

Multiple Choice (5 points each, Put answers in CAPS in the left margin.)

$$R = 8.314 \text{ J/mol}\cdot\text{K} \quad F = 96,500 \text{ C/mol} = 96,500 \text{ J/mol}\cdot\text{V}$$

- Which of the following processes is entropically unfavorable (for the system)?
  - Boiling water
  - Expanding a gas into a vacuum
  - Making a hard-boiled egg
  - Scattering seeds in the wind
  - The burning of coal
- How much  $\text{Mg}(\text{OH})_2$  ( $K_{\text{sp}} = 1.8 \times 10^{-11}$ ) will dissolve in 1.0 L of a 1.0 M HCl solution?
  - 0.5 mol
  - 1.0 mol
  - $4.5 \times 10^{14}$  mol
  - $1.8 \times 10^{15}$  mol
  - $7.4 \times 10^{17}$  mol
- Which of the following is false about the lead storage battery?
  - A lead plate is the cathode.
  - Several cells are hooked together to increase cell potential.
  - They are rechargeable.
  - Sulfuric acid is the solvent in the cell.
  - All are true.
- Which of the following would be an inert electrode?
  - Ag
  - Cu
  - H
  - Pt
  - Zn
- For the ions:  $\text{Ag}^+$ ,  $\text{Al}^{3+}$ ,  $\text{Fe}^{2+}$ ,  $\text{H}^+$ , which is easiest to reduce?
 

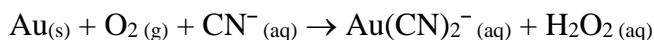
0.80 V	$\text{Ag}^+ + \text{e}^- \rightarrow \text{Ag}$	-0.44 V	$\text{Fe}^{2+} + 2\text{e}^- \rightarrow \text{Fe}$
-1.66 V	$\text{Al}^{3+} + 3\text{e}^- \rightarrow \text{Al}$	0.00 V	$2\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2$

  - $\text{Ag}^+$
  - $\text{Al}^{3+}$
  - $\text{Fe}^{2+}$
  - $\text{H}^+$
  - cannot tell from given information
- For which of the following geometries is a *trans* orientation not possible?
  - Octahedral
  - Square planar
  - Tetrahedral
  - Trigonal bipyramidal
  - All may have a trans arrangement
- On p. 1033 of your book, it says that titanium only forms compounds with oxidation numbers of 3+ and 4+, which is clearly incorrect. Which of the following is the principal oxidation number for titanium that the book missed?
  - 0
  - +1
  - +2
  - +5
  - +6
- Which of the following ions is least likely to form colored coordination complexes?
  - $\text{Au}^+$
  - $\text{Co}^{3+}$
  - $\text{Cr}^{3+}$
  - $\text{Cu}^{2+}$
  - $\text{Ni}^{2+}$

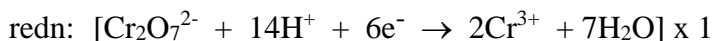
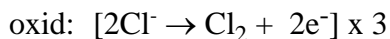
Discussion questions (You must show your work to receive credit!)

- The formation constant of  $[\text{M}(\text{CN})_4]^{4-}$  is  $3.42 \times 10^{14}$ , where M is a generic metal. A 0.150 mole quantity of  $\text{M}(\text{NO}_3)_2$  is added to a liter of 2.31 M NaCN solution. What is the concentration of  $\text{M}^{2+}$  ions at equilibrium? (10 points)

- Balance the following equation in basic solution by any method you choose. Show and label the balanced half-reactions in basic solution. (12 points, partial credit for balancing in acidic solution)



- For the half reactions: (12 points)



Calculate  $E^{\circ}_{\text{cell}}$ ,  $\Delta G^{\circ}$ , and  $K_{\text{eq}}$  for the net reaction at 25 °C.

**Standard Reduction Potentials  
in Aqueous Solutions at 25 °C**

				Reduction Potential (V)	
$\text{F}_2$	+	$2\text{e}^{-}$	$\rightarrow$	$2\text{F}^{-}$	2.87
$\text{H}_2\text{O}_2$	+	$2\text{H}^{+} + 2\text{e}^{-}$	$\rightarrow$	$2\text{H}_2\text{O}$	1.78
$\text{MnO}_4^{-}$	+	$8\text{H}^{+} + 5\text{e}^{-}$	$\rightarrow$	$\text{Mn}^{2+} + 4\text{H}_2\text{O}$	1.51
$\text{Au}^{3+}$	+	$3\text{e}^{-}$	$\rightarrow$	$\text{Au}$	1.50
$\text{Cl}_2$	+	$2\text{e}^{-}$	$\rightarrow$	$2\text{Cl}^{-}$	1.36
$\text{O}_2$	+	$4\text{H}^{+} + 4\text{e}^{-}$	$\rightarrow$	$2\text{H}_2\text{O}$	1.23
$\text{Cr}_2\text{O}_7^{2-}$	+	$14\text{H}^{+} + 6\text{e}^{-}$	$\rightarrow$	$2\text{Cr}^{3+} + 7\text{H}_2\text{O}$	1.23
$\text{Br}_2$	+	$2\text{e}^{-}$	$\rightarrow$	$2\text{Br}^{-}$	1.07
$\text{NO}_3^{-}$	+	$4\text{H}^{+} + 3\text{e}^{-}$	$\rightarrow$	$\text{NO} + 2\text{H}_2\text{O}$	0.96

4. Gallium is produced by the electrolysis of a solution made by dissolving gallium oxide in concentrated  $\text{NaOH}_{(\text{aq})}$ . Calculate the mass of  $\text{Ga}_{(\text{s})}$  that can be deposited from a  $\text{Ga}(\text{III})$  solution using a current of 0.210 A that flows for 20.0 min. ( $1 \text{ C} = 1 \text{ A}\cdot\text{s}$ ) (4 points)

5. Provide three significant ways in which transition metals are different from main group metals. (10 points)

6. Label the following figures by structural isomer type. (12 points)

