Some Selected Electrochemistry Practice Questions

1. Balance the following oxidation-reduction equation, then answer the related question.

   $\_\_\ Mn^{2+}(aq) + \_\_\ S_2O_8^{2-}(aq) + \_\_\ H_2O(l) \rightarrow \_\_\ MnO_2(s) + \_\_\ H^+(aq) + \_\_\ SO_4^{2-}(aq)$

   Which of the following is true?

   A. $Mn^{2+}(aq)$ is the oxidizing agent, $S_2O_8^{2-}(aq)$ is reduced, and 2 e- are transferred
   B. $Mn^{2+}(aq)$ is the oxidizing agent, $S_2O_8^{2-}(aq)$ is oxidized, and 3 e- are transferred
   C. $Mn^{2+}(aq)$ is the reducing agent, $S_2O_8^{2-}(aq)$ is oxidized, and 3 e- are transferred
   D. $Mn^{2+}(aq)$ is the reducing agent, $S_2O_8^{2-}(aq)$ is reduced, and 2 e- are transferred

2. Which energy conversion shown below takes place in a galvanic cell?

   a) electrical to chemical
   b) chemical to electrical
   c) mechanical to chemical
   d) chemical to mechanical
   e) mechanical to electrical

3. A voltaic cell prepared using aluminum and nickel has the following cell notation.

   $Al(s) \mid Al^{3+}(aq) \parallel Ni^{2+}(aq) \mid Ni(s)$

   Which of the following represents the correctly balanced equation for the spontaneous reaction in the cell?

   A. $Ni^{2+}(aq) + Al(s) \rightarrow Al^{3+}(aq) + Ni(s)$
   B. $3Ni^{2+}(aq) + 2Al(s) \rightarrow 2Al^{3+}(aq) + 3Ni(s)$
   C. $Ni(s) + Al^{3+}(aq) \rightarrow Ni^{2+}(aq) + Al(s)$
   D. $3Ni(s) + 2Al^{3+}(aq) \rightarrow 3Ni^{2+}(aq) + 2Al(s)$

4. A voltaic cell can be prepared from copper and tin. What is the $E°_{cell}$ for the cell that forms from the following half reactions?

   $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$ $\quad E° = 0.34$ V
   $Sn^{4+}(aq) + 2e^- \rightarrow Sn^{2+}(aq)$ $\quad E° = 0.13$ V

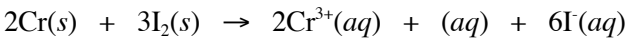
   A. 0.47 V B. 0.21 V C. –0.21 V D. –0.47 V

5. Calculate E°_{cell} and indicate whether the overall reaction shown is spontaneous or nonspontaneous.

$I_2(s) + 2e^- \rightarrow 2I^-(aq)$ $\quad E° = 0.53$ V

$Cr^{3+}(aq) + 3e^- \rightarrow Cr(s)$ $\quad E° = -0.74$ V

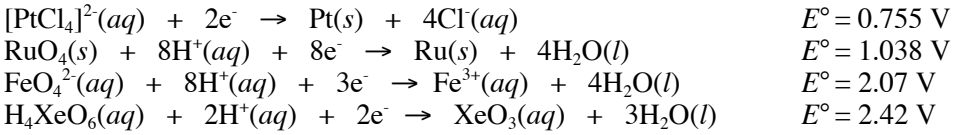
Overall reaction:



$2Cr(s) + 3I_2(s) \rightarrow 2Cr^{3+}(aq) + (aq) + 6I^-(aq)$

A. $E^{\circ}_{cell} = -1.27$ V, spontaneous
B. $E^{\circ}_{cell} = -1.27$ V, nonspontaneous
C. $E^{\circ}_{cell} = 1.27$ V, spontaneous
D. $E^{\circ}_{cell} = 1.27$ V, nonspontaneous

6. Rank the following from the weakest to the strongest oxidizing agents



$[PtCl_4]^{2-}(aq) + 2e^- \rightarrow Pt(s) + 4Cl^-(aq)$ $\quad E° = 0.755$ V

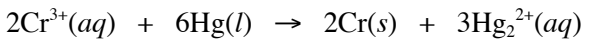
$RuO_4(s) + 8H^+(aq) + 8e^- \rightarrow Ru(s) + 4H_2O(l)$ $\quad E° = 1.038$ V

$FeO_4^{2-}(aq) + 8H^+(aq) + 3e^- \rightarrow Fe^{3+}(aq) + 4H_2O(l)$ $\quad E° = 2.07$ V

$H_4XeO_6(aq) + 2H^+(aq) + 2e^- \rightarrow XeO_3(aq) + 3H_2O(l)$ $\quad E° = 2.42$ V

A. $[PtCl_4]^{2-}(aq) < RuO_4(s) < FeO_4^-(aq) < H_4XeO_6(aq)$
B. $RuO_4(s) < FeO_4^-(aq) < H_4XeO_6(aq) < [PtCl_4]^{2-}(aq)$
C. $FeO_4^-(aq) < H_4XeO_6(aq) < RuO_4(s) < [PtCl_4]^{2-}(aq)$
D. $H_4XeO_6(aq) < FeO_4^-(aq) < RuO_4(s) < [PtCl_4]^{2-}(aq)$

7. The value of E°_{cell} for the reaction



$2Cr^{3+}(aq) + 6Hg(l) \rightarrow 2Cr(s) + 3Hg_2^{2+}(aq)$

is 1.59 V. Calculate ΔG° for the reaction.

A. -921 kJ B. -767 kJ C. -460 kJ D. -307 kJ

8. A concentration cell consists of two Zn/Zn^{2+} electrodes. The electrolyte in compartment A is 0.10 *M* $Zn(NO_3)_2$ and in compartment B is 0.60 *M* $Zn(NO_3)_2$. What is the voltage of the cell at 25°C?

A. 0.010 V
B. 0.020 V
C. 0.023 V
D. 0.046 V

9. A Chem 121 student undertook an experiment to determine when a AA battery would be considered "dead", that is, when it no longer provides power. Which of the following is a correct prediction?

A. $Q < 1$ B. $Q = 1$ C. $Q > 1$ D. $Q = K$

10. Provide the information requested for the following oxidation-reduction equation:

$Cr^{3+}(aq) + NO_3^{1-}(aq) \rightarrow NO(g) + Cr_2O_7^{2-}(aq)$ (E^o_{rxn} = - 0.37V, acidic solution)

Identify the oxidizing agent. _____
Identify the substance that is oxidized. _____
How many electrons (total) are transferred in the reaction? _____
Is the reaction spontaneous? _____
Does chromium(III)nitrate produce a gas when mixed with nitric acid? Circle one. Yes/ No.
Briefly explain why or why not?

11. Which best describes a voltaic cell that is composed of two active metal electrodes?

A. electrons flow from the cathode to the anode, the solid metal anode will loose mass as the voltaic cell produces power, a concentration cell always has electrons flow from the compartment with the lower concentration to the compartment with the higher concentration.
B. electrons flow from the anode to the cathode, the solid metal anode will loose mass as the voltaic cell produces power, a concentration cell always has electrons flow from the compartment with the lower concentration to the compartment with the higher concentration.
C. electrons flow from the anode to the cathode, the solid metal anode will loose mass as the voltaic cell produces power, a concentration cell always has electrons flow from the compartment with the higher concentration to the compartment with the lower concentration.
D. electrons flow from the anode to the cathode, the solid metal cathode will loose mass as the voltaic cell produces power, a concentration cell always has electrons flow from the compartment with the higher concentration to the compartment with the lower concentration.

12. The line notation, $Mg(s) \mid Mg^{2+}(aq) \parallel Fe^{2+}(aq) \mid Fe(s)$, indicates that

A. iron metal is the reducing agent
B. Fe^{2+} ions are oxidized
C. magnesium metal is the reducing agent
D. Mg^{2+} ion is the reducing agent
E. magnesium metal is the cathode

13. For the reaction $2Na(s) + 2H_2O(l) \rightarrow 2Na^+(aq) + 2OH^-(aq) + H_2(g)$, $E° = +1.88$ V. If the standard reduction potential for sodium metal is -2.71 V, calculate the standard reduction potential for water.

A. 0.83 V B. -4.59 V C. -0.83 V D. -0.42 V E. 1.70 V

14. The value of ΔG^o for an oxidaton-reduction reaction, which involves the transfer of 2 electrons, is -48.25 kJ/mol. Calculate the standard cell potential for this reaction.

A. E^o = +0.500 V
B. E^o = -0.500 V
C. E^o = +0.250 V
D. E^o = -0.250 V
E. E^o = +0.125 V
F. E^o = -0.125 V

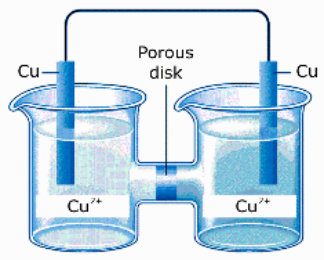
15. If an amount of hydrogen equal to an amount that is used in a fuel cell were burned by ignition in an automobile, the following statement is true.

A. Burning produces less energy than the fuel cell
B. Burning produces more energy than the fuel cell
C. Burning produces the same amount of energy as the fuel cell
D. Cannot determine any difference without knowing the mass of hydrogen used.

16. What amperage is required to plate out 104 g of Cr metal (Atomic Mass = 52.0 g/mol) from a saturated Cr^{3+} solution in a period of 10.0 hr?

A. 965 A B. 16.0 A C. 8.0 A D. 1.60 A E. 96.5 A

17. The concentration cell shown below employs copper metal electrodes in both compartments of the cell. The compartment on the left contains 0.0010 M $Cu^{2+}(aq)$ and the compartment on the right contains 0.10 M $Cu^{2+}(aq)$. Calculate the potential for the cell. Show your calcualtion.



$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$ E^o = +0.34 V
$Cu^{2+}(aq) + 1e^- \rightarrow Cu^{1+}(aq)$ E^o = +0.13 V
$Cu^{1+}(aq) + 1e^- \rightarrow Cu(s)$ E^o = +0.21 V

E^o_{cell} =

What are the $Cu^{2+}(aq)$ concentrations (mol/L) of the compartments when the cell can no longer deliver power?

Left: _____ Right: _____

18. Which of the following is true for the cell shown below?

$$Zn(s) \mid Zn^{2+}(aq) \mid\mid Cr^{3+}(aq) \mid Cr(s)$$

a) The electrons flow from the cathode to the anode.
b) The electrons flow from the zinc to the chromium.
c) The electrons flow from the chromium to the zinc.
d) The chromium is oxidized.
e) The zinc is reduced.

19. The reduction potentials for Au^{3+} and Ni^{2+} are as follows:

$$Au^{3+} + 3e^- \rightarrow Au \qquad E° = +1.50 \text{ V}$$

$$Ni^{2+} + 2e^- \rightarrow Ni \qquad E° = -0.23 \text{ V}$$

Calculate DG° (at 25°C) for the reaction:

$$2Au^{3+} + 3Ni \rightarrow 3Ni^{2+} + 2Au$$

a) -5.00×10^2 kJ
b) $+5.00 \times 10^2$ kJ
c) –2140 kJ
d) $+1.00 \times 10^3$ kJ
e) -1.00×10^3 kJ

20. For a reaction in a voltaic cell both $\Delta H°$ and $\Delta S°$ are positive. Which of the following statements is true?

a) E°cell will increase with an increase in temperature.
b) E°cell will decrease with an increase in temperature.
c) E°cell will not change when the temperature increases.
d) $\Delta G° > 0$ for all temperatures.
e) None of the above statements is true.