14.3 Ideal Gases

Connecting to Your World

Solid carbon dioxide, or dry ice, doesn't melt. It sublimes. Dry ice can exist because gases don't obey the assumptions of kinetic theory under all conditions. You will learn how real gases differ from the ideal gases on which the gas laws are based.

Ideal Gas Law

The gas laws we have examined so far worked if *n* (amount of gas) was constant, so this variable was not included.

Ideal Gas Law

What is needed to calculate the amount of gas in a sample at given conditions of volume, temperature, and pressure?

To calculate the number of moles (amount) of a contained gas requires an expression that contains the variable *n*.

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The gas law that includes all four variables—*P, V, T,* and *n*—is called the **ideal gas law.**

The **ideal gas constant** (*R*) has the value 8.31 (L·kPa)/(K·mol) or 0.0821 (L·atm)/(K·mol)

$$P \times V = n \times R \times T \text{ or } PV = nRT$$

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What is the volume of 1 mole of gas at STP?

$P \times V = n \times R \times T$ or $PV = nRT$

What is the volume of 1 mole of gas at STP?

Knowns

$n = 1$ mol

$T = 273$ K

$P = 101.3$ kPa

$R = 8.31 \frac{(L \cdot kPa)}{(K \cdot mol)}$

Unknown

$V = ?$ L

$PV = nRT$

$V = \frac{nRT}{P}$

$V = \frac{1 \text{ mol} \cdot 8.31 \frac{L \cdot kPa}{K \cdot mol} \cdot 273 K}{101.3 \text{ kPa}}$

$= 22.4$ L

Ideal Gases and Real Gases

An ideal gas is one that follows the gas laws at ALL conditions of pressure and temperature.

Such a gas would have to follow ALL assumptions of kinetic theory. Its particles could have no volume, and there could be no attraction between particles in the gas.

There is no gas for which these assumptions are true.

THEREFORE an ideal gas does not exist. BUT, at many conditions of temperature and pressure, real gases behave very much like an ideal gas.

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Real gases differ most from an ideal gas at low temperatures and high pressures.

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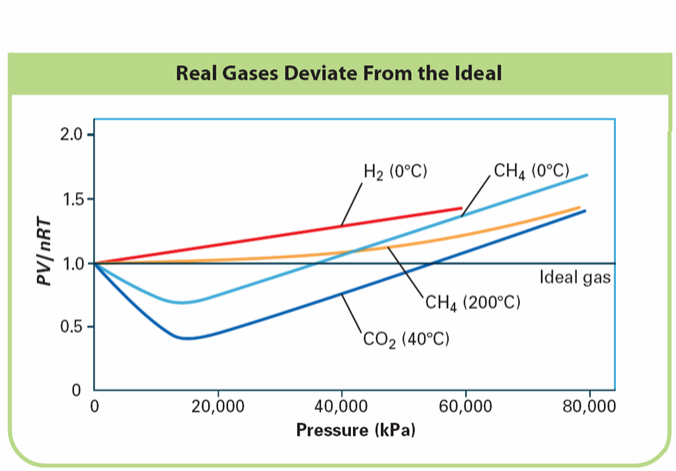

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There are attractions between the particles in an ideal gas. Because of these attractions, a gas can condense,or even solidify, when it is compressed or cooled.

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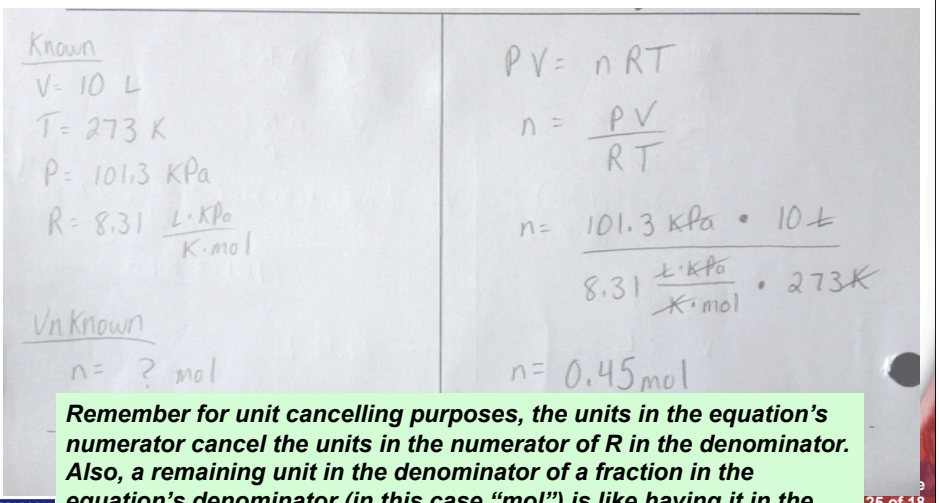
What is the number of moles in 10 L of H_2S gas at STP?



Remember for unit cancelling purposes, the units in the equation's numerator cancel the units in the numerator of R in the denominator. Also, a remaining unit in the denominator of a fraction in the equation's denominator (in this case "mol") is like having it in the equation's numerator

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Please complete your summary on a piece of lined paper. You do not need to staple the sheet as long as your initials are in the top right corner of the paper. Remember to stick to main ideas and facts, not opinions!

14.3 Section Practice

1. An aerosol spray can with a volume of 325 mL contains 3.00 g of propane (C_3H_8) as a propellant. What is the pressure in atm of the gas in the can at 28°C?

a. 524 kPa

b. 2.31 10^4 kPa

c. 475 kPa

d. 0.524 kPa

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2. Find the volume of a gas in liters if 2.95 mol has a pressure of 77.0 kPa at a temperature of 52°C.

a. 22.4 L

b. 16.6 L

c. 103 L

d. 50.2 L

14.3 Section Practice

3. An ideal gas differs from a real gas in that the molecules of an ideal gas

a. have no attraction for one another.

b. have a significant volume.

c. have a molar mass of zero.

d. have no kinetic energy.