CHM 1045 Fall 2014

Test 3

Name (print)_____

Show your work for complete (and partial) credit. Report your answers to the correct number of significant figures, and use units where appropriate. All equations should balance; indicate phases.

$\mu = \sqrt{\frac{3RT}{M}}$ $\frac{\mu_1}{\mu_2} = \sqrt{\frac{M_2}{M_1}}$ $R = .082058 L \cdot atm \cdot mol^{-1}K^{-1} = 8.314 J \cdot mol^{-1}K^{-1}$

$P_A = X_A P_{tot}$ $X_A = n_A/n_{tot}$ 760mm Hg = 760 torr = 1atm.

$E = h\nu$ $h = 6.626 \times 10^{-34} Js$ $\lambda\nu = c = 3.00 \times 10^8 m/s$ density of water = 1.00g/mL

$\Delta H = q = sm\Delta T = hc\Delta T$ specific heat of water = $4.184 Jg^{-1}{}^\circ C^{-1}$ $N_A = 6.022 \times 10^{23}$

1. A sample of gas (volume = 895mL, pressure = 0.875atm, temperature = 31ºC) has its volume changed at constant temperature. What volume would give a pressure of 700.mm Hg?

2. A sample of gas (volume = 1.33L, pressure = 0.875atm, temperature = 25ºC) was heated to 35ºC and compressed to 1.10L. What was the resulting pressure?

3. How does the Kinetic Molecular Theory of Gases explain Boyle's Law? Boyle's Law describes the relationship between a gas sample's pressure and volume at constant temperature. Start your answer with a statement of Boyle's Law.

4. A mixture of gases contains 2.00mol of N_2 and 3.00mol of H_2 and has a total pressure of 1.25atm. What is the partial pressure of N_2?

5. What is the RMS speed of Cl_2 molecules at 50.0ºC?

6. Under conditions of high pressure, gases exhibit nonideal behavior. Why do gases exhibit nonideal behavior at high pressures?

7. What is the molecular weight of a gas that effuses 1.84 times faster that $I_2(g)$ under the same conditions?

8. Dry air at STP (OºC and 1.00 atm pressure) has a density of 1.2929g/L. What is the average molecular weight of the molecules that compose air?

9. When an endothermic reaction occurs in a calorimeter (**T**rue or **F**alse):

___ the calorimeter warms. ___ the sign of q_{rxn} is negative.

___ the sign of ΔH_{rxn} is positive. ___ the reaction absorbs heat.

10. A 150.0-g sample of metal at 80.0°C is added to 150.0 g of H_2O at 20.0°C. The temperature rises to 23.3°C. Assuming that the calorimeter is a perfect insulator, how much heat does the calorimeter absorb?

11. A 150.0-g sample of metal at 80.0°C is added to 150.0 g of H_2O at 20.0°C. The temperature rises to 23.3°C. Assuming that the calorimeter is a perfect insulator, what is the specific heat of the metal?

12. Ammonia burns in the presence of a copper catalyst to form nitrogen gas and water.

$4NH_3(g) + 3O_2(g) \rightarrow 2N_2(g) + 6H_2O(g)$ $\Delta H = -1267kJ$

What is the enthalpy change to burn 5.85g of ammonia?

13. Given the following data,

	$\Delta H°$(kJ/mol)
$S(s) + O_2(g) \longrightarrow SO_2(g)$	–395
$S(g) + O_2(g) \longrightarrow SO_2(g)$	–618

find the heat required for the reaction converting solid sulfur to gaseous sulfur at 298 K and 1 atm pressure. For full credit, show how the chemical equations add.

14. For which of the following equations is the enthalpy change at 25°C and 1 atm equal to ΔH_f^o (HCOOH(*l*))?

a. $CO_2(g) + H_2(g) \longrightarrow HCOOH(l)$
b. $CO(g) + H_2O(l) \longrightarrow HCOOH(l)$
c. $C(s) + 2H(g) + 2O(g) \longrightarrow HCOOH(l)$
d. $C(g) + 2H(g) + 2O(g) \longrightarrow HCOOH(l)$
e. $C(s) + H_2(g) + O_2(g) \longrightarrow HCOOH(l)$

15. What is the Ideal Gas Law? Write it below.

16. Consider two gas samples, one of $H_2(g)$ and one of $N_2(g)$. Both samples are the same volume (1.00L), the same pressure (785mm Hg), and the same temperature (25°C). Indicate whether each item would be greater in the H_2 sample or the N_2 sample, or whether the two samples would be equal. For each item, check the appropriate box.

Item: Which sample would:	H_2	N_2	equal
a) have more molecules?			
b) have a greater density?			
c) have greater kinetic energy?			
d) have a greater root mean squared velocity (μ)?			

17. When 50.0mL of 1.00M HCl reacts with 50.0mL of 1.00M NaOH in a calorimeter, the calorimeter absorbs 2.7×10^3J. What is the value of $\Delta H°_{rxn}$, the enthalpy change per mole of water produced for the reaction
$HCl(aq) + NaOH(aq) \rightarrow H_2O(l) + NaCl(aq)$?

18. Consider the following specific heats of metals.

Metal	Specific Heat
copper	0.385 J/(g • °C)
magnesium	1.02 J/(g • °C)
mercury	0.138 J/(g • °C)
silver	0.237 J/(g • °C)
lead	0.129 J/(g • °C)

a) If the same amount of heat is added to 25.0 g of each of the metals, which are all at the same temperature, which metal will have the highest temperature? _____

b) 100-g samples of each of the metals at 95°C are added to 100 mL of water at 25°C. Which element will increase the temperature of the water the least? _____

19. Give an example of the units that might be used for each of the following. For example, for mass, the answer could be grams or kilograms.

Value:	Mass	Specific heat	Heat capacity	ΔH_f°	$q_{calorimeter}$	Frequency (radiation,υ)
Units:	g					

20. What is the energy of one photon of 435nm light?

21. Consider visible, infrared, and ultraviolet light/radiation (Vis, IR, UV).
Which of the three has the longest wavelength? Vis, IR, UV
Which of the three has the highest frequency? Vis, IR, UV
Which of the three has the highest energy per photon? Vis, IR, UV

22. What determines the wavelength of a line in an emission spectrum? The answer is not color or frequency. Include an energy level diagram and a mathematical equation in your explanation, if possible.

23. 19. What is the maximum number of electrons in an atom:
(note: invalid quantum numbers are for orbitals that don't exist and hold no electrons)
a) with n=3 and l=2? ____ c) with n=5 and l=0? ____
b) with n=2 and l=2? ____ d) with n=5, l=2 and m_l = -1? ____

24. a) For an electron in a 4p orbital, *n* = _____ and *l* = _____.

5 points extra credit: A 1.00-g sample of solid magnesium was burned in chlorine to give a 3.917-g sample of pure solid $MgCl_2$. The energy given off in this reaction was 26.41 kJ. From this information, calculate the enthalpy of formation for $MgCl_2(s)$.