Name _____ AP Chemistry October 29, 2013

AP Chemistry Exam II
Part I: 40 Questions, 40 minutes, Multiple Choice, No Calculator Allowed
Bubble the correct answer on your scantron for each of the following.

For questions 1-6 consider the following system at equilibrium:

$2N_2O(g) \rightleftharpoons 2N_2(g) + O_2(g)$ $\Delta H = -163$ kJ

and select from the following choices:

a. to the right
b. to the left
c. neither
d. in both directions
e. cannot be determined from information provided

1. In which direction will the system move in order to reestablish equilibrium if the temperature is raised?
2. In which direction will the system move in order to reestablish equilibrium if a sample of Ar is added?
3. In which direction will the system move in order to reestablish equilibrium if the volume is decreased?
4. In which direction will the system move in order to reestablish equilibrium if a catalyst is added?
5. In which direction will the system move in order to reestablish equilibrium if N_2O is added?
6. In which direction will the system move in order to reestablish equilibrium if O_2 is removed?

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

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}

8. 100 grams of $O_2(g)$ and 100 grams of He(g) are in separate containers of equal volume. Both gases are at 100ºC. Which of the following statements is true?

a. Both gases would have the same pressure.
b. The average kinetic energy of the O_2 molecules is greater than that of the He molecules.
c. The average kinetic energy of the He molecules is greater than that of the O_2 molecules.
d. There are equal numbers of He molecules and O_2 molecules.
e. The pressure of the He(g) would be greater than that of the $O_2(g)$.

9. At constant temperature and pressure, the heats of formation for $H_2O(g)$, $CO_2(g)$ and $C_2H_6(g)$ are as follows:

Species	ΔH (kJ/mole)
$H_2O(g)$	-251
$CO_2(g)$	-393
$C_2H_6(g)$	-84

If ΔH values are negative for exothermic reactions, what is the ΔH for 1 mole of C_2H_6 gas to oxidize to carbon dioxide gas and water vapor (temperature and pressure are held constant)?

a. -8730 kJ/mole b. -2910 kJ/mole c. 1455 kJ/mole
d. -1455 kJ/mole e. 2910 kJ/mole

10. In expanding from 5.00 to 6.00 liters at a constant pressure of 2.00 atmospheres, a gas absorbs 505.64 joules of energy (101.32 J = 1 liter atm). The change in energy ΔE for the gas is:

a. 50.66 J b. 101.32 J c. 303.00 J d. 505.64 J e. 606.00 J

11. A 3.00-liter flask initially contains 1.50 mol of gas A and 0.450 mol of gas B. Gas A decomposes according to the following reaction: $3A \rightleftharpoons 2B + C$ The equilibrium concentration of gas C is 0.100 mol/L. Determine the equilibrium concentration of gas A.

a. 0.200 M b. 0.100 M c. 0.300 M d. 0.500 M e. none of these

12. Which of the following statements correctly describes the signs of q and w for the following exothermic process at P = 1 atm and T = 370 K? $H_2O(g) \rightarrow H_2O(l)$

a. q and w are both positive b. q and w are negative c. q is negative, w is positive
d. q is positive, w is negative e. q and w are both zero.

13. Which of the following would express the approximate density of carbon dioxide gas at 0°C and 4.00 atm pressure (in grams per liter)?

a. 2 g/L b. 4 g/L c. 6 g/L d. 8 g/L e. none of the above

14. Given these two standard enthalpies of formation:

Reaction 1: $S(s) + O_2(g) \rightleftharpoons SO_2(g)$ $\Delta H° = -295$ kJ/mole

Reaction 2: $S(s) + \frac{3}{2} O_2(g) \rightleftharpoons SO_3(g)$ $\Delta H° = -395$ kJ/mole

What is the heat of reaction for $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ under the same conditions?

a. -1380 kJ/mole b. -690. kJ/mole c. -295 kJ/mole
d. -100. kJ/mole e. -200. kJ/mole

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. A sample of 4.0 grams of an ideal gas at 121 °C and 1.0 atmosphere pressure has a volume of 1.5 liters. Which of the following expressions is correct for the molar mass of the gas? The ideal gas constant, R, is 0.08 (L-atm) / (mole K).

a. [(0.08)(400)] / [(4.0)(1.0)(1.5)] b. [(l.0)(l.5)] / [(4.0)(0.08)(400)]
c. [(0.08)(1.0)(1.5)] / [(4.0)(400)] d. [(4.0)(0.08)(1.5)] / (1.0)(400)]
e. [(4.0)(0.08)(400)] / [(1.0)(1.5)]

17. $3\ C_2H_2(g) \rightleftharpoons C_6H_6(g)$

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

18. A sample of 0.0100 mole of oxygen gas is confined at 37° C and 0.216 atmosphere. What would be the pressure of this sample at 15° C and the same volume?

a. 0.0876 atm b. 0.175 atm c. 0.233 atm d. 0.201 atm e. 0.533 atm

19. In which of the following reactions does $\Delta H°_f = \Delta H°_{rxn}$?

a. $O(g) + O_2(g) \rightarrow O_3(g)$ b. $C(diamond) + O_2 \rightarrow CO_2(g)$ c. $H_2(g) + FeO(s) \rightarrow H_2O(l) + Fe(s)$
d. $H_2(g) + S(s) \rightarrow H_2S(g)$ e. none of the reactions

20. Given the following information:

Reaction 1: $H_2(g) + ½\ O_2(g) \rightarrow H_2O(l)$ $\Delta H° = -286$ kJ

Reaction 2: $CO_2(g) \rightarrow C(s) + O_2(g)$ $\Delta H° = 394$ kJ

Reaction 3: $2CO_2(g) + H_2O(l) \rightarrow C_2H_2(g) + \frac{5}{2} O_2(g)$ $\Delta H° = 1300$ kJ

Find $\Delta H°$ for the reaction: $2C(s) + H_2(g) \rightarrow C_2H_2(g)$

a. -226 kJ b. -113 kJ c. 113 kJ d. 226 kJ e. 452 kJ

21. The equilibrium constant for the reaction: $CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$ is 26 at 50ºC. What is the K_c for $3CO_2(g) + 3H_2(g) \rightleftharpoons 3CO(g) + 3H_2O(g)$ at the same temperature?

a. 0.34 b. 5.7×10^{-5} c. 0.038 d. 1.8×10^{4} e. 2.9

22. 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. 45.8 grams/mole c. 37.0 grams/mole
d. 16.2 grams/mole e. 71.6 grams/mole

23. $H_2(g) + CO_2(g) \rightleftharpoons H_2O(g) + CO(g)$

Initially, a sealed vessel contained only $H_2(g)$ with a partial pressure of 6 atm and $CO_2(g)$ with a partial pressure of 4 atm. The reaction above was allowed to come to equilibrium at a temperature of 700 K. At equilibrium, the partial pressure due to CO(g) was found to be 2 atm. What is the value of the equilibrium constant K_p, for the reaction?

a. $\frac{1}{24}$ b. $\frac{1}{6}$ c. $\frac{1}{4}$ d. $\frac{1}{3}$ e. $\frac{1}{2}$

24. What is the heat capacity of mercury if it requires 167 J to change the temperature of 15.0 g mercury from 25.0°C to 33.0°C?

a. 313 J/g °C b. 1.39 J/g °C c. 1.12×10^{-2} J/g °C d. 0.445 J/g °C e. 6.92×10^{-3} J/g °C

25. 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. 88.0 c. 46.0 d. 94.1 e. 138

26. The density of a gas is directly proportional to its

a. molecular velocity b. volume c. kinetic energy d. temperature e. pressure

27. A gaseous mixture containing 7.0 moles of nitrogen, 2.5 moles of oxygen, and 0.50 mole of helium exerts a total pressure of 0.80 atmosphere. What is the partial pressure of the oxygen?

a. 0.10 atm b. 0.20 atm c. 0.27 atm d. 0.80 atm e. 2.0 atm

28. A piece of metal weighing 418.4 grams was put into a boiling water bath. After 10 minutes, the metal was immediately placed in 500.0 grams of water at 40.0°C. The maximum temperature that the system reached was 50.0 °C. What is the specific heat of the metal? The specific heat of the water is 4.184 J/g°C.

a. 0.500 J/g°C b. 1.00 J/g°C c. 2.00 J/g°C d. 4.00 J/g°C e. 8.00 J/g°C

29. Two metals of equal mass with different heat capacities are subjected to the same amount of heat. Which undergoes the smallest change in temperature?

a. The metal with the higher heat capacity b. The metal with the lower heat capacity.
c. Both undergo the same change in temperature d. You need to know the initial temperatures of the metals.
e. You need to know which metals you have.

30. For a certain reaction at 298K, the value of K is 1.2×10^{-3}. At 323K the value of K is 3.4×10^{-4}. This means that the reaction is:

a. endothermic. b. exothermic. c. never favorable.
d. More information is needed. e. None of these.

31. $CH_4(g) + 2\ O_2(g) \rightarrow CO_2(g) + 2\ H_2O(l)$; $\Delta H = -889.1$ 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. -107.5 kJ/mole b. -75.8 kJ/mole c. -210.0 kJ/mole
d. 75.8 kJ/mole e. 210.0 kJ/mole

32. 9.0 moles of chlorine gas are placed in a 3.0 L flask at 1250 K. At this temperature, the chlorine molecules begin to dissociate into chlorine atoms. What is the value of K_c, if 50.% of the chlorine molecules dissociate when equilibrium has been achieved?

a. 1.0 b. 3.0 c. 4.0 d. 6.0 e. 12.0

33. A hydrocarbon gas with an empirical formula CH_2 has a density of 1.88 grams per liter at 0 °C and 1.00 atmosphere. A possible formula for the hydrocarbon is

a. C_2H_4 b. C_3H_6 c. C_6H_{12} d. C_4H_8 e. C_5H_{10}

34. Sulfur trioxide gas dissociates into sulfur dioxide gas and oxygen gas at 1250°C. In an experiment 3.90 moles of sulfur trioxide were placed into an evacuated 3.0 L flask. The concentration of sulfur dioxide gas measured at equilibrium was found to be 0.30 M. What is the equilibrium constant K_c, for the reaction?

a. 1.3 b. 1.7 c. 8.0×10^{-3} d. 1.4×10^{-2} e. 4.5×10^{-2}

35. 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

36. 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

37. A sealed isothermal container initially contained 2 moles of CO gas and 3 moles of H_2 gas. The following reversible reaction occurred: $CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$

At equilibrium, there was 1 mole of CH_3OH in the container. What was the total number of moles of gas present in the container at equilibrium?

a. 5 b. 4 c. 3 d. 2 e. 1

Questions 38–40 refer to the following gases at 0˚C and 1 atm.

a. Ne b. Xe c. O_2 d. CO e. NO

38. Has an average atomic or molecular speed closest to that of N_2 molecules at 0˚C and 1 atm
39. Has the greatest density
40. Has the greatest rate of effusion through a pinhole