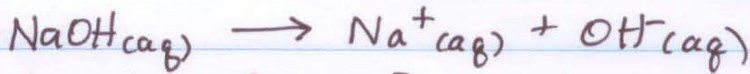PS 6 Key

① 5.00g NaOH to make 2.00 L of NaOH(aq)
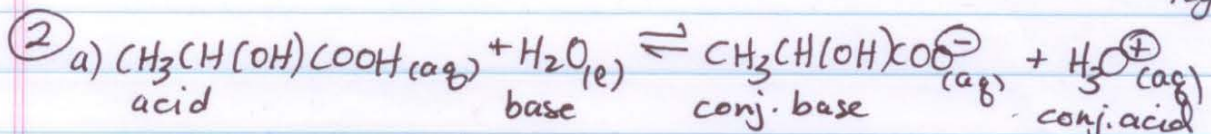
$[NaOH] = 5.00g \left(\dfrac{1 \text{ mol } NaOH}{40.00 g} \right) = \dfrac{0.125 \text{ mol}}{2.00 L} = 0.0625 M$

$NaOH_{(aq)} \longrightarrow Na^+_{(aq)} + OH^-_{(aq)}$

$[OH^-] = [NaOH] = 0.0625 M$

$pOH = -\log(0.625) = 0.204$

$pH = 14.000 - 0.204 = 13.796 = \boxed{13.80}$ 2 decimals for 2 sig figs

② a) $CH_3CH(OH)COOH_{(aq)} + H_2O_{(\ell)} \rightleftharpoons CH_3CH(OH)COO^-_{(aq)} + H_3O^+_{(aq)}$

   acid   base   conj. base   conj. acid

	$[\ ]_{init}$			

$[\ ]_{init}$ 0.075M   0   0

$\Delta[\ ]$ $-x$ $+x$ $+x$

$[\ ]_{\rightleftharpoons}$ $0.075-x$ x x

$\dfrac{x^2}{0.075-x} = 1.4 \times 10^{-4}$ Try assuming $x \ll 0.075$

$\dfrac{x^2}{0.075} \approx 1.4 \times 10^{-4}$ $pH = -\log[H_3O^+]_{\rightleftharpoons}$

$x^2 \approx 1.05 \times 10^{-5}$ $\approx -\log(3.24 \times 10^{-3})$

$x \approx 3.24 \times 10^{-3} M \approx [H_3O^+]_{\rightleftharpoons}$ $\underline{pH \approx 2.49}$

Check assumption:

$\dfrac{x}{0.075} * 100\% \leq 5\% ?$ $\underline{yes}$ (4.32 %)

③ $2K_2FeO_4 + 3Zn \rightarrow Fe_2O_3 + ZnO + 2K_2ZnO_2$

a.
ox.# (each atom)

$\underset{+6}{\overset{+1}{\underline{}}} \quad \overset{-2}{} \qquad \overset{0}{\underline{}} \qquad \underset{}{\overset{+3}{\underline{}}} \overset{-2}{} \quad \underset{\underline{}}{\overset{+2}{}} \overset{-2}{} \qquad \overset{+1}{} \underset{\underline{}}{\overset{+2}{}} \overset{-2}{}$
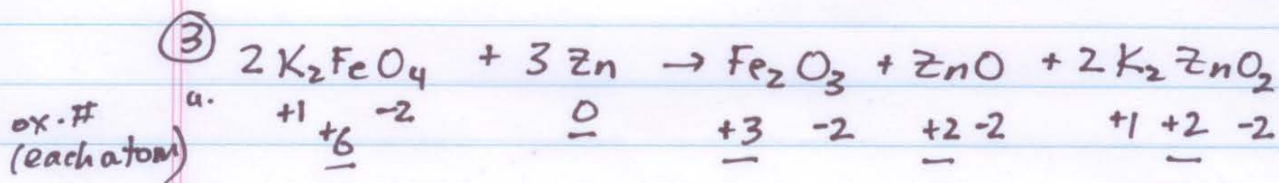
b. Fe is reduced. 2 Fe atoms go from $+6 \rightarrow +3$ $2(3) = 6e^-$ gained

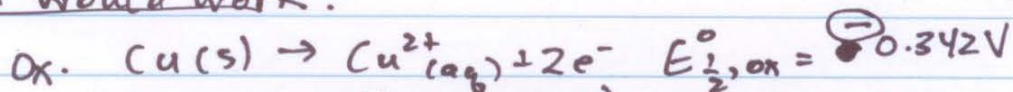Zn is oxidized. 3 Zn atoms $0 \rightarrow +2$ $3(2) = 6e^-$ lost

$6e^-$ are transferred.

④ a. Red. $2H^+(aq) + 2e^- \rightarrow H_2(g)$ $E^\circ_{\frac{1}{2}} = 0.00\,V$

Ox. $Fe(s) \rightarrow Fe^{2+} + 2e^-$ $E^\circ_{\frac{1}{2},ox} = +0.447\,V$

$Fe(s) + 2H^+(aq) \rightarrow Fe^{2+}(aq) + H_2(g)$ $E^\circ cell = +0.447\,V$

Because $E^\circ cell > 0$, process is spontaneous.
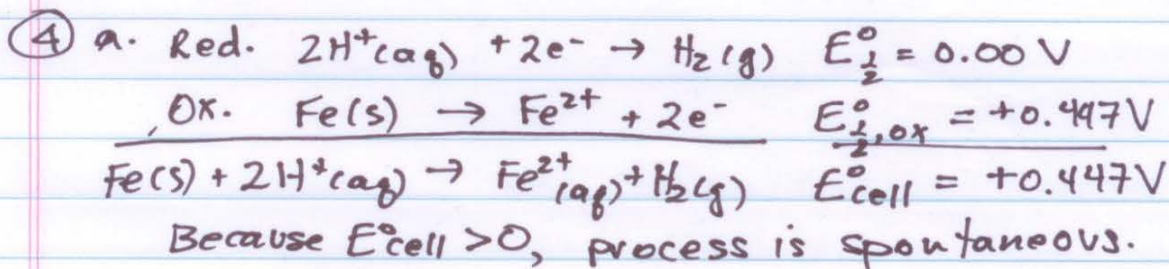
b. Need $E^\circ cell < 0$ for non-spontaneous process.

Red. $2H^+(aq) + 2e^- \rightarrow H_2(g)$ $E^\circ_{\frac{1}{2},red} = 0.00\,V$

Ox. $M \rightarrow M^{n+} + ne^-$ $E^\circ_{\frac{1}{2},ox}$ must be $\ominus$
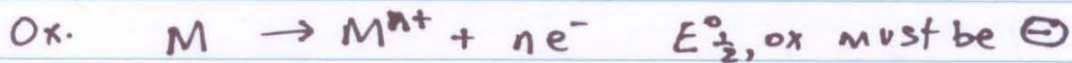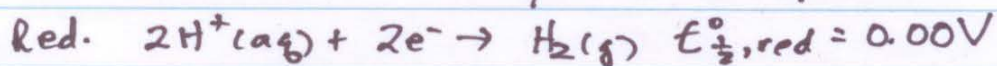
for M = Cu, Pb, Ni, and/or Sn.

*Cu would work:

Ox. $Cu(s) \rightarrow Cu^{2+}(aq) + 2e^-$ $E^\circ_{\frac{1}{2},ox} = -0.342\,V$

$E^\circ cell = 0.00\,V + (-0.342\,V) = -0.342\,V$

*$E^\circ cell$ is positive (spontaneous) for oxidation of Pb, Ni, Sn.

⑤ a,b. (anode) Ox. $Zn(s) + 2OH^-(aq) \rightarrow ZnO(s) + H_2O(\ell) + 2e^-$ $E^\circ_{\frac{1}{2}} = +1.25\,V$

(cathode) red. $2MnO_2(s) + H_2O(\ell) + 2e^- \rightarrow Mn_2O_3(s) + 2OH^-(aq)$ $E^\circ_{\frac{1}{2}} = +0.15\,V$

c. $K^+ \rightarrow$ cathode. ($OH^- \rightarrow$ anode.)
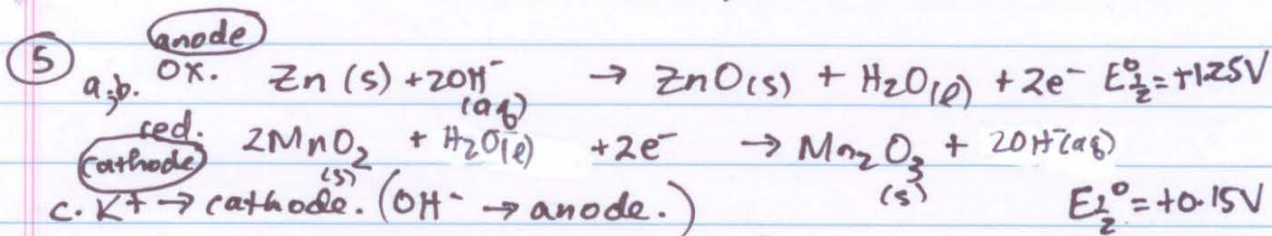
d. $E^\circ cell = +1.40\,V$ $(= +1.25\,V + 0.15\,V)$ Spontaneous.

$\Delta G^\circ = -nFE^\circ = -(2)(96485\,C/mole^-)(1.40\,J/C)\left(\dfrac{1\,kJ}{10^3 J}\right)$

$\Delta G^\circ = -2.70 \times 10^2\,kJ/mol$