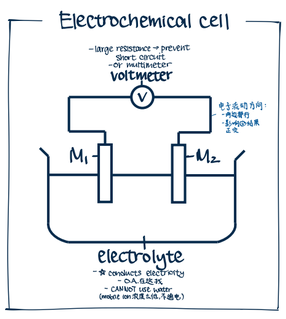
# Simple chemical cell: skills, examples (1 electrolyte)

## 1 Basic skills




自行决定O.A./R.A.

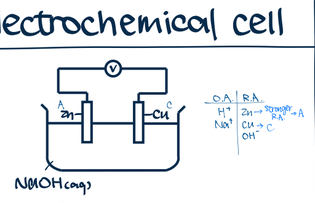
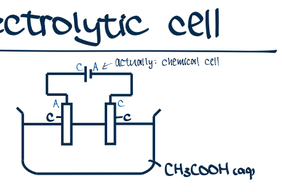
① 画表 O.A. | R.A.
→ 所有metal (even cathode) 也是R.A.!

② 最强 → 决定A, C

③ 写 half equ.
- C: _____ (O.C.)
- A: _____ (O.C.)
} 电子行电线, 离子行 soln

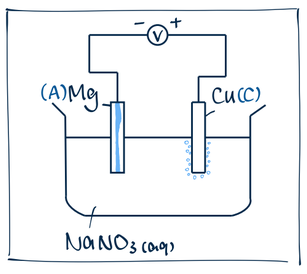
④ 留意electrode 与 electrolyte rx
- metal-acid / displacement / ppt

## 2 Electrochemical cell vs electrolytic cell

| Electrochemical cell | Electrolytic cell |
|---|---|
|   O.A. \| R.A. $H^+$ \| $Zn \rightarrow$ strongest R.A. $\rightarrow A$; $Na^+$ \| $Cu \rightarrow C$; $OH^-$ |   |
| ✗ battery | ✓ battery |
| chemical energy ↓ electrical energy | electrical energy ↓ chemical energy |

## 3 Examples (1 electrolyte)

### EXAMPLE




State and explain observable changes at both electrodes.

**Cathode electrode**
- colourless gas bubbles evolve
  - > $H^+$ is stronger O.A. than $Na^+$
  - > undergoes reduction
  - > $2H^+ + 2e^- \rightarrow H_2$
  - → O.A. 在 soln 寻找

**Anode electrode** (rx stops when Mg anode is no longer in contact w/ electrolyte)
- anode dissolves / become thinner
  - > Mg is stronger R.A. than Cu
  - > undergoes oxidation
  - > $Mg \rightarrow Mg^{2+} + 2e^-$

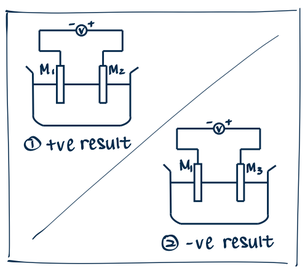
| O.A. | R.A. |
|---|---|
| $H^+$ | $OH^-$ |
| $Na^+$ | Mg (A) |
| | Cu (C) |

**Voltmeter reading**

Mg: anode (∵ 释放电子) → 带负极

↳ 连接 voltmeter 负极 ⇒ +ve reading (when 负极负/正极正)

### COMPARING METAL R.A. STRENGTH



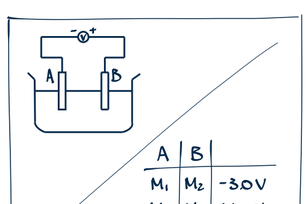

比较正负: Arrange the 3 metals in descending order of their reactivities.

**Exp 1**
- ∵ voltmeter gives +ve reading
- ∴ $M_1$ is -ve anode.
- → $M_1$ loses $e^-$ more readily, undergoes oxidation instead of $M_2$.
- ⇒ R.A. strength: $M_1 > M_2$

**Exp 2**
- ∵ voltmeter gives -ve reading
- ∴ $M_3$ is -ve anode.
- → $M_3$ loses $e^-$ more readily, undergoes oxidation instead of $M_1$.
- ⇒ R.A. strength: $M_3 > M_1$

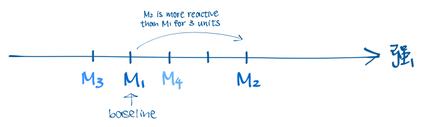
→ Reactivity: $M_3 > M_1 > M_2$.

→ Disadvantage: 只知道A比B强, 不知道强多少。
- eg. If exp 2 gives +ve reading, w/o performing any further exps., can we still arrange the metals?
  - > +ve result ⇒ $M_1 > M_3$ ⇒ $M_1 > M_2, M_3$
  - > 不知道 $M_2$ 还是 $M_3$ 更强, ⇒ cannot be determined.



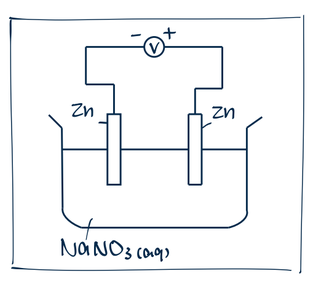

比较数值: Arrange the 4 metals in descending order of their reactivities.
- ☆ Principle: difference ↑ 2 metals' reactivities / R.A. strength ↑ → magnitude of voltage reading ↑

| A | B | |
|---|---|---|
| $M_1$ | $M_2$ | -3.0V |
| $M_1$ | $M_3$ | +1.0V |
| $M_3$ | $M_4$ | -2.0V |



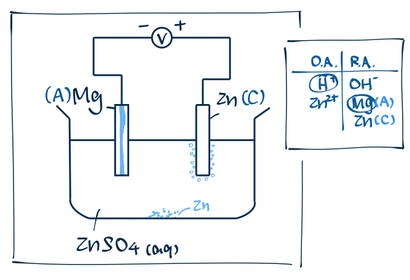

→ Reactivity: $M_2 > M_4 > M_1 > M_3$

→ If A = new metal $M_5$, B = $M_1$, given that $M_5$ is more reactive than $M_2$, predict changes of V reading c.f. A = $M_1$, B = $M_2$.
- ∵ metal reactivity: $M_5 > M_2 > M_1$.
  diff. in reactivity: $M_5, M_1 > M_2, M_1$
- ∴ result will be more negative.




如果两边的metal是一样的
- → 没有一种金属 lose $e^-$ more readily
- → 没有电流通过 voltmeter
- → reading = 0V
- → 注意 metal 可能会与 electrolyte 有 reaction → O.C.

### REACTIONS ↑. ELECTRODE & ELECTROLYTE

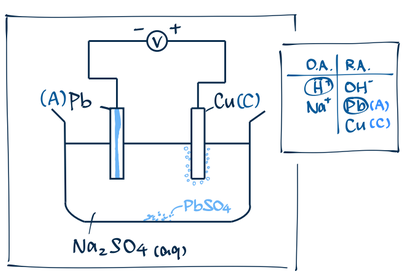



O.A. | R.A.
$H^+$ | $OH^-$
$Zn^{2+}$ | Mg (A)
Zn (C)

C: $2H^+ + 2e^- \rightarrow H_2$
- → colourless gas bubbles evolve

A: $Mg \rightarrow Mg^{2+} + 2e^-$
- → anode becomes thinner

☆ displacement: $Mg + Zn^{2+} \rightarrow Mg^{2+} + Zn$
- → Silvery solid deposits at bottom of beaker

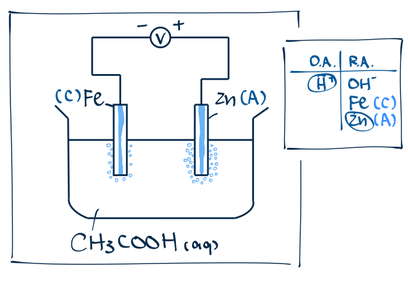



O.A. | R.A.
$H^+$ | $OH^-$
$Na^+$ | Pb (A)
Cu (C)

C: $2H^+ + 2e^- \rightarrow H_2$
- → colourless gas bubbles evolve

A: $Pb \rightarrow Pb^{2+} + 2e^-$
- → anode becomes thinner

☆ precipitation: $Pb^{2+} + SO_4^{2-} \rightarrow PbSO_4$
- → white solid deposits at bottom of beaker

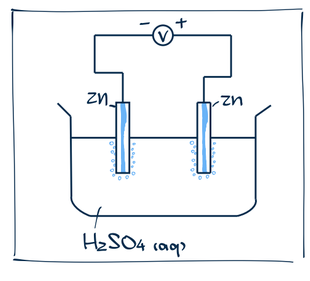



O.A. | R.A.
$H^+$ | $OH^-$
Fe (C)
Zn (A)

C: $2H^+ + 2e^- \rightarrow H_2$
- → colourless gas bubbles evolve

A: $Zn \rightarrow Zn^{2+} + 2e^-$ → 正极负 ⇒ -ve voltmeter reading
- → anode becomes thinner

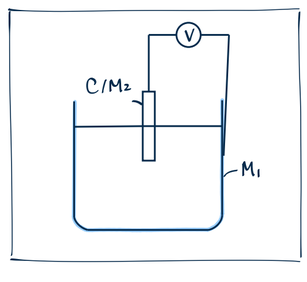
☆ acid-metal: $Fe + 2H^+ \rightarrow Fe^{2+} + H_2$; $Zn + 2H^+ \rightarrow Zn^{2+} + H_2$
- → both electrodes
  - get thinner
  - colourless gas bubbles evolve
- → soln: colourless → green



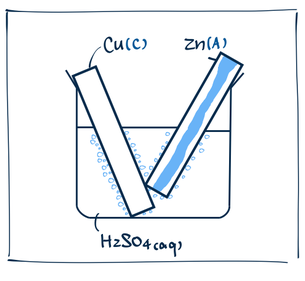

- ∵ same metal
  ∴ voltmeter reading = 0V

☆ acid-metal: $Zn + 2H^+ \rightarrow Zn^{2+} + H_2$
- → both electrodes
  - get thinner
  - colourless gas bubbles evolve

### SPECIAL CASES




If R.A. strength: $M_1 > M_2$
- → $M_1 \rightarrow M_1^{2+} + 2e^-$
- → $M_1$ dissolves, soln leaks out




C: $2H^+ + 2e^- \rightarrow H_2$
- → colourless gas bubbles

A: $Zn \rightarrow Zn^{2+} + 2e^-$
- → anode becomes thinner

$Zn + 2H^+ \rightarrow Zn^{2+} + H_2$
- → colourless gas bubbles