Chemistry 112
Third Hour Exam

Name:____________

Please show all work for partial credit

1. (10 points) Given the equation:

$$u_{rms} = \sqrt{\frac{3RT}{M}}$$

Calculate the root mean square velocity for water vapor in steam at, 150°C.

$$u_{rms} = \sqrt{\frac{3 \cdot 8.3145(J/K \cdot mol)423.15(K)}{.018(kg/mol)}}$$
$$= \sqrt{586380(J/kg)}$$
$$= \sqrt{586380(kg \cdot m^2/s^2)/kg}$$
$$= \sqrt{586380(m^2/s^2)}$$
$$= 766 m/s$$

2. (10 points) What are diffusion and effusion?

Diffusion refers to the movement of a gas particle in the presence of other gas molecules, while effusion refers to the movement of a gas particle in a vacuum.

3. (10 points) In the van der Waals equation for a real gas:

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

What are a and b, and how do they correct for the non-ideality of the gas equation?

Both a and b are corrections terms to the ideal gas law. A is a correction term that compensates for inter-particle interactions in the gas, while the b term corrects for the actual volume of the gas particle.

4. (10 points) Calculate ΔE for the following situations:

a. q= +50 kJ, w = -40 kJ   +10 kJ

b. q= -50kJ, w = -20 kJ   -70 kJ

c. q= +25 kJ, w = 0 kJ   + 25 kJ

d. In which of these cases do the surroundings do work on the system?

If the surroundings work on the system, then w is +.   I accepted either none or c.

5.(10 points) The volume of an ideal gas is **increased** from 75mL to 3.4L at a constant pressure of 2.35 atm. Calculate the work associated with this process.

$W = -P\Delta V$

$\Delta V = V_{final} - V_{inital}$

= 3.4 L - .075 L = +3.325 L

W = - 2.35 atm x 3.325 L = -7.81 L atm

This could get converted into J, but that was not a required part of the problem

6. (10 points) I have a reaction $A \rightarrow 2B$. I will perform this reaction in a constant pressure calorimeter containing 87 grams of water. As the reaction occurs the water changes temperature from 25°C to 12.6 °C. What is the ΔH of this reaction. (The specific heat capacity of water is 4.18 J/°C·g, assume I have 0.1 moles of A to start the reaction.)

Energy = S.H.C x g x ΔT

= 4.18 J/°C·g x 87 g x 12.4°C

= 4,509 J

Since the temperature got colder, the + sign is appropriate.

Also

4,509 J/0.1mole = X J/1.0 mole

=+45,090J/1 mole A or 45.1 kJ/mole

7. (10 points) Given the following data:

$C_2H_2(g) + 5/2O_2(g) \rightarrow 2CO_2(g) + H_2O(l)$ $\Delta H = -1200$ kJ

$C(s) + O_2(g) \rightarrow CO_2(g)$ $\Delta H = -394$ kJ

$H_2(g) + ½ O_2(g) \rightarrow H_2O(l)$ $\Delta H = -286$ kJ

Calculate ΔH for the reaction $2C(s) + H_2(g) \rightarrow C_2H_2(g)$

Reverse the first reaction

$2CO_2(g) + H_2O(l) \rightarrow C_2H_2(g) + 5/2O_2(g)$ $\Delta H = +1200$ kJ

Next reaction goes forward, but you need to double the amounts:

$2C(s) + 2O_2(g) \rightarrow 2CO_2(g)$ $\Delta H = 2x(-394)$ kJ

Final reaction goes forward:

$H_2(g) + ½ O_2(g) \rightarrow H_2O(l)$ $\Delta H = -286$ kJ

Net:

$2CO_2(g) + H_2O(l) + 2C(s) + 2O_2(g) + H_2(g) + ½ O_2(g) \rightarrow$

$C_2H_2(g) + 5/2O_2(g) + 2CO_2(g) + H_2O(l)$ $\Delta H = +1200$ kJ - 2(394) -286

Removing common terms

$2C(s) + H_2(g) \rightarrow C_2H_2(g)$ $\Delta H = 126$ kJ

8. Calculate ΔH for the reaction $2Na(s) + 2H_2O(l) \rightarrow 2Na^+(aq) + H_2(g) + 2\ OH^-(aq)$

From the following heats of reaction:

Substance	$\Delta H^o{}_f$ (kJ/mole)
$Na^+(aq)$	-230
$H_2O(l)$	-286
$OH^-(aq)$	-230

$\Delta H^o_{rxm} = \sum n_p \Delta H_f^o - \sum n_p \Delta H_f^o$

Note: Na(s) and $H_2(g)$ are the normal forms of these elements at STP, so their $\Delta H_f^0 = 0.00$

$\Delta H^o_{rxm} = [2(-230) + 0 + 2(-230)]-[2(0) + 2(-286)]$

$= -460 - 460 + 572$

$= -348$ kJ/mole

9. (10 points) Proteins absorbs light with a wavelength of 280 nm.

A. What is the frequency of this light

$c=\lambda \nu$

$3x10^{8}$(m/s) = $280x10^{-9}$m X

X = $3x10^{8}$ (m/s) / $280x10^{-9}$m = $1.07x10^{15}$ sec^{-1} or Hz

B. What is the energy of 1 mole of photons with this frequency?

E=hν (Energy of 1 photon)

= $6.63x10^{-34}$ (Js) x $1.07x10^{15}$ s^{-1}

=$7.10x10^{-19}$ J per photon

$7.65x10^{-19}$L/photon X $6.022x10^{23}$ phtons/mole

= 428 kJ/mole

10. (10 points) What is the wavelength of an electron (mass=$9.11x10^{-31}$kg) traveling at $7.5x10^{8}$ m/s?

$$m = \frac{h}{vl}; \; l = \frac{h}{mv}$$

λ = $6.63x10^{-34}$ Js/($7.5x10^{8}$ m/s x $9.11x10^{-31}$ kg)

J = kg m^{2}/s^{2}

λ = $9.7x10^{-13}$ m