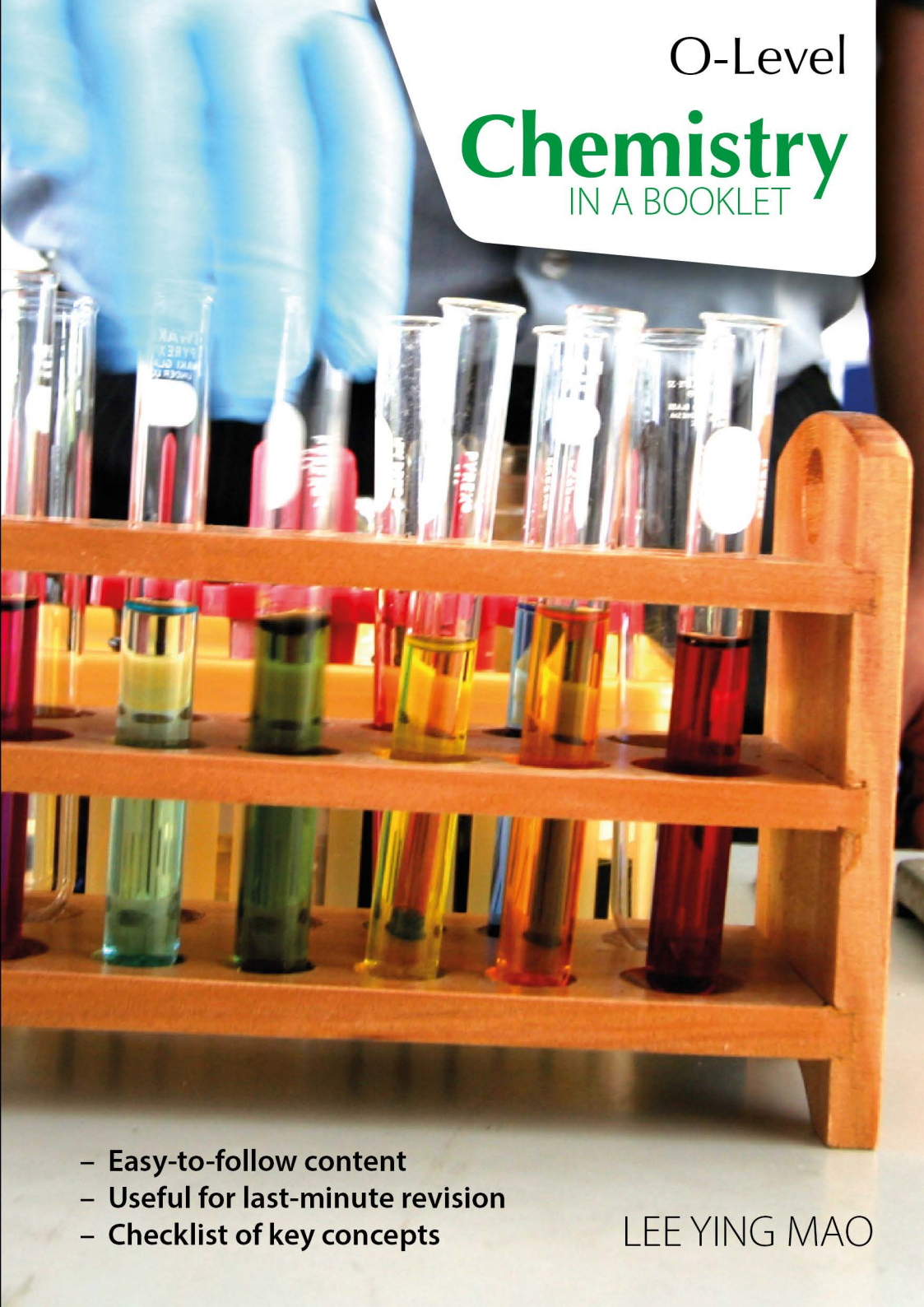

O-Level Chemistry IN A BOOKLET

- Easy-to-follow content
- Useful for last-minute revision
- Checklist of key concepts

LEE YING MAO

O-Level

Chemistry

IN A BOOKLET

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Contents

Preface

From my experience, most students fumble in chemistry primarily because they are unable to connect the key concepts across the different topic areas. To address this issue, I have specially prepared this guide so that you – as a student or as a general reader – are able to better appreciate the logical relationships behind these ideas.

The content of this guide is generally presented in a style similar to what is expected from you at the **GCE O-Level Chemistry examination**. This guide also provides a summary of key concepts aligned to the syllabus requirements.

The syllabus content has been organised into six categories, namely "Experimental Chemistry", "Atomic Structure and Stoichiometry", "Chemistry of Reactions", "Periodicity", "Atmosphere" and "Organic Chemistry". The information contained in this book has been carefully arranged to help you establish the links among the various subtopics from each category.

Warning: This is not a textbook.

While writing this guide, it is assumed that you have adequate knowledge to suggest relevant techniques for chemical analysis and application. This is not a textbook, but a concise reference guide which is filled with a strategic selection of useful information. Pure reliance on this guide without proper understanding of the underlying concepts is inadvisable.

Throughout this guide, the words and phrases which examiners are looking out for are printed in **bold type**. An index of key terminology is included at the end of each chapter to help you locate information more efficiently. The summary checklist at the back of this guide may be something of significance to you, covering important definitions and giving you an overview of the required concepts.

Every student has a different learning style. While efforts have been made to maintain a neutral style in this guide, it is recommended for you to make this book a more personalised copy. Pick up a highlighter, annotate along the margins or affix some colourful sticky flags. Let yourself know where to place more focus on for your revision.

Ask when lost; clarify when in doubt.

Lastly, special thanks goes out to Wei Jie for making this guidebook possible, to Dina and Siyuan for their valuable feedback and inputs, as well as those who have contributed in one way or another.

– Lee Ying Mao

5 Atmosphere

5.1 Air

Air is a mixture of several gases. It contains nitrogen (78%), oxygen (21%), argon (0.9%), carbon dioxide and other gases.

Liquified air can be separated into its constituents by fractional distillation. This process is especially important for obtaining nitrogen and oxygen.

5.1.1 Air Pollution

Air pollution has harmful effects on buildings, human health, plant life and aquatic life. Common atmospheric pollutants include carbon monoxide, methane, nitrogen oxides, ozone, sulfur dioxide and unburnt hydrocarbons.

Table 5.1 summarises the sources of common atmospheric pollutants and their harmful effects.

Pollutant	Sources	Effects
Carbon monoxide	Incomplete combustion of fuels	Causes breathing difficulties and even death
Oxides of nitrogen	Lightning activity and internal combustion engines	Contributes to acid rain

Pollutant	Sources	Effects
Sulfur dioxide	Volcanic eruptions and combustion of fossil fuels	Contributes to acid rain

Table 5.1 - Common Atmospheric Pollutants, Sources and Effects

5.1.2 Acid Rain

Acid rain is formed when oxides of nitrogen and sulfur dioxide dissolve in rainwater to form nitric acid and sulfurous acid respectively. When sulfurous acid is exposed to oxygen in the air, it will be oxidised to sulfuric acid (H_2SO_4).

$$SO_2\,(g) + H_2O\,(l) \rightarrow H_2SO_3\,(aq)$$

$$4\,NO_2\,(g) + 2\,H_2O\,(l) + O_2\,(g) \rightarrow 4\,HNO_3\,(aq)$$

Acid rain reacts with the exterior of buildings made from metal or marble. It is also harmful to aquatic life and reacts with important nutrients in the soil which are essential for plant growth.

5.1.3 Reducing Air Pollution

Possible ways to reduce the emission of pollutants include the usage of catalytic converters and the flue gas desulfurisation process.

Catalytic Converters

Redox reactions occur in the **catalytic converter** when hot exhaust gases are passed over the catalysts. This converts oxides of nitrogen, carbon monoxide and unburnt hydrocarbons into cleaner gases, namely nitrogen, carbon dioxide and water vapour.

$$2\,NO\,(g) + 2\,CO\,(g) \rightarrow N_2\,(g) + 2\,CO_2\,(g)$$

$$C_3H_8\,(s) + 5\,O_2\,(g) \rightarrow 3\,CO_2\,(g) + 4\,H_2O\,(g)$$

Flue Gas Desulfurisation

The **flue gas desulfurisation** process involves the reaction of sulfur dioxide with a suspension of calcium oxide or calcium carbonate to form solid calcium sulfite.

$$CaO\ (s) + SO_2\ (g) \rightarrow CaSO_3\ (s)$$

$$CaCO_3\ (s) + SO_2\ (g) \rightarrow CaSO_3\ (s) + CO_2\ (g)$$

Calcium sulfite is further oxidised to calcium sulfate by atmospheric oxygen. The solid waste product can be easily disposed.

$$2\ CaSO_3\ (s) + O_2\ (g) \rightarrow 2\ CaSO_4\ (s)$$

5.1.4 Ozone Layer

Ozone (O_3) is formed by the photochemical reactions between atoms and molecules of oxygen in the atmosphere.

The ozone layer helps reflect some of the harmful ultraviolet radiation from the sun. Ultraviolet radiation increases the risks of skin cancer, genetic mutations and eye damage.

However, the use of **chlorofluorocarbons** (or CFCs) is causing the depletion of the ozone layer. This is because CFCs decompose under sunlight to produce chlorine atoms, which in turn react with ozone to form chlorine oxide (ClO) and oxygen (O_2).

5.1.5 Carbon Cycle

The **carbon cycle** outlines the mechanism involved in maintaining a constant level of carbon dioxide in the atmosphere.

Respiration and combustion produces carbon dioxide while photosynthesis removes carbon dioxide.

5.1.6 Greenhouse Gases

Greenhouse gases include carbon dioxide, methane and nitrous oxide. They are responsible for the greenhouse effect, which refers to the warming effect when energy (e.g. infrared radiation) is retained in the atmosphere by greenhouse gases.

Increasing the concentration of greenhouse gases in the atmosphere intensifies the greenhouse effect. This in turn contributes to global warming. The negative effects of global warming include desertification, worldwide decrease in crop yields and the melting of large quantity of polar ice which causes floods in low-lying regions.

Index

Checklist

Monitor the progress of your revision with this concise checklist and mark out the various topic areas which need just that little extra bit of attention.

1 Experimental Chemistry

- ❑ Identify the **SI units** of the commonly measured quantities in experimental chemistry.
- ❑ Identify the appropriate **apparatuses** used to measure the quantitative properties in an experiment.
- ❑ Describe the appropriate techniques used to collect different types of gases, including **water displacement**, **upward delivery** and **downward delivery**.
- ❑ Describe tests used to identify common **cations** based on observations from their chemical reactions with aqueous sodium hydroxide and aqueous ammonia.
- ❑ Describe tests used to identify common **anions** based on observations from their chemical reactions with carbonate, chloride, iodide, nitrate and sulfate solutions.
- ❑ Describe tests used to identify common **gases** including ammonia, carbon dioxide, chlorine, hydrogen, oxygen and sulfur dioxide.

1.1 Separation Techniques

- ❑ Identify the relationship between **solute**, **solvent** and **solution**.
- ❑ Describe the appropriate techniques used to separate and purify different types of mixtures, including
  - Filtration
  - Evaporation to dryness
  - Crystallisation
  - Simple distillation
  - Fractional distillation
  - Use of separating funnel
- ❑ Describe **paper chromatography** and its significance, including the use of **R_f values** to compare the constituents of a soluble mixture with known samples.

1.2 Purity

- ❑ Distinguish between **pure** and **impure** substances.
- ❑ Describe **impurities** as substances that decrease the melting point but increase the boiling point of another substance.
- ❑ Deduce the **purity** of substances from boiling and melting points.

2 Atomic Structure and Stoichiometry

- ❑ Define an **atom** as the simplest unit of an element.
- ❑ Define **isotopes** as atoms of the same elements containing the same number of protons but different number of neutrons.
- ❑ Describe **protons**, **electrons** and **neutrons** as **sub-atomic particles**.
- ❑ Describe **proton number** (or atomic number) as the number of protons in the nucleus of an atom.
- ❑ Describe **nucleon number** (or mass number) as the total number of protons and neutrons in the nucleus of an atom.
- ❑ Determine the chemical properties of an atom based on its **electronic configuration**.