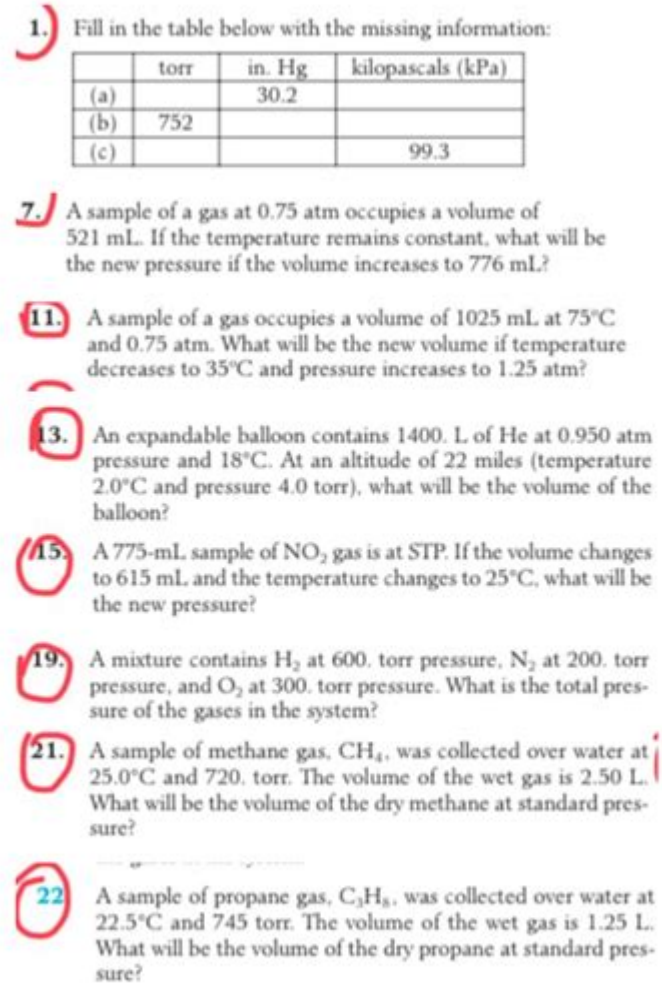
Ideal Gas Law Practice Problems



1. Fill in the table below with the missing information:

	torr	in. Hg	kilopascals (kPa)
(a)		30.2	
(b)	752		
(c)			99.3

7. A sample of a gas at 0.75 atm occupies a volume of 521 mL. If the temperature remains constant, what will be the new pressure if the volume increases to 776 mL?

11. A sample of a gas occupies a volume of 1025 mL at 75°C and 0.75 atm. What will be the new volume if temperature decreases to 35°C and pressure increases to 1.25 atm?

13. An expandable balloon contains 1400. L of He at 0.950 atm pressure and 18°C. At an altitude of 22 miles (temperature 2.0°C and pressure 4.0 torr), what will be the volume of the balloon?

15. A 775-mL sample of NO_2 gas is at STP. If the volume changes to 615 mL and the temperature changes to 25°C, what will be the new pressure?

19. A mixture contains H_2 at 600. torr pressure, N_2 at 200. torr pressure, and O_2 at 300. torr pressure. What is the total pressure of the gases in the system?

21. A sample of methane gas, CH_4, was collected over water at 25.0°C and 720. torr. The volume of the wet gas is 2.50 L. What will be the volume of the dry methane at standard pressure?

22 A sample of propane gas, C_3H_8, was collected over water at 22.5°C and 745 torr. The volume of the wet gas is 1.25 L. What will be the volume of the dry propane at standard pressure?

Ideal gas law practice problems are essential for students studying chemistry and physics. Understanding the ideal gas law, represented by the equation PV = nRT, is crucial for mastering the behavior of gases under varying conditions. This equation relates pressure (P), volume (V), number of moles (n), the ideal gas constant (R), and temperature (T) in kelvins. By practicing with a variety of problems, students can solidify their grasp of this fundamental concept and prepare for exams.

What is the Ideal Gas Law?

The ideal gas law is a fundamental equation in physical chemistry that describes the relationship between the pressure, volume, temperature, and number of moles of an ideal gas. An ideal gas is a theoretical gas composed of many particles that are in constant,

random motion and do not interact with one another. The ideal gas law is expressed as:

$$ PV = nRT $$

Where:
- P = Pressure of the gas (in atm or Pa)
- V = Volume of the gas (in liters or cubic meters)
- n = Number of moles of the gas
- R = Ideal gas constant (0.0821 L·atm/(K·mol) or 8.314 J/(K·mol))
- T = Absolute temperature (in kelvins)

Understanding the Components of the Ideal Gas Law

To effectively solve ideal gas law practice problems, it's important to understand each component of the equation.

Pressure (P)

Pressure is defined as the force exerted by gas particles colliding with the walls of their container. It can be measured in various units, including atmospheres (atm), pascals (Pa), and millimeters of mercury (mmHg).

Volume (V)

Volume is the amount of space that a gas occupies, usually measured in liters (L) or cubic meters (m^3).

Number of Moles (n)

The number of moles represents the quantity of gas present. One mole corresponds to approximately 6.022×10^{23} particles (Avogadro's number).

Ideal Gas Constant (R)

The ideal gas constant (R) can take different values depending on the units used for pressure and volume. The most common value used in chemistry is 0.0821 L·atm/(K·mol).

Temperature (T)

Temperature must always be measured in kelvins (K) when using the ideal gas law. This means that to convert from Celsius to Kelvin, you need to add 273.15.

Applications of the Ideal Gas Law

The ideal gas law has a wide range of applications in science and engineering. Here are a few examples:

- Calculating the behavior of gases in chemical reactions
- Predicting gas behavior under different temperature and pressure conditions
- Understanding the principles of gas diffusion and effusion
- Solving real-world problems involving gas storage and transportation

Common Ideal Gas Law Practice Problems

To master the ideal gas law, it is crucial to engage with various practice problems. Here are some common types of problems you might encounter:

Problem Type 1: Calculating Pressure

Given the volume, temperature, and number of moles, you can find the pressure using the ideal gas law.

Example Problem: A gas occupies a volume of 10.0 L at a temperature of 300 K with 2 moles of gas. What is the pressure?

Solution:
1. Use the ideal gas law: $PV = nRT$.
2. Rearrange to find pressure: $P = \frac{nRT}{V}$.
3. Substitute the values: $P = \frac{(2 \text{ mol})(0.0821 \text{ L·atm/(K·mol)})(300 \text{ K})}{10.0 \text{ L}}$.
4. Calculate P.

Problem Type 2: Finding Volume

You can also find the volume of a gas if you know the pressure, temperature, and number of moles.

Example Problem: How much volume will 1 mole of gas occupy at a temperature of 273 K and a pressure of 1 atm?

Solution:
1. Rearrange the ideal gas law to solve for volume: $V = \frac{nRT}{P}$.

2. Substitute the values: $V = \frac{(1 \text{ mol})(0.0821 \text{ L·atm/(K·mol)})(273 \text{ K})}{1 \text{ atm}}$.
3. Calculate V.

Problem Type 3: Temperature Calculations

You may be asked to find the temperature of a gas when other variables are known.

Example Problem: A gas exerts a pressure of 2 atm in a 5 L container, with 3 moles of gas present. What is the temperature?

Solution:
1. Rearrange the ideal gas law to solve for temperature: $T = \frac{PV}{nR}$.
2. Substitute the values: $T = \frac{(2 \text{ atm})(5 \text{ L})}{(3 \text{ mol})(0.0821 \text{ L·atm/(K·mol)})}$.
3. Calculate T.

Problem Type 4: Number of Moles

You can also find the number of moles if you know pressure, volume, and temperature.

Example Problem: What is the number of moles of gas in a 20 L container at 1 atm and 300 K?

Solution:
1. Rearrange the ideal gas law to solve for moles: $n = \frac{PV}{RT}$.
2. Substitute the values: $n = \frac{(1 \text{ atm})(20 \text{ L})}{(0.0821 \text{ L·atm/(K·mol)})(300 \text{ K})}$.
3. Calculate n.

Tips for Solving Ideal Gas Law Problems

Here are some tips to help you effectively solve ideal gas law practice problems:

- Always convert temperature to kelvins before using the ideal gas law.
- Be consistent with units for pressure, volume, and the ideal gas constant.
- Practice a variety of problems to become familiar with different scenarios.
- Draw diagrams when necessary to visualize the problem.
- Carefully check your calculations to avoid simple mistakes.

Conclusion

Ideal gas law practice problems are an integral part of learning about gas behavior in chemistry and physics. By understanding the components of the ideal gas law and practicing various problem types, students can gain confidence in their ability to apply this fundamental concept. Mastery of the ideal gas law not only prepares students for exams but also lays the foundation for more advanced studies in thermodynamics and physical chemistry. With consistent practice and application, anyone can become proficient in solving ideal gas law problems.

Frequently Asked Questions

What is the ideal gas law equation?

The ideal gas law equation is PV = nRT, where P is pressure, V is volume, n is the number of moles of gas, R is the ideal gas constant, and T is temperature in Kelvin.

How do you calculate the number of moles using the ideal gas law?

To calculate the number of moles (n) using the ideal gas law, rearrange the equation to n = PV / RT.

What units should pressure, volume, and temperature be in for the ideal gas law?

In the ideal gas law, pressure (P) should be in atmospheres (atm) or pascals (Pa), volume (V) in liters (L) or cubic meters (m^3), and temperature (T) in Kelvin (K).

If 2 moles of an ideal gas are at 300 K and occupy 10 L, what is the pressure?

Using the ideal gas law, P = nRT/V. Substituting the values, P = (2 mol)(0.0821 L·atm/(mol·K))(300 K) / (10 L) = 4.926 atm.

How does the ideal gas law relate to real gases?

The ideal gas law is an approximation that works well under conditions of low pressure and high temperature. Real gases deviate from this behavior at high pressures and low temperatures.

What happens to the pressure of a gas if the volume is halved while keeping temperature constant?

According to Boyle's Law, if the volume of a gas is halved while keeping temperature constant, the pressure will double.

How can the ideal gas law be used to determine the molar mass of a gas?

The molar mass (M) can be calculated using the formula M = (mRT) / (PV), where m is the mass of the gas, R is the ideal gas constant, T is the temperature in Kelvin, P is the pressure, and V is the volume.

What is the value of the ideal gas constant R in different units?

The value of the ideal gas constant R is 0.0821 L·atm/(mol·K) or 8.314 J/(mol·K) depending on the units used for pressure and volume.

How do you convert temperature from Celsius to Kelvin for ideal gas law calculations?

To convert temperature from Celsius to Kelvin, you add 273.15: K = °C + 273.15.

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