Chemistry 106 Fall 2006 Exam 4 Form A

1. If the value of $E_{\text{cell}}$ is 1.50 V, what is the free energy change associated with the oxidation reduction reaction involved? Assume that two (2) electrons are transferred in this process.

A. $2.89 \times 10^5$ J/mol  
B. $-1.45 \times 10^5$ J/mol  
C. $1.45 \times 10^5$ J/mol  
D. $-2.89 \times 10^5$ J/mol  
E. -1.50 J/mol

2. The oxidation number of carbon in carbon dioxide is

A. -4  
B. 2  
C. -2  
D. 4  
E. 1

3. As an electrochemical cell is exhausted (a battery has "run down"), its electromotive force approaches 0 volts. What is the value of the Gibbs free energy change when the cell potential is zero?

A. $\Delta G = -nF$  
B. $\Delta G = \Delta E$  
C. $\Delta G = \infty$  
D. $\Delta G = \Delta H$  
E. $\Delta G = 0$

4. Reduction is

A. gain of electrons.  
B. gain of protons.  
C. loss of protons.  
D. loss of electrons.  
E. none of the above.

5. The following redox reaction occurs.

$$2\text{MnO}_2 + 3\text{ClO}^- + 2\text{OH}^- \rightarrow 2\text{MnO}_4^- + 3\text{Cl}^- + \text{H}_2\text{O}$$

Which of the following is the oxidation half-reaction for this chemical reaction?

A. $\text{ClO}^- + \text{H}_2\text{O} + 2e^- \rightarrow \text{Cl}^- + 2\text{OH}^-$  
B. $\text{MnO}_2 + 4\text{OH}^- \rightarrow \text{MnO}_4^- + 2\text{H}_2\text{O} + 3e^-$  
C. $\text{Cl}^- + 2\text{OH}^- \rightarrow \text{ClO}^- + \text{H}_2\text{O} + 2e^-$  
D. $\text{MnO}_4^- + 2\text{H}_2\text{O} + 3e^- \rightarrow \text{MnO}_2 + 4\text{OH}^-$  
E. $\text{MnO}_2 + 4\text{OH}^- \rightarrow \text{MnO}_4^- + 2\text{H}_2\text{O} + 2e^-$

6. The electrode at which oxidation takes place is

A. the voltode  
B. the oxode.  
C. the cathode.  
D. the reductode.  
E. the anode.

7. In an electrolysis cell, electrons flow from the

A. cathode to the anode.  
B. cathode to the salt bridge.  
C. anode to the salt bridge.  
D. anode to the cathode.  
E. the metal surface to the electrolytes.
8. In a reduction half-reaction,
   A. electrons may be written as reactants or products.
   B. no free electrons are written.
   C. electrons appear on both sides of the reaction.
   D. electrons are written as products.
   E. electrons are written as reactants.

9. If acidic water with sulfur in it runs through iron pipes it can start smelling like rotten eggs because the following reaction which produces H₂S occurs:
   \[ S + Fe \rightarrow Fe^{2+} + H_2S \]

   Balance this redox reaction in acidic solution. Which of the balanced equations below is correct?
   A. \( 2S + Fe + 4H^+ \rightarrow Fe^{2+} + 2H_2S \)
   B. \( S + Fe + 2H^+ \rightarrow Fe^{2+} + H_2S \)
   C. \( S + 2Fe + 2H^+ \rightarrow 2Fe^{2+} + H_2S \)
   D. \( 3S + Fe + 6H^+ \rightarrow Fe^{2+} + 3H_2S \)
   E. \( S + 3Fe + 2H^+ \rightarrow 3Fe^{2+} + H_2S \)

10. The standard hydrogen electrode (SHE) is constructed with
    A. standard hydrogen.
    B. zero volts.
    C. bubbling hydrogen gas (1 atm) and 1M acid in contact with a platinum electrode.
    D. liquid hydrogen in contact with solid hydrogen.
    E. bubbling hydrogen gas (1 atm) and 1 M base in contact with a platinum electrode.

11. An electrochemical cell is constructed with a zinc metal anode in contact with a 0.052 M solution of zinc nitrate and a silver cathode in contact with a 0.0042 M solution of silver(I) nitrate. What is the value of Q to use in the Nernst equation for this cell?
    A. 2900
    B. 12
    C. \( 3.4 \times 10^{-4} \)
    D. \( 8.1 \times 10^{-2} \)
    E. 1.0

12. Formation of gases electrolytically usually does not go at the expected potential because of
    A. current.
    B. pressure.
    C. heating.
    D. overpotential.
    E. voltage.
13. Using the following data, determine the value of \( E_{\text{cell}}^\circ \) for the electrochemical cell constructed using the following reaction, where zinc (Zn) is the anode and iron (Fe) is the cathode:

\[
\text{Zn(s)} + \text{Fe}^{2+}(aq) \rightarrow \text{Zn}^{2+}(aq) + \text{Fe(s)}
\]

<table>
<thead>
<tr>
<th>Half Reaction</th>
<th>( E_{\text{red}}^\circ ) (V vs. SHE)</th>
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<tbody>
<tr>
<td>( \text{Zn}^{2+}(aq) + 2e^- \rightarrow \text{Zn(s)} )</td>
<td>-0.763</td>
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<tr>
<td>( \text{Fe}^{2+}(aq) + 2e^- \rightarrow \text{Fe(s)} )</td>
<td>-0.447</td>
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</table>

A. -0.316 V   B. 0.316 V   C. 1.210 V   D. 0.763 V   E. -1.210 V

14. Using the following data, determine \( K_{\text{eq}} \) for the reaction shown below:

\[
\text{Zn(s)} + \text{Fe}^{2+}(aq) \rightarrow \text{Zn}^{2+}(aq) + \text{Fe(s)}
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A. \( 4.88 \times 10^{10} \)   B. \( 2.05 \times 10^{-11} \)   C. \( 5.88 \times 10^{-11} \)   D. \( 1.70 \times 10^{10} \)   E. \( 8.45 \times 10^{40} \)

15. An empty aluminum soda can weighs about 15 grams. If this can could be used as an anode of a battery, how long could it supply a current of 10 amps?

<table>
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<td>( \text{Al}^{3+} + 3e^- \rightarrow \text{Al} )</td>
<td>-1.662</td>
</tr>
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</table>

A. 45 hours   B. 4.5 hours   C. 2.5 hours   D. 2700 hours   E. 5400 hours
16. Hydrogen fuel cells will be practical as an energy source for automobiles when one is developed
   A. that uses hydrogen in its liquid form.
   B. that runs on a fuel that has a high energy density per unit volume and per unit mass.
   C. never
   D. that does not produce pollutants.
   E. which is small enough to fit in a car.

17. An electrochemical cell was constructed from a standard half-cell of Pb in contact with \( \text{Pb}^{2+} \) and a standard half-cell of Cr in contact with \( \text{Cr}^{3+} \). Given the reduction potentials below, what can be said about the reactions that occur?

<table>
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<tr>
<td>( \text{Pb}^{2+} + 2e^- \rightarrow \text{Pb} )</td>
<td>-0.126</td>
</tr>
<tr>
<td>( \text{Cr}^{3+} + 3e^- \rightarrow \text{Cr} )</td>
<td>-0.41</td>
</tr>
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</table>

A. \( \text{Pb}^{2+} \) is reduced to Pb and Cr is oxidized to \( \text{Cr}^{3+} \)
B. Pb is oxidized to \( \text{Pb}^{2+} \) and \( \text{Cr}^{3+} \) is reduced to Cr
C. \( \text{Pb}^{2+} \) is reduced to Pb and \( \text{Cr}^{3+} \) is reduced to Cr
D. Pb is oxidized to \( \text{Pb}^{2+} \) and Cr is oxidized to \( \text{Cr}^{3+} \)
E. none of the above

18. Applying a current to a rechargeable battery converts it from a(n) ________ cell to a(n) ________ cell.
   A. voltaic; electrolytic
   B. electrolytic; voltaic
   C. dry; wet
   D. Nernst; Leclanch
   E. LeclanchÈ; Leclanch
19. The electrochemical cell pictured below was constructed where the concentrations are 1.00 M.

![Diagram of an electrochemical cell with a voltmeter, Sn, Sn(NO₃)₂, Salt Bridge, Al, and Al(NO₃)₃.]  

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<tr>
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<tbody>
<tr>
<td>Sn&lt;sup&gt;2+&lt;/sup&gt; + 2e⁻ → Sn</td>
<td>-0.136</td>
</tr>
<tr>
<td>Al&lt;sup&gt;3+&lt;/sup&gt; + 3e⁻ → Al</td>
<td>-1.662</td>
</tr>
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</table>

Which of the following statements is true?

A. Al is reduced and the electrons flow from the Al anode to the Sn cathode  
B. Sn is reduced and the electrons flow from the Al cathode to the Sn anode  
C. Al is oxidized and the electrons flow from the Al anode to the Sn cathode  
D. Al is reduced and the electrons flow from the Sn cathode to the Al anode  
E. Sn is reduced and the electrons flow from the Sn anode to the Al cathode

20. An electrochemical cell was constructed from a half-cell of Pb in contact with Pb<sup>2+</sup> and a half-cell of Cr in contact with Cr<sup>3+</sup>. Given the reduction potentials below and that [Cr<sup>3+</sup>]= 0.0540 M and [Pb<sup>2+</sup>]=0.0220 M, calculate the cell potential you would measure at 25 °C.

<table>
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<td>-0.41</td>
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A. 0.28 V  
B. 0.14 V  
C. 0.54 V  
D. 0.39 V  
E. 0.26 V
21. Electrical and thermal conductivity in metals
   A. is explained by matrix isolation techniques.
   B. is explained by a dipolar coupling model.
   C. is a function of the level of contamination by excess electrons.
   D. is explained by band theory.
   E. none of the above

22. Many metal tools are pounded into shape. This makes the tools harder by
   A. packing the atoms closer together.
   B. building up the metal's stamina.
   C. increasing the number of intersecting line defects in the metal crystal.
   D. making it the proper shape.
   E. none of the above.

23. Aluminum is reduced from Al₂O₃ electrolytically instead of using CO as the reducing agent because
   A. CO is toxic.
   B. it takes very little energy to do it electrolytically.
   C. Al is more easily oxidized than CO (Al is the better reducing agent).
   D. CO is more easily oxidized than Al (CO is the better reducing agent).
   E. none of the above.

24. One experimental demonstration of refining copper that is sometimes done in undergraduate chemistry labs is the processing of malachite beads. Malachite is commonly used to produce decorative green beads. The chemical composition of malachite is Cu₂CO₃(OH)₂. What is the percent by mass of Cu in these beads.
   A. 77%
   B. 65%
   C. 29%
   D. 25%
   E. 59%

25. Iron oxides are reduced to iron metal during the refining process at high temperatures by
   A. nitrogen
   B. oxygen gas.
   C. carbon dioxide gas.
   D. carbon gas.
   E. carbon monoxide gas.
26. The reduction of CuO by carbon monoxide to Cu is shown below.

\[ \text{CuO(s)} + \text{CO(g)} \rightarrow \text{Cu(s)} + \text{CO}_2(g) \]

What is the change in oxidation number of copper during this process?

A. −1  
B. −2  
C. +2  
D. 0  
E. +1

27. The kind of alloy that forms from metals with atoms of similar sizes is called a(n)

A. interstitial alloy  
B. substituted alloy  
C. substitutional alloy  
D. inhomogeneous alloy  
E. homogeneous alloy

28. Aluminum is resistant to corrosion because of

A. its positive oxidation potential.  
B. the formation of a protective surface film of aluminum nitride.  
C. the formation of a protective surface film of aluminum oxide.  
D. its low density.  
E. its low reactivity

29. Ceramics are most often produced by heating clays. The properties of these ceramics that make them useful are

A. their low thermal conductivity and high electrical conductivity.  
B. that they absorb water and conduct electricity.  
C. the low temperatures necessary to make them.  
D. their heat resistance, low electrical conductivity and chemically inertness.  
E. their low density and high thermal conductivity.
30. The following monomer was used to form an addition polymer. What is the repeating structure of the polymer?

\[
\text{H}_3\text{C} = \text{C} \quad \text{H}
\]

A. \[
\begin{align*}
\text{H}_3\text{C} & \quad \text{C} \\
\text{C} & \quad \text{H} \\
\text{H} & \quad \text{H} \\
\text{O} & \quad \text{H} \\
\end{align*}
\]

B. \[
\begin{align*}
\text{H}_3\text{C} & \quad \text{C} \\
\text{C} & \quad \text{H} \\
\text{H} & \quad \text{H} \\
\text{O} & \quad \text{H} \\
\text{n} & \\
\end{align*}
\]

C. \[
\begin{align*}
\text{H}_3\text{C} & \quad \text{C} \\
\text{C} & \quad \text{H} \\
\text{H} & \quad \text{H} \\
\text{O} & \quad \text{H} \\
\text{n} & \\
\end{align*}
\]

D. \[
\begin{align*}
\text{H}_3\text{C} & \quad \text{C} \\
\text{C} & \quad \text{H} \\
\text{H} & \quad \text{H} \\
\text{O} & \quad \text{H} \\
\text{n} & \\
\end{align*}
\]

E. None of these is correct.

31. A crystalline fiber

A. has regions where the polymer chains are highly ordered.
B. is made of touching crystals.
C. has long-range three-dimensional structure.
D. does not exist.
E. is very brittle.

32. Polymers that are not cross-linked and do not have interchain hydrogen bonds usually

A. form weak fibers
B. form stiff polymers
C. form strong fibers
D. form liquid polymers
E. form colorless polymers

33. Doping is used in photovoltaic cells to

A. provide the electrons necessary for current to flow in the external circuit.
B. control the color of light that is absorbed.
C. increase the band gap to reduce the absorption of longer wavelength light and provide an emf to push electrons through the circuit.
D. provide a use for silicon that is too impure for use in electronics.
E. provide an emf to push electrons through the circuit and shrink the band gap to increase the absorption of longer wavelength light.

34. The ability of silk to stretch is due to

A. reversible bonding between peptides.
B. coil structure within chains.
C. weak interactions among polymer chains allowing them to slide past each other.
D. hydrogen bonding between chains.
E. stretchable covalent bonds that vary in bond order from 3 to 1 during stretching.
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35. A silicon sample is doped with Ga. It is a
   A. n-type semiconductor with an excess of electrons.
   B. p-type semiconductor with a deficiency of electrons.
   C. p-type semiconductor with an excess of electrons.
   D. n-type semiconductor with a deficiency of electrons.
   E. n-p-type semiconductor which will generate electricity when exposed to light.

36. Which of the following polymers is a condensation polymer?

   A. \[
   \left(\text{CH}_2\text{CH}_2\text{O}\cdot\text{C} \cdot \text{C} \cdot \text{O}\right)_n
   \]
   B. \[
   \left(\text{CH}_3\text{CH}_2\right)_n
   \]
   C. \[
   \left(\text{CH}_2\text{CH}_2\right)_n
   \]
   D. \[
   \left(\text{CH}_3\text{CH}_2\right)_n
   \]
   E. \[
   \left(\text{CH}_2\text{CH}_2\right)_n
   \]
## Answer Key for Test “Exam 4 Form A F06.mte”, 12/6/07

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<th>No. in Q-Bank</th>
<th>No. on Test</th>
<th>Correct Answer</th>
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