UCLSE

New Curriculum

Chemistry

Practical Workbook

BY

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(f) How would adding an impurity, such as salt, to the ice in this experiment affect the results? Sketch a graph to support your ideas.

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Exam style questions

Worked example

Plan an investigation to determine the Volume of sulphuric acid required for complete neutralization of $25cm^3$ of sodium hydroxide solution .

You are provided with solutions **BA1** which is a 1M sulphuric acid and **BA2** which contains sodium hydroxide and common laboratory apparatus.

Write a report about your findings. Your report should include the following:

(a) Aim of the experiment
(b) Variables of the experiment
(c) Hypothesis
(d) List of apparatus and materials
(e) Procedure of the experiment
(f) Tabulation of data
(g) A graph of temperature against volume of **BA1**.
(h) Conclusion from the investigation

Answer

(a) **Aim of the experiment:**
To determine the Volume of sulphuric acid required for complete neutralization of $25cm^3$ of sodium hydroxide solution. **01 mark**

(b) **Variables of the experiment**
Independent Variable: Volume of BA1 (1M sulphuric acid).
Dependent Variable: Maximum Temperature during the neutralization reaction.
Controlled Variable: Initial concentration and volume of BA2 (sodium hydroxide solution)
03 marks

(c) **Hypothesis**

The reaction between sodium hydroxide and sulphuric acid is expected to be exothermic, resulting in a temperature increase. The volume of **BA1** needed for neutralization can be used to calculate the neutralizing capacity of **BA2**. **01 mark**

(d) **List of apparatus and materials**

Burette
Pipette
Conical flask
Plastic cup/ beaker
Thermometer
Stirring rod
Clamp and stand
Towel or tissue
Safety equipment (lab coat, goggles, gloves)

01 mark

(e) Procedure of the experiment

(i) Exactly 25cm^3 of **BA2** is measured using a clean dry measuring cylinder and transferred into a plastic beaker and its temperature is recorded.

(ii) The burette is filled with **BA1,** 5cm^3 is run into **BA2** in a plastic beaker. The Mixture is stirred using a thermometer and the maximum temperature, T reached by the mixture is recorded.

(iii) Both the thermometer and the plastic beaker are washed and dried.

(iv) Steps (i) to (iii) are repeated using the set of volumes of **BA1** indicated in the table below.

(v) The values of highest temperatures, T reached by the mixture are recorded in the same table.

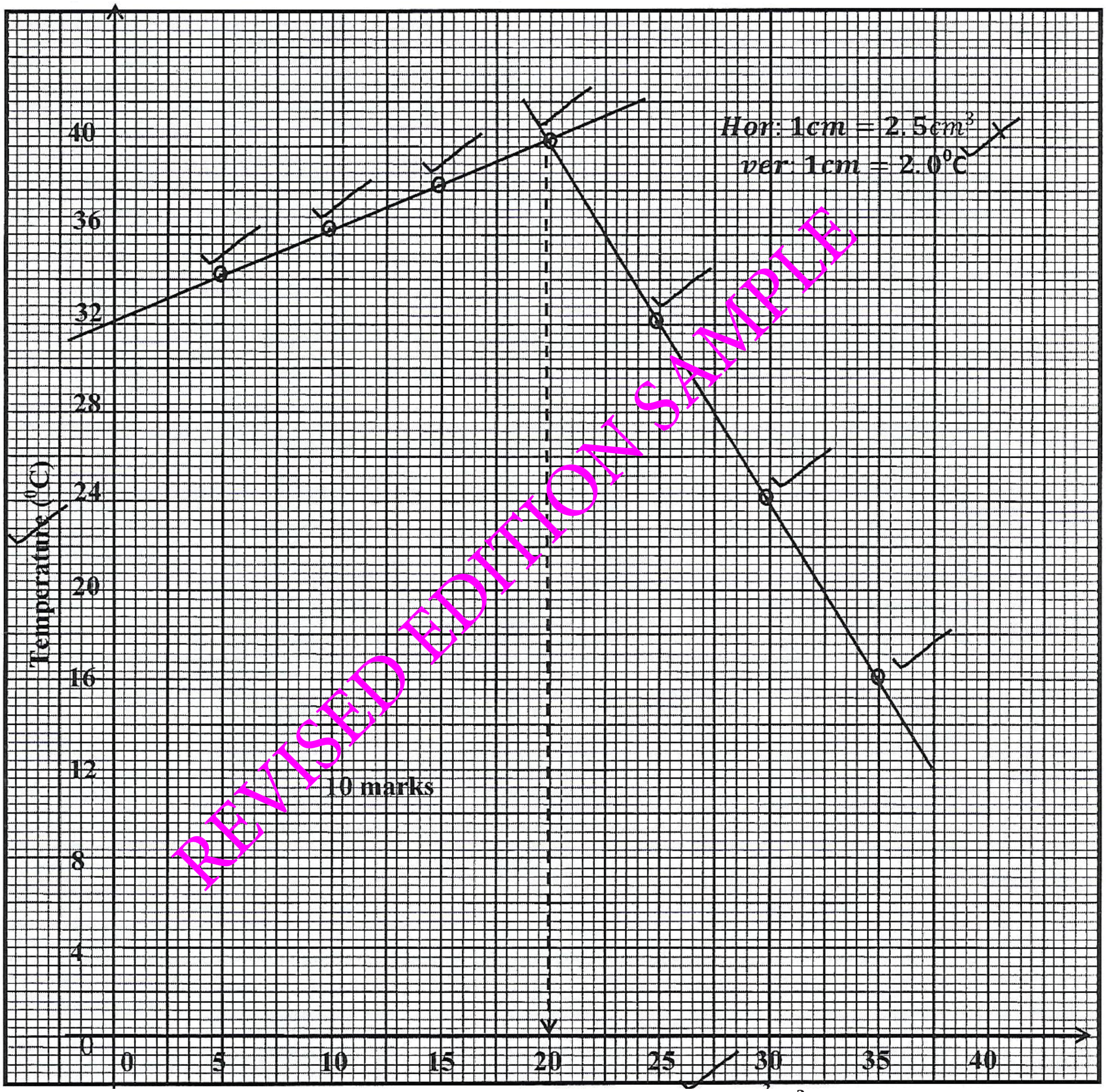
05 marks

(f) **Tabulation of data**

Experiment Number	1	2	3	4	5	6	7
Volume of **BA1** (cm^3)	5	10	15	20	25	30	35
Maximum temperature T(°C)	34	36	38	40	32	24	16

07marks

(g) A graph of temperature against volume of **BA1**.



Volume of BA1 added (cm^3)

(h) **Conclusion from the investigation**

Volume of **BA1** required for complete neutralization of 25cm^3 of **BA2** is obtained from the graph and it is approximately equal to 20.0cm^3

The experiment confirms the hypothesis regarding the neutralizing capacity of **BA2**.

02marks

Total = 30marks

Experiment 1

A chemistry teacher conducted an experiment to investigate the rate of reaction between dilute hydrochloric acid and aqueous sodium thiosulphate. The experiment involved varying the volumes of the reactants to observe their impact on the rate of reaction.

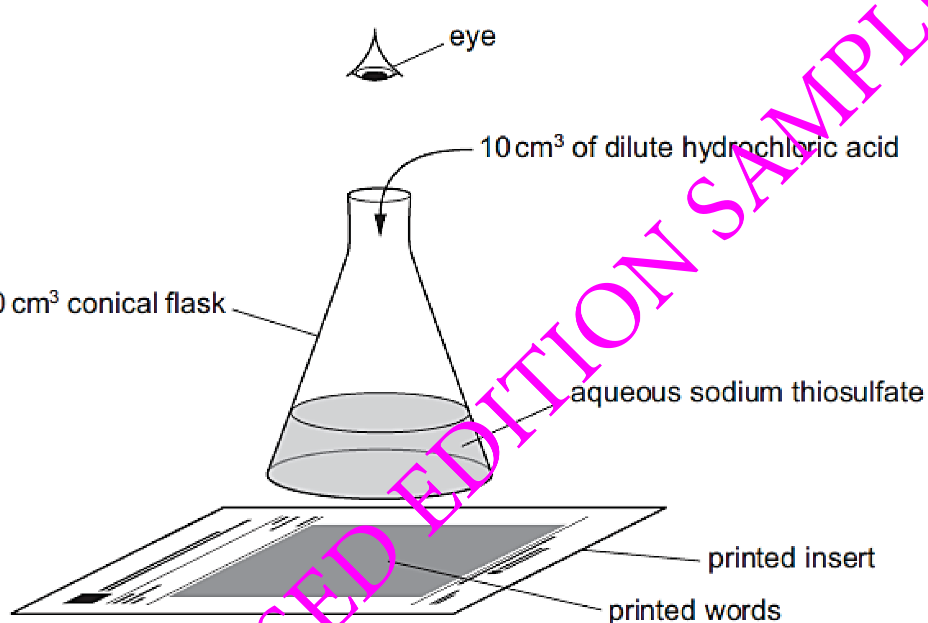
Sodium thiosulphate reacts with hydrochloric acid according to the following equation.

$$Na_2S_2O_3(aq) + 2HCl(aq) \rightarrow 2NaCl(aq) + S(s) + H_2O(l) + SO_2(g)$$

Task:

(a) As a student conducting the experiment;

(i) design an experiment to measure the rate of reaction between dilute hydrochloric acid and aqueous sodium thiosulphate. The setup below may be useful to you.



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(ii) carry out the experiment and record your findings.

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(iii) Describe the appearance of the mixture in the conical flask at the end of each experiment.

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(iv) Explain, in terms of particles, why the rate of reaction was greatest in this experiment.

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(b) Give the name of a more accurate piece of apparatus for measuring volumes than a measuring cylinder.

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(c) Suggest the effect on the results of using a 100 cm^3 conical flask instead of a 250 cm^3 conical flask. Explain your answer.

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Experiment 5

At the local science fair, students were exploring different chemical reactions. One exhibit focused on mixing dilute hydrochloric acid with sodium carbonate solutions.
One student named Tom decided to try the experiment. He was fascinated by the setup and wanted to understand how chemicals react. With the help of the exhibit guide, Mr. Smith, Tom carefully followed the steps. As he added the acid to the solutions, he noticed something interesting - the container felt warm.

Confused but curious, Tom asked Mr. Smith why the container was getting warmer.

Task:

(a) As a student of chemistry;

(i) Design an experiment to investigate the reaction between dilute hydrochloric acid and two different aqueous solutions of sodium carbonate labeled solution **E** and solution **F**.

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(ii) Conduct the experiment and record your findings

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(b) State **two** sources of error in your experiment. For each error suggest an improvement that would reduce the error.

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source of error 2……………………………………………………………………………

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improvement 2 ……………………………………………………………………………

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(c) If you were Mr. Smith, what answer would you give to Tom's question?

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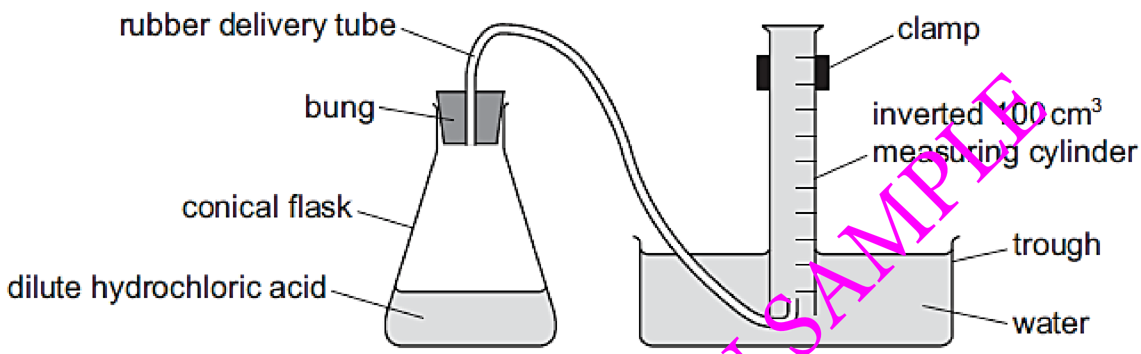
Experiment 6

A high school science fair showcased various experiments, including one investigating the rate of hydrogen gas production when magnesium reacts with two different solutions of dilute hydrochloric acid, labeled **C** and **D**, each with varying concentrations. Participants were recommended to use the set up below.



Task:

(a) As a participant in the science fair,

(i) design an experiment to investigate the rate at which hydrogen gas is made when magnesium reacts with two different solutions of dilute hydrochloric acid, **C** and **D**, with different concentrations

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(ii) Conduct the experiment and record your findings

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(b) Explain what can be deduced about the concentrations of dilute hydrochloric acid **C** and dilute hydrochloric acid **D**.

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(c) Suggest why it is important to replace the bung in the conical flask immediately after adding the magnesium ribbon.

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Experiment 27

A chemical engineering workshop hosted by a local industry aimed to train engineers on practical applications of volumetric analysis in quality control processes. One of the sessions focused on determining the acidity of a sample solution using a standardized solution of sodium hydroxide.

During the workshop, John, a chemical engineer eager to enhance his analytical skills, participated in an experiment demonstrating acid-base titrations. Under the guidance of industry experts, John prepared a burette with a standardized solution of sodium hydroxide ($NaOH$) and obtained a sample solution of unknown acidity.

As John titrated Solution $NaOH$ into the sample solution, he carefully monitored the pH changes using a pH meter until reaching the equivalence point. John recorded the burette readings and pH measurements throughout the titration.

The acid provided is labeled **BA1** and the base provided is labeled **BA2**.

Task:

(a) As an aspiring chemical engineer:

(i) Design an experiment to determine the acidity of **BA1** using **BA2** as the titrant.

(ii) Perform the titration experiment, ensuring precise measurement and monitoring of pH changes.

(iii) Calculate the acidity of **BA1** based on the volume of **BA2** used.

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(b) Based on your experiment's results, explain the significance of acid-base titrations in quality control processes within the chemical industry and their role in ensuring product consistency.

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Experiment 35

A local municipality organized a workshop to educate residents on household cleaning products. During the workshop, participants conducted an experiment to observe the heat changes during the neutralization of acidic household waste with a basic solution.

As participants added a solution of acidic household waste to a solution of sodium hydroxide, they observed a temperature increase in the mixture. One participant noticed the temperature change and questioned why the household waste became warmer during the neutralization process.

The acidic solution provided is labeled **BA1** and the base provided is labeled **BA2**.

Task:

(a) As a learner of chemistry:

(i) Design an experiment to measure the temperature change and determine the amount of heat produced during the neutralization of **BA1** with **BA2**.

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(ii) Conduct the experiment by mixing **BA1** with **BA2** and recording the temperature change over time.

(iii) Calculate the maximum heat produced during the neutralization reaction.

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(b) Based on your findings, explain to the participant how the neutralization reaction between **BA1** and **BA2** generates heat and helps in waste management.

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Experiment Requirements (Practical Instructions)

Each candidate will require the following materials and apparatus.

Experiment 1

(a) 250 cm^3 of aqueous sodium thiosulfate, $Na_2S_2O_3.5H_2O$, containing 40 g / dm^3 labelled **aqueous sodium thiosulfate**.
The aqueous sodium thiosulphate must be freshly prepared.
(b) 100 cm^3 of hydrochloric acid of concentration 2.0 mol / dm^3 labelled **dilute hydrochloric acid**
(c) access to water and distilled water
(d) 50 cm^3 measuring cylinder
(e) 10 cm^3 measuring cylinder
(f) 250 cm^3 conical flask
(g) teat pipette
(h) stop-clock or timer which can measure to an accuracy of 1 s

Per five candidates
A bucket labelled **quenching bath** must be provided.
The bucket must contain 1 dm^3 of approximately 5% sodium carbonate solution (made up by dissolving 50 g of Na_2CO_3 or 135 g of $Na_2CO_3.10H_2O$ in 1 dm^3 of water) and Universal Indicator.
The Supervisor must monitor the colour of the Universal Indicator in each quenching bath to check that the solution has not become acidic. If the solution becomes acidic, the Supervisor must add more 5% sodium carbonate solution to the quenching bath.

Experiment 2

- Measuring cylinders (50cm^3 and 10 cm^3)
- conical flask
- filter paper
- stop clock (stop watch).

Experiment 3

- 50 cm^3 of aqueous barium nitrate, $Ba(NO_3)_2$, of concentration 0.33 mol / dm^3 labelled **aqueous barium nitrate**
- 50 cm^3 of aqueous sodium carbonate, Na_2CO_3, of concentration 0.33 mol / dm^3 labelled **aqueous sodium carbonate**
- access to water and distilled water
- 10 cm^3 measuring cylinder
- 50 cm^3 burette with stand and clamp
- funnel for filling burette
- 6 × **identical** test-tubes, capable of holding 15 cm^3
- test-tube rack
- glass stirring rod
- stop-clock or timer which can measure to an accuracy of 1 s
- marker pen to write on glass
- ruler with millimetre graduations
- teat pipette

Experiment 4

- 50cm^3 of Sodium hydroxide solution (BA2) - 2M
- 50cm^3 of Sulphuric acid solution (BA1) - 1M
- Burette
- Pipette
- Conical flask
- Phenolphthalein indicator
- Distilled water
- Funnel
- Clamp stand
- White tile or paper

Experiment 5

- 200 cm^3 of hydrochloric acid of concentration 0.20mol / dm^3 in a stoppered container
- 100 cm^3 of **solution E**, which is aqueous sodium carbonate of concentration 0.10 mol / dm^3 in a stoppered container
- 50 cm^3 of **solution F**, which aqueous sodium carbonate of concentration 0.15 mol / dm^3 in a stoppered container
- thymolphthalein indicator
- methyl orange indicator
- 50 cm^3 burette with clamp and stand
- white tile
- funnel to fill burette
- 25 cm^3 measuring cylinder
- 250 cm^3 conical flask
- dropping pipettes