

# Introduction to redox reactions

## 1 What is a redox reaction?

- oxidation and reduction occurring simultaneously

Reduction (oxidizing agents)	Oxidation (reducing agents)
oxidation no# of an atom $\downarrow$	oxidation no# of an atom $\uparrow$
$-O / +H$	$+O / -H$
accept $e^-$ ( $e^-$ in half equ. RHS)	loses $e^-$ ( $e^-$ in half equ. LHS)

$\rightarrow$  其中一个条件符合就行

$\rightarrow R.A. \xrightarrow{e^-} O.A.$

## 2 Oxidation number

- (of an element in a compound) imaginary charge / charge an atom would have if it existed as an ion.

- Rules

- > 自己一个 element:  $O = 0, Cl = 0$   
自己一个 ion: charge of ion  $Na^+ = +1, Cl^- = -1$   
Sum of all atoms in element:  $O, H_2O = 0$   
Sum of all atoms in polyatomic ion: charge of ion  $MnO_4^- = -1$   
eg. find Mn oxidation no#:  
 $x + 4(-2) = -1$   
 $x = +7$
- > Oxygen  
 $\rightarrow$  in compound: 通常  $-2, H_2O, ClO_2$   
 $\rightarrow$  exceptions  $\Rightarrow Na_2O_2, K_2O_2, H_2O_2: -1$
- > Hydrogen  
 $\rightarrow$  w/ non-metal:  $+1, H_2O, HCl$   
 $\rightarrow$  w/ metal:  $-1, NaH$
- > Main grp metal  
 $\rightarrow$  in compound:  $+X$  ( $X$  = group no#)  $AlCl_3$
- > Nitrogen  
 $\rightarrow$  max:  $+5$   
min:  $-3$   
 $\therefore$  diff 8  
 $\rightarrow$   
 $NO_3^-: +5$   
 $NO_2^-: +3$   
 $NO_2: +4$   
 $N: 0$   
 $NH_3, NH_4^+: -3$
- > Sulphur  
 $\rightarrow$  max:  $+6$   
min:  $-2$   
 $\therefore$  diff 8  
 $\rightarrow$   
 $SO_4^{2-}, SO_3: +6$   
 $SO_3^{2-}, SO_2: +4$   
 $SO: +2$   
 $S: 0$   
 $H_2S: -2$

## 3 Common O.A.s and R.A.s

Common O.A. (after rx 变 R.A.)	Common R.A. (after rx 变 O.A.)
$MnO_4^- \rightarrow Mn^{2+}$ $\left\{ \begin{array}{l} Cl_2 \rightarrow 2Cl^- \\ Br_2 \rightarrow 2Br^- \\ I_2 \rightarrow 2I^- \end{array} \right.$ $Cr_2O_7^{2-} \rightarrow Cr^{3+}$ conc. $H_2SO_4(l) \rightarrow SO_2$ conc. $NO_3^- \rightarrow NO_2$ dilute $NO_3^- \rightarrow NO$ $Ag^+ \rightarrow Ag$ $Cu^{2+} \rightarrow Cu$ $Ni^{2+} \rightarrow Ni$ $2H^+ \rightarrow H_2$	metal $\left\{ \begin{array}{l} M \rightarrow M^{n+} \\ Fe^{2+} \rightarrow Fe^{3+} \\ SO_2/SO_3^{2-} \rightarrow SO_4^{2-} \end{array} \right.$ conc. $\left\{ \begin{array}{l} 2I^- \rightarrow I_2 \\ 2Br^- \rightarrow Br_2 \\ 2Cl^- \rightarrow Cl_2 \end{array} \right.$ $4OH^- \rightarrow O_2 + 2H_2O + 4e^-$

strength  $\uparrow$

氧化性 + 氧化剂

## 4 Identify if reaction is redox

### SKILLS (MC)

1. 有必背 common O.A./R.A.  $\rightarrow \checkmark$
2. 有 metal element / non-metal element  $\rightarrow \checkmark$
3. Element  $\rightleftharpoons$  Compound  $\rightarrow \checkmark$
4. 1 变 2 / 2 变 1  $\rightarrow \checkmark$
5. 排除法 (rx 为 A-B / ppt)  $\rightarrow \times$
6. 算 O.N.  $\rightarrow ?$

### ANSWERING STRUCTURE (LQ)

- $\checkmark$  redox - oxidation number of  $X$  in  $X_nY = \dots$   
oxidation number of  $X$  in  $X = \dots$   
 $\therefore$  there is change in oxidation number of  $X$  after reaction  
 $\therefore$  It is redox reaction.
- $\times$  redox - There is no change in oxidation number of all atoms before & after reaction.  
Not redox reaction.

### EXAMPLES

1.  $2MnO_4^- + 5SO_3^{2-} + 6H^+ \rightarrow 2Mn^{2+} + 5SO_4^{2-} + 3H_2O$   
判断  $\rightarrow$  Rule 1:  $MnO_4^-, SO_3^{2-}$   
 $\rightarrow \checkmark$  redox  
作答  $\rightarrow$  oxidation number of Mn in  $MnO_4^- = +7$   
oxidation number of Mn in  $Mn^{2+} = +2$   
 $\therefore$  there is change in oxidation number of Mn  
 $\therefore$  It is redox reaction.
2.  $Cl_2 + NaOH \rightarrow NaCl + NaOCl + H_2O$   
判断  $\rightarrow$  Rule 2/3:  $\checkmark$  non-metal element  
Rule 4:  $Cl_2 \Rightarrow NaCl, NaOCl$   
 $\rightarrow \checkmark$  redox  
作答  $\rightarrow$  oxidation number of Cl in  $Cl_2 = 0$   
oxidation number of Cl in  $NaCl = -1$   
oxidation number of Cl in  $NaOCl = +1$   
 $\therefore$  there is change in oxidation number of Cl  
 $\therefore$  It is redox reaction.  
 $NaCl \rightarrow Cl_2$  is O.A.  $\rightarrow$  一样物质同时是 O.A., R.A.  
 $Cl_2 \rightarrow NaOCl$  is R.A.  $\rightarrow$  disproportionation rx
3.  $Cr_2O_7^{2-} + H_2O \rightleftharpoons 2CrO_4^{2-} + 2H^+$   
判断  $\rightarrow$  (其他 rule 不适用, 一定得算) Rule 6  
 $Cr_2O_7^{2-} + H_2O \rightleftharpoons 2CrO_4^{2-} + 2H^+$   
O 与 H 的 O.N. 没变, Cr 不可能自己变 (除非  $-1 = +1$  变  $-1$ )  
作答  $\rightarrow$  There is no change in oxidation number of all atoms before & after reaction  
 $\therefore$  Not redox reaction
4.  $Na_2CO_3 + 2HCl \rightarrow 2NaCl + CO_2 + H_2O$   
判断  $\rightarrow$  Rule 5: Acid-base rx  
 $\rightarrow \times$  redox  
作答  $\rightarrow$  There is no change in oxidation number of all atoms before & after reaction  
 $\therefore$  Not redox reaction
5.  $Pb(NO_3)_2 + 2NaCl \rightarrow 2NaNO_3 + PbCl_2$   
判断  $\rightarrow$  Rule 5: precipitation rx  
 $\rightarrow \times$  redox  
作答  $\rightarrow$  There is no change in oxidation number of all atoms before & after reaction  
 $\therefore$  Not redox reaction