Introduction to redox reactions

1 What is a redox reaction?

- oxidation and reduction occuring simultaneously

Reduction (oxidating agents)	Oxidation (reducing agents)
oxidation no# of an atom ↓	oxidation no# of an atom ↑
-O / +H	+O / -H
accept e^- (e^- in half equ. RHS)	loses e^- (e^- in half equ. LHS)

→ 其中一个条件符合就行

2 Oxidation number

- (of an element in a compound) imaginery charge/ charge an atom would have if it existed as an ion.
- Rules
  - > 自己一个 element : 0   Na = 0, Cl = 0
    - 自己一个 ion: charge of ion $Na^+ = +1$, $Cl^- = -1$
    - sum of all atoms in element : 0 $H_2O = 0$
    - 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
    - → in compound: 通常 -2 H_2O, ClO_2
    - → exceptions ⇒ Na_2O_2, K_2O_2, H_2O_2 : -1
  - > Hydrogen
    - → w/ non-metal : +1 H_2O, HCl
    - → w/ metal : -1   NaH
  - > Main grp metal
    - → in compound: +X (X = group no#) $AlCl_3$
  - > Nitrogen
    - → max : +5 (∵ Grp V), min : -3 } 相差 = 8
    - → NO_3^- : +5; NO_2^- : +3; NO_2 : +4; N : 0; NH_3, NH_4^+ : -3
  - > Sulphur
    - → max : +6 (∵ Grp VI), min : -2 } 相差 = 8
    - → 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

Strength ↑ (不在表上 = 很弱)

Common O.A. (after rx 变 R.A.)	Common R.A. (after rx 变 O.A.)
$MnO_4^- \to Mn^{2+}$	metal (看 metal reactivity series 分高下) { $M \to M^{n+}$
$Cl_2 \to 2Cl^-$ (pale yellowish green)	$Fe^{2+} \to Fe^{3+}$
$Br_2 \to 2Br^-$ (brown; (aq) brown, (s) black, (g) purple, (aq)oil purple)	$SO_2/SO_3^{2-} \to SO_4^{2-}$
$I_2 \to 2I^-$	conc. $2I^- \to I_2$
$Cr_2O_7^{2-} \to Cr^{3+}$	conc. $2Br^- \to Br_2$
conc. $H_2SO_{4(l)} \to SO_2$	conc. $2Cl^- \to Cl_2$
conc. $NO_3^- \to NO_2$	$4OH^- \to O_2 + 2H_2O + 4e^-$
dilute $NO_3^- \to NO$	
$Ag^+ \to Ag$	
$Cu^{2+} \to Cu$	
$Ni^{2+} \to Ni$	
$2H^+ \to H_2$	

4 Identify if reaction is redox

SKILLS (MC)

1. 有必背 common O.A. / R.A. → ✓
2. 有 metal element / non-metal element → ✓
3. Element ⇌ compound → ✓
4. 1 变 2 / 2 变 1 → ✓
5. 排除法 (rx 为 A-B / ppt) → ✗
6. 算 O.N. → ?

ANSWERING STRUCTURE (LQ)

✓ redox – oxidation number of X in X_nY (reactant) = ...
oxidation number of X in X (product) = ...
∵ there is change in oxidation number of X after reaction
∴ It is redox reaction.

✗ redox – There is no change in oxidation number of all atoms before & after reaction.
Not redox reaction.

EXAMPLES

1. $2MnO_4^- + 5SO_3^{2-} + 6H^+ \longrightarrow 2Mn^{2+} + 5SO_4^{2-} + 3H_2O$
   - 判断 → Rule 1 : MnO_4^-, SO_3^{2-}
     → ✓ redox
   - 作答 → oxidation number of Mn in MnO_4^- = +7
     oxidation number of Mn in Mn^{2+} = +2
     ∵ there is change in oxidation number of Mn
     ∴ It is redox reaction.
2. $Cl_2 + NaOH \to NaCl + NaOCl + H_2O$
   - 判断 → Rule 2/3 : ✓ non-metal element
     Rule 4 : $Cl_2 \Rightarrow NaCl, NaOCl$
     → ✓ redox
   - 作答 → oxidation number of Cl in Cl_2 = 0
     oxidation number of Cl in NaCl = -1
     oxidation number of Cl in NaOCl = +1 (reason not yet taught)
     ∵ there is change in oxidation number of Cl
     ∴ It is redox reaction.
3. $Cr_2O_7^{2-} + H_2O \rightleftharpoons 2CrO_4^{2-} + 2H^+$
   - 判断 → (其他 rule 不合用, 一定得算) Rule 6
     $Cr_2O_7^{2-} + H_2O \rightleftharpoons 2CrO_4^{2-} + 2H^+$ (O: -2, H: +1)
     O与H的O.N.没变, Cr不可能自己变 (除非一变二/二变一)
   - 作答 → There is no change in oxidation number of all atoms before & after reaction
     ∴ Not redox reaction
4. $Na_2CO_3 + 2HCl \to 2NaCl + CO_2 + H_2O$
   - 判断 → Rule 5 : Acid-base rx
     → ✗ redox
   - 作答 → There is no change in oxidation number of all atoms before & after reaction
     ∴ Not redox reaction
5. $Pb(NO_3)_2 + 2NaCl \to 2NaNO_3 + PbCl_2$
   - 判断 → Rule 5 : precipitation rx
     → ✗ redox
   - 作答 → There is no change in oxidation number of all atoms before & after reaction
     ∴ Not redox reaction