MATTER & MINERALS

CHEMISTRY HOMEWORK - FALL - WEEK 7

Chapter 4

(57) (a)

K	Mn	O_4	
+1	+7	−2	oxidation #
+1	+7	−8	total

(b)

Ni	O_2
+4	−2
+4	−4

(c)

K_4	Fe	$(CN)_6$
+1	+2	−1
+4	+2	−6

(d) $(NH_4)_2HPO_4 = 2(NH_4)^+ + HPO_4^{2-}$

N	H_4^+
−3	+1
−3	+4

H	P	O_4	$^{2-}$
+1	+5	−2	
+1	+5	−8	

(e)

P_4	O_6
+3	−2
+12	−12

(f)

Fe_3	O_4
+8/3	−2
+8	−8

(g)

Xe	O	F_4
+6	−2	−1
+6	−2	−4

(h)

S	F_4
+4	−1
+4	−4

(i)

C	O
+2	−2

(j) $Na_2C_2O_4 = 2Na^+ + C_2O_4^{2-}$

Na^+
+1

C_2	O_4	$^{2-}$
+3	−2	
+6	−8	

(60) (a)

Li_3	N
+1	−3
+3	−3

(b)

N	H_3
−3	+1
−3	+3

(c)

N_2	H_4
−2	+1
−4	+4

(d)

N	O
+2	−2

(e)

N_2	O
+1	−2
+2	−2

(f)

N	O_2
+4	−2
+4	−4

(g)

N	O_2^-
+3	−2
+3	−4

(h)

N	O_3^-
+5	−2
+5	−6

(i) N_2

0

(61) (a) $\overset{-4}{\overset{+1}{C}}H_4(g) + 2\,O_2(g) \longrightarrow \overset{+4}{\overset{-2}{C}}O_2(g) + 2\,\overset{+1}{\overset{-2}{H_2}}O(g)$

oxidation state

0 → +4 : reduced

−4 → +4 : oxidized

0 → +1 : reduced

This is an oxidation – reduction reaction.

oxidizing agent = O_2

reducing agent = CH_4

(b) $Zn(s) + 2H\overset{+1}{\overset{-1}{Cl}}(aq) \longrightarrow \overset{+2}{\overset{-1}{Zn}}Cl_2(aq) + H_2(g)$

0 → +2 : oxidized

+1 → 0 : reduced

Redox reaction

oxidizing agent = HCl

reducing agent = Zn

(c) $\overset{+6}{Cr_2}\overset{-2}{O_7^{2-}}(aq) + 2\overset{-2}{\overset{+1}{H^-}}(aq) \rightarrow 2\overset{+6}{\overset{-2}{CrO_4^{2-}}}(aq) + \overset{+1}{\overset{-2}{H_2O}}(l)$

Not a redox reaction.

(d) $O_3(g) + N\overset{+2}{\overset{-2}{O}}(g) \longrightarrow O_2(g) + N\overset{+4}{\overset{-2}{O_2}}(g)$

0 → +2 : reduced

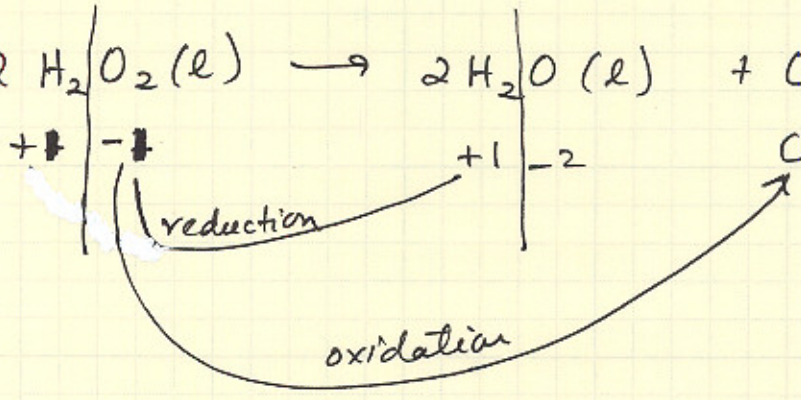
+2 → +4 : oxidized

Redox reaction

O_3 is the oxidizing agent.

NO is the reducing agent.

(e) $2\,H_2O_2(\ell) \longrightarrow 2\,H_2O(\ell) + O_2(g)$

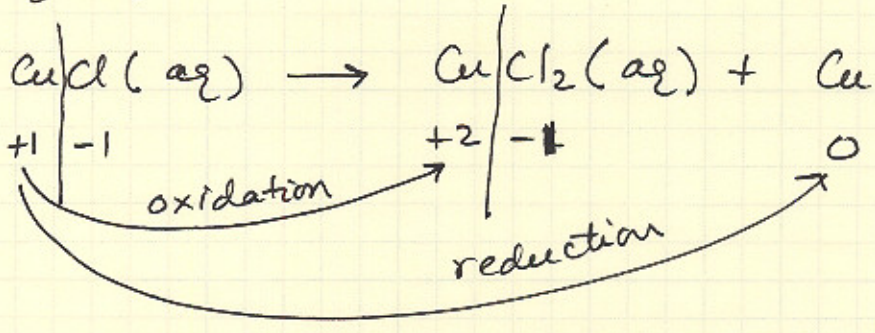


Redox reaction

oxidizing agent = H_2O_2

reducing agent = H_2O_2

(f) $2\,CuCl(aq) \longrightarrow CuCl_2(aq) + Cu(s)$



redox reaction

CuCl = oxidizing agent

CuCl = reducing agent.

(63) (a) $Zn(s) + HCl(aq) \rightarrow Zn^{2+}(aq) + H_2(g) + Cl^-(aq)$

0 ; +1 | -1 ; +2 ; 0 ; -1

oxidation ; reduction

oxidation R^n $Zn(s) \longrightarrow Zn^{2+}(aq) + 2e^-$

Reduction R^n $2HCl(aq) + 2e^- \longrightarrow H_2(g) + 2Cl^-(aq)$ ↓ +

$Zn(s) + 2HCl(aq) \rightarrow Zn^{2+}(aq) + H_2(g) + 2Cl^-(aq)$

(b) $I^-(aq) + ClO^-(aq) \longrightarrow I_3^-(aq) + Cl^-(aq)$

-1 ; +1 | -2 ; $-\frac{1}{3}$; -1

oxidation ; reduction

oxidation R^n $3I^-(aq) \rightarrow I_3^-(aq) + 2e^-$

Reduction R^n $ClO^-(aq) + 2H^+(aq) + 2e^- \longrightarrow Cl^-(aq) + H_2O(l)$ ↓ +

$3I^-(aq) + ClO^-(aq) + 2H^+(aq) \rightarrow I_3^-(aq) + Cl^-(aq) + H_2O(l)$

(c) $AS_2|O_3(s) + NO_3^-(aq) \rightarrow H_3|AsO_4(aq) + NO(g)$

+3 | -2 ; +5 | -2 ; +1 | +5 | -2 ; +2 | -2

oxidation ; reduction

Redox reaction

Oxidation R$^{\hat{=}}$ 3x $[As_2O_3(s) + 5H_2O(\ell) \longrightarrow 2H_3AsO_4(aq) + 4H^+ + 4\bar{e}]$

Reduction 4x $[2\bar{e} + NO_3^-(aq) + 4H^+(aq) \longrightarrow NO(g) + 2H_2O(\ell)]$

$3As_2O_3(s) + 15H_2O(\ell) + 4NO_3^-(aq) + 16H^+(aq) \longrightarrow$

$6H_3AsO_4(aq) + 4H^+(aq) + 4NO(g) + 8H_2O(\ell)$

$+7H_2O(\ell)$

$3As_2O_3(s) + 4NO_3^-(aq) + 4H^+(aq) \longrightarrow 6H_3AsO_4(aq) + 4NO(g)$

(d) $Br^-(aq) + MnO_4^-(aq) \longrightarrow Br_2(\ell) + Mn^{2+}(aq)$

$-1 \quad +7 \quad -2 \quad 0 \quad +2$

Oxidation 5 $[2Br^-(aq) \longrightarrow Br_2(\ell) + 2\bar{e}]$

Reduction 2 $[5\bar{e} + MnO_4^-(aq) + 8H^+(aq) \longrightarrow Mn^{2+}(aq) + 4H_2O(\ell)]$

$10Br^-(aq) + 2MnO_4^-(aq) + 16H^+(aq) \rightarrow 5Br_2(\ell) + 2Mn^{2+}(aq) + 8H_2O(\ell)$

(e) $CH_3OH(aq) + Cr_2O_7^{2-}(aq) \rightarrow CH_2O(aq) + Cr^{3+}(aq)$

oxidation numbers: C: $-2, +1$ → 0; O: -2; H: $+1$; Cr: $+6$ → $+3$; O: -2; H: $+1$; C: 0

oxidation; reduction

Reduction: $6\bar{e} + Cr_2O_7^{2-}(aq) + 14H^+(aq) \rightarrow 2Cr^{3+}(aq) + 7H_2O(l)$

oxidation: $3\left[CH_3OH(aq) \rightarrow CH_2O(aq) + 2H^+(aq) + 2\bar{e}\right]$ ↓ +

$$Cr_2O_7^{2-}(aq) + 14H^+(aq) + 3CH_3OH(aq) \rightarrow 2Cr^{3+}(aq) + 7H_2O(l) + 3CH_2O(aq) + 6H^+(aq)$$

$$Cr_2O_7^{2-}(aq) + 8H^+(aq) + 3CH_3OH(aq) \rightarrow 2Cr^{3+}(aq) + 7H_2O(l) + 3CH_2O(aq)$$

(65) (a) $Al(s) + MnO_4^-(aq) \rightarrow MnO_2(s) + Al(OH)_4^-(aq)$

Al: 0 → $+3$; Mn: $+7$ → $+4$; O: -2; H: $+1$; -2

oxidation; reduction

Oxidation $R^{\hat{n}}$: $\left[Al(s) + 4H_2O(l) \rightarrow Al(OH)_4^- + 4H^+(aq) + 3\bar{e}\right]$

Reduction $R^{\hat{n}}$: $\left[MnO_4^-(aq) + 4H^+(aq) \xrightarrow{+3e} MnO_2(s) + 2H_2O(l)\right]$ ↓ +

$$Al(s) + 4H_2O(l) + MnO_4^-(aq) + 4H^+(aq) \rightarrow Al(OH)_4^- + 4H^+(aq) + MnO_2(s) + 2H_2O(l)$$

$$Al(s) + 2H_2O(l) + MnO_4^-(aq) \rightarrow Al(OH)_4^- + MnO_2(s)$$

(b) $Cl_2(g) \rightarrow Cl^-(aq) + OCl^-(aq)$

0 → −1 (reduction); 0 → +1 (oxidation)

Oxidation R^n: $Cl_2(g) + 2H_2O(l) \rightarrow 2OCl^-(aq) + 4H^+(aq) + 2e^-$

Reduction R^n: $Cl_2(g) + 2e^- \rightarrow 2Cl^-(aq)$

$Cl_2(g) + 2H_2O(l) + Cl_2(g) + 4OH^-(aq) \rightarrow 2OCl^-(aq) + 4H^+(aq) + 2Cl^-(aq) + 4OH^-(aq)$

$2Cl_2(g) + 2H_2O(l) + 4OH^-(aq) \rightarrow 2OCl^-(aq) + 4H_2O + 2Cl^-(aq)$

$2Cl_2(g) + 4OH^-(aq) \rightarrow 2OCl^-(aq) + 2H_2O(l) + 2Cl^-(aq)$

(c) $NO_2^-(aq) + Al(s) \rightarrow NH_3(g) + AlO_2^-(aq)$

+3 → −3 (reduction); 0 → +3 (oxidation)

Oxidation R^n: $2[Al(s) + 2H_2O(l) \rightarrow AlO_2^-(aq) + 4H^+(aq) + 3e^-]$

Reduction R^n: $NO_2^-(aq) + 7H^+(aq) + 6e^- \rightarrow NH_3(g) + 2H_2O(l)$

$2Al(s) + 4H_2O(l) + NO_2^-(aq) + 7H^+(aq) \rightarrow 2AlO_2^-(aq) + 8H^+(aq) + NH_3(g) + 2H_2O(l)$

$$2\,Al(s) + 2H_2O(\ell) + NO_2^-(aq) + OH^-(aq) \rightarrow 2AlO_2^-(aq) + NH_3(g) + H^+(aq) + OH^-(aq)$$

$$H^+(aq) + OH^-(aq) = H_2O(\ell)$$

$$2\,Al(s) + NO_2^-(aq) + OH^-(aq) \rightarrow 2AlO_2^-(aq) + NH_3(g) + H_2O(\ell)$$

(66) (a) $Cr(s) + CrO_4^{2-}(aq) \longrightarrow Cr(OH)_3(s)$

0 ; +6 −2 ; reduction → +3 −2 +1

Oxidation

Oxidation R^n. $\left[Cr(s) + 3H_2O(\ell) \longrightarrow Cr(OH)_3(s) + 3H^+(aq) + 3e^-\right]$

Reduction R^n. $\left[3e^- + CrO_4^{2-}(aq) + 5H^+(aq) \longrightarrow Cr(OH)_3(s) + H_2O(\ell)\right]$

$$Cr(s) + 3H_2O(\ell) + CrO_4^-(aq) + 5H^+(aq) \rightarrow 2Cr(OH)_3(s) + 3H^+(aq) + H_2O(\ell)$$

$$Cr(s) + 2H_2O(\ell) + CrO_4^-(aq) + 2H^+(aq) \rightarrow 2Cr(OH)_3(s) + 2OH^-(aq) + 2OH^-(aq)$$

$$Cr(s) + 4H_2O(\ell) + CrO_4^-(aq) \rightarrow 2Cr(OH)_3(s) + 2OH^-(aq)$$

1 (b) $MnO_4^-(aq) + S^{2-}(aq) \rightarrow MnS(s) + S(s)$

Mn: +7 → +2 (reduction); S: −2 → 0 (oxidation)

Oxidation R^n: $5\left[S^{2-}(aq) \longrightarrow S(s) + 2e^-\right]$

Reduction r^n: $2\left[8H^+(aq) + MnO_4^-(aq) + 5e^- \longrightarrow MnS(s) + 4H_2O(\ell)\right]$

$$5S^{2-}(aq) + 16H^+(aq) + 2MnO_4^-(aq) + 2S^{2-}(aq) \rightarrow 5S(s) + 2MnS(s) + 8H_2O(\ell) + 16OH^-(aq)$$

$$S^{2-}(aq) + 2MnO_4^-(aq) + 8H_2O(\ell) \rightarrow 5S(s) + 2MnS(s) + 16OH^-(aq)$$

(c) $CN^-(aq) + MnO_4^-(aq) \rightarrow CNO^-(aq) + MnO_2(s)$

C: +2 → +4 (oxidation); Mn: +7 → +4 (reduction)

Oxidation R^n: $3\left[CN^-(aq) + H_2O(\ell) \longrightarrow CNO^-(aq) + 2H^+(aq) + 2e^-\right]$

Reduction R^n: $2\left[3e^- + MnO_4^-(aq) + 4H^+(aq) \longrightarrow MnO_2(s) + 2H_2O(\ell)\right]$

$$3CN^-(aq) + 3H_2O(\ell) + 2MnO_4^-(aq) + 8H^+(aq) \longrightarrow 3CNO^-(aq) + 6H^+(aq) + 2MnO_2(s) + 4H_2O(\ell)$$

$3\,CN^-(aq) + 2\,MnO_4^-(aq) + 2\,H^+(aq) \longrightarrow 3\,CNO^-(aq) + 2\,MnO_2(s) + H_2O(\ell)$

$2\,OH^-(aq)$

$+ 2\,OH^-(aq)$

$3\,CN^-(aq) + 2\,MnO_4^-(aq) + H_2O(\ell) \longrightarrow 3\,CNO^-(aq) + 2\,MnO_2(s) + 2\,OH^-(aq)$

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(67)

$NaCl(aq) + H_2SO_4(aq) + MnO_2(s) \longrightarrow Na_2SO_4(aq) +$

$+1\ -1 \quad +1\ +6\ -2 \quad +4\ -2 \quad +1\ +6\ -2$

reduction $\rightarrow MnCl_2(aq) + H_2O(\ell) + Cl_2(g)$

$+2\ -1 \quad +1\ -2 \quad 0$

Oxidation

Oxidation R^{n} $2\,NaCl(aq) + H_2SO_4(aq) \longrightarrow Cl_2(g) + Na_2SO_4(aq) + 2\,H^+(aq) + 2\,e^-$

Reduction R^{n} $4\,H^+(aq) + MnO_2(s) + 2\,Cl^-(aq) \longrightarrow MnCl_2(aq) + 2\,H_2O$

$+ 2\,e^-$

$2\,NaCl(aq) + 2\,H_2SO_4(aq) + 4\,H^+(aq) + MnO_2(s) + 2\,Cl^-(aq) \longrightarrow Cl_2(g) + Na_2SO_4(aq) + 2\,H^+(aq) + MnCl_2(aq) + 2\,H_2O$

$$2NaCl(aq) + H_2SO_4(aq) + 2H^+(aq) + MnO_2(s) + 2Cl^-(aq) \rightarrow Cl_2(g) + Na_2SO_4(aq) + MnCl_2(aq) + 2H_2O$$

There are other ways to solve as well.

(68) $Au(s) + H^+NO_3^-(aq) + H^+Cl^-(aq) \rightarrow AuCl_4^-(aq) + NO(g)$

0 → +3 (oxidation); +5 → +2 (reduction)

oxidation $Au(s) + 4Cl^-(aq) \rightarrow AuCl_4^-(aq) + 3e^-$

Reduction $3e^- + NO_3^-(aq) + 4H^+(aq) \rightarrow NO(g) + 2H_2O(l)$

$$Au(s) + 4Cl^-(aq) + NO_3^-(aq) + 4H^+(aq) \rightarrow AuCl_4^-(aq) + NO(g) + 2H_2O(l)$$

Chapter 7

(39) $\lambda = 7.80 \times 10^2\ nm \qquad c = \nu\lambda \qquad \nu = \frac{c}{\lambda}$

$$\nu = \frac{2.99 \times 10^8\ m\,s^{-1}}{7.80 \times 10^2\ nm} \times \frac{10^9\ nm}{m}$$

$$\nu = 3.83 \times 10^{14}\ Hz$$

(44) $\nu_1 = 107.1\ MHz = 107.1 \times 10^6\ Hz$

$\lambda_2 = 2.12 \times 10^{-10}\ m$

$$\nu_2 = \frac{c}{\lambda_2} = \frac{2.99 \times 10^8 \ m s^{-1}}{2.12 \times 10^{-10} \ m} = 1.41 \times 10^{18} \ s^{-1}$$

$$\nu_1 = 107.1 \times 10^6 \ s^{-1}$$

$\therefore \quad \nu_2 > \nu_1 \Rightarrow E_2 > E_1$

energy of the second type of emr is higher than the energy of the first type of emr.

$$E_3 = 3.97 \times 10^{-19} \ J = h\nu_3$$

$$\nu_3 = \frac{E_3}{h} = \frac{3.97 \times 10^{-19} \ J}{6.626 \times 10^{-34} \ J s} = 5.99 \times 10^{14} \ Hz$$

$$\nu_2 > \nu_3 > \nu_1$$

$$\Rightarrow \quad E_2 > E_3 > E_1$$