Chapter 5 Practice Test

1. A 0.5 mol sample of He(**g**) and a 0.5 mol sample of Ne(**g**) are placed separately in two 10.0 L rigid containers at 25°C. Each container has a pinhole opening. Which of the gases, He(**g**) or Ne(**g**), will escape faster through the pinhole and why?

- (A) He(**g**) will escape faster because the He(**g**) atoms are moving at a higher average speed than the Ne(**g**) atoms. ✔
- (B) Ne(**g**) will escape faster because its initial pressure in the container is higher.
- (C) Ne(**g**) will escape faster because the Ne(**g**) atoms have a higher average kinetic energy than the He(**g**) atoms.
- (D) Both gases will escape at the same rate because the atoms of both gases have the same average kinetic energy.

---

2. A 2 L container will hold about 4 g of which of the following gases at 0°C and 1 atm?

- (A) SO_2
- (B) N_2
- (C) CO_2 ✔
- (D) C_4H_8
- (E) NH_3

---

3. A 2 L sample of N_2(**g**) and a 1 L sample of Ar(**g**), each originally at 1 atm and 0°C, are combined in a 1 L tank. If the temperature is held constant, what is the total pressure of the gases in the tank?

(A) 1 atm

(B) 2 atm

(C) 3 atm ✓

(D) 4 atm

(E) 5 atm

---

4. A flask contains 0.25 mole of SO_2(**g**), 0.50 mole of CH_4(**g**), and 0.50 mole of O_2(**g**). The total pressure of the gases in the flask is 800 mm Hg. What is the partial pressure of the SO_2(**g**) in the flask?

(A) 800 mm Hg

(B) 600 mm Hg

(C) 250 mm Hg

(D) 200 mm Hg

(E) 160 mm Hg ✓

---

5. A sample of an ideal gas is cooled from 50.0°C to 25.0°C in a sealed container of constant volume. Which of the following values for the gas will decrease?
I. The average molecular mass of the gas
II. The average distance between the molecules
III. The average speed of the molecules

(A) I only

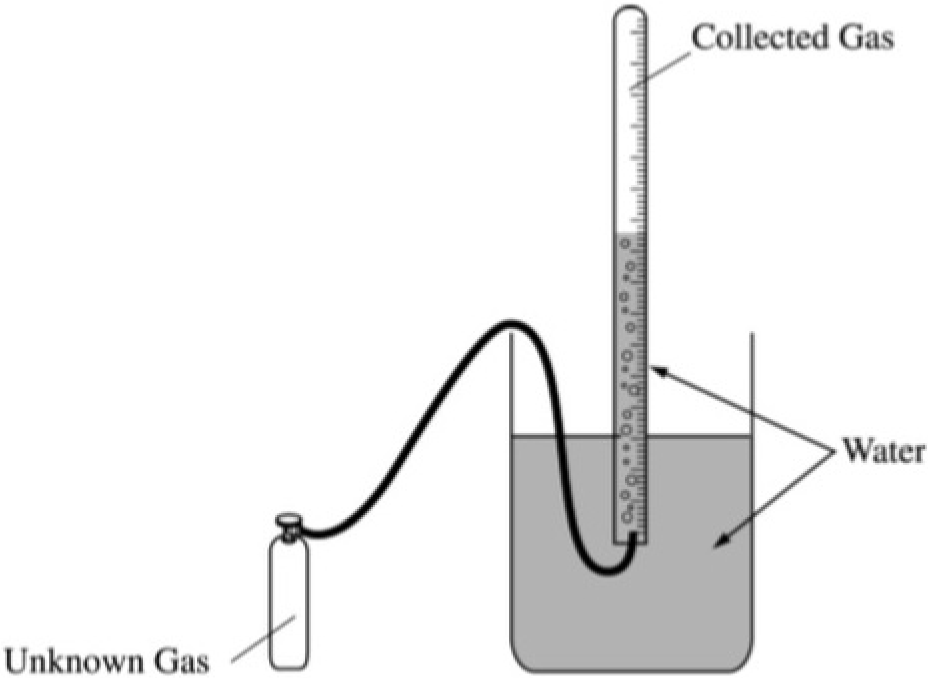
(B) II only

(C) III only ✔

(D) I and III

(E) II and III

6.



A sample of an unknown gas from a cylinder is collected over water in the apparatus shown above. After all the gas sample has been collected, the water levels inside and outside the gas collection tube are made the same. Measurements that must be made to calculate the molar mass of the gas include all of the following EXCEPT

(A) atmospheric pressure

(B) temperature of the water

(C) volume of gas in the gas-collection tube

(D) initial and final mass of the gas cylinder

(E) mass of the water in the apparatus ✔

---

7. A sealed vessel contains 0.200 mol of oxygen gas, 0.100 mol of nitrogen gas, and 0.200 mol of argon gas. The total pressure of the gas mixture is 5.00 atm. The partial pressure of the argon is

(A) 0.200 atm

(B) 0.500 atm

(C) 1.00 atm

(D) 2.00 atm ✔

(E) 5.00 atm

---

8. A student was assigned the task of determining the molar mass of an unknown gas. The student measured the mass of a sealed 843 mL rigid flask that contained dry air. The student then flushed the flask with the unknown gas, resealed it, and measured the mass again. Both the air and the unknown gas were at 23.0°C and 750. torr. The data for the experiment are shown in the table below.

Chapter 5 Practice Test

Volume of sealed flask	843 mL
Mass of sealed flask and dry air	157.70 g
Mass of sealed flask and unknown gas	158.08 g

a. Calculate the mass, in grams, of the dry air that was in the sealed flask. (The density of dry air is 1.18 g L^{-1} at 23.0°C and 750. torr.)

b. Calculate the mass, in grams, of the sealed flask itself (i.e., if it had no air in it).

c. Calculate the mass, in grams, of the unknown gas that was added to the sealed flask.

d. Using the information above, calculate the value of the molar mass of the unknown gas.

After the experiment was completed, the instructor informed the student that the unknown gas was carbon dioxide (44.0 g mol^{-1}) .

e. Calculate the percent error in the value of the molar mass calculated in part (d).

f. For each of the following two possible occurrences, indicate whether it by itself could have been responsible for the error in the student's experimental result. You need not include any calculations with your answer. For each of the possible occurrences, justify your answer.

Occurrence 1: The flask was incompletely flushed with $CO_2(g)$, resulting in some dry air remaining in the flask.

Occurrence 2: The temperature of the air was 23.0°C, but the temperature of the $CO_2(g)$ was lower than the reported 23.0°C.

g. Describe the steps of a laboratory method that the student could use to verify that the volume of the rigid flask is 843 mL at 23.0°C. You need not include any calculations with your answer.

Please respond on separate paper, following directions from your teacher.

Part A

1 point is earned for the correct setup and calculation of mass.

m = **D** x **V** = (1.18 g L^{-1})(0.843 L) = 0.995 g

Note: Significant figures were checked in this problem: parts (a) and (d) were scored with ±1 significant figure needed, and parts (b) and (c) were scored with the correct number of significant figures needed for the subtraction.

0	1

The student response earns one of the following points:

1 point is earned for the correct setup and calculation of mass.

m = **D** x **V** = (1.18 g L^{-1})(0.843 L) = 0.995 g

Note: Significant figures were checked in this problem: parts (a) and (d) were scored with ±1 significant figure needed, and parts (b) and (c) were scored with the correct number of significant figures needed for the subtraction.

Part B

1 point is earned for subtracting the answer in part (a) from 157.70 g.

157.70 g − 0.995 g = 156.71 g

Note: Significant figures were checked in this problem: parts (a) and (d) were scored with ±1 significant figure needed, and parts (b) and (c) were scored with the correct number of significant figures needed for the subtraction.

0	1 ✓

The student response earns one of the following points:

1 point is earned for subtracting the answer in part (a) from 157.70 g.

157.70 g − 0.995 g = 156.71 g

Note: Significant figures were checked in this problem: parts (a) and (d) were scored with ±1 significant figure needed, and parts (b) and (c) were scored with the correct number of significant figures needed for the subtraction.

Part C

1 point is earned for subtracting the answer in part (b) from 158.08 g.

158.08 g − 156.71 g = 1.37 g

Note: Significant figures were checked in this problem: parts (a) and (d) were scored with ±1 significant figure needed, and parts (b) and (c) were scored with the correct number of significant figures needed for the subtraction.

0	1 ✓

The student response earns one of the following points:

1 point is earned for subtracting the answer in part (b) from 158.08 g.

158.08 g − 156.71 g = 1.37 g

Note: Significant figures were checked in this problem: parts (a) and (d) were scored with ±1 significant figure needed, and parts (b) and (c) were scored with the correct number of significant figures needed for the subtraction.

Part D

1 point is earned for the conversion of pressure (if necessary) and temperature and the use of the appropriate **R**.

1 point is earned for the correct setup and calculation of moles of gas.

$$n = \frac{PV}{RT} = \frac{\left(\frac{750.}{760}\,\text{atm}\right)(0.843\ \text{L})}{(0.0821\ \text{L atm mol}^{-1}\ \text{K}^{-1})(296\ \text{K})} = 0.0342\ \text{mol}$$

1 point is earned for the correct setup and calculation of molar mass.

OR

If calculation is done in a single step, 1 point is earned for the correct **P** and **T**, 1 point is earned for the correct density, and 1 point is earned for the correct answer.

molar mass = $\frac{1.37\ \text{g}}{0.0342\ \text{mol}} = 40.1\ \text{g mol}^{-1}$

OR

molar mass = $\frac{DRT}{P}$

$$= \frac{\left(\frac{1.37\ \text{g}}{0.843\ \text{L}}\right)(0.0821\ \text{L atm mol}^{-1}\ \text{K}^{-1})(296\ \text{K})}{\left(\frac{750.}{760}\ \text{atm}\right)}$$

= 40.0 g mol^{-1}

Note: Significant figures were checked in this problem: parts (a) and (d) were scored with ±1 significant figure needed, and parts (b) and (c) were scored with the correct number of significant figures needed for the subtraction.

0	1	2	3 ✔

The student response earns three of the following points:

1 point is earned for the conversion of pressure (if necessary) and temperature and the use of the appropriate **R**.

1 point is earned for the correct setup and calculation of moles of gas.

$$n = \frac{PV}{RT} = \frac{\left(\frac{750.}{760}\text{atm}\right)(0.843\text{ L})}{(0.0821\text{ L atm mol}^{-1}\text{ K}^{-1})(296\text{ K})} = 0.0342\text{ mol}$$

1 point is earned for the correct setup and calculation of molar mass.

OR

If calculation is done in a single step, 1 point is earned for the correct **P** and **T**, 1 point is earned for the correct density, and 1 point is earned for the correct answer.

molar mass = $\frac{1.37\text{ g}}{0.0342\text{ mol}} = 40.1\text{ g mol}^{-1}$

OR

molar mass = $\frac{DRT}{P}$

$$= \frac{\left(\frac{1.37\text{ g}}{0.843\text{ L}}\right)(0.0821\text{ L atm mol}^{-1}\text{ K}^{-1})(296\text{ K})}{\left(\frac{750.}{760}\text{ atm}\right)}$$

= 40.0 g mol^{-1}

Note: Significant figures were checked in this problem: parts (a) and (d) were scored with ±1 significant figure needed, and parts (b) and (c) were scored with the correct number of significant figures needed for the subtraction.

Part E

1 point is earned for the correct setup and answer.

$$\text{percent error} = \frac{|44.0 \text{ g mol}^{-1} - 40.1 \text{ g mol}^{-1}|}{44.0 \text{ g mol}^{-1}} \times 100 = 8.9\%$$

0	1

The student response earns one of the following points:

1 point is earned for the correct setup and answer.

$$\text{percent error} = \frac{|44.0 \text{ g mol}^{-1} - 40.1 \text{ g mol}^{-1}|}{44.0 \text{ g mol}^{-1}} \times 100 = 8.9\%$$

Part F

Occurrence 1:

1 point is earned for the correct reasoning and conclusion.

This occurrence could have been responsible.

The dry air left in the flask is less dense (or has a lower molar mass) than CO_2 gas at the given **T** and **P**. This would result in a lower mass of gas in the flask and a lower result for the molar mass of the unknown gas.

Occurrence 2:

1 point is earned for the correct reasoning and conclusion.

This occurrence could not have been responsible.

The density of CO_2 is greater at the lower temperature. A larger mass of CO_2 would be in the flask than if the CO_2 had been at 23.0°C, resulting in a higher calculated molar mass for the unknown gas.

0	1	2

The student response earns two of the following points:

Occurrence 1:

1 point is earned for the correct reasoning and conclusion.

This occurrence could have been responsible.

The dry air left in the flask is less dense (or has a lower molar mass) than CO_2 gas at the given **T** and **P**. This would result in a lower mass of gas in the flask and a lower result for the molar mass of the unknown gas.

Occurrence 2:

1 point is earned for the correct reasoning and conclusion.

This occurrence could not have been responsible.

The density of CO_2 is greater at the lower temperature. A larger mass of CO_2 would be in the flask than if the CO_2 had been at 23.0°C, resulting in a higher calculated molar mass for the unknown gas.

Part G

1 point is earned for a valid method.

Valid methods include the following:

1. Find the mass of the empty flask. Fill the flask with a liquid of known density (e.g., water at

23°C), and measure the mass of the liquid-filled flask. Subtract to find the mass of the liquid. Using the known density and mass, calculate the volume.

2. Measure 843 mL of a liquid (e.g., water) in a 1,000 mL graduated cylinder and transfer the liquid quantitatively into the flask to see if the water fills the flask completely.

0	1 ✓

The student response earns one of the following points:

1 point is earned for a valid method.

Valid methods include the following:

1. Find the mass of the empty flask. Fill the flask with a liquid of known density (e.g., water at 23°C), and measure the mass of the liquid-filled flask. Subtract to find the mass of the liquid. Using the known density and mass, calculate the volume.

2. Measure 843 mL of a liquid (e.g., water) in a 1,000 mL graduated cylinder and transfer the liquid quantitatively into the flask to see if the water fills the flask completely.

---

9. A vessel contains Ar(g) at a high pressure. Which of the following statements best helps to explain why the measured pressure is significantly greater than the pressure calculated using the ideal gas law?

(A) The molar mass of Ar is relatively large.

(B) A significant number of Ar_2 molecules form.

(C) The attractive forces among Ar atoms cause them to collide with the walls of the container with less force.

(D) The combined volume of the Ar atoms is too large to be negligible compared with the total volume of the container. ✔

---

10. At constant temperature, the behavior of a sample of a real gas more closely approximates that of an ideal gas as its volume is increased because the

(A) collisions with the walls of the container become less frequent

(B) average molecular speed decreases

(C) molecules have expanded

(D) average distance between molecules becomes greater ✔

(E) average molecular kinetic energy decreases

---

11. At standard temperature and pressure, a 0.50 mol sample of H_2 gas and a separate 1.0 mol sample of O_2 gas have the same

(A) average molecular kinetic energy ✔

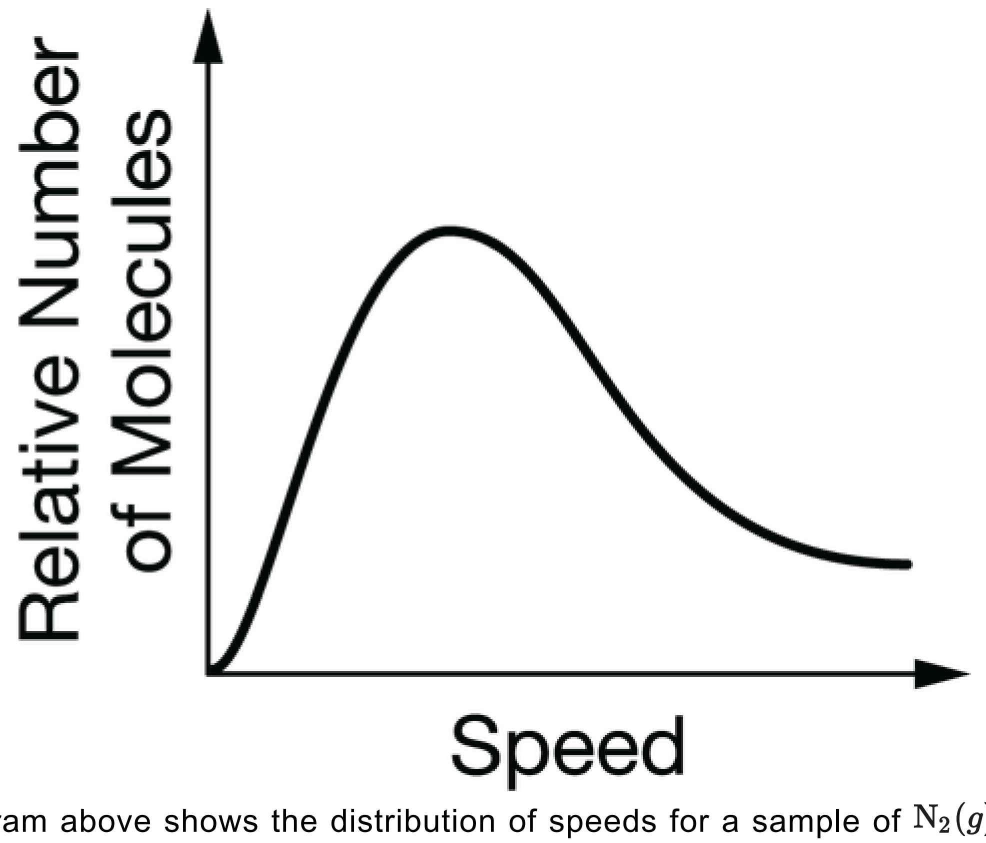
(B) average molecular speed

(C) volume

(D) effusion rate

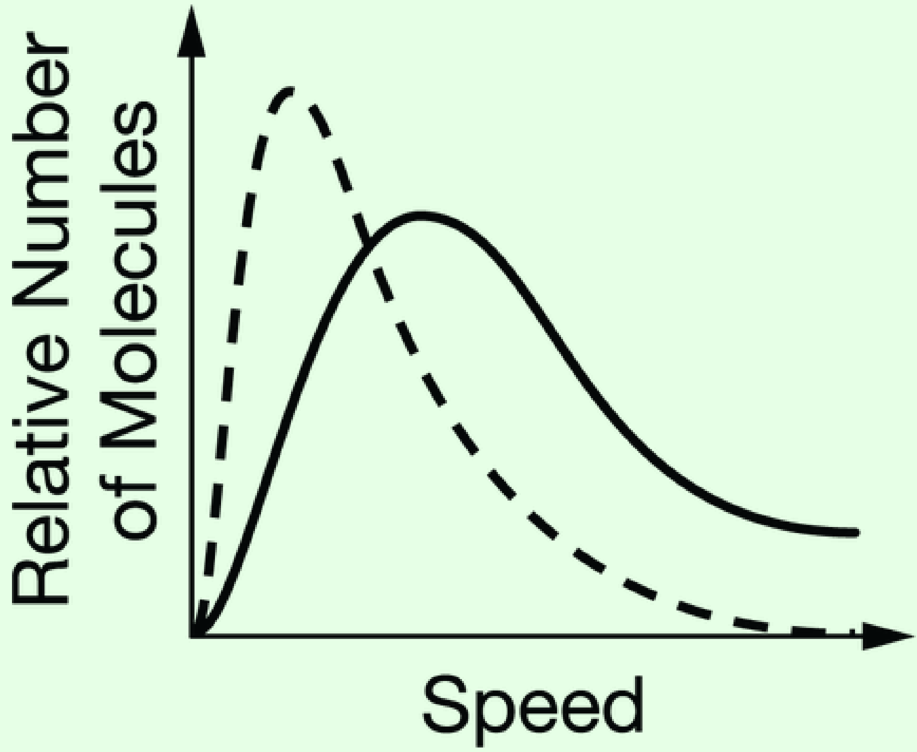
(E) density

12.

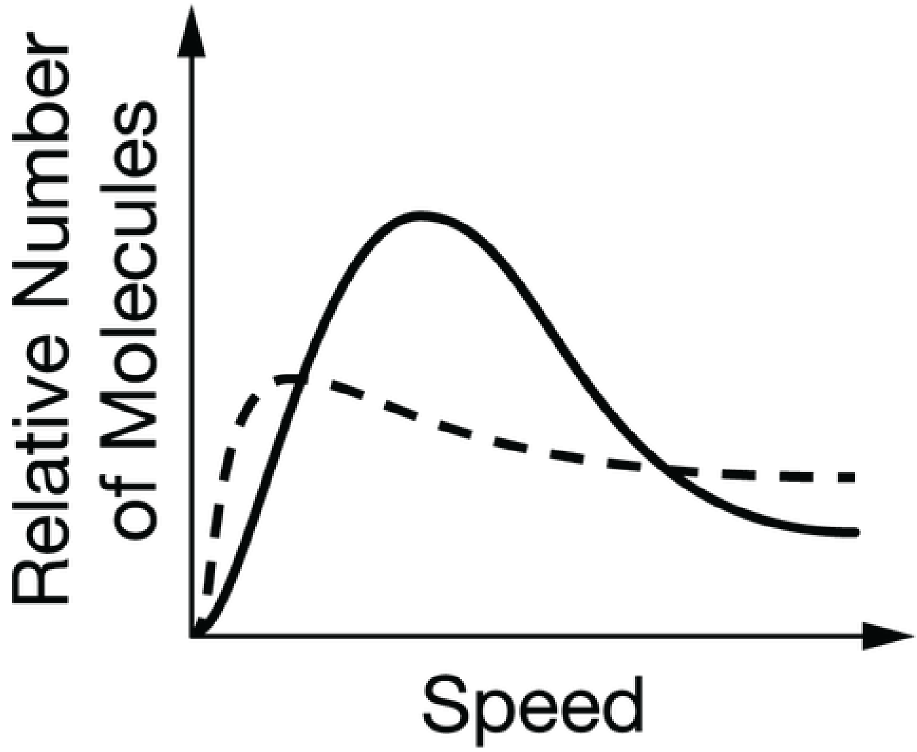


The diagram above shows the distribution of speeds for a sample of $N_2(g)$ at $25^\circ C$. Which of the following graphs shows the distribution of speeds for a sample of $O_2(g)$ at $25^\circ C$ (dashed line) ?

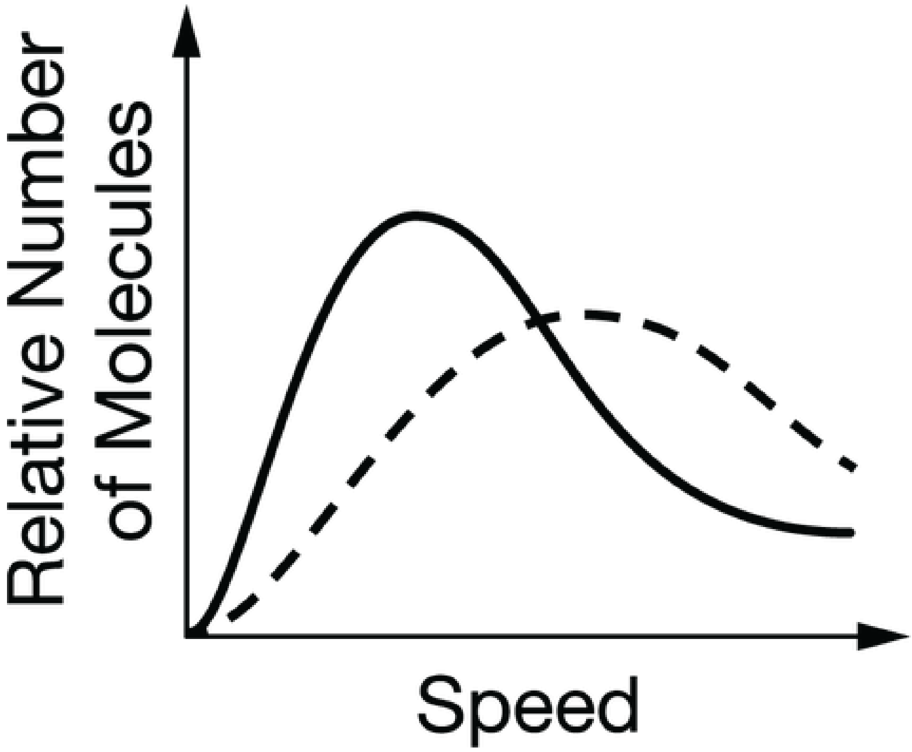
(A)


Relative Number of Molecules
Speed

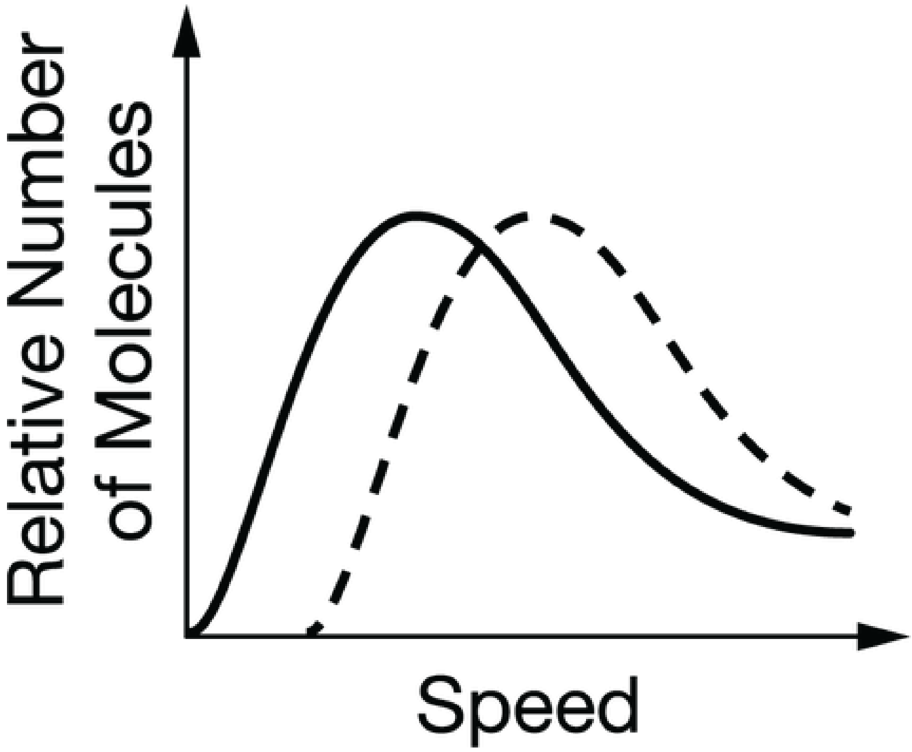
(B)


Relative Number of Molecules
Speed

(C)


Relative Number of Molecules
Speed

(D)


Relative Number of Molecules
Speed

Chapter 5 Practice Test

13. Equal masses of He and Ne are placed in a sealed container. What is the partial pressure of He if the total pressure in the container is 6 atm?

(A) 1 atm

(B) 2 atm

(C) 3 atm

(D) 4 atm

(E) 5 atm ✔

---

14. Equal masses of three different ideal gases, X, Y, and Z, are mixed in a sealed rigid container. If the temperature of the system remains constant, which of the following statements about the partial pressure of gas X is correct?

(A) It is equal to ⅓ the total pressure

(B) It depends on the intermolecular forces of attraction between molecules of X, Y, and Z.

(C) It depends on the relative molecular masses of X, Y, and Z. ✔

(D) It depends on the average distance traveled between molecular collisions.

(E) It can be calculated with knowledge only of the volume of the container.

---

15. Equal numbers of moles of He(**g**), Ar(**g**), and Ne(**g**) are placed in a glass vessel at room temperature. If the vessel has a pinhole-sized leak, which of the following will be true regarding the relative values of the partial pressures of the gases remaining in the vessel after some of the gas mixture has effused?

Chapter 5 Practice Test

(A) $P_{He} < P_{Ne} < P_{Ar}$ ✔

(B) $P_{He} < P_{Ar} < P_{Ne}$

(C) $P_{Ne} < P_{Ar} < P_{He}$

(D) $P_{Ar} < P_{He} < P_{Ne}$

(E) $P_{He} = P_{Ar} = P_{Ne}$