Chem 101 2017 Discussion 9 Chapter 7

Student name:_______________TF's name:___________________ Discussion Day/Time: ____________

Things you should know when you leave Discussion today:

1. The First Law of Thermodynamics: $\Delta U = q + w$
   - Where:
     - ΔU is an internal energy (J)
     - w is pressure-volume work done by gas (J)
     - q is heat transferred (J)
       - $q_p \equiv \Delta H$ is heat transferred at constant pressure
       - q_v is heat transferred at constant volume
   - At constant pressure: $\Delta U = q_p + w$
   - At constant volume ($w \equiv 0$): $\Delta U = q_v$
2. If work is done on the system (by the surrounding), then $w > 0$ and gas is consumed.
3. If work is done by the system (on the surrounding), then $w < 0$ and gas is produced.
4. If no work is done $w = 0$; $\Delta U = q_;$ $q_v = q_p$

1. Gas is consumed during a reaction. Choose one for each of the following relationships.

   a. work is done on the system   work is done by the system

   b. $w < 0$; $w > 0$; $w = 0$

   c. $\Delta U - q < 0$; $\Delta U - q > 0$; $\Delta U - q = 0$

2. For each of the following <u>unbalanced chemical</u> reactions indicate:

a) Is work done? Indicate whether work is done on the system or by the system?
b) Is the final temperature greater, less than or the same as the initial temperature?
c) ΔU >, <, or = q_p?
d) Draw the energy diagram for each reaction
e) Will the surroundings around the reaction get hot or cold?
f) Will the final temperature be greater if the reaction is run at constant pressure or constant volume?(T_{final} (constant pressure) verses T_{final} (constant volume))

1) $H_2 (g) + O_2 (g) \rightarrow H_2O (l)$ Exothermic; **<u>Choose one:</u>** $w < 0$; $w > 0$; $w = 0$
$\Delta U - q < 0$; $\Delta U - q > 0$; $\Delta U - q = 0$
T_{final} (P-const) >,<,= T_{final} (V-const)

2) $H_2O_2 (aq) \rightarrow H_2O (g) + O_2 (g)$ Exothermic; **<u>Choose one:</u>** $w < 0$; $w > 0$; $w = 0$
$\Delta U - q < 0$; $\Delta U - q > 0$; $\Delta U - q = 0$
T_{final} (P-const) >,<,= T_{final} (V-const)

3) $CaCO_3$ (s) → CaO (s) + CO_2 (g) Endothermic; **Choose one:** $w < 0$; $w > 0$; $w = 0$
$\Delta U - q < 0$; $\Delta U - q > 0$; $\Delta U - q = 0$
T_{final} (P-const) >,<,= T_{final} (V-const)

4) H_2O (g) + CO_2 (g) → O_2 (g) + CH_3OH (l) Endothermic **Choose one:** $w < 0$; $w > 0$; $w = 0$
$\Delta U - q < 0$; $\Delta U - q > 0$; $\Delta U - q = 0$
T_{final} (P-const) >,<,= T_{final} (V-const)

5) H_3O^+ (aq) + OH^- (aq) → H_2O (l) Exothermic **Choose one:** $w < 0$; $w > 0$; $w = 0$
$\Delta U - q < 0$; $\Delta U - q > 0$; $\Delta U - q = 0$
T_{final} (P-const) >,<,= T_{final} (V-const)

3. A process is *endothermic*, circle all that apply.

$q < 0$	$w < 0$	$\Delta U < 0$	The surroundings get hot.	$q_v < q_p$
$q > 0$	$w > 0$	$\Delta U > 0$	The surroundings get cold.	$q_v > q_p$

T_{final} (constant pressure) > T_{final} (constant volume) T_{final} (constant pressure) < T_{final} (constant volume)

4. A process is *endothermic* and an *expansion* takes place, circle all that apply.

$q < 0$	$w < 0$	$\Delta U < 0$	The surroundings get hot.	$q_v < q_p$
$q> 0$	$w > 0$	$\Delta U > 0$	The surroundings get cold.	$q_v > q_p$

T_{final} (constant pressure > T_{final} (constant volume) T_{final} (constant pressure) < T_{final} (constant volume)

(For practice at home redo questions 3 and 4 for an *exothermic* process, *exothermic* process and *expansion*, *endothermic* process and *gas is consumed*, *exothermic* process and *gas is consumed*)

5. If q_p = -10.555J and w = -5.000J. What is the value of q_v? (Answer: 303.111, 302.111)

a. If the heat capacity is 5.000 J/(g·K) mass is 1.0000g and the initial temperature was 300.000 K, what would the final temperature be for the reaction at (1) constant pressure and (2) constant volume?

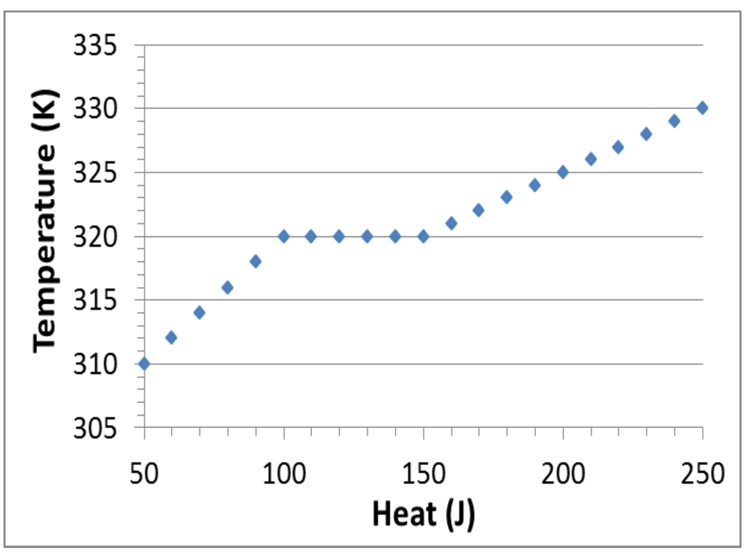
T_{final} (constant pressure)=
T_{final} (constant volume)=

6. A reaction is endothermic. When it is run at constant pressure, it's found that less cooling occurs in the solution than when it is run at constant volume. Draw the diagram for this reaction. Is work **positive, zero, or negative?**

7. A reaction forms a larger volume of gas and it gives off heat. Draw the diagram for this reaction. Compared to the heat given off at constant pressure, will the heat given off at constant volume be **more, the same, or less?**

8. A reaction between gases takes place in a balloon. Balloon shrinks and feels colder. If the balloon were rigid, would the cooling be **more, the same or less? (Use the diagrams)**

9. Answer the following questions related to the plot below of the final temperature of 1g object vs. the amount of heat the object absorbed. During the heating the object changed phase from solid to liquid.



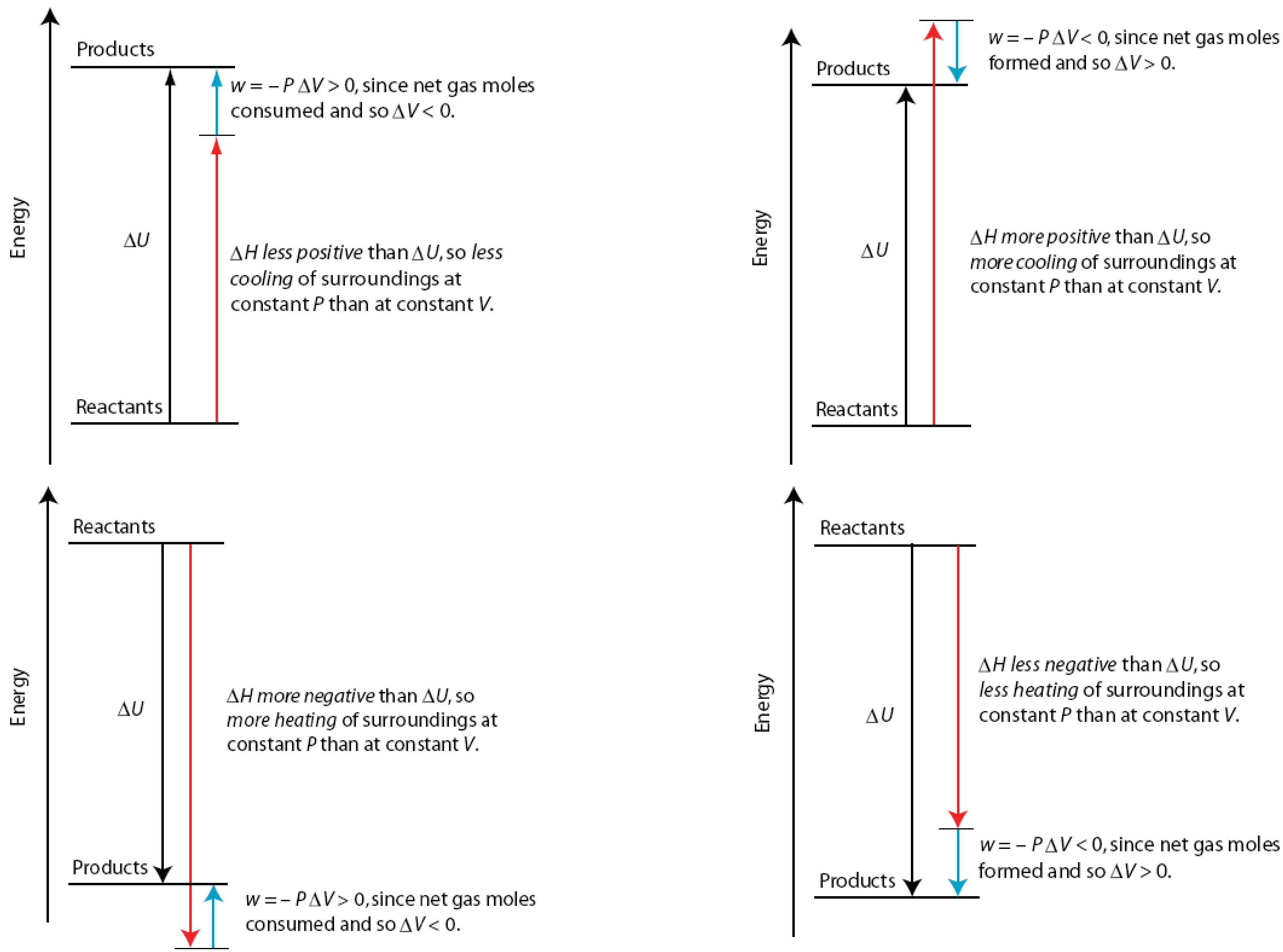
a) What is ΔH_{fusion} for the object? Please give your answer in J.

b) Which of the following is true about the object (circle one)?

$C_{solid} > C_{liquid}$ $C_{solid} < C_{liquid}$ $C_{solid} = C_{liquid}$

c) Calculate the heat capacity in J/K of the object in the liquid phase.

Relationship between internal energy change, ΔU (black path), and enthalpy change, ΔH (red path), according to
(1) whether products have more (upper figures) or less (lower figures) internal energy than reactants, and
(2) whether work (cyan path) is done on the system (left figures) or on the surroundings (right figures).
When no work is done at constant P, then ΔU and ΔH have the same value.



10. Which process requires more energy heating the substance or changing the state of the substance? Why?

11. An ice cube, initially at -10°C, with mass 9.0 grams is placed on top of a 2.0 kg iron plate ($c_p = 0.50 \frac{J}{K \cdot g}$). If the temperature of the iron plate drops by 5.0°C, what is the final temperature of the H_2O ?

(c_{ice}=2.0 $\frac{J}{K \cdot g}$, $\Delta_{fus}H_{(water)}$=6.00kJ/mol, c_{water} =4.2 $\frac{J}{K \cdot g}$)? (Answers: 48°C)

12. A 20.0 g hot block of iron (400. K) is placed against a 40.0 g cold block of gold (200. K). What will the final **t**emperature in K of the blocks be when they reach thermal equilibrium? (C_s[Fe] = 0.500 $\frac{J}{K \cdot g}$,

C_s[Au] = 0.100 $\frac{J}{K \cdot g}$**)** (Answers:343.K)

13. A 10.0 g object, initially at 75.0°C, is added to a calorimeter containing 100. mL of room temperature water (25.0 °C), which causes the temperature of the water to rise until the calorimeter contents reach 45.0 °C. (d(H_2O) = 1.00g/mL c_{water} =4.18 $\frac{J}{K \cdot g}$) (1) How much heat did the water absorb? (2) What is the specific heat capacity of the object?(Answer:27.9)

14. How much energy in kJ is required to fully vaporize (at T_{bp}=2525°C) a 270 g sample of Al(s), initially at 25°C?($\Delta_{vap}H$=300. kJ/mol, $\Delta_{fus}H$=11kJ/mol, c(Al,(s)) = 0.9 $\frac{J}{K \cdot g}$, c(Al,(l)) = 0.9 $\frac{J}{K \cdot g}$, T_{mp}=625°C)

(Answer:4000kJ)

15. Calculate the energy needed, in kJ, to heat 36.0 g of water from 50.0 °C to 100.0 °C and then to completely vaporize it to steam at 100.0 °C. The specific heat of water is 4.18 J/(K g) and its enthalpy change of vaporization is 40.7 kJ/mol. (Answer:88.9)

16. For following endothermic reaction draw the energy diagram that describe the chemical reaction :

$$Al(OH)_3(s) \rightarrow Al_2O_3(s) + H_2O(g)$$

a. Circle the correct relationship between the final temperature of the surroundings when the reaction takes place at constant pressure versus constant volume.

T_{final} (constant pressure) < ≈ > T_{final} (constant volume)

17. If q_p = 10.0J and w = 5.00J. What is the value of q_v?

a. If the heat capacity is 5.00 J/g K mass is 1g and the initial temperature was 300. K. What would the final temperature be for the reaction :(Answer:15.0, 297, 298)

i. T_{final} (at constant pressure)=

ii. T_{final} (at constant volume)=

18. When magnesium metal reacts, both at constant pressure and constant volume, with a strong acid, like HCl, hydrogen gas is generated and the temperature of the solution increases. For each relationship below, circle the correct symbol (<, =, or >); if more information is required, circle nothing.

ΔH < = > 0 w < = > 0 ΔU < = > 0

$|q_v|$ < = > $|q_p|$ T_{final} (constant pressure) < = > T_{final} (constant volume)