ENGINEERING

CHEMISTRY

Assignment Part

For

ENGINEERING AND APPLIED SCIENCE

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by

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1- A balloon has a volume of 2.32 liters at 24.0°C. The balloon is heated to 48.0°C. Calculate the new volume of the balloon. (2.51 L)

2- You are holding two balloons, an orange balloon and a blue balloon. The orange balloon is filled with neon (Ne) gas and the blue balloon is filled with argon (Ar) gas. The orange balloon has twice the volume of the blue balloon. Which of the following best represents the mass ratio of Ne:Ar in the balloons? (1:1)

3- A gas sample is heated from -20.0°C to 57.0°C and the volume is increased from 2.00 L to 4.50 L. If the initial pressure is 0.140 atm, what is the final pressure? (0.0811 atm)

4- Mercury vapor contains Hg atoms. What is the volume of 201 g of mercury vapor at 822 K and 0.512 atm? (132 L)

5- An automobile tire is filled with air at a pressure of 27.0 lb/in^2 at 25°C. A cold front moves through and the temperature drops to 5°C. Assuming no change in volume, what is the new tire pressure? (25.2 lb/in^2)

6- The mass of 1.12 liters of gas Y at STP is found to be 6.23 g. what is the molar mass of gas Y? (125 g/mol)

7- Given reaction $2NH_3(g) + 3Cl_2(g) \rightarrow N_2(g) + 6HCl(g)$, you react 5.0 L of NH_3 with 5.0 L of Cl_2 measured at the same conditions in a closed container. Calculate the ratio of pressures in the container ($P_{final}/P_{initial}$). (1.33)

8- A 3.54 gram sample of a certain diatomic gas occupies a volume of 3.30-L at 1.00 atm and a temperature of 45°C. Identify this gas. (N_2)

9- You carry out the reaction represented by the following balanced equation $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

You add an equal number of moles of nitrogen and hydrogen gases in a balloon. The volume of the balloon is 1.00 L before any reaction occurs. Determine the volume of the balloon after the reaction is complete. Assume constant temperature. (0.67 L)

10- What volume does 40.5 g of N2 occupy at STP? (32.4 L)

11- A 3.31-g sample of lead nitrate, $Pb(NO_3)_2$, molar mass = 331 g/mol, is heated in an evacuated cylinder with a volume of 2.37 L. The salt decomposes when heated, according to the equation:

$$2Pb(NO_3)_2(s) \rightarrow 2PbO(s) + 4NO_2(g) + O_2(g)$$

Assuming complete decomposition, what is the pressure in the cylinder after decomposition and cooling to a temperature of 300. K? Assume the $PbO_{(s)}$ takes up negligible volume. (0.260 atm)

12- A 1.00-g sample of a gaseous compound of boron and hydrogen occupies 0.820 L at 1.00 atm and 3°C. What could be the molecular formula for the compound? (B_2H_6)

13- A gaseous mixture containing 1.5 mol Ar and 3.5 mol CO_2 has a total pressure of 7.3 atm. What is the partial pressure of CO_2? (5.1 atm)

14- Calculate the density of F_2 gas at 26°C and 755 torr. (1.54 g/L)

15- A sample of gas occupies 20.0 liters at 32 ^{0}C when the pressure is 0.750 atm. What temperature in ^{0}C is required to increase the volume to 25.0 liters at a pressure of 0.680 atm? (72.7 ^{0}C)

16- A sample of a gas occupies a volume of 2.62 liters at 25 ^{0}C and 1.00 atm. What will be the volume at 50.0 ^{0}C and 2.00 atm? (1.42 L)

17- Consider the reaction between Mg(s) and HCl(aq) to produce aqueous magnesium chloride and hydrogen gas. How many liters of hydrogen gas at STP will be produced when 12.15 g of magnesium reacts with an excess of hydrochloric acid? (11.2 L)

18 What is the kinetic energy of a 1.56-kg object moving at 94.0 km/hr?

(5.32×10^2 kJ)

19- One mole of an ideal gas is expanded from a volume of 1.00 liter to a volume of 8.93 liters against a constant external pressure of 1.00 atm. How much work (in joules) is performed on the surroundings? Ignore significant figures for this problem. (T = 300 K; 1 L·atm = 101.3 J) (803 J)

20- How much heat is required to raise the temperature of a 5.75-g sample of iron (specific heat = 0.450 J/g°C) from 25.0°C to 79.8°C? (142 J)

21- A 32.5 g piece of aluminum (which has a molar heat capacity of 24.03 J/°C·mol) is heated to 82.4°C and dropped into a calorimeter containing water (specific heat capacity of water is 4.18 J/g°C) initially at 22.3°C. The final temperature of the water is 24.2°C. Ignoring significant figures, calculate the mass of water in the calorimeter. (212 g)

22- 30.0 mL of pure water at 282 K is mixed with 50.0 mL of pure water at 306 K. What is the final temperature of the mixture? (297 K)

23- Calculate ΔH° for the reaction $C_4H_4(g) + 2H_2(g) \rightarrow C_4H_8(g)$, using the following data:

$\Delta H°_{combustion}$ for $C_4H_4(g) = -2341$ kJ/mol
$\Delta H°_{combustion}$ for $H_2(g) = -286$ kJ/mol
$\Delta H°_{combustion}$ for $C_4H_8(g) = -2755$ kJ/mol

(–158 kJ)

24- the following reaction:

$2Al(s) + 3Cl_2(g) \rightarrow 2AlCl_3(s)$; $\Delta H = -1390.81$ kJ

a) Is the reaction exothermic or endothermic?

b) How much heat is produced/required when 10.0 g AlCl3 forms. (52.2 KJ)

c) How many grams of Al are required to absorb/evolve 1.00 kJ of energy?

(0.0388 g Al)

25- How much heat is liberated at constant pressure when 2.35 g of potassium metal reacts with 5.68 mL of liquid iodine monochloride (d = 3.24 g/mL)?

$2K(s) + ICl(l) \rightarrow KCl(s) + KI(s)$ $\Delta H^\circ = -740.71$ kJ/mol

(2.23×10^1 kJ)

26- If the change in entropy of the surroundings for a process at 431 K and constant pressure is –326 J/K, what is the heat flow absorbed by for the system? (141 KJ)

27- The heat of vaporization for 1.0 mole of water at 100.°C and 1.0 atm is 40.56 kJ/mol. Calculate ΔS for the process $H_2O(l) \rightarrow H_2O(g)$ at 100.°C. (109 J/K.mol)

28- The enthalpy of vaporization of ammonia is 23.35 kJ/mol at its boiling point (–33.4°C). Calculate the value of ΔSsurr when 1.00 mole of ammonia is vaporized at –33.4°C and 1.00 atm. (-9.74×10^1 J/K mol)

29- For the process $CHCl_3(s) \rightarrow CHCl_3(l)$, $\Delta H° = 9.19$ kJ/mol and $\Delta S° = 43.9$ J/mol/K. What is the melting point of chloroform? (–64 °C)

30- For the process of a certain liquid vaporizing at 1 atm, $\Delta H°vap = 54.2$ kJ/mol and $\Delta S°vap = 74.1$ J/mol K. Assuming these values are independent of T, what is the normal boiling point of this liquid? (458 °C)

31- Given that $\Delta Hvap$ is 53.3 kJ/mol, and the boiling point is 83.4°C, 1 atm, if one mole of this substance is vaporized at 1 atm, calculate ΔG. (0 J)

32- For the reaction $Cl_2O(g) + 3/2\,O_2(g) \rightarrow 2ClO_2(g)$

$\Delta H° = 126.4$ kJ/mol and $\Delta S° = -74.9$ J/K mol. At 361°C, what is ΔG ?

(173.9 kJ/mol)

33- Given the following data (ΔH_f, S°, respectively) for N_2O_4(l) -20. kJ/mol, 209.0 J/K mol, and N_2O_4(g) 10. kJ/mol, 304.2 J/K mol. What is temperature (in °C) is the vaporization of N_2O_4 liquid spontaneous?

(Above 42 °C.)

34- Consider the reaction: $2SO_2(g) \rightleftharpoons 2SO_3(g)$

for which ΔH° = –200. kJ and ΔS° = –187.1 J/K at 25°C. Assuming that ΔH° and ΔS° are independent of temperature, calculate the temperature where Kp = 1. (1069 K)

35- The standard free energy of formation of nitric oxide, NO, at 1000. K (roughly the temperature in an automobile engine during ignition) is 77.9 kJ/mol. Calculate the equilibrium constant for the reaction at 1000 K

$N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$ (7.27×10^{-9})

35- Water gas, a commercial fuel, is made by the reaction of hot coke carbon with steam.

$$C(s) + H_2O(g) \rightleftharpoons CO(g) + H_2(g)$$

When equilibrium is established at 844°C the concentrations of CO, H_2, and H_2O are 4.00×10^{-2}, 4.00×10^{-2}, and 1.00×10^{-2} mole/liter, respectively. Calculate the value of $\Delta G°$ for this reaction at 844°C.

(17.02 kJ)

36- Calculate the Gross and Net calorific values of a coal having the following compositions, C = 80 %, H_2 =08 %, O_2 = 08 %, S = 2 % and ash=2. Latent heat of steam is = 587 cal/gm.

(8923.8 Kcal/kg, 8501.16 Kcal/kg)

37- Calculate the Gross and Net calorific values of a coal having the following compositions, C = 63 %, H_2 = 19 %, O_2 = 3%, S = 13 % and ash=2. Latent heat of steam is = 587 cal/gm.

(11807.22 Kcal/kg, 10803.45 Kcal/kg)

38- On analysis, a coal sample has the following composition by weight; C = 75 %, O_2 = 04 %, S = 05 %, and ash = 3%. Net calorific value of the fuel is 9797.71kcal / kg. Calculate the percentage of hydrogen and gross calorific value of coal. (13%)

39- calculate the volume of air needed for the combustion of 1kg of carbon (8888.9 L)

40- How do you calculate the volume of oxygen required for the complete combustion of 0.25 dm^3 of methane at STP? (0.5 dm^3)

41- Calculate the weight and volume of air required for complete combustion of 5kg coal with following composition, C = 85%, H = 10 %, O= 5%. (65.4 kg, 50620.6 mL)

42- 1.68 L of an aqueous solution containing 25.00 g of KCl dissolved in pure water is prepared. What is the molarity of the solution? (0.2 M)

43- What volume of a 0.771 M solution of $CaCl_2$ contains 1.28 g of solute? (15 mL)

44- A solution containing 306.5 g of $Mg(NO_3)_2$ per liter has a density of 1.114 g/mL. What is the molarity of the solution? (2.066 M)

45- What is the molality of a solution of 30.1 g of propanol ($CH_3CH_2CH_2OH$) in 152 mL water, if the density of water is 1.00 g/mL? (3.29 m)

46- A 3.140 molal solution of NaCl is prepared. How many grams of NaCl are present in a sample containing 2.314 kg of water? (424.8 g)

47- A 20.0-g sample of methyl alcohol (CH_3OH, molar mass = 32.04 g/mol) was dissolved in 43.3 g of water. What is the mole fraction of CH_3OH? (0.206)

48- Find the mass percent of $CaCl_2$ in a solution whose molarity is 2.20 M and whose density is 1.18 g/mL? (20.7 %)

49- The term "proof" is defined as twice the percent by volume of pure ethanol in solution. Thus, a solution that is 95% (by volume) ethanol is 190 proof. What is the molarity of ethanol in a 92 proof ethanol/water solution?

density of ethanol = 0.8 g/cm3

density of water = 1.0 g/cm3

mol. wt. of ethanol = 46 g/mol

(8.0 M)

50- When 0.811 g of NH_4NO_3 was added to 150.0 g of water in a Styrofoam cup, the temperature dropped by 0.413°C. The heat capacity of H_2O is 4.18 J/g°C. Assume the specific heat of the solution equals that of pure H_2O and that the calorimeter neither absorbs nor leaks heat. What is the molar heat of solution of solid NH_4NO_3?: (+ 25.7 kJ/mol)

51- The vapor pressure of water at 25.0°C is 23.8 torr. Determine the mass of glucose (molar mass = 180 g/mol) needed to add to 500.0 g of water to change the vapor pressure to 22.8 torr. (219 g)

52- An ideal solution is formed from a mixture of the nonvolatile solute urea, $CO(NH_2)_2$, and methanol, CH_3OH. The vapor pressure of pure methanol at 20°C is 89 mmHg. If 4.4 g of urea is mixed with 39.9 g of methanol, calculate the vapor pressure of the methanol solution. (84 mmHg)

53- At 40°C, heptane has a vapor pressure of about 92.2 torr and octane has a vapor pressure of about 31.2 torr. Assuming ideal behavior, what is the vapor pressure of a solution that contains twice as many moles of heptane as octane? (71.9 torr)

54- Consider a solution containing liquids A and B where the mole fraction of B is 0.60. Assuming ideality, calculate the mole fraction of B in the vapor at equilibrium with this solution at 25°C. (The vapor pressures of pure liquid A and B at 25°C are 129.4 torr and 400.0 torr, respectively.)

(0.82)

55- The freezing point (T_f) for t-butanol is 25.50°C and K_f is 9.1°C/m. Usually t-butanol absorbs water on exposure to the air. If the freezing point of a 12.9-g sample of t-butanol is measured as 24.59°C, how many grams of water are present in the sample? (0.023 g)

56- Determine the osmotic pressure of a solution that contains 0.048 g of a hydrocarbon solute (molar mass = 340 g/mol) dissolved in benzene to make a 350-mL solution. The temperature is 20.0°C. (7.4 torr)

57- Calculate the molarity of a solution containing KCl and water whose osmotic pressure at 21.6°C is 125 torr. Assume complete dissociation of the salt. (0.00340 M)

58- You have a 10.40-g mixture of table sugar ($C_{12}H_{22}O_{11}$) and table salt (NaCl). When this mixture is dissolved in 150. g of water, the freezing point is found to be –2.24°C. Calculate the percent by mass of sugar in the original mixture. (53.9 %)

59- For the reaction given below, 2.00 moles of A and 3.00 moles of B are placed in a 6.00-L container. $A(g) + 2B(g) \rightleftharpoons C(g)$

At equilibrium, the concentration of A is 0.246 mol/L. What is the concentration of B at equilibrium? (0.325 mol/L)

60- Determine the equilibrium constant for the system $N_2O_4 \rightleftharpoons 2NO_2$ at 25°C. concentrations are shown here: $[N_2O_4] = 2.32\times10^{-2}$ M, $[NO_2] = 1.41\times10^{-2}$ M.

(8.57×10^{-3})

61- A gas sample is heated from -20.0°C to 57.0°C and the volume is increased from 2.00 L to 4.50 L. If the initial pressure is 0.140 atm, what is the final pressure? (0.0811 atm)

62- Consider the following reaction: $CS_2(g) + 4H_2(g) \rightarrow CH_4(g) + 2H_2S(g)$. The equilibrium constant K is about 0.31 at 900.°C. What is Kp at this temperature? (3.3×10^{-5})

63- Consider the following equilibrated system: $2NO_2(g) \rightarrow 2NO(g) + O_2(g)$. If the Kp value is 0.604, find the equilibrium pressure of the O_2 gas if the NO_2 gas pressure is 0.520 atm and the PNO is 0.300 atm at equilibrium.

(1.81 atm)

64- At a certain temperature K for the reaction $2NO_2 \rightarrow N_2O_4$ is 7.5 liters/mole. If 2.0 moles of NO_2 are placed in a 2.0-liter container and permitted to react at this temperature, calculate the concentration of N_2O_4 at equilibrium. (0.39 moles/liter)

65- Calculate the $[H^+]$ in a solution that has a pH of 9.88. $(1.3 \times 10^{-10}\ M)$

66- Calculate The pH of a solution at 25°C in which $[OH^-] = 3.9 \times 10^{-5}\ M$

(9.59)

67- Solid calcium hydroxide is dissolved in water until the pH of the solution is 11.44. The hydroxide ion concentration $[OH^-]$ of the solution.

(2.8×10^{-3} M)

68- At 65°C, the ion-product constant of water, Kw, is 1.20×10^{-13}. Calculate the pH of pure water at 65°C. (132 L)

69- What volume of water must be added to 11.1 mL of a pH 2.0 solution of HNO3 in order to change the pH to 4.0? (1.10×10^3 mL)

70 -For nitrous acid, HNO_2, Ka = 4.0×10^{-4}. Calculate the pH of 0.27 M HNO_2. (1.98)

70- Calculate the pOH of a 0.12 M solution of acetic acid (Ka = 1.8×10^{-5}). (11.17)

71- Determine the concentration of a solution of the weak acid $HClO_2$ (Ka = 1.10×10^{-2}) if it has a pH of 1.075. (0.644 M)

72- How many moles of benzoic acid, a monoprotic acid with Ka = 6.4 x 10^{-5}, must be dissolved in 250. mL of H_2O to produce a solution with pH = 2.04? (0.32 mole)

73- When 2.5 x 10^{-2} mol of nicotinic acid (a monoprotic acid) is dissolved in 350 mL of water, the pH is 3.05. Calculate the Ka of nicotinic acid.

(1.1×10^{-5})

74- Approximately how much water should be added to 10.0 mL of 11.1 M HCl so that it has the same pH as 0.90 M acetic acid ($K_a = 1.8 \times 10^{-5}$)?

(28 L)

75- A solution of 2.9 M weak acid is 0.52% ionized. What is the Ka value of this acid? (7.9 x 10–5)

76- The pain killer morphine is a weak base when added to water. The K_b is 1.6×10^{-6}. What is the pH of a 4.33×10^{-3} M solution of morphine? (9.92)

77- The pH of a 0.150 M solution of a weak base is 10.98. Calculate the pH of a 0.0603 M solution of the base. (10.78)

78- Given that the Ka for HOCl is 3.45×10^{-8}, calculate the K value for the reaction of HOCl with OH^-. (3.45 x 106)

79- 15.0 mL of 0.50 M NaOH is added to a 100.-mL sample of 0.457 M NH_3 (K_b for NH_3 = 1.8 x 10–5). What is the equilibrium concentration of NH^{4+} ions? (1.1×10^{-4} M)

80- A 100. mL sample of 0.10 M HCl is mixed with 50. mL of 0.11 M NH_3. What is the resulting pH? (K_b for NH_3 = 1.8 x 10^{-5}) (1.52)

81- Consider the titration of 300.0 mL of 0.577 M NH3 (K_b = 1.8 x 10^{-5}) with 0.500 M HNO_3. After 150.0 mL of 0.500 M HNO_3 have been added, what's the pH of the solution? (9.37)

82- A 75.0-mL sample of 0.0650 M HCN (Ka = 6.2 x 10^{-10}) is titrated with 0.65 M NaOH. What volume of 0.65 M NaOH is required to reach the stoichiometric point? (7.5 mL)

83- A 25.00-mL sample of propanoic acid, CH_3CH_2COOH, of unknown concentration was titrated with 0.111 M KOH. The equivalence point was reached when 44.54 mL of base had been added. What is the concentration of the propanoate ion at the equivalence point? (0.0711 M)

84- The molar solubility of PbI_2 is 1.52×10^{-3} M. Calculate the value of Ksp for PbI_2. (1.40×10^{-4})

85- A 300.0-mL saturated solution of copper (II) peroidate, $Cu(IO_4)_2$, contains 0.30 grams of dissolved salt. Determine the Ksp. (4.5×10^{-8})

86- Calculate the concentration of the silver ion in a saturated solution of silver chloride, AgCl ($K_{sp} = 1.57 \times 10^{-10}$). ($1.25 \times 10^{-5}$)

87- What is the molar solubility of $BaCO_3$ ($K_{sp} = 1.6 \times 10^{-9}$) in 0.10 M $BaCl_2$ solution?

88- Chromate ion is added to a saturated solution of Ag_2CrO_4 to reach 0.78 M CrO_4^{-2}. Calculate the final concentration of silver ion at equilibrium (Ksp for Ag_2CrO_4 is 9.0×10^{-12}). (3.4×10^{-6})

89- How many moles of CaF_2 will dissolve in 3.0 liters of 0.089 M NaF solution? (Ksp for $CaF_2 = 4.0 \times 10^{-11}$) ($1.5 \times 10^{-8}$)

الكيمياء الهندسية

(جزء التمارين)

للهندسة والعلوم التطبيقية

2019

دكتور

علاء الدين السيد حسانين

كيمياء – قسم العلوم الأساسية

معهد المستقبل العالى للهندسة والتكنولوجيا