WebAssign
Homework 5 (Quiz)

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CHEM 1202, section 05, Spring 2017
Instructor: John Hogan

Current Score : – / 4 **Due :** Tuesday, April 18 2017 11:59 PM CDT

1. –/0.1 pointsBLB11 20.P.019.

Complete and balance the following half-reactions. In each case indicate whether the half-reaction is an oxidation or reduction. (Use the lowest possible coefficients. Include states-of-matter under SATP conditions in your answer.)

(a) $La(s) \rightarrow La(OH)_3(aq)$ (basic solution)

- oxidation
- reduction

(b) $TiO_2(s) \rightarrow Ti^{2+}$ (acidic solution)

- oxidation
- reduction

(c) $H_2SO_3(aq) \rightarrow SO_4^{2-}(aq)$ (acidic solution)

- oxidation
- reduction

(d) $OH^-(aq) \rightarrow O_2(g)$

- oxidation
- reduction

(e) $Sn^{2+}(aq) \rightarrow Sn^{4+}(aq)$

- oxidation
- reduction

2. –/0.1 points

For each of the following reactions, balance the chemical equation, calculate the emf, and calculate $\Delta G°$ at 298 K. (Use the smallest possible coefficients for $H_2O(l)$, $H^+(aq)$, and $HO^-(aq)$. These may be zero.)

(a) Aqueous iodide ion is oxidized to $I_2(s)$ by $Hg_2^{2+}(aq)$.

____ $I^-(aq)$ + ____ $Hg_2^{2+}(aq)$ + ____ H^+ → ____ $I_2(s)$ ____ $Hg(l)$ + ____ $H_2O(l)$

emf

____ V

$\Delta G°$

____ kJ

(b) In acidic solution copper(I) ion is oxidized to copper(II) ion by nitrate ion.

____ $Cu^+(aq)$ + ____ $NO_3^-(aq)$ + ____ $H^+(aq)$ → ____ $Cu^{2+}(aq)$ ____ $NO(g)$ + ____ $H_2O(l)$

emf

____ V

$\Delta G°$

____ kJ

(c) In basic solution $Cr(OH)_3(s)$ is oxidized to $CrO_4^{2-}(aq)$ by $ClO^-(aq)$.

____ $Cr(OH)_3(s)$ + ____ $ClO^-(aq)$ + ____ $OH^-(aq)$ → ____ $CrO_4^{2-}(aq)$ ____ $Cl^-(aq)$ + ____ $H_2O(l)$

emf

____ V

$\Delta G°$

____ kJ

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3. –/0.1 points

A voltaic cell is constructed that uses the following reaction and operates at 298 K.

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

(a) What is the emf of this cell under standard conditions?

____ V

(b) What is the emf of this cell when $[Ni^{2+}]$ = 2.81 *M* and $[Zn^{2+}]$ = 0.180 *M*?

____ V

(c) What is the emf of the cell when $[Ni^{2+}]$ = 0.288 *M* and $[Zn^{2+}]$ = 0.980 *M*?

____ V

4. –/0.1 points

A voltaic cell utilizes the following reaction and operates at 298 K.

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

(a) What is the emf of this cell under standard conditions?

[ ] V

(b) What is the emf of this cell when $[Ce^{4+}]$ = 1.3 *M*, $[Ce^{3+}]$ = 0.013 *M*, and $[Cr^{3+}]$ = 0.014 *M*?

[ ] V

(c) What is the emf of the cell when $[Ce^{4+}]$ = 0.54 *M*, $[Ce^{3+}]$ = 0.88 *M*, and $[Cr^{3+}]$ = 1.1 *M*?

[ ] V

5. –/0.1 points

(a) Select all of the **correct** statements about reaction rates from the choices below.

- [ ] The lower the rate of a reaction the longer it takes to reach completion.
- [ ] The rate of a fast step has more effect on the overall reaction rate than the rate of a slow step.
- [ ] Solid catalysts do not affect reaction rates.
- [ ] Solid catalysts increase reaction rates as their surface areas increase.
- [ ] The fastest step in a reaction is called the rate-determining step.
- [ ] Reaction rates are determined by reactant concentrations, temperatures, and reactant stabilities.
- [ ] Reaction rates can show little change as masses of solid reactants increase.

6. –/0.1 points

A flask is charged with 0.150 mol of A and allowed to react to form B according to the following hypothetical gas-phase reaction.

$$A(g) \rightarrow B(g)$$

The following data are collected.

times (s)	0	40	80	120	160
moles of A	0.150	0.072	0.049	0.031	0.023

(a) Calculate the number of moles of B at each time in the table.

0 s
[ ] mol

40 s
[ ] mol

80 s
[ ] mol

120 s
[ ] mol

160 s
[ ] mol

(b) Calculate the average rate of disappearance of A for each 40 s interval, in units of mol/s.

0 - 40 s
[ ] mol/s

40 - 80 s
[ ] mol/s

80 - 120 s
[ ] mol/s

120 - 160 mol/s

[ ] mol/s

7. –/0.1 points

Consider the following reaction:

$$2\ NO(g) + 2\ H_2(g) \rightarrow N_2(g) + 2\ H_2O(g)$$

(a) The rate law for this reaction is second order in $NO(g)$ and first order in $H_2(g)$. What is the rate law for this reaction?

- Rate = k $[NO(g)]\ [H_2(g)]$
- Rate = k $[NO(g)]^2\ [H_2(g)]$
- Rate = k $[NO(g)]\ [H_2(g)]^2$
- Rate = k $[NO(g)]^2\ [H_2(g)]^2$
- Rate = k $[NO(g)]\ [H_2(g)]^3$
- Rate = k $[NO(g)]^4\ [H_2(g)]$

(b) If the rate constant for this reaction at a certain temperature is 74300, what is the reaction rate when $[NO(g)]$ = 0.0851 *M* and $[H_2(g)]$ = 0.102 *M*?

Rate = ______ *M*/s.

(c) What is the reaction rate when the concentration of $NO(g)$ is doubled, to 0.170 *M* while the concentration of $H_2(g)$ is 0.102 *M*?

Rate = ______ *M*/s

8. –/0.1 points

The reaction 2 $ClO_2(aq)$ + 2 $OH^-(aq)$ → $ClO_3^-(aq)$ + $ClO_3^-(aq)$ + $H_2O(l)$ was studied at a certain temperature with the following results:

Experiment	**[$ClO_2(aq)$] (*M*)**	**[$OH^-(aq)$] (*M*)**	**Rate (*M*/s)**
1	0.0494	0.0494	0.0471
2	0.0494	0.0988	0.0943
3	0.0988	0.0494	0.189
4	0.0988	0.0988	0.377

(a) What is the rate law for this reaction?

- Rate = k [$ClO_2(aq)$] [$OH^-(aq)$]
- Rate = k [$ClO_2(aq)$]^2 [$OH^-(aq)$]
- Rate = k [$ClO_2(aq)$] [$OH^-(aq)$]^2
- Rate = k [$ClO_2(aq)$]^2 [$OH^-(aq)$]^2
- Rate = k [$ClO_2(aq)$] [$OH^-(aq)$]^3
- Rate = k [$ClO_2(aq)$]^4 [$OH^-(aq)$]

(b) What is the value of the rate constant?

(c) What is the reaction rate when the concentration of $ClO_2(aq)$ is 0.0929 *M* and that of $OH^-(aq)$ is 0.101 *M* if the temperature is the same as that used to obtain the data shown above?

M/s

9. –/0.1 points

Select all of the **correct** statements about equilibrium from the choices below.

- ☐ At equilibrium the rates of forward and reverse reactions are equal.
- ☐ As a reaction proceeds forward toward equilibrium the product concentrations rise.
- ☐ As a reaction proceeds forward toward equilibrium the reverse rate constant rises.
- ☐ At equilibrium the rate constants of forward and reverse reactions are equal.
- ☐ At equilibrium all reactions stop.
- ☐ Reactants are transformed into products even at equilibrium.

10.–/0.1 points

Gaseous BrCl is placed in a closed container at 995 ^{o}C, where it partially decomposes to Br_2 and Cl_2:

$$2\ BrCl(g) \rightleftharpoons 1\ Br_2(g) + 1\ Cl_2(g)$$

At equilibrium it is found that p(BrCl) = 0.002040 atm, p(Br_2) = 0.002880 atm, and p(Cl_2) = 0.005670 atm. What is the value of K_P at this temperature?

K_P = ______ .

11.–/0.1 points

At 301 ^{o}C the equilibrium constant for the reaction:

$$2\ HI(g) \rightleftharpoons H_2(g) + I_2(g)$$

is K_P = 2.64e-10. If the initial pressure of HI is 0.00247 atm, what are the equilibrium partial pressures of HI, H_2, and I_2?

p(HI) = ______ .

p(H_2) = ______ .

p(I_2) = ______ .

12.–/0.1 points

Consider the following equilibrium for which ΔH = -19.51:

$$2\ IBr(g) \rightleftharpoons I_2(g) + Br_2(g)$$

How will each of the following changes affect an equilibrium mixture of the 3 gases in this reaction?

(a) $Br_2(g)$ is added to the system.

---Select---

(b) The reaction mixture is cooled.

---Select---

(c) The volume of the reaction vessel is doubled.

---Select---

(d) A catalyst is added to the reaction mixture.

---Select---

(e) The total pressure of the system is increased by adding a noble gas.

---Select---

(f) $I_2(g)$ is removed from the system.

---Select---

13.–/0.1 points

Choose all of the processes from below which describe changes which are **independent** of the path by which the change occurs.

- [ ] the elevation increase experienced by a traveller travelling from Grand Isle, LA to Denver, Colorado
- [ ] the kinetic energy aquired by a bullet as it reaches a specific speed
- [ ] the work accomplished in burning a gallon of gasoline
- [ ] the latitude increase experienced by a traveller travelling from Baton Rouge, LA to Anchorage, Alaska
- [ ] the longitude decrease experienced by a traveller travelling from Baton Rouge, LA to London, England
- [ ] the work generated by a homogeneous gaseous chemical reaction carried out inside of a bomb calorimeter
- [ ] the enthalpy released by the combustion of a gallon of gasoline

14.–/0.1 points

Consider the following reaction which occurs at constant temperature and pressure:

$$C_6H_6(g) \rightleftharpoons 3\ C_2H_2(g) \qquad \Delta H = 597.2\ \text{kJ}$$

Which has the higher enthalpy, $C_6H_6(g)$ or 3 $C_2H_2(g)$?

- $C_6H_6(g)$
- 3 $C_2H_2(g)$

Without referring to tables indicate which of each of the pairs of choices below has the higher enthalpy:

(a)

- 1 mol of $CO_2(s)$ at 50 K
- 1 mol of $CO_2(g)$ at 25 ^oC

(b)

- 1 mol of He(g) at 300 ^oC
- 1 mol of He(g) at 200 ^oC

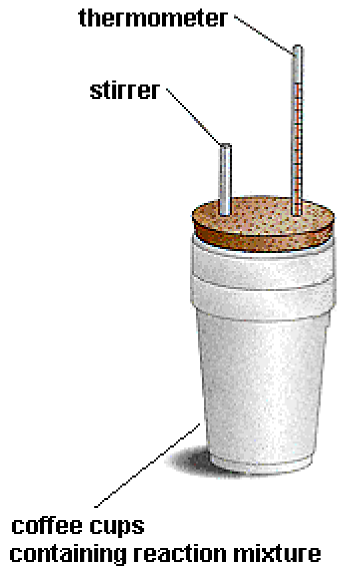
(c)

- 1 mol of $N_2(g)$ at -100 ^oC
- 1 mol of $N_2(l)$ at -100 ^oC

(d)

- 1 mol of CO_2(s) at -78 ^oC
- 1 mol of CO_2(g) at -78 ^oC

15.–/0.1 points



When a 2.74-g sample of solid sodium nitrate dissolves in 41.5 g of water in a coffee-cup calorimeter (see above figure) the temperature falls from 22.00 ^oC to 18.22 ^oC. Calculate ΔH in kJ/mol $NaNO_3$ for the solution process.

$$NaNO_3(s) \rightarrow Na^+(aq) + NO_3^-(aq)$$

The specific heat of water is 4.18 J/g-K.

$\Delta H_{solution}$ = [ ] kJ/mol $NaNO_3$.

16.–/0.1 points

Calculate the standard enthalpy of formation of gaseous hydrogen fluoride (HF) using the following thermochemical information:

$C_2H_4(g) + 6\ F_2(g) \rightleftharpoons 2\ CF_4(g) + 4\ HF(g)$	ΔH = -2486.3 kJ
$CF_4(g) \rightleftharpoons C(s) + 2\ F_2(g)$	ΔH = +680 kJ
$2\ C(s) + 2\ H_2(g) \rightleftharpoons C_2H_4(g)$	ΔH = +52.3 kJ

ΔH = [ ] kJ

17.–/0.1 points

The normal condensation point of 1-propanol gas is 97 ^{o}C.

(a) Is the condensation of 1-propanol gas an endothermic or an exothermic process?

This process is an ---Select--- process.

(b) In what temperature range is the condensation of 1-propanol gas a spontaneous process?

This process is spontaneous ---Select--- 97 ^{o}C.

(c) In what temperature range is this process a nonspontaneous process?

This process is nonspontaneous ---Select--- 97 ^{o}C.

(d) In what temperature range are the two phases involved in the condensation of 1-propanol gas in equilibrium?

These two phases are in equilibrium ---Select--- 97 ^{o}C.

18.–/0.1 points

A certain reaction has ΔH^o = -80.30 kJ and ΔS^o = 0.00 J/K.

(a) Is this reaction exothermic, endothermic or isothermic (neither)?

This reaction is ---Select--- .

(b) Does this reaction lead to a decrease, an increase, or no change in the degree of disorder in the system?

This reaction leads to ---Select--- in the disorder of the system.

(c) Calculate ΔG^o for this reaction at 298 K. If this value is less than 1 kJ/mol then enter 0 in the answer box.

ΔG^o = [ ] kJ.

(d) Is this reaction spontaneous, nonspontaneous, or near equilibrium under standard conditions at 298 K?

This reaction is ---Select--- under these conditions.

19.–/0.1 points

Using values from Appendix C of your textbook, calculate the value of K_{eq} at 298 K for each of the following reactions:

(a) $3\ Fe(s) + 4\ CO_2(g) \rightleftharpoons Fe_3O_4(s) + 4\ CO(g)$

K_{eq} = [ ] .

(b) $3\ NO(g) \rightleftharpoons NO_2(g) + N_2O(g)$

K_{eq} = [ ] .

(c) $2\ C_2H_6(g) + O_2(g) \rightleftharpoons 2\ C_2H_4(g) + 2\ H_2O(g)$

K_{eq} = [ ] .

20.–/0.1 points

For each of the following processes, indicate whether the signs of ΔS and ΔH are expected to be positive, negative, or about zero.

(a) Ice cubes melt at 5 ^{o}C and 1 atm pressure.

For this process ΔS should be ---Select--- ▼ and ΔH should be ---Select--- ▼ .

(b) Liquid water is formed from hydrogen and oxygen gases.

For this process ΔS should be ---Select--- ▼ and ΔH should be ---Select--- ▼ .

(c) A solid sublimes.

For this process ΔS should be ---Select--- ▼ and ΔH should be ---Select--- ▼ .

(d) Pure solid carbon burns in pure oxygen generating carbon dioxide.

For this process ΔS should be ---Select--- ▼ and ΔH should be ---Select--- ▼ .

(e) A nearly ideal gas is allowed to expand and no temperature change occurs.

For this process ΔS should be ---Select--- ▼ and ΔH should be ---Select--- ▼ .

21.–/0.1 points

Complete the following table by calculating the missing entries. In each case indicate whether the solution is acidic or basic.

pH	pOH	$[H^+]$	$[OH^-]$	acidic or basic?
13.32		M	M	acidic / basic
	1.57	M	M	acidic / basic
		5.90×10^{-13} M	M	acidic / basic
		M	5.70×10^{-6} M	acidic / basic

22.–/0.1 points

Calculate the pH of each of the following strong acid solutions.

(a) 0.00108 M HI

pH =

(b) 0.266 g of HIO_4 in 17.0 L of solution

pH =

(c) 13.0 mL of 4.50 M HI diluted to 4.10 L

pH =

(d) a mixture formed by adding 38.0 mL of 0.00351 M HI to 79.0 mL of 0.000840 M HIO_4

pH =

23.–/0.1 points

Determine the pH of each of the following solutions.

(a) 0.495 M boric acid (weak acid with K_a = 5.8e-10).

(b) 0.799 M acetic acid (weak acid with K_a = 1.8e-05).

(c) 0.230 M pyridine (weak base with K_b = 1.7e-09).

24.–/0.1 points

Calculate the percent ionization of acetic acid ($HC_2H_3O_2$) in solutions of each of the following concentrations (K_a = 1.8e-05.)

(a) 0.239 M

[ ] %

(b) 0.313 M

[ ] %

(c) 0.769 M

[ ] %

25.–/0.1 points

(a) Select all of the **correct** statements about the relative acid strengths of pairs of acids from the choices below.

- HCl is a stronger acid than H_2S because Cl is more electronegative than S.
- $HAsO_4^{2-}$ is a stronger acid than $H_2AsO_4^-$ because it has more charge (is more unstable).
- H_3AsO_4 is a stronger acid than $H_2AsO_4^-$ because it has more acidic H atoms.
- $HBrO_2$ is a stronger acid than $HBrO_3$ because it has fewer oxygens surrounding the central Br atom.
- NH_3 is a stronger acid than H_2O because N is larger than O.
- HF is a stronger acid than HCl because F is more electronegative than Cl.

26.–/0.1 points

(a) Calculate the percent ionization of 0.00430 M hypobromous acid (K_a = 2.5e-09).

% ionization = ____ %

(b) Calculate the percent ionization of 0.00430 M hypobromous acid in a solution containing 0.0260 M sodium hypobromite.

% ionization = ____ %

27.–/0.1 points

A buffer solution contains 0.47 mol of hypochlorous acid (HClO) and 0.90 mol of sodium hypochlorite (NaOCl) in 3.00 L.
The K_a of hypochlorous acid (HClO) is K_a = 3e-08.

(a) What is the pH of this buffer?

pH = ____

(b) What is the pH of the buffer after the addition of 0.39 mol of NaOH? (assume no volume change)

pH = ____

(c) What is the pH of the original buffer after the addition of 0.61 mol of HI? (assume no volume change)

pH = ____

28.–/0.1 points

Consider the titration of 80.0 mL of 0.0200 M NH_3 (a weak base; K_b = 1.80e-05) with 0.100 M HIO_4. Calculate the pH after the following volumes of titrant have been added:

(a) 0.0 mL

pH =

(b) 4.0 mL

pH =

(c) 8.0 mL

pH =

(d) 12.0 mL

pH =

(e) 16.0 mL

pH =

(f) 25.6 mL

pH =

29.–/0.1 points

(a) If the molar solubility of $Cd_3(PO_4)_2$ at 25 ^oC is 1.19e-07 mol/L, what is the K_{sp} at this temperature?

K_{sp} = [ ]

(b) It is found that 0.00100 g of $BaCO_3$ dissolves per 100 mL of aqueous solution at 25 ^oC. Calculate the solubility-product constant for $BaCO_3$.

K_{sp} = [ ]

(c) The K_{sp} of $Sc(OH)_3$ at 25 ^oC is 2.22e-31. What is the molar solubility of $Sc(OH)_3$?

solubility = [ ] mol/L

30.–/0.1 points

A solution of Na_2CO_3 is added dropwise to a solution that is 0.0725 M in Nd^{3+} and 3.05e-08 M in Hg_2^{2+}.

The K_{sp} of $Nd_2(CO_3)_3$ is 1.08e-33.
The K_{sp} of Hg_2CO_3 is 3.6e-17.

(a) What concentration of CO_3^{2-} is necessary to begin precipitation? (Neglect volume changes.)

$[CO_3^{2-}]$ = ______ M.

(b) Which cation precipitates first?

- Nd^{3+}
- Hg_2^{2+}

(c) What is the concentration of CO_3^{2-} when the second cation begins to precipitate?

$[CO_3^{2-}]$ = ______ M.

31.–/0.1 points

Choose all of the statements from below which are **true** about oxidation and reduction.

- [ ] Oxidation and reduction are opposite processes with respect to bookkeeping electrons.
- [ ] Oxidation is what happens when an element in a substance gains electrons.
- [ ] Electrons appear on the right side of an oxidation half reaction.
- [ ] An oxidant is an oxidizing agent, which becomes oxidized during the course of a redox reaction.
- [ ] Reduction is what happens when an element in a substance loses electrons.
- [ ] Electrons appear on the left side of a reduction half reaction.
- [ ] A reductant is an reducing agent, which becomes oxidized during the course of a redox reaction.

32.–/0.1 points

Balance the following equations. (Use the lowest possible whole-number coefficients. These may be zero.)

(a) $Cr_2O_7^{2-}(aq) + CH_3OH(aq) \rightleftharpoons HCO_2H(aq) + Cr^{3+}(aq)$

[ ] $Cr_2O_7^{2-}$ + [ ] CH_3OH + [ ] H^+ + [ ] $H_2O \rightleftharpoons$ [ ] Cr^{3+} + [ ] HCO_2H + [ ] H^+ + [ ] H_2O

(b) $Cr_2O_7^{2-}(aq) + I^-(aq) \rightleftharpoons Cr^{3+}(aq) + IO_3^-(aq)$

[ ] $Cr_2O_7^{2-}$ + [ ] I^- + [ ] H^+ + [ ] $H_2O \rightleftharpoons$ [ ] Cr^{3+} + [ ] IO_3^- + [ ] H^+ + [ ] H_2O

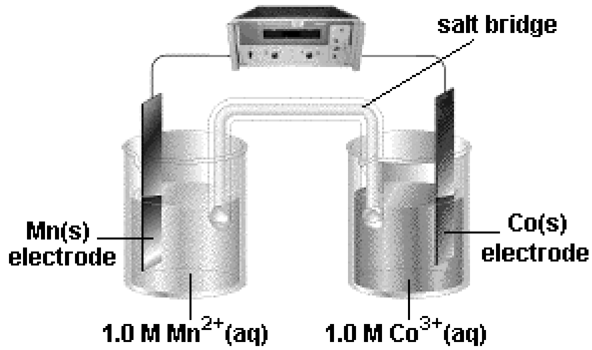
(c) $ClO^-(aq) + Pb(OH)_4^{2-}(aq) \rightleftharpoons Cl^-(aq) + PbO_2(s)$

[ ] ClO^- + [ ] $Pb(OH)_4^{2-}$ + [ ] OH^- + [ ] $H_2O \rightleftharpoons$ [ ] Cl^- + [ ] PbO_2 + [ ] OH^- + [ ] H_2O

(d) $MnO_4^-(aq) + Sn^{2+}(aq) \rightleftharpoons MnO_2(s) + Sn^{4+}(aq)$

[ ] MnO_4^- + [ ] Sn^{2+} + [ ] OH^- + [ ] $H_2O \rightleftharpoons$ [ ] MnO_2 + [ ] Sn^{4+} + [ ] OH^- + [ ] H_2O

33.–/0.1 points



A voltaic cell similar to that shown in the figure above is constructed. The electronic device shown at the top of the figure is a volt meter. One electrode compartment consists of a cobalt strip placed in a 0.5 M $Co_2(SO_4)_3$ solution, and the other has a manganese strip placed in a 1.0 M $Mn(NO_3)_2$ solution. The overall cell reaction is:

$$3\ Mn(s) + 2\ Co^{3+}(aq) \rightleftharpoons 3\ Mn^{2+}(aq) + 2\ Co(s)$$

(a) Fill in the information necessary to complete the half reactions that occur in the two electrode compartments. Use the lowest-possible whole-number coefficients. To input an ion surround the ion's element symbol with square brackets and put the ion's charge to the right like this: Al^{3+} = [Al]3+ (**not** [Al]+3), and Li^{+} = [Li]+ (**not** [Li]1+ or [Li]+1). Do not use brackets for neutral species.

Anode half reaction: ☐ (s) ⇌ ☐ (aq) + ☐ e^-

Cathode half reaction: ☐ (aq) + ☐ e^- ⇌ ☐ (s)

(b) Figure out which electrode is the anode, which is the cathode, the signs on these electrodes, the direction in which the electrons flow through the volt meter, and the direction in which cations and anions migrate through the salt bridge and solutions. Use this work to pick all of the statements from below which are **true**.

☐ Electrons flow from the manganese electrode to the cobalt electrode through the volt meter.

- The cobalt electrode is the anode and the manganese electrode is the cathode.
- Electrons flow from the cobalt electrode to the manganese electrode through the volt meter.
- The manganese electrode is the anode and the cobalt electrode is the cathode.
- Anions migrate from the 1.0 M $Mn(NO_3)_2$ solution through the salt bridge to the 0.5 M $Co_2(SO_4)_3$ solution.
- Cations migrate from the 1.0 M $Mn(NO_3)_2$ solution through the salt bridge to the 0.5 M $Co_2(SO_4)_3$ solution.
- Cations migrate from the 0.5 M $Co_2(SO_4)_3$ solution through the salt bridge to the 1.0 M $Mn(NO_3)_2$ solution.
- Anions migrate from the 0.5 M $Co_2(SO_4)_3$ solution through the salt bridge to the 1.0 M $Mn(NO_3)_2$ solution.
- The manganese electrode is positive and the cobalt electrode is negative.
- The cobalt electrode is positive and the manganese electrode is negative.

34.–/0.1 points

Using data found in Appendix E of your textbook calculate the nonstandard emf for each of the following reactions if the concentration of each of the ions in these reactions is 0.0009 molar and everything else is standard (use 298 K for the temperature, R = 8.314 J/mol-K, and F = 96,485 C/mol):

(a) 2 Cr^{3+}(aq) + 3 Mn(s) --> 2 Cr(s) + 3 Mn^{2+}(aq) E = ____ V

(b) 2 Hg^{2+}(aq) + 2 Cu(s) --> 1 Hg_2^{2+}(aq) + 2 Cu^{+}(aq) E = ____ V

(c) 2 Na^{+}(aq) + 1 Cu(s) --> 2 Na(s) + 1 Cu^{2+}(aq) E = ____ V

(d) 2 Cu^{2+}(aq) + 1 Pb(s) --> 2 Cu^{+}(aq) + 1 Pb^{2+}(aq) E = ____ V

35.–/0.1 points

Choose all of the statements from below which are **true** about strengths of oxidants and reductants.

- [ ] The strengths of oxidants and reductants on opposite sides of redox equations correlate oppositely.
- [ ] For a strong reductant E^o_{red} should be positive.
- [ ] Reducing agents are found on the right-hand side of reduction half reactions.
- [ ] For a strong oxidant E^o_{red} should be negative.
- [ ] Oxidizing agents are found on the right-hand side of reduction half reactions.

36.–/0.1 points

(a) Assuming standard conditions, arrange the following in order of increasing strength as oxidizing agents in strong acid:

Al^{3+}, Ba^{2+}, IO_3^-, Fe^{2+}, $PtCl_4^{2-}$

○ Al^{3+}		○ Al^{3+}		○ Al^{3+}		○ Al^{3+}		○ Al^{3+}
○ Ba^{2+}		○ Ba^{2+}		○ Ba^{2+}		○ Ba^{2+}		○ Ba^{2+}
○ IO_3^-	$<$	○ IO_3^-	$<$	○ IO_3^-	$<$	○ IO_3^-	$<$	○ IO_3^-
○ Fe^{2+}		○ Fe^{2+}		○ Fe^{2+}		○ Fe^{2+}		○ Fe^{2+}
○ $PtCl_4^{2-}$		○ $PtCl_4^{2-}$		○ $PtCl_4^{2-}$		○ $PtCl_4^{2-}$		○ $PtCl_4^{2-}$

(b) Assuming standard conditions, arrange the following in order of increasing strength as reducing agents in strong base:

NO, Co^{2+}, Cr, H_3AsO_3, Br^-

○ NO		○ NO		○ NO		○ NO		○ NO
○ Co^{2+}		○ Co^{2+}		○ Co^{2+}		○ Co^{2+}		○ Co^{2+}
○ Cr	$<$	○ Cr	$<$	○ Cr	$<$	○ Cr	$<$	○ Cr
○ H_3AsO_3		○ H_3AsO_3		○ H_3AsO_3		○ H_3AsO_3		○ H_3AsO_3
○ Br^-		○ Br^-		○ Br^-		○ Br^-		○ Br^-

37.–/0.1 points

(a) Choose all of the statements from below which **correctly** describe issues pertaining to the relationship between the emf of a reaction and its Gibbs free energy change.

- The Gibbs free energy change and emf values of a reaction have opposite algebraic signs (+ vs. -).
- Faraday's constant is used to interconvert coulombs of electrons and moles of electrons.
- Electron stoichiometry need not be used to interconvert a Gibbs free energy change and a reaction emf.
- A Gibbs free energy change involves moles of substances whereas an emf involves coulombs of electrons.
- Electron stoichiometry must be used to interconvert a Gibbs free energy change and a reaction emf.

Calculate the standard Gibbs free energy changes at 25 ^oC for each of the reactions shown below using the E^o values given. Select whether each of these reactions is nonspontaneous, at equilibrium, or spontaneous under standard conditions.

(a) $1\ Cu^{2+}(aq) + 1\ Pb(s) \rightleftharpoons 1\ Cu(s) + 1\ Pb^{2+}(aq)$ E^o = 0.463 V ΔG^o = ______ kJ/mol

- nonspontaneous
- at equilibrium
- spontaneous

(b) $3\ Sn^{4+}(aq) + 2\ Cr(s) \rightleftharpoons 3\ Sn^{2+}(aq) + 2\ Cr^{3+}$ E^o = 0.894 ΔG^o = ______

(aq) V kJ/mol

- nonspontaneous
- at equilibrium
- spontaneous

(c) 1 Mg^{2+}(aq) + 2 Hg(l) ⇌ 1 Mg(s) + 1 Hg_2^{2+}(aq) E^o = -3.159 V ΔG^o = ____ kJ/mol

- nonspontaneous
- at equilibrium
- spontaneous

(d) 1 Cd^{2+}(aq) + 2 Na(s) ⇌ 1 Cd(s) + 2 Na^+(aq) E^o = 2.307 V ΔG^o = ____ kJ/mol

- nonspontaneous
- at equilibrium
- spontaneous

38.–/0.1 points

A electrolytic cell operating under **standard conditions** (1.0 M ion concentrations) utilizes the following reaction:

$$3\ Mn^{2+}(aq) + 2\ Cr(s) \rightleftharpoons 3\ Mn(s) + 2\ Cr^{3+}(aq)$$

What is the effect on the cell emf of each of the following changes?

(a) Water is added to the anode compartment, diluting the solution.

- The positive cell emf rises, becoming more positive.
- The positive cell emf drops closer to zero.
- The negative cell emf rises closer to zero.
- The negative cell emf drops, becoming more negative.
- No change in cell emf occurs.

(b) The size of the manganese electrode is increased.

- The positive cell emf rises, becoming more positive.
- The positive cell emf drops closer to zero.
- The negative cell emf rises closer to zero.
- The negative cell emf drops, becoming more negative.
- No change in cell emf occurs.

(c) A solution of 1.0 M $MnCl_2$ is added to the cathode compartment.

- The positive cell emf rises, becoming more positive.
- The positive cell emf drops closer to zero.
- The negative cell emf rises closer to zero.
- The negative cell emf drops, becoming more negative.

- No change in cell emf occurs.

(d) Some Na_2S is added to the Cr^{3+} compartment, precipitating some Cr^{3+} as chromium sulfide.

- The positive cell emf rises, becoming more positive.
- The positive cell emf drops closer to zero.
- The negative cell emf rises closer to zero.
- The negative cell emf drops, becoming more negative.
- No change in cell emf occurs.

39.–/0.1 points

Metallic magnesium can be made by the electrolysis of molten $MgCl_2$.

(a) What mass of Mg is formed by passing a current of 8.39 A through molten $MgCl_2$ for 2.80 days? The unbalanced chemical reaction representing this electrolysis is shown below.

$$MgCl_2 \rightarrow Mg + Cl_2$$

[ ] g of Mg is formed by this electrolysis.

(b) How many minutes are needed to plate out 6.00 g of Mg from molten $MgCl_2$ using 5.14 A current?

[ ] minutes are needed.

40.–/0.1 points

(a) In the electrolysis of aqueous Na_2O_2, how many liters of $H_2(g)$ (at STP) are generated by a current of 64.5 A for a period of 58.3 min? The unbalanced chemical reaction representing this electrolysis is shown below.

$$Na_2O_2(aq) + H_2O(l) \rightarrow O_2(g) + H_2(g) + NaOH(aq)$$

[ ] liters of $H_2(g)$ is generated by this electrolysis.

(b) How many moles of NaOH(aq) are formed in the solution in this process?

[ ] moles of NaOH(aq) are formed.