Free Energy and Cell Potential Name Answer Key

1. Given the electrochemical reaction shown, what is the standard free energy change $\Delta G°$ if $E° = +1.61$ V?

$$Mg / Mg^{2+}(aq) // Zn^{2+}(aq) / Zn \qquad E° = +1.61 \text{ V}$$

$\Delta G° = -2(96,500)(+1.61\text{ V})$
$= -310.7 \text{ kJ/mol}$

2. The oxidation of hydrogen by oxygen is one of the most-used reactions in fuel-cell technology. The overall reaction, which is given below, has a $\Delta G°$ value of –474 kJ/mol. What is the standard cell potential for this fuel cell?

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(l) \qquad \Delta G° = -474 \text{ kJ/mol}$$

$-474,000 = -2(96,500)(E)$
$E° = +2.46\text{V}$

3. What is $\Delta G°$ for the following balanced reaction, if $E° = +2.431$ V?

$$Al(s) + Fe^{3+}(aq) \rightarrow Al^{3+}(aq) + Fe(s) \qquad E° = +2.431 \text{ V}$$

$\Delta G° = -3(96,500)(2.431)$
$\Delta G° = -703.8 \text{ kJ/mol}$

4. The oxidation of methanol, as described by the equation below, has a $\Delta G°$ value of –937.9 kJ/mol. What is the standard cell potential for a methanol fuel cell?

$$\overset{-2+3-2+1}{2CH_3OH} + \overset{0}{3O_2} \rightarrow \overset{+4-2}{2CO_2} + \overset{+1-2}{4H_2O} \qquad \Delta G° = -937.9 \text{ kJ/mol}$$

$-937,900 = -6(96,500)(E)$
$E° = +1.62\text{V}$

$4(H_2O + CH_3OH \rightarrow CO_2 + 6e^- + 6H^+)$
$6(4e^- + 4H^+ + O_2 \rightarrow 2H_2O)$
$3(2e^- + 2H^+ + 1/2\,O_2 \rightarrow H_2O)$
$4H_2O + 4CH_3OH + 2H^+ + 6O_2 \rightarrow 4CO_2 + 2H^+ + 12H_2O$

$4CH_3OH + 6O_2 \rightarrow 4CO_2 + 8H_2O$
$2CH_3OH + 3O_2 \rightarrow 2CO_2 + 4H_2O$

5. For the following reaction, all of the reactants and products are in their standard states/standard 1.0 mol dm^{-3} concentrations. Which of the following statements must be <u>true</u>?

$$\overset{0}{Zn}(s) + \overset{+2\ -1}{SnBr_2}(aq) \rightarrow \overset{+2\ -1}{ZnBr_2}(aq) + \overset{0}{Sn}(s) \qquad E° = +0.60 \text{ V}$$

a. The reaction would be **<u>product-favored</u>** as written → true, $E°$ is (+)
b. $\Delta G°$ for the reaction as written is **<u>positive</u>** → false, $\Delta G < 0$
c. Zinc is undergoing reduction → false, Zn oxidized
d. $SnBr_2$ is the reducing agent → false, $SnBr_2$ is oxidizing agent