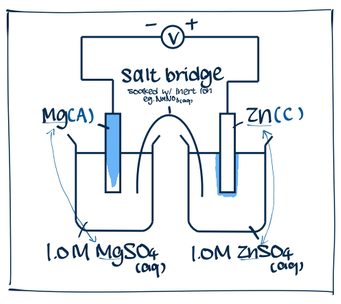
Simple chemical cells: examples (2 electrolyte)

1 Metal-metal ion cells

EXAMPLE



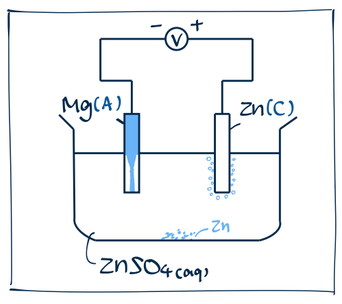
Metal-metal ion cell = 2× metal-metal ion half cell + 1× salt bridge

C: $Zn^{2+} + 2e^- \rightarrow Zn$ → 两个soln分开, electrode = metal, electrolyte = 那种金属的ion ⇒ 不可能选 H^+ 为O.A.

A: $Mg \rightarrow Mg^{2+} + 2e^-$

⇒ 肥 Cat 瘦 An

VS NORMAL SIMPLE CHEMICAL CELL



A: $Mg \rightarrow Mg^{2+} + 2e^-$

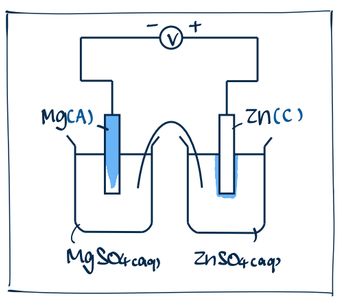
C: $2H^+ + 2e^- \rightarrow H_2$

→ 尽管 electrolyte 不是 acid, 也会用 H^+ 作 O.A.

→ ✓ displacement

→ ↑ voltage

(Mg 与 H_2 的 R.A. strength 相差较大)



A: $Mg \rightarrow Mg^{2+} + 2e^-$

C: $Zn^{2+} + 2e^- \rightarrow Zn$

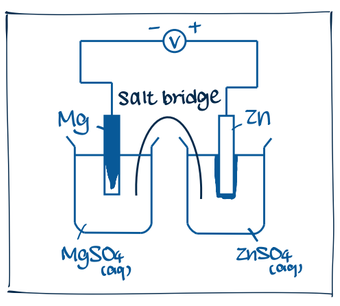
→ 不可能选 H^+

→ X displacement (Mg 与 $ZnSO_4$ 分开了)

→ ↓ voltage

(Mg 与 Zn 的 R.A. strength 相差较小)

SALT BRIDGE

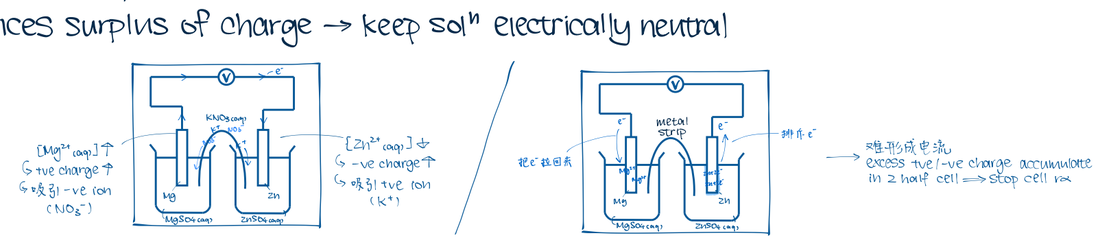


What is it?

- strip of filter paper soaked w/ saturated soln of salt

Uses

- provides complete circuit (电子并不会经过 salt bridge (电子行电线, 离子行 soln))
- balances surplus of charge → keep soln electrically neutral



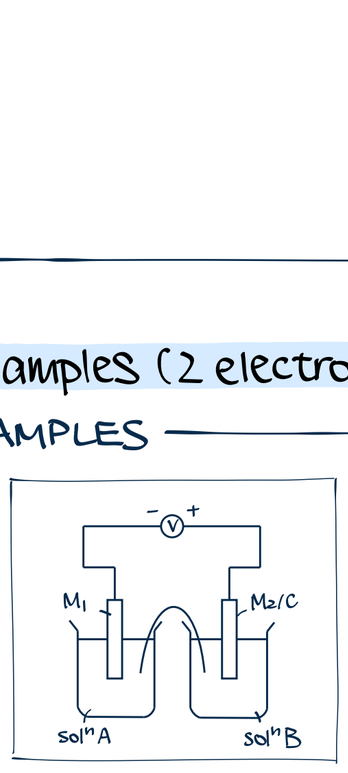
- prevents direct mixing of soln
  - direct mixing → mixed molecules have stronger VDW force ∴ them (ie enthalpy ↓)
  - → release heat
    - ⇒ soln: loses heat
    - ⇒ chemical energy ↓
    - ⇒ produced electrical energy ↓
    - ⇒ voltage ↓

Choice of ion in salt bridge

- inert ions (does not react w/ substances in half cells/ become O.A., R.A.)
  - > can coloured ions be used?
    - No.
    - coloured ions are reactive
- no ppt reactions
  - > insoluble precipitate → clogs passage of ion → incomplete circuit
  - > Zn/Mg cell → can KOH, NaOH be used?
    - No.
    - $Zn^{2+} + 2OH^- \rightarrow Zn(OH)_2$, $Mg^{2+} + 2OH^- \rightarrow Mg(OH)_2$
  - > Zn/Pb cell → can K_2SO_4 be used?
    - No.
    - $Pb^{2+} + SO_4^{2-} \rightarrow PbSO_4$

2 Examples (2 electrolyte)

EXAMPLES

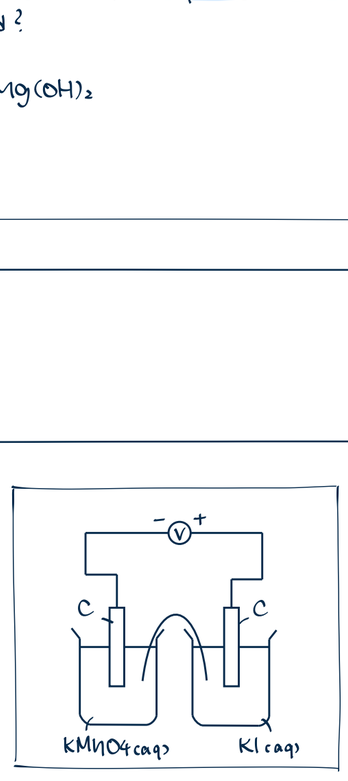


If O.A. is found in soln B / Ⓥ reading is +ve

→ R.A. strength: $M_1 > M_2$ / $M_1 > C$

☆ soln A, B 不能放 H_2O

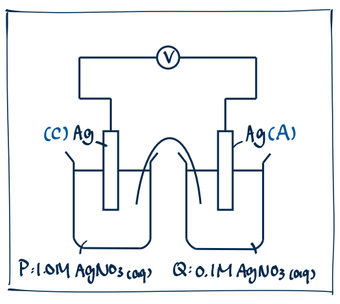
→ mobile ions 浓度太低, 不通电



C: $5e^- + 8H^+ + MnO_4^- \rightarrow Mn^{2+} + 4H_2O$

A: $2I^- \rightarrow I_2 + 2e^-$

☆ 永远最后才考虑 H^+ 为 O.A. (OH^- 不用考虑)



∵ P: 1.0M $Ag^+_{(aq)}$ gains e^- more readily than Q: 0.1M $Ag^+_{(aq)}$

∴ undergoes reduction → Ag

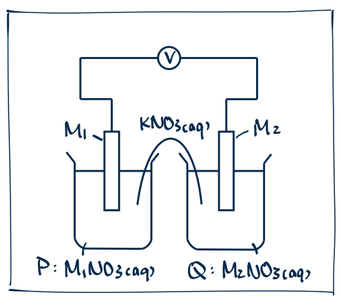
- C (P): $Ag^+ + e^- \rightarrow Ag$

  A (Q): $Ag \rightarrow Ag^+ + e^-$

☆ As cell rx continue, P: $[Ag^+_{(aq)}]$ ↓ (difference in conc. ↓ → voltage ↓), Q: $[Ag^+_{(aq)}]$ ↑

finally: $P[Ag^+_{(aq)}] = Q[Ag^+_{(aq)}]$

⇒ rx stops ⇒ Ⓥ: 0V

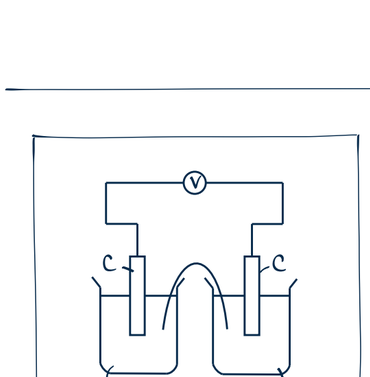


Given P: $[K^+_{(aq)}]$↑, which metal is stronger R.A.?

- P: $[K^+_{(aq)}]$↑ → -ve soln (带来负极, 所以吸引 K^+ ion)

→ Q: +ve soln → At Q: $M_2 \rightarrow M_2 + e^-$

⇒ R.A. strength: $M_2 > M_1$



P: 1.0M 40cm³ X_2 (aq) mixed w/ 1.0M 40cm³ KX (aq)

Q: 0.8M 50cm³ Y_2 (aq) mixed w/ 0.8M 50cm³ KY (aq)

Given: resulting $[X^-_{(aq)}] = 0.7M$, which halogen is stronger O.A.?

- original $[X^-_{(aq)}] = \frac{1.0}{2} = 0.5M < 0.7M$ ⇒ $[X^-_{(aq)}]$↑ (1.0M 40cm³ 稀释至两倍, 浓度 = 本来一半)

⇒ $X_2 + 2e^- \rightarrow 2X^-$, X_2 gains e^- more readily, undergoes reduction ⇒ X^-

∴ X_2 is stronger O.A.

Find resulting $[Y^-_{(aq)}]$

- $X_2 + 2Y^- \rightarrow 2X^- + Y_2$

$M = \frac{mol}{V}$ ← $= \frac{0.016}{0.1} M$ ← ↓0.016 mol, ↑0.2M

$= 0.16 M$

$= 0.4M - 0.16M$

$= 0.24 M$

↑ $= 0.2 \times 0.08$ mol → $mol = M \times V$

$= 0.016$ mol

∴ $[Y^-_{(aq)}] = 0.24M$