

Assignment

1. $\text{H}_2\text{SO}_4(\text{l})$ was completely reacted with some sodium hydroxide in a bomb calorimeter in temperature from 23.2°C to 43.8°C . Assuming only the calorimeter water and completely. (5 marks)

2. You are given the following information equations:

1: $\text{H}_2(\text{g}) + \frac{1}{2} \text{O}_2(\text{g}) \rightarrow \text{H}_2\text{O}(\text{l}) \quad \Delta H_f^\circ = -285.8 \text{ kJ}$

2: $\text{H}_2\text{SO}_4(\text{l}) + \text{H}_2\text{O}(\text{l}) \rightarrow 2 \text{H}_2\text{SO}_4(\text{aq}) \quad \Delta H_f^\circ = -76.6 \text{ kJ}$

3: $\frac{1}{2} \text{H}_2(\text{g}) + \frac{3}{2} \text{O}_2(\text{g}) + \frac{1}{2} \text{H}_2\text{SO}_4(\text{l}) \rightarrow \text{H}_2\text{SO}_4(\text{aq}) \quad \Delta H_f^\circ = -174.1 \text{ kJ}$

Calculate the ΔH_f° for the following reaction: $2 \text{H}_2(\text{g}) + 3 \text{O}_2(\text{g}) \rightarrow 2 \text{H}_2\text{SO}_4(\text{l})$

3. Use the following fusion and fission reactions to answer this question.

$\frac{235}{92}\text{U} + \frac{1}{0}\text{n} \rightarrow \frac{141}{54}\text{Ba} + \frac{92}{36}\text{Kr} + 3 \frac{1}{0}\text{n} + 1.9 \times 10^{10} \text{ kJ}$

$\frac{2}{1}\text{H} + \frac{2}{1}\text{H} \rightarrow \frac{4}{2}\text{He} + \frac{1}{0}\text{n} + 1.70 \times 10^9 \text{ kJ}$

a. Which substance, $\frac{235}{92}\text{U}$ or $\frac{2}{1}\text{H}$, is more efficient by releasing more energy?

4. How much energy is released when 1.000t (1000kg) of sulphur dioxide is (3 marks)

250 kJ

Assignment

Lesson 4 Hand-in Assignment

Energy is Predictable

1. The bombardier beetle uses the following explosive reaction as a defence mechanism

$$\text{C}_6\text{H}_5\text{O}_2\text{H}(\text{aq}) + \text{H}_2\text{O}_2(\text{aq}) \rightarrow \text{C}_6\text{H}_5\text{OH}(\text{aq}) + 2 \text{H}_2\text{O}(\text{l})$$

Calculate the enthalpy change for the above reaction using the following information

1. $\text{C}_6\text{H}_5\text{O}_2\text{H}(\text{aq}) + \text{H}_2(\text{g}) \rightarrow \text{C}_6\text{H}_5\text{OH}(\text{aq}) \quad \Delta H_f^\circ = -177.4 \text{ kJ}$

2. $\frac{1}{2} \text{H}_2\text{O}_2(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{g}) + \frac{1}{2} \text{H}_2\text{O}(\text{l}) \quad \Delta H_f^\circ = -189.8 \text{ kJ}$

3. $\frac{1}{2} \text{O}_2(\text{g}) + \text{H}_2(\text{g}) \rightarrow \text{H}_2\text{O}(\text{l}) \quad \Delta H_f^\circ = -285.8 \text{ kJ}$

2. Sulphur trioxide gas, $\text{SO}_3(\text{g})$ and water can react under appropriate conditions to form sulphuric acid, $\text{H}_2\text{SO}_4(\text{aq})$. This reaction is exothermic.

a. What is the enthalpy change when one mole of the acid forms from $\text{SO}_3(\text{g})$? Show marks

b. Draw a labelled potential energy diagram to represent the change. You do not have to show the actual energy values.

3. Use the given diagram to answer this question.

Calculate the heat of solution for one mole of $\text{NaCl}(\text{s})$. Show your work completely.

Assignment

Calculate the heat of solution for one mole of $\text{NaCl}(\text{s})$. Show your work completely.

4. Aluminum metal reacts with solid copper(II) oxide to form copper metal and aluminum oxide. Write the equation (balanced with whole numbers) representing this reaction. (4 marks)

b. Draw a labelled potential energy diagram for this reaction. You do not have to show the actual energy values.

5. A student is required to determine the molar enthalpy (heat) of combustion of $\text{Ca}(\text{s}) + \frac{1}{2} \text{O}_2(\text{g}) \rightarrow \text{CaO}(\text{s})$, using the following reactions and the data collected.

Reaction 1: $\text{Ca}(\text{s}) + 2 \text{HCl}(\text{aq}) \rightarrow \text{CaCl}_2(\text{aq}) + \text{H}_2(\text{g}) \quad \Delta H_f^\circ = ?$

Reaction 2: $\text{CaO}(\text{s}) + 2 \text{HCl}(\text{aq}) \rightarrow \text{CaCl}_2(\text{aq}) + \text{H}_2\text{O}(\text{l}) \quad \Delta H_f^\circ = ?$

Reaction 3: $\text{H}_2(\text{g}) + \frac{1}{2} \text{O}_2(\text{g}) \rightarrow \text{H}_2\text{O}(\text{l}) \quad \Delta H_f^\circ = -285.8 \text{ kJ}$

Chart 2

Reaction	Mass	Volume of 1.0 mol/L	Initial Temperature	Final Temperature
1	0.50 g $\text{Ca}(\text{s})$	0.10 L	22.3°C	35.9°C
2	1.50 g $\text{CaO}(\text{s})$	0.10 L	22.0°C	29.1°C

Assume the specific heat and density of $\text{HCl}(\text{aq})$ are the same values as for water. Show your complete work in each part of this question.

a. Determine the molar enthalpy ΔH_f° value for calcium solid in Reaction 1. (4 marks)

b. Determine the molar enthalpy ΔH_f° value for calcium oxide solid in Reaction 2. (4 marks)

c. Using Reactions 1, 2, and 3 determine the ΔH_f° value for the combustion of $\text{Ca}(\text{s}) + \frac{1}{2} \text{O}_2(\text{g}) \rightarrow \text{CaO}(\text{s})$.

Hand in your final completed answers and make sure to label it properly

Assignment

Lesson 4 Assignment: Electron Transfer and Reactions

1. Using your periodic table of the elements, indicate whether each of the following is an oxidation or reduction reaction. (4 marks)

a. $\text{Ba}^{2+}(\text{aq}) \rightarrow \text{Ba}(\text{s})$

b. $\text{Co}^{2+}(\text{aq}) \rightarrow \text{Co}(\text{s})$

c. $\text{Se}(\text{s}) \rightarrow \text{Se}^{2-}(\text{aq})$

d. $\text{Ca}(\text{s}) \rightarrow \text{Ca}^{2+}(\text{aq})$

2. A student completed an investigation to identify some unknown metal ions. The student gives results of reactions that occurred between the metal ions and metal ions.

A positive result for a reaction is indicated by the word yes.

	$\text{Mn}^{2+}(\text{aq})$	$\text{Zn}^{2+}(\text{aq})$	$\text{Fe}^{2+}(\text{aq})$	$\text{Fe}^{3+}(\text{aq})$
$\text{Mn}^{2+}(\text{aq})$	yes			
$\text{Zn}^{2+}(\text{aq})$		yes		
$\text{Fe}^{2+}(\text{aq})$			yes	
$\text{Fe}^{3+}(\text{aq})$				yes

a. From the results in the table, create a redox table of reduction half-reactions.

b. Match each letter of the unknown metals with its correct metal symbol. (2 marks)

c. Which chemical species is the titrant? (1 mark)

d. When would the equivalence point of this titration be reached? Be specific. Give the actual mole ratio reaction. (3 marks)

4. Indicate for each of the following equations whether or not they represent a redox reaction. Write redox or not redox.

- $\text{Ca(s)} + \text{F}_2(\text{g}) \rightarrow \text{CaF}_2(\text{s})$
- $\text{MgCl}_2(\text{aq}) + \text{Zn(OH)}_2(\text{aq}) \rightarrow \text{Mg(OH)}_2(\text{aq}) + 2 \text{NaCl}(\text{aq})$
- $\text{CaCO}_3(\text{s}) + 2\text{HCl}(\text{aq}) \rightarrow \text{CaCl}_2(\text{aq}) + \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g})$
- $\text{NaI}(\text{aq}) + 3\text{HOCl}(\text{aq}) \rightarrow \text{NaIO}_3(\text{aq}) + \text{HOCl}(\text{aq})$

5. Indicate the oxidation number of phosphorus in each of the following species. For each case, write P =

- HPO_4^{2-}
- H_2PO_4^-
- P_2O_5
- Na_2HPO_4

6. Write the balanced chemical equation for the redox reaction (5 step method) that might occur when hypochlorite reacts with iodide in acidic solution. In your response, show the half-reactions, the overall equation, and predict the spontaneity of the reaction.

7. Balance the following redox equation by using the oxidation number method or the $1/2$ reaction method.

$$\text{NaIO}_3(\text{aq}) + \text{NaI}(\text{aq}) + \text{HCl}(\text{aq}) \rightarrow \text{NaCl}(\text{aq}) + \text{I}_2(\text{s}) + \text{H}_2\text{O}(\text{l})$$

8. This question is a numerical response question. Record only your final answer to three digits in a box size 3.

Enter the first digit of your answer in the left-hand box and leave any unused boxes blank. If a decimal point is required, enter it in the box between the two digits.

2. You are given the following information equations:

$$\text{E: } \text{H}_2(\text{g}) + \frac{1}{2} \text{O}_2(\text{g}) \rightarrow \text{H}_2\text{O}(\text{l}) \quad \Delta H_f^\circ = -285.8 \text{ kJ}$$

$$\text{F: } \text{H}_2\text{O}_2(\text{g}) + \text{H}_2(\text{g}) \rightarrow 2 \text{H}_2\text{O}(\text{g}) \quad \Delta H_f^\circ = -106.6 \text{ kJ}$$

$$\text{G: } \frac{1}{2} \text{H}_2(\text{g}) + \frac{1}{2} \text{O}_2(\text{g}) + \frac{1}{2} \text{H}_2\text{O}(\text{g}) \rightarrow \text{H}_2\text{O}_2(\text{g}) \quad \Delta H_f^\circ = -136.1 \text{ kJ}$$

Calculate the ΔH_f° for the following reaction: $2 \text{H}_2(\text{g}) + 5 \text{O}_2(\text{g}) \rightarrow 2 \text{H}_2\text{O}_2(\text{g})$. Show how you manipulate your information equations to achieve the target reaction.

3. Use the following fusion and fusion reactions to answer this question.

$$\text{H}_2\text{O}(\text{l}) \rightarrow \text{H}_2\text{O}(\text{g}) \quad \Delta H_{\text{vap}}^\circ = 44.0 \text{ kJ mol}^{-1} \quad \text{H}_2\text{O}(\text{s}) \rightarrow \text{H}_2\text{O}(\text{l}) \quad \Delta H_{\text{fus}}^\circ = 6.0 \text{ kJ mol}^{-1}$$

$$\text{H}_2(\text{g}) + \frac{1}{2} \text{O}_2(\text{g}) \rightarrow \text{H}_2\text{O}(\text{g}) \quad \Delta H_f^\circ = -241.8 \text{ kJ mol}^{-1}$$

a. Which substance, $\text{H}_2\text{O}(\text{l})$ or $\text{H}_2\text{O}(\text{g})$, is more efficient by releasing more energy per gram reacted? Support your answer with calculations. (3 marks)

4. How much energy is released when 1.000t (1000kg) of sulphur trioxide is produced by the following reaction? (3 marks)

$$2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{SO}_3(\text{g}) \quad \Delta H_f^\circ = -192.8 \text{ kJ mol}^{-1}$$

5. In combustion glucose is oxidized by oxygen gas to produce carbon dioxide gas, liquid water, and energy. What is the energy released when 1.000t (1000kg) of glucose is oxidized? (3 marks)

Make sure to copy and paste the question

Lesson 7 Assignment: Redox Applications

Total /34

Review the Evaluation information found in the introductory pages of this lesson.

1. An increase in the oxidation number of a chemical species causes it to be _____ (oxidant/reductant) (1 mark)
2. Explain if it is possible to have a reaction in which oxidation takes place, but reduction does not, and vice versa. (2 marks)
3. A student titrated a sample of an acidified tin(II) chloride solution with potassium permanganate.
 - a. List the oxidizing agent and reducing agent that would participate in the reaction. (2 marks)
 - b. What colour change would signify the endpoint? (1 mark)
 - c. Which chemical species is the titrant? (1 mark)
 - d. When would the equivalence point of this titration be reached? Be specific. Give the actual mole ratio reaction. (3 marks)
4. Indicate for each of the following equations whether or not they represent a redox reaction. Write yes or no. (2 marks)
 - a. $\text{Ca(s)} + \text{F}_2\text{(g)} \rightarrow \text{CaF}_2\text{(s)}$
 - b. $\text{MgCl}_2\text{(aq)} + 2\text{NaOH(aq)} \rightarrow \text{Mg(OH)}_2\text{(s)} + 2\text{NaCl(aq)}$
 - c. $\text{CaCO}_3\text{(s)} + 2\text{HCl(aq)} \rightarrow \text{CaCl}_2\text{(aq)} + \text{H}_2\text{O(l)} + \text{CO}_2\text{(g)}$
 - d. $\text{Na(s)} + 2\text{HCl(aq)} \rightarrow \text{NaCl(aq)} + \text{H}_2\text{(g)}$

Make sure to copy and paste the question

Lesson 8 Assignment: Electron Transfer and Reactions

1. Using your periodic table of the elements, indicate whether each of the following is an oxidizing agent or a reducing agent. (4 marks)
 - a. $\text{Ba}^{2+}\text{(aq)}$
 - b. $\text{Co}^{2+}\text{(aq)}$
 - c. Se(s)
 - d. Cs(s)
2. A student completed an investigation to identify some unknown metal ions. The student gives results of reactions that occurred between the metal ions and metal ions. (4 marks)

A positive result for a reaction is indicated by the word yes.

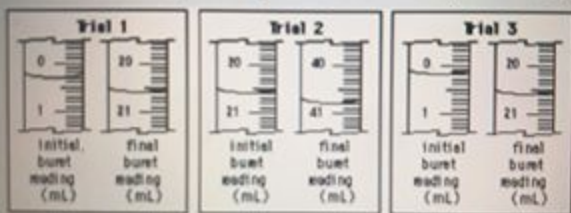
	$\text{Fe}^{2+}\text{(aq)}$	$\text{Fe}^{3+}\text{(aq)}$	$\text{Zn}^{2+}\text{(aq)}$	$\text{Al}^{3+}\text{(aq)}$	$\text{X}^{n+}\text{(aq)}$
$\text{Fe}^{2+}\text{(aq)}$	yes				
$\text{Fe}^{3+}\text{(aq)}$		yes			
$\text{Zn}^{2+}\text{(aq)}$			yes		
$\text{Al}^{3+}\text{(aq)}$				yes	
$\text{X}^{n+}\text{(aq)}$					yes

- a. From the results in the table, create a redox table of reduction half-reactions. (2 marks)
- b. Match each letter of the unknown metals with its correct metal symbol. (2 marks)

- a. Match each letter of the unknown metals with its correct metal symbol. (2 marks)

3. For each of the following, indicate whether the equation represents a redox reaction. (2 marks)
 - a. $2\text{H}_2\text{O(l)} + 2\text{e}^- \rightarrow \text{H}_2\text{(g)} + 2\text{OH}^-\text{(aq)}$
 - b. $\text{S(s)} + 3\text{H}_2\text{O(l)} \rightarrow \text{H}_2\text{SO}_3\text{(aq)} + 4\text{H}^+\text{(aq)} + 4\text{e}^-$
 - c. $\text{As}_2\text{O}_3\text{(s)} + 6\text{H}^+\text{(aq)} + 6\text{e}^- \rightarrow 2\text{As(s)} + 3\text{H}_2\text{O(l)}$
 - d. $\text{Fe}^{3+}\text{(aq)} + 3\text{e}^- \rightarrow \text{Fe(s)}$
 - e. $\text{Pb(s)} + \text{SO}_4^{2-}\text{(aq)} \rightarrow \text{PbSO}_4\text{(s)} + 2\text{e}^-$
4. Explain historically, in one-quarter page or less, what the terms oxidation and reduction mean. (2 marks)
5. Could you successfully store a solution of acidified potassium permanganate in a tin container? Explain. (2 marks)
6. For each of the following situations, write out the most likely redox equation. Follow the instructions. (4 marks)
 - a. Zinc metal is placed into a solution of $\text{AuCl}_3\text{(aq)}$. (3 marks)
 - b. Chlorine gas and hydrogen gas are simultaneously bubbled into a sodium hydroxide solution. (3 marks)
 - c. A perchloric acid solution is slowly added to hydrogen peroxide, H_2O_2 . (3 marks)
 - d. A fountain pen dipped into hydrochloric acid is used to etch a student's name onto a piece of copper. (3 marks)
7. Did the pen in question 6. d. successfully etch the copper foil? Explain. (2 marks)
8. Predict the products of a reaction between a small piece of sodium metal and water. Give support your answer for this question with chemical equations. (5 marks)

10. A chemistry student titrated three 25.0 mL samples of acidified tin(II) nitrate with potassium permanganate. The student recorded the initial and final buret readings (in millilitres) of $\text{KMnO}_4(\text{aq})$ for each of the three trials by reading the buret volumes (in millilitres) of $\text{KMnO}_4(\text{aq})$.



Endpoint colour = pink

Endpoint colour = pink

Endpoint colour = pink

Based on the data given, calculate the concentration of $\text{Sn}^{2+}(\text{aq})$ ions in the

2. Calculate the potential difference of the cells represented by the following information.

a. $\text{Cd}(\text{s}) | \text{Cd}^{2+}(\text{aq}) || \text{Ag}^+(\text{aq}) | \text{Ag}(\text{s})$ (2 marks)

b. $\text{Cu}(\text{s}) | \text{Cu}^{2+}(\text{aq}) || \text{NO}_3^-(\text{aq}) | \text{Na}^+(\text{aq}) | \text{SO}_4^{2-}(\text{aq}) | \text{Pt}(\text{s})$ (2 marks)

3. If $\text{Fe}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Fe}(\text{s})$ was chosen as the standard reference electrode, explain.

4. Rearrange the following sets of half-reactions to create an electrochemical cell. Also calculate the net cell potential. Show all your work clearly. Marks will be given for each part.

a. $\text{Fe}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Fe}(\text{s})$ $E^\circ = -0.04\text{ V}$

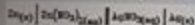
$\text{Fe}(\text{s}) + 2\text{H}^+(\text{aq}) + 2\text{e}^- \rightarrow \text{H}_2(\text{g})$ $E^\circ = +0.03\text{ V}$

b. $\text{NO}_3^-(\text{aq}) + 2\text{H}^+(\text{aq}) + \text{e}^- \rightarrow \text{NO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$ $E^\circ = +0.80\text{ V}$

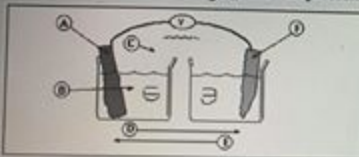
$\text{SO}_4^{2-}(\text{aq}) + 4\text{H}^+(\text{aq}) + 2\text{e}^- \rightarrow \text{H}_2\text{SO}_4(\text{aq}) + \text{H}_2\text{O}(\text{l})$ $E^\circ = +0.17\text{ V}$

total /32

1. The following diagram represents a zinc/silver electrochemical cell with the following notation:



The salt bridge contains $\text{NaNO}_3(\text{aq})$. Use the preceding notation and the diagram to answer the seven parts.



- a. Label the appropriate letters with the following terms (not all letters may be used and the same letter may be used more than once):
- cathode
- direction of anion flow
- location of strongest oxidizing agent (SOA)
- location of strongest reducing agent (SRA)

b. The ions initially present in the solution indicated by point B would be _____.

c. The ions initially present in the salt bridge would be _____ (1 mark).

d. The ions that would migrate through the salt bridge from each solution would be _____.

e. The direction of flow of electrons would be towards the electrode labelled letter _____.

f. Describe what happens to the concentrations of the following ions as the cell operates: $\text{Ag}^+(\text{aq})$, $\text{Zn}^{2+}(\text{aq})$, $\text{Na}^+(\text{aq})$ (4 marks)

5. Use the following information to answer all parts of this question. Show all your work clearly. Marks will be given for both

A voltaic cell was constructed from two half-cells as follows:

One half-cell was made from an unknown metal and a solution containing its ion. The other half-cell was $\text{Cu(s)} | \text{Cu}^{2+}(\text{aq})$. It was observed that the blue colour of the copper half-cell solution had intensified.

a. Determine the reduction potential of the unknown metal. (3 marks)

b. Considering experimental error, use your table of redox half-reactions to predict the most likely identity of the unknown metal. (3 marks)

6. Three standard half-cells are constructed from unknown metals X(s) , Y(s) , and Z(s) and their ions $\text{X}^{2+}(\text{aq})$, $\text{Y}^{2+}(\text{aq})$, and $\text{Z}^{2+}(\text{aq})$. When constructing various electrochemical cells, the following information is obtained from the different combinations:

• An $\text{X(s)} | \text{X}^{2+}(\text{aq})$ standard half-cell attracts anions when the other standard

half-cell is $\text{Y(s)} | \text{Y}^{2+}(\text{aq})$. The $\Delta E^\circ = 0.30 \text{ V}$.

• In a standard cell between X(s) and Z(s) , the cathode is X(s) and the $E^\circ_{\text{cell}} = 0.14 \text{ V}$.

Determine the cathode, anode, and net cell potential of a standard cell between $\text{Y(s)} | \text{Y}^{2+}(\text{aq})$ and $\text{Z(s)} | \text{Z}^{2+}(\text{aq})$.

Show all your work clearly. Marks will be given for both your work and your answer. (4 marks)

2. A student wanted to determine the purity of a sample piece of iron. The student constructed a cell using some of this material and recorded

- the impure iron sample • a piece of zinc
- a piece of copper • $1.0 \text{ mol/L Fe}(\text{NO}_3)_2(\text{aq})$
- $1.0 \text{ mol/L} \cdot 1.0 \text{ mol/L Cu}(\text{NO}_3)_2(\text{aq})$
- (2) 250 mL beakers • steel wool
- a porous cup • wire
- an electronic balance • voltmeter

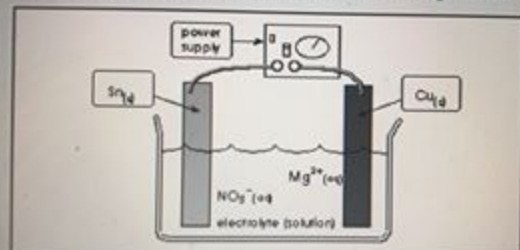
The student constructed a cell using some of this material and recorded

	Electrode A	Electrode B
Initial mass (g ± 0.001 g)	5.884	6.917
Final mass (g ± 0.001 g)	6.213	6.587
Mass change (g ± 0.002 g)	0.329	0.330

(Assume that the impurities are unreactive.)

a. Write the anode equation, cathode equation, and net ionic equation for the cell. (3 marks)

5. Use the following diagram to answer this question.



a. Predict the strongest oxidizing and reducing agents in the given cell. or from Cu(s) to Sn(s) Explain your rationale. (2 marks)

b. Calculate the time in hours needed to make the anode change in mass by 1.00 g. Marks will be given for both your work and your answer. (3 marks)

Lesson 10 Assignment: Systems in Balance

Review the Evaluation Information found in the introduction of this

Part A: Multiple Choice

Read each question carefully and decide which of the choices best answer the question. Place your answer (A, B, C, or D) beside each number. (Total = 5 marks)

Use the following information to answer questions 1-3.

I. $\text{SO}_2(\text{g}) + \text{Cl}_2(\text{g}) \rightleftharpoons \text{SO}_2\text{Cl}_2(\text{g}) + \text{energy}$

II. $\text{CH}_4(\text{g}) + \text{H}_2\text{O}(\text{g}) + \text{energy} \rightleftharpoons \text{CO}(\text{g}) + 3 \text{H}_2(\text{g})$

III. $2 \text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2 \text{SO}_3(\text{g}) + \text{energy}$

IV. $3 \text{O}_2(\text{g}) + \text{energy} \rightleftharpoons 2 \text{O}_3(\text{g})$

V. $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) + \text{energy} \rightleftharpoons 2 \text{HI}(\text{g})$

1. Which of the system(s) would shift towards the products with the addition of energy?

A. I, III
B. II

Part B: Written Response

For full marks, your answers must show all pertinent explanations, calculations, and chemical equations.

6. The following is a graphical representation of this equilibrium:

$$2 \text{CO}(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2 \text{CO}_2(\text{g}) + \text{energy}$$

Describe what stress must have occurred to create each situation shown on the graph. The stresses are marked by a., b., c., and d. (4 marks)

Describe each situation shown on the graph. The stresses are marked by a., b., c., and d. (4 marks)

Phosphorus trichloride will decompose into, and form an equilibrium system with, phosphorus trichloride and chlorine gas.

$$\text{PCl}_5(\text{g}) \rightleftharpoons \text{PCl}_3(\text{g}) + \text{Cl}_2(\text{g})$$

At 25°C if a set of equilibrium concentrations were found to be $[\text{PCl}_5] = 0.80 \text{ mol/L}$ and $[\text{PCl}_3] = 0.80 \text{ mol/L}$, and $[\text{Cl}_2] = 0.80 \text{ mol/L}$, the system is at equilibrium. If a small amount of $\text{N}_2\text{O}_4(\text{g})$ is added to the system, the brown color characteristic of $\text{NO}_2(\text{g})$ appears and the color steadily intensifies. Is this system at equilibrium? Explain your reasoning. (3 marks)

PC.

$$\text{N}_2\text{O}_4(\text{g}) + 3 \text{H}_2(\text{g}) \rightleftharpoons 2 \text{NH}_3(\text{g}) \quad \Delta H = -92 \text{ kJ}$$

2 (Reaction 1). When this same reaction was performed at a different temperature, the equilibrium constant was different. Was the temperature higher or lower than 1000°C? Explain your reasoning. (3 marks)

(Reaction 2).

Was the temperature in Reaction 2 higher or lower than 1000°C? Explain.

10.

EQUILIBRIUM CONDITIONS FOR $\text{NO} - \text{O}_2 - \text{NO}_2$ SYSTEM AT 222°C

System	$[\text{NO}]$ mol/L	$[\text{O}_2]$ mol/L	$[\text{NO}_2]$ mol/L
1	2.50×10^{-3}	5.56×10^{-4}	1.50×10^{-1}
2	1.50×10^{-3}	— i —	2.00×10^{-1}
3	— ii —	3.00×10^{-2}	7.50×10^{-2}
4	2.00×10^{-4}	1.00×10^{-3}	— iii —

a. Write the equilibrium law expression and use the preceding table to calculate K_c .

b. Calculate the values necessary to complete the rest of the table (i, ii, and iii). Show all your work. (3 marks)

10. Construct a table similar to the one that follows and fill in the blanks.

$[\text{H}^+(\text{aq})]$	$[\text{OH}^-(\text{aq})]$	pH	pOH	Acid, Base, or Neutral
2.5×10^{-5}				
	8×10^{-11}			
		11.3		
			3.46	
				neutral

(10 marks)

11. Your solubility table will tell you that CH_3COO^- (aq) ions are insoluble with Ag^+ .

- Make a prediction about the effect of Ag^+ (aq) ions on the pH of acetic acid.
- Predict what the pH of the acetic acid solution should be if its concentration is 0.1 M.
- Write an experimental design for an investigation to test what effect the addition of Ag^+ has on the pH of acetic acid.
- Write a procedure for the investigation. (3 marks)

1	orange/y	yellow
2	reddish orange	yellow
3	bromocresol green	blue
4	reddish red	orange
5	bromothymol blue	yellow

The pH range of the solution is

A. 3.0 to 4.0
B. 4.0 to 5.0
C. 5.0 to 6.0
D. 6.0 to 7.0

Answer

Part B: Written Response

For full marks, your answers must show all pertinent explanations, calculations, and formulas.

12. Write the Brønsted-Lowry net ionic equation for each of the following reactions. Predict:

a. A solution of lithium acetate is added to a solution of ammonium bromide. (2 marks)

b. A student mixes a calcium hydrogen phosphate solution with ethanoic acid. (2 marks)

c. A solution of hydrobromic acid reacts with an ammonia solution. (2 marks)

13. Analyse the following data. List the acids in order of increasing strength (weakest to strongest).

$\text{HA}_1(\text{aq}) + \text{B}^-(\text{aq}) \rightleftharpoons \text{HB}(\text{aq}) + \text{A}^-(\text{aq})$ (products favoured)

$\text{HC}_1(\text{aq}) + \text{A}^-(\text{aq}) \rightleftharpoons \text{HA}_1(\text{aq}) + \text{C}^-(\text{aq})$ (products favoured)

$\text{HD}_1(\text{aq}) + \text{C}^-(\text{aq}) \rightleftharpoons \text{HC}_1(\text{aq}) + \text{D}^-(\text{aq})$ (reactants favoured)

$\text{HE}_1(\text{aq}) + \text{B}^-(\text{aq}) \rightleftharpoons \text{HB}(\text{aq}) + \text{E}^-(\text{aq})$ (reactants favoured)

b. reacts with $\text{H}_2\text{O}(\text{l})$

Answer

3. $\text{HA}_1(\text{aq}) + \text{B}^-(\text{aq}) \rightleftharpoons \text{HB}(\text{aq}) + \text{A}^-(\text{aq})$
 $\text{HC}_1(\text{aq}) + \text{A}^-(\text{aq}) \rightleftharpoons \text{HA}_1(\text{aq}) + \text{C}^-(\text{aq})$
 Increasing strength of acid

Using the given information, the strongest conjugate base is

A. $\text{C}^-(\text{aq})$
B. $\text{A}^-(\text{aq})$
C. $\text{B}^-(\text{aq})$
D. $\text{D}^-(\text{aq})$

Answer

4. The reaction equilibrium that favours products is

A. $\text{H}_2\text{CO}_3(\text{aq}) + \text{F}^-(\text{aq}) \rightleftharpoons \text{HF}(\text{aq}) + \text{HCO}_3^-(\text{aq})$
 B. $\text{HS}^-(\text{aq}) + \text{Cl}^-(\text{aq}) \rightleftharpoons \text{HCl}(\text{aq}) + \text{S}^{2-}(\text{aq})$
 C. $\text{HSO}_4^-(\text{aq}) + \text{NO}_2^-(\text{aq}) \rightleftharpoons \text{HNO}_2(\text{aq}) + \text{SO}_4^{2-}(\text{aq})$
 D. $\text{NH}_4^+(\text{aq}) + \text{CN}^-(\text{aq}) \rightleftharpoons \text{NH}_3(\text{aq}) + \text{HCN}(\text{aq})$

Answer

5. The net ionic equation for the reaction between solutions of $\text{NaHSO}_4(\text{aq})$ and $\text{NaHCO}_3(\text{aq})$ is

A. $\text{HSO}_4^-(\text{aq}) + \text{CO}_3^{2-}(\text{aq}) \rightleftharpoons \text{HCO}_3^-(\text{aq}) + \text{SO}_4^{2-}(\text{aq})$
 B. $\text{HSO}_4^-(\text{aq}) + \text{HCO}_3^-(\text{aq}) \rightleftharpoons \text{CO}_3^{2-}(\text{aq}) + \text{H}_2\text{SO}_4(\text{aq})$
 C. $\text{HSO}_4^-(\text{aq}) + \text{HCO}_3^-(\text{aq}) \rightleftharpoons \text{H}_2\text{CO}_3(\text{aq}) + \text{SO}_4^{2-}(\text{aq})$
 D. $\text{HSO}_4^-(\text{aq}) + \text{HCO}_3^-(\text{aq}) \rightleftharpoons \text{HSO}_3^-(\text{aq}) + \text{HCO}_2^-(\text{aq})$

Answer

6. The reaction in which the state of equilibrium favours the reactants is one that is

A. $\text{HF}(\text{aq}) + \text{HSO}_4^-(\text{aq}) \rightleftharpoons \text{H}_2\text{SO}_4(\text{aq}) + \text{F}^-(\text{aq})$
 B. $\text{H}_2\text{PO}_4^-(\text{aq}) + \text{HS}^-(\text{aq}) \rightleftharpoons \text{H}_2\text{PO}_3^-(\text{aq}) + \text{HSO}_4^-(\text{aq})$

6. The reaction in which the state of equilibrium favours the reactants is one that is

A. $\text{H}_2\text{O}(\text{l}) + \text{HCO}_3^-(\text{aq}) \rightleftharpoons \text{H}_2\text{CO}_3(\text{aq}) + \text{OH}^-(\text{aq})$
 B. $\text{H}_2\text{PO}_4^-(\text{aq}) + \text{HS}^-(\text{aq}) \rightleftharpoons \text{H}_2\text{PO}_3^-(\text{aq}) + \text{HSO}_4^-(\text{aq})$
 C. $\text{H}_2\text{SO}_4(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) \rightleftharpoons \text{HSO}_4^-(\text{aq}) + \text{HSO}_3^-(\text{aq})$
 D. $\text{CH}_3\text{COOH}(\text{aq}) + \text{HCO}_3^-(\text{aq}) \rightleftharpoons \text{H}_2\text{CO}_3(\text{aq}) + \text{CH}_3\text{COO}^-(\text{aq})$

Answer

7. In the reaction $\text{HSO}_4^-(\text{aq}) + \text{HS}^-(\text{aq}) \rightleftharpoons \text{NH}_4^+(\text{aq}) + \text{SO}_4^{2-}(\text{aq})$, one conjugate pair is

A. $\text{NH}_4^+(\text{aq})$ and $\text{HSO}_4^-(\text{aq})$
 B. $\text{SO}_4^{2-}(\text{aq})$ and $\text{NH}_4^+(\text{aq})$
 C. $\text{NH}_4^+(\text{aq})$ and $\text{SO}_4^{2-}(\text{aq})$
 D. $\text{NH}_4^+(\text{aq})$ and $\text{NH}_3(\text{aq})$

Answer

8. A weak solution extracted from red cabbage reacts with water according to the following equation: $\text{HR}_{\text{c}}(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{H}_3\text{O}^+(\text{aq}) + \text{R}_{\text{c}}^-(\text{aq})$. In acidic solutions this substance is red; in basic solutions, it is yellow. A correct inference is that the red substance is

A. $\text{H}_3\text{O}^+(\text{aq})$
 B. $\text{HR}_{\text{c}}(\text{aq})$
 C. $\text{R}_{\text{c}}^-(\text{aq})$
 D. $\text{OH}^-(\text{aq})$

Answer

9. In which of the following solutions would phenolphthalein be red?

A. $[\text{OH}^-(\text{aq})] = 10^{-9} \text{ mol/L}$
 B. $[\text{H}_3\text{O}^+(\text{aq})] = 10^{-4} \text{ mol/L}$
 C. $[\text{H}_3\text{O}^+(\text{aq})] = 10^{-4} \text{ mol/L}$
 D. $[\text{OH}^-(\text{aq})] = 10^{-10} \text{ mol/L}$

Answer

10. A solution of sodium acetate, $\text{NaCH}_3\text{COO}(\text{aq})$, turns red litmus paper blue because

A. acetate solutions are acidic
 B. solid sodium acetate contains $\text{OH}^-(\text{aq})$
 C. water molecules donate $\text{H}^+(\text{aq})$ to $\text{CH}_3\text{COO}^-(\text{aq})$
 D. water molecules donate $\text{OH}^-(\text{aq})$ to $\text{CH}_3\text{COO}^-(\text{aq})$

reaction would be incorrect?

A. There would be one sharp change in pH during the titration.
 B. The pH of the solution would increase as the titration progressed.
 C. Methyl orange could be used to detect the point at which the reaction was complete.
 D. The pH of the hydrobromic acid solution would change slowly at the beginning of the titration.

Consider the following information when answering question 2.

A sodium carbonate solution was titrated with hydrochloric acid. The following pH curve was

2. Bromocresol green indicator would indicate an endpoint at

A. I
B. II
C. III
D. IV

3. Which one of the following species would be considered polyprotic?

A. $\text{C}_2\text{H}_3\text{O}_2(\text{g})$
 B. $\text{CH}_3\text{COOH}(\text{l})$
 C. $\text{HOOCCH}_2\text{COOH}(\text{l})$
 D. $\text{HCl}(\text{g})$

4. What volume of $2.50 \times 10^{-2} \text{ mol/L}$ $\text{HF}(\text{aq})$ would be required to react completely with 0.950 g of

A. 11.1 mL
 B. 22.2 mL
 C. 22.2 mL
 D. 44.4 mL

5. A student used 40.0 mL of 0.10 mol/L $\text{HBr}(\text{aq})$ to neutralise 20.0 mL of a 0.10 mol/L basic solution.

A. KOH
 B. $\text{NaOCCOCH}_3(\text{aq})$
 C. NaOH

14. If the $[\text{OH}^-]$ of a solution changes from 10^{-4} mol/L to 10^{-5} mol/L , what will be the pH?

15. Match each of the statements in Column 1 to the appropriate statement from Column 2.

Column 1	Column 2
a. conjugate pair	i. indigo carmine
b. indicator is red at pH = 11	ii. solution is yellow
c. amphiprotic substance	iii. OH^- (aq)
d. strong attraction for protons	iv. methyl violet
e. acid above base $\rightarrow$ 50% reaction	v. H_2SO_4 (aq) $\rightarrow$ SO_4^{2-} (aq)
f. bromothymol blue in 0.10 mol/L HCl (aq) solution	vi. HSO_4^- (aq)
g. is green during colour change range	vii. phenolphthalein
h. is the strongest acid on the indicator chart	viii. Brønsted-Lowry acid
i. is limited to aqueous solutions	ix. a useful generalization
	x. Brønsted-Lowry theory
	xi. solution is blue
	xii. H_3PO_4 (aq) $\rightarrow$ H_2PO_4^- (aq)
	xiii. Arrhenius theory

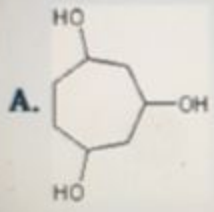
a. _____
 b. _____
 c. _____
 d. _____
 e. _____
 f. _____
 g. _____
 h. _____
 i. _____

L2 Hand in Assignment

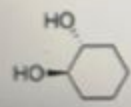
This is your hand in assignment for the week.

Part I
 Name the following compounds

A.



B.

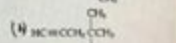
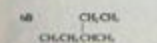
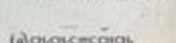
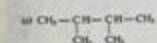
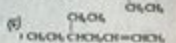
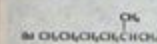
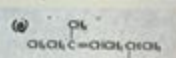


Part II
 Name the following compounds

1 Hand in Assignment

Part 1

W O L O C O L O C O L O C O L O

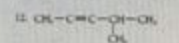
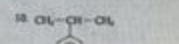
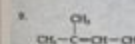
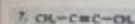


- a)
- b)
- c)
- d)
- e)
- f)
- g)
- h)

Part 2

Part III

Name the following compounds



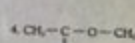
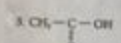
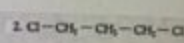
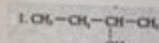
Part IV

For each of the following questions, draw a balanced, structural

- 1) 2-methyl-1-pentene + hydrogen $\rightarrow$ 2-methylpentane
- 2) butane $\rightarrow$ 1-butene + 2-butene + hydrogen (note: balance equation)
- 3) Acetylene + oxygen $\rightarrow$ (first finish equation by predicting the products)

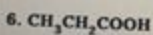
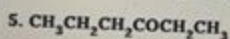
Part I

Part 1
Name the following compounds



Part II

Name the following compounds and give the group number.



Part III

Do the following from your text:

page 438---question 2a,b,c