CHM 2046 Exam 3 Spring 2021

D 1) I. $2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(g)}$ $-\Delta S$
II. $C_2H_5OH_{(l)} + O_{2(g)} \rightarrow 2CO_{2(g)} + H_2O_{(g)}$ $+\Delta S$
III. $H_2O_{2(g)} \rightarrow H_{2(g)} + O_{2(g)}$ $+\Delta S$

B 2) ✱need enough energy from one rxn to power the other✱
$\Delta G = 31$ kJ/mol provides free energy for $\Delta G° = +14.3$ kJ/mol to use ∴ B is the answer

A 3) $\Delta G° = \Delta H° - T\Delta S°$
$\Delta G° = (-90.79\times10^3 \frac{J}{mol}) - (1020+273K)(70.27 \frac{J}{mol\cdot K})$
$\Delta G° = -181649 \frac{J}{mol}$ → spontaneous, provides energy

B 4) $HBrO + H_2O \rightarrow H_3O^+ + BrO^-$
$0.20 \rightarrow 6\times10^{-4} + 0.10$ $\quad Q = \frac{(0.10)(6\times10^{-4})}{(0.20)} = 3\times10^{-4}$

$\Delta G = RT\ln\left(\frac{Q}{K}\right) = (8.314 \frac{J}{mol\cdot K})(298)\ln\left(\frac{3\times10^{-4}}{2.3\times10^{-9}}\right)$
$\Delta G = 29182$ J/mol → nonspontaneous

B 5) I. anode loses mass
II. true, cations flow into the cathode
III. false, e^- flow from anode to cathode

A 6) $Cu + Br_2 \rightarrow Cu^{2+} + 2Br^-$ $\quad E° = 0.73$ $\quad E = 0.87$

$0.87 = 0.75 - \frac{.0592}{2}\log Q$
$Q = 8.83\times10^{-5} = [Cu^{2+}][Br^-]^2 = (.9)[Br^-]^2$
$[Br^-] = 0.0099$
$MBr_2 \rightarrow M^+ + 2Br^-$ $\quad K_{sp} = [M^+][Br^-]^2 = (.00495)(.0099)^2$

$\boxed{K_{sp} = 4.9\times10^{-7}}$

A 7) anode

$2I^- \rightarrow I_2 + 2e^-$

$2F^- \rightarrow F_2 + 2e^-$

cathode

$K^+ + e^- \rightarrow K_{(s)}$

$Mg^{2+} + 2e^- \rightarrow Mg_{(s)}$

use periodic trends for molten salts

- F has larger EN, therefore does not want to get oxidized and I_2 would form
- Mg is smaller, has larger pull on e^-

E 8) $Ni^{2+} + 2e^- \rightarrow Ni_{(s)} \quad E^\circ = -.25$

$Cd^{2+} + 2e^- \rightarrow Cd_{(s)} \quad E^\circ = -.40$

$E^\circ = -.25 - (-.40) = 0.15$

$$0.2 = 0.15 - \frac{.0592}{2} \log Q$$

$$Q = 0.02 = \frac{[Cd^{2+}]}{[Ni^{2+}]} = \frac{(0.10)}{[Ni^{2+}]}$$

$$\boxed{[Ni^{2+}] = 4.9M}$$

A 9) $E^\circ = \emptyset V \qquad Q = \left(\frac{\text{dilute}}{\text{concentrated}}\right)$

$$E = \emptyset - \frac{.0592}{3} \log\left(\frac{0.01}{1.0}\right)$$

$$E = 0.039V$$

$$\Delta G = -nFE = -(3)(96485)(.039) = -11423.8 \frac{J}{mol} = \boxed{-11.4 \ kJ/mol}$$

10) concentration cell: $\boxed{E^\circ = 0V}$

$\Delta G^\circ = -nFE^\circ = -(2)(96485)(0) = \boxed{0\ kJ/mol}$

$\Delta G^\circ = -RT\ln K \quad 0 = -(8.314)(298)\ln K \rightarrow \boxed{K = 1}$

$Q = \frac{\text{dilute}}{\text{concentrated}} = \frac{.01}{1} = \boxed{0.01}$

$E = E^\circ - \frac{.0592}{n}\log Q \quad E = 0 - \frac{.0592}{2}\log(.01) \quad \underline{E = 0.0592V}$ $\boxed{E = 0.06V}$

$\Delta G = -nFE = -(2)(96485)(0.06) = -11578.2\ J/mol = \boxed{-11.6\ kJ/mol}$

C 11) $\underbrace{[Ni(H_2O)_6]}_{+2}\ Cl_2$ (+2, 0, −1, −2)

$6\ H_2O$ (monodentate) = 6

$\underbrace{[Cr(en)_3]}_{+3}(ClO_4)_3$ (+3, 0, −1, −3)

3 en (bidentate) = 6

$K_4\underbrace{[Mn(CN)_6]}_{+2\ -6\ =\ -4}$ (+1, +2, −1, +4)

$6\ CN^-$ (monodentate) = 6

B 12) $:\ddot{O}-\ddot{N}=\ddot{O}:$ can bond on N or O

$:\ddot{O}=\ddot{S}=\ddot{O}:$ can bond on S or O

$:\ddot{O}-N(=\ddot{O}:)-\ddot{O}:$ can only bond on O

D 13) strong ligand = absorbs high energy = absorbs yellow, is violet

B 14) $1.56 \times 10^6 \frac{\text{disintegrations}}{\text{second}}$

$$(1.56\times10^6 \tfrac{\text{dis}}{\text{s}})\left(\frac{1\ \text{Ci}}{3.70\times10^{10}\ \text{dis/s}}\right)\left(\frac{1}{1.65\times10^{-3}\text{g}}\right) = 0.0255$$

$$= \boxed{2.56\times10^{-2}\ \text{Ci/g}}$$

C 15)

$$t_{\frac{1}{2}} = \frac{\ln 2}{K} = 1.01 \rightarrow K = 0.686\ \text{yr}^{-1}$$

3.75×10^3 hr = 0.4281 years

$$\ln A_t = -(.686)(0.4281) + \ln(2)$$

$$\ln A_t = 0.399$$

$$\boxed{A_t = 1.49\text{mg}}$$

16)

gamma: ${}^0_0\gamma$
alpha: ${}^4_2\text{He}$
beta: ${}^0_{+1}\beta$
[e^- capture: ${}^0_{-1}e^-$
positron: ${}^0_{+1}\beta$

emitting positive element is the same as capturing a negative one

A 17)

^{15}C vs ^{12}C is too heavy $\therefore {}^0_{-1}\beta$ decay
^{120}Xe vs ^{131}Xe is too light $\therefore {}^0_{+1}\beta$ emission / ${}^0_{-1}e$ capture
^{224}Th has $Z > 83$ $\therefore$ alpha decay