Name: _____**KEY**_____ Section: _____

CHM 151 Exam 4: Chapters 9 and part of 8
You must show all work to receive credit. Clearly mark your final answer!

1. (10 pts) Matching: Indicate how the following changes made to a system (shown on the left) will affect the pressure of the system (letter options on the right). The system is initially filled with neon atoms. Assume variables not mentioned are held constant. Note: Answer choices may be used more than once!

Changes to system:
_C__ Volume is doubled
_A__ Temperature is doubled
_E__ Temperature is halved and volume is halved
_B__ Number of atoms is tripled
_E__ Neon atoms are replaced with xenon atoms

Pressure changes:
a. Pressure is doubled
b. Pressure is tripled
c. Pressure is decreased by 1/2
d. Pressure is decreased by 1/3
e. No change

_D__2. (5 pts) Which of the following statements about gases is true?
a. Gases are highly compressible.
b. There are relatively large distances between atoms/molecules of a gas.
c. A gas expands spontaneously to fill its container.
d. All of these are true.

_E__ 3. (5 pts) A sample of gas (24.2g) initially at 4.00 atm was compressed from 8.00 L to 2.00 L at constant temperature. After the compression, the gas pressure was _____ atm.
a. 1.00
b. 2.00
c. 4.00
d. 8.00
e. 16.0 $P_1V_1 = P_2V_2$

4. (6 pts) How many moles of gas occupy a volume of 60.82 L at 31.1°C and 367 torr?

V = 60.82 L
P = 367 torr = 0.4829 atm
T = 31.1 °C = 304.25 K

$$n = PV / RT = \frac{0.4829\ atm * 60.82\ L}{0.08206\ L{\cdot}atm/mol{\cdot}K * 304.25\ K}$$

n = 1.18 mol

_C_ 5. (5 pts) An unknown gas occupies a volume of 725 mL at STP and has a mass of 1.036 g. This gas could be
a. nitrogen, N_2
b. carbon dioxide, CO_2
c. oxygen, O_2 MM = dRT / P
d. hydrogen, H_2
e. chlorine, Cl_2

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6. (12 pts) The reaction of calcium hydride, CaH_2, with water is often used in cases where the expansion of volume of an object needs to be delayed (e.g., life vests). This reaction produces hydrogen gas and aqueous calcium hydroxide. Complete and balance the equation below (with phases) and then calculate the mass of CaH_2 needed to generate 53.5 L of gas if the pressure of the gas is 814 torr at 21.7°C?

$$CaH_2(s) + 2\ H_2O(l) \rightarrow 2\ H_2\ (g) + Ca(OH)_2\ (aq)$$

V = 53.5 L

P = 814 torr = 1.071 atm

T = 21.7 °C = 294.85 K

$$n = PV / RT = \frac{1.071\ atm * 53.5\ L}{0.08206\ L{\cdot}atm/mol{\cdot}K * 294.85\ K}$$

n = 2.36816 mol H_2 g 2.36816 mol H_2 * (1 mol CaH_2 / 2 mol H_2) * (42.096 g CaH_2 / 1 mol)

49.8 g CaH_2 are needed

7. (6 pts) A closed container holds CH_4 and H_2 gases. The total pressure in the container is measured to be 723 torr. The container has 0.651 moles of CH_4 and 0.184 moles of H_2. Calculate the mole fractions and the partial pressures of both gases in the container.

X_{CH4}: (0.651 / 0.835) = **0.780** P_{CH4} = (0.780)(723 torr) = **564 torr (or 0.742 atm)**

X_{H2}: (0.184 / 0.835) = **0.220** P_{H2} = (0.220)(723 torr) = **159 torr (or 0.209 atm)**

_A_ 8. (5 pts) In a balloon with a small pinhole leak, which gas will escape the balloon the **fastest**?

a. H_2O (g)
b. N_2 (g)
c. O_2 (g)
d. Ar (g)
e. CO_2 (g)

9. (6 pts) For each blank, circle the word that correctly completes the sentence. A chemical reaction that absorbs heat from the surroundings is said to be _endo____ (**endothermic** or **exothermic**), has a _pos____ (**positive** or **negative**) value of ΔH at constant pressure, and feels _cold_ (**cold** or **warm**) to the touch.

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_C_ 10. (5 pts) Specific heat is the

a. amount of energy required to melt 1.00 g of a substance
b. amount of heat energy needed to change 1.00 mol of a substance by 1.00 ^{o}C
c. amount of heat energy needed to change 1.00 g of a substance by 1.00 ^{o}C
d. amount of a substance that is heated by 1.00 ^{o}C
e. the number of Kelvins that 1.00 g of a substance is raised by heating it for 1.00 minute

11. (8 pts) Calculate the amount of heat (in kJ) released by an acid-base neutralization reaction if a total of 99.56 g of reactants are used. This reaction is measured to go from 36.0^{o}C to 24.3^{o}C and can be assumed to have the specific heat of water (4.184 J/g·^{o}C).

q = mass * sp.ht. * ΔT = (99.56 g)(4.184 J/g·^{o}C)(24.3^{o}C – 36.0^{o}C) = -4873.74 J = **-4.87 kJ**

12. (8 pts) Determine if the following reactions are endothermic or exothermic (circle your answer):

a. Condensation of steam	Endothermic	**Exothermic**
b. Freezing lemonade	Endothermic	**Exothermic**
c. Sublimation of NH_4Cl	**Endothermic**	Exothermic
d. Decomposition of $CuCO_3$	**Endothermic**	Exothermic

13. (8 pts) How much total heat (in kJ) is transferred when 6.781 grams of oxygen combusts as shown in the equation below?

___ CH_4 (g) + _2_ O_2(g) → _2_ $H_2O(g)$ + ___ $CO_2(g)$ ΔH = -980.0 kJ

6.781 g O_2 * (1 mol / 32.00 g) * (-980.0 kJ / 2 mol O_2) = **-103.8 kJ**

14. (6 pts) Sulfur trioxide can be synthesized by combining sulfur dioxide and oxygen gas, as described by the equation:

$2SO_2$ (g) + O_2 (g) → $2SO_3$ (g) ΔH^{o} = ?

Use the equations below to calculate ΔH^{o}, in kJ, for the reaction above.

SO_2 (g) → S (s) + O_2 (g) ΔH^{o} = 296 kJ (x 2)
2 SO_3 (g) → 2 S (s) + 3 O_2 (g) ΔH^{o} = 789 kJ (reverse)

2 SO_2 (g) → 2 S (s) + 2 O_2 (g)	ΔH^{o} = 592 kJ
2 S (s) + 3 O_2 (g) → 2 SO_3 (g)	ΔH^{o} = -789 kJ
2 SO_2 (g) + O_2 (g) → $2SO_3$ (g)	**ΔH^{o} = -197 kJ**

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15. (5 pt) What grade do you **honestly** feel you deserve in this class (based on the amount of effort you have put in and amount of material you have learned)? _A+_____

Why? Because this is the best class ever and I love chemistry! ☺

Extra Credit (6 points) – Show your work on the back of this page.

A 30.01 g block of Al at 5.00°C (specific heat = 0.897 J/g·°C) is dropped into a calorimeter containing 1.00 L of water at 75.0°C (specific heat = 4.184 J/g·°C). What is the final temperature of the system after it reaches thermal equilibrium (assuming no heat is lost from the calorimeter)?

$q_{H2O} < 0$ (loses heat) mass: 1000 g (density = 1.00 g / mL)

sp. ht.: 4.184 J/g·°C

T_f: ?

T_i: 75.0°C

$q_{Al} > 0$ (gains heat) mass: 30.01 g

sp. ht.: 0.897 J/g·°C

T_f: ?

T_i: 5.00°C

$-q_{H2O} = q_{Al}$ $-(1000\text{ g})(4.184\text{ J/g·°C})(T_f - 75.0\text{°C}) = (30.01\text{ g})(0.897\text{ J/g·°C})(T_f - 5.00\text{°C})$

$-4184\text{J}(T_f - 75.0\text{°C}) = 26.92\text{ J/°C}(T_f - 5.00\text{°C})$

$-4184\text{J/°C} * T_f + 313800\text{ J} = 26.92\text{ J/°C} * T_f - 134.6\text{ J}$

$313934.6\text{ J} = 4210.92\text{ J/°C} * T_f$

$T_f = 313934.6\text{ J} / 4210.92\text{ J/°C}$

$T_f = 74.6\text{°C}$