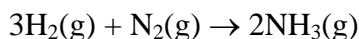


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**Multiple-Choice Questions**

Circle the letter for the choice that best completes the statement or answers the question.

1. In the reaction shown below, all gases are measured at SATP. What volume of nitrogen,  $\text{N}_2(\text{g})$ , reacts with 1.120 L of hydrogen,  $\text{H}_2(\text{g})$ , to form ammonia,  $\text{NH}_3(\text{g})$ ?



- a) 0.373 L  
b) 1.120 L  
c) 2.240 L  
d) 3.360 L
2. A sample of methane gas has a volume of 5.881 L at STP. The temperature decreases by  $23.00^\circ\text{C}$  and the pressure rises by 5.700 kPa. Which expression can be solved to find the correct new volume?
- a)  $5.881 \text{ L} \times \frac{273.15 \text{ K}}{296.15 \text{ K}} \times \frac{101.325 \text{ kPa}}{107.025 \text{ kPa}}$   
b)  $5.881 \text{ L} \times \frac{250.15 \text{ K}}{273.15 \text{ K}} \times \frac{101.325 \text{ kPa}}{105.025 \text{ kPa}}$   
c)  $5.881 \text{ L} \times \frac{250.15 \text{ K}}{273.15 \text{ K}} \times \frac{101.325 \text{ kPa}}{107.025 \text{ kPa}}$   
d)  $5.881 \text{ L} \times \frac{273.15 \text{ K}}{250.15 \text{ K}} \times \frac{101.325 \text{ kPa}}{107.025 \text{ kPa}}$
3. A container holds a 4.00 L sample of propane gas. If the pressure on the gas in the container is increased by a factor of 4 and the Kelvin temperature is doubled, what is the new volume?
- a) 1.00 L  
b) 2.00 L  
c) 8.00 L  
d) 32.00 L
4. The partial pressure of gas A in a sample is twice the partial pressure of gas B in that same sample. The number of particles of gas A is \_\_\_\_\_ the number of particles of gas B.
- a) twice  
b) half  
c) the same as  
d) less than

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5. 3.50 mol of oxygen gas is added to an empty, deflated balloon at 90.0 °C and standard pressure. To what volume will the balloon expand?
- 8.12 L
  - 104 L
  - 8.51 L
  - 126 L
6. A sample of gas is trapped at standard temperature and pressure. The gas has a mass of 0.301 g and a volume of 0.153 L. What is the identity of this gas?
- CH<sub>4</sub>
  - NH<sub>3</sub>
  - C<sub>2</sub>H<sub>6</sub>
  - CO<sub>2</sub>
7. Students performing a chemistry experiment reacted nitrogen gas and oxygen gas. They found that 20 mL of nitrogen gas reacted with 40 mL of oxygen gas to produce 40 mL of nitrogen dioxide gas. In order to produce 1.0 L of nitrogen dioxide gas, they would need to use \_\_\_\_\_ L of nitrogen gas.
- 1.0
  - 2.0
  - 0.50
  - 0.25
8. What volume will 36.0 g of water occupy when it evaporates to water vapour at SATP?
- 24.8 L
  - 99.2 L
  - 49.6 L
  - 44.8 L
9. The molar volume of all gases is the same at STP, yet equal volumes of different gases at STP have different densities. This is because
- there are different numbers of particles of each gas
  - the pressures are different for each of the gases
  - the particles of each gas have different average speeds
  - the particles of each gas have different masses
10. The molar volume of hydrogen gas at 50.0 kPa and 300 K is
- 22.4 L
  - 24.8 L
  - 45.1 L
  - 49.9 L
11. The density of methane gas at STP is
- |               |             |
|---------------|-------------|
| a) 0.0446 g/L | c) 1.40 g/L |
| b) 0.717 g/L  | d) 359 g/L  |

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12. For a mixture of gases in a closed container to behave ideally, each gas exerts the same pressure as if it alone occupied the entire container. This is a statement of
- Charles's law
  - Dalton's law of partial pressures
  - Avogadro's law
  - law of combining volumes
13. A sample of gas in a closed container contains  $1.00 \times 10^{21}$  molecules. The volume of the container is decreased and the temperature is increased. Assuming ideal behavior is maintained, which statement about this sample of gas is incorrect?
- The same number of moles of gas are present.
  - The pressure in the container increases.
  - The collisions between molecules are no longer elastic.
  - The molecules are colliding more often.
14. Three gases are in a closed container at  $25.0^\circ\text{C}$  and  $102.0\text{ kPa}$  pressure. The volume of the container is  $5.00\text{ L}$ . In this mixture, 25% of the molecules are gas A, 55% are molecules of gas B, and the remainder are molecules of gas C. What volume is occupied by the molecules of gas C?
- $5.00\text{ L}$
  - $4.00\text{ L}$
  - $1.25\text{ L}$
  - $1.00\text{ L}$
15. If you had  $2.0\text{ g}$  of each of the following gases at STP, which would have the greatest volume?
- $\text{NH}_3$
  - $\text{N}_2$
  - $\text{NO}$
  - $\text{N}_2\text{O}$
16. What volume of  $\text{N}_2(\text{g})$  contains the same number of molecules as a  $4.04\text{ g}$  sample of  $\text{H}_2(\text{g})$  if each gas is measured at STP?
- $24.8\text{ L}$
  - $22.4\text{ L}$
  - $11.2\text{ L}$
  - $44.8\text{ L}$
17. At SATP,  $4.0 \times 10^{20}$  molecules of gas occupy  $10.0\text{ L}$ . At these same conditions, a  $20.0\text{ L}$  sample of this gas contains  $8.0 \times 10^{20}$  molecules. This is an application of
- Charles's law
  - the ideal gas equation
  - Avogadro's law
  - Dalton's law

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18. A sample of ideal gas cooled from 200 °C to 100 °C. By what factor must the pressure change if the volume is to remain constant?

a)  $\frac{273}{473}$

b)  $\frac{473}{373}$

c)  $\frac{200}{100}$

d)  $\frac{373}{473}$

19. 45.5 mL of oxygen gas, O<sub>2</sub>(g), is collected in a cylinder by the downward displacement of water at 18.0 °C and 102.61 kPa pressure. The vapour pressure of water at 18.0 °C is 2.07 kPa. Which one of the following statements is correct?

a) The total pressure of the gas in the cylinder is 104.68 kPa.

b) The pressure of the dry oxygen is 100.54 kPa.

c) The pressure of the dry oxygen is  $\frac{2.07 \text{ kPa}}{102.61 \text{ kPa}}$ .

d) The pressure of the dry oxygen is  $\frac{102.61 \text{ kPa}}{104.68 \text{ kPa}}$ .

20. Under ideal conditions, the molar volume of He gas at STP is 22.4 L/mol and the molar volume of Ne gas at SATP is 24.8 L/mol. Which one of the following statements is correct?

a) The number of molecules in both volumes is  $6.02 \times 10^{23}$ .

b) There are more molecules in the 24.8 L of Ne than in the 22.4 L of He.

c) The mass of the He sample is greater than the mass of the Ne sample.

d) The number of molecules cannot be compared for two different gases.

### Numerical Response Questions

For each numerical response question, record the answer in the following response box.

21.	22.	23.	24.	25.
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## ASSESSMENT

## Chapter 4 Test

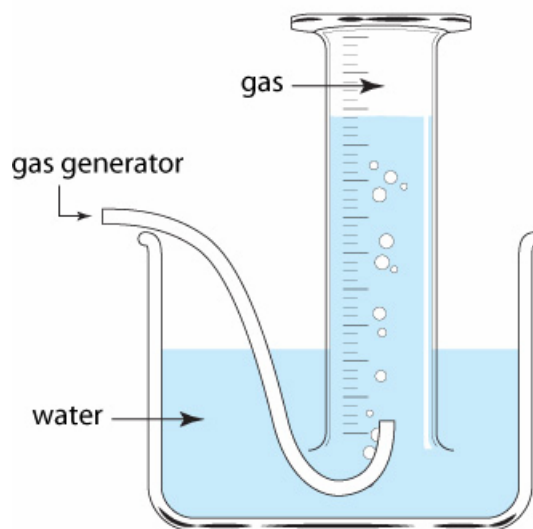
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21. A sample of gas is trapped at  $25.0^{\circ}\text{C}$  and  $104.2\text{ kPa}$  pressure. The gas has a mass of  $0.755\text{ g}$  and a volume of  $0.253\text{ L}$ . What is the molar mass of the gas?
22.  $14.67\text{ mL}$  of nitrogen,  $\text{N}_2(\text{g})$  at  $64.85^{\circ}\text{C}$  and  $40.675\text{ kPa}$  is cooled and the pressure drops by  $10.00\text{ kPa}$ . The volume is now  $10.46\text{ mL}$ . To what temperature, in degrees Celsius, was the sample cooled?
23. What is the mass of helium,  $\text{He}(\text{g})$ , in a balloon having a volume of  $5.00\text{ kL}$  at  $-50.00^{\circ}\text{C}$  and  $68.3\text{ kPa}$  pressure?
24. The boiling point of liquid nitrogen is  $-195.79^{\circ}\text{C}$ . At this temperature, the density of liquid nitrogen is  $0.807\text{ g/mL}$ .  $1.00\text{ mL}$  of liquid nitrogen is placed into a deflated balloon. What will be the volume of nitrogen gas in the balloon at STP?
25. What is the density of butane gas,  $\text{C}_4\text{H}_{10}(\text{g})$ , at  $45.35^{\circ}\text{C}$  and  $104.38\text{ kPa}$  pressure?

**Written Response Questions**

Answer each question in the space provided. Use complete sentences and diagrams when necessary.

26. In an investigation to determine the molar mass, a gas is collected by the downward displacement of water. Refer to the following diagram.



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Before reading the volume of gas collected in the cylinder, the instructions say to “adjust the position of the cylinder so that the water level inside the cylinder is exactly the same as the water in the beaker.” Why is this an important step in the process?

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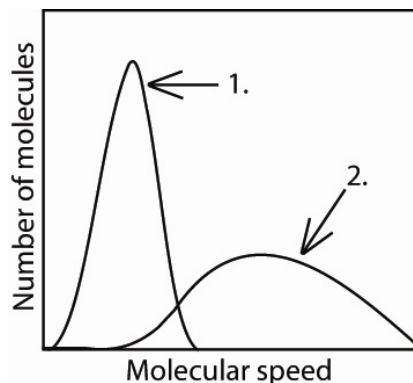
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27. The kinetic energy of molecules in a sample of gas is given by the equation  $E_k = \frac{1}{2} mv^2$ . The graph shown below represents the distribution of the speeds of molecules of helium gas, He(g), and nitrogen gas, N<sub>2</sub>(g), at 50.0 °C.



- a) Why are all of the molecules of each gas not moving at the same speed?

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- b) Which curve, 1 or 2, represents nitrogen gas molecules? Give a reason for your answer.

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28. The mass of the Earth's atmosphere has been estimated to be  $5.0 \times 10^{18}$  kg. If the molar mass of air is taken as 28.75 g/mol, how many molecules are in the atmosphere?

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29. A mixture of gases in a 4.0 L container is made up of 4.00 g of oxygen,  $\text{O}_2(\text{g})$ , 4.040 g of hydrogen,  $\text{H}_2(\text{g})$  and 16.04 g of methane,  $\text{CH}_4(\text{g})$ . The total pressure in the container is 100.0 kPa. What is partial pressure of the methane gas?

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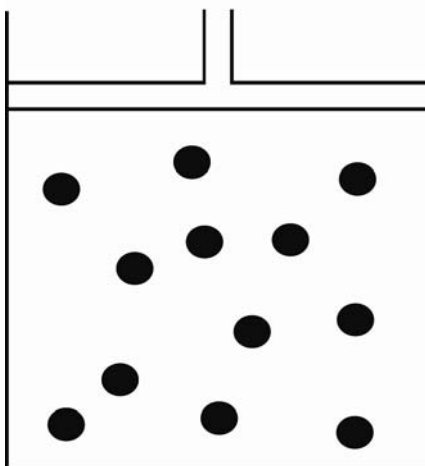
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30. A sample of an ideal gas is in a cylinder that is fitted with a movable piston.



List three ways in which the pressure can be increased inside this cylinder.

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