Chapter 29
Simple chemical cells

- ✓ describe and demonstrate how to build simple chemical cells using metal electrodes and electrolytes
- ✓ measure the voltage produced by a chemical cell
- ✓ explain the problems associated with a simple chemical cell consisting of two metal electrodes and an electrolyte
- ✓ explain the functions of a salt bridge/porous device
- ✓ describe and demonstrate how to build simple chemical cells using metal-metal ion half cells and salt bridges/porous devices
- ✓ explain the differences in voltages produced in chemical cells when different metal couples are used as electrodes
- ✓ write a half equation representing the reaction at each half cell of a simple chemical cell
- ✓ write overall equations for simple chemical cells
- ✓ predict the electron flow in the external circuit and the chemical changes in the simple chemical cells

29.1 Simple chemical cells consisting of two metal electrodes and an electrolyte

(1) In chemistry, electricity = _____

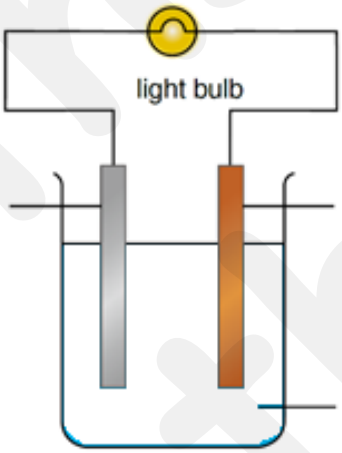
(2) Metal reactivity series:

K > > > > > > > > > Ag

(3) More reactive metals will lose _____ to less reactive metals.

A. Building a simple chemical cell

Example 1: Zn/Cu using NaCl(aq) as electrolyte



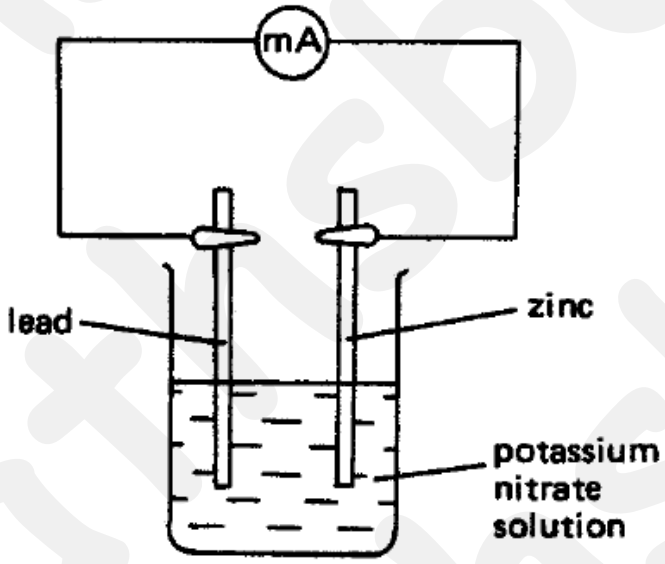
	Zn electrode ( )	Cu electrode ( )
Reactivity		
Half equation		
Overall equation		
Anode / Cathode		
Observation		
e^- flow		
Current flow		

Remarks:

- e^- flow and current flow are opposite in direction.
- If Zn electrode is replaced by another Cu electrode ⇒ no voltage / current / e^- flow

Class Practice 1:

Refer to the chemical cell below.



(a) Which is the positive pole?

(b) Which is the negative pole?

(c) What is the electrolyte used?

(d) What is the direction of flow of electron?

(e) Is there any changes in the chemical cell if potassium nitrate solution is replaced by olive oil?

29.2 The Electrochemical Series of metals

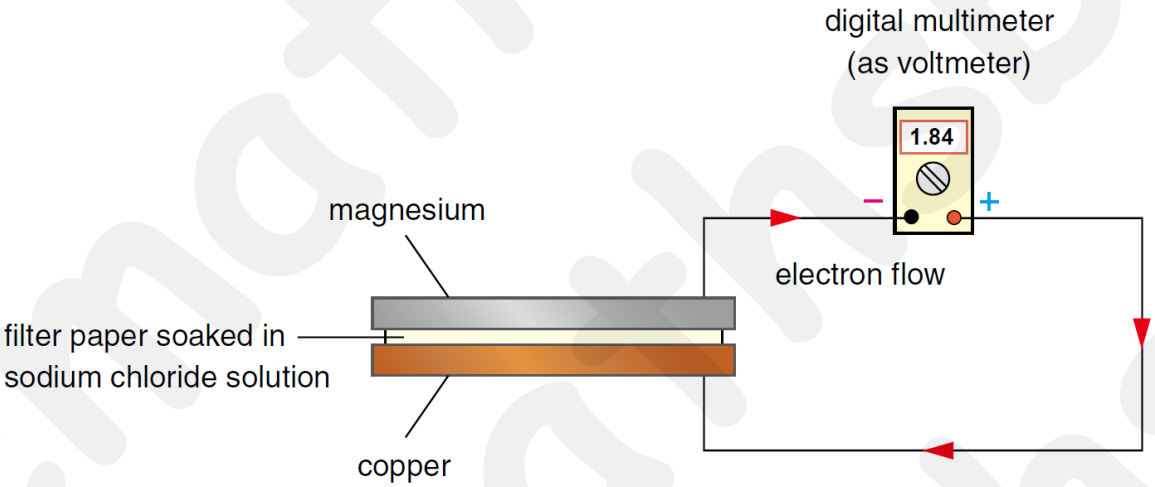
A. Measuring the voltage produced by a chemical cell

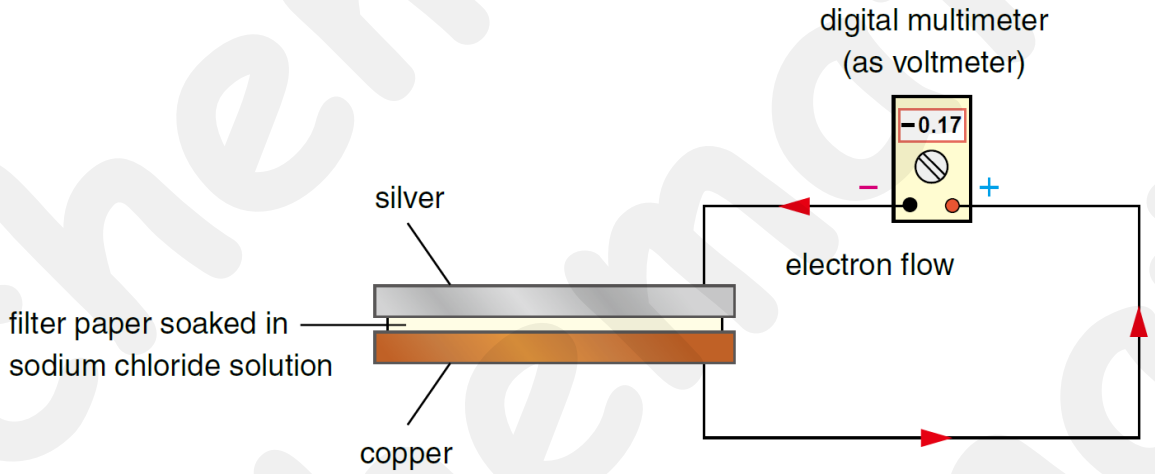
(1) Different metals have different tendencies to form _____ (_____ electrons).

- This tendencies can be arranged in order called _____ (E.C.S.).

(2) E.C.S. of metals ≈ Reactivity of metals

(3) Metal couple with larger difference in E.C.S. → larger voltage



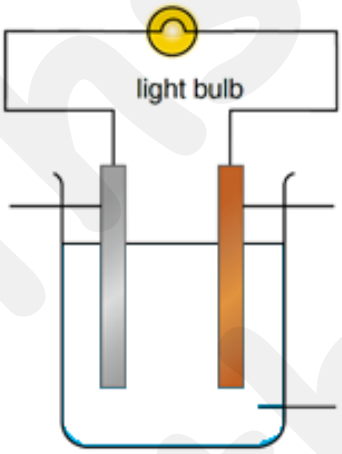


B. Relative positions of metals in the Electrochemical Series

Electrochemical Series	Ease of losing e-	Metal Reactivity Series
K	metal lose e- most easily	K
Ca		Ca
Na		Na
Mg		Mg
Al		Al
Zn		Zn
Fe		Fe
Pb		Pb
Cu		Cu
Hg		Hg
Ag		Ag
Pt		Pt
Au	metal lose e- least easily	Au

Remarks:
For a simple chemical cell consisting of two metals and an electrolyte, the **further apart** the two metals are in the E.C.S., the **higher** is the voltage of the cell.

Example 2: Zn/Cu using $H_2SO_4(aq)$ as electrolyte

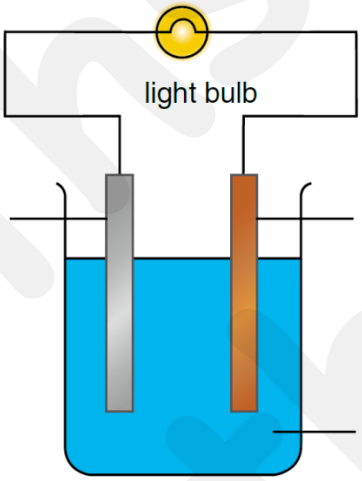


	Zn electrode ( )	Cu electrode ( )
Reactivity		
Half equation		
Overall equation		
Anode / Cathode		
Observation		
e^- flow		
Current flow		

But there is one problem:

(1) The Zinc metal will be used up very quickly because _____.

Example 3: Zn/Cu using $CuSO_4(aq)$ as electrolyte



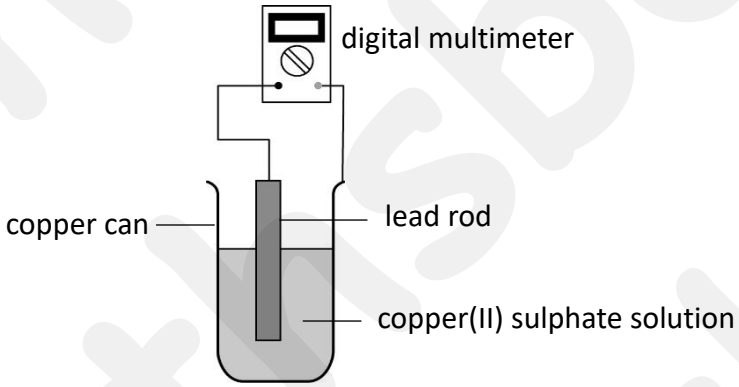
	Zn electrode ( )	Cu electrode ( )
Reactivity		
Half equation		
Overall equation		
Anode / Cathode		
Observation		
e^- flow		
Current flow		

But there is another problem:

(1) The Zinc metal will be used up very quickly because _____.

Class Practice 2:

A student set up a simple chemical cell as shown below. The student found that the digital multimeter reading dropped continuously.



(a) Write a half equation for the reaction occurring on the inner wall of the copper can.

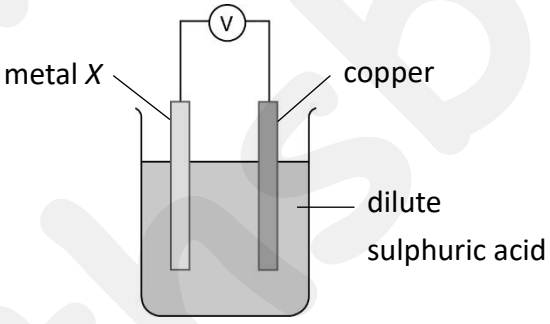
(b) Write a half equation for the reaction occurring on the lead rod.

(c) Hence, explain the decrease of voltage.

(d) The student replaced the solution in the can with very dilute nitric acid. State TWO observable changes in the set-up.

Class Practice 3:

The following set-up is used to compare the voltages of different metal couples. Metal *X* could be copper, iron or zinc.



(a) Write the overall equation for the set-up when metal *X* is zinc.

(b) State TWO observable changes in the cell when metal *X* is iron.

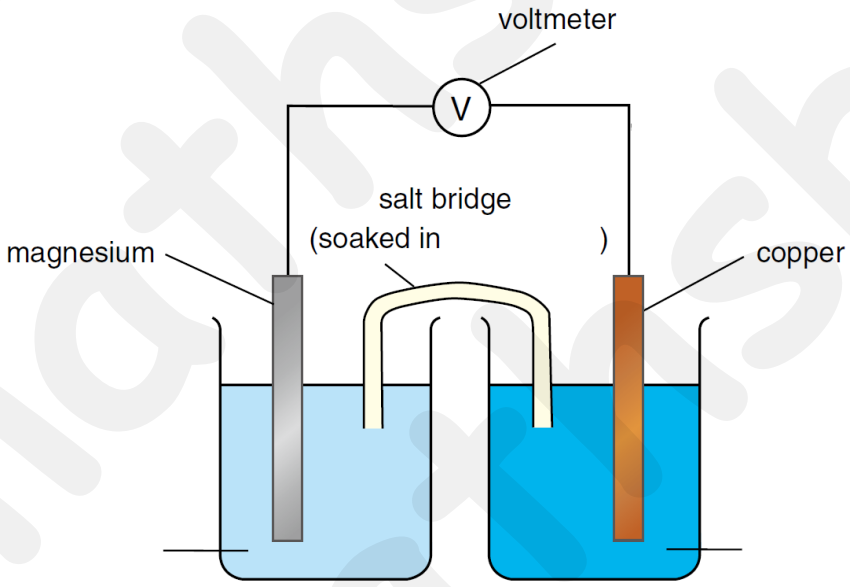
(c) Complete the following table by matching the metals (copper, iron or zinc) with the voltage.

Voltage (V)	Metal *X*
+0.92	
+0.49	
0.00	

(d) Arrange copper, iron and zinc in descending order of their tendencies to lose electrons.

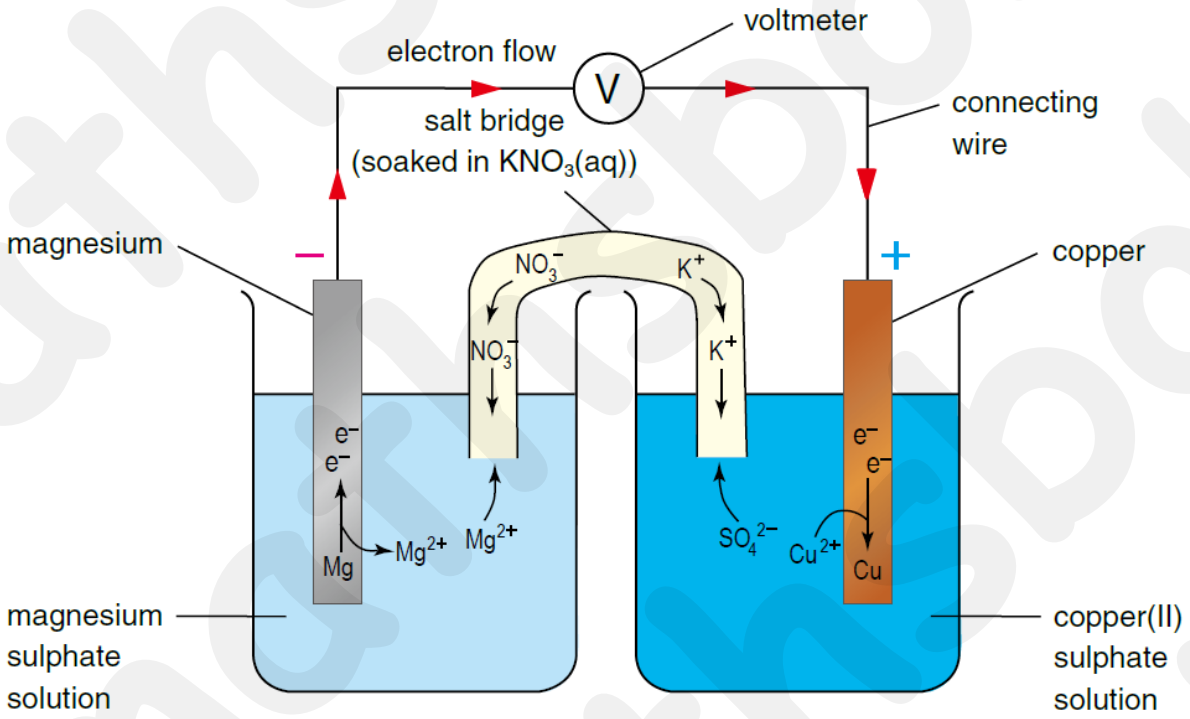
29.3 Simple chemical cells consisting of metal-metal ion half cells and salt bridge / porous device

A. Building simple chemical cells using metal-metal ion half cells and salt bridges



	Mg electrode ( ) / Left half cell	Cu electrode ( ) / Right half cell
Reactivity		
Half equation		
Overall equation		
Anode / Cathode		
Observation		

B. Function of a salt bridge



(1) A salt bridge joins the two half cells.

(2) It is a strip of filter paper soaked in a solution of an electrolyte.

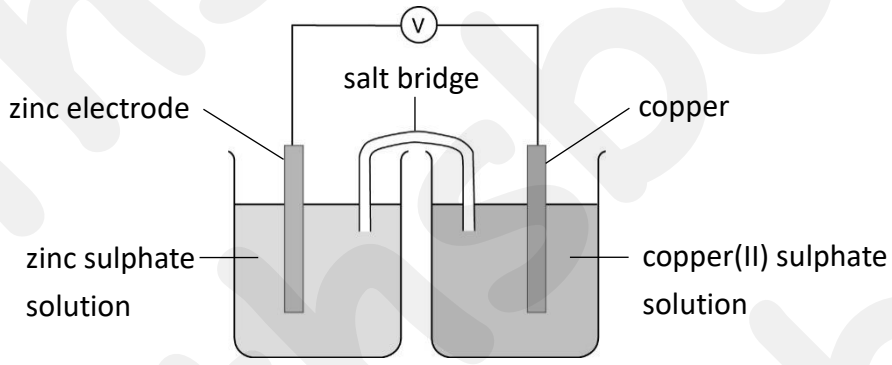
(3) Functions of a salt bridge :

I. to _____ the _____ by allowing ions to move between 2 half cells (without direct mixing of the 2 solutions)

II. to provide _____ to _____ the charge in the solution of the 2 half cells

Class Practice 4:

Consider the following chemical cell:

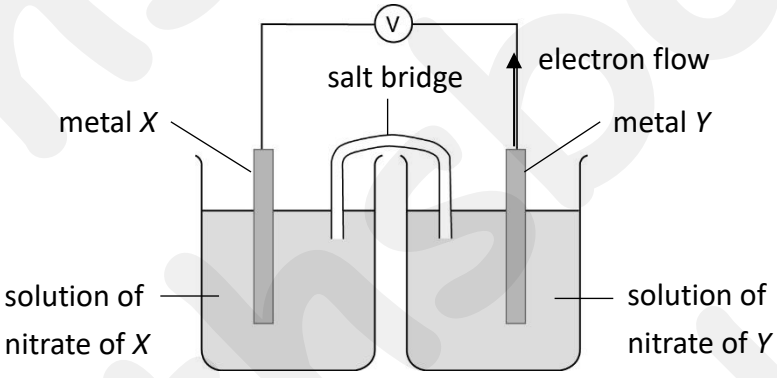


Which of the following statements about the cell are correct?

(1) The mass of the copper electrode increases.
(2) The salt bridge can be prepared by soaking a strip of filter paper in potassium nitrate solution.
(3) Electrons flow from zinc electrode to copper electrode in the external circuit.

Class Practice 5:

Consider the following chemical cell:



(a) State and explain whether *X* or *Y* is more reactive.

(b) Which metal is the positive pole of the cell?

(c) (i) How can a salt bridge be prepared?

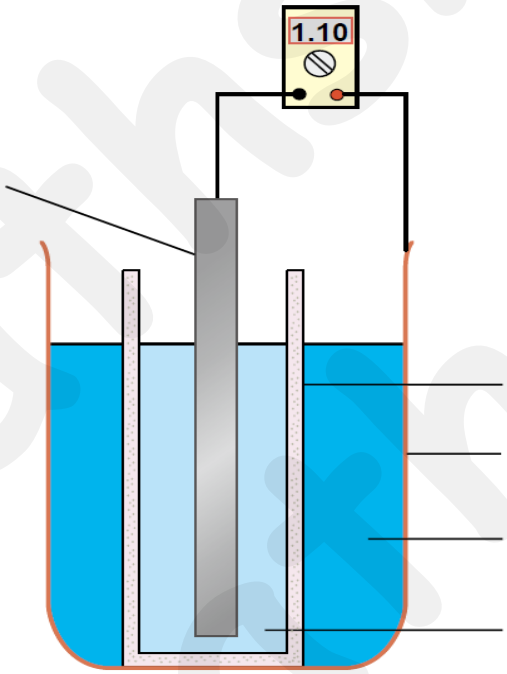
(ii) State ONE function of the salt bridge.

(iii) What would happen if the salt bridge is removed?

C. Simple chemical cells with metal-metal ion half cells and a porous device

(1) The half cells are separated by a _____ **device (porous pot)**, which act as a salt bridge, separates the half cells.

- This type of cell is called Daniell Cell.



half equation at **negative electrode** :

half equation of **positive electrode** :

overall equation :

(2) Inside the porous pot: ∵ Zn^{2+}(aq) ions are formed

∴ there is an excess of _____ charges

(3) Outside the porous pot: ∵ Cu^{2+}(aq) ions gain e^- to form Cu(s)

∴ there is a drop of positive charges

∴ there is an excess of _____ charges

(4) To maintain electrical neutrality,

Zn^{2+}(aq) ions move out from the pot & SO_4^{2-}(aq) move into the pot.

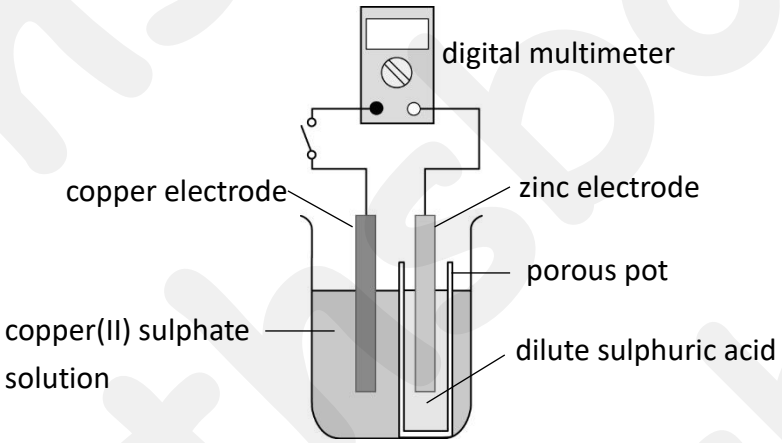
(5) **Functions of a porous device** :

I. to _____ direct mixing of the two electrolytes.

II. It _____ the circuit by allowing _____ to move from one electrolyte into the other.

Class Practice 6:

Consider the following chemical cell. The digital multimeter shows a reading when the switch is closed.



(a) Write half equations for the reactions taking place at the zinc electrode and copper electrode respectively.

(b) What is the direction of electron flow in the external circuit?

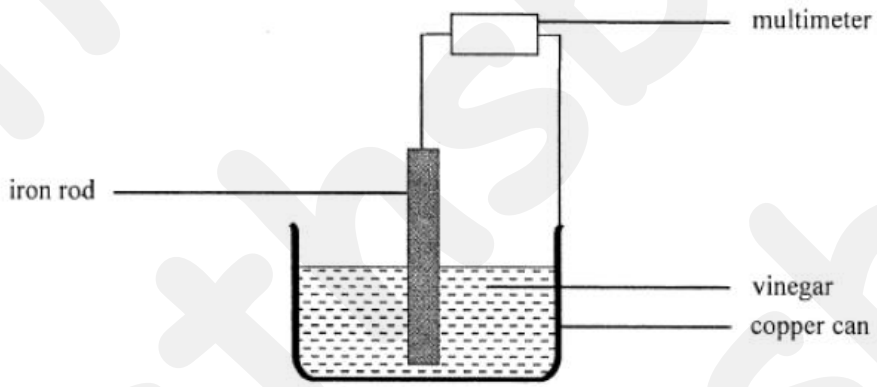
(c) What is the use of the porous pot?

(d) In what direction do the sulphate ions pass through the porous pot? Explain your answer.

(e) State and explain the change of the voltmeter reading if the zinc electrode is replaced by a copper electrode.

Class Practice 7: [HKCEE 2007 I 4]

A student learnt from a book that an ancient chemical cell could be made by immersing an iron rod in a liquid placed inside a copper can. The liquid used was vinegar but not wine. The diagram below shows the set-up designed by him in simulating the cell.



(a) Explain, in terms of structure and property of particles, why the liquid inside the ancient chemical cell was vinegar but not wine.

(b) The student found that the iron rod dissolved gradually, and colourless gas bubbles were given out on the inner wall of the copper can.
   (i) Write a half equation, involving iron, for the reaction that occurred at the iron rod.
   (ii) Write a half equation for the reaction that occurred on the inner wall of the copper can.

(c) The student found that colourless gas bubbles were also given out at the surface of the iron rod that immersed in vinegar. Explain the observation.

chemathsbob

S.5 Chemistry Regular Course

S.5 Elite Regular Course		
月份	章節	內容
September	Section 7 Chemical Cells, Redox Reaction & Electrolysis	Redox Reaction
		Redox Reaction
		Chemical Cells
		Chemical Cells
October		Electrolysis
		Electrolysis
	Section 8 Chemical Reaction & Energy	Standard Enthalpy Change
		Standard Enthalpy Change

*以上課程內容只供參考，實際次序或進度可能因情況而略作修改，一切以當時教學進度為準。

S.6 Chemistry Regular Course

S.6 Elite Regular Course		
月份	章節	內容
September	Section 13 Industrial Chemistry	Rate Equation
		Rate Equation
		Activation Energy
		Activation Energy
October		Catalysis and Industrial Processes
		Industrial Processes
		Industrial Processes
		Green Chemistry & Integrated Exam Skills Tactics

*以上課程內容只供參考，實際次序或進度可能因情況而略作修改，一切以當時教學進度為準。

S.6 Chemistry Reborn Course [亦即 Intensive]

＝＝＝＝＝＝＝＝＝＝＝＝＝＝＝＝＝＝＝＝＝＝＝＝＝＝＝＝＝＝＝＝＝＝＝＝

Chemistry 速效課程　幫你迅速提升幾個 Levels！

- 此課程專為**想短時間快速提升成績**或**想快速重溫 S.4 & S.5 課題**的中六同學而設。在 32 堂內極速幫助同學重溫 S.4 & S.5 非常重要及佔分極重的幾個 Core 必修部分的課題，教授**極重要的考試技巧及常考內容及題種**，讓同學鞏固根基，為考試作充足準備。
- 此課程所教授的內容極為濃縮，只抽取**考試常見及極重要的內容**，並不會浪費太多時間於不重要的支節上。
- 此課程建議配合『S.6 Chemistry Regular Course』。此課程的內容並**不會**與 Regular Course 重疊。
- 每堂課均為 Double Lesson (每堂課為 2.5 小時) 。

課程包括:

1. 精華講義 [只設英文版本]
   - ✓ Cover 整個 DSE Chemistry Syllabus、精選試題 Demo 及最專業 Marking Scheme
2. 應試操練題目
   - ✓ MC + LQ 皆有。只有通過不斷實踐，才能達到考評局的要求。
3. 課後問書支援

S.6 Chemistry Reborn Course		
月份	章節	內容
September	Section 2 Microscopic World I Section 6 Microscopic World II	Atomic Structure & Periodic Table Bonding & Structure Covalent Bond, Bond Polarities and Shape of Molecules Intermolecular Forces
October	Section 4 Acids & Bases	Intro. To Acid and Bases Concentration, pH, Indicator, Strength Salt & Neutralization
November	Integrated Calculation	Mole Concepts Reacting Masses Volumetric Analysis Molar Volume of Gas
December	Section 7 Redox, Chemical Cells & Electrolysis	Simple Chemical Cells Redox Reaction Redox Reaction in Chemical Cells Electrolysis
January		
February	Section 8 Chemical Reaction & Energy	Standard Enthalpy Change Hess's Law
March	Section 9 Rate of Reaction	Intro. Rate of Reaction Factors Affecting Rate of Reaction
	Section 10 Chemical Equilibrium	Dynamic Equilibrium Equilibrium Constant Effect of External Factors on Eqm.

*以上課程內容只供參考，實際次序或進度可能因情況而略作修改，一切以當時教學進度為準。

導師簡介:

滿分・化學權威

- ✧ 香港大學 化學及化學教育雙學士，真正教 chem 專家，與一般教主修化學導師不同。 Bob Sir 並不止於化學，更著重提升學生成績的化學教學法。
- ✧ DSE 數學科 (必修及延伸) 及化學科 輕鬆全取 5**，其後於多屆文憑試中仍堅持與學生一起應戰，與學生一起成就最強，絕非紙上談兵。
- ✧ Bob Sir 擁有接近十年教育經驗，多年來不斷研究，鑽研一套最有效而完善的教學系統，協助同學最得佳績。

科目 Subject	科目等級 Subject Level/Grade	分部等級 Component Level
MATHEMATICS Compulsory Part & Extended Part (Algebra and Calculus)	5**(Five**) &5**(Five**)	
CHEMISTRY	5**(Five**) ♦	

戰績・忠於考評

- ✧ Bob Sir 學生來自數十間中學，每年眾多套星學生卻不止名校，無數 Band 2 學生亦能在 Bob Sir 指導下奪星。
- ✧ Bob Sir 的教學內容 100% 針對公開試，貼地而不 OUT-SYL，全面覆蓋所有考核範圍。教學方法由學生思維出發，靈活演繹，教學技巧深得學生、老師、家長歡迎。

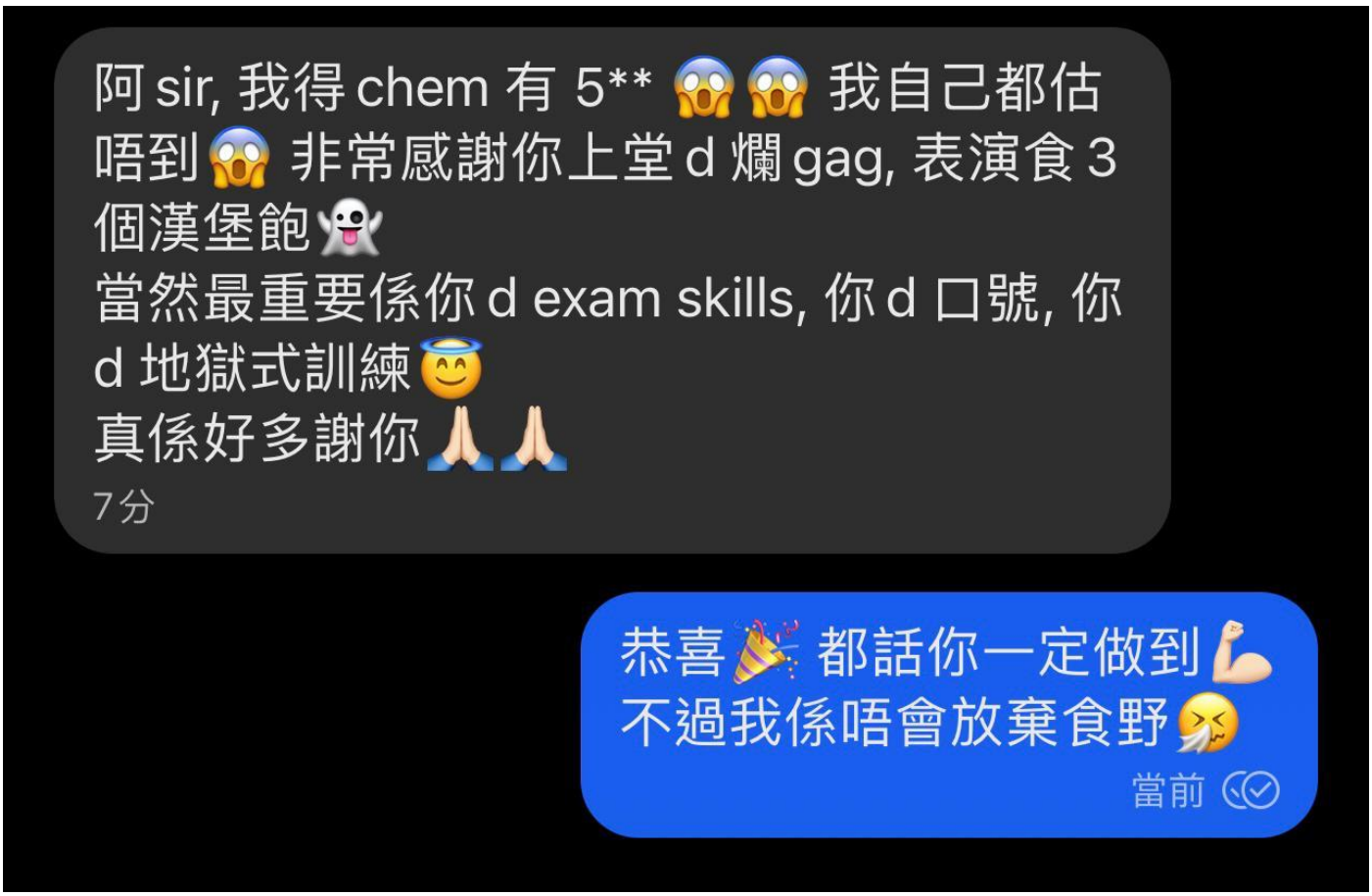
獨家・必殺絕招

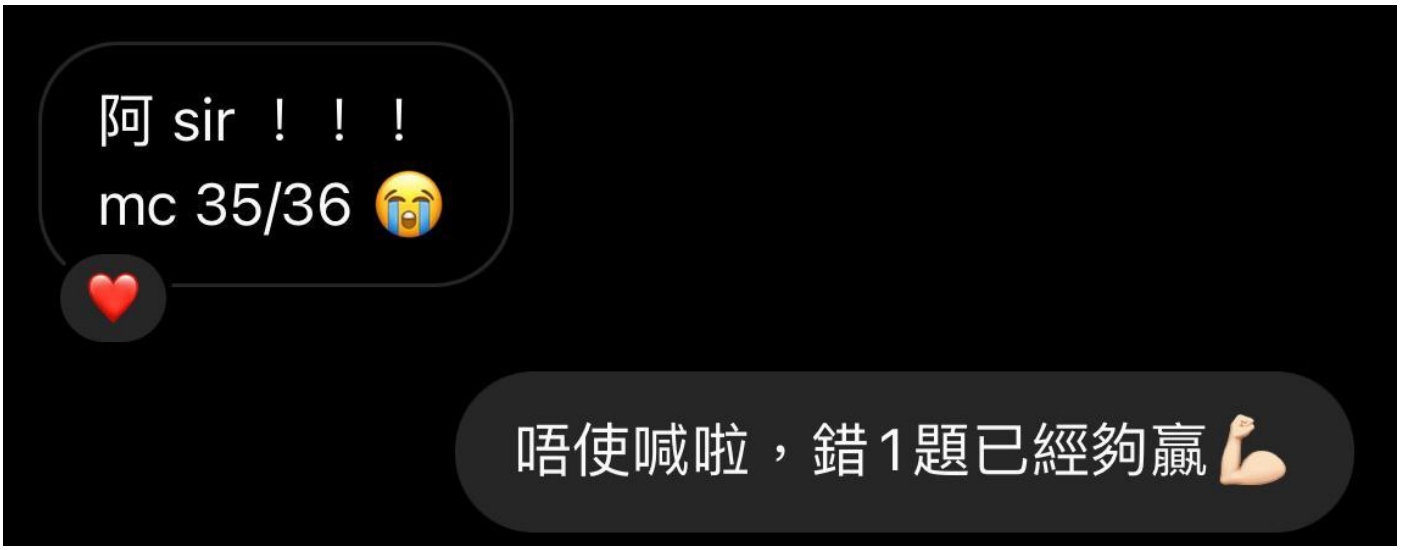
- ✧ 以清晰概念及考評出題模式為基礎，配以口號和記憶法，每一個技巧招招實用，將化學化繁為簡。
- ✧ 真正做到快、狠、準，技巧無人能敵，口碑足以證明一切。

完美・全面支援

- ✧ Bob Sir 為每位同學於每個課題中準備了平均 200 頁的精華筆記，另外亦會派發大量緊貼考評的《Exam Drilling》及《答題框架攻略》，方便同學作最高程度操練。
- ✧ Bob Sir 建立了專業 5**助教團隊，不惜工本，希望同學得到最專業的指導及支援。

學生感言:


阿 sir, 我得 chem 有 5** 😱😱 我自己都估唔到😱 非常感謝你上堂 d 爛 gag, 表演食 3 個漢堡飽👻
當然最重要係你 d exam skills, 你 d 口號, 你 d 地獄式訓練😇
真係好多謝你🙏🙏
7分
恭喜🎉 都話你一定做到💪
不過我係唔會放棄食野🤧
當前


阿 sir ！ ！ ！
mc 35/36 😭
❤️
唔使喊啦，錯1題已經夠贏💪

化学 Chemistry - E

1B3

24 M1

(out of 28)

24

chemathsbob

464 (out of 501)

5**

化學 Chemistry - E

	1B3	
	25 M1 25 C (out of 28)	
	25	

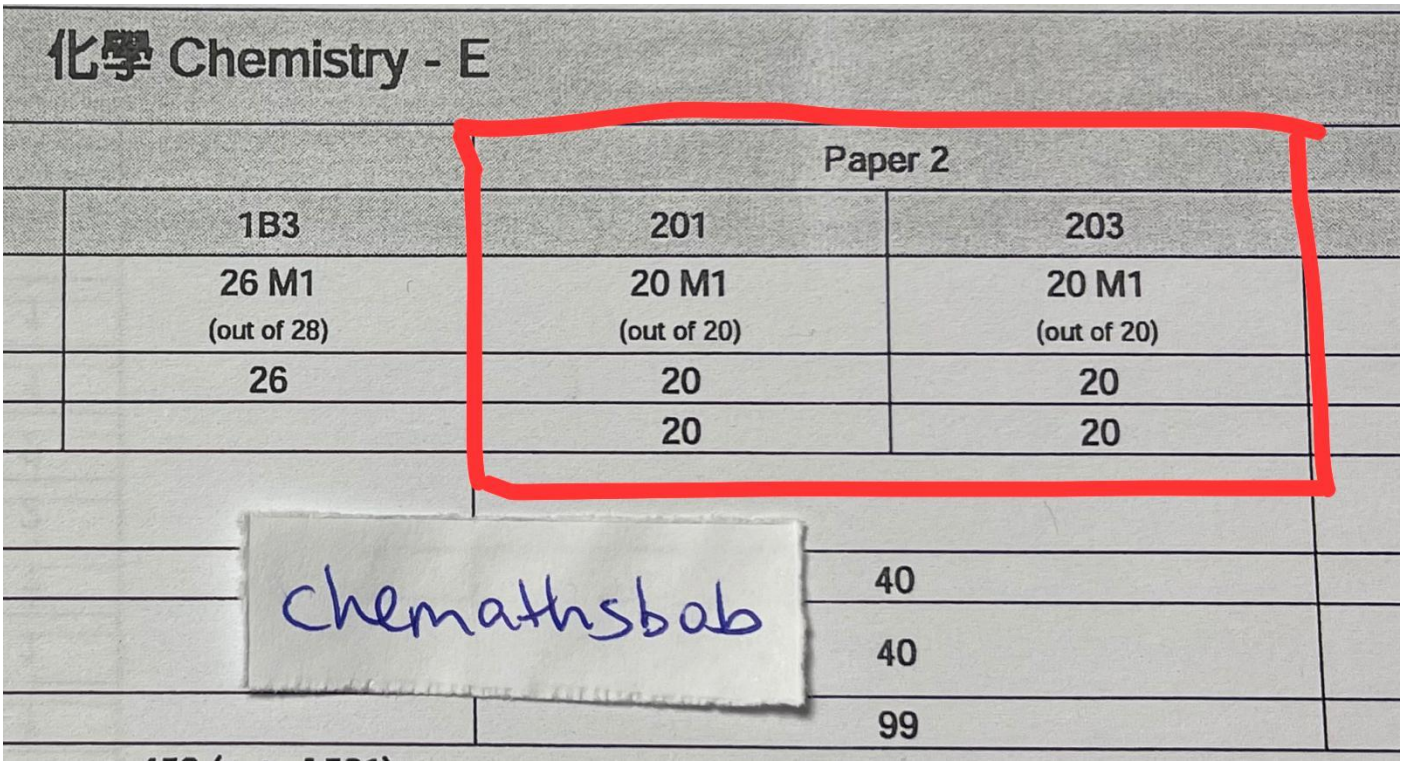
chemathsbab

460 (out of 499)

5**

arr sirrrr, chem 有 5* 呀~~🤓
其實真係可以拎多粒*, 但我 paper 2 滿分😍
可能真係仲有 careless, 不過我已經 appeal 左
真係好好好好多謝你呀!
你教嘅技巧真係屈晒機, 成份卷都輕輕鬆鬆咁做
我敢講, 冇你 冇我🥰🥰
2分

你好叻女呀👍❤️
揀 jupas 有野問記得返黎，有幾個 admission 同學喺度坐陣
1分



上午 1:41

last lesson 完左真係好想講聲多謝
我中 5 先跟你, 補左你 1 年多 d
但就由我 chem 得 17 分變到而家全級第 2
印象最深刻係上你 mole cal 同 redox
以前睇真係唔知做緊乜, 一堆符號同公式
但其實明左個原理根本乜都唔使記, 一定 full mark
係你令我有返信心
不過你都唔好食咁多野同夜訓, 超唔健康
btw 一定會廣傳你比 d 師弟

點按兩下可傳達 ❤️

使用閱後即焚模式

chemathsbob

Chemistry

Elite Intensive Course　[12 期，每期 4 堂]

痛苦地獄煉出火鳳凰

超癲精英班

每星期 2.5 小時

無信心奪 5** 免問！

- 此課程以 Online 形式上課，同學安在家中收看直播。
- 每堂 Double Lesson，唔係精英點頂得順
- 當然，兩星期內你會發現自己急劇進步，出現屈機效果！
- 學生成績瞬間提升，有根基，又有 skills ，是最痛苦，又最有成效的一班。
- 課程會由中 4、中 5 的基礎課題，一直延伸到中 6 選修部分。

chemathsbob

Chemistry

Elite Regular Course　[每期 4 堂]

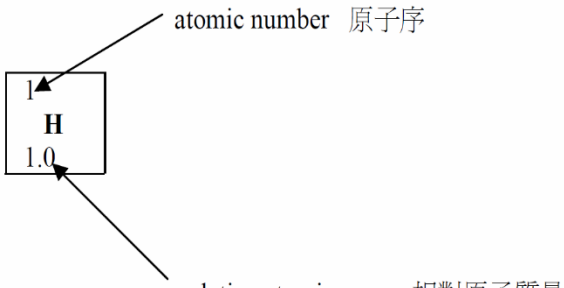
痛苦地獄煉出火鳳凰　無心奪 5** 勿擾

立即報名
踏上摘星之旅！

- 此課程以 Online 形式上課，同學安在家中收看直播。
- 每個課顯深入淺出，傳授所有必備化學概念及公開考評設題法、所有考試秘技、口號，助你穩陣奪星。
- 設有大量高質素之應試練習題，務求一擊即中 Marking 瞬間搶分。
- 課堂亦有互動問書環節，全港第一 5** 滿分真跡，補底摘星，一應俱全。

PERIODIC TABLE 周期表

GROUP 族



I	II											III	IV	V	VI	VII	0
																	2 **He** 4.0
3 **Li** 6.9	4 **Be** 9.0											5 **B** 10.8	6 **C** 12.0	7 **N** 14.0	8 **O** 16.0	9 **F** 19.0	10 **Ne** 20.2
11 **Na** 23.0	12 **Mg** 24.3											13 **Al** 27.0	14 **Si** 28.1	15 **P** 31.0	16 **S** 32.1	17 **Cl** 35.5	18 **Ar** 40.0
19 **K** 39.1	20 **Ca** 40.1	21 **Sc** 45.0	22 **Ti** 47.9	23 **V** 50.9	24 **Cr** 52.0	25 **Mn** 54.9	26 **Fe** 55.8	27 **Co** 58.9	28 **Ni** 58.7	29 **Cu** 63.5	30 **Zn** 65.4	31 **Ga** 69.7	32 **Ge** 72.6	33 **As** 74.9	34 **Se** 79.0	35 **Br** 79.9	36 **Kr** 83.8
37 **Rb** 85.5	38 **Sr** 87.6	39 **Y** 88.9	40 **Zr** 91.2	41 **Nb** 92.9	42 **Mo** 95.9	43 **Tc** (98)	44 **Ru** 101.1	45 **Rh** 102.9	46 **Pd** 106.4	47 **Ag** 107.9	48 **Cd** 112.4	49 **In** 114.8	50 **Sn** 118.7	51 **Sb** 121.8	52 **Te** 127.6	53 **I** 126.9	54 **Xe** 131.3
55 **Cs** 132.9	56 **Ba** 137.3	57 * **La** 138.9	72 **Hf** 178.5	73 **Ta** 180.9	74 **W** 183.9	75 **Re** 186.2	76 **Os** 190.2	77 **Ir** 192.2	78 **Pt** 195.1	79 **Au** 197.0	80 **Hg** 200.6	81 **Tl** 204.4	82 **Pb** 207.2	83 **Bi** 209.0	84 **Po** (209)	85 **At** (210)	86 **Rn** (222)
87 **Fr** (223)	88 **Ra** (226)	89 ** **Ac** (227)	104 **Rf** (261)	105 **Db** (262)													

*	58 **Ce** 140.1	59 **Pr** 140.9	60 **Nd** 144.2	61 **Pm** (145)	62 **Sm** 150.4	63 **Eu** 152.0	64 **Gd** 157.3	65 **Tb** 158.9	66 **Dy** 162.5	67 **Ho** 164.9	68 **Er** 167.3	69 **Tm** 168.9	70 **Yb** 173.0	71 **Lu** 175.0
**	90 **Th** 232.0	91 **Pa** (231)	92 **U** 238.0	93 **Np** (237)	94 **Pu** (244)	95 **Am** (243)	96 **Cm** (247)	97 **Bk** (247)	98 **Cf** (251)	99 **Es** (252)	100 **Fm** (257)	101 **Md** (258)	102 **No** (259)	103 **Lr** (260)