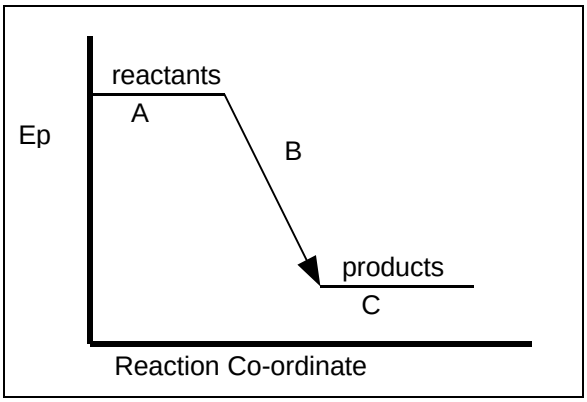
Chemistry 30 Review Test 1
Thermodynamics /40

Part I Multiple choice / Numerical Response

Answer the following multiple choice questions on the scantron sheet. Answer the numerical response on your short answer sheet. DO NOT WRITE ON THE TEST PAPER!
(25 marks)

1. Which statement correctly describes the energy changes when a solid changes to a liquid at a constant temperature?
   a) the potential energy remains constant and the kinetic energy increases
   b) the potential energy increases and the kinetic energy remains constant
   c) the potential energy increases and the kinetic energy decreases
   d) the potential energy decreases and the kinetic energy decreases



1. The diagram to the left could apply to a nuclear reaction or a chemical reaction. However, in the
   a) nuclear reaction, section B will be much larger
   b) nuclear reaction, section B will be much smaller than in the chemical reaction
   c) nuclear reaction, section C must be above section A
   d) chemical reaction, section C must be above section A

Numerical response #1

Use the following information to answer the question:

Room temperature	21.00°C
Mass of reactant	1.23 g
Molar mass of reactant	56.5 g/mol
Initial calorimeter temperature	18.45°C
Final calorimeter temperature	24.85°C
Mass of water in calorimeter	86.00 g

According to this information, the molar heat of reaction is _____ kJ/mol

3. Which of the following does NOT have a standard enthalpy of formation of zero?
   a) $CO_{(g)}$
   b) $Co_{(s)}$
   c) $Ca_{(s)}$
   d) $Cf_{(s)}$

Use the following information to answer question #4

$C_{(s)} + 2H_{2(g)} \rightarrow CH_{4(g)}$	$\Delta H = -74.8$ kJ
$C_{(s)} + 2Cl_{2(g)} \rightarrow CCl_{4(l)}$	$\Delta H = -106.4$ kJ
$\frac{1}{2} H_{2(g)} + \frac{1}{2} Cl_{2(g)} \rightarrow HCl_{(g)}$	$\Delta H = -92.3$ kJ

4. The heat of reaction for $CH_{4(g)} + 4Cl_{2(g)} \rightarrow CCl_{4(l)} + 4HCl_{(g)}$ is:
   a) -123.9 kJ
   b) -216.2 kJ
   c) -273.5 kJ
   d) -400.8 kJ

5. The amount of heat required to change 54.1 g of water at 25.0°C to steam at 130°C is
   a) 143 kJ
   b) 140 kJ
   c) 23.8 kJ
   d) 11.4 kJ

Use the following information to answer question 6

Molar Heat of Formation (kJ/mol)			
$HI_{(g)}$	+26.5	$NaI_{(s)}$	-287.8
$HBr_{(g)}$	-36.4	$NaBr_{(s)}$	-361.1
$HCl_{(g)}$	-92.3	$NaCl_{(s)}$	-411.2

6. A generalization that could be made about these compounds is that:
   a) iodine forms stronger bonds than chlorine does
   b) iodine compounds are less stable than chlorine compounds
   c) hydrogen forms stronger bonds with halogens than sodium does
   d) sodium halides are less stable than hydrogen halides

Numerical response #2

The heat of formation for 40.31 g of MgO is: _____ kJ

7. If you are "burning the candle at both ends" rather than one, when the candle is completely burned, the
   a) ΔH for the combustion of candle wax will double
   b) total heat produced by the entire candle will double
   c) heat released per mole of wax burned will remain unchanged
   d) ΔH_f for the formation of candle wax will double

8. The reaction that involves the largest change in energy per mole of a substance is the:
   a) sublimation of water
   b) combustion of magnesium
   c) formation of liquid water from the elements
   d) fusion of hydrogen atoms to produce helium

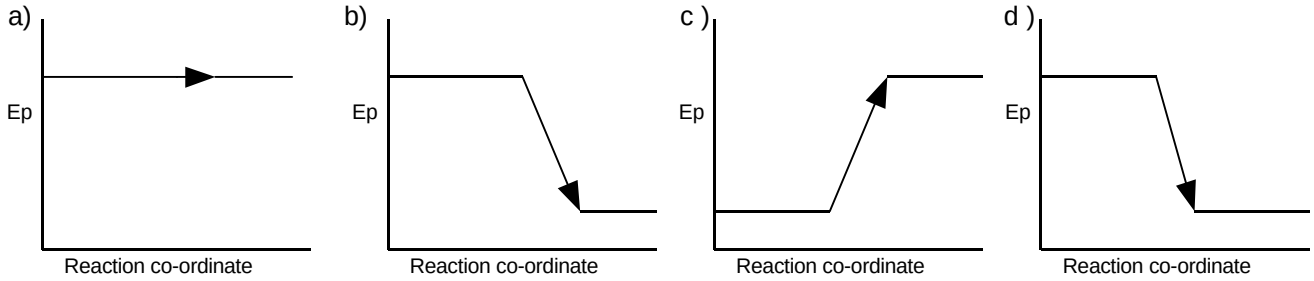
Numerical response #3

A substance has a molar heat of combustion of -810.4 kJ/mol. When 0.285 mol of the substance is burned in a calorimeter containing 8.60 kg of water, the increase in water temperature is:_____°C

Use the following information to answer question 9

$3H_{2(g)} + 2C_{(s)} + \frac{5}{2}O_{2(g)} \rightarrow C_2H_5OH_{(l)} + 277.1\ kJ$
$3H_{2(g)} + 2C_{(s)} \rightarrow C_2H_{6(g)} + 84.7kJ$

9. The diagram that best represents the reaction $C_2H_{6(g)} + \frac{5}{2}O_{2(g)} \rightarrow C_2H_5OH$ is:



10. When the three types of energy changes are arranged in order of decreasing molar heat values, the order is:
    a) phase, chemical, nuclear
    b) chemical, phase, nuclear
    c) nuclear, phase, chemical
    d) nuclear, chemical, phase

11. The energy changes that occur when steam at 150°C gradually loses energy until it finally becomes ice at -50°C consist of a series of
    a) 2 potential energy changes and 1 kinetic energy change
    b) 2 kinetic energy changes and 1 potential energy change
    c) 3 potential energy changes and 2 kinetic energy changes
    d) 3 kinetic energy changes and 2 potential energy changes

12. An endothermic reaction is a chemical reaction in which:
    a) reactants have more energy than products
    b) reactants have less energy than products
    c) the molar heat of formation is negative
    d) the enthalpy of the system is negative

13. For which of the following reactions is a ΔH of -7120 MJ possible?
    a) $UF_{6(l)} \rightarrow UF_{6(s)}$
    b) $U_{(s)} + 3F_{2(g)} \rightarrow UF_{6(s)}$
    c) $^{238}U + {}^{1}n \rightarrow {}^{239}U$
    d) $UF_{6(g)} \rightarrow UF_{6(l)}$

14. A sample of natural gas consists of 8.0 mol of methane and 2.0 mol of ethane. Which of the following statements is true?
    a) When ethane burns, it releases more heat per mole than methane.
    b) For combustion, ethane requires less oxygen per mole than methane.
    c) For combustion, the heat released per mole of mixture will be equivalent to that of methane.
    d) For combustion, the heat released per mole of mixture will be less than that of methane but more than that of ethane.

Numerical response #4

Given the equation $CH_3COOH_{(l)} + 2O_{2(g)} \rightarrow 2CO_{2(g)} + 2H_2O_{(g)}$, the heat of the reaction is: _____kJ

Use the following information to answer question 15

A 2.00 g sample of hot-dog was burned in a calorimeter and the heat given off raised the temperature of 500g of water in he calorimeter from 20.2°C to 30.4°C.

15. Calculate the energy that can be obtained from a 35.0 g wiener.
    a) 1.22×10^2 kJ
    b) 3.74×10^2 kJ
    c) 7.49×10^2 kJ
    d) 1.50×10^3 kJ

16. Identify the false statement about the following equation:

$$2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(g)} \qquad \Delta H = -483.6 \text{ kJ}$$

    a) the reaction is exothermic
    b) 483.6 kJ of heat are evolved per mole of O_2 used
    c) the heat of formation of water vapor is -241.8 kJ/mol
    d) 483.6 kJ of heat are evolved per mole of water produced

Use the following information to answer question 17

These statements deal with changes in matter and the related changes in energy.

I Phase change energies relate to changes in intermolecular bonds.
II The magnitude of stored energy increases as the state of a substance changes from a gas to a liquid
III Chemical changes involve energy changes which result from forming and breaking of bonds between molecules
IV The magnitude of the energy change for phase changes is generally smaller than the energy change for chemical changes
V Both phase changes and chemical changes may involve the absorption of energy to break bonds

17. Which of the statements are true?
    a) I and IV only
    b) I, IV, and V
    c) I, II and III
    d) II, III and IV

18. Which of these compounds is the most stable?
    a) $H_2O_{(l)}$
    b) $NO_{2(g)}$
    c) $C_2H_{4(g)}$
    d) $Al_2O_{3(s)}$

Use the following information to answer question #19

A student was required to study experimentally the dissolving of potassium hydroxide in water. The student prepared a data table and filled in the missing data at the end of the experiment.

Trial Number	1	2	3
mass of KOH dissolved	2.5 g	5.0 g	7.5 g
mass of solvent used	200 g	200 g	200 g
initial temperature	_____°C	_____°C	_____°C
final temperature	_____°C	_____°C	_____°C

19. By using the data from the completed table, the student would NOT be able to verify which statement?
    a) the dissolving of KOH is exothermic
    b) the temperature change of the solution depends on the mass of KOH used
    c) the amount of heat gained by the solvent is affected by the concentration of KOH
    d) the mass of solvent affects dissolving time

20. The heat of formation of methane is -74.8 kJ/mol. This means that:
    a) a methane molecule has a higher enthalpy than its constituent elements
    b) the formation of methane is an endothermic process
    c) if two moles of methane are formed, the heat released is 149.6 kJ
    d) 74.8 kJ of energy are released when one mole of methane is burned

Numerical response #5

Given the following reaction: $C_8H_{16(l)} + 12O_{2(g)} \rightarrow 8CO_{2(g)} + 8H_2O_{(g)} + 4902.4$ kJ, the heat of formation of 1-octene ($C_8H_{16(l)}$) is:_____kJ/mol

Part II - Short Answer Questions

Answer the following questions on a separate piece of paper. Show all of your work for part marks. (15 marks)

1. A student performed an experiment during which 17.04 g of hydrogen sulphide gas were burned in a calorimeter to form $H_2O_{(g)}$ and $SO_{2(g)}$. The heat produced was used to heat 1.50 L of water from 14.60°C to 55.20°C.
    a) Using the standard heats of formation provided in the data booklet, calculate the molar heat of combustion of $H_2S_{(g)}$
    b) Use the student's data to determine the experimental value for the molar heat of combustion of $H_2S_{(g)}$
    c) List one factor and how it may account for any difference between the ΔH values obtained in part a and b (6 marks total)

2. For the experimental determination of the heat of combustion for an unidentified liquid, a chemistry class was divided into four groups. The class results were as follows:

Group	Mass of Liquid burned (g)	Calculated heat released (kJ)
1	3.40	92.5
2	2.90	75.7
3	3.60	96.1
4	3.50	95.8

All the products of the combustion were in the vapour state. The students concluded that the liquid may be ethanol. Agree or disagree with their conclusion. Support your answer with relevant calculations and state the basis for your agreement or disagreement. (5 marks)

3. Design an experiment to determine the specific heat capacity of an unknown substance. State clearly what equipment you would use and the steps you would take. (4 marks)