mol dm$^{-3}$. Predict the change in temperature obtained in this experiment.

(f) Write ionic equation for the reaction in this experiment

Essay Paper 3

19

A company manager was approached by a sales man who tried to convince him octane (petrol) is a better fuel than heptane in terms of the heat released when burnt in excess oxygen.

Design a laboratory experiment to compare the heat of combustion for the above mentioned fuels. Your answer should include the following:

(a) Aim of experiment
(b) Hypothesis
(c) All variables
(d) List of materials and apparatus
(e) Procedure
(f) Tabulation of data
CHEMISTRY PERFECT SCORE MODULE

SET 1 2 3 4

1. Carbon Compounds
2. Manufactured Substances in Industry
3. Chemicals for Consumers
1. Diagram 1 shows the conversions of compound P to other compounds.

![Diagram 1](image)

(a) State the name of compound W

(b) State the temperature and catalyst used in Process II.

   Temperature: ..........................................................  [1 mark]

   Catalyst: ..............................................................  [1 mark]

(c) Write the chemical equation for the reaction in process I.

   …………………………………………………………………………………………  [1 mark]

(d) Compound C₄H₈ and compound Q are members of alkenes.

   Draw the structural formulae for two isomers of compound C₄H₈.

   …………………………………………………………………………………………  [2 marks]

(c) Gas Q and gas R are passed through bromine water.

<table>
<thead>
<tr>
<th>Gas</th>
<th>Observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas Q</td>
<td></td>
</tr>
<tr>
<td>Gas R</td>
<td></td>
</tr>
</tbody>
</table>

(i) State the observations of the reactions between gas Q and gas R with bromine water in the above table.  [2 marks]

(ii) Explain the differences in the above observations

   …………………………………………………………………………………………

   …………………………………………………………………………………………

   …………………………………………………………………………………………  [2 marks]
2. Diagram 2 shows the flow chart of a series of conversion of carbon compounds.

Diagram 2

Based on Diagram 2 answer the following questions:

(a) Name the reaction in conversion I.

................................................................................................. [1 mark]

(b) Ethanol is produced by hydration of ethene in II.

(i) State the catalyst used in this reaction.

................................................................................................. [1 mark]

(ii) Write a chemical equation for the reaction in II.

................................................................................................. [1 mark]

(iii) Name the reaction that converts glucose to ethanol in the laboratory.

................................................................................................. [1 mark]

(c) (i) Name substance Q.

................................................................................................. [1 mark]

(ii) Suggest an oxidising agent that can be used in reaction IV.

................................................................................................. [1 mark]

(d) Write a chemical equation for the reaction in III.

................................................................................................. [1 mark]

(e) Ethanol and substance Q react to produce substance X with a molecular formula of CH$_3$COOC$_2$H$_5$.

(i) Name the reaction in V to produce substance X.

................................................................................................. [1 mark]

(ii) State one physical property of substance X.

................................................................................................. [1 mark]

(iii) Draw the structural formula of substance X.

................................................................................................. [1 mark]
Diagram 3 shows the structure of olive oil.

Diagram 3

(a) (i) State the name of the homologous series that olive oil belongs to.
........................................................................................................................................... [1 mark]

(ii) Circle on the diagram, the functional group that determines the homologous series for olive oil. [1 mark]

(iii) Write down the formulae of the two main components to make olive oil
........................................................................................................................................... [2 marks]

(b) Is olive oil a saturated or unsaturated compound? Give a reason.
........................................................................................................................................... [2 marks]

(c) Olive oil can be converted into margarine.
(i) Name the reactant, catalyst and temperature for the reaction to convert olive oil to margarine.

Reactant:...........................................................................................................................................

Catalyst:...........................................................................................................................................

Temperature:.....................................................................................................................................

(ii) Name the type of reaction in c(i).
........................................................................................................................................... [4 marks]
4. Diagram 4 shows the conversions of organic compound A to other substances, $C_2H_4Br_2$ and $C_2H_5OH$ through Processes A and C.

(a) What is meant by organic compound?

...........................................................................................................................................

...........................................................................................................................................

[1 mark]

(b) (i) Write the molecular formula of compound A.

...........................................................................................................................................

...........................................................................................................................................

[1 mark]

(ii) State the name of the compound A.

...........................................................................................................................................

...........................................................................................................................................

[1 mark]

(iii) Identify a functional group of compound A.

...........................................................................................................................................

...........................................................................................................................................

[1 mark]

(c) Compound A reacts with Reagent B to produce substance $C_2H_4Br_2$ through Process I.

(i) Suggest Reagent B.

...........................................................................................................................................

...........................................................................................................................................

[1 mark]

(ii) State the name of Process I.

...........................................................................................................................................

...........................................................................................................................................

[1 mark]

(i) State the observation when the reaction occurs.

...........................................................................................................................................

...........................................................................................................................................

[1 mark]

(d) Substance $C_2H_5OH$ is produced when the compound A reacts with steam through Process II.

(i) Write the equation to show the reaction.

...........................................................................................................................................

...........................................................................................................................................

[1 mark]

(ii) State the homologous series represented by $C_2H_5OH$.

...........................................................................................................................................

...........................................................................................................................................

[1 mark]
(iii) State one condition to carry out Process II.

…………………………………………………………………………………………... [1 mark]

5. Table 5 shows the manufactured substances in industries.

<table>
<thead>
<tr>
<th>Material</th>
<th>Substance Q</th>
<th>Alloy</th>
<th>Polymer</th>
<th>Glass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example</td>
<td>Photochromic glass</td>
<td>Bronze</td>
<td>Polyvinyl chloride (PVC)</td>
<td>Borosilicate glass</td>
</tr>
</tbody>
</table>

Table 5

Based on Table 5, answer the following questions.

(a) State the name of substance Q.

…………………………………………………………………………………………... [1 mark]

(b) Diagram 5.1 shows the arrangement of atoms in bronze.

![Diagram 5.1](attachment:image.png)

(i) Bronze is a type of alloy. State the meaning of alloy.

…………………………………………………………………………………………... [1 mark]

(ii) State the name of atom X.

…………………………………………………………………………………………... [1 mark]

(c) Draw the structural formula for the monomer of polyvinyl chloride.

(d) State one reason for borosilicate glass to use in laboratory glassware.

…………………………………………………………………………………………... [1 mark]
(e) Diagram 5.2 shows the manufactured of ammonia.

Diagram 5.2

(i) What is the name of this process?

......................................................................................................................... [1 mark]

(ii) Write the chemical equation for the reaction to produce ammonia.

......................................................................................................................... [2 marks]

(iii) State the name of catalyst Y.

......................................................................................................................... [1 mark]

(iv) The ammonia produced can be used to manufacture fertilisers.
Name one fertilizer manufactured from ammonia.

......................................................................................................................... [1 mark]

6 The following equation shows a reaction in the preparation of soap in a laboratory.

Palm oil + Concentrated sodium hydroxide $\xrightarrow{\text{Boild}}$ Sodium palmitate (soap) + Glycerol

(a) What is the name of this reaction?

......................................................................................................................... [1 mark]

(b) (i) What is the homologous series of palm oil?

......................................................................................................................... [1 mark]

(ii) Complete the anion part of the soap particle in the space provided.

$\text{CH}_3 \text{CH}_2 \text{CH}_2 \text{CH}_2 \text{CH}_2 \text{CH}_2 \text{CH}_2$

$\text{CH}_2 \text{CH}_2 \text{CH}_2 \text{CH}_2 \text{CH}_2 \text{CH}_2 \text{CH}_2 \text{CH}_2 \text{C}$

......................................................................................................................... [1 mark]
(c) A pupil wants to prepare a potassium palmitate soap. What alkali should he use?

(d) Diagram 6 shows part of the washing action of detergent particles on a grease-stained cloth.

(i) State the part of a detergent particle that is soluble in grease.

(ii) Based on the figure above, explain the washing action of detergent particles on greasy stains.

(iii) Complete the figure below to show the condition of grease and detergent particles when the water is stirred.
7. The following equation shows a reaction in the preparation of soap.

\[
\begin{align*}
\text{Palm oil (Tripalmitin)} & \quad \text{Concentrated sodium hydroxide solution} \\
\text{CH}_2-O-C-(\text{CH}_2)_{14}\text{CH}_3 & \quad \text{CH}_2\text{OH} \\
\text{CH}-O-C-(\text{CH}_2)_{14}\text{CH}_3 & \quad \text{CH}_2\text{OH} \\
\text{CH}_2-O-C-(\text{CH}_2)_{14}\text{CH}_3 & \quad \text{CH}_2\text{OH} \\
& + 3\text{NaOH} \rightarrow \text{CH}_2\text{OH} + 3\text{CH}_3(\text{CH}_2)_{14}\text{COO}^-\text{Na}^+ \\
\text{Glycerol} & \quad \text{Soap molecule}
\end{align*}
\]

(a) (i) State the name of the process used to produce soap.

........................................................................................................................................... [1 mark]

(ii) Why is sodium chloride added to the reacting mixture during the preparation of the soap?

........................................................................................................................................... [1 mark]

(iii) Why the soap is formed rinsed with water?

........................................................................................................................................... [1 mark]

(iv) A student wants to prepare a potassium palmitate soap. What alkali should he use?

........................................................................................................................................... [1 mark]

(v) Draw the structural formula for sodium palmitate in the space provided

........................................................................................................................................... [2 marks]

(vi) One of the properties of soaps is that they can form lather with water. What is the function of lather?

........................................................................................................................................... [1 mark]
Diagram below shows the structural formula of a particle of detergent.

\[ \text{CH}_3(\text{CH}_2)_n(\text{CH}_2) - \text{O} - \text{S} - \text{O}^-\text{Na}^+ \]

(i) Draw the hydrophobic and hydrophilic parts of the detergent particle.

(ii) The formula mass of the detergent particles is 330. Calculate the value of \( n \).

[Given that the relative atomic mass of H = 1, C = 12, O = 16, Na = 23, S = 32]

(iii) State one advantage of using detergent over soap.

………………………………………………………………………………………………………………... [5 marks]

8. Table 8 shows the examples and side effects of modern medicine.

<table>
<thead>
<tr>
<th>Name of medicine</th>
<th>Side Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amphetamine</td>
<td>Cause addiction, suspicious, fearful, aggressive, insomnia and weight loss</td>
</tr>
<tr>
<td>Barbiturate</td>
<td>Cause addiction and death</td>
</tr>
<tr>
<td>Cortisone</td>
<td>Weight gains, high blood pressure, weak heart, blindness, children's growth stunted, headache</td>
</tr>
</tbody>
</table>

Table 8

a. State the type of modern medicine in Table 8
   i. Amphetamine: ………………………………………………………………………….. [3 marks]
   ii. Barbiturate: …………………………………………………………………………..
   iii. Cortisone: …………………………………………………………………………..

b. State the function of stimulant.

………………………………………………………………………………………………………………... [1 mark]

c. Why psychotherapeutic drugs cannot be taken without doctor’s prescription?

………………………………………………………………………………………………………………... [1 mark]

d. Name two health problems that can be treated using cortisone?
ESSAY SECTION B

9. (a) Explain briefly what is meant by ‘homologous series’

(b) Explain the difference in sootiness for the combustion of the 5 carbon members from the alkane and alkene series. [Relative atomic mass: H = 1, C = 12]

(c) Diagram 8 shows the structural formulae of two organic compounds, W and Z.

(i) Name W and Z. State the similarities and differences between W and Z in terms of their formulae.

(ii) Compare physical properties W and Z in term of solubility and smell.

(iii) A compound Y has the molecular formula and chemical properties similar to that of Z. Write the structural formula of Y and give one use of Y.

(iv) Write the chemical equation to form Y and name the catalyst for the reaction.

10. Diagram 9 shows the conversions of several organic compounds.

(a) Compound X comprises of 52.2% carbon, 34.8% oxygen and 13% hydrogen with a relative molecular mass of 46. Determine the molecular formula of compound X and draw its structural formula. [Relative atomic mass: H = 1, C = 12, O = 16]

(b) Describe an experiment to prepare ethyl ethanoate

(c) What type of reaction is required to change compound X into ethene and what are the conditions required?

(d) Explain how ethanoic acid can coagulate latex. How can you prevent the coagulation process?
(e) Ethene can be converted into a polymer.
   (i) What is a polymer?
   (ii) Write the equation for this process.

11. (a) Sulphur dioxide, \( \text{SO}_2 \), is one of the by-products of the Contact Process. It can cause environmental pollution like acid rain.

   Sulphur dioxide gas dissolves in rain water to produce sulphurous acid
   (i) Write the chemical equation for the reaction between sulphur dioxide gas and rain water.
   (ii) State three effects of acid rain to the environment.

(b) Diagram 11 shows an industry preparation of sulphuric acid by the Contact Process.

\[ \text{S} \quad \text{Stage I} \quad \text{SO}_2 \quad \text{Stage II} \quad \text{SO}_3 \quad \text{Stage III} \quad \text{X} \quad \text{Stage IV} \quad \text{H}_2\text{SO}_4 \]

(i) Name the compound X.
(ii) Write the chemical equation of the reaction at stage II.
(iii) The chemical equation below shows the reaction between sulphur and oxygen gas at stage I.

\[ \text{S} + \text{O}_2 \rightarrow \text{SO}_2 \]

Given that the relative atomic mass of S = 32, O = 16 and the molar volume of any gas is 24 dm\(^3\)mol\(^{-1}\) at room temperature and pressure.

Calculate the maximum volume of sulphur dioxide gas produced if 48 g of sulphur is burnt completely in oxygen gas.

(c) Brass is an alloy of copper. Pure copper is ductile and malleable whereas brass is stronger and harder than copper.

(i) Explain why pure copper is ductile and malleable?

(ii) Name the element which is added to copper to make brass. Explain why brass is strong and harder than copper. Draw a diagram to show the arrangement of atoms in brass.
Diagram 12.1 shows the structural formula of soap.

![Soap Structure](image)

Diagram 12.1

(a) State the name part X and part Y. State the solubility of each parts in water and grease.  

(b) Diagram 12.2 shows a set-up of apparatus when a student carried out two experiments to investigate the cleansing effect of soap and detergent on oily stained cloth in hard water.

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Arrangement of apparatus</th>
<th>Observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experiment I:</td>
<td>Soap + hard water</td>
<td>Oily stain remained</td>
</tr>
<tr>
<td>Experiment II:</td>
<td>Detergent + hard water</td>
<td>Oily stain disappeared</td>
</tr>
</tbody>
</table>

Diagram 12.2

Compare the cleansing effect between Experiment I and Experiment II. Explain why there are differences in the observations. State the substance which is more suitable as a cleansing agent to remove stain in hard water.

(c) Patient X, Y and Z are suffering from dental pain, pneumonia and depression respectively. What are the medicines that can be used to treat patients X, Y and Z?

(d) Based on your answer in (c),

(i) State one precaution that should be followed by patient X while taking the medicine. Explain why.

(ii) Explain why patient Y must complete the whole course of the medicine prescribes to him even if he feels better.

(iii) State two side effects of the medicine taken by patient Z.
ESSAY SECTION C

13(a) The diagram 13 shows the release of sulphur dioxide gas from the smokestack of a power station.

Diagram 13
Sulphur dioxide is always associated with the cause of acid rain. Describe how the sulphur dioxide affects the quality of environment.
Your description should include the following aspects:
- Sources of sulphur dioxide
- Health hazards of sulphur dioxide
- Formation of acid rain and its effects [10 marks]

(b) Samuel believes that brass is harder than copper. On the other hand, Kelly thinks otherwise.

Based on the above argument, describe a laboratory experiment to show the hardness of brass compared to copper. Explain the results from the experiment. [10 marks]

14 (a) 5.6 g of ethene burns completely in oxygen at room condition

(i) Write the chemical equation for the combustion of ethene. [2 marks]
(ii) Calculate the volume of oxygen gas to react completely with 5.6 g of ethene. [2 marks]

[Relative atomic mass: C=12, H=1, O=16; Molar volume of gas: 24 dm³ mol⁻¹ at room condition]

(b) Table 14.1 shows two compounds P and Q.

<table>
<thead>
<tr>
<th>Compound P</th>
<th>Sebatian P</th>
<th>Compound P</th>
<th>Sebatian Q</th>
</tr>
</thead>
<tbody>
<tr>
<td>H – C – C – O – H</td>
<td>H – C – H</td>
<td>H – C – C – C – H</td>
<td>H – H</td>
</tr>
</tbody>
</table>

Table 14.1

(i) State the name of compounds P and Q. [2 marks]
(ii) Compare compound P and compound Q based on their

- colour of flame when burn in oxygen
- solubility in water [4 marks]

(c) Diagram 14.2 shows the structural formula of an ester.

Diagram 14.2
Describe a laboratory experiment to prepare the ester. In your description, include the materials, chemical equation involved and a suitable diagram for the set-up apparatus. [10 marks]
5. Diagram 15 shows the apparatus set-up for an experiment to compare the elasticity properties of vulcanised rubber and unvulcanised rubber.

![Diagram 15](image)

Diagram 15

An experiment is carried out using weights of 10g, 20g and 30g to get the increase in length of the vulcanised rubber and the unvulcanised rubber. The table below shows the results obtained from the experiment.

<table>
<thead>
<tr>
<th>Types of rubber</th>
<th>Vulcanised rubber</th>
<th>Unvulcanised rubber</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weights (g)</td>
<td>10 20 30</td>
<td>10 20 30</td>
</tr>
<tr>
<td>Initial length, ( l_1 ) (cm)</td>
<td>8.0 8.0 8.0</td>
<td>8.0 8.0 8.0</td>
</tr>
<tr>
<td>Length after stretching, ( l_2 ) (cm)</td>
<td>10.0 12.0 11.0</td>
<td>12.0 16.0 20.0</td>
</tr>
<tr>
<td>Increase in length, ( l_2 - l_1 ) (cm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increase in length after weight is removed. (cm)</td>
<td>8.5 9.0 9.5</td>
<td>10.0 12.0 14.0</td>
</tr>
</tbody>
</table>

(a) Complete the table above based on the above experiment. [3 marks]

(b) State one hypothesis for this experiment. ……………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………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(d) Based on the experiment above, which rubber strip is more elastic? Explain your answer.

-------------------------------------------------------------------------------------------------------------------------------------

-------------------------------------------------------------------------------------------------------------------------------------

-------------------------------------------------------------------------------------------------------------------------------------

[3 marks]

(e) Give the definition of vulcanised rubber?

-------------------------------------------------------------------------------------------------------------------------------------

-------------------------------------------------------------------------------------------------------------------------------------

-------------------------------------------------------------------------------------------------------------------------------------

[3 marks]

16. An experiment was carried out to compare the elasticity of unvulcanized and vulcanized rubber. The lengths of the rubber strips were measured as shown in Table 16.

<table>
<thead>
<tr>
<th>Weight (g)</th>
<th>Unvulcanized rubber strip</th>
<th></th>
<th>Vulcanized rubber strip</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Initial length (cm)</td>
<td>Length after removal of weight (cm)</td>
<td>Initial length (cm)</td>
</tr>
<tr>
<td>10</td>
<td>7.0</td>
<td>7.0</td>
<td>7.0</td>
</tr>
<tr>
<td>20</td>
<td>7.0</td>
<td>7.0</td>
<td>7.0</td>
</tr>
<tr>
<td>30</td>
<td>7.0</td>
<td>7.0</td>
<td>7.0</td>
</tr>
<tr>
<td>40</td>
<td>7.0</td>
<td>8.0</td>
<td>7.0</td>
</tr>
<tr>
<td>50</td>
<td>8.0</td>
<td>9.0</td>
<td>7.0</td>
</tr>
</tbody>
</table>

Table 16

(a) State the problem statement for this experiment.

-------------------------------------------------------------------------------------------------------------------------------------

[3 marks]

(b) State the variables for this experiment.

(i) Manipulated variable:

(ii) Responding variable:

(iii) Controlled variable

[3 marks]

(c) State the hypothesis for this experiment.

-------------------------------------------------------------------------------------------------------------------------------------

[3 marks]

(d) Give the operational definition for this experiment.

-------------------------------------------------------------------------------------------------------------------------------------

[3 marks]

(e) State the minimum weight at which each of the rubber strip failed to return to its original length after the removal of the weight.

-------------------------------------------------------------------------------------------------------------------------------------

[3 marks]
17. An experiment is carried out as shown in diagram 17.

![Diagram 17](image)

Two beakers A and B are filled with 200 cm$^3$ of sea water. A spatula of soap and detergent are added to beakers A and B respectively and stirred until they dissolve. Two cloths stained with greasy spots are added to both solutions and stirred for 10 minutes. The cloths are then examined.

(a) State the aim of the experiment.

(b) State the hypothesis of the experiment.

(c) For the experiment, state the

(i) manipulated variable:

(ii) responding variable:

(iii) constant variable:

(d) Record the results of the experiment in the table.

<table>
<thead>
<tr>
<th>Beaker</th>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(e) What conclusion can you make from your result?

(f) Explain your answer in part (e).
18.

If the body of a bus is made of iron, it would easily rust due to its exposure to air and water. Such a body is soft and can be easily dented in an accident. Thus, to overcome these problems, the body of the bus is made of steel.

Referring to the above situation, design a laboratory experiment to compare iron and steel based on one of the following properties:

Resistant to rust or hardness

The experiment designed must include the followings:
(i) Problem statement
(ii) Hypothesis
(iii) Lists of substances and apparatus
(iv) Procedure
(v) Tabulation of data

19.

Diagram 19 shows three reagent bottles containing three colourless organic liquids X, Y and Z.

The three liquids are hexan-1-ol, hex-1-ene and hexane. The labels on the three bottles are missing. Plan a laboratory experiment to differentiate and identify the liquids in each of the three reagent bottles. Your description must include the following:

(i) Aim
(ii) Variables
(iii) List of materials and apparatus
(iv) Procedure
(vi) Tabulation of data