1. State the combined gas law. Derive from this law the molar volume of a gas at STP. What would be the value of R if it were expressed in liter-Torr/mole K ?

2. Describe the kinetic theory of gases. Use the theory to explain Boyle's Law, Charles' law, and the law of partial pressures.

3. True or false? If false explain why. a)Equal volumes of all gases contain the same number of molecules. b)equal volumes of all ideal gases at STP contain the same number of atoms. c)of two gases containing the same number of molecules and having the same volume, the hotter one is at a higher pressure. d)Of two gases at the same temperature, the one having the heavier molecules will have greater kinetic energy. e)when two gases are at the same temperature, molecular motion is slower in the lighter gas. f) the same weights of two different gases are confined in equal volumes at the same temperature. The one with the smaller molecular weight will exert a greater pressure. g) A temperature of 400°C indicates twice the average kinetic energy of a temperature of 200°C. h) The average speed of molecular motion is twice as high at 400 K as it is at 100 K. i) molecules of molecular weight 16 move twice as fast as molecules of molecular weight 32 at the same temperature.

4. In a gaseous mixture at 20°C and 780 Torr there are three gases. 25.6% of the mixture is hydrogen, 20.2% is CO2, and the rest is nitrogen. What is the partial pressure of each gas? (Note that in gaseous mixtures, the % is usually the % by volume.)

5. 2.0 g of an ideal gas occupies 2.00 liters at STP. What is the new volume

 at 1)0°C and 720 torr 2) 27°C and 760 torr 3)27°C and 720 torr.

 4)what is the molecular weight of the gas?

6. 500 ml. of O2 at a pressure of 600 torr are expanded into a 1.00 liter flask.

 Into the same flask are compressed 1500 ml. of N2, originally at a pressure

 of 500 torr. Find the total pressure in the flask.

7. A gas occupies 825 ml. at -30°C and 0.556 atmospheres. What is the new

 pressure if the volume becomes 1000. ml. at a temperature of 20° C?

8. The density of a gas at standard temp. and pressure is 1.942 g/l. What is its density at 25°C and 770 torr? Derive an equation which relates density to molecular weight, pressure and temperature. What is the molecular weight of the above gas?

9. 12,800 ml. of a gas at 39°C and 0.5 atm. weighs 1.000 g. Find at STP a) the volume b) the weight in grams of one liter c) the molecular weight d) the density.

10. 300. ml of a gas at 293K, 400 torr, weighs 0.10 grams. a)What would be the

 volume of 0.050 g of that gas at 303 K and 900 torr? b) At what temperature

 would 0.20 g of this gas exert a pressure of 500 torr in a volume of 250 ml.?

11.Exactly 100 ml of oxygen is collected over water at 23°C and an atmospheric pressure of 800 torr. What would the volume of that amount of dry oxygen be at STP?

12. How many liters of hydrogen gas, measured at 20oC and 740 torr will be

 evolved by the action of excess dilute H2SO4 on 100 g of pure Zn?

13. Suppose that 4.20 g of N2 and 3.20 g of O2 are mixed and placed in a container that

holds some liquid alcohol at 0°C. If the volume of the gas phase is 7.60 liter and the pressure is 572 Torr, what is the vapor pressure of the alcohol at 0o C?

14. 0.2350 g of a liquid is vaporized. The volume of displaced air measured over water

in a gas buret is 40.2 ml. at 23°C and 730 torr. Find the molecular weight of the vaporized material.

15. Equal volumes of H2 and O2, both at room temperature, and standard pressure were introduced into an empty reaction bomb. The bomb was sealed and heated to 120°; at this temperature the pressure of the mixture of unreacted gases was 100 torr. A spark in the container caused the gases to react, forming water. Assuming all remaining gases behave ideally, what is the pressure in the bomb when the temperature is brought back to 120°C?

16. A 20. liter vessel contains 1.0 mole of H2 and 1.0 mole of O2. When the mixture is ignited with a spark the reaction proceeds to completion. The system is then cooled to 27o C. What is the final pressure in the vessel?

17. An organic liquid is 24.77% C, 2.08% H, and 73.15 % Cl. 0.0922 g of this vapor

 occupy 183 ml. at 100°C and 122 mm of Hg. Find the molecular formula of the liquid.

18. An evacuated Dumas bulb weighs 18.5670 g. Filled with water of density

0.997 g/ml it weighs 43.7750 g. The bulb filled with a vapor weighs 18.7645 grams. The temperature is 22°C, pressure is 748 torr. Find the molecular mass of the vapor.

19. What volume of hydrogen, measured at 745 torr and 27° C will react with

 2.00 moles of Cl2 to form HCl?

20. What is the density of oxygen at 100° C and 700 Torr? How much does

 3 liters of H2 weigh at -20°C and a pressure of 3 atmospheres?

21. A mixture of 0.10 g of H2 and 0.70 g of N2 is to be stored at 760 mm of Hg

 and 26oC. What must the volume of the container be, assuming ideal behavior?

22. What is the mass of 1.24 liters of nitrogen at 25°C and 770 torr?

23. What is the density of ammonia at 25°C and 770 torr?

24. Calculate the molecular mass of a gas if 0.30 g occupies 250. ml. at STP.

25. 0.121 g of H2 and 1.60 g of O2 are injected into an empty box which has a volume of

246 ml. and is kept at 273°C. Assuming no reaction, what is the pressure in the box?

b) A spark causes the two gases to react to form water. What will be the final pressure in the box if the volume and temperature remain the same?

26. 400 ml. of an organic vapor weighed 0.514 g at 27o and 750 torr.

 Chemical analysis gave 37.52% C, 12.56% H, and 49.90% O. Find the empirical

 formula, the molecular mass, and the molecular formula.

27. A chemist found that the vapor produced from 0.443 g of a volatile liquid

 occupied a volume of 134 ml.at 200° C and standard pressure. Find the

 molecular weight of the liquid.

28. If the average velocity of H2molecules is one mile per second at room

 temperature, find the average velocity of N2 molecules at that temperature.

29. The pressure in a vessel of pure oxygen dropped from 2000 mm to 1500 mm in 47 minutes when some O2 diffused out. When filled with another gas, the pressure dropped from 2000mm to 1500 mm in 94 minutes. Find the molecular weight of the second gas.

30. How are the factors which cause deviations from ideal gas behavior taken

 into account in the van der Waals equation?

31. What is meant by critical temperature? Critical pressure?

32.The critical temperatures of oxygen and carbon dioxide, respectively, are -120oC and 31.1oC. At 25oC and ten atmospheres which behaves more ideally? Why? How does the critical temperature serve as an indication of the strengths of intermolecular attractive forces?

33. What happens to the temperature of a gas when it expands rapidly through a

 small opening? Why does this happen?

Gas problems from AP exams.

I. 2 NaOOCH + H2SO4 ⭢ 2 CO + 2 H2O + Na2SO4

A 0.964 g sample of a mixture of sodium formate and NaCl is analyzed by adding sulfuric acid. The reaction of sodium formate with sulfuric acid is given above. The carbon monoxide formed measures 242 ml. when collected over water at 753 torr and 22.0°C. Calculate the % of sodium formate in the original mixture.

II. A 2.000 gram sample containing graphite (C) and an inert substance was burned in

oxygen and produced a mixture of carbon dioxide and carbon monoxide in a mole ratio of 2.00 to 1.00. The volume of oxygen consumed was 747.0 ml. at 1092 K and 12.00 atmospheres. Calculate the % by mass of graphite in the original mixture.

III. A vessel contains 142 grams of chlorine gas and 3.0 moles of Ar gas at 0oC and a total

 pressure of 4.0 atm.

a)Calculate the volume of the vessel and the partial pressure of each gas.

b) When sodium metal weighing 46.0g. is introduced into the vessel, a reaction occurs and one of the reactants is completely consumed. What is the mass of the NaCl formed?

c)Ignoring any solid materials, calculate the partial pressures of any gases present after the reaction in part b is complete, and the temperature has been brought back to 0oC.

IV. When propane is burned in oxygen, the reaction proceeds as follows:

 C3H8 + 5 O2 ⭢ 3 CO2 + 4 H2O (all are assumed ideal gases)

 If the reaction is carried out in a mixture prepared by mixing 6.1 g of

 propane and 11.0 liters of O2 measured at 1.0 atm. and 150°C what will be

 the total final volume under the same conditions after the reaction is

 complete?

V. A saturated solution of SO2 was prepared at 27°C and 760 torr. A 5.00 ml.

 sample of this solution was diluted and an excess of potassium iodate solution

 was added. The iodine liberated was equivalent to 32.80 ml. of 0.100 molar

 sodium thiosulfate solution. The reactions are given below:

 5 SO2 + 2 IO3− + 4 H2O ⭢ 5 HSO4− + 3 H+ + I2

 2 S2O32- + I2 ⭢ 2 I− + S4O62−

 a) calculate the moles of I2 liberated. b) calculate the volume of SO2

 needed to prepare 1.00 liter of the saturated sulfur dioxide solution.