Name ________________________________ **AP Chem** ___/___/___

Chapter 13 – Homework

Solve the following gas, thermodynamic and equilibrium problems. Circle and write the correct letter on the line in front of the problem.

1.____________ The density of an unknown gas is 4.20 grams per liter at 3.00 atmospheres pressure and 127 °C. What is the molecular weight of this gas? (R = 0.0821 liter-atm / mole-K)
(A) 14.6 (B) 46.0 (C) 88.0 (D) 94.1 (E) 138

2.____________ $CH_4(g) + 2\ O_2(g) \rightarrow CO_2(g) + 2\ H_2O(l)$; $\Delta H = -\ 889.1$ kJ
$\Delta H_f°\ H_2O(l) = -\ 285.8$ kJ / mole
$\Delta H_f°\ CO_2(g) = -\ 393.3$ kJ / mole
What is the standard heat of formation of methane, $\Delta H_f°\ CH_4(g)$, as calculated from the data above?
(A) -210.0 kJ/mole (B) -107.5 kJ/mole (C) -75.8 kJ/mole
(D) 75.8 kJ/mole (E) 210.0 kJ/mole

3.____________ When the actual gas volume is greater then the volume predicted by the ideal gas law, the explanation lies in the fact that the ideal gas law does NOT include a factor for molecular.
(A) volume (B) mass (C) velocity (D) attractions (E) shape

4.____________ Hydrogen gas is collected over water at 24 °C. The total pressure of the sample is 755 millimeters of mercury. At 24 °C, the vapor pressure of water is 22 millimeters of mercury. What is the partial pressure of the hydrogen gas?
(A) 22 mm Hg (B) 733 mm Hg (C) 755 mm Hg (D) 760 mm Hg (E) 777 mm Hg

5.____________ A 2.00-liter sample of nitrogen gas at 27 °C and 600. millimeters of mercury is heated until it occupies a volume of 5.00 liters. If the pressure remains unchanged, the final temperature of the gas is
(A) 68 °C (B) 120 °C (C) 477 °C (D) 677 °C (E) 950. °C

6.____________ Which of the following is the correct equilibrium expression for the hydrolysis of CO_3^{2-} ?
(A) $K = [HCO_3^-] / ([CO_3^{2-}] [H_3O^+])$
(B) $K = ([HCO_3^-] [OH^-]) / [CO_3^{2-}]$
(C) $K = ([CO_3^{2-}] [OH^-]) / [HCO_3^-]$
(D) $K = [CO_3^{2-}] / ([CO_2] [OH^-]^2)$
(E) $K = ([CO_3^{2-}] [H_3O^+]) / [HCO_3^-]$

7.____________ As the temperature is raised from 20°C to 40°C, the average kinetic energy of neon atoms changes by a factor of
(A) ½ (B) $\sqrt{(313/293)}$ (C) 313/293 (D) 2 (E) 4

8.____________ A sample of 0.0100 mole of oxygen gas is confined at 37° C and 0.216 atmospheres. What would be the pressure of this sample at 15° C and the same volume?
(A) 0.0876 atm (B) 0.175 atm (C) 0.201 atm (D) 0.233 atm (E) 0.533 atm

9.____________ Based on the information below, what is the standard enthalpy change for the following reaction?

$$Na_2O(s) + H_2O(l) \rightarrow 2\ NaOH(s)$$

$H_2(g) + (½)\ O_2(g) \rightarrow H_2O(l)$ $\Delta H° = -\ 286$ kJ
$2\ Na(s) + (½)\ O_2(g) \rightarrow Na_2O(s)$ $\Delta H° = -\ 414$ kJ
$Na(s) + (½)\ O_2(g) + (½)\ H_2(g) \rightarrow NaOH(s)$ $\Delta H° = -\ 425$ kJ
(A) -1,125 kJ (B) -978 kJ (C) -722 kJ (D) -150 kJ (E) +275 kJ

10.____________ A hydrocarbon gas with an empirical formula CH_2 has a density of 1.88 grams per liter at 0 °C and 1.00 atmospheres. A possible formula for the hydrocarbon is:
(A) CH_2 (B) C_2H_4 (C) C_3H_6 (D) C_4H_8 (E) C_5H_{10}

11.____________ A sample of 3.30 grams of an ideal gas at 150.0 °C and 1.25 atmospheres pressure has a volume of 2.00 liters. What is the molar mass of the gas? (The gas constant, R, is 0.0821 L atm $mol^{-1}\ K^{-1}$).
(A) 0.0218 gram/mole (B) 16.2 grams/mole (C) 37.0 grams/mole
(D) 45.8 grams/mole (E) 71.6 grams/mole

12.____________ $4\ HCl(g) + O_2(g) <===> 2\ Cl_2(g) + 2\ H_2O(g)$

Equal numbers of moles of HCl and O_2 in a closed system are allowed to reach equilibrium as represented by the equation above. Which of the following must be true at equilibrium?

I. [HCl] must be less than [Cl_2].

II. [O_2] must be greater than [HCl].

III. [Cl_2] must equal [H_2O].

(A) I only (B) II only (C) I and III only (D) II and III only (E) I, II, and III

13.____________ $2\ SO_2(g) + O_2(g) <===> 2\ SO_3(g)$

When 0.40 mole of SO_2 and 0.60 mole of O_2 are placed in an evacuated 1.00-liter flask, the reaction represented above occurs. After the reactants and the product reach equilibrium and the initial temperature is restored, the flask is found to contain 0.30 mole of SO_3. Based on these results, the equilibrium constant, K_c for the reaction is

(A) 20. (B) 10. (C) 6.7 (D) 2.0 (E) 1.2

14.____________ A hot-air balloon rises. Which of the following is the best explanation for this observation?

(A) The pressure on the walls of the balloon increases with increasing temperature.

(B) The difference in temperature between the air inside and outside the balloon produces convection currents.

(C) The cooler air outside the balloon pushes in on the walls of the balloon.

(D) The rate of diffusion of cooler air is less than that of warmer air.

(E) The air density inside the balloon is less than that of the surrounding air.

15.____________ $NH_4NO_3(s) \rightarrow N_2O(g) + 2\ H_2O(g)$

A 0.03 mol sample of $NH_4NO_3(s)$ is placed in a 1 L evacuated flask, which is then sealed and heated. NH_4NO_3 decomposes completely according to the balanced equation above. The total pressure in the flask measured at 400 K is closest to which of the following? (The value of the gas constant, R, is 0.082 L atm mol^{-1} K^{-1})

(A) 3 atm (B) 1 atm (C) 0.5 atm (D) 0.1 atm (E) 0.03 atm

16.____________ $C_2H_4(g) + 3\ O_2(g) \rightarrow 2\ CO_2(g) + 2\ H_2O(g)$

For the reaction of ethylene represented above, ΔH is - 1,323 kJ. What is the value of ΔH if the combustion produced liquid water $H_2O(l)$, rather than water vapor $H_2O(g)$? (ΔH for the phase change $H_2O(g) \rightarrow H_2O(l)$ is -44 kJ mol^{-1}.)

(A) -1,235 kJ (B) -1,279 kJ (C) -1,323 kJ (D) -1,367 kJ (E) -1,411 kJ

Questions 17–19 refer to the following gases at 0˚C and 1 atm.

(A) Ne (B) Xe (C) O_2 (D) CO (E) NO

17.____________ Has an average atomic or molecular speed closest to that of N_2 molecules at 0˚C and 1 atm

18.____________ Has the greatest density

19.____________ Has the greatest rate of effusion through a pinhole

20.____________ A flask contains 0.25 mole of $SO_2(g)$, 0.50 mole of $CH_4(g)$, and 0.50 mole of $O_2(g)$. The total pressure of the gases in the flask is 800 mm Hg. What is the partial pressure of the $SO_2(g)$ in the flask?

(A) 800 mm Hg (B) 600 mm Hg (C) 250 mm Hg (D) 200 mm Hg (E) 160 mm Hg

$$3\ C_2H_2(g) \rightleftharpoons C_6H_6(g)$$

21. ____________ What is the standard enthalpy change, ΔH°, for the reaction represented above? (ΔH°_f of $C_2H_2(g)$ is 230 kJ mol^{-1}; ΔH°_f of $C_6H_6(g)$ is 83 kJ mol^{-1}.)

(A) –607 kJ (B) –147 kJ (C) –19 kJ (D) +19 kJ (E) +773 kJ

22. ____________ A 2 L container will hold about 4 g of which of the following gases at 0˚C and 1 atm?

(A) SO_2 (B) N_2 (C) CO_2 (D) C_4H_8 (E) NH_3

$CS_2(l) + 3\ O_2(g)$ □ $CO_2(g) + 2\ SO_2(g)$

31. What volume of $O_2(g)$ is required to react with excess $CS_2(l)$ to produce 4.0 L of $CO_2(g)$? (Assume all gases are measured at 0˚C and 1 atm.)

(A) 12 L (B) 22.4 L (C) $^1/_3$ □ 22.4 L (D) 2 □ 22.4 L (E) 3 □ 22.4 L

$HCO_3^-(aq) + OH^-(aq) \leftrightarrow H_2O(l) + CO_3^{2-}(aq)$ $\Delta H = -41.4$ kJ

37. When the reaction represented by the equation above is at equilibrium at 1 atm and 25˚C, the ratio $\frac{[CO_3^{2-}]}{[HCO_3^-]}$ can be increased by doing which of the following?

(A) Decreasing the temperature (B) Adding acid
(C) Adding a catalyst (D) diluting the solution with distilled water
(E) Bubbling neon gas through the solution

40. An excess of Mg(*s*) is added to 100. mL of 0.400 *M* HCl. At 0˚C and 1 atm pressure, what volume of H_2 gas can be obtained?

(A) 22.4 mL (B) 44.8 mL (C) 224 mL (D) 448 mL (E) 896 mL

$H_2(g) + Br_2(g) \leftrightarrow 2\ HBr(g)$

42. At a certain temperature, the value of the equilibrium constant, *K*, for the reaction represented above is 2.0□10^5. What is the value of *K* for the reverse reaction at the same temperature?

(A) -2.0 □ 10^{-5} (B) 5.0 □ 10^{-6} (C) 2.0 □ 10^{-5} (D) 5.0 □ 10^{-5} (E) 5.0 □ 10^{-4}

53. According to the VSEPR model, the progressive decrease in the bond angles in the series of molecules CH_4, NH_3, and H_2O is best accounted for by the

(A) increasing strength of the bonds
(B) decreasing size of the central atom
(C) increasing electronegativity of the central atom
(D) increasing number of unshared pairs of electrons
(E) decreasing repulsion between hydrogen atoms