

CHM2132 Test 1: Wednesday October 5th, 2011

Name: _____

Student #: _____

This is a closed book exam with no notes allowed.

Calculators are permitted.

Show all your work.

Remember to include units in all your calculations.

Marks will be deducted if units are not shown in your final answer.

Constants and Data:

$$R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1} = 0.08206 \text{ L atm mol}^{-1} \text{ K}^{-1} = 0.08314 \text{ L bar mol}^{-1} \text{ K}^{-1}$$

$$1 \text{ L} = 10^{-3} \text{ m}^3$$

$$1 \text{ kJ} = 1000 \text{ J}$$

$$1 \text{ atm} = 101325 \text{ Pa}$$

$$1 \text{ bar} = 10^5 \text{ Pa}$$

$$1 \text{ L atm} = 101.325 \text{ J}$$

$$1 \text{ J} = 1 \text{ kg m}^2 \text{ s}^{-2} \quad 1 \text{ Pa} = 1 \text{ kg m}^{-1} \text{ s}^{-2}$$

$$\Delta_f H^\circ(\text{C}_3\text{H}_8\text{O(l)}) = -303 \text{ kJ/mol}$$

$$\Delta_f H^\circ(\text{CO}_2(\text{g})) = -354 \text{ kJ/mol}$$

$$\Delta_f H^\circ(\text{H}_2\text{O (g)}) = -242 \text{ kJ/mol}$$

$$\Delta_{\text{vap}} H^\circ(\text{H}_2\text{O}) = 44.0 \text{ kJ/mol at 298 K}$$

$$pV = nRT$$

$$z = \frac{pV}{nRT}$$

$$p = \frac{nRT}{V - nb} - a \left(\frac{n}{V} \right)^2$$

$$w = -\int p dV$$

$$\Delta U = w + q$$

$$H = U + pV$$

$$\left(\frac{\partial U}{\partial T} \right)_V = C_V$$

$$\left(\frac{\partial H}{\partial T} \right)_P = C_P$$

$$\pi_T = \left(\frac{\partial U}{\partial V} \right)_T$$

$$C_P - C_V = nR$$

$$p_1 V_1^\gamma = p_2 V_2^\gamma \quad \gamma = \frac{C_P}{C_V}$$

$$\frac{T_2}{T_1} = \left(\frac{V_1}{V_2} \right)^{(\gamma-1)}$$

$$\Delta_r H_m^\circ = \sum_{\text{Products}} \nu \Delta_f H_m^\circ - \sum_{\text{Reactants}} \nu \Delta_f H_m^\circ$$

$$\Delta(\Delta_r H^\circ) = \Delta C_P \Delta T$$

Q1: _____/8 Q2: _____/12 Q3: _____/15 Q4: _____/5

Total = _____/40

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1. The following statements are **FALSE**. **Choose 4 of the 5 statements below** and:

- (i) Change the sentence so that it becomes a correct statement.
 - (ii) In one sentence explain why the statement was incorrect. In some cases you might use a p - V graph to help your explanation. (8 marks)
- a) The surroundings does work on the system when a balloon is taken from a cold room to a warm room.
- b) It is possible to do an adiabatic expansion at constant pressure.
- c) The work of a constant pressure isothermal expansion is larger when it is done irreversibly instead of reversibly.
- d) If $q < 0$ then the temperature of the system must decrease.
- e) The formation enthalpy of graphite at 300 K can be calculated using:

$$\Delta_f H_m^\circ(300 \text{ K}) = \Delta_f H_m^\circ(298 \text{ K}) + \Delta C_{p,m}^\circ \Delta T$$

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3. A sample consisting of 0.50 mol of an ideal monoatomic gas ($C_p = 5/2 R$) is confined in a 2.00 L container at 1.50 bar is allowed to expand adiabatically and reversibly to a final volume of 1.00 bar.

a) Draw the path for this process in a p-V diagram. Be sure to label the axes with p and V , show isotherm(s) and indicate pressure values for the initial and final states in the graph. Indicate the direction of the process with an arrow. (5 marks)

b) What is the heat of this process? (1 mark)

c) What is the final volume of the gas? (3 marks)

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c) How much work was done in this process? (4 marks)

d) Suppose the gas was taken back to the initial state by constant volume heating back up to the initial temperature, followed by isothermal compression back to the initial volume. What would ΔU be for this process? (2 marks)

4. In Joule's experiment, the temperature of the water bath surrounding the two goes up for a real gas with a negative internal pressure ($\pi_T < 0$).

a) Is work greater than, less than, or equal to zero in this experiment? (1 mark)

b) Explain why the temperature increases in this experiment in terms of energy and molecular interactions. (2 marks)

c) What is the partial derivative that describes how the volume of an ideal gas changes with the temperature for a fixed amount of gas at a constant pressure? (2 marks)