EQUATIONS and CONSTANTS:

\[ \mathcal{E} = \mathcal{E}^\circ - \frac{(RT/nF)}{\ln Q} \]

\[ \Delta G = \Delta G^\circ + RT \ln Q \]

\[ \Delta G = -nF\mathcal{E} \]

\[ \mathcal{E} = \mathcal{E}^\circ - \frac{(0.0257/n)}{\ln Q} \text{ at } 25^\circ \text{C} \]

\[ \Delta G = \Delta H - T\Delta S \]

\[ \Delta G^\circ = -nF \mathcal{E} \]

\[ \Delta G = \Delta H^\circ - T\Delta S^\circ \]

\[ \Delta G^\circ = -RT \ln K \]

\[ \mathcal{E}^\circ = (RT/nF) \ln K \]

\[ R = 8.3145 \text{ J mol}^{-1}\text{K}^{-1} \]

\[ F = 96,485 \text{ C/mol} \]

1. Indicate the signs of \( \Delta H \) and \( \Delta S \) such that the reaction is spontaneous at all temperatures.

   \[ \Delta H \quad \Delta S \]
   
   a) – –
   b) + –
   c) – +
   d) + +

2. Consider the following reaction:

\[ \text{H}^\circ (\text{aq}) + \text{OH}^- (\text{aq}) \rightarrow \text{H}_2\text{O} (\text{l}) \]

\[ \Delta H = -56 \text{ kJ} \]

How much heat is released when 100 mL of 0.4 M HCl is mixed with 100 mL of 0.3 M Ba(OH)\(_2\)?

   a) 3.36 kJ
   b) 5.60 kJ
   c) 1.68 kJ
   d) 56.0 kJ
   e) 2.24 kJ

3. What is the oxidation state (number) for S in Na\(_2\)S\(_2\)O\(_3\)?

   a) + 2
   b) – 2
   c) + 4
   d) – 4
   e) none of these

4. In an electrochemical cell, a cobalt electrode is immersed in a Co\(^{2+}\) solution and a lead electrode is immersed in a Pb\(^{2+}\) solution.

\[ \text{Co} + \text{Pb}^{2+} \rightarrow \text{Pb} + \text{Co}^{2+} \]

Calculate the chemical potential, \( \mathcal{E} \), if [Co\(^{2+}\)] = 0.001 M and [Pb\(^{2+}\)] = 0.1 M.

\[ \text{Pb}^{2+} + 2e^- \rightarrow \text{Pb} (\text{s}) \quad \mathcal{E}^\circ = -0.13 \text{ V} \]

\[ \text{Co}^{2+} + 2e^- \rightarrow \text{Co} (\text{s}) \quad \mathcal{E}^\circ = -0.28 \text{ V} \]

   a) 0.15 V
   b) 0.091 V
   c) 0.21 V
   d) 0.27 V
   e) none of these

ANSWERS ARE AT THE BOTTOM
5. Using the above half reactions, indicate the strongest oxidizing agent.
   a) Ni^{2+}         b) Ag (s)         c) Ag^{+}         d) Ni (s)         e) Cu^{2+}

6. Given the above half reactions, which of the following species could be reduced by Cu (s)?
   a) Sn^{2+}            b) Ag^{+}         c) Ag (s)         d) Pb^{2+}, Sn^{2+} and Ni^{2+}  e) Pb (s)

7. Which substance is the oxidizing agent in the following reaction?
   SiCl_{4} (l) + 2 Mg (s) → 2 MgCl_{2} (s) + Si (s)
   a) SiCl_{4}            b) Mg            c) MgCl_{2}         d) Si (s)

Answers
1. c       2. e       3. a       4. c
5. c       6. b       7. a