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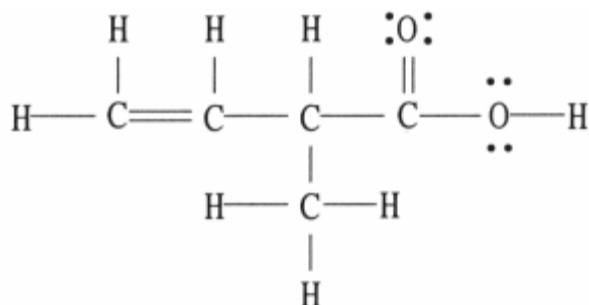
T-Score _____

- You will have **70 minutes** to complete the exam.
- There is **one best answer** to each question and all questions are worth the same number of points.
- **Sign your name on the answer sheet** above the General Purpose logo on the front.
- Print and fill in your name (**last name-space-first name**) on the back of your answer sheet.
- Be sure to mark the correct answers on your exam booklet so you can compare your answers to the answer key.
- An answer key will be posted immediately following the test at the course website as well as outside DO-236.

1. In a typical multiple bond, which of the following is true?

- π bonds occur along the internuclear axis in overlapping hybrid orbitals.
- π bonds occur along the internuclear axis in overlapping atomic orbitals.
- π bonds occur above and below the internuclear axis in overlapping atomic orbitals.
- All of the statements are true.

2. Determine the number of σ and π bond(s) in the molecule below.



- 14 σ and 2 π bonds
- 12 σ and 4 π bonds
- 2 σ and 14 π bonds
- 4 σ and 12 π bonds

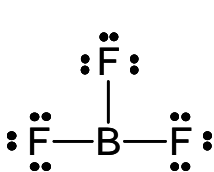
3. For the molecule shown in question 2, which of the following statements is correct?

- All of the carbon atoms have the same molecular geometry.
- All of the carbon atoms have the same orbital hybridization
- There are delocalized electrons in the carbon – oxygen bonds
- All of the bond angles are either 90° or 180°

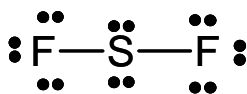
4. If the central atom in a molecule has sp^3 hybridization, how many electron domains must the central atom have?

- one
- two
- three
- none of these

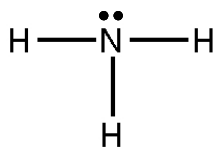
Use the following Lewis dot structures to answer questions 5 & 6



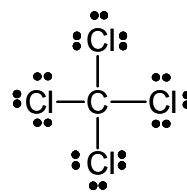
I



II



III



IV

5. Which of the above molecules have the same hybridization on the central atom?

- a. I, II, and III only **b.** II, III and IV only
c. I and III only d. all of them

6. Which of the above molecules are POLAR?

- a. I and IV only
b. II and III only
c. III only
d. None of them are polar

7. Which of the following molecules has square planar molecular geometry?

- a. CCl_4
b. XeF_4
c. PH_3
d. ICl_3

8. If temperature is held constant, what happens to the volume of an ideal gas if its pressure is doubled from 1 atm to 2 atm.?

- a. With double the pressure, the volume increases to twice its original value.
b. With double the pressure, the volume decreases to half its original value.
c. With double the pressure, the volume will remain constant if temperature stays constant.
d. With double the pressure, the volume could increase or decrease depending on the size of gas.

9. What volume does a sample of He gas (2.35 mol) occupy at 423 K and 760 torr.
- 0.709 L
 - 41.1 L
 - 81.6 L
 - 1.41 L
10. If 0.35 mol of the He escaped from the container in question 9, but the pressure and volume remained constant, what would happen to the temperature?
- the temperature would not change
 - the temperature would go up
 - the temperature would go down
 - can't tell from the info provided
11. A 2 L glass flask is filled with O₂ gas at 2.5 atm pressure and 25 °C. If the flask is cooled to -20 °C, what is the resulting pressure (in mm Hg) in the flask?
- 1208 mmHg
 - 1613 mm Hg
 - 2.1 mm Hg
 - 2238 mm Hg
12. What is the density of carbon dioxide at STP?
- 44 g / L
 - 3.93 g / L
 - 1.96 g / L
 - 385 g / L
13. A SCUBA tank contains compressed air at a total pressure of 100 atm and is at the same temperature (25 °C) as this classroom. Which of the statements correctly completes the following sentence?
- The partial pressures of N₂ and O₂ of the air in the SCUBA tank
- are the same as the partial pressures of N₂ and O₂ of the air in this classroom.
 - are less than the partial pressures of N₂ and O₂ of the air in this classroom.
 - are greater than the partial pressures of N₂ and O₂ of the air in this classroom.
 - cannot be calculated without knowing the volume of the SCUBA tank.
14. The thermal decomposition of potassium chlorate can be used to produce oxygen gas in the laboratory according to the following reaction.



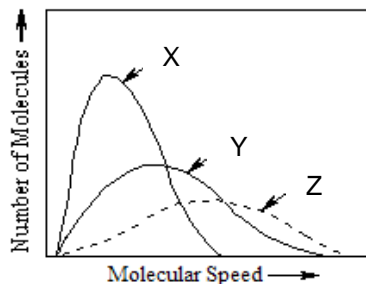
What volume (L) of O₂ gas at 25 °C and 1.00 atm pressure is produced by the decomposition of 15 g of KClO₃ (FW = 122.55 g/mol)?

- 4.5 L
- 7.5 L
- 2.2 L
- 3.7 L

15. A gas mixture of He, Ne, and Ar is found to exert a total pressure of 8.40 atm at 25°C. The partial pressures of He and Ne are 1.50 and 2.00 atm, respectively. What is the mole fraction of Ar in the mixture?

- a. 0.179 b. 0.238 c. 0.357 **d. 0.583**

16. The distribution of molecular speeds for three unknown gases X, Y, and Z was determined at the same temperature. From the Boltzmann Distributions shown on the graph below, determine which of the following statements are correct according to kinetic molecular theory.



- The order of molar mass is $X > Y > Z$
- The order of molar mass is $Z > Y > X$
- The average kinetic energy of gas X is greater than gas Y and Z.
- The average kinetic energy of gas Z is greater than gas X and Y.
- The average kinetic energy for all three gases is the same.

- a.** i and v only b. ii and iv only c. i and iii only d. none are correct

17. Carbon monoxide (CO) effuses through a pinhole at the rate of 24 mol/hr. What is the effusion rate for N_2 under identical conditions?

- a. 12 mol/hr **b. 24 mol/hr** c. 36 mol/hr d. 48 mol/hr

18. The Van der Waals equation makes corrections to the Ideal Gas Law to compensate for the differences that exist between a real gas and an ideal gas. Which of the following statements are not correct?

- The molecules of a real gas are in constant random motion.
- Real gases behave most like ideal gases at high temperature and low pressure.
- The size of all real gases is the same.
- Intermolecular attractive forces do not exist among the molecules of a real gas.

- a. I and IV b. II and IV c. II and III **d. III and IV**

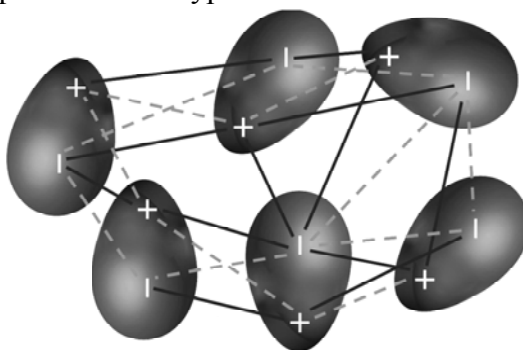
19. Which of the following statements about liquids is not correct?

- a. The viscosity of a liquid will increase with increasing molecular weight.
- b. Liquids with large intermolecular forces will have high surface tension.
- c.** London dispersion forces do not affect the viscosity of liquid.
- d. Liquids composed of longer chain molecules will generally have higher viscosity than liquids with shorter chain molecules

20. Which of the following substances has the lowest boiling point?

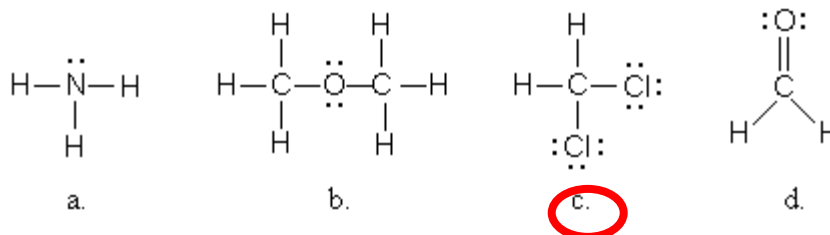
- a.** H₂ b. CO c. HF d. Ne

21. The graphic below represents what type of intermolecular force?



- a. hydrogen bonding **b.** dipole-dipole interactions
c. London dispersion forces d. hydrogen bonding and dipole-dipole interactions

22. Which of the molecules pictured below could not exhibit hydrogen bonding with water?



Important Formulas and Constants

$$PV = nRT \quad \frac{P_1V_1}{n_1T_1} = \frac{P_2V_2}{n_2T_2} \quad PV = \frac{mRT}{M} \quad M = \frac{dRT}{P}$$

$$P_T = P_1 + P_2 + P_3 + \dots \quad P_a = X_a P_T \quad X_a = \frac{n_a}{n_T} \quad \frac{r_1}{r_2} = \sqrt{\frac{M_2}{M_1}}$$

$$\left[P + a \left(\frac{n}{V} \right)^2 \right] [V - bn] = nRT$$

$$1 \text{ in} = 2.54 \text{ cm}$$

$$1 \text{ qt} = 0.946 \text{ L}$$

$$453.6 \text{ g} = 1 \text{ lb}$$

$$R = 0.0821 \text{ L} \cdot \text{atm} \cdot \text{K}^{-1} \cdot \text{mol}^{-1}$$

$$N_A = 6.02 \times 10^{23}$$

$$K = ^\circ\text{C} + 273$$

$$1 \text{ atm} = 760 \text{ mm Hg} = 760 \text{ torr} = 101.3 \text{ kPa}$$