

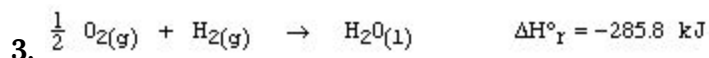
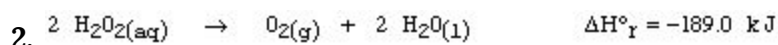
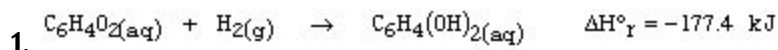
Lesson 4 Hand-in Assignment:

Energy Is Predictable

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



Calculate the enthalpy change for the above reaction using the following information equations. Show your complete work. (4 marks)

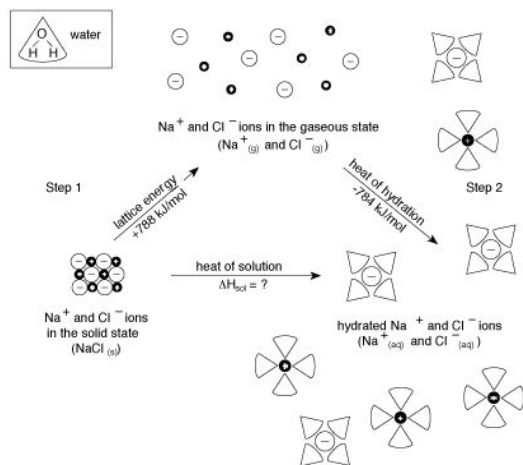


2. Sulphur trioxide gas, $\text{SO}_3(\text{g})$ and water can react under appropriate conditions to form sulphuric acid in the atmosphere. The reaction is responsible for much of the acid rain that is affecting the environment.

a. What is the enthalpy change when one mole of the acid forms from $\text{SO}_3(\text{g})$? Show your complete calculations. Assume that the water is liquid and the sulphuric acid is liquid. (4 marks)

b. Draw a labelled potential energy diagram to represent the change. You do not have to use graph paper. Your graph axes should be between 5 cm and 7 cm long. (2 marks)

3. Use the given diagram to answer this question.



Calculate the heat of solution for one mole of NaCl(s). Show your work completely. (2 marks)

4. Aluminum metal reacts with solid copper(II) oxide to form copper metal and solid aluminum oxide.

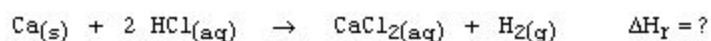
a. Write the equation (balanced with whole numbers) representing this reaction and show all necessary calculations to find the enthalpy(Hr)change for two moles of aluminum reacting. (4 marks)

b. Draw a labelled potential energy diagram for this reaction. You do not have to use graph paper. Your graph axes should be between 5 cm and 7 cm long. (2 marks)

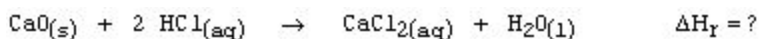
5. A student is required to determine the molar enthalpy (heat) of combustion for calcium in the reaction

$\text{Ca(s)} + \frac{1}{2} \text{O}_{2(\text{g})} \rightarrow \text{CaO(s)}$, using the following reactions and the data collected.

Reaction 1



Reaction 2



Reaction 3

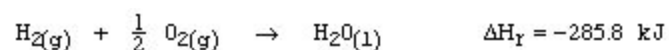


Chart 2

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

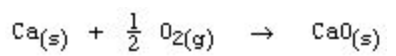
Assume the specific heat and density of HCl(aq) are the same values as for water.

Show your complete work in each part of this question.

a. Determine the molar enthalpy H_r value for calcium solid in Reaction 1 . (4 marks)(
Hint---Use the information in the second chart)

b. Determine the molar enthalpy H_r value for calcium oxide solid in Reaction 2 . (4
marks)(Hint---Use the information in the second chart)

c. Using Reactions 1 , 2 , and 3 determine the ΔH_r value for the combustion of calcium
metal. (4 marks) (Hint--- Use Hess' Law -- and your answers from a and b. to solve



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

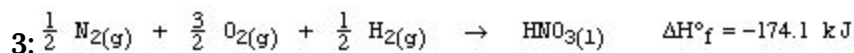
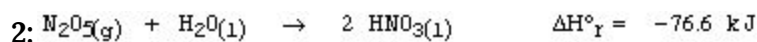
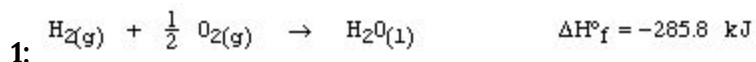
Lesson 5 Assignment: Energy Alternatives and Society

Total /37

1. A student wished to determine the molar heat (enthalpy) of formation for sodium sulphide, $\text{Na}_2\text{S(s)}$. The student designed an investigation where 11.4 g of hydrogen sulphide gas, $\text{H}_2\text{S(g)}$, was completely reacted with solid sodium hydroxide in a bomb calorimeter producing solid sodium sulphide and liquid water. The 250 mL of water in the calorimeter changed in temperature from 23.2°C to 43.8°C. Assuming only the calorimeter water gained the heat energy, calculate the molar heat of formation for sodium sulphide. Show your work neatly and completely.

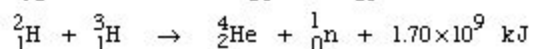
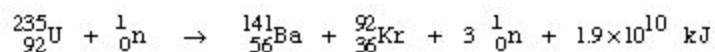
(5 marks)

2. You are given the following information equations:



Calculate the ΔH°_r for the following reaction: $2 \text{N}_2(\text{g}) + 5 \text{O}_2(\text{g}) \rightarrow 2 \text{N}_2\text{O}_5(\text{g})$ Show how you manipulate your information equations to achieve your answer. (4 marks)

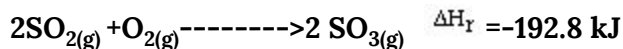
3. Use the following fission and fusion reactions to answer this question.



a. Which substance, $^{235}_{92}\text{U}$ or ^2_1H , 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)



5. In respiration, glucose is oxidized by oxygen gas to produce carbon dioxide gas, liquid water, and energy. What is the energy released when 18.0 g of glucose is consumed?

(5 marks)

6. Pick any one of the alternate energies covered in this lesson and provide a risk/benefit assessment on the technology. Provide a minimum of 5 risk and 5 benefits

for it.(You may have to use the internet and other sources) Give our opinion and explain using 3 different perspectives (ie. social, economical, ecological, political etc.) why or why not it would be a viable alternative energy source for Canada. (8 marks)

7.a) Explain the difference between a chemical catalyst and a biological catalyst. (2 marks)

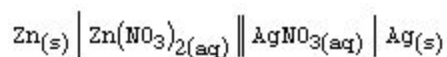
b) Explain why, in terms of energy, why $\text{H}_2\text{O}(\text{l})$ is always produced in oxidation reactions, using enzymes, in the body. (3 marks)

Hand in your answers to the hand-in folder --make sure to label it properly.

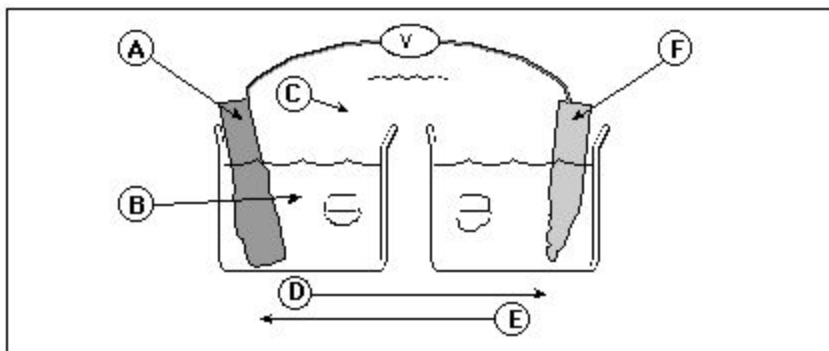
Lesson 8 Assignment: Chemical Energy at Work

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 of this question.



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) • salt bridge
- location of strongest reducing agent (SRA)

b. The ions initially present in the solution indicated by point B would be _____ . (1 mark)

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 _____ . (2 marks)

e. The direction of flow of electrons would be towards the electrode labelled letter _____ . (1 mark)

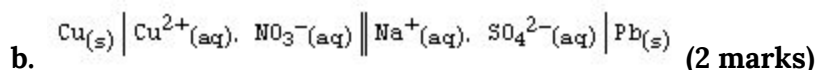
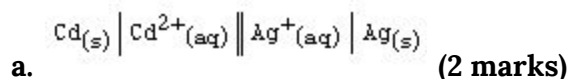
f. Describe what happens to the concentrations of the following ions as the cell operates:

$\text{Ag}^+(\text{aq})$, $\text{Zn}^{2+}(\text{aq})$, $\text{Na}^+(\text{aq})$, and $\text{NO}_3^-(\text{aq})$

(4 marks)

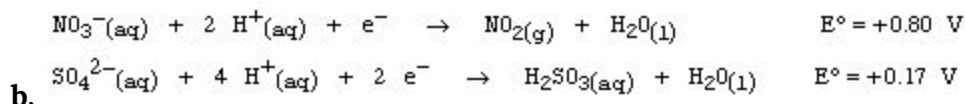
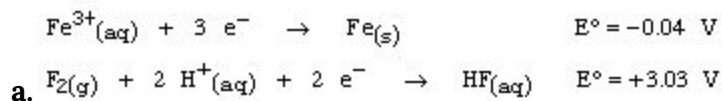
Calculate the standard cell potential of this silver/zinc cell. (2 marks)

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



3. If $\text{F}_{2(g)} + 2 \text{e}^{-} \rightarrow 2 \text{F}^{-}_{(aq)}$ was chosen as the standard reference electrode, explain how it would affect the answer to question 2. a. (2 marks)

4. Rearrange the following sets of half-reactions to create an electrochemical cell in each case. Write the labelled cathode half-reaction, anode half-reaction, and net ionic reaction. Also calculate the net cell potential. Show all your work clearly. Marks will be given for both your work and your answer. (6 marks)



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

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 $\text{Cu(s)} \mid \text{Cu(NO}_3)_2\text{(aq)}$. The net cell potential was +1.13 V. After 24 hours, 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. (1 mark)

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 $\text{Z}^{2+}\text{(aq)}$. Different combinations of the three half-cells are tried when constructing various electrochemical cells. The following information is obtained from the different combinations:

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

half-cell is $\text{Y(s)} \mid \text{Y}^{2+}\text{(aq)}$. The $\Delta E^\circ = 0.50 \text{ V}$

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

Determine the cathode, anode, and net cell potential of a standard cell between



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

Lesson 9 Assignment:

Turning Electricity into Chemistry

total /31

1. Decide whether each of the following statements concerning an electrolytic cell are true (T) or false (F). For each statement, explain why it is true or false. (7 marks)

a. A salt bridge or other semi-permeable membrane is required.

b. The oxidation number of the species reacting at the anode increases as the cell operates.

c. The reduction half-reaction has a higher reduction potential than the reduction potential of the oxidation half-reaction.

d. The reduction potential of $\text{Cd}^{2+}_{(l)} + 2\text{e}^- \rightarrow \text{Cd}_{(l)}$ is - 0.40 V during the electrolysis of molten cadmium chloride ($\text{CdCl}_{2(l)}$) .

e. In the electrolysis of NaBr(aq) , the solution will turn darker at the anode, while the mass of the cathode will increase.

f. A greater mass increase will occur at the cathode from a $\text{CoCl}_2(\text{aq})$ solution than from a $\text{NiCl}_3(\text{aq})$ solution with the same current over the same time.

g. An electrochemical cell with a potential of 3.0 V can be used to produce hydrogen at the cathode in the electrolysis of aqueous lithium hydroxide.

2. A student wanted to determine the purity of a sample piece of iron. The following equipment was available:

- the impure iron sample • a piece of zinc
- a piece of copper • 1.0 mol/L $\text{Fe}(\text{NO}_3)_2(\text{aq})$
- 1.0 mol/L • 1.0 mol/L $\text{Cu}(\text{NO}_3)_2(\text{aq})$
- (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 the following results:

	Electrode A	Electrode B
Initial mass ($\text{g} \pm 0.001 \text{ g}$)	5.884	6.917
Final mass ($\text{g} \pm 0.001 \text{ g}$)	6.213	6.587
Mass change ($\text{g} \pm 0.002 \text{ g}$)	0.329	0.330

(Assume that the impurities are unreactive.)

a. Write the anode equation, cathode equation, and net ionic equation that represent the reaction that occurs. (3 marks)

b. Calculate the net potential difference of this cell. (1 mark)

c. Draw a sketch of the cell operating in this question. Label the cathode, anode, direction of cation and electron flow, and all materials used in the construction of the cell. You may use only the materials listed in this question. (6 marks)

d. Is the cathode Electrode A or Electrode B? Explain. (2 marks)

3. Calculate the net cell potential of the following cells, making sure you include the labelled cathode and anode half-reaction equations and the net ionic reaction equation in your answer. Indicate, as well, whether the reaction is spontaneous or non-spontaneous. Show all your work clearly. Marks will be given for both your work and your answer.

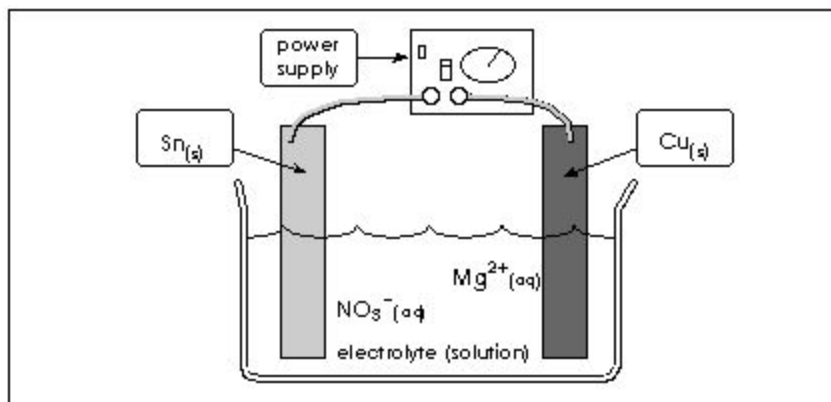
a. A platinum and a copper electrode are immersed into a lead(II) nitrate solution and connected to make a cell. (3 marks)

b. Two silver electrodes are placed in a solution of $\text{CaI}_2(\text{aq})$ and connected to make a cell. (3 marks)

4. Calculate the mass of element produced at the anode during the electrolysis of molten chromium(III) bromide if 2.50 A runs through the cell for 45 minutes. Show all your work clearly. Marks will be given for both your work and your answer.

(3 marks)

5. Use the following diagram to answer this question.



a. Predict the strongest oxidizing and reducing agents in the given cell. Based on your answer, describe the necessary direction of electron flow in the cell (either from Sn(s) to Cu(s) 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 3.00 g if the current through the solution is 275 mA. Remember, $1 \text{ mA} = 10^{-3} \text{ A}$. Show all your work clearly. Marks will be given for both your work and your answer. (3 marks)

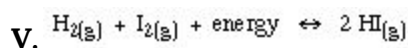
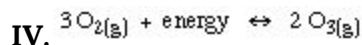
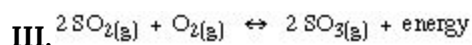
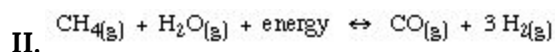
Lesson 10 Assignment: Systems in Balance

Review the Evaluation information found in the introduction of this lesson.

Part A: Multiple Choice

Read each question carefully and decide which of the choices best answers the question or completes the statement. Place the number of each question in a vertical column and place your answer (A, B, C, or D) beside each number. (Total = 5 marks)

Use the following information to answer questions 1-3.



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

- A. I, III
- B. II
- C. II, IV, V
- D. V

2. The system(s) which would shift towards reactants with an increase in pressure by compressing the system into a smaller vessel would be

- A. I, III, IV
- B. II
- C. IV
- D. V

3. The system whose equilibrium would not shift because of any change in pressure is

- A. I
- B. III
- C. IV
- D. V

4. Which of the following statements is true about a chemical system at equilibrium?

- A. $K = 1$
- B. $[\text{products}]/[\text{reactants}] = 1$
- C. $[\text{reactants}] = [\text{products}]$
- D. forward reaction rate = reverse reaction rate

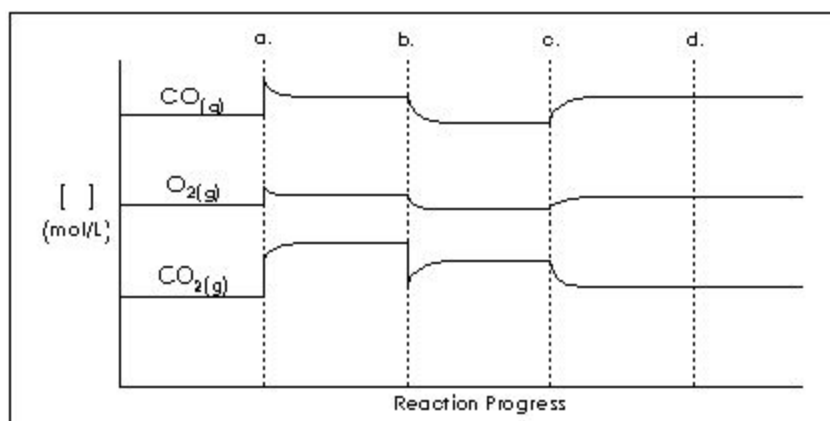
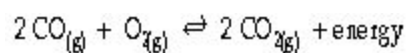
5. A particular chemical equilibrium has an equilibrium constant $K = 1250$. A true statement about this equilibrium would be

- A. The products are favoured.
- B. The reactants are favoured.
- C. The reaction is exothermic.
- D. The reaction reaches equilibrium quickly.

Part B: Written Response

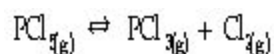
For full marks, your answers must show all pertinent explanations, calculations, and formulas.

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



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)

7. In a closed environment, phosphorus pentachloride will decompose into, and form an equilibrium system with, phosphorus trichloride and chlorine gas.

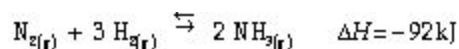


Calculate the equilibrium constant for this reaction at 25°C if a set of equilibrium

concentrations were found to be $[\text{PCl}_{3(g)}] = [\text{Cl}_{2(g)}] = 0.850 \text{ mol/L}$ and $[\text{PCl}_{5(g)}] = 0.406 \text{ mol/L}$. (2 marks)

8. In a flask initially containing colourless molecules of $\text{N}_2\text{O}_4(g)$ the brown colour characteristic of $\text{NO}_2(g)$ appears and the colour steadily intensifies. Is this system in equilibrium? Explain. (2 marks)

9. The following reaction was performed at 1000°C.



The equilibrium constant was found to be 0.0232 (Reaction 1). When this same reaction was performed at a different temperature, the equilibrium constant was calculated as 0.0563 (Reaction 2).

Was the temperature in Reaction 2 higher or lower than 1000°C? Explain your reasoning. (3 marks)

10.

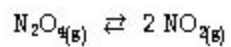
EQUILIBRIUM CONDITIONS FOR NO – O₂ – NO₂ SYSTEM AT 227°C

System	[NO(g)] (mol/L)	[O ₂ (g)] (mol/L)	[NO ₂ (g)] (mol/L)
1	2.50 × 10 ⁻²	5.58 × 10 ⁻²	1.50 × 10 ⁻¹
2	1.50 × 10 ⁻²	_____ i _____	2.00 × 10 ⁻¹
3	_____ ii _____	3.00 × 10 ⁻³	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 the K value for the equilibrium system $2\text{NO}_{(g)} + \text{O}_{2(g)} \rightleftharpoons 2\text{NO}_{2(g)}$ at 227°C. (2 marks)

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

11. Dinitrogen tetraoxide exists in an equilibrium with nitrogen dioxide:



An amount of 0.40 mol of $\text{N}_2\text{O}_4(\text{g})$ was placed in a 1.0 L container which was heated to 100°C . When equilibrium was reached, the concentration of $\text{N}_2\text{O}_4(\text{g})$ was found to be 0.16 mol/L.

a. How many moles of $\text{N}_2\text{O}_4(\text{g})$ were used up in reaching equilibrium? (1 mark)

b. How many moles of $\text{NO}_2(\text{g})$ were produced and what was the $[\text{NO}_2(\text{g})]$ at equilibrium? (2 marks)

c. Write the equilibrium law expression for this system. (1 mark)

d. Calculate the equilibrium constant for this system at 100°C . (1 mark)

e. What macroscopic property could you observe in this system to establish that equilibrium was reached? (1 mark)

12. As a project in Chemistry 30, Pat was assigned the task of proving that equilibrium is dynamic. The teacher provided Pat with a saturated solution of lead(II) sulphate in a test tube (some solid lead(II) sulphate remained on the bottom of the test tube), a small sample of solid lead(II) sulphate which contained radioactive , and a stopper that fit the test tube. Pat placed the radioactive sample in the test tube containing the saturated solution of lead(II) sulphate, stoppered the test tube, and agitated it vigorously for several minutes. Pat then let the mixture settle overnight, filtered it, and tested both the filtrate and the residue for radioactivity.

Evidence: Both the residue and the filtrate gave a positive test for radioactivity. Also, the mass of the residue remained constant.

Complete the analysis for this investigation. How does the investigation show that equilibrium is dynamic? (3 marks)