Displacement reactions

1 Principle

$X_{(s)} + YSO_{4\,(aq)} \rightarrow XSO_{4\,(aq)} + Y_{(s)}$ → single displacement, double displacement
参考 Precipitation reaction

ionic ↓

$X_{(s)} + Y^{2+}_{(aq)} \rightarrow X^{2+}_{(aq)} + Y_{(s)}$

$X \rightarrow X^{2+} + 2e^-$ $Y^{2+} + 2e^- \rightarrow Y$ ⇒交换电子→ redox

- 越 reactive 的金属(X), 越容易流失电子成为离子 → strong reducing agent, weak oxidating agent
  越 unreactive 的金属(Y), 它的离子越易吸收电子成为金属 → weak reducing agent, strong oxidating agent
  ↳ 必须为强金属 + 弱金属离子 才有 reaction
- reactivity: 参考 reactivity series
- 注意点
  > 如果两种金属颜色相同, 则不能观察 dissolve/deposit
  > 因为 reactant 与 product 都有 solid, 因此不可能获取 pure 的 product
  → Y is insoluble in water, encloses X ⇒ stops further reaction
  > 若两个 reactant 也是 solid, 则必须加热才有 reaction (没 mobile ion)
  > K, Na, Ca 永远也没有 displacement (还没 displace 以前已经先与 H_2O/O_2 react 了)

2 Examples

不懂罚站题

1. $Zn_{(s)} + MgCl_{2\,(aq)}$
   - Zn is a weaker reducing agent than Mg
   ⇒ X reaction
2. $Cu_{(s)} + AgNO_{3\,(aq)}$
   - Cu is a stronger reducing agent than Ag
   ⇒ ✓ reaction
   - $Cu_{(s)} + 2AgNO_{3\,(aq)} \rightarrow Cu(NO_3)_{2\,(aq)} + 2Ag_{(s)}$
     $Cu + 2Ag^+ \rightarrow Cu^{2+} + 2Ag$
   - observable changes
     a. Solution: colourless → blue
     b. Cu dissolves
     c. Silvery solid deposits
     } 只可以说 reactant 的名字, product 要用 <colour> <state> 形容

狡猾题

1. $Zn_{(s)} + FeSO_{4\,(aq)}$
   - Zn is a stronger reducing agent than Fe
   ⇒ ✓ reaction
   - $Zn_{(s)} + FeSO_{4\,(aq)} \rightarrow ZnSO_{4\,(aq)} + Fe_{(s)}$
     $Zn + Fe^{2+} \rightarrow Zn^{2+} + Fe$
   - observable changes
     a. Solution: pale green → colourless
     * no dissolve/deposit OC as both is silvery solid
2. $Al_{(s)} + CuO_{(s)}$
   - Al is a stronger reducing agent than Cu
   ⇒ ✓ reaction (needs heat ∵ both are solid)
   - $2Al_{(s)} + 3CuO_{(s)} \xrightarrow{\Delta} Al_2O_{3\,(s)} + 3Cu_{(s)}$
     no ionic equ. as all reactant/product is solid
   - observable changes
     a. Solid: black ($\xrightarrow{CuO}$) → white ($\xrightarrow{Al_2O_3}$)
     b. reddish brown solid deposits

3a. $Na_{(s)} + Cu(NO_3)_{2\,(aq)}$
   - 看似有, 但 K, Na, Ca 会先跟水 react (→ hydroxide)
   ⇒ X displacement reaction

3b. $Ca_{(s)} + Ag_2O_{(s)}$
   - K, Na, Ca 会先跟空气里面的氧气 react (→ oxide)
   ⇒ X displacement reaction