

1. A sealed, rigid container contains three gases: 28.0 g of nitrogen, 40.0 g of argon, and 36.0 g of water vapor. If the total pressure exerted by the gases is 2.0 atm, what is the partial pressure of the nitrogen?

- ☐ A. 0.33 atm
- ☐ B. 0.40 atm
- ☐ C. 0.50 atm
- ☐ D. 2.0 atm

2. Which of the following pairs of elements is most likely to create an interstitial alloy?

- ☐ A. Titanium and copper
- ☐ B. Aluminum and lead
- ☐ C. Silver and tin
- ☐ D. Magnesium and calcium

3. Why can a molecule with the structure of NBr_5 not exist?

- ☐ A. Nitrogen only has two energy levels and is thus unable to expand its octet.
- ☐ B. Bromine is much larger than nitrogen and cannot be a terminal atom in this molecule.
- ☐ C. It is impossible to complete the octets for all six atoms using only valence electrons.
- ☐ D. Nitrogen does not have a low enough electronegativity to be the central atom of this molecule.

Questions 4-6 refer to the following information.

An evacuated rigid container is filled with exactly 2.00 g of hydrogen and 10.00 g of neon. The temperature of the gases is held at 0°C and the pressure inside the container is a constant 1.0 atm.

4. What is the mole fraction of neon in the container?

- ☐ A. 0.17
- ☐ B. 0.33
- ☐ C. 0.67
- ☐ D. 0.83

5. What is the volume of the container?

- ☐ A. 11.2 L
- ☐ B. 22.4 L
- ☐ C. 33.5 L
- ☐ D. 48.8 L

6. Which gas particles have a higher RMS velocity and why?

- ☐ A. Hydrogen, because it has a lower molar mass
- ☐ B. Neon, because it has a higher molar mass
- ☐ C. Hydrogen, because it has a larger atomic radius
- ☐ D. Neon, because it has a smaller atomic radius

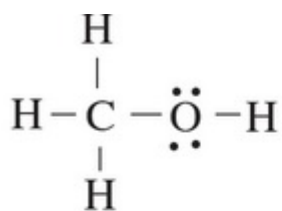
7. A sample of liquid NH_3 is brought to its boiling point. Which of the following occurs during the boiling process?

- ☐ A. The N-H bonds within the NH_3 molecules break apart.
- ☐ B. The overall temperature of the solution rises as the NH_3 molecules speed up.
- ☐ C. The amount of energy within the system remains constant.
- ☐ D. The hydrogen bonds holding separate NH_3 molecules together break apart.

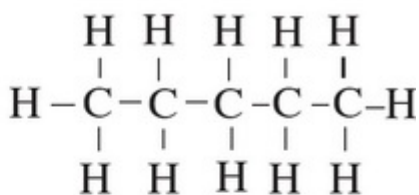
8. Which of the following compounds would have the highest lattice energy?

- ☐ B. MgCl_2
- ☐ C. CaBr_2
- ☐ D. C_2H_6

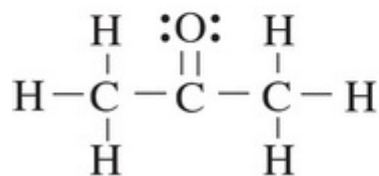
9. The following diagrams show the Lewis structures of four different molecules. Which molecule would travel the farthest in a paper chromatography experiment using a polar solvent?



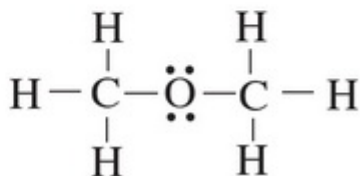
Methanol



Pentane

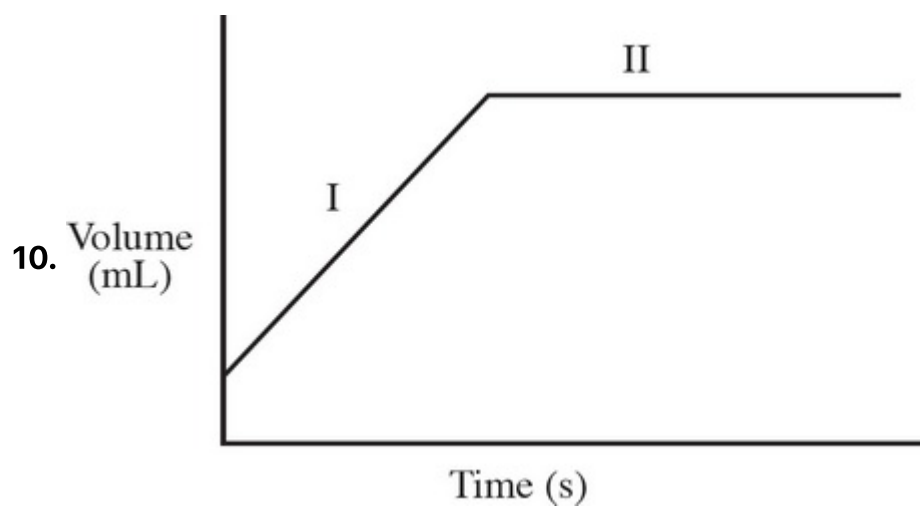


Acetone



Ether

- ☐ A. Methanol
- ☐ B. Pentane
- ☐ C. Acetone
- ☐ D. Ether

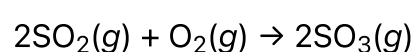


The volume of a gas is charted over time, giving the above results. Which of the following options provides a possible explanation of what was happening to the gas during each phase of the graph?

- ☐ A. During phase I, the temperature decreased while the pressure increased. During phase II, the temperature was held constant as the pressure decreased.
- ☐ B. During phase I, the temperature increased while the pressure was held constant. During phase II, the temperature and pressure both decreased.
- ☐ C. During phase I, the temperature was held constant while the pressure increased. During phase II, the temperature and pressure both decreased.
- ☐ D. During phase I, the temperature and pressure both increased. During phase II, the temperature was held constant while the pressure decreased.

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Questions 1-3 refer to the following information.

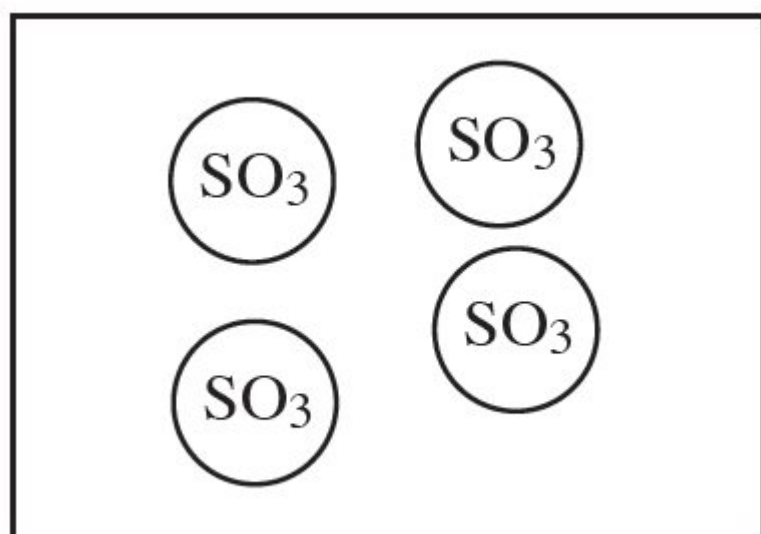


4.0 mol of gaseous SO_2 and 6.0 mol of O_2 gas are allowed to react in a sealed container.

1. Which particulate drawing best represents the contents of the flask after the reaction goes to completion?

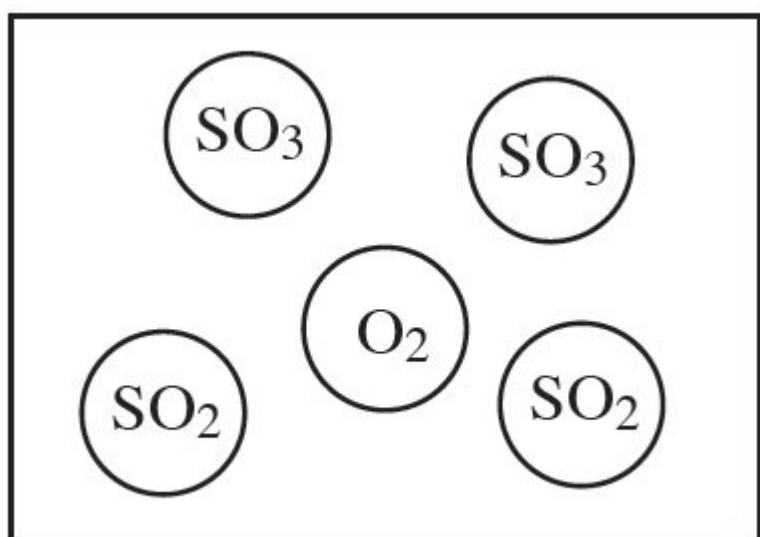
☐

A.



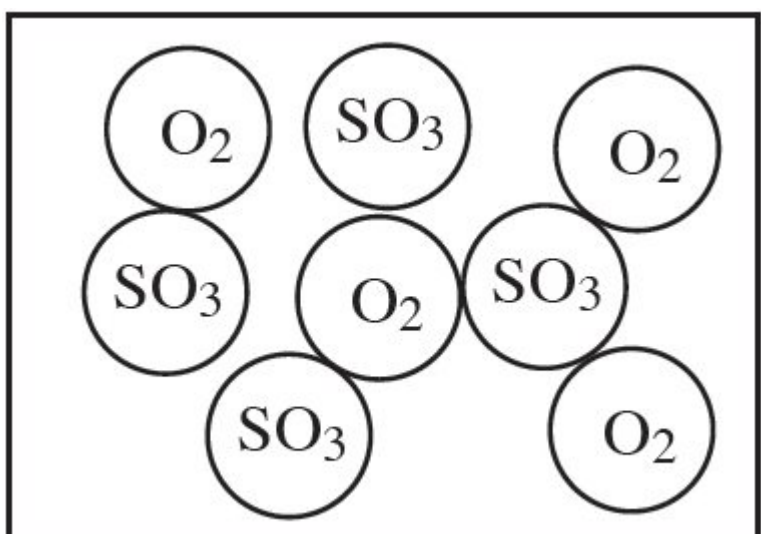
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B.



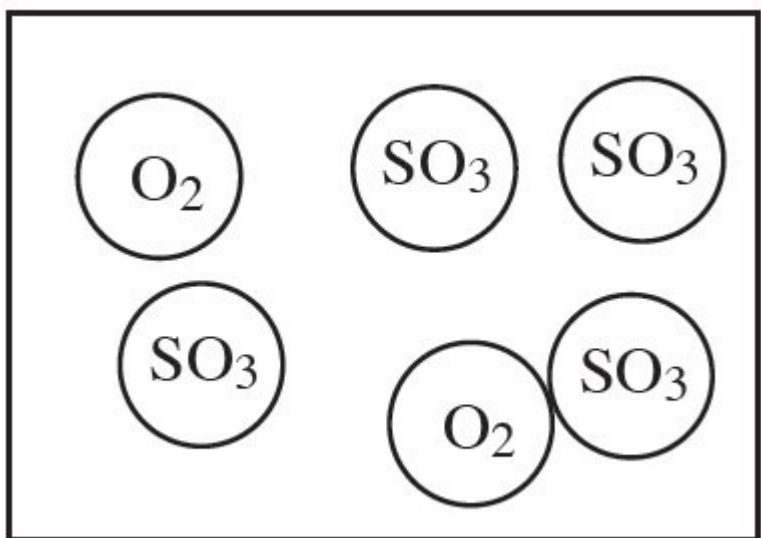
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C.



☐

D.



2. If the temperature remains constant, what percentage of the original pressure will the final pressure in the container be equal to?

☐

A. 67%

☐

B. 80%

☐

C. 100%

3. Under which of the following conditions would the gases in the container most deviate from ideal conditions and why?

- ☐ A. Low pressures, because the gas molecules would be spread far apart
- ☐ B. High pressures, because the gas molecules will be colliding frequently
- ☐ C. Low temperatures, because the intermolecular forces between the gas molecules would increase
- ☐ D. High temperatures, because the gas molecules are moving too fast to interact with one another

4. $2\text{CO}(g) + \text{O}_2(g) \rightarrow 2\text{CO}_2(g)$

2.0 mol of $\text{CO}(g)$ and 2.0 mol of $\text{O}_2(g)$ are pumped into a rigid, evacuated 4.0-L container, where they react to form $\text{CO}_2(g)$. Which of the following values does NOT represent a potential set of concentrations for each gas at a given point during the reaction?

CO O_2 CO_2

- ☐ A. (A) 0.5 0.5 0
- ☐ B. (B) 0 0.25 0.5
- ☐ C. (C) 0.25 0.25 0.5
- ☐ D. (D) 0.25 0.38 0.25

5. A mixture of helium and neon gases has a total pressure of 1.2 atm. If the mixture contains twice as many moles of helium as neon, what is the partial pressure due to neon?

- ☐ A. 0.2 atm
- ☐ B. 0.3 atm
- ☐ C. 0.4 atm
- ☐ D. 0.8 atm

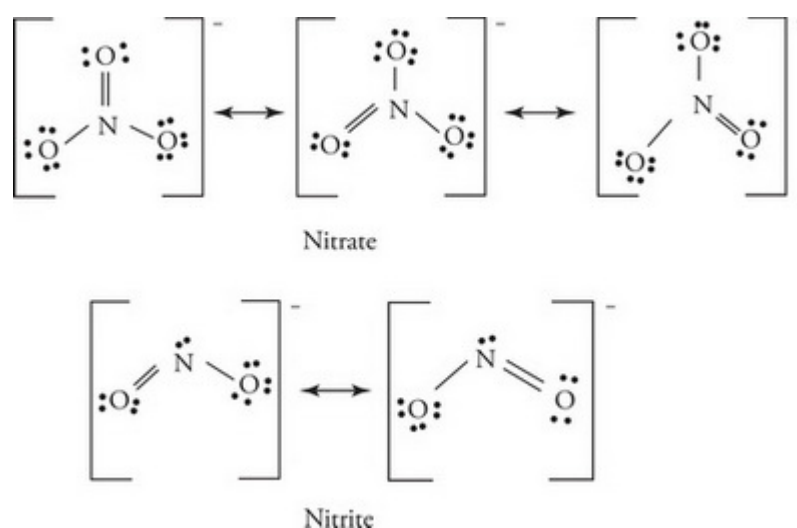
6. Nitrogen gas was collected over water at 25°C. If the vapor pressure of water at 25°C is 23 mmHg, and the total pressure in the container is measured at 781 mmHg, what is the partial pressure of the nitrogen gas?

- ☐ A. 46 mmHg
- ☐ B. 551 mmHg
- ☐ C. 735 mmHg
- ☐ D. 758 mmHg

7. A 22.0 gram sample of an unknown gas occupies 11.2 liters at standard temperature and pressure. Which of the following could be the identity of the gas?

- ☐ A. CO_2
- ☐ B. SO_3
- ☐ C. O_2
- ☐ D. He

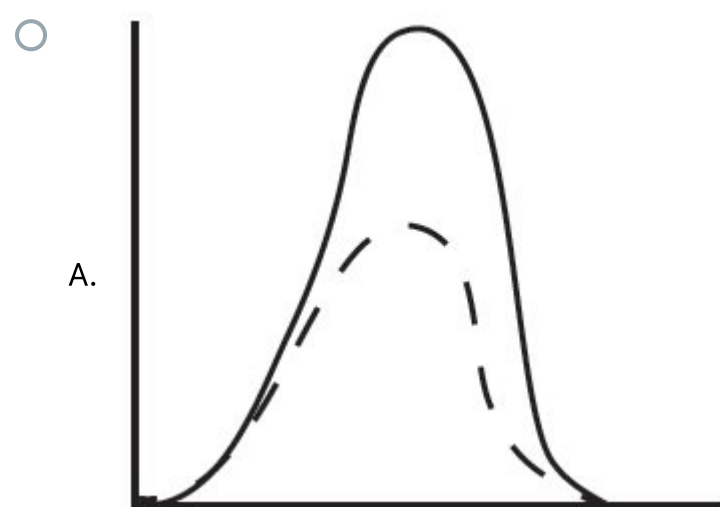
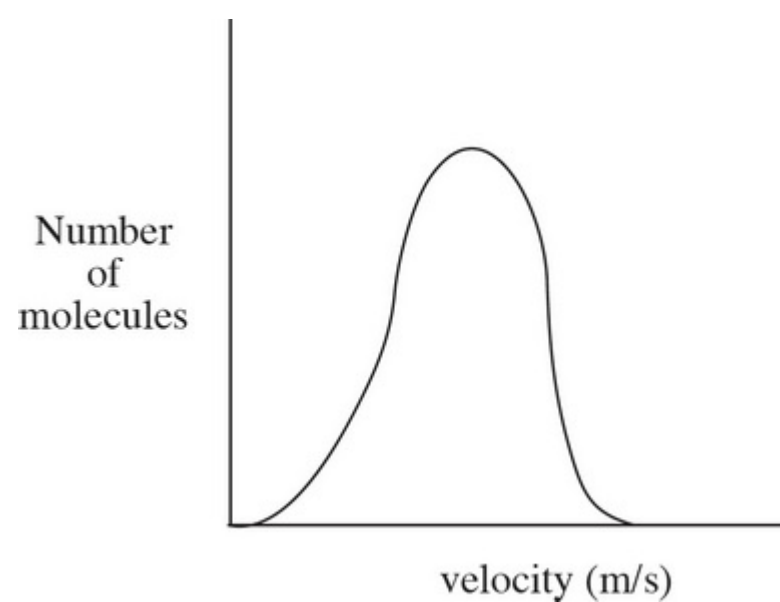
8. Lewis diagrams for the nitrate and nitrite ions are shown below. Choose the statement that correctly describes the relationship between the two ions in terms of bond length and bond energy.



- ☐ A. Nitrite has longer and stronger bonds than nitrate.

- ☐ C. Nitrite has shorter and stronger bonds than nitrate.
- ☐ D. Nitrite has shorter and weaker bonds than nitrate.

9. The diagram below shows the speed distribution of molecules in a gas held at 200 K. Which of the following representations would best represent the gas at a higher temperature? (Note: The original line is shown as a dashed line in the answer options.)



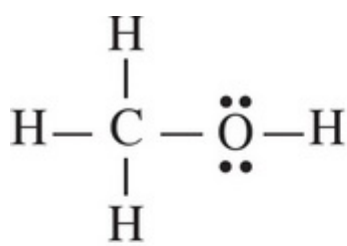


10. A sample of oxygen gas at 50°C is heated, reaching a final temperature of 100°C. Which statement best describes the behavior of the gas molecules?

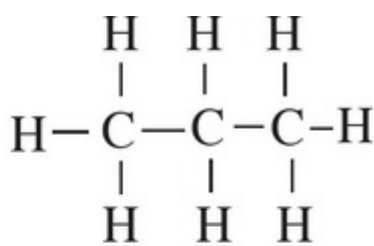
- ☐ A. Their velocity increases by a factor of two.
- ☐ B. Their velocity increases by a factor of four.
- ☐ C. Their kinetic energy increases by a factor of 2.
- ☐ D. Their kinetic energy increases by a factor of less than 2.

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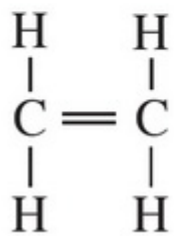
Questions 1-3 refer to the following information.



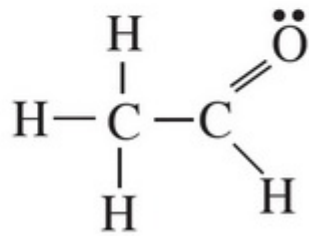
Methanol



Propane



Ethene



Ethanal

1. Based on the strength of the intermolecular forces in each substance, estimate from greatest to smallest the vapor pressures of each substance in liquid state at the same temperature.

- ☐ A. Propane > Ethanal > Ethene > Methanol
- ☐ B. Ethene > Propane > Ethanal > Methanol
- ☐ C. Ethanal > Methanol > Ethene > Propane
- ☐ D. Methanol > Ethanal > Propane > Ethene

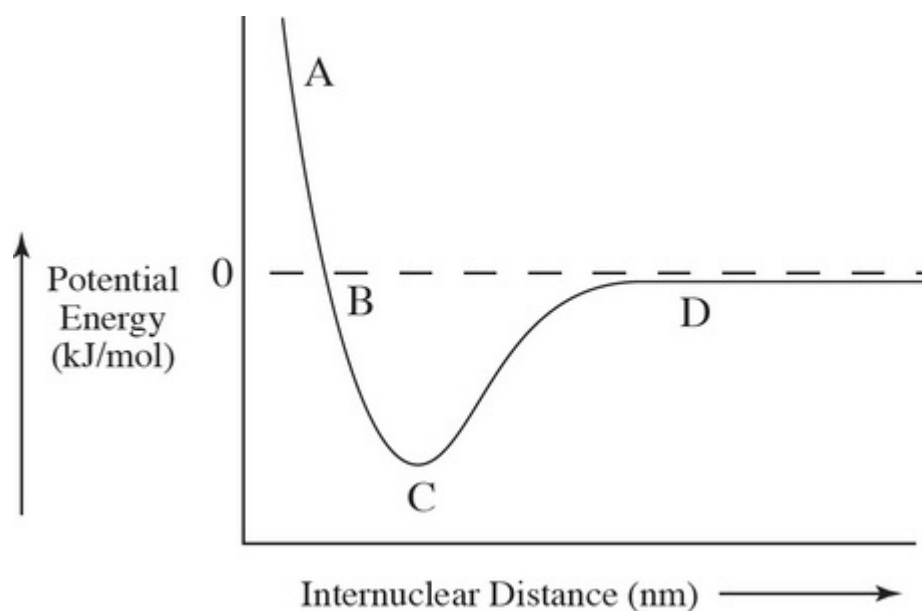
2. When in liquid state, which two substances are most likely to be miscible with water?

- ☐ A. Propane and ethene
- ☐ B. Methanol and propane
- ☐ C. Ethene and ethanal
- ☐ D. Methanol and ethanal

3. Between propane and ethene, which will likely have the higher boiling point and why?

- ☐ A. Propane, because it has a greater molar mass
- ☐ B. Propane, because it has a more polarizable electron cloud
- ☐ C. Ethene, because of the double bond
- ☐ D. Ethene, because it is smaller in size

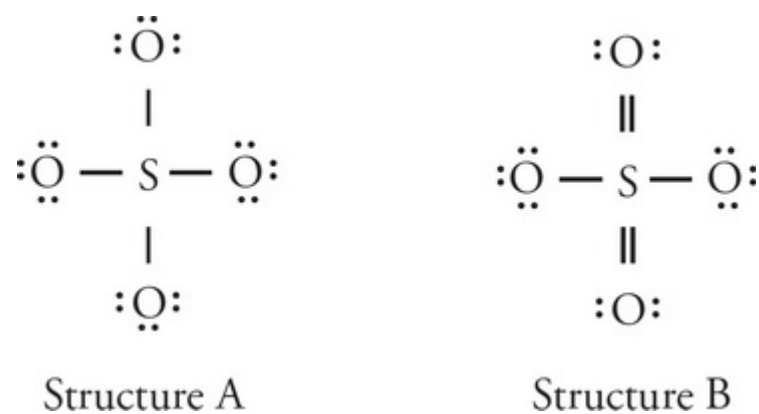
4. The graph below shows the amount of potential energy between two hydrogen atoms as the distance between them changes. At which point in the graph would a molecule of H₂ be the most stable?



- ☐ A. Point A
- ☐ B. Point B
- ☐ C. Point C

Questions 5-8 refer to the following information.

There are several different potential Lewis diagrams for the sulfate ion, two of which are below.



5. What is the molecular geometry in the structure A?

- ☐ A. Tetrahedral
- ☐ B. Trigonal Planar
- ☐ C. Trigonal Pyramidal
- ☐ D. Octahedral

6. What is the S-O bond order in the structure B?

- ☐ A. 1.0
- ☐ B. 1.33
- ☐ C. 1.5
- ☐ D. 1.67

7. Which of the following statements regarding the structure B is true?

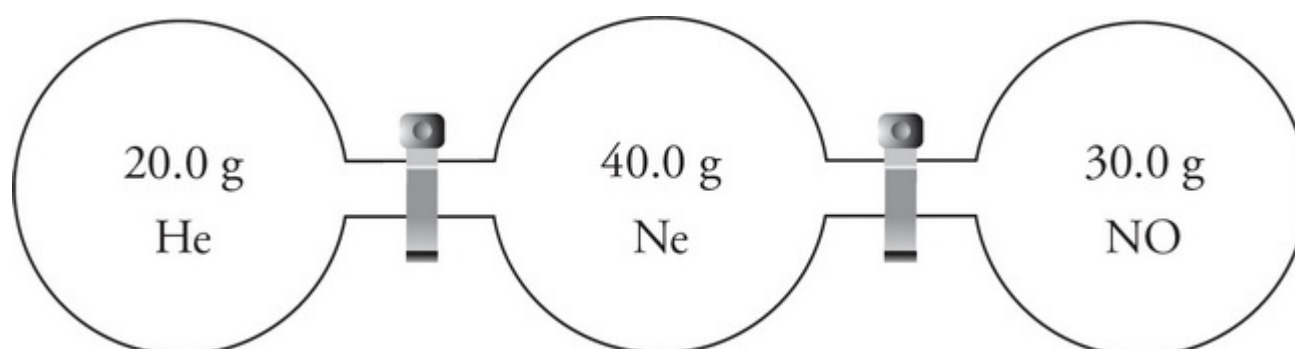
- ☐ A. The double bonds must be located opposite of each other due to additional electron repulsion.
- ☐ B. It is a more polar molecule than the molecule represented by structure A.
- ☐ C. The bonds in the molecule are weaker than those in structure A.
- ☐ D. All bonds in the molecule are identical to each other.

8. Which structure is more likely to correspond with the actual Lewis diagram for the sulfate ion?

- ☐ A. Structure A; single bonds are more stable than double bonds
- ☐ B. Structure A; it has the most unshared pairs of electrons
- ☐ C. Structure B; there are more possible resonance structures
- ☐ D. Structure B; fewer atoms have formal charges

Questions 9-11 refer to the following information.

The diagram below shows three identical 1.0 L containers filled with the indicated amounts of gas. The stopcocks connecting the containers are originally closed and the gases are all at 25°C. Assume ideal behavior.



9. Which gas exerts the greatest pressure?

- ☐ A. He
- ☐ B. Ne

☐ D. All gases exert the same amount of pressure.

10. Which gas has the strongest IMFs?

☐ A. He

☐ B. Ne

☐ C. NO

☐ D. All gases have identical IMFs.

11. The stopcocks are opened. If the tubing connecting the containers has negligible volume, by what percentage will the pressure exerted by the neon gas decrease?

☐ A. 25%

☐ B. 33%

☐ C. 50%

☐ D. 67%

12. A sample of an unknown chloride compound was dissolved in water, and then titrated with excess $\text{Pb}(\text{NO}_3)_2$ to create a precipitate. After drying, it is determined there are 0.0050 mol of precipitate present. What mass of chloride is present in the original sample?

☐ A. 0.177 g

☐ B. 0.355 g

☐ C. 0.522 g

☐ D. 0.710 g

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