Chemistry H: Form TR5.6A — Name ______________________________

TEST 5REVIEW — Date _________________ Period _____

Test Review № 5

Temperature scales. The Celsius scale is based on water. The freezing point of water is 0°C, while the boiling point of water is 100°C. The Kelvin scale is based on the Celsius scale with the zero at absolute zero. Absolute zero is the lowest possible temperature. It is the temperature at which particles of matter stop moving.

K = °C + 273 and **°C = K – 273**

Kinetic Molecular Theory. Matter is composed of particles that are in constant motion (kinetic energy). There are forces of attraction between particles that depend on the distance between the particles. The further apart the particles are, the smaller the forces of attraction between them are. The higher the temperature (average kinetic energy) is, the faster the particles move. The *Kinetic Molecular Theory* explains the phases. In gases the forces of attraction between particles are weaker than in other phases. The particles can move from place to place independently of each other because they do NOT attract or repel each other. The particles are relatively far apart. The volume of the particles is small compared to the space between them. Gases tend to spread out to fill their container. Therefor both the shape and volume are determined by the container.

Gas Laws. There are a number of relationships between the pressure, volume, temperature, and the number of moles of a gas: Boyle's law says the volume of a gas is inversely proportional to the pressure at a constant temperature [$\mathbf{V} \propto {}^{1}/_{\mathbf{P}}$]; Charles law says at a constant pressure, the volume of a gas is directly proportional to its Kelvin temperature [$\mathbf{V} \propto \mathbf{T}$]; Avogadro's law says that at constant temperature, the volume of a gas is directly proportional to the number moles [$\mathbf{V} \propto \boldsymbol{n}$]; and finally Gay-Lussac's law says for a gas at constant volume, the temperature and pressure are directly proportional [$\mathbf{T} \propto \mathbf{P}$]. For a constant number of moles, the combined gas law provides the relationship between the temperature, pressure, and volume of a gas as any of these variables changes. The ideal gas law gives the relationship among all the variables of Boyle's, Charles, and Avogadro's laws.

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Combined Gas Law

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

Ideal Gas Law

$$PV = nRT$$

$$R = 0.0821\,\frac{L \cdot atm}{mol.K}$$

Applications of Avogadro's Law. The volume of 1 mole of gas at STP (Standard Temperature and Pressure) is always 22.4 L. Standard temperature is 0°C or 273 K. Standard pressure is 1 atm, 101.3 kPa, or 760 mm Hg. Using the standard molar volume, it is possible to solve several types of problems. See below

Sample Problem 1: Moles to Volume

How many liters do 3.50 moles of oxygen occupy at STP?

$$3.50mol\left(\frac{22.4L}{1mol}\right) = 78.4L$$

Sample Problem 2: Volume to Moles

How many moles of nitrogen occupy 186 *L* at STP?

$$186L\left(\frac{1mol}{22.4L}\right) = 8.30mol$$

Sample Problem 3: Grams to Volume

What is the volume of 84.21 g of methane (CH_4) at STP?

$$84.21g\left(\frac{1mol}{16.04g}\right)\left(\frac{22.4L}{1mol}\right) = 118L$$

Sample Problem 4: Volume to Grams

What is the mass of 25.0 *mL* of dinitrogen trioxide (N_2O_3) at STP?

$$25.0mL\left(\frac{1L}{1000mL}\right)\left(\frac{1mol}{22.4L}\right)\left(\frac{76.02g}{1mol}\right) = 8.48 \times 10^{-2}\,g$$

Applications of the Combined Gas Law. The combined gas law has 6 variables. Any of the variables can be determined if 5 are known.

Sample Problem

A gas with a volume of 250. mL at 35°C and 101.3 kPa is heated to 57°C and the pressure is increased to 151.3 kPa. What is its new volume?

- $T_1 = 35 + 273 = 308K;\ T_2 = 57 + 273 = 330K$
- $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$
- $V_2 = \frac{P_1V_1T_2}{T_1P_2} = \frac{(101.3kPa)(250mL)(330K)}{(308K)(151.3kPa)} = 179mL$

Applications of the Ideal Gas Law. The molar mass and density of a gas can be determined from the ideal gas law.

$$PV = nRT;\ \textit{If}\ m = mass\ and\ M = molar\ mass,\ n = \frac{m}{M}$$

- $PV = \frac{mRT}{M}$
- $M = \frac{mRT}{PV}\ but\ D = \frac{m}{V}\ \ so\ \ M = \frac{DRT}{P}$
- $D = \frac{MP}{RT}$

Sample Problem

What is the volume of 6.06 g of hydrogen at 27°C and 1.50 atm?

$$PV = nRT \quad \therefore \quad V = \frac{nRT}{P}$$

$$6.06g\left(\frac{1mol}{2.02g}\right) = 3.00mol$$

$$V = \frac{(3.00mol)(0.0821\,\frac{L\cdot atm}{mol\cdot K})(300.K)}{1.50atm} = 49.3L$$

Sample Problem 1

What is the molar mass of a gas that has a density of 2.16 g/L at 15°C and 3.00 atm?

$$M = \frac{(2.16\,g/L)(0.0821\,\frac{L\cdot atm}{mol\cdot K})(288K)}{3.00atm} = 17.0\,g/mol$$

Sample Problem 2

What is the density of methane (CH_4) at 100.°C and 2.00 atm?

$$D = \frac{(16.0\,g/mol)(2.00atm)}{(0.0821\,\frac{L\cdot atm}{mol\cdot K})(373K)} = 1.04\,g/L$$

Assumptions of the Ideal Gas Law. This Ideal Gas model is based on the following assumptions, and can be applied only under conditions of low pressure and high temperature: (1) gas molecules are continuously moving in a random, straight line motion. (2) when gas molecules collide with each other or with the walls of the container there is no energy lost. Therefore, the total energy of the system never changes. (3) the actual volume of the molecules is insignificant when compared to the volume of the contained area (the container). (4) no attraction exists between molecules. Gases deviate from the ideal conditions when conditions of high pressure and low temperature exist. These conditions lead to confinement and intermolecular attractions begin to act. In fact, gas molecules do have a volume of their own, and there are forces of attraction between gas molecules. The factors allow for the existence of gases as either solids or liquids under certain conditions,

Graham's Law. The rate at which gases effuse is inversely proportional to the square root of the molar mass.

$$\frac{rate\ of\ effusion\ of\ A}{rate\ of\ effusion\ of\ B} = \frac{\sqrt{M_B}}{\sqrt{M_A}}$$

Sample Problem 1

How does the rate of effusion of hydrogen compare to the rate of effusion of nitrogen?

$$\frac{rate\ of\ effusion\ of\ H_2}{rate\ of\ effusion\ of\ N_2} = \frac{\sqrt{28.0}}{\sqrt{2.02}} = 3.72$$

Sample Problem 2

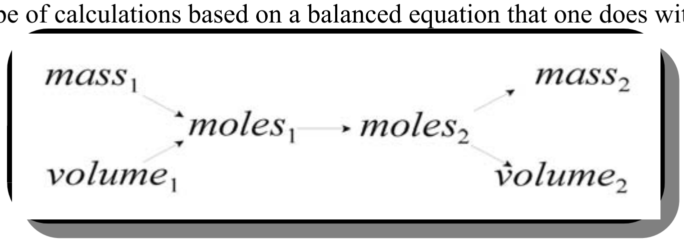
What is the molar mass of a gas that effuses at 1.25 times the speed of carbon dioxide?

$$\frac{rate\ of\ effusion\ of\ A}{rate\ of\ effusion\ of\ CO_2} = \frac{\sqrt{M_{CO_2}}}{\sqrt{M_A}}$$

$$1.25 = \frac{\sqrt{44.0\,{}^{g}/_{mol}}}{\sqrt{M_A}} \quad so \quad (1.25)^2 = \frac{44.0\,{}^{g}/_{mol}}{M_A}$$

$$M_A = \frac{44.0\,{}^{g}/_{mol}}{(1.25)^2} = 28.2\,{}^{g}/_{mol}$$

Gas Stoichiometry. Since the ideal gas law makes it possible to calculate the number of moles of a gas contained in a given volume of gas, it is possible to do the same type of calculations based on a balanced equation that one does with masses.



Sample Problem 1

How many grams of rust (Fe_2O_3) form when iron reacts with 25.0 L of oxygen at 25°C and 200. kPa?

Step 1: Write a balanced equation
$4Fe + 3O_2 \rightarrow 2Fe_2O_3$

Step 2: Substitute values into the gas equation to get the number of moles of gas

$$n = \frac{PV}{RT} = \frac{(200.\,kPa)(1atm)(25.0L)}{(101.3kPa)(0.0821\,\frac{L\cdot atm}{mol\cdot K})(298K)} = 2.02mol$$

Step 3: Solve the remaining problem by the factor label method.

$$2.02mol_{O_2}\left(\frac{2mol_{Fe_2O_3}}{3mol_{O_2}}\right)\left(\frac{159.7g_{Fe_2O_3}}{1mol_{Fe_2O_3}}\right) = 215g_{Fe_2O_3}$$

Sample Problem 2

How many milliliters of ammonia are formed when 150.mL of hydrogen combines with nitrogen at constant temperature and pressure?

Step 1: Write a balanced equation
$N_2 + 3H_2 \rightarrow 2NH_3$

Step 2: Set up a proportion and solve

$$\frac{3mol_{H_2}}{150.ml_{H_2}} = \frac{2mol_{NH_3}}{x} \qquad x = 100ml_{NH_3}$$

Sample Problem 3

How many liters of oxygen are liberated when 18.4 g of potassium chlorate decompose at STP?

Step 1: Write a balanced equation.
$2KClO_3 \rightarrow 2KCl + 3O_2$

Step 2: Solve by the factor label method

$$18.4g_{KClO_3}\left(\frac{1mol_{KClO_3}}{122.6g_{KClO_3}}\right)\left(\frac{3mol_{O_2}}{2mol_{KClO_3}}\right)\left(\frac{22.4L_{O_2}}{1mol_{O_2}}\right) = 5.04L$$

Answer the questions below by circling the number of the correct response

1. Which temperature represents absolute zero? (1) 0 K (2) 0°C (3) 273 K (4) 273°C

2. At which temperature does a water sample have the highest average kinetic energy (1) 0°C, (2) 100°C, (3) 0 K, (4) 100 K

3. Which Kelvin temperatures represent, respectively, the normal freezing point and the normal boiling point of water? (1) 0 K and 273 K (2) 0 K and 100 K (3) 100 K and 273 K (4) 273 K and 373 K

4. At which temperature would the molecules in a one gram sample of water have the lowest average kinetic energy? (1) 5°C (2) –100°C (3) 5 K (4) 100 K

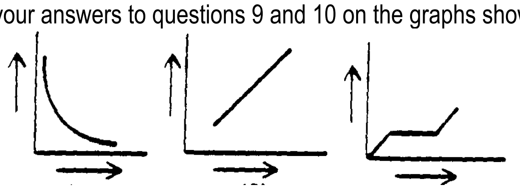
5. The temperature of a substance changes from –173°C to 0°C. How many Kelvin degrees does this change represent? (1) 100. (2) 173 (3) 273 (4) 446

6. Which Kelvin temperature is equal to –33°C? (1) - 33 K (2) 33 K (3) 240 K (4) 306 K

7. The molecules of which substance have the highest average kinetic energy? (1) He(g) at 0°C (2) CO_2(g) at 20°C (3) HCl(g) at 40°C (4) N_2(g) at 60°C

8. A sample of a gas is at STP. As the pressure decreases and the temperature increases, the volume of the gas (1) decreases (2) increases (3) remains the same

Base your answers to questions 9 and 10 on the graphs shown below.



(1) (2) (3)

Note that questions 9 and 10 have only three choices.

9. Which graph best represents how the volume of a given mass of a gas varies with the Kelvin temperature at constant pressure?

10. Which graph best represents how the volume of a given mass of a gas varies with the pressure on it at constant temperature.

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11. A 100. milliliter sample of a gas at a pressure of 50.8 kPa is reduced to 25.4 kPa at constant temperature. What is the new volume of the gas? (1) 50.0 mL (2) 90.0 mL (3) 200. mL (4) 290. mL

12. At constant temperature the pressure on 8.0 liters of a gas is increased from 1 atmosphere to 4 atmospheres. What will be the new volume of the gas? (1) 1.0 ℓ (2) 2.0 ℓ (3) 32 ℓ (4) 4.0 ℓ

13. As the temperature of a sample of gas decreases at constant pressure, the volume of the gas (1) decreases (2) increases (3) remains the same

14. A 100 milliliter sample of a gas is enclosed in cylinder under a pressure of 101.3 kPa. What volume would the gas sample occupy at a pressure of 202.6 kPa, temperature remaining constant? (1) 50 mL (2) 100 mL (3) 200 mL (4) 380 mL

15. The volume of a sample of hydrogen gas at STP is 1.00 liter. As the temperature decreases, pressure remaining constant, the volume of the sample (1) decreases (2) increases (3) remains the same

16. The pressure on 200. milliliters of a gas at constant temperature is changed from 0.500 atm to 1.00 atm. The new volume of the gas is (1) 100. mL (2) 200. mL (3) 400. mL (4) 600. mL

17. As the pressure on a given sample of a gas increases at constant temperature, the mass of the sample (1) decreases (2) increases (3) remains the same

18. A gas sample is at 10.0°C. If pressure remains constant, the volume will increase when the temperature is changed to (1) 263 K (2) 283 K (3) 273 K (4) 293 K

19. A gas has a volume of 640 mL at 15°C and a pressure of 408 torr. What is the volume of the gas at STP? (1) 724 mL (2) 362 mL (3) 652 mL (4) 326 mL

20. The volume of a gas at STP is 20 mL. What will the volume be when the pressure and temperature is doubled? (1) 10 mL (2) 20 mL (3) 30 mL (4) 40 mL

21. If the temperature of the water bath is increased and the piston is allowed to move freely so that the pressure on the gas remains at 1 atmosphere, then the gas will (1) increase in pressure (2) increase in volume (3) decrease in pressure (4) decrease in volume

22. If 10 liters of a gas at 273°C is cooled to 0°C at constant pressure, the volume of the gas at 0°C will be (1) 2.5 liters (2) 5 liters (3) 30 liters (4) 40 liters

23. At STP 1.00 mole of oxygen gas would occupy the same volume as (1) 11.2 liters of nitrogen (2) 22.4 liters of chlorine (3) 33.6 liters of hydrogen (4) 44.8 liters of helium

24. A sample of dry hydrogen has a volume of 400 milliliters at STP . If the temperature remains constant and the pressure is changed to 800 millimeters of mercury, then the new volume of the gas will be equal to (1) 400 x 800/760 (2) 400 x 800/273 (3) 400 x 760/800 (4) 400 x 800/800

25. Real gas behavior deviates from ideal gas behavior because the molecules of a real gas (1) have an attraction for each other (2) occupy no volume (3) are in constant motion (4) undergo perfectly elastic collisions

26. Equal volumes of SO_2(g) and NO(g) at the same temperature and pressure would have the same (1) mass (2) density (3) number of atoms (4) number of molecules

27. As the temperature of a gas increases, the average kinetic energy of the gas particles (1) decreases (2) increases (3) remains the same (4) none of the above

28. The temperature of a 180 mL sample of gas is decreased from 400 K to 200 K , pressure remaining constant. The new volume of the gas is (1) 90 mL (2) 126 mL (3) 273 mL (4) 360 mL

29. Which gas has properties that are most similar to those of an ideal gas at low temperature and high pressure? (1) He (2) O_2 (3) H_2S (4) CO_2

30. The volume of 4.00 grams of helium at 760. millimeters pressure and 20°C would be (1) less than 11.2 liters (2) 11.2 liters (3) 22.4 liters (4) more than 22.4 liters

31. At standard temperature, the volume occupied by 1.00 mole of gas is 11.2 liters. The pressure exerted on this gas is (1) 1.00 atm (2) 2.00 atm (3) 0.50 atm (4) 1.50 atm

Use the following information to answer the questions32-33 below.

You have two samples of the same gas in the same size container, with the same pressure. The gas in the first container has a kelvin temperature four times that of the gas in the other container.

32. The ratio of the number of moles of gas in the first container compared to that in the second is (1) 1 : 1 (2) 4 : 1 (3) 1 : 4 (4) 2 : 1 (5) 1 : 2

33. The ratio of collisions with the wall in the first container compared to that in the second is (1) 1 : 1 (2) 4 : 1 (3) 1 : 4 (4) 2 : 1 (5) 1 : 2

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34. A gas sample is held at constant pressure The gas occupies 3.62 L of volume when the temperature is 21.6°C. Determine the temperature at which the volume of the gas is 3.45 L. (1) 309 K (2) 281 K (3) 20.6 K (4) 294 K (5) 326 K

35. Gaseous chlorine is held in two separate containers at identical temperature and pressure. The volume of container 1 is 1.30 L and it contains 6.70 mol of the gas. The volume of container 2 is 2.20 L. How many moles of the gas are in container 2? (1) 11.3 mol (2) 19.2 mol (3) 0.427 mol (4) 3.96 mol (5) none of these

36. Two moles of gas A spontaneously convert to 3 mol of products in a container where the temperature and pressure are held constant. The sample originally took up 10.2 L of volume. What is the new volume of the products? (1) 0.189 L (2) 6.73 L (3) 12.3 L (4) 1.15 L (5) 15.3 L

Use the following information to answer the questions 37-38 below.

Three 1.00-L flasks at 25 °C and 725 torr contain the gases CH_4 (flask A), CO_2 (flask B), and C_2H_6 (flask C).

37. In which flask is there 0.039 mol of gas? (1) flask A (2) flask B (3) flask C (4) all (5) none

38. In which single flask do the molecules have the greatest mass, the greatest average velocity, *and* the highest kinetic energy? (1) flask A (2) flask B (3) flask C (4) all (5) none

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39. 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 0.125 atm, what is the final pressure? (1) 0.189 atm (2) 0.555 atm (3) 0.0605 atm (4) 0.247 atm (5) none of these

40. A sample of oxygen gas has a volume of 4.50 L at 27°C and 800.0 torr. How many oxygen molecules does it contain? (1) 1.16×10^{23} (2) 5.8×10^{22} (3) 2.32×10^{24} (4) 1.16×10^{22} (5) none of these

41. Use the ideal gas law to predict the relationship between n and T if pressure and volume are held constant. (1) $n \propto T$ (2) $n \propto 1/T$ (3) n/T = constant (4) $PT = nRV$ (5) $PV/T = R$

42. A 6.35-L sample of carbon monoxide is collected at 55°C and 0.892 atm. What volume will the gas occupy at 1.05 atm and 20°C? (1) 1.96 L (2) 5.46 L (3) 4.82 L (4) 6.10 L (5) none of these

43. Body temperature is about 308 K. On a cold day, what volume of air at 273 K must a person with a lung capacity of 2.00 L breathe in to fill the lungs? (1) 2.26 L (2) 1.77 L (3) 1.13 L (4) 3.54 L (5) none of these

44. Mercury vapor contains Hg atoms. What is the volume of 200. g of mercury vapor at 822 K and 0.500 atm? (1) 135 L (2) 82.2 L (3) 329 L (4) 67.2 L (5) none of these

45. What volume is occupied by 19.6 g of methane (CH4) at 27°C and 1.59 atm? (1) 1.71 L (2) 19.0 L (3) 27.7 L (4) 302 L (5) not enough data to calculate

46. Consider a cylinder fitted with a movable piston. The initial pressure inside the cylinder is P_i and the initial volume is V_i. What is the new pressure in the system when the piston decreases the volume of the cylinder by half? (1) $(1/4)P_i$ (2) $(½)P_i$ (3) $2P_i$ (4) $2V_iP_i$ (5) P_i ,

47. Hydrogen and chlorine gases react to form HCl. You and a friend are on opposite sides of a long hallway, you with H_2 and your friend with Cl_2. You both want to form HCl in the middle of the room. Which of the following is true? (1) You should release the H_2 first. (2) Your friend should release the Cl_2 first. (3) You both should release the gases at the same time. (4) You need to know the length of the room to answer this question. (5) You need to know the temperature to answer this question.

48. Which conditions of *P, T*, and *n*, respectively, are most ideal? (1) high *P*, high *T*, high *n* (2) low *P*, low *T*, low *n* (3) high *P*, low *T*, high *n* (4) low *P*, high *T*, high *n* (5) low *P*, high *T*, low *n*

49. A 4.40-g piece of solid CO_2 (dry ice) is allowed to sublime in a balloon. The final volume of the balloon is 1.00 L at 300 K. What is the pressure of the gas? (1) 2.46 atm (2) 246 atm (3) 0.122 atm (4) 122 atm (5) none of these

50. A sample of gas is in a 50.0-mL container at a pressure of 645 torr and a temperature of 25°C. The entire sample is heated to a temperature of 35°C and transferred to a new container whose volume is 65.0 mL. The pressure of the gas in the second container is: (1) 867 torr (2) 694 torr (3) 480. torr (4) 760. torr (5) none of these

51. Given a cylinder of fixed volume filled with 1 mol of argon gas, which of the following is correct? (Assume all gases obey the ideal gas law.) (1) If the temperature of the cylinder is changed from 25°C to 50°C, the pressure inside the cylinder will double. (2) If a second mole of argon is added to the cylinder, the ratio *T/P* would remain constant. (3) A cylinder of identical volume filled with the same *pressure* of helium must contain more atoms of gas because He has a smaller atomic radius than argon. (4) Two of these. (5) None of these.

Use the following information to answer the questions 52-55 below.

Four identical 1.0-L flasks contain the gases He, Cl_2, CH_4, and NH_3, each at 0 °C and 1 atm pressure.

52. Which gas has the highest density? (1) He (2) Cl_2 (3) CH_4 (4) NH_3 (5) all gases the same

53. For which gas do the molecules have the highest average velocity? (1) He (2) Cl_2 (3) CH_4 (4) NH_3 (5) all gases the same

54. Which gas has the most molecules? (1) He (2) Cl_2 (3) CH_4 (4) NH_3 (5) all gases the same

55. For which gas do the molecules have the smallest average kinetic energy? (1) He (2) Cl_2 (3) CH_4 (4) NH_3 (5) all gases the same

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56. Argon has a density of 1.78 g/L at STP. How many of the following gases have a density at STP *greater* than that of argon? [Cl_2, He, NH_3, NO_2] (1) 0 (2) 1 (3) 2 (4) 3 (5) 4

57. It is found that 250. mL of gas at STP has a mass of 1.00 g. What is the molar mass? (1) 89.6 g/mol (2) 28.0 g/mol (3) 14.0 g/mol (4) 22.4 g/mol (5) none of these

58. Gaseous C_2H_4 reacts with O_2 according to the following equation:
$$C_2H_4(g) + 3O_2(g) \rightarrow 2CO_2(g) + 2H_2O(g)$$
What volume of oxygen at STP is needed to react with 1.50 mol of C_2H_4? (1) 4.50 L (2) 33.6 L (3) 101 L (4) 67.2 L (5) Not enough information is given to solve the problem.

59. Which of the following statements is correct? (1) At STP, CO_2 is more dense than O_3. (2) At STP, NH_3 is more dense than CO. (3) At STP, Ne is more dense than NH_3. (4) At STP, CO_2 is more dense than O_3 and Ne is more dense than NH_3. (5) none of these

60. Air has an average molar mass of 29.0 g/mol. The density of air at 1.00 atm and 30°C is (1) 29.0 g/L (2) 40.0 g/mL (3) 1.17 g/L (4) 1.29 g/L (5) 12 g/L

61. If a 2.15-g sample of a gas occupies 750. mL at STP, what is the molar mass of the gas at 125°C? (1) 3.07×10^{-2}, (2) 64.2 (3) 70.1 (4) 75.0 (5) Not enough information is given.

62. The density of nitrogen at STP is (1) 1.60 g/cm^3 (2) 0.800 g/L (3) 1.25 g/L (4) 0.625 g/L (5) Not enough information is given.

63. What volume of carbon dioxide measured at STP will be formed by the reaction of 1.30 mol of oxygen with 9.00×10^{-1} mol of ethyl alcohol CH_3CH_2OH? (1) 8.70 L (2) 19.4 L (3) 28.0 L (4) 40.3 L (5) 91.9 L

64. What volume of $H_2O(g)$ measured at STP is produced by the combustion of 4.00 g of natural gas (CH_4) according to the following equation?
$$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$$
(1) 5.60 L (2) 11.2 L (3) 22.4 L (4) 33.6 L (5) 44.8 L

65. At 1000°C and 100. torr, the density of a certain element in the gaseous state is 2.9×10^{-2} g/L. The element is: (1) Ne (2) He (3) Na (4) Ar (5) Hg

66. Into a 3.00-liter container at 25°C are placed 1.23 moles of O_2 gas and 3.20 moles of solid C (graphite). If the carbon and oxygen react completely to form CO(g), what will be the final pressure in the container at 25°C? (1) 20.1 atm (2) 26.1 atm (3) 10.2 atm (4) 1.68 atm (5) none of these

67. Calcium hydride combines with water according to the equation:
$$CaH_2(s) + 2H_2O(\ell) \rightarrow 2H_2(g) + Ca(OH)_2(s)$$
Beginning with 84.0 g of CaH_2 and 36.0 g of H_2O, what volume of H_2 will be produced at 273 K and a pressure of 1520 torr? (1) 22.4 L (2) 44.8 L (3) 89.6 L (4) 179 L (5) none of these

68. An excess of sodium hydroxide is treated with 1.1 L of dry hydrogen chloride gas measured at STP. What is the mass of sodium chloride formed? (1) 0.50 g (2) 1.8 g (3) 2.0 g (4) 2.9 g (5) 22 g

69. 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 is the molecular formula for the compound? (1) BH_3 (2) B_2H_6 (3) B_4H_{10} (4) B_3H_{12} (5) B_5H_{14}

70. A 5.10-L sample of chlorine gas is prepared at 15°C and 740 torr. Calculate the volume of this sample of chlorine gas at standard conditions of temperature and pressure. (1) 6.41 L (2) 4.71 L (3) 5.89 L (4) 11.4 L (5) 2.97 L

71. A sample of 35.1 g of methane gas (CH_4) has a volume of 5.20 L at a pressure of 2.70 atm. Calculate the temperature. (1) 4.87 K (2) 78.1 K (3) 46.3 K (4) 275 K (5) 129 K

72. Which of the following is *not* a postulate of the kinetic molecular theory? (1) Gas particles have most of their mass concentrated in the nucleus of the atom. (2) The moving particles undergo perfectly elastic collisions with the walls of the container. (3) The forces of attraction and repulsion between the particles are insignificant. (4) The average kinetic energy of the particles is directly proportional to the absolute temperature. (5) All of these are postulates of the kinetic molecular theory.

73. Consider the following gas samples:

Sample A	**Sample B**
$S_2(g)$	$O_2(g)$
n = 1 mol	n = 2 mol
T = 800 K	T = 400 K
P = 0.20 atm	P = 0.40 atm

Which one of the following statements is *false*? (1) The volume of sample A is twice the volume of sample B. (2) The average kinetic energy of the molecules in sample A is twice the average kinetic energy of the molecules in sample B. (3) The fraction of molecules in sample A having a kinetic energy greater than some high fixed value is larger than the fraction of molecules in sample B having kinetic energies greater than that same high fixed value. (4) The mean square velocity of molecules in sample A is twice as large as the mean square velocity of molecules in sample B. (5) Assuming identical intermolecular forces in the two samples, sample A should be more nearly ideal than sample B.

74. At 200 K, the molecules or atoms of an unknown gas, X, have an average velocity equal to that of Ar atoms at 400 K. What is X? (Assume ideal behavior.) (1) He (2) CO (3) HF (4) HBr (5) F_2

75. Which of the following is *not* an assumption of the kinetic molecular theory for a gas? (1) Gases are made up of tiny particles in constant chaotic motion. (2) Gas particles are very small compared to the average distance between the particles. (3) Gas particles collide with the walls of their container in elastic collisions. (4) The average velocity of the gas particles is directly proportional to the absolute temperature. (5) All of these are correct.

76. Use the kinetic molecular theory of gases to predict what would happen to a closed sample of a gas whose temperature increased while its volume decreased. (1) Its pressure would decrease. (2) Its pressure would increase. (3) Its pressure would hold constant. (4) The number of moles of the gas would decrease. (5) The average kinetic energy of the molecules of the gas would decrease.

77. Which of the following would have a higher rate of effusion than C_2H_2? (1) N_2 (2) O_2 (3) Cl_2 (4) CH_4 (5) CO_2

78. Calculate the ratio of the effusion rates of N_2 and N_2O. (1) 0.637 (2) 1.57 (3) 1.25 (4) 0.798 (5) 1.61

79. Order the following in increasing rate of effusion: F_2, Cl_2, NO, NO_2, CH_4 (1) $Cl_2 < NO_2 < F_2 < NO < CH_4$ (2) $Cl_2 < F_2 < NO_2 < CH_4 < NO$ (3) $CH_4 < NO_2 < NO < F_2 < Cl_2$ (4) $CH_4 < NO < F_2 < NO_2 < Cl_2$ (5) $F_2 < NO < Cl_2 < NO_2 < CH_4$

Answers

1. 1	21. 2	41. 2	61. 2
2. 2	22. 2	42. 3	62. 3
3. 4	23. 2	43. 2	63. 2
4. 3	24. 3	44. 1	64. 1
5. 2	25. 1	45. 2	65. 3
6. 3	26. 4	46. 3	66. 1
7. 4	27. 2	47. 2	67. 1
8. 2	28. 1	48. 4	68. 4
9. 2	29. 1	49. 1	69. 2
10. 1	30. 4	50. 5	70. 2
11. 3	31. 2	51. 5	71. 2
12. 2	32. 3	52. 2	72. 1
13. 1	33. 1	53. 1	73. 5
14. 1	34. 2	54. 5	74. 3
15. 1	35. 1	55. 5	75. 4
16. 1	36. 5	56. 3	76. 2
17. 3	37. 4	57. 1	77. 4
18. 4	38. 5	58. 3	78. 3
19. 4	39. 5	59. 3	79. 1
20. 2	40. 5	60. 3	