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Cambridge IGCSE™ Chemistry

PRACTICAL WORKBOOK

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How to Use This Book

Scientists study the structure of the matter that makes up our world and us, and how and why that matter reacts. When scientists investigate, they start by proposing an explanation, known as the hypothesis. They then test the hypothesis in the laboratory. The results of the experiments are published in scientific journals for other scientists to review and test for themselves.

Good practical skills are essential to many scientists' work. This book will help you to develop practical skills. This resource also reinforces some of the theoretical knowledge you will have learnt in the Student's Book by providing opportunities to apply this to practical contexts, including both core and supplement activities.

In the Cambridge IGCSE™ Chemistry qualification, practical skills are assessed through either:

- the **Practical Test**, where you will carry out laboratory experiments and answer questions; or
- the **Alternative to Practical**, in which you will answer questions but not carry out any laboratory experiments.

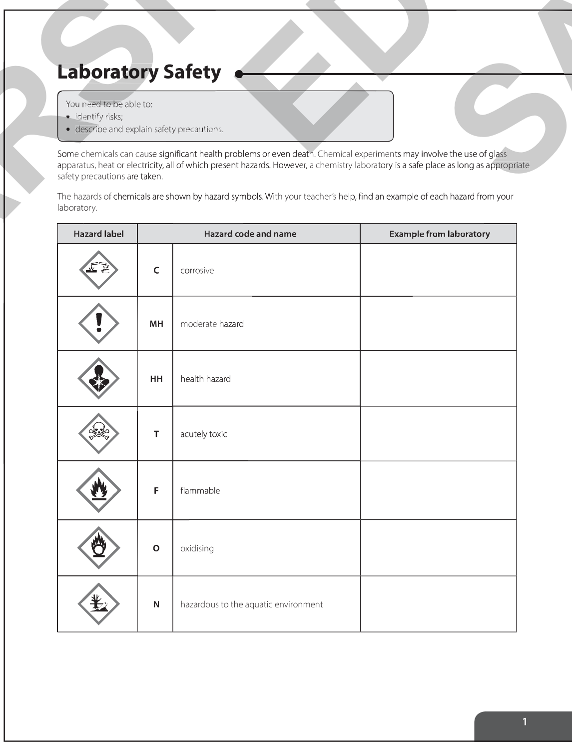
Both of these papers assess the same practical skills. They account for 20% of the overall Cambridge IGCSE Chemistry qualification.

(The information in this section is taken from the Cambridge IGCSE Chemistry (0620/0971) syllabus for examination from 2023. You should always refer to the appropriate syllabus document for the year of your examination to confirm the details and for more information. The syllabus document is available on the Cambridge International website at www.cambridgeinternational.org.)

By using this book, you will learn the following:

- recognise and use the apparatus and techniques you will use most often;
- how to make and record observations and measurements accurately;
- different methods for handling observations and data;
- how to plan, carry out and evaluate experiments.

This Practical Workbook is part of the Marshall Cavendish Education suite of resources that will support you as you follow the Cambridge IGCSE Chemistry (0620/0971) syllabus and equip you with the practical aspects of your Cambridge IGCSE Chemistry course.



Laboratory Safety

You need to be able to:
- identify risks;
- describe and explain safety precautions.

Some chemicals can cause significant health problems or even death. Chemical experiments may involve the use of glass apparatus, heat or electricity, all of which present hazards. However, a chemistry laboratory is a safe place as long as appropriate safety precautions are taken.

The hazards of chemicals are shown by hazard symbols. With your teacher's help, find an example of each hazard from your laboratory.

Hazard label	Hazard code and name		Example from laboratory
	C	corrosive	
	MH	moderate hazard	
	HH	health hazard	
	T	acutely toxic	
	F	flammable	
	O	oxidising	
	N	hazardous to the aquatic environment	

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Laboratory Safety
This lists the basic safety pointers that you should be aware of.

Practical Skills Build-up
This introduces essential practical skills and techniques, such as appropriate use of apparatus and methods of recording and presenting data. The questions included in this section will help reinforce the skills learnt.

- Always wear safety goggles when an experiment is being carried out.
- Make sure you understand the method before you start work. If you have any questions, ask your teacher.
- Never carry out a procedure not mentioned in the method.
- Always follow the school's safety rules.
- Always follow your teacher's instructions.

Practical Skills Build-up

Materials:

You need to be able to:
- identify apparatus from diagrams or descriptions;
- draw, complete or label diagrams of apparatus.

(a) Key laboratory apparatus:

This table lists laboratory apparatus that you should recognise and know how to use. As you work through the experiments in this book, write the numbers of the practicals in which you use each piece of apparatus.

Apparatus	Practical
Apparatus for taking measurements	
balance	
burette	
gas syringe	
measuring cylinder	
stopwatch	
thermometer	
volumetric pipette and filler	
Glassware and associated apparatus (sometimes a plastic alternative is used)	
beaker	
boiling tube	
conical flask	
delivery tube	
filter funnel and paper	
stirring rod	

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(d) Taking readings:

You should know how to measure mass, temperature, time, length, and the volume of a gas or liquid. When using a digital scale, write the value shown on the display. When using a non-digital scale, always read the scale at eye level and read to the nearest half unit. For example, the burettes shown below have scales to 0.1 cm^3 (e.g. 20.0, 20.1, 20.2, …), so they should be read to the nearest 0.05 cm^3 (20.00, 20.05, 20.10, 20.15, 20.20, …) When reading a volume of liquid, always read from the bottom of the meniscus, as shown in Figure A.

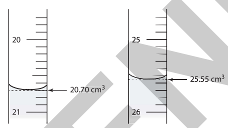
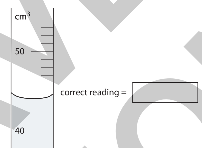


Figure A

Question:

5 Write the reading on this scale:



(e) Making observations:

An observation is something that you can see happening, such as "a white precipitate forms" or "a colourless solution forms". You should always give the colour of any solution or precipitate. This includes saying that a "colourless solution" formed if the solution has no colour. When you are making observations, you do so as a trained observer. You should think about the possible outcomes of the experiment or test. When a carbonate is added to acid, carbon dioxide gas is formed. A correct observation would be "bubbling occurs". "Carbon dioxide formed" is not an observation. It is a conclusion. You cannot see carbon dioxide.

Question:

6 In the table below, choose the correct observation for each test, A or B.

Test	Observation A	Observation B	A or B?
Add litmus to acid	Turns red	Turns red-brown	
Bubble carbon dioxide through limewater	Goes grey	White precipitate	
Add magnesium to acid	Effervescence	Hydrogen forms	

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Chapter 1

Practical 1B **Diffusion**

Skills
You will practise how to:
- Make qualitative observations
- Carefully handle a hazardous solid – potassium manganate(VII)
- Use apparatus to carefully place crystals in an experiment

Theory:

Diffusion is the movement of particles from a region of higher concentration to a region of lower concentration. The particles of a solid, of a liquid and of a gas can all diffuse. The particles that are in a region of high concentration will spread out and mix with the particles that surround them.

Objective: To observe evidence that diffusion occurs, and to see what affects the rate of diffusion.

Materials:

- petri dish with a layer of agar gel (about 1mm thick; made from about [illegible]g agar powder in 100cm^3 water)
- petri dish
- distilled water
- dropping pipette
- tweezers
- 250cm^3 beakers
- straws
- kettle
- long glass tube
- clamp and stand
- stoppers
- cotton wool
- potassium manganate(VII) crystals (oxidising, moderate hazard, harmful to the aquatic environment)
- concentrated ammonia solution (corrosive, moderate hazard, harmful to the aquatic environment)
- concentrated hydrochloric acid (corrosive, moderate hazard)

Procedure:

Put on safety goggles before you start the experiment.

Part A – diffusion in a solid and in a liquid:

1 Place a petri dish on the bench and add distilled water with a dropping pipette until the water just covers the surface of the petri dish.
2 Place by the side of the first petri dish another petri dish that has a coating of agar gel.
3 Using tweezers, place one large crystal of potassium manganate(VII) onto each petri dish.
4 Observe the two petri dishes. Leave them while you carry out Part B and Part C, then observe again.
5 Follow your teacher's instructions to clear up the apparatus.

16 States of Matter

Skills
A summary of the practical skills that you will practise are listed at the beginning of each practical.

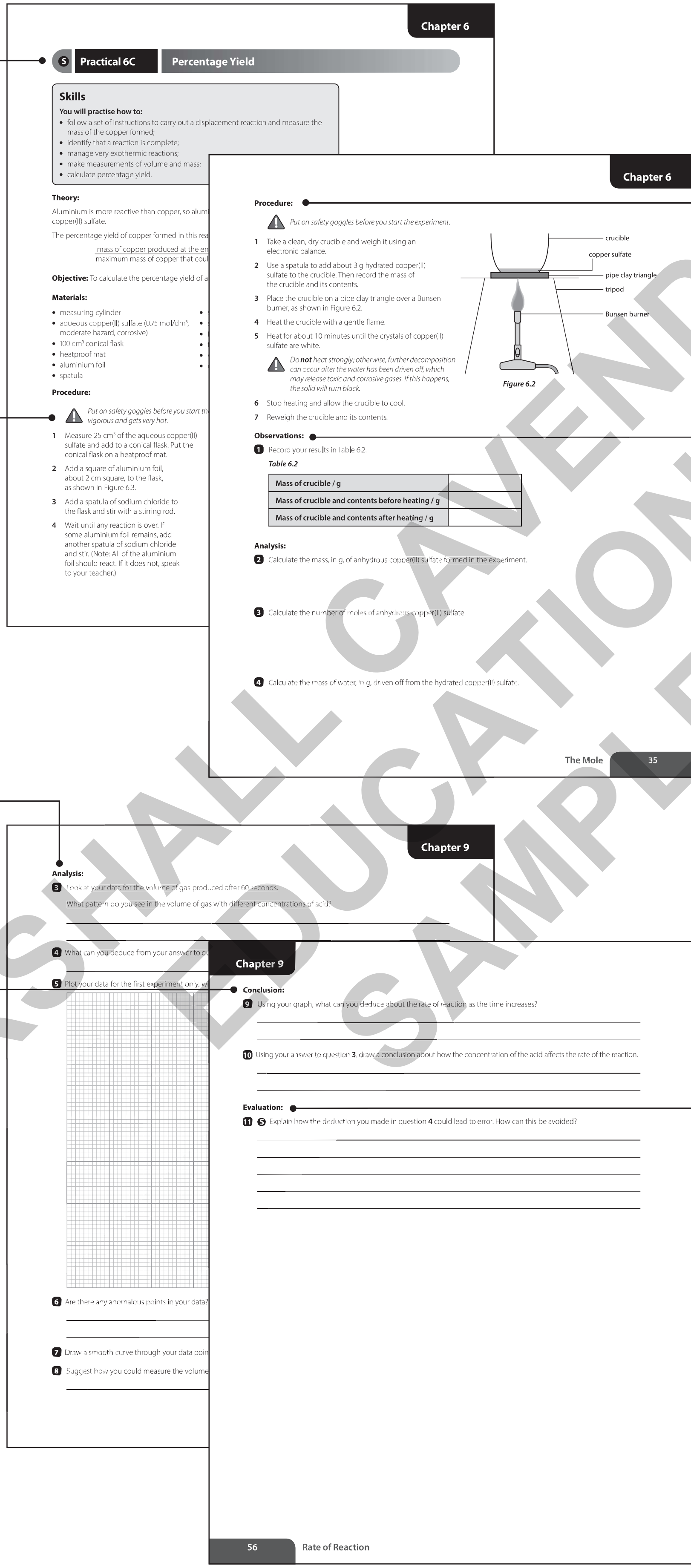
Theory
This gives a brief introduction to the theory behind the practical.

Objective
This states the aim or purpose of the practical.

Materials
This lists the items required for the practical such as apparatus and chemical substances.

Supplement content is clearly marked for those studying the extended syllabus.

Procedure
This lists a series of steps for the practical. Read through the procedure in full at least once before you start, taking particular note of any warnings and safety guidance. Do not start work until you are confident that you have understood everything.



This icon embedded throughout the practicals highlights practical tips for good laboratory practices and potential hazards that you may encounter while doing the practicals.

Observations
This section requires you to record your results, qualitative and/or quantitative.

Analysis and **Conclusion**
Questions are provided to guide you through calculations, drawing of graphs, etc. and help you interpret and evaluate your results in order to form conclusions.

Evaluation
This section is included at the end of most practicals. You will reflect on the practical you have just performed and identify improvements or things you could have done differently.

Contents

The chapters below and the chapter numbering throughout match the chapters of the Student's Book. Not all chapters include practical elements. This is indicated in the contents below.

CHAPTER 1

States of Matter

Practical 1A The Evaporation of Propanone

Skills

You will practise how to:

- follow a set of instructions to measure the temperature change over time as propanone evaporates;
- safely use a flammable liquid;
- measure temperature;
- consider the control of variables;
- plot a graph.

Theory:

Propanone is a liquid with a relatively low boiling point. The evaporation of a liquid absorbs energy.

Objective: To measure the temperature change when a liquid evaporates

Materials:

- thermometer
- cotton wool
- elastic band
- dropping pipette
- 1 cm^3 propanone (flammable, moderate hazard)
- retort stand
- stopwatch

Procedure:

Put on safety goggles before you start the experiment.
Keep propanone away from naked flames.

1 Wrap some cotton wool around the bulb of a thermometer and use an elastic band to hold it in place.

2 Clamp the thermometer as shown in Figure 1.1.

3 Take 1 cm^3 propanone in a dropping pipette and drip it onto the cotton wool.

4 Start the stopwatch and take the temperature. Record this value in Table 1.1.

5 Measure and record the temperature each minute for six minutes.

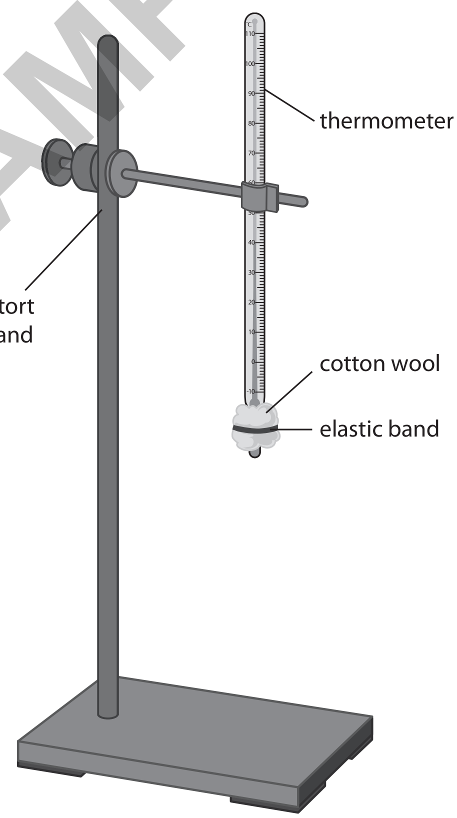


Figure 1.1

Observations:

1 Record your results in Table 1.1.

Table 1.1

Time / min	0	1	2	3	4	5	6
Temperature / °C							

Analysis:

2 Plot a graph of temperature (on the *y*-axis) against time (on the *x*-axis).
Draw a smooth curve of best fit through the plotted points.

3 Estimate from your graph:

(a) the minimum temperature reached

(b) the time taken to reach the minimum temperature

Conclusion:

4 Explain why the temperature at first went down.

5 Explain why the temperature started to rise at the end of the experiment.

Evaluation:

6 Propanone is flammable and presents a moderate hazard to health.
State the safety precautions you should take when using propanone.

7 **(a)** Why should scientists repeat experiments?

(b) Explain what you would have to control if you wanted to repeat this experiment.

8 Plan an experiment to test how airflow affects the rate of evaporation of propanone.

This is a planning exercise but if the experiment is carried out, a full risk assessment will be required.

Practical 1B Diffusion

Skills

You will practise how to:

- Make qualitative observations
- Carefully handle a hazardous solid – potassium manganate(VII)
- Use apparatus to carefully place crystals in an experiment

Theory:

Diffusion is the movement of particles from a region of higher concentration to a region of lower concentration. The particles of a solid, of a liquid and of a gas can all diffuse.
The particles that are in a region of high concentration will spread out and mix with the particles that surround them.

Objective: To observe evidence that diffusion occurs, and to see what affects the rate of diffusion.

Materials:

- petri dish with a layer of agar gel (about 1mm thick; made from about 1g agar powder in 100cm^3 water)
- petri dish
- distilled water
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- kettle
- long glass tube
- clamp and stand
- stoppers
- cotton wool
- potassium manganate(VII) crystals (oxidising, moderate hazard, harmful to the aquatic environment)
- concentrated ammonia solution (corrosive, moderate hazard, harmful to the aquatic environment)
- concentrated hydrochloric acid (corrosive, moderate hazard)

Procedure:

Put on safety goggles before you start the experiment.

Part A – diffusion in a solid and in a liquid:

1. Place a petri dish on the bench and add distilled water with a dropping pipette until the water just covers the surface of the petri dish.
2. Place by the side of the first petri dish another petri dish that has a coating of agar gel.
3. Using tweezers, place one large crystal of potassium manganate(VII) onto each petri dish.
4. Observe the two petri dishes. Leave them while you carry out Part B and Part C, then observe again.
5. Follow your teacher's instructions to clear up the apparatus.

Part B – diffusion in hot and cold liquids:

1 Place two $250cm^3$ beakers side by side on the bench.

Take care of the very hot water used in step 2.

2 Boil a kettle, then add hot water to one of the beakers to about the $200cm^3$ mark.
3 Add about $200cm^3$ cold water to the other beaker.
4 Hold a straw into one of the beakers so that the bottom of the straw touches the bottom of the beaker. Using tweezers, drop one large crystal of potassium manganate(VII) through the straw so that it lands on the bottom of the beaker. Remove the straw. Repeat with the other beaker.
4 Observe the two beakers. Leave them while you carry out Part C, then observe again.
5 Follow your teacher's instructions to clear up the apparatus.

Part C – diffusion in gases:

Your teacher will demonstrate this part. Wear safety goggle and gloves before your start the experiment.

1 Clamp the long glass tube in the centre.

The bottles of the two solutions should only have their stoppers removed for the minimum time needed to soak the cotton wool. Ensure that the soaked cotton wool does not drip.

2 Using tweezers, soak a piece of cotton wool in the concentrated ammonia solution. Place the cotton wool in one side of the glass tube. Stopper the glass tube.
3 Using tweezers, soak a piece of cotton wool in the concentrated hydrochloric acid. Place the cotton wool in other side of the glass tube. Stopper the glass tube.
4 Observe what is formed in the glass tube.

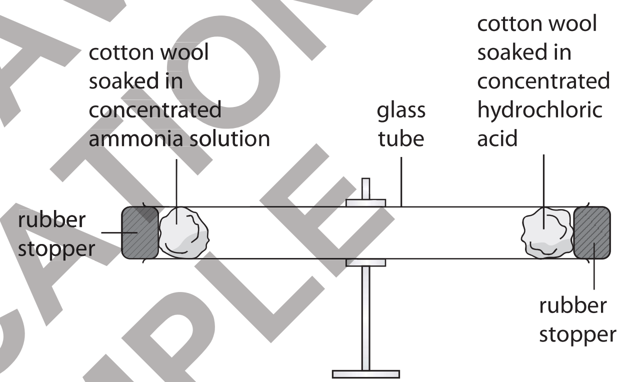

Figure 1.2

Observations

Part A – diffusion in a solid and in a liquid:

1 What was observed in both petri dishes?

2 What is the difference in the observation between the petri dish covered in agar gel and the petri dish containing water?

Part B – diffusion in hot and cold liquids:

3 What was observed in both beakers?

4 What is the difference in the observation between the beaker containing hot water and the beaker containing cold water?

Part C – diffusion in gases:

5 Record what you observed in the glass tube.

6 Where in the glass tube did the observation recorded in **5**. form?

Analysis:

Part A – diffusion in a solid and in a liquid:

7 What can you deduce about diffusion in a solid compared to a liquid?

Part B – diffusion in hot and cold liquids:

8 What can you deduce about diffusion in a hot liquid compared to a cold liquid?

Part C – diffusion in gases:

9 Complete the equation for the reaction between the two substances.

$NH_3 + HCl \rightarrow$ ______

10 Give the name and the state of the substance that caused the observation made in part C.

Conclusion:

11 S The relative mass of the molecules in part C are ammonia: 17, hydrogen chloride: 36.5. Use this data and the observation in **6**. to deduce how the relative mass of particles affects the rate of diffusion.

For over 60 years Marshall Cavendish Education has been empowering educators and students in over 80 countries with high-quality, research-based, Pre-K-12 educational solutions. We nurture world-ready global citizens by equipping students with crucial 21st century skills through our resources for schools and education centres worldwide, including Cambridge schools, catering to national and international curricula.

The *Marshall Cavendish Education Cambridge IGCSE™ Chemistry* series is designed for students preparing for the 0620/0971 syllabuses. The series translates insights from educational psychology classic "How People Learn" into highly effective learner-centred classroom practices.

PWB The **Practical Workbook** is designed to complement the Student's Book and help learners develop necessary investigative and experimental skills. Good laboratory practice is encouraged with safety tips and pointers on good experimental technique, while probing questions test students' understanding of underlying theory and experimental design.

This resource is endorsed by
Cambridge Assessment International Education

- ✓ Provides learner support for the Cambridge IGCSE and IGCSE (9–1) Chemistry syllabuses (0620/0971) for examination from 2023
- ✓ Has passed Cambridge International's rigorous quality-assurance process
- ✓ Developed by subject experts
- ✓ For Cambridge schools worldwide

Series architecture

- Student's Book
- Theory Workbook
- Practical Workbook
- Teacher's Guide
- e-book

ISBN 978-981-4927-98-7
9 789814 927987

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