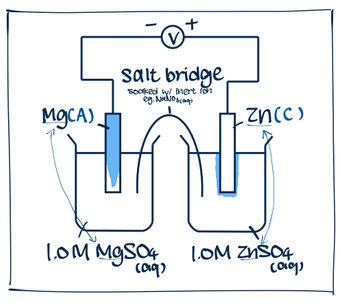
Simple chemical cells: examples (2 electrolyte)

1 Metal-metal ion cells

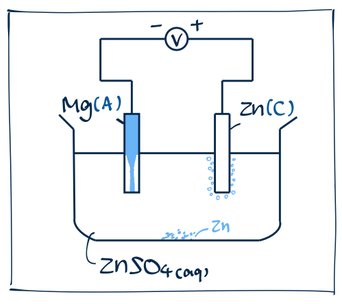
EXAMPLE



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

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

VS NORMAL SIMPLE CHEMICAL CELL

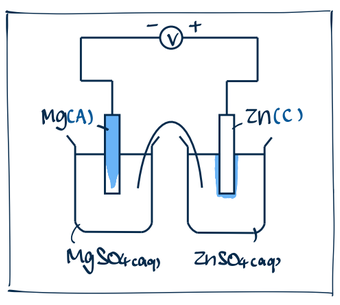


A: $Mg \rightarrow Mg^{2+} + 2e^-$
C: $2H^+ + 2e^- \rightarrow H_2$

→ 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)



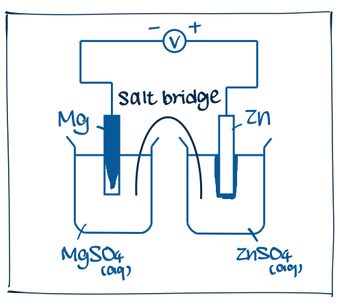
A: $Mg \rightarrow Mg^{2+} + 2e^-$
C: $Zn^{2+} + 2e^- \rightarrow Zn$

→ 不可能选 H^+

→ X displacement
(Mg 与 $ZnSO_4$ 分开了)

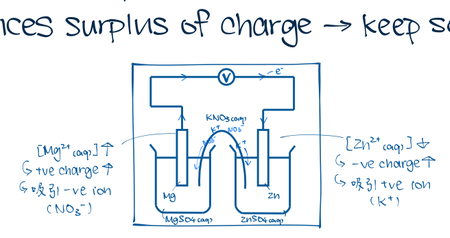
→ ↓ voltage
(Mg 与 Zn 的 R.A. strength 相差较小)

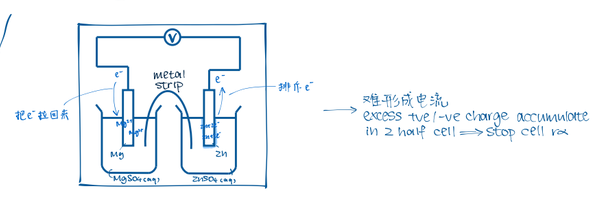
SALT BRIDGE



What is it?
- strip of filter paper soaked w/ saturated soln of salt

Uses
- provides complete circuit
- balances surplus of charge → keep soln electrically neutral



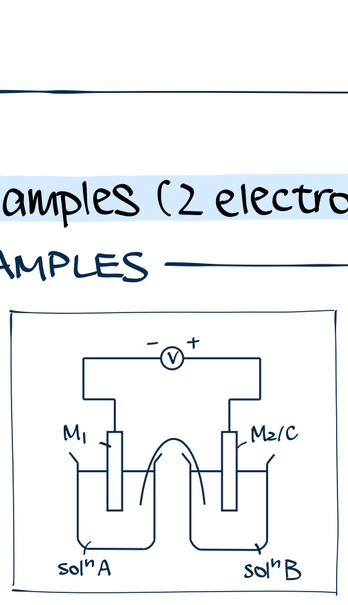


- prevents direct mixing of soln
  - direct mixing → mixed molecules have stronger VDW force ∴ them (ie enthalpy ↓)
  → release heat
  ⇒ soln: loses heat
  ⇒ chemical energy ↓
  ⇒ produced electrical energy ↓
  ⇒ voltage ↓

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.
    - $Pb^{2+} + SO_4^{2-} \rightarrow PbSO_4$

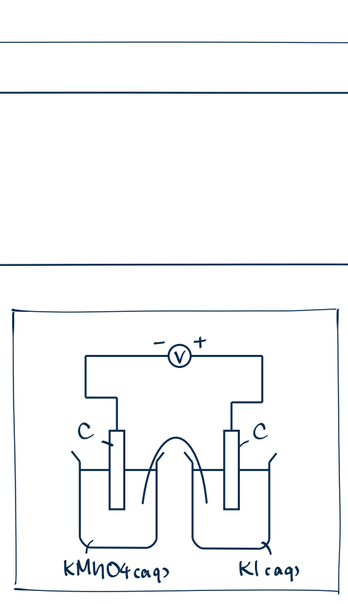
2 Examples (2 electrolyte)

EXAMPLES



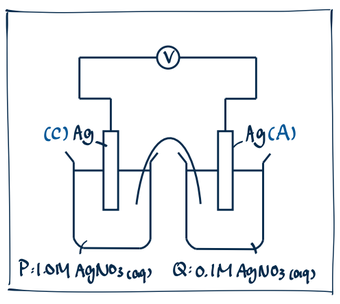
If O.A. is found in soln B / Ⓥ reading is +ve
→ R.A. strength: $M_1 > M_2$ / $M_1 > C$

☆ soln A, B 不能放 H_2O
→ mobile ions 浓度太低, 不通电



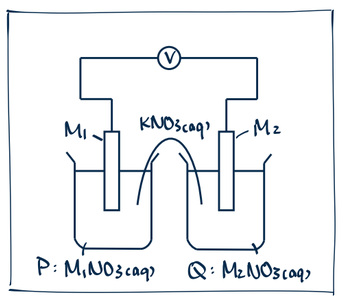
C: $5e^- + 8H^+ + MnO_4^- \rightarrow Mn^{2+} + 4H_2O$
A: $2I^- \rightarrow I_2 + 2e^-$

☆ 永远最后才考虑 H^+ 为 O.A. (OH^- 不用考虑)

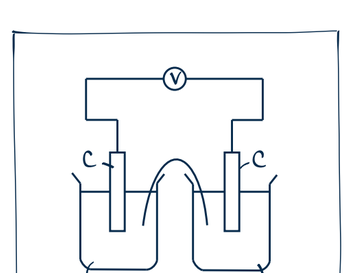


∵ P: 1.0M $Ag^+_{(aq)}$ gains e^- more readily than Q: 0.1M $Ag^+_{(aq)}$
∴ undergoes reduction → Ag
- C (P): $Ag^+ + e^- \rightarrow Ag$
  A (Q): $Ag \rightarrow Ag^+ + e^-$

☆ 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 $[X^-_{(aq)}] = \frac{1.0}{2} = 0.5M < 0.7M \Rightarrow [X^-_{(aq)}]$ ↑ (1.0M 40cm³ 稀释至两倍, 浓度 = 本来一倍)

⇒ $X_2 + 2e^- \rightarrow 2X^-$, X_2 gains e^- more readily, undergoes reduction ⇒ X^-
∴ X_2 is stronger O.A.

Find resulting $[Y^-_{(aq)}]$
- $X_2 + 2Y^- \rightarrow 2X^- + Y_2$

$M = \frac{mol}{V} \leftarrow = \downarrow\frac{0.016}{0.1} M = \downarrow 0.16 M = 0.4M - 0.16M = 0.24 M$
$\downarrow 0.016 mol = \uparrow 0.2 \times 0.08 mol = \uparrow 0.016 mol$ ← $\uparrow 0.2M$ → $mol = M \times V$

∴ $[Y^-_{(aq)}] = 0.24M$