Molecular Composition of Gases

**DIRECTIONS:** Write on the line at the right of each statement the letter preceding the word or expression that best completes the statement.

1. When Gay-Lussac’s law of combining volumes holds, which of the following can be expressed in ratios of small whole numbers? (a) pressures before and after reaction (b) volumes of gaseous reactants and products (c) Kelvin temperatures (d) molar masses of products and reactants

2. The law of combining volumes applies only to gas volumes (a) measured at constant temperature and pressure; (b) that equal 1 L; (c) that equal 22.4 L; (d) measured at STP.

3. Equal volumes of diatomic gases, under the same conditions of temperature and pressure, contain the same number of (a) protons; (b) ions; (c) molecules; (d) Dalton’s “ultimate particles.”

4. At constant temperature and pressure, gas volume is directly proportional to the (a) molar mass of the gas; (b) number of moles of gas; (c) density of the gas at STP; (d) rate of diffusion.

5. The molar volume of a gas at STP is all of the following except (a) the volume occupied by one mole of the gas; (b) 22.4 g; (c) 22.4 L; (d) the volume occupied by one molar mass.

6. The volume occupied by one mole of oxygen at STP is (a) 11.2 L; (b) 22.4 L; (c) 16.0 L; (d) 32.0 L.

7. The molar mass of a gas at STP is simply the density of the gas (a) multiplied by the mass of one mole; (b) divided by the mass of one mole; (c) multiplied by 22.4 L; (d) divided by 22.4 L.

8. The value for the gas constant is (a) 0.0821 L·atm/mol·K; (b) 0.0281 L·atm; (c) 0.0281 L·atm/mol·K; (d) 0.0821 mol·K.

9. To use the ideal gas law to determine the molar mass of a gas (a) the mass of a molar volume of that gas must be determined; (b) the mass of any known volume of the gas may be used; (c) a volume of less than 22.4 L may not be used; (d) the volume measurement must be made at STP.

10. The ideal gas law is equivalent to Boyle’s law when (a) Avogadro’s number is reached; (b) R equals zero; (c) the pressure is 1 atm; (d) the number of moles and the temperature are constant.

11. In a chemical equation, the coefficients for reactants and products that are gases indicate (a) volumes at STP; (b) volume ratios; (c) molar masses of each substance; (d) densities.

12. In the reaction C(s) + O_2(g) → CO_2(g), 3.0 L of O_2 will yield what volume of CO_2 at constant temperature and pressure? (a) 1.5 L (b) 0.5 L (c) 2.0 L (d) 3.0 L

13. The complete combustion of methane is given by the equation CH_4(g) + 2O_2(g) → 2H_2O(g) + CO_2(g). If 50 L of methane at STP are burned, how many liters of carbon dioxide at STP will be produced? (a) 50 L (b) 16.6 L (c) 25 L (d) 100 L

14. The equation \( \frac{v_A}{v_B} = \) the square root of \( M_B/\)the square root of \( M_A \) is an expression of (a) Graham’s law; (b) Avogadro’s principle; (c) Gay-Lussac’s law; (d) Boyle’s law.

15. Suppose that two gases with unequal molar masses were injected into opposite ends of a long tube at the same time and allowed to diffuse toward the center. They should begin to mix (a) at the end that held the heavier gas; (b) closer to the end that held the heavier gas; (c) closer to the end that held the lighter gas; (d) exactly in the middle.

**DIRECTIONS:** Write on the line at the right of each statement the word or expression that best completes the meaning when substituted for the corresponding number.

16. The standard molar volume of a gas, the volume occupied by one mole of a gas at STP, is equal to \( \_\_\_\_\_\_\_\_ \).

17. The process called \( \_\_\_\_\_\_\_ \) is the process by which gas molecules confined in a container having a small opening encounter the opening and pass through it.
18. One volume of O2 yields _18_ volume(s) of CO2 in the equation C(s) + O2(g) → CO2(g).

19. The volume occupied by one mole of water vapor (H2O) at STP is _19_.


21. PV = _21_ is the ideal gas equation.

22. When the ideal gas law reduces to PV = k, the expression is equivalent to _22_ law.

23. The volume ratio of N2 to NO2 is _23_ in the equation N2(g) + O2(g) → 2NO2(g).

24. When the ideal gas law reduces to V = kT, the expression is equivalent to _24_ law.

25. The volume of a gas is directly proportional to the number of moles if both pressure and _25_ are constant.

**DIRECTIONS:** Write the answer to questions 26–35 on the line to the right, and show your work in the space provided.

26. What is the volume occupied by 2.5 moles of hydrogen gas at STP? _____ 26

27. One liter (1.0 L) of a gas has a mass of 0.716 g at STP. What is its molar mass? _____ 27

28. What is the density at STP of NO2 gas (46.0 g/mol) in grams per liter? _____ 28

29. What volume will be occupied by 2.0 g of CS2 vapor (76.13 g/mol) at 70 °C and 726 mm Hg? _____ 29

30. A quantity of chlorine gas (70.906 g/mol) occupies a volume of 50.0 L at 27.0 °C and 721 mm Hg. What is the mass of the chlorine? _____ 30

31. At 0.00 °C, 0.750 moles of a gas occupies a volume of 5.00 L. What pressure (in atm) is exerted by the gas? _____ 31

32. A gas with a mass of 0.934 g is collected at 20.0 °C and 733.5 mm Hg. The volume is 200. mL. What is the molar mass of the gas? _____ 32

33. A sample of gas with a mass of 5.16 g occupies a volume of 1.0 L at 28°C and 740 mm Hg. What is the approximate molar mass of the gas? _____ 33

34. How much volume of oxygen is required for the complete combustion of 100 L of CO to CO2? _____ 34

35. How many times greater is the rate of diffusion of helium (atomic mass = 4.0026 u) than that of argon (atomic mass = 39.948 u)? _____ 35

**DIRECTIONS:** In the parentheses at the right of each word or expression in the first column, write the letter of the expression in the second column that is most closely related.

36. At constant temperature and pressure, the volumes of gaseous reactants and products can be expressed as ratios of small whole numbers. ( ) a. ideal gas law

37. Equal volumes of gases at the same temperature and pressure contain equal numbers of molecules. ( ) b. Charles' law

38. Pressure times volume equals molar amount times temperature times 0.0821 L·atm/mol·K. ( ) c. Gay-Lussac's law of combining volumes

39. The rates of effusion of gases at the same temperature and pressure are inversely proportional to the square roots of their molar masses. ( ) d. Boyle's law

40. Pressure times volume equals a constant when molar amount and temperature are constant. ( ) e. Avogadro's principle

f. Graham's law