KEY

Practice Exam Chapters 19-20

Use the table below to answer the questions that follow.

Thermodynamic Quantities for Selected Substances at 298.15 K (25 °C)

Substance	ΔH°f (kJ/mol)	ΔG°f (kJ/mol)	S (J/K-mol)
Carbon			
C (s, diamond)	1.88	2.84	2.43
C (s, graphite)	0	0	5.69
C_2H_2 (g)	226.7	209.2	200.8
C_2H_4 (g)	52.30	68.11	219.4
C_2H_6 (g)	−84.68	−32.89	229.5
CO (g)	−110.5	−137.2	197.9
CO_2 (g)	−393.5	−394.4	213.6
Hydrogen			
H_2 (g)	0	0	130.58
Oxygen			
O_2 (g)	0	0	205.0
H_2O (l)	−285.83	−237.13	69.91

1. The value of $\Delta S°$ for the oxidation of carbon to carbon monoxide,

$$2C\ (s, \text{graphite}) + O_2\ (g) \rightarrow 2CO\ (g)$$

= 2(197.9) − (2(5.69) + 205.0)

179.4 J/K

is _____ J/K• mol. Carbon monoxide is produced in the combustion of carbon with limited oxygen.

Table 20.2

Half-reaction	E° (V)
$Cr^{3+}(aq) + 3e^- \rightarrow Cr\ (s)$	−0.74
$Fe^{2+}(aq) + 2e^- \rightarrow Fe\ (s)$	−0.440
$Fe^{3+}(aq) + e^- \rightarrow Fe^{2+}\ (s)$	+0.771
$Sn^{4+}(aq) + 2e^- \rightarrow Sn^{2+}(aq)$	+0.154

$E^0 = .154 + .74$

$= 0.894$

2. The standard cell potential ($E°_{cell}$) for the voltaic cell based on the reaction below is _____ V.

$$3Sn^{4+}(aq) + 2Cr\ (s) \rightarrow 2Cr^{3+}(aq) + 3Sn^{2+}(aq)$$

$\Delta G^\circ = -RT\ln K$

$3.05 = -(8.314\times10^{-3}\ \frac{kJ}{K})(298K)$

3. ___ The value of ΔG° for a reaction conducted at 25 °C is 3.05 kJ/mol The equilibrium constant for a reaction is _____ at this temperature?

$K = 0.292$

4. ___ The standard cell potential (E°_{cell}) of the reaction below is –0.55 V. The value of ΔG° for the reaction is _____ J/mol.

$\Delta G^\circ = -nFE^\circ$

$I_2(s) + 2Br^-(aq) \rightarrow 2I^-(aq) + Br_2(l)$

$1.06\times10^5 J = (-2mol)(\frac{96500C}{mole^-})(-.55\frac{J}{C})$

5. ___ The standard cell potential (E°_{cell}) for the reaction below is +1.10 V. The cell potential for this reaction is _____ V when the concentration of $[Cu^{2+}] = 1.0\times10^{-5}$ M and $[Zn^{2+}] = 3.5$ M.

$Zn(s) + Cu^{2+}(aq) \rightarrow Cu(s) + Zn^{2+}(aq)$

1×10^{-5} 3.5

$E = +1.1 - \frac{.0592}{2}\log\frac{3.5}{}$

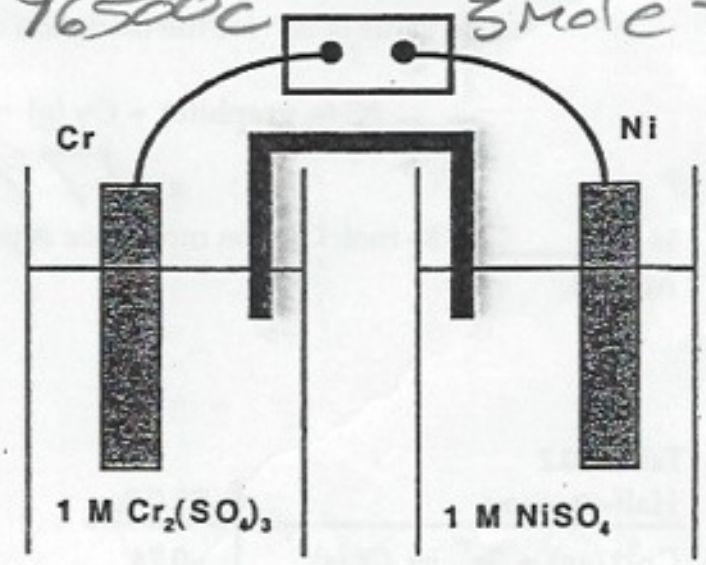
$E = 0.935$

6. ___ The electrolysis of molten $AlCl_3$ for 3.25 hr with an electrical current of 15.0 A produces _____ g of aluminum metal.

$3.25hr \times \frac{3600s}{1hr} \times \frac{15C}{1s} \times \frac{1mole^-}{96500C} \times \frac{1mol\ Al}{3mole^-} \times \frac{27g}{mol}$ 1×10^5

$= 1.64g\ Al$

7. ___ What is the standard cell potential E° for this galvanic cell?



positive voltage

$Cr^{3+} + 3e^- \rightarrow Cr$ $-.44V$

$Ni^{2+} + 2e^- \rightarrow Ni$ $-.25$

$Cr \rightarrow Cr^{3+} + 3e^-$ $+.44V$

$Ni^{2+} + Cr \rightarrow Cr^{3+} + Ni$ $0.19V = E^\circ$

1] $2C + O_2 \rightarrow 2CO$

$\Delta^\circ S_{rxn} = 2(197.9)$

$-[2(5.69) + 205.0]$

$= 179.4\ J/k$

2] $3Sn^{4+} + 2Cr \rightarrow 2Cr^{3+} + 3Sn^{2+}$

$\mathcal{E}^\circ = 0.154 + 0.74$

$= +0.894$

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

$\Delta G^\circ = -2mol \times \frac{96500\,C}{1mole^-} \times \frac{-0.55J}{C}$

$= 1.06 \times 10^5 J$

3] $\Delta G^\circ = -RT \ln K$

$3.05\,kJ = -\left(8.314\times10^{-3}\,\frac{kJ}{K}\right)(298K)\ln k$

$k = 0.292$

5] $\mathcal{E} = \mathcal{E}^\circ - \frac{0.0592}{n}\log Q$

$= 1.1 - \frac{0.0592}{2}\log\frac{3.5}{1\times10^{-5}}$

$\mathcal{E} = 0.935$

6] $3.25\,hr \times \frac{3600\,s}{1\,hr} \times \frac{15\,C}{s} \times \frac{1\,mole^-}{96500\,C} \times \frac{1\,mol\,Al}{3\,mole^-} \times \frac{27\,g}{1\,mol\,Al} = 1.64\,g\,Al$

7] $Ni^{2+} + 2e^- \rightarrow Ni \quad -0.25 \quad \mathcal{E}^\circ_{red}$

$Cr \rightarrow Cr^{3+} + 3e^- \quad +0.44 \quad \mathcal{E}^\circ_{ox}$

$Ni^{2+} + Cr \rightarrow Cr^{3+} + Ni \quad \mathcal{E}^\circ_{cell}\ 0.19\,V$