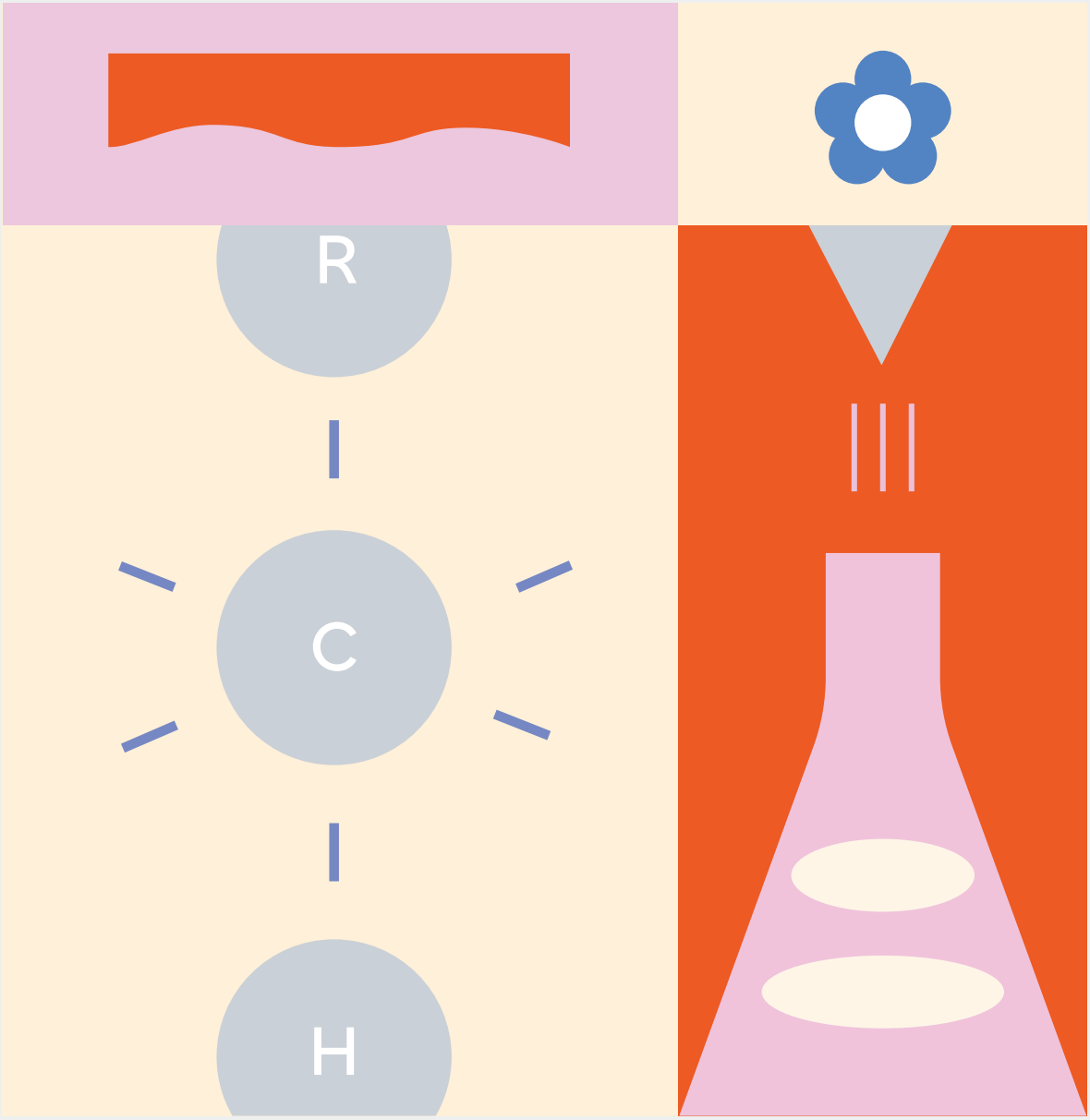
國中自然領域

雙語教學資源手冊 化學科英語授課用語

A Reference Handbook for Junior High School Bilingual Teachers in the Domain of Natural Sciences (Chemistry): Instructional Language in English

〔國中八年級〕



國立彰化師範大學雙語教學研究中心 發行

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★主題一 物質的基本結構★
The Basic Structure of Substance

國立彰化師範大學化學系　方宣幃、邱韋慈
國立彰化師範大學英語系　劉俊億、徐毓瑩

■ 前言 Introduction

學生在本學期第二單元已學會區分「純物質和混合物」。在本章節中，教師更深入地介紹純物質包括元素與化合物，並認識元素與化合物有特定的化學符號表示法。藉由實驗讓學生認識生活中常見元素的性質及生活上的應用。以原子模型的發展讓學生認識科學史上重要發現的過程，以及不同性別、背景、族群者於其中的貢獻，介紹原子說知道化學反應是原子重新排列。教師以週期表讓學生認識元素的性質有規律性和週期性。最後進一步了解分子與化學式，說明原子與分子的關係。

在學生參與課堂的過程中，需要透過學習建議的專有詞彙，有利於未來以物質作為基礎的化學課程進行。建議老師在課程中多以「對比、舉例」以及比較級與最高級等功能之句型，以利師生間的提問與發表，並了解專有詞彙定義。

1-1 元素與化合物
Elements and Compounds

■ 前言 Introduction

本節的教學重點為帶學生認識純物質包括元素與化合物，及讓學生了解元素與化合物有特定的化學符號表示法。

本節老師要注意以簡單的短句介紹元素與化合物的觀念，並建議多舉例讓學生運用比較功能的句型來了解元素與化合物的定義。

■ 詞彙 Vocabulary

單字	中譯	單字	中譯
glucose	葡萄糖	calcium	鈣
carbon	碳	compound	化合物
sodium	鈉	mixture	混合物
chlorine	氯	pure substance	純物質
sodium chloride	氯化鈉	oxygen	氧
chromium	鉻	element	元素

■ 教學句型與實用句子 Sentence Frames and Useful Sentences

❶ _____. However, _____.

例句：Compounds are pure substances that can be chemically decomposed into other substances. **However,** elements are pure substances that cannot be chemically decomposed into other substances.

化合物是可以用化學方法分解出其他物質的純物質，然而，元素是不行用化學方法分解出其他物質的純物質。

❷ _____, while _____.

例句：Sodium chloride is a compound composed of a sodium element and a chlorine element, **while** the properties of the three are not the same.

氯化鈉是由鈉元素以及氯元素組成的化合物，但是三者性質都不相同。

❸ _____ is named after _____.

例句：In Chinese, every substance **is named after** its different forms at normal temperature and pressure, and then expressed by its radical.

中文命名方式是以各元素在常溫常壓下所呈現不同的狀態，再以不同的部首表示。

❹ _____ gets its name from _____.

例句：Some elements of symbols **get their name from** Latin, Greek, or English.

一些符號元素的名稱來自拉丁語、希臘語或英語。

■ 問題講解 Explanation of Problems

☙ 學習目標 ❧

一、我們利用心智圖了解物質分為純物質與混合物，純物質又分為元素與化合物。
二、我們利用文字的部首來教學生辨認元素在常溫常壓下之狀態。
三、我們可以以英語短句來向學生提問，並且在短句中給學生定義元素與化合物，以確保學生了解。
四、我們可以先提供簡答句或是是非句型讓學生回答，再問學生為什麼(Why)來確保學生會以更確定及更自信發言的方式講解他的看法。

☙ 例題講解 ☙

例題一

說明：學生只要知道元素無法用一般化學方法分解出其他物質，而化合物可以，就能順利完成題目。

Students can solve the problem as long as they know elements cannot be decomposed into other matters by ordinary chemical methods but compounds can.

（英文）Which of the following can be decomposed into other matters by general chemical methods?
(A) Nitrogen
(B) Water
(C) Gold
(D) Magnesium

（中文）下列何者能用一般化學方法分解出其他的物質？
(A) 氮氣
(B) 水
(C) 金
(D) 鎂帶　（翰林版教學式講義國中自然 3）

解題 Solution:

元素不可再分解成其他物質，而化合物可以，故選(B)。

Elements can no longer be decomposed into other matters, but compounds can, so choose (B).

Teacher: What are the key ideas for this question?

Student: It can be decomposed by chemical methods.

Teacher: Yes, is the matter that can be decomposed by chemical method an element or a compound?

Student: Compounds.

Teacher: Then, which one of the following options is compound?

Teacher: Probably (B).

Student: Yes.

老師： 請問這一題的關鍵字為何？

學生： 能用化學方法分解。

老師： 對的，那能用化學方法分解的物質是元素還是化合物？

學生： 化合物。

老師： 那選項哪一個是化合物？

老師： 可能是(B)。

學生： 沒錯。

例題二

說明：學生只要知道固態、液態、氣態的元素中文名稱之命名方式，即可完成此題。
Students can solve the problem as long as they know how to name elements of solid, liquid, and gas in Chinese.

（英文）Mg、C、Br、Hg、Al、H、He. How many are liquid elements at room temperature?

（中文）鎂、碳、溴、汞、鋁、氫、氦；請問元素在常溫等下壓為液態的數目為何？

(A) 4
(B) 5
(C) 1
(D) 2　（翰林版教學式講義國中自然 3）

解題 Solution:
部首有「水」的只有溴和汞，可知此兩種元素為液態，故選(D)。
The only radicals with "water" are bromine and mercury, which shows that these two elements are liquid, so choose (D).

Teacher: What are the key ideas for this question?
Student: Liquid element.
Teacher: Yes, how do you determine the state of the elements?
Student: Radicals.
Teacher: That's right, therefore, what radical should we look for for liquid elements?
Student: "Water" radicals.
Teacher: Great, who are the liquid elements among the options?
Student: Mercury and Bromine.

老師：　請問這一題的關鍵字為何？
學生：　液態元素。
老師：　對的，那該如何判斷元素的狀態？
學生：　部首。
老師：　沒錯，所以液態元素要找什麼部首？
學生：　「水」部。
老師：　很好，所以選項中有誰為液態元素？
學生：　汞和溴。

1-2 生活中常見的元素
Common Elements in Life

■ 前言 Introduction

本節之教學重點在於介紹元素性質及常見的金屬元素和非金屬元素在生活上的應用，教師應舉較貼近學生生活的例子，有助學生的理解和學習。

本節老師要注意以簡單的語言描述各常見元素的特性，先要求學生認識個元素及化合物，再套用本節的句型讓學生了解元素與化合物的定義。

■ 詞彙 Vocabulary

單字	中譯	單字	中譯
coal	煤炭	metal	金屬
nonmetal	非金屬	silicon	矽
conductor	導體	silicon wafer	矽晶圓
copper	銅	graphite	石墨
sulfur	硫	graphene	石墨烯
aluminum	鋁	diamond	鑽石
mercury	汞	malleability	延展性
gold	金		

■ 教學句型與實用句子 Sentence Frames and Useful Sentences

❶ _____ is the only _____.

例句：Bromine **is the only** liquid non-metal element.

溴是唯一的液態非金屬元素。

❷ _____ is the most _____. /_____ is the _____-est _____.

例句：Gold **is the most** malleable metal.

金是延展性最高的金屬。

❸ For example/instance, _____.

例句：**For example/instance**, copper is a common pure substance.

舉例來說，銅是常見的純物質。

■ 問題講解 Explanation of Problems

學習目標

一、我們利用觀察金屬與非金屬，了解其差異和通性。

二、我們利用生活中的物質引導學生認識常見的金屬和非金屬的性質及用途。

三、我們可以以英語短句來向學生提問，並且在短句中給學生充分定義金屬與非金屬，以確保學生了解。

四、我們可以先提供簡答句或是是非句型讓學生回答，再問學生為什麼(Why)來確保學生會以更確定及更自信發言的方式講解他的看法。

例題講解

例題一

說明：學生只要了解金屬元素和非金屬元素的通性，即可完成題目。
Students can solve the problem as long as they know general properties of metal elements and nonmetal elements.

（英文）There is an unknown substance, which is glossy and malleable in appearance, with good electrical and thermal conductivity. Which may be this substance?

(A) metal

(B) nonmetal

（中文）有一未知物質，外觀具有光澤，此物質同時具有延展性、良好的導電性和導熱性，請問這一個物質可能為何？

(A) 金屬

(B) 非金屬

（翰林版教學式講義國中自然 3）

解題 Solution:

金屬具有金屬光澤且有良好的延展性、導電性、導熱性，故選(A)。

Metal has a metallic luster and has good ductility, electrical conductivity, and thermal conductivity, so select (A).

Teacher: What are the keywords in this question?

Student: Gloss, electrical conductivity, thermal conductivity, ductility.

Teacher: Yes, is it metal or non-metal with these characteristics?

Student: Metal.

老師： 請問這一題的關鍵字為何？

學生： 光澤、導電性、導熱性、延展性。

老師： 沒錯，請問有這些特性的是金屬還是非金屬？

學生： 金屬。

例題二

說明：學生只要知道常見元素的性質及基本常識即可完成此題。Students can solve the problem as long as they know the properties and basic knowledge of common elements.

（英文）Which of the following is a wrong statement?

(A) Aluminum is the most abundant metal element in the earth's crust.

(B) Silicon is the most abundant element in the earth's crust.

(C) Graphite and diamond are allotropes. (A chemical element can exist in two or more separate physical forms.)

(D) Gold is the most malleable of all metals.

（中文）根據下列敘述何者錯誤？

(A) 鋁是地殼中含量最豐富的金屬元素。

(B) 矽在地殼中含量是最多的。

(C) 石墨和鑽石為同素異形體。

(D) 金有最佳的延展性。　（翰林版教學式講義國中自然 3）

解題 Solution:

答案為(B)，因為矽在地殼中含量僅次於氧，而不是最多的。

The answer is (B) because the content of silicon in the earth's crust is second only to oxygen, not the most.

Teacher: Is aluminum the most abundant metal element in the earth's crust?
Student: Yes.
Teacher: Yes, I would like to ask whether the content of silicon in the earth's crust is the most?
Student: No.
Teacher: How should I amend this answer?
Student: We should turn “Silicon is the most abundant in the earth's crust” to “the content of silicon in the earth's crust is second only to oxygen”.

老師： 請問鋁是否為地殼中含量最豐富的金屬元素？
學生： 是。
老師： 沒錯，請問矽是否在地殼中含量是最多的？
學生： 不對。
老師： 那請問應該如何更改此選項才會讓他變成正確的答案？
學生： 要將「矽在地殼中含量是最多的」改成「矽在地殼中含量僅次於氧」才對。

1-3 物質結構與原子
Structure of Substances and Atoms

■ 前言 Introduction

本節將介紹科學史上重要發現的過程，以及不同性別、背景、族群者於其中的貢獻，並希望學生能理解原子相關概念的歷史演進。過程中，學生應該要學習到不同科學家提出的原子模型的發展，在原子說的部分教師應讓學生了解化學反應是原子重新排列，教學過程中也要為學生建立原子結構，包括質量數及原子序的概念。

建議老師可以以表達組成的句型來引導學生了解各個科學家所發現原子的組成結構。可以嘗試以簡短的對話來引導學生進行角色扮演活動。

■ 詞彙 Vocabulary

單字	中譯	單字	中譯
electron	電子	atom	原子
Dalton	道耳頓	Atomic Theory	原子說
isotope	同位素	proton	質子
Thomson	湯姆森	neutron	中子
Rutherford	拉塞福	Chadwick	查兌克
structure	結構		

■ 教學句型與實用句子 Sentence Frames and Useful Sentences

❶ It is possible that _____.

例句：**It is possible that** there are no neutrons in an atom.
一個原子內可能沒有中子。

❷ ____ consists of _____.

例句：A substance **consists of** a certain number of protons, neutrons, and neutrons.
物質由特定數量的質子、中子與電子組成。

❸ ____ can be made up of ____. = ____ can be composed of ____.

例句：The nucleus **can be composed of** positively-charged protons and neutrons.
原子核中由帶有正電的質子與不帶電的中子組成。

❹ I found that _____.

例句：**I found that** an element and its isotope have the same number of protons.
我發現物質與其同位素有一樣數量的質子。

■ 問題講解 Explanation of Problems

學習目標

一、我們講解原子的發展故事，讓學生了解原子說和原子結構（電子、質子及中子）。
二、我們可以以英語短句向學生提問，並且在短句中給學生充分解釋原子結構，以確保學生了解。
三、我們可以先提供簡答句或是是非句型讓學生回答，再問學生為什麼(Why)來確保學生會以更確定及更自信發言的方式講解他的看法。

例題講解

例題一

說明：學生只要知道原子理論歷史發展的順序及其內容，即可完成題目。

Students can solve the problem as long as they know the order and content of the historical development of atomic theory.

（英文）Based on the time sequence, please put the following findings about atoms into the right order:

A. Dalton's Atomic Theory

B. Rutherford's Atomic Model

C. Thomson's findings of neutrons

(A)ABC　(B)BAC　(C)CAB　**(D)ACB**

（中文）請根據提出時間的先後，將甲、乙、丙三項事實依序排列：

甲、道耳頓提出原子說；乙、拉塞福提出原子模型；丙、湯木生發現電子

(A)甲乙丙　(B)乙甲丙　(C)丙甲乙　**(D)甲丙乙**

（改編自 https://www.phyworld.idv.tw/Nature/Jun_2/htm/UNIT_3/05.htm）

解題 Solution:

甲、道耳頓提出原子說（西元 1803 年）

乙、拉塞福提出原子模型（西元 1909 年）

丙、湯木生發現電子（西元 1904 年）

A. Dalton's Atomic Theory (1803 A.D.)

B. Rutherford's Atomic Model (1909 A.D.)

C. Thomson's findings of neutrons (1904 A.D.)

Teacher: When did Dalton launch his Atomic Theory?

Student: In the 19th century.

Teacher: When did Rutherford launch his Atomic Model?

Student: In the 20th century.

Teacher: How about Thomson's findings of neutrons?

Student: Also in the 20th century.

Teacher: Which one is farther from now, Rutherford's Atomic Model or Thomson's findings of neutrons?

Student: I guess it is Thomson's findings of neutrons.

Teacher: That's right. Rutherford introduced the Atomic Model in 1909 and Thomson found neutrons in 1904.

老師： 道耳頓何時發表他的原子理論？
學生： 在 19 世紀。
老師： 拉塞福何時提出原子模型？
學生： 在 20 世紀。
老師： 湯木生何時發現電子？
學生： 也是在 20 世紀。
老師： 是拉塞福先提出原子模型，還是湯木生先發現電子？哪個比較早？
學生： 我猜是湯木生先發現電子。
老師： 對的。拉塞福在西元 1909 年提出原子模型，而湯木生在西元 1904 年發現電子。

例題二

說明：學生只要能知道道耳頓提出原子說，即可完成此題。
Students can solve the problem as long as they know the atomic theory proposed by Dalton.

（英文）Which of the following statements is not included in Dalton's Atomic Theory?

(A) Atoms are the smallest particles of which an element consists.

(B) An atom can be divided into atomic nucleus and valence electrons.

(C) The same elements are with the same number, mass and size of atoms.

（中文）以下各項敘述，何者不屬於道耳頓原子說的內容？

(A) 原子為組成所有物質的最小粒子

(B) 原子可再分割原子核及外圍電子

(C) 相同元素的原子，原子質量與大小均相同

（改編自 https://www.phyworld.idv.tw/Nature/Jun_2/htm/UNIT_3/05.htm）

解題 Solution:：

道耳頓不知原子可以分割。

Dalton still did not know that an atom can be divided into smaller parts.

Teacher: What about atoms did Dalton introduce?

Student: He introduced the theory that elements consist of indivisible atoms and that all atoms of the same element are of the same number, mass, and size.

Teacher: What else?

Student: He also included the fact that that atoms can neither be created nor destroyed.

Teacher: So, he did not know that an atom can be divided into smaller parts, right?

Student: Yes.

Teacher: Therefore (B) will be the answer.

老師： 道耳頓有提出什麼關於原子的理論？

學生： 他提出物質由不可分割的原子組成，還有相同元素的原子，其原子質量與大小均相同。

老師： 還有其他的嗎？

學生： 他也提出原子無法被創造或毀壞。

老師： 所以他沒發現原子可以被分割成更小單位，對吧？

學生： 對的。

老師： 所以答案是(B)。

1-4 週期表
Periodic Table

■ 前言 Introduction

本節將介紹門得列夫如何由元素的規律性和週期性發現元素週期表及其貢獻，並讓學生了解元素的性質有規律性和週期性。

老師以先以中文帶領學生認識元素週期表，確認學生理解後，再提出以下描述關係與位置的英文句型，待同學透過例句學會用法後，可套用不同的元素名稱、週期表上不同的族群、不同的化學性質，讓同學練習造樣造句，最終可以讓學生試著用英語解釋或描述元素週期表。

■ 詞彙 Vocabulary

單字	中譯	單字	中譯
crust	地殼	alkali metal group	鹼金屬族
halogen	鹵素	alkaline earth metal group	鹼土金屬族
mineral oil	礦物油	periodic table	週期表
activity	活性	precipitation	沉澱
group	族	noble gas	鈍氣

■ 教學句型與實用句子 Sentence Frames and Useful Sentences

❶ _____ all of them _____

例句：Lithium, Sodium, and Potassium react violently with water, so **all of them** are alkali metals.
鋰、鈉和鉀與水反應劇烈，所以他們都是活性大的金屬。

❷ both _____ and _____

例句：**Both** Iron **and** Copper are common metals in daily life.
鐵和銅都是生活中常見的金屬。

❸ _____ be arranged by _____.

例句：The periodic table **is arranged by** atomic number.
週期表由原子序大小排列。

❹ the row/column of _____

例句(1)：**The rows of** the table are called periods.
週期表的橫列稱為週期。

例句(2)：**The columns of** the table are called groups.
週期表的縱行稱為族。

■ 問題講解 Explanation of Problems

學習目標

一、我們利用元素週期表讓學生了解其元素的規律性和週期性。
二、我們利用元素週期表介紹不同族元素的化學性質。
三、我們可以以英語短句向學生提問，並且在短句中給學生足夠的敘述，以確保學生了解。
四、我們可以先提供簡答句或是是非句型讓學生回答，再問學生為什麼(Why)來確保學生會以更確定及更自信發言的方式講解他的看法。

例題講解

例題一

說明：學生只要能了解元素週期表縱行與橫列代表的意義，即可完成此題。
Students can solve this problem as long as they understand the meaning of the row and column of the periodic table.

（英文）Which of the following statements about the modern periodic table is false?

(A) The columns of the table are called groups.

(B) The rows of the table are called periods.

(C) Elements from the same period of the periodic table show similar chemical characteristics.

(D) The periodic table is arranged by atomic number.

（中文）下列關於現代元素週期表的敘述何者錯誤？

(A) 週期表的縱行稱為族

(B) 週期表的橫列稱為週期

(C) 同一週期的元素化學性質相同

(D) 週期表由原子序大小排列

解題 Solution:

同一族的元素化學性質相同，故(C)選項錯誤。

Elements from the same group of the periodic table show similar chemical characteristics, so (C) is false.

Teacher: What is the modern periodic table arranged by?
Student: Atomic number.
Teacher: What are the rows of the periodic table called?
Student: Period.
Teacher: What are the columns called?
Student: Group.
Teacher: Do elements from the same period or group show similar chemical characteristics?
Student: Same group.
Teacher: Therefore (C) is false.

老師：　現代元素週期表是以什麼大小排列？
學生：　原子序。
老師：　週期表的橫列稱為什麼？
學生：　週期。
老師：　縱行稱為什麼？
學生：　族。
老師：　同一週期還是族的元素化學性質相同？
學生：　同一族。
老師：　所以(C)選項是錯的。

例題二

說明：學生只要能認識元素週期表中不同族的元素和化學性質，即可完成題目。
Students can solve this problem as long as they recognize different groups and their chemical properties in the periodic table.

（英文）Which of the following elements will react with water similarly to lithium?

(A) Non-metallic elements of the same group as argon
(B) Non-metallic elements of the same period as argon
(C) Metal elements of the same group as potassium
(D) Metal elements of the same period as potassium

（中文）下列哪一類的元素碰到水會和鋰與水的反應相似？

(A) 與氬同一族的非金屬元素都會
(B) 與氬同一週期的非金屬元素都會
(C) 與鉀同一族的金屬元素都會
(D) 與鉀同一週期的金屬元素都會

（修改自 104 年會考）

解題 Solution:

同一族的化學性質相同，鋰屬於鹼金屬，同樣屬於鹼金屬的元素有鈉、鉀。

Elements from the same group show similar chemical characteristics. Lithium is an alkali metal, and the elements that also belong to the alkali metal are sodium and potassium.

Teacher: Do elements from the same period or group show similar chemical characteristics?
Student: Same group.
Teacher: What are the elements of the same group as lithium?
Student: Sodium and potassium.

老師： 同一週期還是族的元素化學性質相同？
學生： 同一族。
老師： 與鋰同一族的元素有哪些？
學生： 鈉和鉀。

1-5 分子與化學式
Molecules and Chemical Formulas

■ 前言 Introduction

本章節教師可以從簡單的模型或符號說明原子與分子的關係，最後讓學生認識常見的化學式，並學會化合物特定的化學符號表示法。

在本章 6-3 時已學過「由…所組成」的用法，因此在本節區分純物質、混合物、元素、化合物時可以多加利用，並同時搭配「將…分為」和比較差異的句型。最後老師可以搭配簡報，使用簡單的描述句，介紹化學式的通則。

■ 詞彙 Vocabulary

單字	中譯	單字	中譯
proportional	比例的	mixture	混合物
molecule	分子	pure substance	純物質
molecular	分子的	oxygen	氧氣
inert gas	惰性氣體	atomic group	原子團
chemical formula	化學式	carbon dioxide	二氧化碳

■ 教學句型與實用句子 Sentence Frames and Useful Sentences

❶ _____ be further classified as _____.

例句：Pure substances can **be further classified as** elements and compounds.
純物質可分為元素和化合物。

❷ _____ be written first _____.

例句：The name of the metal should **be written first** in salt.
在鹽類中要先寫金屬的名稱。

❸ the difference between _____ and _____

例句：**The difference between** elements **and** compounds lies in the type of atoms.
元素和化合物的差別在於組成原子的種類。

❹ _____ be piled up by _____.

例句：Metal elements **are piled up by** a single type of atom.
金屬元素由單一類型的原子所堆疊而成。

■ 問題講解 Explanation of Problems

學習目標

一、我們利用道耳頓原子說讓學生了解原子與分子的概念。
二、我們利用元素符號及數字表示原子與分子的化學式。
三、我們可以以英語短句來向學生提問，並且在短句中充分說明原子與分子的概念，以確保學生了解。
四、我們可以先提供簡答句或是是非句型讓學生回答，再問學生為什麼(Why)來確保學生會以更確定及更自信發言的方式講解他的看法。

例題講解

例題一

說明：學生只要能了解物質組成的微觀形式及週期表的元素性質，即可完成題目。
Students can solve the problems as long as they understand the microform of material composition and the properties of elements in the periodic table.

（英文）Which of the following statements does not match the current particle viewpoint?

(A) Oxygen consists of two oxygen atoms, so it is an element.

(B) Helium is an element and an inert gas.

(C) Elements consist of a single type of atom.

(D) The smallest particles that can present the chemical properties of substances are elements.

（中文）下列哪一項敘述不符合目前的粒子觀點？

(A) 氧氣由兩個氧原子組成，所以是元素

(B) 氦氣是一種元素，也是一種惰性氣體

(C) 元素是由單一種原子所組成

(D) 能表現純物質化學性質的最小粒子是元素

（改編自南一版教師手冊第 273-5 頁）

解題 Solution:：

分子是能表現物質化學性質的最小粒子，故(D)選項錯誤。

Molecules are the smallest particles that can present the chemical properties of substance, so (D) is false.

Teacher: What is the difference between elements and compounds?

Student: Elements consist of a single type of atom, and compounds compose different atoms.

Teacher: Yes, so (C) is correct. Is it true that oxygen consists of two oxygen atoms?

Student: Yes, it is true.

Teacher: So (A) is correct. What is an inert gas?

Student: Inert gas is an element that exists as a monatomic substance.

Teacher: Yes. Helium is an inert gas, so (B) is correct. Why is (D) incorrect.

Student: The smallest particles that can present the chemical properties of substances are molecules.

Teacher: Therefore (D) is false.

老師：　元素和化合物的區別是什麼呢？
學生：　元素由一種原子所組成，而化合物由不同種類的原子所組成。
老師：　是的，所以(C)是正確的。請問氧氣只由兩個氧原子所組成是正確的嗎？
學生：　是的。
老師：　所以(A)是正確的。那什麼是惰性氣體？
學生：　惰性氣體是以單原子物質存在的元素。
老師：　是的，而氦氣是種惰性氣體，故(B)是正確的。那(D)選項為何錯誤？
學生：　能表現物質化學性質的最小粒子是分子。
老師：　是的，所以這題答案選(D)。

例題二

說明：學生只要知道化學式的書寫通則及判讀化學式中元素符號及數字代表的涵意，即可完成此題。

Students can solve the problem as long as they know the general rules of writing chemical formulas and interpret the meaning of element symbols and numbers in chemical formulas.

（英文）According to the general rules of chemical formula, Which of the following statements about the chemical formula is wrong?

(A) CO_2 represents carbon dioxide, which consists of a carbon atom and two oxygen atoms.

(B) Silver is piled up by many atoms, so it is represented in Agn, and n means there are many atoms.

(C) Metal elements are often written first and followed by nonmetal elements, so the chemical formula of sodium chloride is NaCl.

(D) $5H_2O$ represents that there are five water molecules.

（中文）依據化學式的通則，下列有關各化學式的敘述何者錯誤？

(A) CO_2 表示二氧化碳分子，由一個碳原子和兩個氧原子所組成。

(B)銀金屬由很多原子堆疊而成，因此以 Agn 表示，n 表示有很多原子。

(C) 鹽類的為金屬陽離子加上非金屬陰離子，金屬元素常寫在非金屬元素前面，因此氯化鈉的化學式寫為 NaCl。

(D) $5H_2O$ 表示有五個水分子。

（改編自翰林版 6-5 簡報）

解題 Solution:

金屬元素直接以元素符號表示，銀的化學式寫成 Ag。故答案為(B)。

Metal elements are directly represented by element symbols. The chemical formula of silver is written as Ag, so the answer is (B).

Teacher: Are metal elements piled up by a single type of atom?

Student: Yes, they are.

Teacher: Do we need to write an n to indicate that there are many atoms in metal?

Student: No, we don't.

Teacher: How do we write the chemical formula of metal elements?

Student: We can simply represent it by the symbol of the element.

老師： 請問金屬元素是由單一種原子堆疊而成的嗎？

學生： 是。

老師： 那金屬元素的化學式需要寫一個 n 表示有很多原子嗎？

學生： 不需要。

老師： 那金屬元素的化學式要如何寫呢？

學生： 直接以元素符號表示。

★主題二 化學反應★
Chemical Reaction

國立彰化師範大學化學系　方宣幃、邱韋慈
國立彰化師範大學英語系　劉俊億、徐毓瑩

■ 前言 Introduction

本章節中，希望學生能運用在國二上學期已學過物質的物理量及基本結構，進而認識本學期第一章「化學反應」。老師在課程中除了讓學生學習到關於化學反應的基本觀念，也可以多提供學生比較已學過的物理反應與正在學習的化學反應的機會，並系統性地學習「化學反應的書寫步驟」及「反應平衡」，以便未來學習更複雜的化學反應。

語言作為引導學生問與答的作用，希望學生透過思考及分析來理解化學反應的相關反應，並能連結實例，因此課堂中老師需要以簡單的方式定義、舉例和歸納複雜的專有名詞，來強化學生對於知識的內化。

2-1 常見的化學反應
Common Chemical Reactions

■ 前言 Introduction

在此小節，學生初次學習何謂化學反應，教師藉由觀察蝶豆花水溶液顏色變化的實驗及小蘇打加熱實驗，讓學生認識化學反應時的物質變化、能量的轉換、新物質的產生及顏色的變化等。

在授課中，老師需要以定義及分類等方式，間接搭配英語句型，讓學生能在定義及範例中相互辨別，必要時提供圖示化的化學反應流程，讓學生能更容易瞭解實驗中較難以肉眼觀察到的細節。

■ 詞彙 Vocabulary

單字	中譯	單字	中譯
exothermic	放熱	endothermic	吸熱
mass	質量	precipitation	沉澱
sodium carbonate	碳酸鈉	clear limewater	澄清石灰水
chemical reaction/ chemical change	化學反應/化學變化	physical reaction/ physical change	物理反應/物理變化
baking soda/ sodium bicarbonate	小蘇打/碳酸氫鈉		

■ 教學句型與實用句子 Sentence Frames and Useful Sentences

❶ _____ refers to _____.

例句：A chemical reaction **refers to** a process in which one or more substances are changed to different one or more substances.

化學反應指的是一個或多個物質轉變成一個或多個不同於原物質的新物質過程。

❷ _____ is a type of _____.

例句：Burning candles **is a type of** chemical reactions

蠟燭燃燒屬於化學反應。

■ 問題講解 Explanation of Problems

☙ 學習目標 ❧

在學習完本單元後，學生應習得以下觀念：

一、化學反應中的能量改變常以吸熱或放熱形式發生。

Chemical reactions are often accompanied by the exchange of energy, that is to say, exothermic and endothermic reactions.

二、化學反應中常伴隨沉澱、氣體、顏色及溫度變化等現象。

Chemical reactions are often accompanied by precipitation, the production of gas, the change of color and the change of temperature.

❧ 例題講解 ☙

例題一

說明：學生只要知道化學反應中常伴隨沉澱、氣體、顏色及溫度變化等現象，就能順利完成題目。

Students can solve the problem as long as they know chemical reactions are often accompanied by precipitation, the production of gas, the change of color and the change of temperature.

（英文）In the cold winter, it is common to see people with a hand warmer in their hand. It can bring warmth, as if it is a small sun, but where does the heat of the hand warmer come from?

The common disposable hand warmer is mainly composed of iron powder. As the hand warmer is unpacked, the iron powder in the hand warmer undergoes an oxidation-reduction reaction, which means the iron powder will interact with the oxygen in the air and generate heat. However, iron powder normally should be slowly oxidized. In order to allow the iron powder to oxidize and to release heat in a short time, other substances that can accelerate the oxidation reaction of the iron powder are added to the hand warmer, such as salt, activated carbon and vermiculite (a silicate mineral).

Which of the following is not the type of the chemical reaction like the hand warmer?

(A) The wood burns violently.

(B) Creatures respirate.

(C) After the rain, the puddles gradually disappear.

(D) Chlorine is added to the swimming pool for sanitization.

（中文）在寒冷的冬天，人手一個暖暖包已經是常見的現象，它能夠帶來溫暖，彷彿是手中的小太陽，但是暖暖包的放熱原理是什麼呢？

日常生活中常見的拋棄式暖暖包，主要成分是鐵粉，而暖暖包的放熱原理，是因為暖暖包裡的鐵粉進行了氧化還原反應，所以暖暖包拆封後，鐵粉會與空氣中的氧氣反應而放熱。但鐵粉在一般的情況下應是緩慢的氧化，所以為了讓鐵粉能夠在短時間內氧化放熱，暖暖包裡除了鐵粉外，還會加入能夠加快鐵粉的氧化反應的物質，如食鹽、活性碳與蛭石（一種矽酸鹽類礦物）。

下列何種現象與暖暖包作用的化學反應原理不同？

(A) 木材劇烈燃燒

(B) 生物行呼吸作用

(C) 雨後地上的積水逐漸消失

(D) 游泳池加入氯氣消毒

（翰林素養 LEVEL UP 題組：「手中的小太陽-暖暖包」之第一小題，P.6）

解題 Solution:

水變為水蒸氣屬於物質的三態變化，並沒有發生任何沉澱、氣體、顏色等新物質的產生，故「(C)雨後地上的積水逐漸消失」屬於物理反應而非化學反應。

The change of water into water vapor is a three-state change of matter, and does not produce any new substances such as precipitation, gas or color.

Teacher: What is this question about?

Student: This question is about chemical reactions.

Teacher: So what is the definition of chemical reaction that we just learned in class?

Student: It should be “When a substance undergoes a chemical change, the process involving the rearrangement of atoms to form a new substance is called a chemical reaction.”

Teacher: Then, what are the key ideas in the options that enable you to judge whether it belongs to a physical reaction or a chemical reaction?

Student: In (A) option, “burn”; in (B) option “breathing”; in (C) option, it is hard to tell but keyword may be “disappeared”; in (D) option, “chlorine gas disinfection".

Teacher: Great. Option (C) is actually about “evaporation.” Which examples are similar to those we have learned in class?

Student: Burning and adding other substances.

Teacher: Then think about it: we all say what is another way to say breathe in and breathe out?

Student: We can say “inhaling and exhaling carbon d.”

Teacher: That's right! Although breathing is more complicated than we thought it is, it is also a chemical reaction!

Student: Is the evaporation of water a type of a chemical reaction?

Teacher: When water turns into steam, it's like changing from a state of being united to a state of being separated, but they are different forms of water!

Student: I see. Because water and steam are just different in state, and no new substances are produced, so (C) is not a chemical reaction.

Teacher: Yes, that’s right.

老師： 請問這一題主要想問什麼？

學生： 這題在問化學反應。

老師： 那麼我們剛剛在課堂學過化學反應的定義是什麼？

學生： 應該是「當物質發生化學變化時，涉及原子重新排列組成新物質的過程，稱為化學變化。」

老師： 那選項中有那些關鍵字能讓你判斷是物理反應還是化學反應呢？

學生： (A)選項的「燃燒」; (B)選項的「呼吸」; (C)選項有點看不出來但或許是「消失」; (D)選項則是「加入氯氣消毒」。

老師： 很棒，(C)選項其實就是在說「蒸發」。那哪些選項我們在課堂中有學過相似的例子呢？

學生： 課本上有燃燒跟加入其它物質。

老師： 那想想看我們都說我們呼吸的時候都會吸出什麼氣體，吐出什麼氣體呢？

學生： 好像是「吸入氧氣及呼出二氧化碳」。

老師： 答對了！雖然呼吸比我們想像得更複雜，但是它也是一種化學反應喔！

學生： 那水蒸發不算化學反應嗎？

老師： 水變為水蒸氣就像是從感情很好而團結在一起的樣子，到變成感情不好而分開地樣子，但是他們的本質都還是水喔！

學生： 原來如此，因為水跟水蒸氣只是型態不一樣，沒有新物質產生，所以不是化學反應。

老師： 沒錯，很棒。

例題二

說明：學生只要知道化學反應中常伴隨沉澱、氣體、顏色及溫度變化等現象，就能順利完成題目。

Students can solve the problem as long as they know chemical reactions are often accompanied by precipitation, the production of gas, the change of color and the change of temperature.

（英文）A complete pyrotechnic bomb consists of a fuse, gunpowder and light beads. The fuse is in the inner layer of the pyrotechnic bomb, and it controls the time of detonation. Usually, the burning time of a 1 cm long fuse is about 1 second. When the fuse is ignited, it will soon ignite the gunpowder. The gunpowder is mainly composed of carbon powder, potassium nitrate or sulfur. The gas generated when the gunpowder burns can push the firework into the sky and the light beads will explode.

There are many chemical substances in the light beads, which can be classified as luminescent agents and coloring agents. The luminous parts are metal powders of aluminum and magnesium, which emit a strong white light when they are burned. Coloring agent is the key to colorful fireworks! Different metals or their compounds will produce flames when they burn. For common flame colors, please refer to Table 1. The pyrotechnic pattern is derived from the arrangement of light beads in different positions in the pyrotechnic bomb. After the explosion, it will form a special shape such as a circle, a heart, or a waterfall.

Based on the reaction or changing colors of fireworks in this passage, which of the following is a chemical reaction?

(A) Fuse is burned

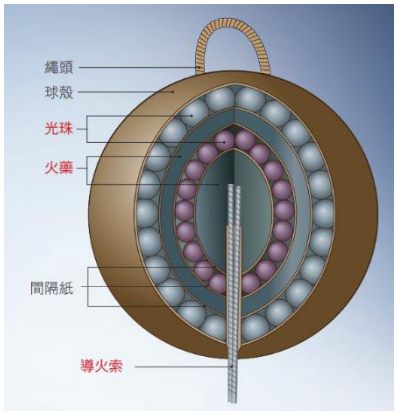
(B) Gunpowder is ignited to produce gas

(C) Gas pushes fireworks to the sky

(D) Magnesium powder burns to produce strong white light

（中文）一顆完整的煙火彈會包含三個部分：導火索、火藥及光珠等。導火索在煙火彈裡層，作用是控制引爆的時間，通常 1 公分長的導火索燃燒時間約 1 秒。點燃導火索後，會引燃火藥，火藥主要是由碳粉、 硝酸鉀或硫磺組成，火藥燃燒時產生的氣體能將煙火推上天空，並將光珠炸開。

光珠內有多種化學物質，又可以分成發光劑和發色劑。發光的部分是鋁、鎂的金屬粉末，這兩種金屬燃燒時會發出強烈 白光。發色劑則是煙火五顏六色的關鍵！不同的金屬或其化合物燃燒時會產生不同顏色的火焰，常見焰色可參考表一。而煙火的圖案，則是來自光珠在煙火彈中不同位置的排列，爆炸之後能形成像是圓形、愛心或瀑布等特殊的形狀。



■表一　常見元素的焰色反應

金屬化合物	Li	Na	K	Pb
焰色	紅色	金黃色	淡紫色	藍色
金屬化合物	Ca	Sr	Ba	Cu
焰色	橘色	洋紅色	黃綠色	藍色

關於煙火的反應或變化，下列哪一項並不屬於化學反應？

(A) 導火索燃燒

(B) 引燃火藥產生氣體

(C) 氣體將煙火推向天空

(D) 鎂粉燃燒產生白色強光

（翰林國中二下化學第一章 科學大事記：跨年的理化課，PP.26~27）

解題 Solution:

「(C)氣體將煙火推向天空」並沒有發生任何沉澱、氣體、顏色及溫度變化等現象，故屬於物理反應而非化學反應。

In “(C) Gas pushes fireworks to the sky” has nothing to do with precipitation, gas, color or temperature change. Therefore, it is a physical reaction rather than a chemical reaction.

Teacher: What is this question asking?
Student: This question is about chemical reactions.
Teacher: So what is the definition of chemical reaction that we just learned in class?
Student: It should be "When a substance undergoes a chemical change, the process involving the rearrangement of atoms to form a new substance is called a chemical reaction."
Teacher: Then let's take a look at these options. Did the options appear in the short passage we just read?
Student: Yes, it's in the second paragraph.
Teacher: Then we have to look closer at the short passage. Think about it: we have learned about chemical reactions in class before, how do we tell whether the option is a chemical reaction?
Student: It depends on whether new substances are produced, or whether there are signs for a chemical reaction such as precipitation, gas production, color changes, and temperature changes.
Teacher: Let's take a look at the four options. Which ones meet the characteristics of chemical reactions?
Student: (B) and (D) have produced new substances.
Teacher: Yes, what about (A) and (C)?
Student: (A) is burning; (C) is fireworks blasting into the sky.
Teacher: Yes, when we burn things with fire, it will become hot, and it may emit a little smoke, right?
Student: Yes. Doesn't (C) option mention gas?
Teacher: Yes, but the options are. The gas pushes the fireworks upwards but gas is not produced for the pushing of fireworks, so it is not a chemical reaction!
Student: I got it. There is indeed no new substance produced, and there is no precipitation, gas, color, and temperature changes.

老師： 請問這一題主要想問什麼？
學生： 這題在問化學反應。
老師： 那麼我們剛剛在課堂學過化學反應的定義是什麼？
學生： 應該是「當物質發生化學變化時，涉及原子重新排列組成新物質的過程，稱為化學變化。」
老師： 那我們看看選項是不是在剛剛讀過的短文中出現過？

學生： 對的，都在短文的第二段。

老師： 那麼我們要觀察上面的短文。先想想，我們之前上課學過，要怎麼樣判斷選項是不是化學反應呢？

學生： 要看有沒有新物質產生，又或者有沉澱、氣體、顏色及溫度變化等現象。

老師： 那我們看看四個選項，哪些符合化學反應的特徵呢？

學生： (B)跟(D)有產生新物質。

老師： 對的，那(A)跟(C)呢？

學生： (A)是燃燒；(C)是煙火衝上天。

老師： 對的，我們用火燒導引線的時候，會變熱，而且可能會冒一點煙對吧？

學生： 那(C)選項不是也說到有氣體嗎？

老師： 對的，但是選項是說。氣體推著煙火往上飛，而不是產生氣體，所以不是化學反應喔！

學生： 原來如此，這樣的確沒有產生新物質，也沒有發生任何沉澱、氣體、顏色及溫度變化等現象。

2-2 質量守恆定律
Law of Conservation of Mass

■ 前言 Introduction

本節課先回顧上節課所提到的化學反應，並請學生用英文推測化學反應是否會產生質量上的變化。再藉由小蘇打粉與鹽酸會產生氣體的化學反應實驗，觀察物質於封閉系統中的質量變化，進而了解化學反應的質量守恆。

語言多注意學生對於增加與減少的變化，並讓學生試著藉由觀察判斷質量的增減。教師可以在課程活動中以變化、增加、減少等句型來協助學生表達自己的觀察結果。

■ 詞彙 Vocabulary

單字	中譯	單字	中譯
glass rod	玻璃棒	baking powder	小蘇打粉/碳酸氫鈉
dropper	滴管	the law of conservation of mass	質量守恆定律
closed system	封閉系統	Erlenmeyer flask	錐形瓶
electronic balance	電子天秤	weighing paper	秤量紙
sodium carbonate	碳酸鈉	test tube	試管
calcium chloride	氯化鈣	test tube rack	試管架
rubber plug	橡皮塞	hydrochloric acid	鹽酸

■ 教學句型與實用句子 Sentence Frames and Useful Sentences

❶ _____ increase.

例句：After we use the hand warmer, the mass of the hand warmer will **increase**.
我們使用暖暖包後，它的質量會增加。

❷ _____ decrease.

例句：After the baking powder is heated, the mass of the hand warmer will **decrease**.
小蘇打粉加熱後，它的質量會減少。

❸ _____ be more than _____.

例句：The total mass of the reactants **is more than** the total mass of the products.
反應物的質量大於生成物的質量。

❹ _____ be equal to _____.

例句：The total mass of the reactants **is equal to** the total mass of the products.
反應物的質量等於生成物的質量。

❺ _____ be less than _____.

例句：The total mass of the reactants **is less than** the total mass of the products.
反應物的質量小於生成物的質量。

■ 問題講解 Explanation of Problems

學習目標

在學習完本單元後，學生應習得以下觀念：

一、物理反應與化學反應要遵守質量守恆定律。
Both physical reactions and chemical reactions obey the law of conservation of mass.

二、反應物的質量等於生成物的質量，稱為質量守恆定律。
The total mass of the reactants is equal to the total mass of the products, which is called the law of conservation of mass.

例題講解

例題一

說明：學生只要知道化學反應必遵守質量守恆定律，就能順利完成題目。
Students can solve the problem as long as they know chemical reactions must obey the law of conservation of mass.

（英文）(A) the reaction of burning birthday candles, (B) soaking an effervescent tablet in water, (C) rusting of iron nails, (D) mixing carbon dioxide with limewater.
Which of the above-mentioned chemical reactions obeys the law of conservation of mass?

（中文）(甲)生日蠟燭的燃燒反應、(乙)發泡錠泡水、(丙)鐵釘生鏽、(丁)二氧化碳與石灰水混合。請問上述化學反應中，哪項遵守質量守恆定律？

（翰林課本 P.7）

解題 Solution：

所有化學反應皆滿足質量守恆定律，因此(甲)(乙)(丙)(丁)皆遵守質量守恆定律。
All the chemical reactions obey the law of conservation of mass, so (A)(B)(C)(D) obey the law of conservation of mass.

Teacher: What chemical reaction did we learn in this class?
Student: Adding baking powders into the hydrochloric acid.
Teacher: What happened after we put baking powders into the hydrochloric acid?
Student: It produced the gas, and the balloon expanded.
Teacher: Did the mass increase or decrease before we removed the balloon?
Student: No, it didn't.
Teacher: Which law does chemical reaction obey?
Student: The law of conservation of mass.
Teacher: This question tells us that the choices are chemical reactions, so which choices obey the law of conservation of mass?
Student: (A)(B)(C)(D) are chemical reactions, so they all obey the law of conservation of mass.

老師： 請問我們剛剛上課學到了哪兩種物質產生化學反應的實驗？
學生： 鹽酸加入小蘇打粉的實驗。

老師： 請問鹽酸加入小蘇打粉之後發生了什麼事？

學生： 會產生氣體，讓氣球膨脹。

老師： 那氣球取下之前質量有增加或減少嗎？

學生： 沒有

老師： 那是因為化學反應都遵守什麼定律？

學生： 質量守恆定律。

老師： 這題題目告訴我們這些選項都是化學反應，所以有哪幾項會符合質量守恆定律？

學生： 因為(甲)(乙)(丙)(丁)都是化學變化，所以全部都遵守質量守恆定律。

例題二

說明：本題使學生從應用題中更了解多項式的運算規則。

Students can know more about how to solve polynomial equations by practicing the word problem below

（英文）In a chemical reaction, 300 grams of reactant A are combined with 100 grams of reactant B. Both A and B react to completion. What is the mass of the product?

(A) 200 grams

(B) 400 grams

(C) 300 grams

（中文）在一化學反應中，300 公克的反應物 A 和 100 公克的反應物 B 結合，且 A 與 B 完全反應。試問產物的質量？

(A) 200 公克

(B) 400 公克

(C) 300 公克

(The Law of Conservation of Mass: Definition, Equation & Examples. https://study.com/academy/practice/quiz-worksheet-law-of-conservation-of-mass.html)

解題 Solution:

已知反應物 A 質量=300 公克，反應物 B 質量=100 公克，反應物 A + 反應物 B 質量=生成物質量，則 300 + 100 = 400，故生成物質量=400 公克。

The mass of reactant A is 300 grams, and the mass of reactant B is 100 grams. That the mass of reactant A plus the mass of reactant B is equal to the mass of production.
300 + 100 = 400. Conclude the mass of production is 400 grams.

Teacher: What does this question ask about?
Student: The mass of the product which is produced by the combination of A and B.
Teacher: What kind of reaction is the combination of A and B?
Student: Chemical reaction.
Teacher: What law does chemical reaction obey?
Student: The law of conservation of mass.
Teacher: What is the law of conservation of mass?
Student: The mass of the reactant is equal to the mass of the product.
Teacher: What are the reactants in this question?
Student: Material A and material B.
Teacher: How do we figure out the mass of production?
Student: That the mass of reactant A plus the mass of reactant B is equal to the mass of production. And 300 plus 100 is 400, so the product is 400 grams.

老師： 請問這一題要求的是什麼？
學生： A 和 B 結合後，生成物的質量。
老師： 請問 A 和 B 結合生成新的物質屬於何種反應？
學生： 化學反應。
老師： 請問化學反應會遵守什麼定律呢？
學生： 質量守恆定律。
老師： 什麼是質量守恆定律呢？
學生： 反應物質量的總和等於生成物質量的總和。
老師： 那這一題中，反應物是什麼呢？
學生： 物質 A 和物質 B。
老師： 請問如何算出總質量呢？
學生： 反應物 A+反應物 B 質量=生成物質量，300 + 100 = 400，所以反應物是 400 公克。

2-3 反應式與化學計量
Chemical Equation and Stoichiometry

■ 前言 Introduction

學生初次學習書寫化學反應步驟、認識原子量、分子量和莫耳數的定義、學習化學計量。教師需在教學過程中，利用片語讓學生學會以英文的方式表達物質的質量，並且讓學生利用句型學會陳述一個化學反應式。

■ 詞彙 Vocabulary

單字	中譯	單字	中譯
molar quantity	莫耳數	gas	氣體
reaction condition	反應條件	hydrogen	氫
reactant	反應物	solution	水溶液
molecular mass	分子量	liquid	液體
carbon	碳	oxygen	氧
Stoichiometry	化學計量	atomic mass	原子量
solid	固體	atom	原子
product	生成物	carbon dioxide	二氧化碳
chemical equation	化學反應式		

■ 教學句型與實用句子 Sentence Frames and Useful Sentences

❶ _____ mole of _____

例句：1 **mole of** CO_2 contains 12g carbon and 32g oxygen.

一莫耳 CO_2 含有 12 克的碳和 32 克的氧。

❷ ____ react with ____

例句：Hydrochloric acid **reacts with** sodium bicarbonate.

鹽酸會與小蘇打粉反應。

❸ ____ reacts with ____to give _____.

例句：Hydrochloric acid **reacts with** sodium bicarbonate **to form** sodium chloride, water and carbon dioxide.

鹽酸與小蘇打粉反應，產生氯化鈉、水和二氧化碳。

❹ How to ___? /How do we ___?

例句(1)：**How do** we indicate the state of reactants and products?

我們要如何表示反應物和產物的物質狀態？

例句(2)：**How to** calculate molecular mass?

要如何計算分子質量？

■ 問題講解 Explanation of Problems

☙ 學習目標 ❧

在學習完本單元後，學生應習得以下觀念：

一、了解如何利用反應物、生成物、箭頭以及係數等書寫並平衡化學反應式

Understand how to use reactants, products, arrows and coefficients to write and balance the chemical equation.

二、了解質量、分子量與莫耳數的關係

Understand the relations of mass, molecular mass and molar quantity.

❧ 例題講解 ☙

例題一

說明：學生能應用質量守恆定律平衡係數來完成化學反應式。

Students can apply the Law of Conservation of Mass to balance chemical equations.

（英文）Try to balance the following chemical equation.

$$\_\_\_\_CH_4 + \_\_\_\_O_2 \rightarrow \_\_\_\_CO_2\uparrow + \_\_\_\_H_2O$$

（中文）試平衡下列反應式。

$$\_\_\_\_CH_4 + \_\_\_\_O_2 \rightarrow \_\_\_\_CO_2\uparrow + \_\_\_\_H_2O$$

（翰林版課本 P.20）

解題 Solution:

化學反應式須遵守質量守恆定律，先觀察反應式左右兩邊只出現過一次的元素，為 C、H，優先平衡，因此左邊的氧為 2，因此得 $\underline{\mathbf{1}}CH_4 + \underline{\mathbf{2}}O_2 \rightarrow \underline{\mathbf{1}}CO_2\uparrow + \underline{\mathbf{2}}H_2O$

The chemical reaction must obey the law of conservation of mass. First of all, observe the elements that only appear once on the left and right sides of the reaction, which are C and H. After balancing the two elements, the oxygen on the left is 2. So, we get

$\underline{\mathbf{1}}CH_4 + \underline{\mathbf{2}}O_2 \rightarrow \underline{\mathbf{1}}CO_2\uparrow + \underline{\mathbf{2}}H_2O$

Teacher: Students, what are the reactants and products in the above chemical equation?

Student: Methane and oxygen are reactants, carbon dioxide and water are products.

Teacher: In the chemical equation, will the number of atoms increase or decrease after the reaction?

Student: The number of the atoms will not change because this reaction should abide by the law of conservation of matter.

Teacher: Good. What are some other rules that a balanced chemical reaction needs to obey?

Student: The law of conservation of mass.

Teacher: That's right. What are the steps of balancing the chemical equation?

Student: First of all, observe the elements that only appear once on the left and right sides of the reaction and balance them first. Second, balancing the unbalanced elements, if there are fractions, let the coefficient be the simple whole number ratio.

老師： 同學，上面的反應式哪些為反應物，哪些為生成物呢？

學生： 甲烷和氧氣是反應物，二氧化碳和水是生成物。

老師： 化學反應式中，原子的數量會不會增加或減少。

學生： 不會，會遵守原子不滅定律。

老師： 很好，那平衡化學反應還需要遵守哪一個規則？

學生： 質量守恆定律。

老師： 沒錯，接下來由課堂所學平衡化學反應步驟為何？

學生： 首先觀察反應左右兩邊只出現一次的元素，先平衡。其次，平衡不平衡的元素，如果有分數，讓係數為最簡單的整數比。

例題二

說明：學生利用質量與莫耳數的關係進行計算。

Students use the relationship between mass and molar quantity to calculate.

（英文）In recent years, the increase in the concentration of CO_2 in the atmosphere has become a global problem. As a result, energy-saving and carbon-reduction campaigns have emerged. Domestic environmental protection groups have also promoted "No barbecue during the Mid-Autumn Festival." If you don't have a barbecue, you will not need a pack of 10 kg of charcoal (90% carbon content). When the charcoal is completely burned, how many kg of CO_2 will be reduced?

(A)11　(B) 22　**(C) 33**　(D) 44

（中文）近年來，大氣中 CO_2 的濃度上升已成為全球性的問題，因而興起節能減碳運動，國內的環保團體也宣導「中秋節不烤肉」。若因不烤肉會少用掉一包 10 公斤的木炭(含碳量為 90%)，當一包木炭完全燃燒後會減少產生幾公斤的 CO_2？

(A)11　(B) 22　**(C) 33**　(D) 44

（六龜高中段考題）

解題 Solution:

依原子不滅：消耗的碳莫耳數 = 生成的 CO_2 莫耳數，則生成的 CO_2 的質量 = $[(10000 \times 90\%)/12] \times 44 = 33000(g) = 33(kg)$

According to the law of conservation of mass: the number of moles of carbon consumed = the number of moles of CO_2 produced, then the mass of CO_2 produced = $[(10000 \times 90\%)/12] \times 44 = 33000(g) = 33(kg)$

Teacher: What does the burning of charcoal and oxygen produce?

Student: It produces water and carbon dioxide.

Teacher: What are the reactants and products?

Student: Charcoal and oxygen are the reactants, carbon dioxide and water are the products.

Teacher: From what we have learned in class, what is the coefficient ratio of the reaction equation related to?

Student: Molar ratio.

Teacher: What is the relationship between the molar quantity and mass?

Student: The mass divided by the molecular mass equals the molar quantity.

老師： 木炭和氧氣燃燒會產生什麼？

學生： 會產生水和二氧化碳。

老師： 那反應物和生成物分別為何？

學生： 木炭和氧氣是反應物，二氧化碳和水是生成物。

老師： 由上課所學，我們知道反應方程式的係數比會等於什麼？

學生： 莫耳數比。

老師： 莫耳數和質量的關係是什麼？

學生： 質量除以分子量等於莫耳數。

★主題三 氧化還原反應★
Oxidation-Reduction Reaction

國立彰化師範大學化學系　方宣幃、邱韋慈
國立彰化師範大學英語系　劉俊億、徐毓瑩

■ 前言 Introduction

在本章學生藉由金屬和物質的燃燒，來認識物質與氧氣反應產生氧化的過程稱為氧化反應。由教師的引導，去探討金屬燃燒的快慢，藉此導出活性的概念；再去介紹狹義的氧化還原定義，並強調氧化與還原必定同時相伴發生，於此，教師也須說明並釐清氧化劑和還原劑的差別。在上述講解後，帶入氧化還原的應用，以金屬的冶煉，介紹其中氧化還原的原理，最後引導學生舉例出其他生活中常見的氧化還原反應，以做為本章的結束。

語言方面，學生首先要學會反應相關的句型，例如：比較活性大小、反應程度，並能使用舉例類型的句子，來分別日常生活中氧化還原反應的實例。老師在說明氧化還原反應時，可以讓學生試著描述何者為氧化還原反應、何者是氧化劑、何者是還原劑。

3-1 氧化反應與活性
Oxidation Reaction and Activity

■ 前言 Introduction

本章節從生鏽與燃燒現象，認識緩慢與劇烈的氧化反應；教師透過金屬與非金屬的燃燒示範實驗，探討其燃燒難易程度及其氧化物溶於水的酸鹼性，歸納金屬與非金屬氧化物的特性，並介紹氧化的難易程度代表其對氧的活性大小。教師可以用生活中的例子，讓學生了解金屬活性大小的實際運用。

學生在本堂課需要常描述化學反應和比較反應程度，其中需要討論物質與水的反應來判斷其活性，因此會需要使用物質和水反應的用法；也能順帶一提如何表達物質溶與水中後水溶液的酸鹼性，而判斷酸鹼性的句型在第三章「酸鹼中和」也會用到。

■ 詞彙 Vocabulary

單字	中譯	單字	中譯
magnesium	鎂	base	鹼性
nonmetal oxide	非金屬氧化物	metal oxide	金屬氧化物
copper	銅	zinc	鋅
carbon	碳	neutral	中性
sodium	鈉	acid	酸性
sulfur	硫	oxidation reaction	氧化反應
activity	活性		

■ 教學句型與實用句子 Sentence Frames and Useful Sentences

❶ **_____ react with _____ to form _____.**

例句：Zinc **reacts with** oxygen **to form** zinc oxide.

鋅與氧反應會產生氧化鋅。

❷ **_____ react violently with _____.**

例句：Sodium **reacts vigorously with** oxygen.

鈉與氧會發生劇烈反應。

❸ **_____ dissolve in water.**

例句：Sodium oxide **dissolves in** water.

氧化鈉溶於水。

❹ **_____ dissolve in water to form the base solution.**

例句：Sodium oxide **dissolves in water to form the base solution.**

氧化鈉溶於水形成鹼性。

❺ **_____ dissolve in water to form the acid solution.**

例句：Carbon dioxide **dissolves in water to form the acid solution.**

二氧化碳溶於水形成酸性。

❻ **_____ is more active than _____.**

例句：Potassium **is more active than** sodium.

鉀比鈉活性更大。

❼ **_____ is less active than _____.**

例句：Gold **is less active than** silver.

金比銀活性更小。

■ 問題講解 Explanation of Problems

☙ 學習目標 ❧

在學習完本單元後，學生應習得以下觀念：

一、學生能從物質燃燒實驗認識氧化，並知道金屬與非金屬氧化物的特性。

Students can understand oxidation, and know the properties of metal and non-metal oxides.

二、學生能從金屬氧化的實驗，了解元素活性大小與金屬氧化劇烈程度的關係。

Students can understand the relationship between the activity of elements and the vigorousness of metal oxidation from the experiment of metal oxidation.

❧ 例題講解 ☙

例題一

說明：學生學會藉由元素燃燒難易程度判斷活性大小，並知道金屬與非金屬氧化物溶於水的酸鹼性。

Students learn to determine the activity by observing whether it is easy to burn the element, and know the acid-base of metal and non-metal oxides which are dissolved in water.

（英文）Regarding the properties of highly reactive metals, such as potassium and sodium, which of the following is correct?

(A) It is flammable, and its oxides dissolve in water to become basic.

(B) It is flammable, and its oxides dissolve in water to become acidic.

(C) It is not flammable, and its oxides dissolve in water to become basic.

(D) It is not flammable, and its oxides dissolve in water to become acidic.

（中文）關於對氧活性大的金屬元素，如鉀、鈉等所具有的特性，下列何者正確？

(A) 在空氣中容易燃燒，其氧化物溶於水成鹼性。

(B) 在空氣中容易燃燒，其氧化物溶於水成酸性。

(C) 在空氣中不容易燃燒，其氧化物溶於水成鹼性。

(D) 在空氣中不容易燃燒，其氧化物溶於水成酸性。

（99 年第一次國中基測 21）

解題 Solution:

活性大代表容易燃燒，且金屬氧化物溶於水呈鹼性，故選(A)。

High activity stands for flammability, and metal oxides are dissolved in water to form base solution, so choose (A)

Teacher: What does the active mean?

Student: Flammability: the more active, the easier to burn.

Teacher: Great, so is the metal oxides dissolved in water to form base solution, or acid solution?

Student: Metal oxides are basic when dissolved in water, and non-metal oxides are acid when dissolved in water.

老師： 活性大小代表什麼？

學生： 燃燒的難易度，活性越大越容易燃燒。

老師： 很棒，那麼燃燒後金屬和非金屬的氧化物溶於水的酸鹼性為何？

學生： 金屬氧化物溶於水是鹼性，非金屬氧化物溶於水是酸性。

例題二

說明：學生會判斷物質的可燃性、活性、與水的反應。

Students judge the flammability, activity, and reaction with water of substances.

（英文）The following figure is the dangerous warning diagram of a chemical. According to the hazard（危害）degree, the value is marked from low to high. The value range is 0 to 4, and the special hazard is marked with symbols. Which of the following chemicals does the picture most likely stand for?

(A) sodium

(B) ethanol

(C) potassium nitrate

(D) manganese dioxide

（中文）下圖為某一種化學品的危險警示圖，根據危害程度低至高標示數值，數值範圍為 0～4，並以符號標示特殊危害性。右圖的化學品最可能是下列何者？

(A) 鈉

(B) 乙醇

(C) 硝酸鉀

(D) 二氧化錳

（109 年國中會考 30）

解題 Solution:：

會與水發生劇烈反應的只有鈉。故選(A)。

Only sodium can react violently with water, so (A) is selected.

Teacher: What metals did we observe in this class?

Student: Magnesium, copper, sodium, carbon, and sulfur.

Teacher: Yes. What among them is the most active element and most likely to react with oxygen?

Student: It's sodium.

Teacher: Yes. What is the main idea of this question?

Student: "Which substance reacts violently with water?"

Teacher: Great. Is this substance usually active or inactive?

Student: It's active.

Teacher: That's right. Which of the following substances is active and easy to react violently with water?

Student: It's sodium.

老師：　請問今天我們觀察了哪些金屬的活性呢？

學生：　鎂、銅、鈉、碳、硫。

老師：　對的，請問這些物質中活性最大、最容易與氧氣發生反應的元素是什麼呢？

學生：　是鈉。

老師：　是的，請問這一題的題目在問什麼呢？

學生：　題目問哪一個物質會與水劇烈反應。

老師：　很好，請問這種物質的活性通常較大還是較小？

學生：　活性大。

老師： 對的，請問下列選項中哪個物質活性大且容易與水產生劇烈反應？

學生： 是鈉。

3-2 氧化與還原
Oxidation and Reduction

■ 前言 Introduction

在此小節學生初次學習狹義的氧化還原定義，教師透過實例，讓學生了解氧化還原反應化學反應式中氧的得失，教師應避免提及氧化數的概念，避免學生在國中階段混淆觀念；在講解完狹義的氧化還原定義後，介紹金屬的活性，並讓學生練習比較金屬活性的大小。英語教學時，教師需要先跟學生釐清氧化還原反應之概念與定義，讓學生有機會在練習題目的過程中，嘗試使用英語來區分氧化反應與還原反應實例與其差別。如果字彙過於專業可能導致學生難以理解，也可以提供學生較生活化、簡化的用法。

■ 詞彙 Vocabulary

單字	中譯	單字	中譯
reduction reaction	還原反應	quicklime	生石灰
activity of metals	金屬活性	ferric oxide	氧化鐵
disproportionation	自身氧化還原	magnesium oxide	氧化鎂
oxidation reaction	氧化反應	copper oxide	氧化銅
redox reaction/ oxidation-reduction reaction	氧化還原反應		

■ 教學句型與實用句子 Sentence Frames and Useful Sentences

❶ _____is more/less active than_____.

例句：Sodium **is more active than** gold.

鈉的活性大於金。

❷ The faster_____, the more_____.

例句：**The faster** the metal interacts with oxygen, **the more** active it is.

越快與氧作用的金屬，其活性越大。

❸ That _____ is an oxidation reaction.

例句：**That** the iron on the bike rusted **is an oxidation reaction**.

自行車上的鐵生鏽是一種氧化反應。

❹ _____ is a reduction reaction.

例句：Metal smelting **is a reduction reaction.**

金屬冶煉是一種還原反應。

■ 問題講解 Explanation of Problems

☙ 學習目標 ❧

在學習完本單元後，學生應習得以下觀念：

一、學生學會判斷氧化還原反應中氧的得失，並了解金屬的活性大小。

Students learn to judge the gain-loss of oxygen in the oxidation-reduction reaction and understand the activity of metals.

例題講解

例題一

說明：學生能分辨出物質的氧化反應和還原反應。

Students can distinguish between oxidation and reduction reactions of matters.

（英文）The main component of the deoxidizer is iron powder. Iron can easily react with oxygen to consume oxygen. Reduce the oxygen concentration in the package and extend the shelf life of food or medicine.

Regarding the description of the iron powder in the above reaction, which of the following is correct?

(A) Carry out oxidation reactions to make food or medicine anti-oxidant.

(B) Carry out a reduction reaction to oxidize food or medicine.

（中文）脫氧劑的主要成分為鐵粉，利用鐵易與氧氣反應而消耗氧氣，降低包裝內的氧氣濃度，可以延長食品或藥品的保存期限。關於鐵粉在上述反應的敘述，下列何者正確？

(A) 進行氧化反應，優先使食品或藥品內的空氣反應使其本身能不被氧化

(B) 進行還原反應，使食品或藥品被氧化

（103 年國中會考題改編）

解題 Solution:

鐵粉與氧氣反應，即氧化反應；其消耗氧氣，使食品或藥品得以不被氧化，故選(A)。

Iron powder reacts with oxygen, that is, oxidation reaction; it consumes oxygen and prevents food or medicine from being oxidized, so select (A).

Teacher: From what you have learned in class, what kind of reaction does the substance that reacts easily with oxygen?

Student: Oxidation reaction.

Teacher: Yes, as known from the title, iron powder will consume the oxygen around the food or medicine, indicating that the food or medicine is easy to recombine with oxygen?

Student: No.

Teacher: That's right, because iron powder reacts with oxygen, food or medicine is not easily oxidized, so it can resist oxidation.

老師： 從課堂中所學，容易與氧反應的物質進行什麼反應？

學生：　氧化反應。
老師：　沒錯，由題目所知，鐵粉會把食品或藥品周遭的氧氣消耗掉，表示食品或藥品容易再和氧氣結合嗎？
學生：　不容易。
老師：　沒錯，因此有了鐵粉和氧氣反應，食品或藥品就不容易被氧化，也就能夠抗氧化。

例題二

說明：學生能了解金屬對氧的活性大小。
Students can understand the reactivity series.

（英文）"True gold is not afraid of burning tests" literally means that pure gold is not afraid of being roasted by fire. This is because gold does not easily react with oxygen. Judging by the above description of the properties of gold, which of the following elements has the closest oxygen activity to gold?
(A) An element that can react with water to produce hydrogen when put in water.
(B) In nature, the elements that exist mostly in the oxide state.
(C) In nature, metal elements that mostly exist in elemental state.
(D) In the ironmaking process, it can reduce iron oxide to iron.

（中文）「真金不怕火煉」在字面上的意思是指純正的黃金不怕被火烤，這是因為黃金不易與氧發生反應。依上述對黃金性質的描述判斷，下列哪一類元素對氧的活性與黃金對氧的活性最接近？
(A) 放入水中能與水反應而產生氫氣的元素
(B) 在自然界中，多以氧化物狀態存在的元素
(C) 在自然界中，多以元素狀態存在的金屬元素
(D) 在煉鐵過程中，可使氧化鐵還原成鐵的元素

（107 年國中會考 17）

解題 Solution:
黃金對氧的活性小，與黃金類似對氧活性小的金屬，就不會與氧作用，在自然界中可以元素狀態存在。故選(C)。
Gold is less active than oxygen. metals like gold that are less active than oxygen will not

interact with oxygen and are able to exist in the elemental state in nature.

Teacher: From what we have learned in class, we know that metals with high activity tend to exist as oxides and in what form are metals with low activity easy to exist?
Student: elements.
Teacher: Yes. Is it easy for metals with low activity to combine with oxygen?
Student: No.
Teacher: That's right, so we know from the question that gold is a low-reactivity metal, so it often exists in the elemental state in nature.

老師： 從課堂中所學，我們知道活性高的金屬容易以氧化物存在而活性低的金屬容易以什麼形式存在？
學生： 元素。
老師： 沒錯，而活性低的金屬容易和氧氣結合嗎？
學生： 不容易。
老師： 沒錯，因此我們從題目可知金為活性低的金屬，所以在自然界常以元素狀態存在。

3-3 氧化還原的應用
Application of oxidation-reduction reaction

■ 前言 Introduction

本節包含金屬的冶煉與生活中的氧化還原，重點在於讓學生能藉由前幾節課已習得的氧化反應及還原反應之定義，延伸思考，並探究生活中其他氧化還原反應之實例。活動中強調學生對於氧化還原反應的發想及連結，希望以描述及總結用途的語言，強化學生記憶及思考能力。教師可以基於課本的例子為基礎，引導學生發散式思考，並在學生提出想法後，確認學生對於氧化還原反應之理論觀念理解清楚無誤。

本小節重點為氧化還原在生活中的應用，需要學生學會何種物質為氧化劑，何種物質為還原劑，因此可以讓學生試著用「將...從...分離出來」的句型。在課堂活動中，可以讓學習本節的重點句型——指認氧化劑和還原劑。在說明氧化還原在生活中的應用時，可以多使用「舉例」的句型。

■ 詞彙 Vocabulary

單字	中譯	單字	中譯
bleach	漂白	reducing agent	還原劑
enzyme	酶	sanitize	消毒
polyphenol	多酚	pig iron	生鐵
deoxidizer	脫氧劑	combustion	燃燒
ironmaking	煉鐵	wrought iron	熟鐵
steel/iron	鋼鐵	sodium hypochlorite	次氯酸鈉

photosynthesis	光合作用	oxidizing agent	氧化劑
antioxidant	抗氧化劑	vitamin C	維生素 C
respiration	呼吸作用		

■ 教學句型與實用句子 Sentence Frames and Useful Sentences

❶ I can see _____ in my daily life.

例句：**I can see** the iron nail rusting **in my daily life**.

我在日常生活中可以看到鐵釘生鏽。

❷ _____ is a common example (of _____).

例句：Rusted nail **is a common example of** oxidation reaction.

生鏽的鐵釘是氧化反應的常見例子。

❸ _____ play an oxidizing agent/antioxidant role _____.

例句：Vitamin E **plays an antioxidant role** in the human body.

維生素 E 在人體中扮演抗氧化劑的角色。

❹ separate _____ from _____.

例句：We use oxidation-reduction reactions to **separate** iron **from** metal ore.

我們利用氧化還原反應將鐵從金屬礦中分離出來。

■ 問題講解 Explanation of Problems

☙ 學習目標 ❧

在學習完本單元後，學生應習得以下觀念：

一、了解並延伸探討生活中運用氧化還原的例子。

Understand and extend the discussion on the applications of oxidation reduction reactions in daily life.

❧ 例題講解 ☙

例題一

說明：學生只要知道氧化還原反應的意義，就能完成此題。

Students can solve the problem as long as they know the meaning of oxidation-reduction reaction.

（英文）The process of making sulfuric acid is as follows:

Stage 1: Combustion of sulfur and oxygen to produce sulfur dioxide

Stage 2: Using a catalyst to make sulfur dioxide react with oxygen to produce sulfur trioxide

Sulfuric acid is generated through subsequent reactions. Which of the following are the reducing agents in the above two-stage reaction?

(A) O_2 in Stage 1 and O_2 in Stage 2

(B) S in Stage 1, and SO_2 in Stage 2

(C) SO_2 in Stage 1, and O_2 in Stage 2

(D) SO_2 in Stage 1, and SO_2 in Stage 2

（中文）製造硫酸的過程如下：

階段一：硫與氧氣燃燒產生二氧化硫

階段二：利用催化劑使二氧化硫與氧氣反應產生三氧化硫

再經由後續反應生成硫酸。上述兩階段反應中的還原劑分別為下列何者？

(A) 階段一為 O_2，階段二為 O_2

(B) 階段一為 S，階段二為 SO_2

(C) 階段一為 SO_2，階段二為 O_2

(D) 階段一為 SO_2，階段二為 SO_2

（106 年國中會考 22）

解題 Solution:

階段一：硫與氧氣燃燒產生二氧化硫

$S + O_2 \rightarrow SO_2$，硫進行氧化反應，所以是還原劑。

階段二：利用催化劑使二氧化硫與氧氣反應產生三氧化硫。

$2SO_2 + O_2 \rightarrow 2SO_3$，二氧化硫進行氧化反應，所以是還原劑。

Stage 1: Combustion of sulfur and oxygen produces sulfur dioxide

$S + O_2 \rightarrow SO_2$ Sulfur undergoes oxidation reaction, so it is a reducing agent.

Stage 2: A catalyst is used to react with sulfur dioxide and oxygen to produce sulfur trioxide.

$2SO_2 + O_2 \rightarrow 2\ SO_3$ Sulfur dioxide is a reducing agent in this oxidation reaction.

Teacher: What does this question ask about?

Student: This question is asking about the reducing agent in the oxidation-reduction reaction.

Teacher: So what is a reducing agent? We seem to have just learned it in class, right?

Student: Reducing agent refers to the role of being oxidized in the redox reaction while reducing another reactant.

Teacher: For this question, we have to observe from stage one and stage two. Then we should use the definition just mentioned to judge. In stage one, what is the reducing agent?

Student: Sulfur in stage one as the reducing agent, because it undergoes oxidation reaction itself.

Teacher: What about stage two?

Student: Sulfur dioxide is used in stage two as the reducing agent because it undergoes oxidation reaction itself.

Teacher: Yes, we can write down the reaction formula to verify it!

老師： 請問這一題主要想問什麼？

學生： 這題問氧化還原反應中的還原劑。

老師： 那什麼是還原劑呢？我們好像剛剛在課堂中學過，對吧？

學生： 還原劑是指在氧化還原反應中本身被氧化，同時還原另一個反應物的角色。

老師： 這題我們從階段一和階段二判斷，那用我們剛剛提到的定義判斷，在階段一中，什麼是還原劑呢？

學生： 階段一中的硫，因為它本身進行氧化反應。

老師： 那階段二呢？

學生： 階段二中是二氧化硫，因為它本身進行氧化反應。

老師： 對的，我們可以把反應式寫出來驗證看看喔！

例題二

說明：學生能判斷氧化還原反應及氧化劑和還原劑

Students can identify redox reactions and oxidizing and reducing agents.

（英文）Some processed meat foods contain nitrates (compounds containing NO_3). Nitrate will "react" to produce nitrites (compounds containing NO_2), which can inhibit the growth of botulinum, but excessive consumption of such foods should be avoided. In the above "reactions", what role does nitrate play and what kind of reaction does it perform?

(A) Reducing agent, reduction reaction

(B) Reducing agent, oxidation reaction

(C) Oxidizing agent, reduction reaction

(D) Oxidizing agent, oxidation reaction

（中文）部分的肉類加工食品含有硝酸鹽(為含有 NO_3 的化合物)，硝酸鹽會「反應」產生亞硝酸鹽(為含有 NO_2 的化合物)，皆可抑制肉毒桿菌生長，但應避免過量食用這類食品。在上述「反應」中，硝酸鹽扮演何種角色，以及進行何種反應？

(A)還原劑，還原反應

(B)還原劑，氧化反應

(C)氧化劑，還原反應

(D)氧化劑，氧化反應

（109 年國中會考 31）

解題 Solution:

本題中，硝酸鹽失去氧產生亞硝酸鹽，為還原反應，所以硝酸鹽扮演氧化劑。

In this question, nitrate loses oxygen to produce nitrite, which is a reduction reaction, so nitrate acts as an oxidant.

Teacher: What does this question ask about?

Student: This question is asking about the oxidizing agent and reducing agent in the oxidation-reduction reaction.

Teacher: So what is a reducing agent? We seem to have just learned it in class, right?

Student: Reducing agent refers to the role of being oxidized in the redox reaction while reducing another reactant.

Teacher: Yes, then what is the key sentence of this question?

Student: Nitrate will "react" to produce nitrite.

Teacher: So does nitrate gain oxygen or lose oxygen?

Student: Nitrate loses oxygen.

Teacher: Yes, nitrate loses oxygen to produce nitrite, which is a reduction reaction. According to the definition of oxidant and reducing agent, what role does nitrate play?

Student: Nitrate is a reducing agent.

Teacher: Yes, nitrate itself is oxidized, so it is a reducing agent.

老師： 請問這一題主要想問什麼？

學生： 這題在問氧化還原反應中的還原劑及氧化劑。

老師： 那什麼是還原劑呢？我們好像剛剛在課堂中學過，對吧？

學生： 還原劑是指在氧化還原反應中本身被氧化，同時還原另一個反應物的角色。

老師： 對的，那這題的關鍵句是什麼呢？

學生： 硝酸鹽會「反應」產生亞硝酸鹽。

老師： 那硝酸鹽是得到氧還是失去氧呢？

學生： 失去氧。

老師： 對的，硝酸鹽失去氧產生亞硝酸鹽，為還原反應。那根據氧化劑跟還原劑的定義，硝酸鹽扮演何種角色？

學生： 硝酸鹽是還原劑。

老師： 對的，硝酸鹽本身被氧化，所以是還原劑。

★主題四 電解質與酸鹼鹽★
Electrolytes and Acid-Base Salts

國立彰化師範大學化學系　方宣幃、邱韋慈
國立彰化師範大學英語系　劉俊億、徐毓瑩

■ 前言 Introduction

本章節接續前一章的原子學說，進一步讓學生探討電離說的觀念，因此本章將以「電解質」及「離子」的觀點出發，先為學生建立好與離子相關的觀念，再延伸到「酸與鹼」，希望學生能夠學習到酸鹼的性質、用途與判別；並運用適當的檢測方式，辨別出酸和鹼的特性，接著讓學生認識常見的酸與鹼。建構好學生基本的酸鹼概念後，再教導學生「體積莫耳濃度」並告訴學生此為常見的濃度表示法，教師可進一步導入酸鹼的解離觀念，並讓學生了解酸鹼的強弱和解離的關係。接著講解水溶液的酸鹼性與 pH 值，並介紹常見酸鹼指示劑。最後教師透過實驗，向同學介紹酸鹼反應的過程和原理，並帶領同學認識生活中常見的鹽類及其應用。

英語在本章中，主要用於讓學生釐清觀念。老師在課程中可以多運用片語句型，讓學生練習如何描述理論本身及其用途。

4-1 電解質
Electrolytes

■ 前言 Introduction

本節學生將要學會「電解質」及「電離說」兩大觀念，教師需要以水溶液的導電實驗，教導學生判別電解質與非電解質，並應注意以英文句型輔助學生了解電解質的構成，並強調電離說中「電中性」的重要性。

使用英語時，老師要注意避免使用過難的句型，重點是讓學生能理解電中性的觀念而非單字常見的意思。

■ 詞彙 Vocabulary

單字	中譯	單字	中譯
non-electrolyte	非電解質	ion	離子
theory of electrolytic dissociation	電離說	positive ion	正離子
electrolytes	電解質	negative ion	負離子
electrical neutrality	電中性	anion	陰離子
dissociation	解離	cation	陽離子/正離子
saline	食鹽水	root ion	根/根離子
litmus paper	石蕊試紙		

■ 教學句型與實用句子 Sentence Frames and Useful Sentences

❶ _____is able to_____.

例句：Electrolyte **is able to** conduct electricity.

電解質能導電。

❷ _____ is capable of _____.

例句：Electrolyte **is capable of** conducting electricity.

電解質能導電。

❸ _____ is equal to_____.

例句：In aqueous electrolyte solution, the charge magnitude of positive ions **is equal to** the charge magnitude of negative ions.

在電解質水溶液中，正離子的帶電量等同於負離子的帶電量。

■ 問題講解 Explanation of Problems

☙ 學習目標 ❧

在學習完本單元後，學生應習得以下觀念：

一、電解質與非電解質的異同。

The similarities and differences between electrolyte and non-electrolyte.

二、電解質在水溶液中會解離出陰離子和陽離子而導電。

The electrolyte in aqueous solution will dissociate into anions and cations that lead to conduct electricity.

例題講解

例題一

說明：學生能根據導電特性區分電解質與非電解質。
Students can distinguish between electrolytes and non-electrolytes based on the conductive properties.

（英文）The picture shows the steps of an experiment, in which we can finally observe whether the light bulb is on. Regarding whether the bulb is on or not and the explanation, which of the following is correct?

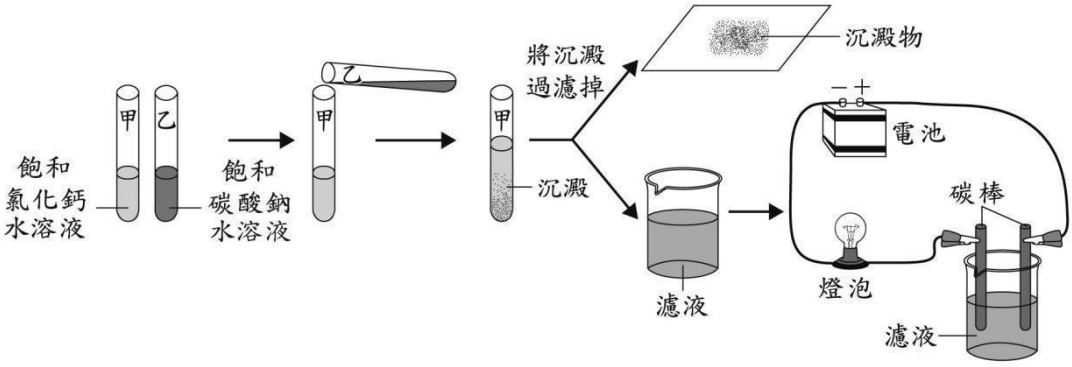
(A) It will shine because the filtrate only contains water.

(B) It will shine because the filtrate contains electrolytes.

(C) It will not shine because the filtrate only contains water.

(D) It will not shine because the filtrate contains electrolytes.

（中文）圖為小賀進行某實驗的步驟圖，最後觀察燈泡是否發亮。關於燈泡發亮與否及其解釋原因，下列何者正確？



(A)會發亮，因濾液只含有水

(B)會發亮，因濾液含有電解質

(C)不會發亮，因濾液只含有水

(D)不會發亮，因濾液含有電解質

（取自 108 年國中會考 2）

解題 Solution:

$CaCl_2 + Na_2CO_3 \rightarrow CaCO_3\downarrow + 2NaCl$，所以濾液為 NaCl 水溶液，也就是食鹽水，食鹽水為電解質，可導電。故選(B)。

$CaCl_2 + Na_2CO_3 \rightarrow CaCO_3\downarrow + 2NaCl$, so the filtrate NaCl aqueous solution is saline, saline is the electrolyte, which can conduct electricity. So choose (B).

Teacher: What is this question about?

Student: This question is about the conditions under which the light bulb in the picture shines or not.

Teacher: In the lesson we just learned, what can make the light bulb shine?

Student: It should be electrolyte.

Teacher: Why?

Student: Electrolytes can conduct electricity and thus can make the light bulb shine, but non-electrolytes cannot.

Teacher: It's great, so which option is right?

Student: Option (B). Because the filtrate NaCl aqueous solution is saline, saline is the electrolyte, which can conduct electricity

Teacher: That's right, because $CaCl_2 + Na_2CO_3 \rightarrow CaCO_3\downarrow + 2NaCl$. Saline is actually sodium chloride, an electrolyte that can dissociate into positive and negative ions, so it can conduct electricity.

老師： 請問這一題主要想問什麼？

學生： 這題在問，圖片中燈泡在什麼情況下會發光。

老師： 那麼我們剛剛在課堂學過什麼物質可以讓燈泡發亮？

學生： 應該是電解質。

老師： 為什麼呢？

學生： 電解質可以導電，非電解質不行。可以導電就能讓燈泡發亮。

老師： 很棒，那哪一個選項是對的呢？

學生： (B)。因為濾液為 NaCl 水溶液，也就是食鹽水，食鹽水可導電。

老師： 沒錯，因為 $CaCl_2 + Na_2CO_3 \rightarrow CaCO_3\downarrow + 2NaCl$，NaCl 水溶液是一種電解質，可以解離出正負離子，所以可以導電。

例題二

說明：學生能知道正離子與負離子在電解質水溶液中的關係。

Students can understand the relationship between positive ions and negative ions in the electrolyte aqueous solution.

（英文）The table lists the number of neutrons, electrons, and protons of the three ions, and different spheres represent neutrons, electrons, and protons (not arranged in this order). Given that two of these three ions are positive ions and one is negative ions, what should be the number of electrons in the negative ions in the table?

(A) 10

(B) 12

(C) 17

(D) 18

（中文）

	甲離子	乙離子	丙離子
○	18	12	12
●	17	12	11
◎	18	10	10

此表列出三種離子的中子數、電子數和質子數，且分別以不同的球表示中子、電子和質子（未依照此順序排列）。已知這三種離子中有兩個為正離子，一個為負離子，則表中負離子的電子數應為多少？

(A)10

(B)12

(C)17

(D)18

（取自 109 年會考 32）

解析 Solution:

根據題目敘述條件，三者皆為離子，質子數與電子數不會相等，故白球－黑球、白球－灰球皆不會是質子與電子的組合，可知黑球－灰球為質子與電子的組合。再由負離子電子數較多、正離子質子數較多可推知，甲離子為負離子，乙、丙為正離子，甲離子的質子數、電子數、中子數分別為 17、18、18。故選(D)。

According to the conditions described, all three items are ions, and the number of protons and electrons will not be equal. Therefore, the white ball-black ball, white ball and gray ball will

not be a combination of protons and electrons. It can be seen that the black ball-gray ball is a proton combined with electronics. Furthermore, it can be inferred from the fact that the number of negative ions has more electrons and the number of positive ions has more protons, A ions are negative ions, B and C are positive ions, and the number of protons, electrons, and neutrons of A ions are 17, 18, and 18, respectively. So we should choose (D).

Teacher: What is the question about??

Student: This question is about the structure of atoms and ions.

Teacher: So we learned protons, neutrons and electrons in class, right? Do you remember the relationship between their numbers?

Student: Yes. The number of protons and electrons in an electrically neutral atom is equal. If it is a positive ion, the number of electrons will be less than the number of protons. If it is a negative ion, the number of electrons will be more than the number of protons.

Teacher: Therefore, if an atom is an ion, will the number of protons be the same as the number of electrons?

Student: No. The number of white balls and gray balls of A ions is the same, and the number of white balls and black balls of B ions is the same, so it can be known that the black and gray balls may be protons and electrons.

Teacher: It's great, so which one is the negative ion, A, B or C?

Student: A is a negative ion, B and C are not. Because there is only one negative ion, and the number of electrons of the negative ion needs to be greater than the number of protons, it is judged by the black and gray balls of A, B, C, only the number of gray ball of A ion is larger than the black balls, so it can be determined that the gray ball is an electron, and the black ball is proton.

Teacher: That's right, can we tell the number of electrons of the A ion?

Student: Yes, it is 18.

Teacher: That's right. Good job.

老師： 請問這一題主要想問哪兩個觀念？

學生： 這一題問原子的構造跟離子。

老師： 那麼我們以前在課堂學過質子、中子及電子對吧?還記得他們數量間有什麼關係嗎？

學生： 是的，電中性的原子其質子數與電子數相等，若為正離子電子數會小於質子數，若為負離子電子數會大於質子數。

老師： 所以原子若為離子的話，質子數是否會和電子數相同？

學生： 不會。甲離子的白球與灰球數量相同，且乙離子的白球與黑球數量相同，因此可知黑球和灰球可能為質子和電子。

老師： 很棒，那哪個是負離子呢？

學生： 甲是負離子，乙、丙則不是。因為負離子只有一個，而負離子的電子數需大於質子數，因此由甲乙丙的黑球和灰球來判斷，只有甲離子的灰球大於黑球數量，如此可以確定灰球為電子，黑球為質子。

老師： 沒錯，那甲離子的電子數可以判斷出來嗎？

學生： 可以，是 18。

老師： 沒錯。

4-2 酸和鹼
Acid and base

■ 前言 Introduction

在本節課會利用一些物質和酸、鹼產生的不同反應，來教導學生認識酸和鹼的性質，除此之外，教師也會帶學生認識常見的酸、鹼，並介紹其特性、用途及安全性。

本章老師將以英文引導學生了解酸鹼物質的定義及用途，因此如果在英語使用頻率偏高的情況下，老師要先注意學生認不認得該物質，再進行說明。亦可以字根來引導學生判別。

■ 詞彙 Vocabulary

單字	中譯	單字	中譯
fertilizer	肥料	Nitric acid	硝酸
sulfuric acid	硫酸	deliquescence	潮解
universal test paper	廣用試紙	Acetic acid	醋酸
base	鹼	Acid	酸
Sodium hydroxide	氫氧化鈉	Hydrochloric acid	鹽酸
Calcium hydroxide	氫氧化鈣	Ammonia	氨

■ 教學句型與實用句子 Sentence Frames and Useful Sentences

❶ _____ is used to_____.

例句：Sulfuric acid **is used to** make fertilizers.

硫酸被用來製造肥料。

❷ _____ is used for_____.

例句：Sulfuric acid **is used for** the production of fertilizers.

硫酸被用來製造肥料。

❸ _____ is called _____.

例句：Sodium hydroxide **is called** caustic soda.

氫氧化鈉被稱為燒鹼。

❹ _____ is also known as _____.

例句：Sodium hydroxide **is also known as** caustic soda.

氫氧化鈉也被稱為燒鹼。

■ 問題講解 Explanation of Problems

☙ 學習目標 ❧

在學習完本單元後，學生應習得以下觀念：

一、了解酸與鹼性質。

Understand the properties of acids and bases.

二、認識常見的酸與鹼。

Recognize common acids and bases.

例題講解

例題一

說明：學生能夠辨別酸與鹼的不同特性。

Students can distinguish the different characteristics of acids and bases

（英文）Which one of the following methods can be used to identify whether a substance is an acid or base in the first stage?

(A) Add the substance to the water to see if it dissolves.

(B) Dissolve the substance in water and observe its temperature change.

(C) Dissolve the substance in water and observe whether it will conduct electricity.

(D) Dissolve the substance in water and test it with the universal test paper.

（中文）可以用下列哪一種方法，初步辨識物質屬於酸或是鹼？

(A) 將物質加入水中觀察是否溶解。

(B) 將物質溶於水觀察其溫度變化。

(C) 將物質溶於水中觀察是否會導電。

(D) 將物質溶於水中以廣用試紙檢驗。

（翰林版八下教學式講義）

解題 Solution:

物質的酸鹼性常用指示劑來辨別，若物質使廣用試紙變成紅、橙色為酸；藍、紫色為鹼，故選(D)。

The acidity and alkalinity of substances are often distinguished by indicators. If the substance makes the universal test paper turn red and orange, it is acid; blue and purple are base. So we choose (D).

Teacher: In the class, what are the common methods to distinguish the acid and base substances when we learned at the beginning?

Student: Using indicators.

Teacher: Yes, what are the common indicators?

Student: Litmus test paper and universal test paper.

Teacher: Yes, so considering all the options, which one is the most appropriate answer.

Student: Probably (D).

Teacher: Yes.

老師： 從課堂中，我們一開始學到要辨別物質的酸鹼常見的方法有哪些？

學生： 利用指示劑。

老師： 沒錯，那請問常見的指示劑有什麼？

學生： 石蕊試紙和廣用試紙。

老師： 沒錯，因此從選項中來看，哪一個是最合適的答。

學生： 可能是 (D)。

老師： 沒錯。

例題二

說明：學生能認識常見的酸鹼性物質的特性。

Students can understand the characteristics of common acid and alkaline substances.

（英文）Regarding the description of the properties of various acids and bases, which of the following is NOT correct?

(A) Ammonia has a foul smell and is neutral when dry.

(B) Sodium hydroxide easily absorbs carbon dioxide and deliquescence occurs.

(C) Sulfuric acid is widely used and has the title of "mother of the chemical industry".

(D) Concentrated nitric acid will decompose gas when exposed to light, so it appears light yellow.

（中文）關於各種酸鹼的性質描述，下列何者錯誤？

(A) 氨具有臭味，乾燥時呈中性。

(B) 氫氧化鈉容易吸收二氧化碳而發生潮解。

(C) 硫酸用途廣泛而有「化學工業之母」的稱號。

(D) 濃硝酸受光照會分解出氣體，因此呈現淡黃色。

（翰林版八下教學式講義改編）

解題 Solution:

氫氧化鈉容易吸收空氣中的水而發生潮解，而非二氧化碳，故選(B)。

Sodium hydroxide easily absorbs water in the air and deliquescence occurs instead of carbon

dioxide, so we choose (B).

Teacher: Is the statement describing the properties of ammonia correct from what we have learned in class?

Student: That's right, ammonia has a foul smell and is neutral when dry, so the aqueous solution will be alkaline.

Teacher: Yes, I would like to ask whether the description of sodium hydroxide in option (B) is correct?

Student: No

Teacher: What is wrong with the option?

Student: Sodium hydroxide easily absorbs water in the air and deliquescence occurs instead of carbon dioxide.

Teacher: In the class, it was mentioned that sulfuric acid is widely used in industry and has the title of “the mother of the chemical industry”. Concentrated nitric acid will decompose the toxic gas nitrogen dioxide when exposed to light, so it appears pale yellow, so choose (B).

老師： 請問由上課所學，對於氨性質的描述是否正確？

學生： 正確，氨具有臭味，乾燥時呈中性，溶於水時才會呈鹼性。

老師： 對的，那請問(B)選項對於氫氧化鈉的描述是否正確？

學生： 不對。

老師： 那錯誤的地方在哪邊？

學生： 氫氧化鈉容易吸收空氣中的水而發生潮解，而不是二氧化碳。

老師： 上課中也提到，硫酸在工業上用途廣泛有「化學工業之母」的稱號。而濃硝酸受光照，分解出有毒氣體二氧化氮，會呈現淡黃色，因此選項選(B)。

4-3 酸鹼的強弱與 pH 值
The Strength of Acid Base and pH

■ 前言 Introduction

本節將先介紹實驗室配置水溶液時，常用的體積莫耳濃度。接著介紹水的解離方程式，進而介紹不同強弱的酸鹼在水中的解離狀況。讓學生知道酸鹼水溶液中的氫離子與氫氧離子的多寡及 pH 值的定義，最後再透過介紹各種酸鹼指示劑，了解測試 pH 值的方式。本節有許多同類型的單字，如：酚酞、廣用指示劑、石蕊試紙，還有一些常見的離子；當提及其中一個單字時，可順帶引導學生回憶同類型的相似單字。句型方面則提供了比較和判讀酸鹼值的句子，讓學生在進行活動時或閱讀題目時可以使用到。

■ 詞彙 Vocabulary

單字	中譯	單字	中譯
Molarity	體積莫耳濃度	hydroxide ion	氫氧根離子
phenolphthalein	酚酞	litmus paper	石蕊試紙
universal indicator	廣用指示劑	weak base	弱鹼
dissociation	解離	weak acid	弱酸
hydrogen ion	氫離子	acid-base indicator	酸鹼指示劑
strong base	強鹼	pH meter	pH 計
strong acid	強酸	pH value	pH 值

■ 教學句型與實用句子 Sentence Frames and Useful Sentences

❶ _____ more/less _____ than_____.

例句：There are **more** hydrogen ions **than** hydroxide ions in acid solution.
酸性溶液中的氫離子比氫氧根離子多。

❷ _____ change from _____to_____.

例句：The lemon juice **change**s the red litmus paper **from** red **to** blue.
酸性溶液使紅色石蕊試紙從紅色變成藍色。

❸ _____ be used to _____.

例句：The universal indicator **is used to** test the pH value.
廣用指示劑用來測試酸鹼值。

❹ the more/-er _____, the more/-er _____

例句：**The lower** the pH value is, **the higher** the hydrogen ion concentration is.
pH 值愈低，氫離子濃度愈高。

❺ aqueous solution of _____

例句：The **aqueous solution of** sodium chloride is neutral, so the pH scale is 7.
因為氯化鈉水溶液是中性的，所以它的 pH 值是 7。

❻ _____ be less than _____.

例句：The aqueous solution of hydrogen chloride is acid, so the pH scale **is less than** 7.
氯化氫水溶液是酸性的，因此 pH 值小於 7。

❼ _____ be more than _____.

例句：The aqueous solution of sodium hydroxide is base, so the pH scale **is more than** 7.
氫氧化鈉水溶液是鹼性的，因此 pH 值小於 7。

■ 問題講解 Explanation of Problems

☙ 學習目標 ❧

在學習完本單元後，學生應習得以下觀念：

一、了解各種指示劑在酸鹼中的顏色變化。

Students understand the color changes of various indicators in acid and base.

二、了解不同酸鹼強弱的解離度。

Students understand the degree of dissociation of different acid and base strengths.

❧ 例題講解 ☙

例題一

說明：學生能了解石蕊試紙在酸鹼中的顏色變化。

Students can understand the color change of litmus paper in acid and base.

（英文）Akai collects rainwater in one place, and tests the acidity and alkalinity of rainwater with different test papers at 25°C. Which of the following test paper color changes is most likely to be the reason that indicates "the pH value of rainwater here is less than 5.0" one of the reasons?

(A) The blue litmus paper turns red

(B) The red litmus paper turns blue

(C) The blue cobalt chloride paper turns pink

(D) The pink cobalt chloride paper turns blue

（中文）阿凱於某地收集雨水，並在 25°C 的環境下，以不同的試紙測試雨水的酸鹼性，下列哪一種試紙的顏色變化情形，最可能是說明「此地雨水的 pH 值小於 5.0」的理由之一？

(A) 藍色石蕊試紙變成紅色

(B) 紅色石蕊試紙變成藍色

(C) 藍色氯化亞鈷試紙變成粉紅色

(D) 粉紅色氯化亞鈷試紙變成藍色

（106 年國中會考 13）

解題 Solution:

氯化亞鈷試紙常用來檢驗水的存在。而石蕊試紙常用來測試酸鹼，在酸性溶液中呈紅色，在鹼性溶液中則呈現藍色，故選(A)。

Cobalt chloride paper is often used to test the presence of water. Litmus paper is used to test acid and base. It is red in acidic solution and blue in alkaline solution, so choose (A)

Teacher: What color does litmus paper change in acid solution?

Student: Red.

Teacher: Right, so do you know what the cobalt chloride test paper is?

Student: I have no idea.

Teacher: Cobalt chloride paper is not used to test acid and base, it is used to test whether there is water.

老師： 石蕊試紙在酸性溶液中會變什麼顏色呢？

學生： 紅色。

老師： 沒錯，那麼大家知道氯化亞鈷試紙是什麼嗎？

學生： 不知道。

老師： 氯化亞鈷試紙不是用來測試酸鹼，是用來檢驗是否有水的存在。

例題二

說明：學生能知道不同強度的酸或鹼在同濃度時 pH 值的大小關係。

Students can understand the relationship between the pH values of acids or bases of different strengths at the same concentration.

（英文）At room temperature, Xiaoqi prepared three cups of A, B, and C aqueous solutions with a concentration of 0.2 M. The types and descriptions of the solutes are shown in the table. Which of the following should be the relationship between the pH value of the three cups of aqueous solution?

(A) A>B>C　　(B)A=B>C

(C) C>B>A　　(D)C>B=A

（中文）室溫下，小綺分別配製甲、乙、丙三杯濃度皆為 0.2 M 的水溶液，其溶質種類與說明，如表所示。這三杯水溶液 pH 值的大小關係，應為下列何者？

(A)甲>乙>丙　(B)甲=乙>丙

(C)丙>乙>甲　(D)丙>乙=甲

水溶液	溶質	說明
甲	HCl	強酸
乙	CH_3COOH	弱酸
丙	NaOH	強鹼

（109 年國中會考 13）

解題 Solution:

在相同濃度下，pH 值大小會考慮酸鹼的強弱，酸性越強，解離出的氫離子越多，pH 值越小，故選(C)。

At the same concentration, the pH value considers the strength of acid and base. The stronger the acidity is, the more hydrogen ions are dissociated and the lower the pH value, so choose (C).

Teacher: At the same concentration, the pH value considers the strength of acid and base, which solution dissociates the highest concentration of hydrogen ions?

Student: Strong acid.

Teacher: The higher the hydrogen ion concentration, the higher or the lower the pH value?

Student: Lower.

Teacher: That's right, so the pH value of strong acid is lower, followed by weak acid, and strong base is the largest.

老師：在相同濃度下，pH 值大小會考慮酸鹼的強弱，哪一種溶液解離的氫離子濃度最高？

學生：強酸。

老師：氫離子濃度越高，pH 值會越大還是越小？

學生：越小。

老師：沒錯，所以強酸 pH 值越小，其次是弱酸，最大的是強鹼。

4-4 酸鹼反應
Acid-Base Reaction

■ 前言 Introduction

本章將結合前幾堂課所學的莫耳濃度、pH 值、酸鹼指示劑，透過鹽酸與氫氧化鈉的中和來認識酸鹼反應，並引導學生思考酸鹼反應中酸鹼性的變化，最後再帶領同學們認識生活中常見的酸鹼實例及各種鹽類的特性與應用。

有些實驗器材以前已經上過，可用提問的方式讓學生回憶這些單字，而「滴定管」為新的單字，且與滴管的英文相差甚遠；因此，可以先說明這兩種器材的用途，再讓學生認識此單字。本章句型會用到解離與結合兩相反句型，在題目論述上較常見。

■ 詞彙 Vocabulary

單字	中譯	單字	中譯
phenolphthalein indicator	酚酞指示劑	evaporating dish	蒸發皿
exothermic reaction	放熱反應	Erlenmeyer flask	錐形瓶
buret	滴定管	acid-base titration	酸鹼滴定
dropper	滴管	acid-base neutralization	酸鹼中和
funnel	漏斗	salt	鹽類
Sodium hydroxide	氫氧化鈉	hydrochloric acid	鹽酸
dilute	稀釋	thermometer	溫度計

■ 教學句型與實用句子 Sentence Frames and Useful Sentences

❶ _____ dissociate into_____.

例句：Hydrochloric acid will **dissociate into** hydrogen ions and chlorine ions in water.
鹽酸在水中會解離出氫離子與氯離子。

❷ _____ react with _____.

例句：When an acid reacts **with** a base, neutralization occurs.
當酸與鹼結合時，會產生中和作用。

❸ _____ depend(s) on _____.

例句：The pH value of an aqueous solution **depends on** its hydrogen ion concentration.
水溶液的 pH 值取決於其氫離子濃度。

❹ _____ come(s) from _____.

例句：Salts can be obtained by acid-base neutralization reactions. Salt's cation **come from** bases and its anion come from anion.
鹽類可由酸鹼中和反應求得，而鹽的陽離子來自鹼，其陰離子來自酸。

■ 問題講解 Explanation of Problems

學習目標

在學習完本單元後，學生應習得以下觀念：

一、了解酸鹼反應所產生的現象

Students should understand the phenomena caused by acid-base reactions.

二、了解中和反應是水溶液中氫離子(H^+)和氫氧根離子(OH^-)化合成水的反應，其生成物為鹽

Students should understand that neutralization is the reaction of hydrogen ions (H^+) and hydroxide ions (OH^-) in an aqueous solution to form water, the product of which is salt.

例題講解

例題一

說明：學生能了解酸鹼中和為放熱反應。

Students should understand that acid-base neutralization is an exothermic reaction.

（英文）Picture (17) is the diagram of the experiments of group A and group B, both of which are about mixing liquids. The following statements are about the experiments of endothermic or exothermic reactions. Which description is correct?

(A) Only experiment “A” is an endothermic reaction.

(B) Only experiment “A” is an exothermic reaction.

(C) Both experiments were endothermic reactions.

(D) Both experiments were exothermic reactions.

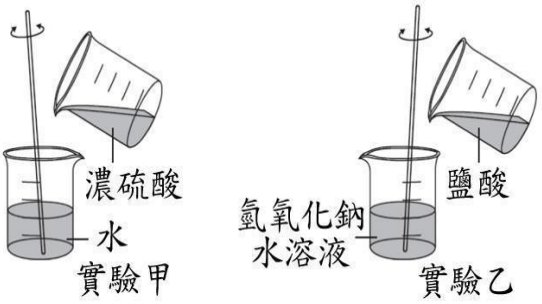
（中文）圖(十七)為進行甲和乙兩組溶液混合實驗的示意圖，關於兩組實驗是吸熱反應或放熱反應的說明，下列何者正確？

(A)只有實驗甲是吸熱反應

(B)只有實驗甲是放熱反應

(C)兩組實驗均是吸熱反應

(D)兩組實驗均是放熱反應



圖(十七)

（109 年國中會考 25）

解題 Solution:

稀釋濃硫酸實驗與酸鹼中和均會使溶液溫度上升，均為放熱反應。故答案選(D)。

Both the experiment of diluting concentrated sulfuric acid and acid-base neutralization will increase the temperature of solution. They are all exothermic reactions, so the answer is (D).

Teacher: What experiment did we learn in this class?

Student: The acid-base neutralization experiment of sodium hydroxide and hydrochloric acid.

Teacher: When we slowly drop hydrochloric acid into sodium hydroxide, what changes have we found?

Student: The phenolphthalein indicator changes from red to transparent and colorless.

Teacher: Yes, what's the temperature change?

Student: The temperature after the reaction is higher than that before the reaction.

Teacher: Yes, so is it acid-base neutralization exothermic or endothermic?

Student: Exothermic reaction.

Teacher: Do you remember the precautions and introduction in the laboratory that we learned before? When diluting concentrated sulfuric acid, should we add water into sulfuric acid or add sulfuric acid into water?

Student: Adding sulfuric acid into water.

Teacher: That's correct. Otherwise the sulfuric acid will boil, which may cause danger. Therefore, can we know whether the diluted sulfuric acid is an exothermic reaction or an endothermic reaction?

Student: Exothermic reaction.

Teacher: The answer is (D). Both groups of experiments are exothermic reactions.

老師： 請問這堂課我們認識了什麼實驗呢？

學生： 氫氧化鈉與鹽酸的酸鹼中和實驗。

老師： 我們將鹽酸慢慢滴入氫氧化鈉中，請問我們發現了哪些變化？

學生： 酚酞指示劑從紅色變成透明無色。

老師： 是的，請問溫度上有什麼變化呢？

學生： 反應後的溫度比反應前的溫度高。

老師： 是的，所以酸鹼中和是放熱反應還是吸熱反應呢？

學生： 放熱反應。

老師： 還記得我們之前上的實驗注意事項與介紹嗎？在稀釋濃硫酸時，要將水加入硫酸中，還是將硫酸加入水中呢？

學生： 將硫酸加入水中。

老師： 沒錯，否則硫酸遇水會沸騰，讓大量硫酸噴濺出來，可能會造成危險，由此可知稀釋硫酸是放熱反應還是吸熱反應呢？

學生： 放熱反應。

老師： 所以答案為(D)兩組實驗均是放熱反應。

例題二

說明：學生能理解酸鹼中和的意義，操作酸鹼中和實驗。

Students can understand the relationship between the pH values of acids or bases of different strengths at the same concentration.

（英文）Xuan and Ping conducted acid-base neutralization experiments respectively. They put 0.5 M sodium hydroxide solution into a buret and start dropping it into an Erlenmeyer flask containing 0.5 M, 3 mL hydrochloric acid and several drops of phenolphthalein indicator. They shake the Erlenmeyer flask from time to time until the color of the solution changes. The table shows the scale of sodium hydroxide solution dosage and the record of solution color in the Erlenmeyer flask during the process.

Which of the following statements is true about the results of different dosage between the two people?

(A) Xuan's result is more accurate. The solution in the bottle turns red, which means that the solution is alkaline at this time.

(B) Ping's result is more accurate. The solution in the bottle turns red, which means that the solution is alkaline at this time.

(C) The result of Xuan is more accurate. When it is close to the discoloration range, the amount of sodium hydroxide should be increased step by step

(D) The result of Ping is more accurate. When it is close to the discoloration range, the amount of sodium hydroxide should be decreased step by step.

（中文）小萱和小屏分別進行酸鹼中和實驗，將 0.5M 氫氧化鈉溶液裝入滴定管中，開始滴入裝有 0.5 M、3 mL 鹽酸和數滴酚酞指示劑的錐形瓶內，且不時搖晃錐形瓶，直到溶液顏色發生變化為止。表為過程中，氫氧化鈉溶液用量的刻度與錐形瓶內溶液顏色的紀錄。關於二人用量不同的結果，下列敘述何者正確？

小萱

NaOH（mL）	錐形瓶內溶液顏色
0	無色
0.2	無色
0.5	無色
1.0	無色
1.5	無色
2.0	無色
4.0	紅色

小屏

NaOH（mL）	錐形瓶內溶液顏色
0	無色
1.0	無色
2.0	無色
2.5	無色
2.7	無色
2.9	無色
3.1	紅色

(A)小萱的結果較準確，瓶內溶液變紅色代表此時溶液呈鹼性
(B)小屏的結果較準確，瓶內溶液變紅色代表此時溶液呈鹼性
(C)小萱的結果較準確，接近變色範圍時應逐次增加氫氧化鈉滴入量
(D)小屏的結果較準確，接近變色範圍時應逐次減少氫氧化鈉滴入量

（100 年第一次基測 36）

解題 Solution:

酸鹼中和時，水溶液中氫離子(H^+)和氫氧根離子(OH^-)之莫耳數要相等。因氫氧化鈉與鹽酸皆為 0.5 M，且鹽酸的體積為 3 mL，因此需要氫氧化鈉的體積也應為 3 mL。接近變色範圍時，應逐漸減少滴入量。故答案為(D)。

In acid-base neutralization, the molar number of hydrogen ion (H^+) and hydroxide ion (OH^-) in aqueous solution should be equal. Since both sodium hydroxide and hydrochloric acid are 0.5 M and the volume of hydrochloric acid is 3 mL, the volume of sodium hydroxide should also be 3 mL. When approaching the discoloration range, the dripping amount shall be gradually reduced. So the answer is (D).

Teacher: What experiment did we learn in this class?

Student: Neutralization experiment of adding hydrochloric acid to sodium hydroxide.

Teacher: Can you recall how the experiment was carried out?

Student: We use a buret to slowly drop hydrochloric acid into an Erlenmeyer flask with sodium hydroxide.

Teacher: Why is the solution in the Erlenmeyer flask red at first?

Student: Because we add the phenolphthalein indicator.

Teacher: How does phenolphthalein indicator show the acid and base of substances?

Student: It will turn red in neutral and base conditions and transparent and colorless in acid conditions.

Teacher: In the question, Xuan and Ping put sodium hydroxide in the buret, while they add phenolphthalein indicator and hydrochloric acid in the Erlenmeyer flask. They finally succeeded in turning the phenolphthalein indicator red. What's the difference between their experiment methods?

Student: In the last step, Xuan added 2 mL of sodium hydroxide and Ping added 0.2 mL of sodium hydroxide.

Teacher: Please think about which student will get the acid-base neutralization dose more accurately? And think about why.

Student: When Ping almost neutralizes the solution, he gradually reduces the amount of dripping. We know that acid-base neutralization will be achieved within the range of 0.2 mL. Xuan drips more sodium hydroxide, so the error range will be larger.

老師： 請問我們這堂課上了什麼實驗？

學生： 鹽酸加入氫氧化鈉的中和實驗。

老師： 可以回憶一下實驗如何進行的嗎？

學生： 將鹽酸用滴定管，慢慢滴入裝有氫氧化納的錐形瓶中。

老師： 為什麼剛開始錐形瓶中的液體是紅色的呢？

學生： 因為加入了酚酞指示劑。

老師： 請問酚酞指示劑如何呈現物質的酸鹼性呢？

學生： 在中性和鹼性的狀況下會成紅色，在酸性的狀況下會成透明無色。

老師： 我們看到題目中，小萱和小屏是將氫氧化鈉放在滴定管中，而酚酞指示劑和鹽酸放在錐形瓶中，他們最後都成功讓酚酞指示劑變成紅色了，請問他們兩人的實驗方法差在哪裡？

學生： 小萱最後一個步驟加了 2 毫升的氫氧化納，而小屏加了 0.2 毫升的氫氧化納。

老師： 請思考一下哪一位同學得到的酸鹼中和劑量會比較準確？並想一下原因。

學生： 小屏在接近變色範圍時，逐漸減少滴入的量，讓我們得知在 0.2 毫升的範圍內就會達到酸鹼中和，而小萱滴入的量較多，誤差範圍會更大。

★主題五 反應速率與平衡★
Reaction Rate and Equilibrium

國立彰化師範大學化學系　方宣幃、邱韋慈
國立彰化師範大學英語系　劉俊億、徐毓瑩

■ 前言 Introduction

本章首先介紹反應速率的定義及反應速率表示法，教師先帶學生探討反應物的本質、催化劑、接觸面積、濃度及溫度對反應速率的影響，再進一步介紹可逆反應與平衡狀態，透過和學生討論的方式讓學生了解改變平衡狀態的因素。

在語言方面，比較句於本章十分重要，老師可在教學活動前提供句型，讓學生試著照樣造句，能對觀念加深印象與熟悉語言的使用。本章需使用到較進階的單字，如：酵素、催化劑，較難以記憶，建議能在兩小節中反覆出現，以利記憶。

5-1 反應速率
Reaction Rate

■ 前言 Introduction

教師可利用課本中或生活中的例子，讓學生理解何謂反應速率，並帶領同學思考何種因素會影響反應速率，再分別介紹反應物的本質、催化劑、濃度、接觸面積、溫度與反應速率之間的關係，並舉例說明，再以題目檢測學生的理解程度。

語言方面，教師可以提供學生情境或是以生活中的例子來訓練學生的表達能力，但是要注意學生是否理解各項之間的關係，比如說連接詞或是轉折語的使用。

■ 詞彙 Vocabulary

單字	中譯	單字	中譯
collision frequency	碰撞頻率	precipitation	沉澱物
reaction rate	反應速率	enzyme	酵素；酶
concentration	濃度	catalyst	催化劑或觸媒
Haber process	哈柏法	temperature	溫度
contact area	接觸面積	ammonia	氨

■ 教學句型與實用句子 Sentence Frames and Useful Sentences

❶ _____ influence _____.

例句：Temperature, concentration of reactants, contact area and catalyst will **influence** chemical reaction rate.

溫度、反應物濃度、接觸面積及催化劑會影響反應速率。

❷ The more adj. / adj.-er _____, the faster _____.

例句：**The larger** the contact area is, **the faster** the reaction rate will be.

接觸面積越大，反應速率越快。

❸ _____ such as _____.

例句：Some factors will affect the chemical reaction rate, **such as** the nature of the reactants, temperature, concentration of reactants, contact area and catalyst.

有些因素會影響反應速率，如反應物的本質、溫度、反應物濃度、接觸面積和催化劑。

❹ _____ bump into _____.

例句：If the concentration of reactants gets higher, the particles of reactants are more likely to **bump into** one another.

如果反應物濃度愈高，反應物的粒子就愈有可能相互碰撞。

❺ have/has to do with_____

例句：Why does the catalyst **have to do with** the reaction rate?

為什麼催化劑與反應速率有關？

❻ cut _____ into pieces

例句：I **cut** the meat **into pieces** to increase the contact surfaces.

我把肉切成小塊以增加接觸面積。

■ 問題講解 Explanation of Problems

☙ 學習目標 ❧

在學習完本單元後，學生應習得以下觀念：

一、認識化學反應速率及影響反應速率的因素，例如:本質、溫度、濃度、接觸面積及催化劑。

Students should understand the chemical reaction rate and the factors that affect the reaction rate, such as the nature of the reactants, temperature, concentration, contact area and catalyst.

❧ 例題講解 ☙

例題一

說明：了解物質之接觸面積會影響反應速率。

Knowing the contact area of a substance affects the rate of a reaction.

（英文）There are two beakers A and B on the both sides of the weighing pan of the balanced scale. The beakers contain hydrochloric acid with the same concentration and volume. The pointer points to the center when it is still. We pour two pieces of X and Y marble pieces with the same mass but different particle sizes into the A and B beakers at the same time, as is shown in the left picture. When there is reaction at the beginning, some gases are emitted, which the mass of the two cups is reduced, and the pointer deflected to the right, as shown in the picture on the right.

According to the results on the right, which of the following is the correct result and explanation for the speed of the initial reaction rate in the beaker?

(A) A beaker is faster because the particles of X are larger

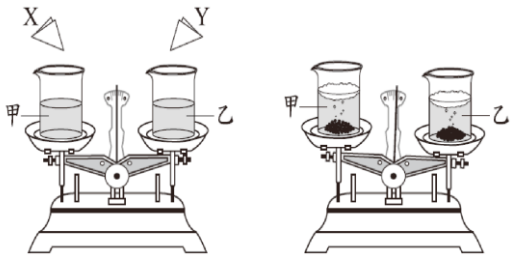
(B) A beaker is faster because the particles of X are smaller

(C) The second beaker is faster because the particles of Y are larger

(D) The second beaker is faster because the particles of Y are smaller

（中文）天平兩邊秤盤上分別有甲、乙兩燒杯，燒杯中盛有濃度、體積均相同的鹽酸，靜止時指針指在中央的位置。將質量相同但顆粒大小不同的 X、Y 兩份大理石碎塊，同時分別倒入甲、乙兩燒杯，如左圖所示。反應剛開始冒出氣體，使兩杯質量均減輕，且指針往右偏轉，如右圖所示。根據右圖結果，判斷燒杯內初始反應速率的快慢及其原因，下列說明何者正確？

(A)甲燒杯較快，因為 X 的顆粒較大
(B)甲燒杯較快，因為 X 的顆粒較小
(C)乙燒杯較快，因為 Y 的顆粒較大
(D)乙燒杯較快，因為 Y 的顆粒較小



（109 年國中會考 11）

解題 Solution:：

大理石和鹽酸反應會產生 CO_2 氣體逸散至空氣中，使兩杯質量減少，因天平指針向右偏，代表開始反應時甲杯質量減輕的幅度比乙杯大，也就是甲杯反應速率較快，X 的顆粒較小，減輕的質量較多。故選(B)。

The reaction of marble and hydrochloric acid will cause CO_2 gas to escape into the air, which will reduce the mass of the two cups. The pointer of the balanced scale is shifted to the right, meaning that the weight loss of cup A is greater than that of cup B when the reaction starts. Therefore, cup A has a faster reaction rate and X are smaller particles and more reduced mass.

Teacher: After you read the question and options, what is this question mainly talking about?

Student: Relationship between reaction rate and particle size.

Teacher: Recall what we just said. What factors affect the reaction rate?

Student: Properties of reactants, temperature, concentration, contact area and catalyst.

Teacher: Excellent. What factors do marble particle size have to do with it? Properties? Temperature? Concentration? Contact area? Or catalyst?

Student: Contact area.

Teacher: Does the big contact area make the reaction rate faster? Or does the small contact area make the reaction rate faster?

Student: Big contact area.

Teacher: How can you tell that both beakers have chemical reactions?

Student: Both beakers produce gas.

Teacher: According to the question, does “the pointer deflects to the right” mean that the A beaker becomes heavier or lighter?

Student: Lighter.

Teacher: Why does the A beaker become lighter at the beginning of the reaction?

Student: The gas produced by chemical reaction is released into the air, and A beaker releases more gas than B beaker.

Teacher: Is the reaction rate of A beaker faster or B beaker?

Student: A beaker.

Teacher: That's correct. So the answer is (b) A beaker is faster because the particles of X are smaller.

老師： 看完題目和選項後，請問這個題目大概是想問什麼呢？

學生： 反應速率和顆粒大小的關係。

老師： 請回想一下我們剛剛說過，有哪些因素會影響到反應速率呢？

學生： 反應物本身的本質、溫度、濃度、接觸面積及催化劑。

老師： 很好。請問這題問的大理石顆粒大小與什麼因素想關呢？性質？溫度？濃度？接觸面積？還是催化劑呢？

學生： 接觸面積。

老師： 那請問接觸面積大會讓反應速率的比較快？還是接觸面積小讓反應速率比較快？

學生： 接觸面積大。

老師： 請問怎麼看出兩杯都產生化學反應呢？

學生： 兩杯都產生出氣體。

老師： 根據題目所說，請問「指針往右偏轉」代表甲杯變得比較重還是比較輕？

學生： 比較輕。

老師： 為什麼反應初期甲杯會變得比較輕呢？

學生： 化學反應產生的氣體釋放到空氣中，而甲杯釋放的氣體比乙杯多。

老師： 請問是甲杯的反應速率比較快還是乙杯？

學生： 甲杯。

老師： 沒錯，所以答案選(B)甲燒杯較快，因為 X 的顆粒較小。

例題二

說明：學生能了解增加反應速率的方法。

Students can learn about ways to increase the rate of a reaction.

（英文）When camping in the wild or climbing high mountains, magnesium is often one of the essential items for survival. Cutting magnesium blocks into fragments can ignite wood fires even in humid environments or in strong winds, which is a way of making fires in the wild that is less restricted by the environment. Regarding the action of "cutting the magnesium block into pieces", which of the following factors affect the reaction rate is mainly considered?

(A) Temperature

(B) Catalyst

(C) Material nature

(D) Contact area

（中文）野外露營或攀登高山時，鎂塊常是求生必備的物品之一。將鎂塊削成碎片，在潮濕環境或強風吹襲中，仍然能引燃柴火，是一種較不受環境限制的野外生火方式。關於將鎂塊「削成碎片」的動作，主要是考慮下列何種影響反應速率的因素？

(A)溫度

(B)催化劑

(C)物質本質

(D)接觸面積

（108 年國中會考 1）

解題 Solution:

把鎂塊削成碎片，可增加與空氣中氧的接觸面積，以加速反應速率。故選(D)。

Cutting the magnesium block into fragments can increase the contact area, and thus the oxygen in the air can easily accelerate the reaction rate.

Teacher: What factors are related to the reaction rate?

Student: Nature of reactants, temperature, concentration, contact area and catalyst.

Teacher: According to the question, what should be done with the magnesium block?

Student: Cut the magnesium block into pieces.

Teacher: After the magnesium block is cut into pieces, will the overall surface area become larger or smaller?

Student: Becoming larger.

Teacher: That's correct. What is the factor that affects the reaction rate, such as slicing meat and dividing charcoal into small pieces?

Student: Increasing the contact area.

Teacher: Therefore, the magnesium block is sliced to increase the contact area between air and magnesium block, so (D) is selected.

老師： 請問這堂課上過，反應速率與何種因素有關？

學生： 反應物本身的性質、溫度、濃度、接觸面積及催化劑。

老師： 請問這個題目要將鎂塊做何種處理？

學生： 將鎂塊削成碎片。

老師： 將鎂塊削成碎片後，整體的表面積會變大還是變小？

學生： 變大。

老師： 對。請問這堂課所舉的例子，如：將肉切片、將木炭分成小塊，皆是應用何種影響反應速率的因素？

學生： 增加接觸面積。

老師： 所以將鎂塊切片也是為了增加空氣與鎂塊接觸面積，故選(D)。

5-2 可逆反應與平衡
Reversible Reaction and Equilibrium

■ 前言 Introduction

本節介紹可逆反應與平衡，教師可以先講解可逆反應的定義及實例，並介紹物理變化及化學變化的可逆反應例子，在此，老師也可以為學生釐清觀念，並非所有反應都是可逆反應。接著簡單複習反應速率後再講解化學平衡狀態的定義及改變平衡狀態的因素。教師可以以表達「影響」的句型來引導學生表達影響平衡的因素。如果學生學習狀況良好可以補充更多相關的句型讓學生練習。

■ 詞彙 Vocabulary

單字	中譯	單字	中譯
closed system	密閉系統	reversible reaction	可逆反應
dynamic balance	動態平衡	forward reaction	正反應
equilibrium state	平衡狀態	catalyst	催化劑
cobalt chloride	氯化亞鈷	dinitrogen tetroxide	四氧化二氮
reverse reaction	逆反應	potassium dichromate	二鉻酸鉀
potassium chromate	鉻酸鉀	nitrogen dioxide	二氧化氮

■ 教學句型與實用句子 Sentence Frames and Useful Sentences

❶ affect _____. = have an effect on _____.

例句：Changing the temperature will **affect** the equilibrium state of nitrogen dioxide.

＝Changing the temperature of nitrogen dioxide will **have an effect on** its state of equilibrium.

改變溫度會影響二氧化氮的平衡狀態。

❷ when _____.

例句：**When** the precipitation rate is equal to its dissolution rate in the saturated salt solution, it is called the equilibrium state.

當沉澱速率與溶解速率在飽和食鹽溶液中相同時，稱為平衡狀態。

❸ the rate of _____

例句：The evaporation rate of water is equal to **the** condensation **rate of** water vapor in the closed system.

在封閉系統中，水的蒸發速率等於水蒸氣的凝結速率。

■ 問題講解 Explanation of Problems

學習目標

在學習完本單元後，學生應習得以下觀念：

一、了解化學反應處於平衡狀態時，依然為動態平衡。

Understand that when chemical reactions are in equilibrium state, it is still in dynamic balance.

二、認識影響平衡狀態的各種因素，並學會判斷正逆反應的進行方向。

Understand the various factors that affect the equilibrium state, and learn to determine the direction of the forward and reverse reactions.

例題講解

例題一

說明：讓學生了解化學反應的平衡狀態且理解此過程為動態平衡。
Students can understand the equilibrium state of chemical reactions and know this process as dynamic balance.

（英文）At room temperature, there is a sealed transparent bottle filled with half-full water. After a period of time, the water level does not change significantly. Regarding the description in the bottle, which of the following is correct.

(A) The rate at which hydrogen reacts with oxygen to form water is greater than the rate at which water decomposes into hydrogen and oxygen.

(B) The evaporation rate of water is less than the condensation rate of water vapor, so water can still be seen in the bottle.

(C) The evaporation rate of water is equal to the condensation rate of water vapor, and the two continue and the rate is equal.

(D) After the evaporation rate of water and the condensation rate of water vapor reach equilibrium, both evaporation and condensation stop.

（中文）室溫下，有一密封的透明瓶子，裝了半滿的水，放置一段時間後，水位沒有明顯變化，關於瓶內的敘述，下列何者正確。

(A) 氫氣與氧氣反應生成水的速率大於水分解成氫氣與氧氣的速率。

(B) 水的蒸發速率小於水蒸氣的凝結速率，所以瓶中仍見得到水。

(C) 水的蒸發速率等於水蒸氣的凝結速率，兩者持續進行且速率相等。

(D) 水的蒸發速與水蒸氣得凝結速率達到平衡後，蒸發與凝結均停止。

（100 第二次國中基測 15）

解題 Solution:

平衡狀態通常發生在溫度固定的密閉系統中，水的蒸發速率等於水蒸氣的凝結速率，兩者達成平衡，且此為動態平衡，故選(C)。

The equilibrium state usually occurs in a closed system with a fixed temperature. The evaporation rate of water is equal to the condensation rate of water vapor. The two reach a balance, and this is a dynamic equilibrium, so select (C).

Teacher: We have learned in class, will the amount of water change when the water is kept at a certain temperature in a closed space for a period of time?

Student: No.
Teacher: Yes, what will happen to the water inside the bottle in this closed space?
Student: Evaporation and condensation.
Teacher: That's right, when in a closed space at a constant temperature, the evaporation rate of water after a period of time will be equal to the condensation rate. What is this called?
Student: The reaction reaches an equilibrium state.
Teacher: Yes. Does the reaction stop after reaching equilibrium?
Student: No, the reaction will be in dynamic equilibrium.
Teacher: Great, and what should we choose for the answer to this question?
Student: The answer is (C).

老師： 在課堂中我們學過，當水在一定溫度且密閉空間中過一段時間後水的量會改變嗎？
學生： 不會。
老師： 沒錯，那請問瓶子內部的水在這個密閉空間中會發生什麼事？
學生： 蒸發和凝結。
老師： 沒錯，當在固定溫度中的密閉系統，過一段時間後水的蒸發速率會等於凝結速率，此稱為什麼？
學生： 反應達平衡狀態。
老師： 沒錯，那請問到達平衡後反應是否停止？
學生： 沒有，反應會處於動態平衡。
老師： 很好，所以這題的答案要選什麼？
學生： 答案要選(C)。

例題二

說明：學生能判斷改變平衡狀態的因素以及正逆反應的相對速率。

Students can determine the factors that change the equilibrium state and determine how the relative rates of forward and reverse reactions proceed.

（英文）At room temperature, adding sodium hydroxide to an aqueous solution containing orange-red dichromate ions ($Cr_2O_7^{2-}$) will produce yellow chromate ions (CrO_4^{2-}). When equilibrium is reached, the reversible reaction is expressed as:

$$Cr_2O_7^{2-} + 2\,OH^- \underset{\text{逆反應}}{\overset{\text{正反應}}{\rightleftharpoons}} 2\,CrO_4^{2-} + H_2O$$

If carbon dioxide is introduced into the above aqueous solution to make the balance move again, which of the following statements about the reaction trend and substance concentration is correct?

(A) The reaction proceeds in the direction of forward reaction, and when a new equilibrium is reached, $[Cr_2O_7^{2-}]$ is equal to 0.

(B) The reaction proceeds in the direction of forward reaction, when a new equilibrium is reached, $[CrO_4^{2-}]$ increases.

(C) The reaction proceeds in the reverse reaction direction, and when a new equilibrium is reached, $[CrO_4^{2-}]$ is equal to 0.

(D) The reaction proceeds in the reverse reaction direction, when a new equilibrium is reached, $[Cr_2O_7^{2-}]$ increases.

（中文）室溫時，在含有橘紅色二鉻酸根離子($Cr_2O_7^{2-}$)的水溶液中加入氫氧化鈉，會產生黃色的鉻酸根離子(CrO_4^{2-})，達平衡時，其可逆反應表示為：

$$Cr_2O_7^{2-} + 2\,OH^- \underset{\text{逆反應}}{\overset{\text{正反應}}{\rightleftharpoons}} 2\,CrO_4^{2-} + H_2O$$

若對上述水溶液通入二氧化碳，使平衡再次移動，則關於此反應趨向和物質濃度的敘述，下列何者正確？

(A) 反應向正反應方向進行，達新平衡時，$[Cr_2O_7^{2-}]$等於 0

(B) 反應向正反應方向進行，達新平衡時，$[CrO_4^{2-}]$增加

(C) 反應向逆反應方向進行，達新平衡時，$[CrO_4^{2-}]$等於 0

(D) 反應向逆反應方向進行，達新平衡時，$[Cr_2O_7^{2-}]$增加

（109 年國中會考補考 37）

解題 Solution:

二氧化碳溶於水為酸性，解離出碳酸根和H^+，因此反應向逆反應進行，$[Cr_2O_7^{2-}]$增加，故選(D)。

Carbon dioxide dissolves in water is acidic, dissociates carbonate and H^+, so the reaction proceeds to the reverse reaction, $[Cr_2O_7^{2-}]$ increases, so select (D).

Teacher: Is carbon dioxide soluble in water acidic or alkaline?

Student: Acidic, is carbonic acid.

Teacher: Excellent. From the reaction formula of the question, do you think the reaction will proceed in the forward or reverse direction?

Student: Proceed in the reverse reaction direction, because the acidic substance will dissociate hydrogen ions, and react with the hydroxide ions of the reaction formula to generate water, resulting in a decrease in the concentration of hydroxide ions, so the reaction proceeds in the reverse reaction direction, resulting in an increase in $[Cr_2O_7^{2-}]$.

老師： 二氧化碳溶於水是酸性或鹼性呢？

學生： 酸性，是碳酸。

老師： 很好，那由題目的反應式來看，你們認為反應會向正反應方向還是逆反應方向進行呢？

學生： 向逆反應方向進行，因為酸性物質會解離出氫離子，和反應式的氫氧根離子反應生成水，而導致氫氧根離子濃度減少，因此反應往逆反應方向進行，而導致$[Cr_2O_7^{2-}]$增加。

★主題六 有機化合物★
Organic Compound

國立彰化師範大學化學系　方宣幃、邱韋慈
國立彰化師範大學英語系　劉俊億、徐毓瑩

■ 前言 Introduction

本章首先介紹有機化合物的定義和重要特徵，教師透過乾餾實驗讓學生驗證有機化合物與無機化合物的差異，再進一步介紹有機化合物種類如:烴、醇、酸、酯的結構與性質，並認識石油、天然氣等化石燃料。最後先讓學生了解聚合物的定義，再透過討論與活動，讓學生能將衣物材質、食物成分和皂化反應等生活實例與有機化合物做連結。

在語言方面，「含有」的用法於本章十分重要，老師可在教學活動中提供同學練習，能加深學生對有機物結構、性質和句型用法的印象。因為本章與生活實例高度相關，所以要訓練學生舉例說明的語言能力，能幫助學生能將知識與語言在生活中應用。

6-1 有機化合物的組成
Composition of Organic Compounds

■ 前言 Introduction

本節學生將要學會「電解質」及「電離說」兩大觀念，教師需要以水溶液的導電實驗，教導學生判別電解質與非電解質。

使用英語時，老師要注意避免使用過難的句型，重點是讓學生能理解電中性的觀念而非單字常見的意思。

語言方面，教師應以較常見的例子介紹有機化合物的相關知識，並以表達「轉變」與「組成」之句型，讓學生更深入了解有機化合物的結構與性質。

■ 詞彙 Vocabulary

單字	中譯	單字	中譯
flour	麵粉	methane	甲烷
calcium carbide	電石	cyanide	氰化物
carbonate	碳酸鹽	organic compound	有機化合物
urea	尿素	carbon monoxide	一氧化碳
dry distillation	乾餾	inorganic compound	無機化合物
tar	焦油		

■ 教學句型與實用句子 Sentence Frames and Useful Sentences

❶ _____ turn into _____.

例句：The powdered sugar or flour in aluminum foil **turns into** black flammable solids after heating.

鋁箔中的糖粉或麵粉在加熱後會轉變成黑色的可燃性固體。

❷ _____ change into _____.

例句：The powdered sugar or flour in aluminum foil **changes into** black flammable solids after heating.

鋁箔中的糖粉或麵粉在加熱後會轉變成黑色的可燃性固體。

❸ _____ contain _____.

例句：Smoke from the dry distillation of powdered sugar or flour **contain**s combustible carbon monoxide, methane, hydrogen and non-flammable carbon dioxide and water vapor.

糖粉或麵粉乾餾時產生的濃煙，其中含有可燃的一氧化碳、甲烷、氫氣和不可燃的二氧化碳及水蒸氣。

■ 問題講解 Explanation of Problems

學習目標

在學習完本單元後，學生應習得以下觀念：

一、學生學會區分有機化合物和無機化合物，並探討從乾餾實驗中了解其有機化合物的組成。

Students learn to distinguish the difference between organic compounds and inorganic compounds and understand the composition of organic compounds from dry distillation experiments.

例題講解

例題一

說明：學生能了解有機化合物和無機化合物的性質概念。
Students can understand the properties of organic compounds and inorganic compounds.

（英文）(I) All organic compounds contain carbon; (II) Carbon-containing compounds are organic compounds; (III) Inorganic compounds do not contain carbon; (IV) Non-carbon-containing compounds are inorganic compounds. Which of the above is correct?
(A) (I)(II)
(B) (I)(III)
(C) (I)(IV)
(D) (II)(IV)

（中文）(I) 有機化合物都含碳；(II) 含碳的化合物都是有機化合物；(III) 無機化合物都不含碳；(IV) 不含碳的化合物都是無機化合物。以上正確的有哪些？
(A) (I)(II)
(B) (I)(III)
(C) (I)(IV)
(D) (II)(IV)　（翰林版教學式講義國中自然 4）

解題 Solution:
(II) 含碳的化合物不一定為有機化合物；(III) 無機化合物有可能含碳。故選(C)。
(II) Carbon-containing compounds are not necessarily organic compounds; (III) Inorganic compounds may contain carbon. So choose (C).

Teacher: From what we have learned in class, we have introduced the properties of organic compounds and inorganic compounds. I would like to ask students what are the properties of organic compounds?
Student: All organic compounds must contain carbon.
Teacher: Are compounds that do not contain carbon defined as organic compounds?
Student: No.. Compounds that do not contain carbon must be inorganic compounds.
Teacher: That's right. Then we know that both (I) and (IV) are correct.
Teacher: Did we mention in class that all carbon-containing compounds are organic compounds?
Student: No, for example, carbon monoxide and cyanide are inorganic compounds although they contain carbon.
Teacher: Good. Then we know that (II), (III) are wrong. So the answer is (C).

老師：從我們上課所學中我們介紹過有機化合物和無機化合物的性質，想問同學還記得有機化合物的性質有什麼？

學生：有機化合物一定都含有碳。

老師：那不含碳的化合物是有機化合物嗎？

學生：不是。不含碳的化合物一定是無機化合物。

老師：沒錯。因此我們知道(I) (IV)都是對的。

老師：那請問上課中我們有提過，含碳的化合物都是有機化合物嗎？

學生：不是，例如一氧化碳及氰化物，雖然含碳但為無機化合物。

老師：很好。因此我們可知道(II) (III)是錯的。所以答案選(C)。

例題二

說明：學生能學會從乾餾法來探討有機化合物的組成。

Students can explore the composition of organic compounds from dry distillation.

（英文）Which of the following is wrong about the description of dry distillation of bamboo chopsticks?

(A) The gaseous products produced from dry distillation are pure substances.

(B) The gases produced during dry distillation are flammable.

(C) The main component of the material left after dry distillation is carbon.

(D) The solid matter remaining after dry distillation can be ignited.

（中文）關於竹筷乾餾的敘述，下列何者錯誤？

(A) 乾餾時所生成的氣態產物是純物質。

(B) 乾餾時產生的氣體具有可燃性。

(C) 乾餾後留下的物質的主要成分是碳。

(D) 經乾餾後殘留的固態物質可以點燃。

（翰林版教學式講義國中自然 4）

解題 Solution:

竹筷乾餾後產生的氣體有氫、甲烷、一氧化碳、二氧化碳及水蒸氣等混合物氣體，因此(A)選項的敘述錯誤，故答案選(A)。

The gas produced by the dry distillation of bamboo chopsticks is a mixture of hydrogen,

methane, carbon monoxide, carbon dioxide, and water vapor. Therefore, the description of the option (A) is wrong, so the answer is (A).

Teacher: In the last class, we did a dry distillation experiment of powdered sugar in the laboratory similar to the dry distillation experiment of bamboo chopsticks. We know that there will be solid, liquid, and gaseous products after dry distillation. Do you remember which ones are there?

Student: The solid product is charcoal, and the main component is carbon. At that time, experiments were done to understand that the solid product could continue to burn.

Student: The gaseous product has been tested with clarified lime water to prove the existence of carbon dioxide; cobalt chloride test paper is used to prove the existence of water vapor; when the gas floats out, the flame becomes larger with a match, which proves that there is a flammable gas.

Teacher: Great, so from all options, the answer is (A), because the gaseous product generated during dry distillation is a mixture.

老師： 上一堂課我們在實驗室做過類似竹筷乾餾實驗的糖粉乾餾實驗，我們知道乾餾後會有固態、液態、氣態產物，同學還記得分別有哪些嗎？

學生： 固態產物是木炭，主要成分是碳，當時做實驗了解固態產物可以繼續燃燒。

學生： 氣態產物從當時做實驗有用澄清石灰水證明二氧化碳的存在；用氯化亞鈷試紙證明有水蒸氣的存在；在氣體飄出來時用火柴放在旁邊火焰有變大，證明有可燃性氣體。

老師： 很好，因此從選項來看，我們答案要選(A)，因為乾餾時生成的氣態產物為混合物。

6-2 常見的有機化合物
Common Organic Compounds

■ 前言 Introduction

老師透過日常生活中常見的各種有機化合物，讓學生自己做實驗測試其性質，老師再藉由學生的實驗結果介紹不同種類有機化合物的結構與性質，以及日常生活中的用途，本章節也補充同分異構物的定義，學生能知道原子的排列方式不同能使物質的性質不同。教師在實驗過程中可以以英語提問，讓學生實驗過程中可以進行比較、舉例及類推，如果必要時可以提供學生句型來讓學生試著表達他們在實驗中看到什麼。

■ 詞彙 Vocabulary

單字	中譯	單字	中譯
natural gas	天然氣	petroleum	石油
hydrocarbon	烴	ethanol	乙醇
isomer	同分異構物	acetic acid	乙酸
methanol	甲醇	ethyl acetate	乙酸乙酯
formic acid	甲酸	ethane	乙烷
ester	酯	liquefied petroleum gas	液化石油氣
esterification reaction	酯化反應	organic acid	有機酸
alcohol	醇		

■ 教學句型與實用句子 Sentence Frames and Useful Sentences

❶ What kind of _____?

例句：**What kind of** organic compound is petroleum?

石油是什麼種類的有機化合物？

❷ For example, _____.

例句：Hydrocarbons are common fuels. **For example,** natural gas and liquefied petroleum gas.

烴類是常見的燃料。舉例來說，天然氣和液化石油氣。

❸ When the organic compounds contain _____, they are called ____.

例句(1)：**When the organic compounds** only **contain** carbon and hydrogen atoms, **they are called** hydrocarbons.

有機化合物中僅有碳、氫原子時，稱為碳氫化合物。

例句(2)：**When the organic compounds contain** -OH functional groups, **they are called** alcohols.

有機化合物中含有-OH 原子團時，稱為醇類。

■ 問題講解 Explanation of Problems

☙ 學習目標 ❧

在學習完本單元後，學生應習得以下觀念：

一、認識各種有機化合物的特性與學會如何分辨。

Understand the characteristics of various organic compounds and learn how to distinguish them.

二、認識酯化反應的化學反應式，並知道酯化反應中加入濃硫酸或加熱的目的。

Understand the chemical equation of the esterification reaction, and know the purpose of adding concentrated sulfuric acid or heating in the esterification reaction.

例題講解

例題一

說明：學生能藉由含有的原子種類與物質性質分辨有機化合物的種類。
Students can distinguish the types of organic compounds by the types of atoms contained and the properties of substances.

（英文）Toluene is an organic compound containing only carbon and hydrogen atoms. It is a colorless liquid at room temperature. It has a special odor and is difficult to dissolve in water. It is a commonly used solvent in the manufacture of paints, adhesives and nail polishes. Long-term contact may cause damage to the nervous system. Based on the above, which of the following organic compounds should toluene be?

(A) Organic acid
(B) Alcohol
(C) Ester
(D) Hydrocarbon

（中文）甲苯是僅含有碳、氫原子的有機化合物，常溫時為無色的液體，具有特殊的氣味，而且難溶於水是製造塗料、黏著劑與指甲油時常用的溶劑，長期接觸可能會對神經系統造成傷害。根據上述，甲苯應為下列哪一類有機化合物？

(A) 酸類
(B) 醇類
(C) 酯類
(D) 烴類

（改自 105 年國中會考 40）

解題 Solution: ：
有機化合物中僅有碳、氫原子時，稱為烴類，故選(D)。
When there are only carbon and hydrogen atoms in organic compounds, they are called hydrocarbons, so select (D).

Teacher: In the question, What atom does "toluene" contain?
Student: Carbon and hydrogen atoms.
Teacher: When there are only carbon and hydrogen atoms in an organic compound, what are they called?
Student: Hydrocarbons.

Teacher:　Right, so toluene is a kind of hydrocarbon.

老師：題目說「甲苯」含有什麼原子呢？
學生：碳和氫原子。
老師：有機化合物中僅有碳、氫原子時，稱為什麼？
學生：烴類。
老師：沒錯，所以甲苯是烴類。

例題二

說明：學生能知道各反應中加入化學藥品的目的。
Students can understand the purpose of adding chemicals to each reaction.

（英文）In order to make the steak more delicious, some chefs add "tenderizer" before cooking, which contains papain enzyme. Enzyme can accelerate the decomposition of protein and make the steak taste more tender. Which principle of speeding up the reaction rate in the following experiment is similar to the principle of adding "tenderizer"?
(A) "Phenolphthalein" will be added in the acid-base neutralization experiment.
(B) "Sodium hydroxide" will be added in the soap making experiment.
(C) "Concentrated sulfuric acid" will be added in the ethyl acetate experiment.
(D) "Hydrochloric acid" will be added in the experiment where calcium carbonate will react to make carbon dioxide.

（中文）有些廚師為了讓牛排更加美味，會在烹調前加入「嫩精」，內含有木瓜酵素，可加速蛋白質分解，讓牛排吃起來加更軟嫩。請問加入「嫩精」的原理與何種實驗中加快反應速率的原理相似？
(A)酸鹼中和實驗中會加入『酚酞』
(B)製造肥皂實驗中會加入『氫氧化鈉』
(C)製造乙酸乙酯實驗中會加入『濃硫酸』
(D)碳酸鈣製造二氧化碳實驗中會加入『鹽酸』

（改自 107 年國中會考 42）

解題 Solution:

酯化反應中加入濃硫酸可加快反應速率，濃硫酸為催化劑，故選(C)。

Adding concentrated sulfuric acid in the esterification reaction can speed up the reaction rate and act as a catalyst, so (C) is selected.

Teacher: Why should we add phenolphthalein to the acid-base neutralization experiment?

Student: In order to observe the color change caused by the change of pH value. basic is red, acid and neutral are colorless.

Teacher: Yes, why should we add sodium hydroxide to the saponification reaction?

Student: In order to react with oil to produce soap.

Teacher: Great, so do you know what an esterification reaction is? Why add concentrated sulfuric acid?

Student: The esterification reaction refers to the action of alcohol and acid to generate ester and water. The addition of concentrated sulfuric acid is to speed up the reaction rate as a catalyst for this reaction.

Teacher: Excellent, Great, so why do we add hydrochloric acid when using calcium carbonate to make carbon dioxide?

Student: In order to react with calcium carbonate to produce carbon dioxide.

Teacher: Yes, so which one can speed up the reaction rate as in the question?

Student: Concentrated sulfuric acid for esterification reaction.

老師： 酸鹼中和實驗為什麼要加入酚酞呢？

學生： 為了觀察 pH 值改變而造成的顏色變化，鹼性為紅色，酸性和中性為無色。

老師： 沒錯，那皂化反應為什麼要加入氫氧化鈉呢？

學生： 為了與油酯反應產生肥皂。

老師： 很棒，那你們知道什麼是酯化反應嗎？為什麼要加入濃硫酸呢？

學生： 酯化反應是指醇和酸作用，生成酯和水，加入濃硫酸是為了加快反應速率，當作此反應的催化劑。

老師： 太棒了，那麼利用碳酸鈣製造二氧化碳為什麼要加入鹽酸呢？

學生： 為了與碳酸鈣反應產生二氧化碳。

老師： 對，所以題目中可以加快反應速率的是哪個呢？

學生： 酯化反應的濃硫酸。

6-3 聚合物與衣料纖維
Polymer and Cloth Fiber

■ 前言 Introduction

教師在本節課程中，可以以概念圖、樹狀圖或是傘狀圖輔助學生理解不同觀念，如人造纖維、再生纖維與合成纖維的相關性。此外，本章內容可以與日常生活結合，教師可以以生活中常見的的纖維及聚合物舉例，加強學生學習的動機並加深學生的學習。

為了能釐清「聚合物」及其相關概念，教師可以運用「分類」及「舉例」的語言，如 the instance of 或 be categorized into 來幫助學生同時學科知識及語言的功能，因本章內容相對更生活化，建議教師本章的統合性任務可以以更高層次的思考能力為主。

■ 詞彙 Vocabulary

單字	中譯	單字	中譯
protein	蛋白質	polymer	聚合物
starch	澱粉	polyethylene	聚乙烯
animal fiber	動物纖維	plant fiber	植物纖維
natural polymer	天然聚合物	artificial fiber	人造纖維
natural fiber	天然纖維	thermoset polymer	熱固性聚合物
chain polymer	鏈狀聚合物	thermoplastic polymer	熱塑性聚合物
rayon	螺縈	regenerated fiber	再生纖維
synthetic polymer	合成聚合物	reticulated polymer	網狀聚合物
synthetic fiber	合成纖維		

■ 教學句型與實用句子 Sentence Frames and Useful Sentences

❶ **_____ is an instance of _____.**

例句：Rayon **is an instance of** plant fiber.
嫘縈是植物纖維的實例。

❷ **_____ can be categorized into _____.**

例句：Artificial fiber **can be categorized into** regenerated fiber and synthetic fiber.
人造纖維可分為再生纖維與合成纖維。

❸ **_____ is a type of _____.**

例句：Polyethylene is a type of synthetic polymer.
聚乙烯屬於合成聚合物。

❹ **_____ be made up of _____.**

例句：Cellulose **is made up of** carbohydrates.
纖維素由碳水化合物組成。

❺ **both _____ and _____**

例句：**Both** starch **and** protein are natural polymers.
澱粉和蛋白質都是天然聚合物。

■ 問題講解 Explanation of Problems

☙ 學習目標 ❧

在學習完本單元後，學生應習得以下觀念：

一、常見人造纖維的特性、簡單的製造過程及在生活上的應用。
Students are able to recognize the characteristics of common artificial materials, simple manufacturing processes and application in daily life.

例題講解

例題一

說明：學生了解聚合物的種類。

Students learn about types of polymers

（英文）According to the classification of organic compounds studied in this chapter, which one is “tire (of a car)” categorized into?

(A) small molecule compounds

(B) natural polymer

(C) thermoplastic polymer

(D) thermoset polymer

（中文）根據本章節所學的有機化合物分類，輪胎屬於哪一類？

(A)小分子化合物

(B)天然聚合物

(C)熱塑性聚合物

(D)熱固性聚合物

（改翰林二下第五章有機化合物 p.137）

解題 Solution:

因為輪胎的主要成分為聚異戊二烯聚合物，為人工合成的網狀結構之熱固性聚合物。

Because the main component of the tire is polyisoprene polymer, which is a thermosetting polymer with a synthetic network structure.

Teacher: Where have you seen tires in your life?

Student: Car, car dealership.

Teacher: From what we have learned in the classroom, do we know whether tires are polymers or compounds?

Student: Polymer.

Teacher: That's right, what are polymers subdivided into?

Student: natural polymers and synthetic polymers.

Teacher: We know that tires are made of natural rubber, so we can tell what kind of polymer the tire should be.

Student: Synthetic polymers.

Teacher: Very good. In addition, we have learned how to classify polymers based on whether they will melt when burned at high temperature?

Student: Thermoset polymers and thermoplastic polymers, thermoset polymers will not melt when heated, and thermoplastic polymers will melt when heated.

Teacher: Will the tires melt when heated?

Student: No, so the tires are thermoset polymers.

Teacher: Yes, so the answer is (D).

老師： 請問你們在生活中哪些地方看過輪胎呢？

學生： 車子、車行。

老師： 由課堂中所學，我們知道輪胎是聚合物還是化合物呢？

學生： 聚合物。

老師： 沒錯，聚合物又細分成什麼？

學生： 天然聚合物及合成聚合物。

老師： 我們知道輪胎是由天然橡膠經過處理加工而成的，因此我們可以判斷出輪胎應該是哪種聚合物。

學生： 合成聚合物。

老師： 很好，另外我們學過，若以聚合物拿去高溫燃燒時會不會融化為依據可以如何分類？

學生： 熱固型聚合物和熱塑型聚合物，熱固型聚合物加熱不會融化，熱塑型聚合物加熱則會融化。

老師： 輪胎加熱會融化嗎？

學生： 不會，所以輪胎是熱固型聚合物。

老師： 對，所以答案選(D)。

例題二

說明：學生了解常見天然纖維的特性。

Students are able to recognize the characteristics of common natural fiber.

（英文）Cotton clothing is made from cellulose in cotton fruit, while silk clothing is woven from silk. Regarding the comparison between cotton clothing and silk clothing, which of the following statements is correct?

(A) The former is inorganic and the latter is organic.

(B) The former is a mixture; the latter is a pure substance.

(C) The former is composed of non-polymers and the latter is composed of polymers.

(D) The former is composed of carbohydrates and the latter is composed of protein.

（中文）棉質衣料是由棉花果萊內的纖維素所製得，而絲綢衣料是抽取蠶絲後編織而得。關於棉質衣料與絲綢衣料的比較，下列敘述何者正確？

(A) 前者為無機物，後者為有機物

(B) 前者為混合物，後者為純物質

(C) 前者由非聚合物組成，後者由聚合物組成

(D) 前者由碳水化合物組成，後者由蛋白質組成

（102 年試辦國中會考 28）

解題 Solution:

棉質衣料由纖維素組成，纖維素是由碳水化合物組成；絲綢衣料由蠶絲編織而得，蠶絲是一種動物性蛋白質。兩種都是有機化合物。故答案選(D)。

Cotton clothing is made up of cellulose, which is composed of carbohydrates; silk clothing is woven from silk, which is an animal protein. Both are organic compounds. So the answer is (D).

Teacher: Have you learned the classification method in the options before?

Student: Yes.

Teacher: Let's look at option (A). Cotton clothing is inorganic, and silk clothing is organic, right?

Student: No, they both are organic.

Teacher: Why can it be said that both are organic?

Student: Because both plant fibers and animal fibers contain carbon, hydrogen and oxygen elements.

Teacher: Let's look at option (B). Cotton clothing is a mixture, and silk clothing is a pure substance, right?

Student: No, they both are pure substance.

Teacher: Let's look at option (C). Cotton clothing is made of non-polymer, and silk clothing is made of polymer, right?

Student: No, they both are polymers.

Teacher: Let's look at option (D). Cotton clothing is composed of carbohydrates, and silk clothing is composed of protein, right?

Student: Yes. Cotton clothing is composed of cellulose, which is composed of carbohydrates; silk clothing is woven from silk, which is an animal protein.

Teacher: So the answer is (D). Good job.

老師： 大家看到選項中的分類方式，是不是我們以前都有學過？

學生： 是。

老師： 那我們看(A)選項，棉質衣料為無機物，絲綢衣料為有機物，是嗎？

學生： 不是，因為兩種都是有機物。

老師： 為什麼可以說這兩種都是有機物。

學生： 因為植物纖維和動物纖維都含有碳、氫、氧元素。

老師： 那我們看(B)選項，棉質衣料為混合物，絲綢衣料為純物質，是嗎？

學生： 不是，因為兩種都是純物質。

老師： 那我們看(C)選項，棉質衣料由非聚合物組成，絲綢衣料由聚合物組成，是嗎？

學生： 不是，因為兩種都是聚合物。

老師： 那我們看(D)選項，棉質衣料由碳水化合物組成，絲綢衣料由蛋白質組成，是嗎？

學生： 是。棉質衣料由纖維素組成，纖維素是由碳水化合物組成；絲綢衣料由蠶絲編織而得，蠶絲是一種動物性蛋白質。

老師： 所以答案選(D)。

6-4 有機物在生活中的應用
Application of Organic Substances in Life

■ 前言 Introduction

在本小節要著重於讓學生思考與發現，教師可提供學生鷹架，如問題或提示，讓學生發現他們發現食物中的營養成分為何，清潔劑的製作和去污原理，培養學生將課本知識帶入生活情境。

教師可以注意讓學生描述醣類、蛋白質、脂質組成及皂化反應中的分離的現象，作為本節的教學重點。活動中主要讓學生專注於「描述」功能的語言。

■ 詞彙 Vocabulary

單字	中譯	單字	中譯
soap	肥皂	detergent/synthetic detergent	清潔劑/合成清潔劑
Lipid	脂質	saponification reaction	皂化反應
Protein	蛋白質	coconut oil	椰子油
Starch	澱粉	salting out	鹽析
Carbohydrate	醣類	hydrophilic part	親水端
Glycerol	甘油	lipophilic part	親油端
Cellulose	纖維素		

■ 教學句型與實用句子 Sentence Frames and Useful Sentences

❶ _____ be composed of _____.

例句：Carbohydrate **is composed of** carbon, hydrogen, and oxygen elements.

醣類是由碳、氫、氧元素所組合而成的。

❷ _____ consist(s) of _____.

例句：Carbohydrates **consist of** carbon, hydrogen, and oxygen elements.

醣類是由碳、氫、氧元素所組合而成的。

❸ _____ separate(s)____ from _____.

例句：Saturated salt water can **separate** soap **from** glycerol.

飽和食鹽水可使肥皂與甘油分離。

❹ _____ infiltrate(s) into _____.

例句：The lipophilic part will **infiltrate into** oil stains and remove them from the cloth.

親油端會滲進油汙裡，並將油汙從布料上清除。

❺ _____ react(s) with _____.

例句：When the oil **reacts with** the sodium hydroxide, it will produce the sodium aliphatate and the glycerol.

當油脂與氫氧化鈉反應時，會產生脂肪酸鈉和丙三醇。

■ 問題講解 Explanation of Problems

☙ 學習目標 ❧

在學習完本單元後，學生應習得以下觀念：

一、認識醣類、蛋白質、油脂等食物成分。

Understand the ingredients of foods, such as carbohydrate, protein, and fat.

二、認識如何製作肥皂與油脂的皂化反應。

Understand how to make soap and the saponification reaction of fat.

三、認識肥皂的去汙原理並比較肥皂與清潔劑的異同。

Understand the oil removal principle of soap and compare the differences between soap and detergent.

❧ 例題講解 ☙

例題一

說明：學生能夠了解肥皂的去污作用和皂化反應。

Students are able to understand the oil removal principle and saponification of soap.

（英文）There is a substance A (containing lipophilic part and hydrophilic part). This substance can be dissolved in water, and the lipophilic part will penetrate into the oil stains of the clothes and take the oil stains away from the clothes. Which reaction can produce a substance with the same function as this one?

(A) ethanol + ethanoic acid

(B) calcium carbonate + hydrochloric acid

(C) oil + sodium hydroxide

(D) sulfuric acid + sodium hydroxide

（中文）有一物質甲（含有親油端和親水端），此物質能溶入水中且親油端會滲入衣料的油污而親水端把油污帶離衣料，請問哪一個反應可以產生與該物質相同功能的產物？

(A)乙醇 + 乙酸 →　　(B)碳酸鈣 + 鹽酸 →

(C)油脂 + 氫氧化鈉 →　　(D)硫酸 + 氫氧化鈉 →

（改自 106 年國中會考 7）

解題 Solution:

題目提及「親油端會滲入衣料的油污」，再利用親水端將油汙牽入水中與衣物分離，得知物質甲為肥皂或清潔劑。本題是問以下選項何者為皂化反應。

皂化反應：油脂＋氫氧化鈉→脂肪酸鈉（肥皂）＋丙三醇（甘油）

(A) 乙醇＋乙酸 →為酯化反應，產生酯類。

(B) 碳酸鈣＋鹽酸 →產生二氧化碳。

(C) 油脂＋氫氧化鈉 →為皂化反應，產生肥皂。

(D) 硫酸＋氫氧化鈉 →為中和反應，產生鹽類。

故答案為(C)。

It is mentioned that “the lipophilic part will penetrate into the oil stains of the clothes.” Later, it uses the hydrophilic end to pull the oil into the water and remove the oil stains from the clothes. We know that substance A is soap or detergent. This question asks which of the following choices belongs to the saponification reaction.

saponification reaction: oil + sodium hydroxide → sodium fatty acid (soap) + glycerol

(A) ethanol + ethanoic acid → esterification reaction, producing esters

(B) calcium carbonate + hydrochloric acid → producing carbon dioxide

(C) oil + sodium hydroxide → saponification reaction, producing soap

(D) sulfuric acid + sodium hydroxide → neutral reaction, producing salt

Therefore, the answer is (C).

Teacher:	We just introduced the knowledge of soap. What did we learn in this class?
Student:	We learned about the making of soap and its oil removal principle.
Teacher:	That is the saponification reaction. What is the saponification reaction? Please name the reactants and products.
Student:	When the oil reacts with the sodium hydroxide, it will produce the sodium fatty acid and the glycerol.
Teacher:	It is mentioned that “the substance A will penetrate into the oil stains of the clothes and take them away from the clothes.” What seems to have happened?
Student:	It seems to be an oil removal process.
Teacher:	So, what may the substance A be?
Student:	It may be a soap.
Teacher:	So, we have to find out the chemical reaction that can make soap, that is, saponification. What is the reaction when alcohol and acid are combined?
Student:	Esterification reaction.
Teacher:	What will calcium carbonate and hydrochloric acid produce?

Student: Carbon dioxide.

Teacher: What is the reaction of oil and sodium hydroxide?

Student: Saponification reaction.

Teacher: What is the reaction of sulfuric acid combining with sodium hydroxide, acid combining with alkali?

Student: Neutralization reaction.

Teacher: Yes, so the answer is (C).

老師： 剛才我們有介紹肥皂的知識，請問我們上了什麼？

學生： 我們上到了肥皂的製作和他的去汙原理。

老師： 肥皂的製作就是皂化反應，請問何謂皂化反應呢？請說出他的反應物和生成物。

學生： 當油脂與氫氧化鈉結合時，會產生脂肪酸鈉和丙三醇。

老師： 題目說此物質甲能滲入衣料的油污並把油污帶離衣料，請問這看起來是發生了什麼事呢？

學生： 看起來是去汙的過程。

老師： 所以物質甲應該是什麼呢？

學生： 可能是肥皂。

老師： 所以我們要找出選項中能製造肥皂的化學反應，也就是皂化反應。請問當醇加酸是什麼反應？

學生： 酯化反應。

老師： 那碳酸鈣加鹽酸會產生什麼呢？

學生： 二氧化碳。

老師： 油脂加氫氧化鈉是什麼反應？

學生： 皂化反應。

老師： 那硫酸加氫氧化鈉，酸性加鹼性是什麼反應？

學生： 中和反應。

老師： 沒錯，故答案選(C)。

例題二

說明：學生能夠了解食物的成分和構成分子。

Students can understand the composition and constituent molecules of food.

（英文）Because of the large amount of starch and sucrose, the cake is high in calories. Junjun only cut a small piece to eat, and put the rest of the cake in the refrigerator to save it so that it will not go bad. Which type of substance of a large amount in cakes keeps Junjun from overconsuming?

(A) Hydrocarbons

(B) Carbohydrates

(C) Synthetic polymers

(D) Inorganic compounds

（中文）蛋糕因澱粉、蔗糖含量高，熱量也就高，君君因此只切了一小塊來吃，並把剩下的蛋糕放進冰箱保存，才不易變壞。請問君君因蛋糕中的哪一類物質含量高而不敢多吃？

(A)碳氫化合物

(B)碳水化合物

(C)合成聚合物

(D)無機化合物

（改自 103 年國中會考 49）

解題 Solution:

從「蛋糕因澱粉、蔗糖含量高，熱量也就高」得知，君君因為蛋糕中的澱粉、蔗糖而不敢多吃，澱粉與蔗糖均為碳水化合物，故選(B)。

In the question, "the cake has high calories due to the large amount of starch and sucrose." Junjun is afraid to eat a lot because of the starch and sucrose in the cake. Both starch and sucrose are carbohydrates, so the answer is (B).

Teacher: What nutrients that we have learned in class do living beings get energy from food?

Student: Carbohydrate, protein, and lipid.

Teacher: In the question, the ingredients of cake are starch and sucrose. What kind of nutrients is it?

Student: Carbohydrates.

Teacher: Because that carbohydrates have the same ratio of hydrogen and oxygen atoms as water molecules, so what is it also called?

Student: Carbohydrates.

Teacher: Therefore, the answer is (B).

老師： 請問這堂課上到，生物主要從食物的哪三種營養成分獲得能量？

學生： 醣類、蛋白質、脂質。

老師： 請問題目中，蛋糕的成分是澱粉和蔗糖，他們都是哪一種營養成分？

學生： 醣類。

老師： 醣類因為氫原子和氧原子的數目比例與水分子相同，所以又被稱為什麼？

學生： 碳水化合物。

老師： 所以答案選(B)。

國內外參考資源 More to Explore

Ward's Science featuring Ward's World 提供國中及高中年齡層學生及教師使用，也有影片。也有其他自然科。 https://wardsworld.wardsci.com/chemistry	
Middle School Chemistry 提供國中教師完整教學指引，學習單，教學影片。 https://www.middleschoolchemistry.com/	
American Association of Chemistry Teachers 美國教師化學協會，提供個階段教師資源分享。 https://teachchemistry.org/	
Khan Academy 可汗學院，有分年級的化學教學影片及問題的討論。 https://www.khanacademy.org/	
Interactive Simulations, University of Colorado Boulder 互動式電腦模擬，除了化學，還有其他自然科。 https://phet.colorado.edu/	

雙語教學資源手冊：化學科英語授課用語

[八年級]

A Reference Handbook for Junior High School Bilingual Teachers in the Domain of Natural Sciences (Chemistry): Instructional Language in English

[8th grade]

- 研編單位：國立彰化師範大學雙語教學研究中心
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- 編輯排版：吳依靜
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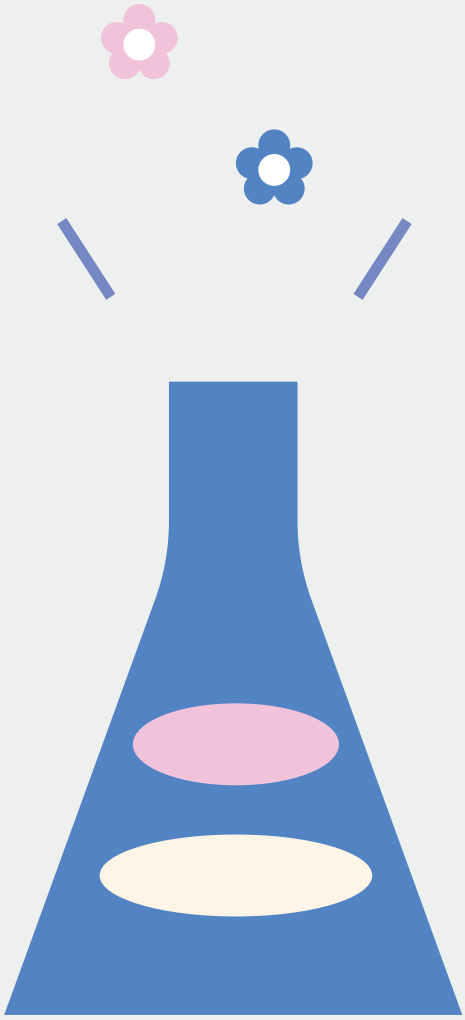

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