

Introduction to redox reactions

1 What is a redox reaction?

- oxidation and reduction occurring simultaneously

Reduction (oxidating 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: 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 $MnO_4^- = -1$

- > 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 \rightarrow :: Grp V
- min: -3 } 相差=8
- \rightarrow $NO_3^-: +5$
- $NO_2^-: +3$
- $NO_2: +4$
- $N: 0$
- $NH_3, NH_4^+: -3$

- > Sulphur

- \rightarrow max: +6 \rightarrow :: Grp VI
- min: -2 } 相差=8
- \rightarrow $SO_4^{2-}, SO_3: +6$
- $SO_3^{2-}, SO_2: +4$
- $SO: +2$
- $S: 0$
- $H_2S: -2$

- Minimum and maximum O.N.

- > main group metals \rightarrow max = +X (X=Grp no#)
- min = 0

- main group non-metals \rightarrow max = +X (X=Grp no#)
- min = -(8-X)

- transitional metals \rightarrow max = +7
- min = 0

- > original O.N. = min O.N. \rightarrow can only \uparrow after rx \rightarrow R.A.

- original O.N. = max O.N. \rightarrow can only \downarrow after rx \rightarrow O.A.

- original O.N. in (min O.N., max O.N.) \rightarrow can \uparrow/\downarrow after rx \rightarrow O.A./R.A.

\rightarrow if in middle of range \rightarrow weak
 \rightarrow requires strong R.A./O.A. for rx

\leftarrow exclusive range

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.)
acidified $MnO_4^- \rightarrow Mn^{2+}$	metal { $M \rightarrow M^{n+}$
$\left\{ \begin{array}{l} Cl_2 \rightarrow 2Cl^- \text{ (pale yellowish green)} \\ Br_2 \rightarrow 2Br^- \text{ (brown)} \\ I_2 \rightarrow 2I^- \text{ (grey)} \end{array} \right.$	$\left\{ \begin{array}{l} Fe^{2+} \rightarrow Fe^{3+} \\ SO_2/SO_3^{2-} \rightarrow SO_4^{2-} \end{array} \right.$
acidified $Cr_2O_7^{2-} \rightarrow Cr^{3+}$	conc. $\left\{ \begin{array}{l} 2I^- \rightarrow I_2 \\ 2Br^- \rightarrow Br_2 \\ 2Cl^- \rightarrow Cl_2 \end{array} \right.$
conc. $H_2SO_4(l) \rightarrow SO_2$	$4OH^- \rightarrow O_2 + 2H_2O + 4e^-$
conc. $NO_3^- \rightarrow NO_2$	
dilute $NO_3^- \rightarrow NO$	
$Ag^+ \rightarrow Ag$	
$Cu^{2+} \rightarrow Cu$	
$Ni^{2+} \rightarrow Ni$	
$2H^+ \rightarrow H_2$	

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 $X_nY = \dots$ \rightarrow reactant
- oxidation number of X in $X \rightarrow \dots$ \rightarrow product
- \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

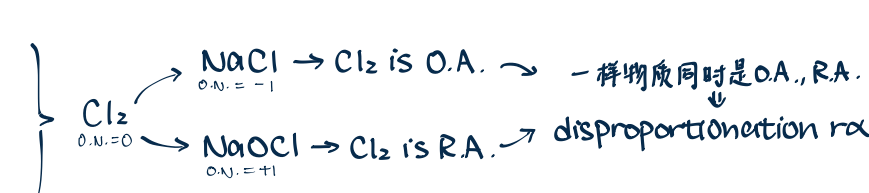
作答 \rightarrow oxidation number of Cl in $Cl_2 = 0$

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.



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. 不变, Cr 不可能自己变 (除非 -1 变 = / = 变 -)

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