Chemistry 化學

Paper 1
卷一

Section A
甲部

題號 (Q No.)	答案 (Answer)	題號 (Q No.)	答案 (Answer)
1	B	26	C
2	A	27	B
3	/	28	A
4	B	29	C
5	B	30	B
6	B	31	D
7	C	32	C
8	B	33	D
9	A	34	C
10	D	35	C
11	D	36	A
12	C		
13	C		
14	C		
15	A		
16	A		
17	A		
18	C		
19	C		
20	C		
21	D		
22	A		
23	D		
24	A		
25	D		

Section B

乙部

1(a) They have the same number of protons but different numbers of neutrons.

1(b) (i) Because chlorine exists as a mixture of isotopes with different relative abundances.

(ii)
Let % abundance of Cl-35 = x.
Then % abundance of Cl-37 = 100−x
$(35x+37(100−x))/100=35.5$
$x=75$
So:
- Cl-35 = 75%
- Cl-37 = 25%

2 marks (1 for correct setup, 1 for correct final abundances)

1(c)

$$Cl_2 + 2NaOH \rightarrow NaCl + NaClO + H_2O$$

1(d) (i)
Yes. Bromine, like chlorine, is a halogen. Both undergo disproportionation with cold dilute NaOH.
Observation: The orange-brown colour of bromine water becomes paler / colour fades.

2 marks (1 for "Yes + same group → similar chemical properties", 1 for correct observation)

(ii)

$$Br_2 + 2NaOH \rightarrow NaBr + NaBrO + H_2O$$

1(e)
Any TWO of the following:
- Conduct the experiment in a fume cupboard (chlorine is poisonous).
- Wear safety goggles / gloves to avoid contact with chlorine solution.
- Avoid inhaling chlorine gas.
- Use small quantities only.

2(a) (難度: Lv3)
　　Zinc is more reactive because it is higher in the reactivity series / more easily oxidised / loses electrons more easily/has a stronger reducing power.

2(b) **(i)**
Mass of O in compound = 3.20 – 2.56 = 0.64 g
Moles of Cu = 2.56 ÷ 63.5 = 0.0403 mol
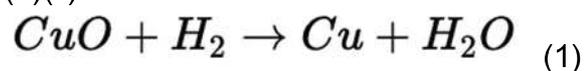Moles of O = 0.64 ÷ 16.0 = 0.0400 mol
Ratio Cu : O ≈ 1 : 1
Empirical formula = **CuO**
(2 marks)
- 1 mark: correct calculation of moles (Cu and O)
- 1 mark: correct formula

(b)(ii)

$$CuO + H_2 \rightarrow Cu + H_2O \quad (1)$$

(iii)
Precaution: Keep away from flames / perform in a fume cupboard, as hydrogen is flammable.
(1 mark)

3(a)

    (i) BF_3: trigonal planar,

    (ii) NH_3: trigonal pyramidal,

    (iii) CCl_4: tetrahedral,

(3 marks)

    1 mark each correct structure + angle

3(b)

    (i) BF_3: B–F bonds are polar (ΔEN), but trigonal planar & symmetrical → polar bonds cancel each other → overall non-polar. (1½ marks)

    (ii) NH_3: trigonal pyramidal, polar bonds cannot cancel each other→ polar molecule. (1½ marks)

    (3 marks)

(c)

- NH_3 molecules form extensive hydrogen bonding → much stronger intermolecular forces → higher boiling point.
- BF_3 and CCl_4: only weak van der waals forces
  (2 marks)
- 1 mark: hydrogen bonding explanation
- 1 mark: contrast with BF_3, CCl_4

4(a) (難度: Lv2)
蒸氣冷凝成液體（或氣體液化），部分液體會滴入冰水/杯中，並且會看到有氣泡冒出。
接受：蒸氣消失/液滴形成。(1)
Vapour condenses into a liquid (or gas **liquefies**), and some liquid drips into the ice water/beaker, and **bubbles** are seen escaping. *(1)*
Accept: Vapour disappears / liquid droplets form.

4(b)
必須先移走或熄滅實驗室中所有的火源（如本生燈、酒精燈）。(1)
原因：這個餾分（如石油氣）極度揮發，會在錐形瓶口釋放出易燃氣體。(1)

Must first **remove** or **extinguish** all **sources of ignition** (e.g., Bunsen burner, spirit lamp) in the lab. (1)
This fraction (like petroleum gas) is extremely **volatile** and releases **flammable gas** at the mouth of the conical flask. (1)
        (接受其他可行答案)

4(c)(i)   (難度: Lv2)

這個餾分是不溶於水的碳氫化合物（或密度比水小），因此它會漂浮在水面上，與空氣直接接觸。(1)
火焰通常是藍色或淺藍色。煙塵（炭黑）的程度很低或沒有（因為分子中的碳原子數很少，C1~C4）。(1)

The fraction is **insoluble in water** and is a **hydrocarbon** (or less dense than water), so it **floats on the surface** of the water, making direct contact with air. (1)
The flame is usually **blue** or **pale blue** and the sootiness is **low** or **non-existent** (because the molecules have very few carbon atoms, C1~C4). (1)

4(c)(ii)
使用排液集氣法（或排水集氣法，如果產物不溶於水）來收集氣態餾分。(1)

Use the **displacement method** (specifically **water displacement** since the product is likely insoluble in water) to collect the gaseous fraction. (1)

5(a) (難度: Lv5)
 (i) 含有鋅片舊電池外殼 / 某些屋頂材料 / 某些防銹螺絲。Casing of an old battery / Certain roofing materials / Certain anti-rust screws.
   (ii)碳棒: 舊電池中的碳棒 / 鉛筆芯 (含碳)。**Carbon rod** from an old battery / Pencil lead (contains carbon).

5(b)
(i) $Zn(s) \rightarrow Zn^{2+}(aq) + 2e^-$
(ii) $ClO^-(aq) + H_2O(l) + 2e^- \rightarrow Cl^-(aq) + 2OH^-(aq)$

(c)
次氯酸鹽半電池中 ClO^- 還原時會產生 **OH⁻** 離子：$ClO^- + H_2O + 2e^- \rightarrow Cl^- + 2OH^-$.
陽極產生的 Zn^{2+} 通過鹽橋進入該半電池，並與 OH⁻ 反應，生成不溶於水的氫氧化鋅沉澱：
$Zn^{2+} + 2OH^- \rightarrow Zn(OH)_2(s)$.
沉澱的形成消耗了溶液中可自由移動的導電離子（Zn^{2+} 和 OH⁻），導致電池的內部電阻顯著增加，從而使電流下降。

The reduction of ClO^- in the hypochlorite half-cell **produces OH⁻ ions**: $ClO^- + H_2O + 2e^- \rightarrow Cl^- + 2OH^-$.
The Zn^{2+} produced at the anode passes into this half-cell and reacts with OH⁻ to form **insoluble zinc hydroxide precipitate**: $Zn^{2+} + 2OH^- \rightarrow Zn(OH)_2(s)$.
The formation of precipitate **consumes mobile conducting ions** in the solution (Zn^{2+} and OH⁻), leading to a significant **increase in the cell's internal resistance**, thus decreasing the current.
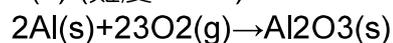
接受：沉澱物可能覆蓋電極表面，阻礙電子轉移。
Accept: The precipitate may cover the electrode surface, hindering electron transfer.

6(a) (難度: Lv4)
打斷或斷裂化學鍵（或 Al−O 鍵）。**Breaking of chemical bonds** (or Al−O bonds).1 分
不能

6(b) (難度: Lv5*)
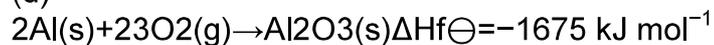$2Al(s)+\frac{2}{3}O_2(g)\rightarrow Al_2O_3(s)$
1 分 (必須平衡，且生成物為 1 摩爾，反應物為標準狀態)

(c)
根據赫斯定律，生成反應是分解反應的逆反應。By Hess's Law, the formation reaction is the
reverse of the decomposition reaction.1

$\Delta H_f^\ominus=1/2\times(-3350 \text{ kJ mol}^{-1})=-1675 \text{ kJ mol}^{-1}$

備註：-3350 kJ mol^{-1} for the reverse reaction (1 mark). Divide by 2 for 1 mol of product (1 mark).

(d)
$2Al(s)+\frac{2}{3}O_2(g)\rightarrow Al_2O_3(s) \Delta H_f^\ominus=-1675 \text{ kJ mol}^{-1}$
1 分 (必須有正確的 ΔH 值和單位)

7(a) (難度: Lv4)

步驟 (Steps)	中文解釋 (Chinese Explanation)	英文解釋 (English Explanation)	分數 (Marks)
1. 碳的質量	碳的質量 (C): $0.22 \text{ g} \times \frac{12.0}{44.0} = \mathbf{0.060}$ g	Mass of C: $0.22 \text{ g} \times \frac{12.0}{44.0} = \mathbf{0.060}$ g	1 (brace spanning steps 1–3)
2. 氫的質量	氫的質量 (H): $0.09 \text{ g} \times \frac{2 \times 1.0}{18.0} = \mathbf{0.010}$ g	Mass of H: $0.09 \text{ g} \times \frac{2 \times 1.0}{18.0} = \mathbf{0.010}$ g	
3. 氧的質量	氧的質量 (O): $0.15 \text{ g} - 0.060 \text{ g} - 0.010 \text{ g} = \mathbf{0.080}$ g	Mass of O: $0.15 \text{ g} - 0.060 \text{ g} - 0.010 \text{ g} = \mathbf{0.080}$ g	
4. 摩爾比	摩爾比 (C : H : O): $\frac{0.060}{12.0} : \frac{0.010}{1.0} : \frac{0.080}{16.0} = 0.005 : 0.010 : 0.005$	Molar ratio (C : H : O): $\frac{0.060}{12.0} : \frac{0.010}{1.0} : \frac{0.080}{16.0} = 0.005 : 0.010 : 0.005$	1
5. 實驗式	最小整數比: $1 : 2 : 1$。實驗式為 $\mathbf{CH_2O}$。	Simplest ratio: $1 : 2 : 1$. Empirical formula is $\mathbf{CH_2O}$.	1

7(b) (難度: Lv2)

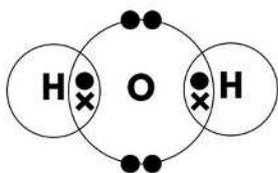| 步驟 (Steps)	中文解釋 (Chinese Explanation)	英文解釋 (English Explanation)	分數 (Marks)
1. 實驗式質量	實驗式 CH_2O 的質量: $12.0 + 2(1.0) + 16.0 = \mathbf{30.0}$。	Empirical formula mass of CH_2O: $12.0 + 2(1.0) + 16.0 = \mathbf{30.0}$.	1
2. 分子式	$n = \frac{\text{相對分子質量}}{\text{實驗式質量}} = \frac{60}{30.0} = \mathbf{2}$。分子式為 $\mathbf{(CH_2O)_2}$ 或 $\mathbf{C_2H_4O_2}$。	$n = \frac{\text{Relative molecular mass}}{\text{Empirical formula mass}} = \frac{60}{30.0} = \mathbf{2}$. Molecular formula is $\mathbf{(CH_2O)_2}$ or $\mathbf{C_2H_4O_2}$.	1

7(c) (難度: Lv4)

(i)

判斷 (Deduction)	中文解釋 (Chinese Explanation)	英文解釋 (English Explanation)	分數 (Marks)
結構式	Y 與碳酸氫鈉反應生成 CO_2 表明 Y 是一種**羧酸**。$C_2H_4O_2$ 唯一的羧酸是乙酸。$\mathbf{CH_3COOH}$。	Liberation of CO_2 with $NaHCO_3$ indicates Y is a **carboxylic acid**. The only carboxylic acid for $C_2H_4O_2$ is **Ethanoic acid**. $\mathbf{CH_3COOH}$.	1

(ii)

中文答案 (Chinese Answer)	英文答案 (English Answer)
$\mathbf{CH_3COOH}(aq) + NaHCO_3(s) \rightarrow CH_3COONa(aq) + H_2O(l) + CO_2(g)$	$\mathbf{CH_3COOH}(aq) + NaHCO_3(s) \rightarrow CH_3COONa(aq) + H_2O(l) + CO_2(g)$
接受 H_2CO_3 中間產物，但不需寫出。	Accept H_2CO_3 intermediate, but not required.

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8(a) (難度: Lv3)

評分要點 (Key Points)	中文解釋 (Chinese Explanation)	英文解釋 (English Explanation)
結構	氧原子與兩個氫原子形成共用電子對。	Oxygen atom forming shared electron pairs with two hydrogen atoms.
電子	顯示氧原子上有**兩對非共用電子**（孤對電子），並正確顯示所有價電子（O 6 個，H 1 個）。	Show **two lone pairs of electrons** on the oxygen atom and all valence electrons correctly (6 for O, 1 for H).

8(b) (難度: Lv5)

步驟 (Steps)	中文解釋 (Chinese Explanation)	英文解釋 (English Explanation)	分數 (Marks)
1. 方程式	反應方程式：$2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$	Reaction equation: $2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$	1
2. 限量試劑	氣體體積比 (2:1) 與摩爾比相同 (阿伏加德羅定律)。所需 O_2 體積: $\frac{1}{2} \times 80.0 \ cm^3 = 40.0 \ cm^3$。由於只有 $60.0 \ cm^3$ 氧氣，所以 H_2 是**限量試劑**。(或 H_2/O_2 體積比為 $80/60 = 4/3 > 2/1$，故 H_2 不足)	Volume ratio (2:1) is same as mole ratio (Avogadro's Law). Volume of O_2 needed: $\frac{1}{2} \times 80.0 \ cm^3 = 40.0 \ cm^3$. Since $60.0 \ cm^3$ of O_2 is available, H_2 is the **limiting reactant**.	1
3. 剩餘體積	剩餘氣體是 O_2。剩餘體積: $60.0 \ cm^3 - 40.0 \ cm^3 = \mathbf{20.0 \ cm^3}$。	Remaining gas is O_2. Remaining volume: $60.0 \ cm^3 - 40.0 \ cm^3 = \mathbf{20.0 \ cm^3}$.	1

8(c)

(i)　純水的**導電性**很差。加入硫酸是為了提供**離子**，以**增加溶液的導電性**（或作為電解質）。
Pure water is a **poor conductor of electricity**. Sulphuric acid is added to provide **ions** to **increase the conductivity of the solution** (or act as an electrolyte).

(ii)　鉑 (Platinum) 或 石墨 / 碳棒 (Graphite / Carbon rod)。

(iii)

$$2H_2O(l) \rightarrow O_2(g) + 4H^+(aq) + 4e^-$$
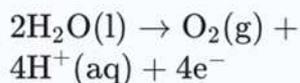
(iv)

氫氣 (H_2)	將燃著的木條 (或火柴) 移近氣體（收集管）。	會發出**爆鳴聲** (Pop sound)。
氧氣 (O_2)	將帶火星的木條 (或火柴) 移近氣體（收集管）。	**木條會重新燃燒**（或火星復燃）。

9. (難度: Lv4)

評分要點 (Marking Point)	中文解釋 (Chinese Explanation)	英文解釋 (English Explanation)	分數 (Marks)
1. 氫鍵的形成 (定義)	當一個氫原子以共價鍵連接到一個**高電負性**的原子（例如：N、O 或 F 原子）時，該氫原子帶有較高的**部分正電荷**。在該氫原子與另一個分子上的**高電負性原子**（例如 N、O 或 F 原子）的**孤對電子**之間，存在著**靜電引力**。這些引力被稱為**氫鍵**。	When a hydrogen atom is covalently bonded to a **highly electronegative** atom (e.g., N, O, or F atom), the hydrogen atom carries a high **partial positive charge. Electrostatic attractions** exist between this hydrogen atom and the **lone pair electrons** on a **highly electronegative atom** (e.g., N, O, or F atom) of another molecule. These attractions are called **hydrogen bonding**.	1
2. 乙醇中的應用	在每個乙醇分子中，都有一個氫原子直接連接到氧原子。氧原子有孤對電子。因此，一個乙醇分子的氫原子可以與另一個乙醇分子的氧原子形成**氫鍵**。	In each ethanol molecule, there is a hydrogen atom directly bonded to an oxygen atom. The oxygen atom has lone pairs. Hence, the hydrogen atom of an ethanol molecule can form a **hydrogen bond** with the oxygen atom of another ethanol molecule.	1
3. 影響：溶解度	由於乙醇分子可以與水分子形成氫鍵，因此乙醇和水可以**完全互溶**。	Since ethanol molecules can form **hydrogen bonds** with water molecules, ethanol and water are **completely miscible**.	1
4. 影響：沸點	由於乙醇分子由**氫鍵**維繫在一起，因此與相對分子質量相近但不能形成氫鍵的化合物相比，乙醇具有**更高的沸點**。	Since ethanol molecules are held together by **hydrogen bonds**, ethanol has a **higher boiling point** than compounds with comparable relative molecular masses which cannot form hydrogen bonds.	1
5. 影響：黏度	由於存在廣泛的分子間**氫鍵**，乙醇比相對分子質量相近但不能形成氫鍵的化合物**更具黏性**。	Because of the presence of extensive intermolecular **hydrogen bonds**, ethanol is **more viscous** than compounds with comparable relative molecular masses which cannot form hydrogen bonds.	1

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10. (難度: Lv4)
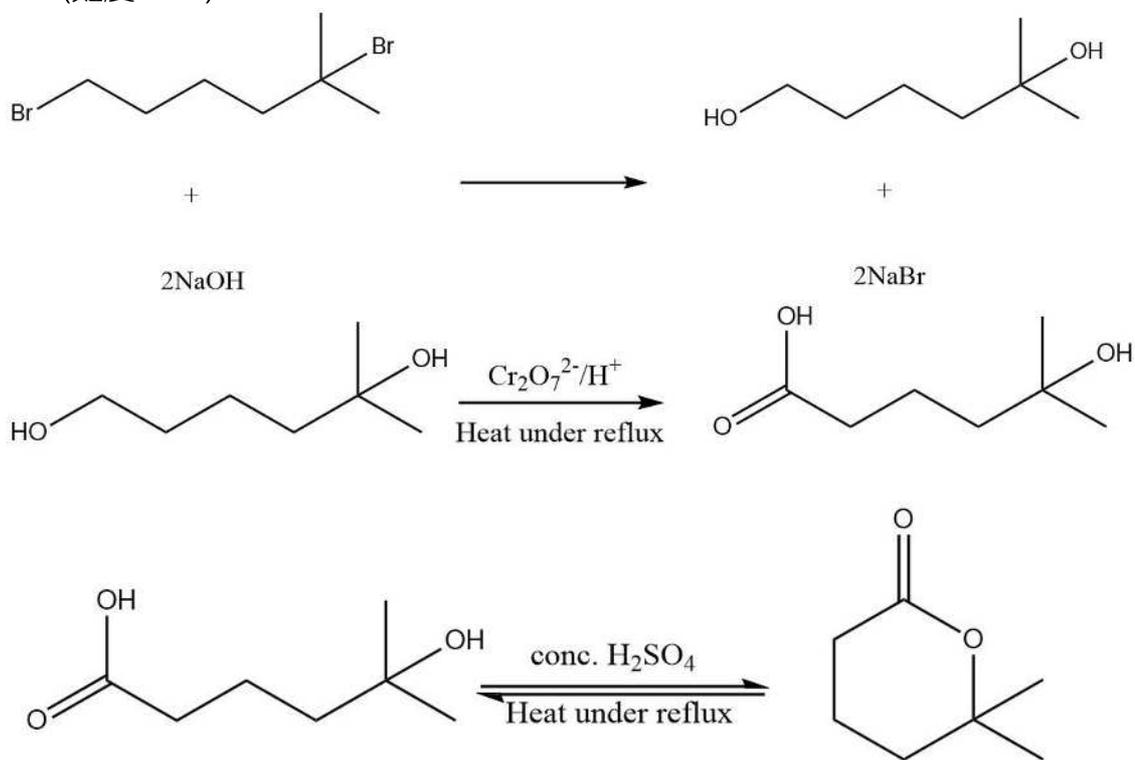
(3)

11. (難度: Lv4)

(a)

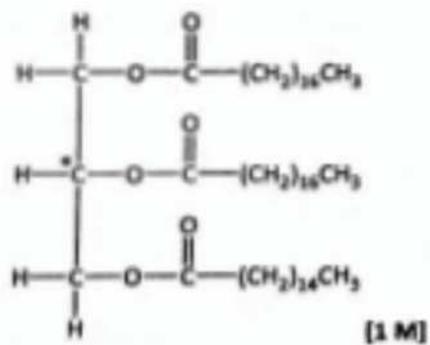| 步驟 (Steps)	中文解釋 (Chinese Explanation)	英文解釋 (English Explanation)
1. 反應量 (Moles Consumed)	根據方程式，生成 4.0 mol 的 AB_3 會消耗 2 mol 的 A_2 和 6 mol 的 B_2。	According to the equation, the formation of 4.0 mol of AB_3 will consume 2 mol of A_2 and 6 mol of B_2.
2. 平衡時 A_2 濃度	$[A_2] = \frac{4.0-2.0}{20.0 \text{ dm}^3} = \frac{2.0}{20.0} = \mathbf{0.1} \text{ mol dm}^{-3}$	$[A_2] = \frac{4.0-2.0}{20.0 \text{ dm}^3} = \frac{2.0}{20.0} = \mathbf{0.1} \text{ mol dm}^{-3}$
3. 平衡時 B_2 濃度	$[B_2] = \frac{12.0-6.0}{20.0 \text{ dm}^3} = \frac{6.0}{20.0} = \mathbf{0.3} \text{ mol dm}^{-3}$	$[B_2] = \frac{12.0-6.0}{20.0 \text{ dm}^3} = \frac{6.0}{20.0} = \mathbf{0.3} \text{ mol dm}^{-3}$
4. 平衡時 AB_3 濃度	$[AB_3] = \frac{4.0}{20.0 \text{ dm}^3} = \mathbf{0.2} \text{ mol dm}^{-3}$	$[AB_3] = \frac{4.0}{20.0 \text{ dm}^3} = \mathbf{0.2} \text{ mol dm}^{-3}$

(b)

步驟 (Steps)	中文解釋 (Chinese Explanation)	英文解釋 (English Explanation)	分數 (Marks)
1. K_c 表達式	$K_c = \frac{[AB_3]^2}{[A_2][B_2]^3}$	$K_c = \frac{[AB_3]^2}{[A_2][B_2]^3}$	1
2. 數值代入	$K_c = \frac{(0.2)^2}{(0.1)(0.3)^3}$	$K_c = \frac{(0.2)^2}{(0.1)(0.3)^3}$	
3. 結果和單位	$K_c = \mathbf{14.8} \text{ dm}^4 \text{ mol}^{-2}$ (或 14.8)	$K_c = \mathbf{14.8} \text{ dm}^4 \text{ mol}^{-2}$ (or 14.8)	1

(C)

步驟 (Steps)	中文解釋 (Chinese Explanation)	英文解釋 (English Explanation)	分數 (Marks)
1. B_2 消耗量	B_2 消耗量: 12.0 mol（初始）- 9.0 mol（平衡）= $\mathbf{3.0}$ mol。	B_2 consumed: 12.0 mol (initial) - 9.0 mol (equilibrium) = $\mathbf{3.0}$ mol.	
2. 新平衡的 A_2 濃度	A_2 消耗量: 3.0 mol $\times \frac{1}{3}$ = 1.0 mol。 $[A_2] = \frac{4.0-1.0}{V} = \frac{3.0}{V}$	A_2 consumed: 3.0 mol $\times \frac{1}{3}$ = 1.0 mol. $[A_2] = \frac{4.0-1.0}{V} = \frac{3.0}{V}$	1
3. 新平衡的 AB_3 濃度	AB_3 生成量: 3.0 mol $\times \frac{2}{3}$ = 2.0 mol。 $[AB_3] = \frac{2.0}{V}$	AB_3 formed: 3.0 mol $\times \frac{2}{3}$ = 2.0 mol. $[AB_3] = \frac{2.0}{V}$	1
4. 計算 V	$K_c = 14.8 = \frac{(2.0/V)^2}{(3.0/V)(9.0/V)^3} \Rightarrow$ $14.8 = \frac{4.0 \cdot V^2}{3.0 \cdot 729}$ $V^2 = \frac{14.8 \times 3.0 \times 729}{4.0} \approx 8100 \Rightarrow \mathbf{V} \approx \mathbf{90.0} \text{ dm}^3$	$K_c = 14.8 = \frac{(2.0/V)^2}{(3.0/V)(9.0/V)^3} \Rightarrow$ $14.8 = \frac{4.0 \cdot V^2}{3.0 \cdot 729}$ $V^2 = \frac{14.8 \times 3.0 \times 729}{4.0} \approx 8100 \Rightarrow \mathbf{V} \approx \mathbf{90.0} \text{ dm}^3$	1

接受 $\mathbf{V} \approx \mathbf{90} \text{ dm}^3$

12(a)　(難度: Lv4)

$$\begin{array}{c}
H-\underset{\displaystyle |}{\overset{\displaystyle H}{C}}-O-\overset{\displaystyle O}{\overset{\displaystyle \|}{C}}-(CH_2)_{16}CH_3 \\
H-\underset{\displaystyle |}{\overset{\displaystyle \bullet}{C}}-O-\overset{\displaystyle O}{\overset{\displaystyle \|}{C}}-(CH_2)_{16}CH_3 \\
H-\underset{\displaystyle \overset{|}{H}}{C}-O-\overset{\displaystyle O}{\overset{\displaystyle \|}{C}}-(CH_2)_{14}CH_3
\end{array}$$

[1 M]

12(b)　(難度: Lv4)

$$\begin{array}{c}
H-\underset{\displaystyle |}{\overset{\displaystyle H}{C}}-O-\overset{\displaystyle O}{\overset{\displaystyle \|}{C}}-(CH_2)_{16}CH_3 \\
H-\underset{\displaystyle |}{C}-O-\overset{\displaystyle O}{\overset{\displaystyle \|}{C}}-(CH_2)_{14}CH_3 \\
H-\underset{\displaystyle \overset{|}{H}}{C}-O-\overset{\displaystyle O}{\overset{\displaystyle \|}{C}}-(CH_2)_{16}CH_3
\end{array}$$

[1 M]
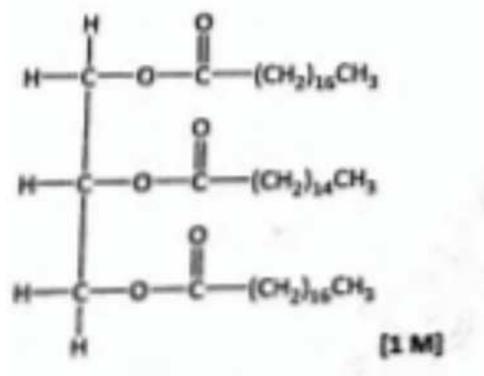
12(c)　(難度: Lv4)

3 moles of base

13(a)(i) (難度: Lv4)

(a) 150 cm^3

(b)   At about the 22$^{\text{nd}}$ minute

(c)   Average rate of O_2 produced $= \dfrac{150 \text{ cm}^3}{22 \text{ min}} = 6.82 \text{ cm}^3 \text{ min}^{-1}$

(d)   From the graph, about 112 cm^3 of O_2 were produced at the 4$^{\text{th}}$ minute.
      When the reaction completed, 150 cm^3 of O_2 were produced.

      $\therefore$ percentage of H_2O_2 decomposed at the 4$^{\text{th}}$ minute $= \dfrac{112}{150} \times 100\% = 74.7\%$

(e)
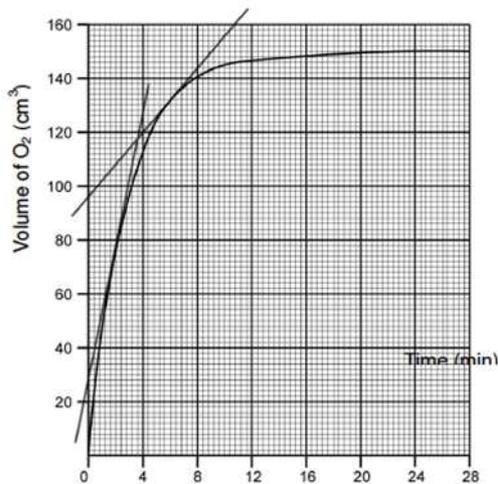
The tangent at the second minute is steeper (has a greater value) than that at the sixth minute.
This suggests that the instantaneous reaction rate at the second minute is higher than that at the sixth minute.

(f)

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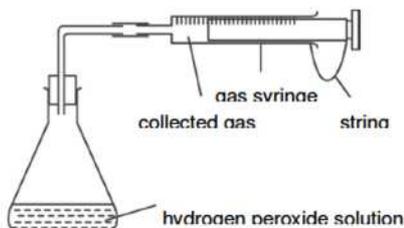
14(a)　(難度: Lv4)

內容 (Content)	中文 (Chinese)	英文 (English)	分數 (Marks)
配平方程式	$Cr_2O_7^{2-}(aq) + 3S_2O_3^{2-}(aq) + 8H^+(aq) \longrightarrow 2Cr^{3+}(aq) + 6SO_4^{2-}(aq) + 4H_2O(l)$	$Cr_2O_7^{2-}(aq) + 3S_2O_3^{2-}(aq) + 8H^+(aq) \longrightarrow 2Cr^{3+}(aq) + 6SO_4^{2-}(aq) + 4H_2O(l)$	1 1
趨勢解釋	橙色強度隨時間下降，因為反應物 $Cr_2O_7^{2-}(aq)$ (橙色) 在反應過程中被消耗 / 濃度降低。	The orange intensity **decreases** over time because the **reactant** $Cr_2O_7^{2-}(aq)$ (orange) is **consumed** / its concentration decreases during the reaction.	1

14(b)　(難度: Lv3)

| 內容 (Content)	中文 (Chinese)	英文 (English)	分數 (Marks)
實驗方法	進行**兩組**反應，一組為對照組，另一組（實驗組）在起始時加入少量額外的 $Cr^{3+}(aq)$（例如 $Cr(NO_3)_3$），然後比較兩組反應的初始速率。	Conduct **two sets** of reactions: a control set and an experimental set, where a small amount of **extra** $Cr^{3+}(aq)$ (e.g., as $Cr(NO_3)_3$) is added at the beginning. Then, compare the **initial rates** of the two reactions.	1
預測結果	若 Cr^{3+} 是自身催化劑，則**加入額外 Cr^{3+} 的實驗組的初始反應速率會顯著大於對照組。**	If Cr^{3+} is an auto-catalyst, the **initial rate of reaction** for the **experimental set with added Cr^{3+} will be significantly greater** than that of the control set.	1

14(c)

內容 (Content)	中文 (Chinese)	英文 (English)	分數 (Marks)
特性 1	可變氧化態 (e.g., Cr^{6+} 和 Cr^{3+})。	**Variable oxidation states** (e.g., Cr^{6+} and Cr^{3+}).	1
特性 2	形成錯合物 (或配位化合物) / 高熔點和高密度 / 具有催化活性（非自身催化）/ 形成有色化合物或離子。（任選其一）	**Formation of complex ions** (or coordination compounds) / **High melting point and high density** / Possesses **catalytic activity** (non-auto-catalysis) / **Formation of coloured compounds or ions**. (Any one)	1

1(a)(i)

(a) $BrO_3^-(aq) + 5Br^-(aq) + 6H^+(aq) \rightarrow 3Br_2(aq) + 3H_2O(l)$ **[1 M]**
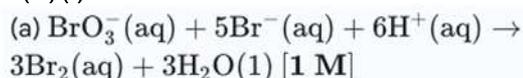
(b) Rate $= k[BrO_3^-(aq)]^a[Br^-(aq)]^b[H^+(aq)]^c$

$1.30 \times 10^{-7} = k(0.05)^a(0.04)^b(0.06)^c$ ......(1)

$2.60 \times 10^{-7} = k(0.10)^a(0.04)^b(0.06)^c$ ......(2)

$\frac{(2)}{(1)}: 2 = 2^a$ and $a = 1$ **[1 M]**

$6.91 \times 10^{-7} = k(0.15)^a(0.04)^b(0.08)^c$ ......(3)

$\frac{(3)}{(2)}$ and substitute the value of a into the equation,

$2.66 = (\frac{3}{2})^1(\frac{4}{3})^c$ and $c = 2$ **[1 M]**

$1.15 \times 10^{-7} = k(0.05)^a(0.08)^b(0.04)^c$ ......(4)

$\frac{(1)}{(4)}$ and substitute the value of c into the equation,

$1.13 = (0.5)^b(1.5)^2$ and $b = 1$ **[1 M]**

(c) Substitute the values of a, b and c into (1)(or (2)/(3)/(4)) :

$1.30 \times 10^{-7} = k(0.05)^1(0.04)^1(0.06)^2$

$k = 0.0181\ \mathrm{dm^9\ mol^{-3}\ s^{-1}}$ **[2 M]**

(**1 M** for numerical answer; **1 M** for unit)

(b) 速率 $= k[BrO_3^-(aq)]^a[Br^-(aq)]^b[H^+(aq)]^c$

$1.30 \times 10^{-7} = k(0.05)^a(0.04)^b(0.06)^c$ ......(1)

$2.60 \times 10^{-7} = k(0.10)^a(0.04)^b(0.06)^c$ ......(2)

$\frac{(2)}{(1)}: 2 = 2^a$ 且 $a = 1$ **[1 分]**

$6.91 \times 10^{-7} = k(0.15)^a(0.04)^b(0.08)^c$ ......(3)

$\frac{(3)}{(2)}$ 並將 a 的值代入方程式，

$2.66 = (\frac{3}{2})^1(\frac{4}{3})^c$ 且 $c = 2$ **[1 分]**

$1.15 \times 10^{-7} = k(0.05)^a(0.08)^b(0.04)^c$ ......(4)

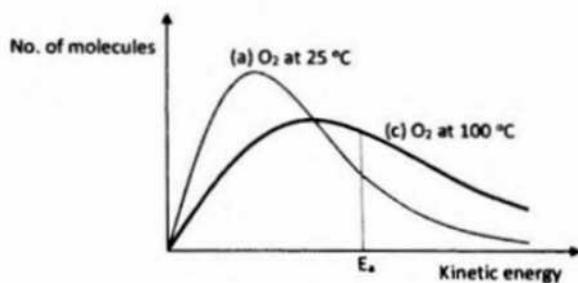$\frac{(1)}{(4)}$ 並將 c 的值代入方程式，

$1.13 = (0.5)^b(1.5)^2$ 且 $b = 1$ **[1 分]**

(c) 將 a, b 和 c 的值代入 (1)(或 (2)/(3)/(4)) :

$1.30 \times 10^{-7} = k(0.05)^1(0.04)^1(0.06)^2$

$k = 0.0181\ \mathrm{dm^9\ mol^{-3}\ s^{-1}}$ **[2 分]**

(**1 分**予數值答案；**1 分**予單位)

1(b)(i)

(1 M for correct labelling of axes, 1 M for shape of the curve.)

(ii)
The motion of gas molecules is random. It follows that the collisions between molecules also occur randomly. Some collisions result in a gain of kinetic energy for one molecule and a loss of kinetic energy for the other. (1 mark)

If a molecule undergoes a series of collisions such that each collision adds to its kinetic energy, it will end up with a kinetic energy higher than the average. (1 mark)

Conversely, if a molecule undergoes a series of collisions such that each collision results in a loss of kinetic energy, it will end up with a kinetic energy lower than the average. (1 mark)

氣體分子的運動是隨機的。因此，分子之間的碰撞也是隨機發生的。有些碰撞會導致一個分子獲得動能，而另一個分子失去動能。(1 mark)

如果一個分子經歷一系列碰撞，使得每次碰撞都增加了它的動能，那麼它的動能最終將高於平均值。(1 mark)

相反地，如果一個分子經歷一系列碰撞，使得每次碰撞都導致動能損失，那麼它的動能最終將低於平均值。(1 mark)

(iii)
Refer to the curve in (b)(i) [1 M].
參考 (b)(i) 中的曲線。[1 M].

(iv)
As seen from the graph (for O_2 at 25°C and O_2 at 100°C), there are more molecules which possess the kinetic energy greater than or equal to the activation energy of the reaction [1 M]. Hence, the reaction rate increases.

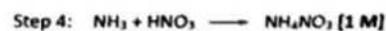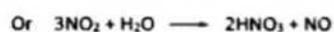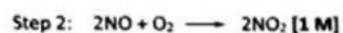從圖表（對於 25°C 的 O_2 和 100°C 的 O_2 ）中可見，具有大於或等於反應活化能的動能的分子數量增加了 [1 M]。因此，反應速率增加。

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1(c)(i)

(1)

Increase the crop yield of farmland [1 M]

增加農地/農作物的產率[1 M]

(2)

Step 1: $4NH_3 + 5O_2 \longrightarrow 4NO + 6H_2O$ **[1 M]**

Step 2: $2NO + O_2 \longrightarrow 2NO_2$ **[1 M]**

Step 3: $4NO_2 + 2H_2O + O_2 \longrightarrow 4HNO_3$ **[1 M]**

Or $3NO_2 + H_2O \longrightarrow 2HNO_3 + NO$

Or $2NO_2 \longrightarrow N_2O_4$ followed by

$3N_2O_4 + 2H_2O \longrightarrow 4HNO_3 + 2NO$

Step 4: $NH_3 + HNO_3 \longrightarrow NH_4NO_3$ **[1 M]**

(ii)

$CH_4 + H_2O \rightleftharpoons CO + 3H_2$ [1 M]

It uses methane (CH_4), a readily available and relatively cheap natural resource (feedstock), which is a core principle of green chemistry (e.g., Use of renewable feedstocks). / It involves a high because most reactants are converted into the desired products (H_2) [1 M]

它利用了甲烷 (CH_4) 這種易得且相對廉價的天然資源（原料），這是綠色化學的一個核心原則（例如：使用可再生原料）。/ 它涉及高的原子經濟因為大部分反應物都被轉化為所需的產物(H_2) [1 M]

2(a) condensation polymerization 縮合聚合作用[1]
diol and dioic acid[1]
二醇 和 二酸

2(b)For thermosetting plastic there are cross linkage between different polymer chain.
就熱固性塑膠，聚合物鏈之間會有交叉鏈接。[1]

For polyester there are dipole-dipole attraction between the polymer chain.
就聚酯，聚合物鏈之間會有偶極－偶極吸引力。[1]

2(c) It is a good electrical insulator and a good heat insulator
極佳的電絕緣體[1],極佳的耐熱物質[1]

2(d)(i)
Using the material which is biodegradable and adding material that is biodegradable to the plastic.
使用可生物降解的物質[1]及加入可生物降解的物料至塑膠[1]。

2(d)(ii)
Using the material which is biodegradable: the microorganism can decompose it directly.
使用可生物降解的物質: 微生物可以直接將其分解[1]

Adding material that is biodegradable to the plastic: after the biodegradable substance decomposed, the surface area of the other part of plastic will be increased.
加入可生物降解的物料至塑膠: 當生物可降解的物質被分解後，其他塑膠部分的表面面積會增加。[1]

2(d)(iii)
polylactide (PLA)
聚乳酸

2(e)(i)
The unit cell is the simplest arrangement of atoms (or ions)which when repeated will reproduce the whole structure.
晶胞是能描述晶體結構的最小結構單位。把晶胞複製，並有規律地排列，可得出整個晶體。[1]

2(e)(ii)
The coordination number is defined as the number of atoms (or ions) immediately surrounding an atom (or ion) in a crystal lattice.
配位數是指在一個晶格中包圍一個原子（或離子）的原子（或離子）的數目。[1]
2(e)(iii)(1)   12 [1]
2(e)(iii)(2)   8 [1]
2(e)(iv) brass 黃銅 [1]

2(e)(v)

In a pure copper, all the atoms are of the same size. The layers of atoms can slide past one another easily when a force is applied. [1] In an brass, atoms of a different size are added. This distorts the regular structure of the pure metal. [1] The layers of atoms in the alloy are difficult to slide past one another when a force is applied. Hence brass is stronger and harder than copper.[1]

在銅，所有原子的體積都相同。當施加力時，原子層能夠輕易滑動經過其他的原子。在黃銅，不同體積的原子加入，令到當中有規律的結構被破壞。當施加力時，原子層較難滑動經過其他的原子。因此，黃銅的硬度比銅高。

2(e)(vi)

A regularly packed solid has a higher melting point than one with a less regular structure. The structure of brass is less regular than pure copper. Hence brass has a lower melting point than the copper.

一個規則排列的固體比不規則排列的固體有更高的熔點。黃銅的結構比純銅的排列更不規則。因此黃銅比銅有更低的熔點。

3(a)(i)
adding H_2SO_4 to the sample, filter out the sample and carry out the flame test. If there are brick red flame, it indicates that there is the presence of Ca^{2+}.

加入 H_2SO_4 至樣本，過濾樣本並進行焰色測試，若有磚紅色的火焰生成，這顯示該樣本是有 Ca^{2+}

的存在。

(2)

3(a)(ii)
Add water to the sample respectively. $CaCl_2$ would be soluble but $CaSO_4$ would be insoluble (1)
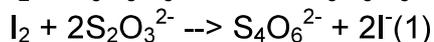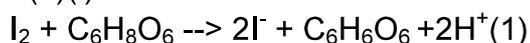
將水分別地加進樣本， $CaCl_2$ 是可溶的，但 $CaSO_4$ 是不可溶的(1)

3(a)(iii)
No, the compound with the same Rf value in the same mobile phase and stationary phase is the same compound.(1)
The mobile phase of this two experiments are different. (1)

不，在同一個固定相和流動相之中擁有相同 Rf 值的化合物是同一化合物。(1)

但在兩個實驗中流動相是不相同的。(1)

3(b)(i)
$I_2 + C_6H_8O_6 \longrightarrow 2I^- + C_6H_6O_6 + 2H^+$ (1)
$I_2 + 2S_2O_3^{2-} \longrightarrow S_4O_6^{2-} + 2I^-$ (1)

3(b)(ii)
Starch solution(1), from dark blue to colorless(1)

澱粉溶液(1)，由藍黑色轉為無色(1)

3(b)(iii)

No. of mole of $S_2O_3^{2-}$ used = 17.27/1000 x 0.1 = 1.727×10^{-3}mol

No. of mole of I_2 reacted with $S_2O_3^{2-}$ = 1.727×10^{-3} /2 = 8.635×10^{-4}mol

No. of mole of I_2 added = 10/1000 x 0.2 = 2×10^{-3}mol

No. of mole of I_2 reacted with $C_6H_8O_6$ = 2×10^{-3} - 8.635×10^{-4} = 1.1365×10^{-3}mol

Mass of $C_6H_8O_6$ in the sample = 1.1365×10^{-3} (12x 6 + 8 + 16x6) = 0.200g

Percentage by mass = 0.200/3 x100% =6.67%

(3)

使用的 $S_2O_3^{2-}$ 的摩爾數= 17.27/1000 x 0.1 = 1.727×10^{-3}mol

與 $S_2O_3^{2-}$反應的 I_2 的摩爾數 = 1.727×10^{-3} /2 = 8.635×10^{-4}mol

加入的 I_2 的摩爾數= 10/1000 x 0.2 = 2×10^{-3}mol

與 $C_6H_8O_6$ 反應的 I_2 的摩爾數= 2×10^{-3} - 8.635×10^{-4} = 1.1365×10^{-3}mol

在樣本中 $C_6H_8O_6$ 的質量 = 1.1365×10^{-3} (12x 6 + 8 + 16x6) = 0.200g

質量百分比 = 0.200/3 x100% =6.67%

(3)

3(c)(i)

From characteristic (1), the compound X should have a aldehyde, primary alcohol or secondary alcohol. (1)

The spectrum does not show strong absorption at about 3230-3670 cm^{-1} ruling out the presence of a hydroxyl group.(1)

The spectrum has a strong absorption at 1700 cm^{-1} which corresponds to C=O Stretching. The compound contain C=O bond.(1)

By combine two information, the compound should be aldehyde. (1)

從特性(1), 化合物 X 應為醛,一級醇或二級醇。(1)

在光譜中 3230-3670 cm^{-1} 處沒有強吸收,可排除羥基團的存在。(1)

在光譜在 1700 cm^{-1} 處有強吸收對應於 C=O 的伸展。(1)

整合兩個資料,該化合物應為醛。(1)

3(c)(ii)

molecular formula = $(C_9H_8O_2)n$ where n is a integer.

The molecular ion peak can represent it relative molecular mass.(1)

hence,

(12x9 + 1x8 + 16x2)   n   = 148

n   = 1

So, the molecular formula is $C_9H_8O_2$(1)

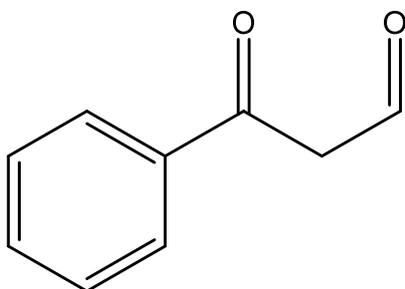分子式 = $(C_9H_8O_2)n$, n 是一個整數

分子離子峰能夠用於反映與相對分子質量。(1)

因此，

(12x9 + 1x8 + 16x2)   n   = 148

n   = 1

所以，分子式是 $C_9H_8O_2$(1)

3(c)(iii)

The peak at m/z = 77 suggest the presence of $[C_6H_5]^+$.(1)

於 m/z=77 的峰應為$[C_6H_5]^+$.的存在(1)

(1)