

Gas Basics**Characteristics****Some Necessary Mathematics**

Direct Proportion

Indirect Proportion

Variables

| Variable | What is it? | Definition | Unit |
|--------------------|--------------------|-------------------|-------------|
| Pressure | | | |
| Volume | | | |
| Temperature | | | |
| Amount | | | |

Temperature Facts

| | Celsius | Kelvin | Fahrenheit | Rankine |
|---------------|---------|--------|------------|---------|
| Water Boils | | | | |
| Water Freezes | | | | |
| Absolute Zero | | | | |

STP**Barometers****Robert Boyle**

1. What's the pressure when 10.0 L of argon at 5.00 atm is compressed to 5.0 L?
2. What is the volume when 15.0 L of neon at 7.55 atm is subjected to 11.55 atm?

Charles Law and Absolute Zero

1. What is the volume when 3.75 L of Neon at 25 Celsius is heated to 35 Celsius?
2. If 7.50 liters of helium at 25 Celsius is expanded to 13.50 liters what is the new temperature?

Combined Gas Law

1. 17.5 L of Helium at STP is heated to 300 Kelvin and 2.00 atm. What is the new volume of the sample?
2. 10.00 liters of a gas is at 2.00 atmospheres at 100 Kelvin. If it is heated by 50 Kelvin and it expands to 15.00 liters what is the new pressure?

Joseph Gay-Lussac

1. If a gas exerts 10.0 atmospheres at 25°C what pressure will it exert at 50°C?
2. If a gas exerts 760 torr at 298 K what temperature will cause it to exert 660 torr?

Amadeo Avogadro**Ideal Gas Law**

Put it all together

$$R = 62.4 \text{ liter mm Hg}/(\text{mole K}) = 0.08206 \text{ liter atm}/(\text{mole K}) = 8.31 \text{ kPa L}/(\text{mole K})$$

1. 25.00 grams of Neon are held at 2.99 atm and 400. Kelvin. What is the volume of the sample?
2. If an ideal gas is held at STP and occupies 35.4 L how many moles of the ideal gas are present?

3. What is the pressure exerted by 64.00 g of oxygen gas at 273 Kelvin in 1.00 liter?
4. What pressure can be exerted by 100.0 g of Helium at 27 Celsius in a 10.0 liter container?
5. What is the volume of one mole of an ideal gas at STP?

Molar Volume

6. What is the volume of one mole of an ideal gas at 25 Celsius and 1.00 atmosphere?

7. Fill in the following table:

| Pressure | Volume | Moles | Temperature |
|-----------------|---------------|--------------|--------------------|
| 0.75 atm | 1.50 liter | 0.25 moles | |
| 750 torr | 7.50 liter | | 273 Kelvin |
| 125 kPa | | 2.50 moles | 100.0 Celsius |
| | 5250 mL | 3.55 moles | 100 Kelvin |

Stoichiometry

Molecules A ----- Moles A ----- Mass A ----- Volume A

Balanced Chemical Equation

Molecules B ----- Moles B ----- Mass B ----- Volume B

1. How many liters of carbon dioxide will form at STP from the reaction of 50.0 grams of CaCO_3 with excess hydrochloric acid?

Reaction

Calculations

2. What volume of HF at 743 torr and 24 Celsius will be released by the reaction of 47.2 g of XeF_2 with excess water?

Reaction

Calculations

3. Hydrogen chloride gas is produced by the decomposition of ammonium chloride. How many liters of HCl can be produced by the reaction of 250. g of ammonium chloride at STP?

Reaction

Calculations

4. Calcium hydride reacts with water to produce hydrogen gas. How many grams of calcium hydride are needed to produce 10.0 L of hydrogen at 27 °C and 740 torr?

Reaction

Calculations

5. Oxygen is prepared by the decomposition of KClO_3 . If you need 4 bottles (250 mL each) filled with oxygen, how much KClO_3 do you need to start with at STP if you waste 50% of the gas?

Reaction

Calculations

Gas Density and Determining Molar Masses

Can we solve the ideal gas law for molar mass or density even if we do not see it in the equation?

1. What is the density of sulfur hexafluoride at STP?
2. What is the density of sulfur hexafluoride at 500. K and 0.500 atm?
3. What is the density of carbon tetrachloride at 714 torr and 125 Celsius?
4. The density of a certain gaseous fluoride of phosphorus is 5.63 g/L at STP. Calculate the molecular weight of the fluoride and determine its molecular formula.

5. A compound has the empirical formula of CHCl . A 256 mL flask, at 373 K and 750 torr contains 0.80 g of the gas. Find the molecular formula of the gas.

6. A gas is composed of 46.2% Carbon and 53.8% Nitrogen. At 25 Celsius and 751 torr 1.05 grams of the gas occupies 0.500 L. What is the molecular formula of the gas?

7. A compound containing 37.5% carbon, 49.9% oxygen, and 12.6% hydrogen was vaporized. What is the empirical formula of the gas? The gas is found to exert 740 torr at 95° Celsius in a 270 mL vessel. If the mass of the gas was 0.276 g what is the molar mass and molecular formula of the compound?

Gas Mixtures

Dalton's Law

Mole Fraction

1. Imagine mixing 1.0 g of Helium and 1.0 g of Hydrogen in a 5.0 liter container at 25 Celsius. What are the partial pressures of each gas and the total pressure? What if it were 1.0 mole of each? Would you get the same ratios?

2. Nitrogen and oxygen gas are mixed in a 10.00 liter container at standard temperature. If you have 25.00 grams of each gas what is the partial pressure of each, total pressure in the container and the mole fraction of each gas?

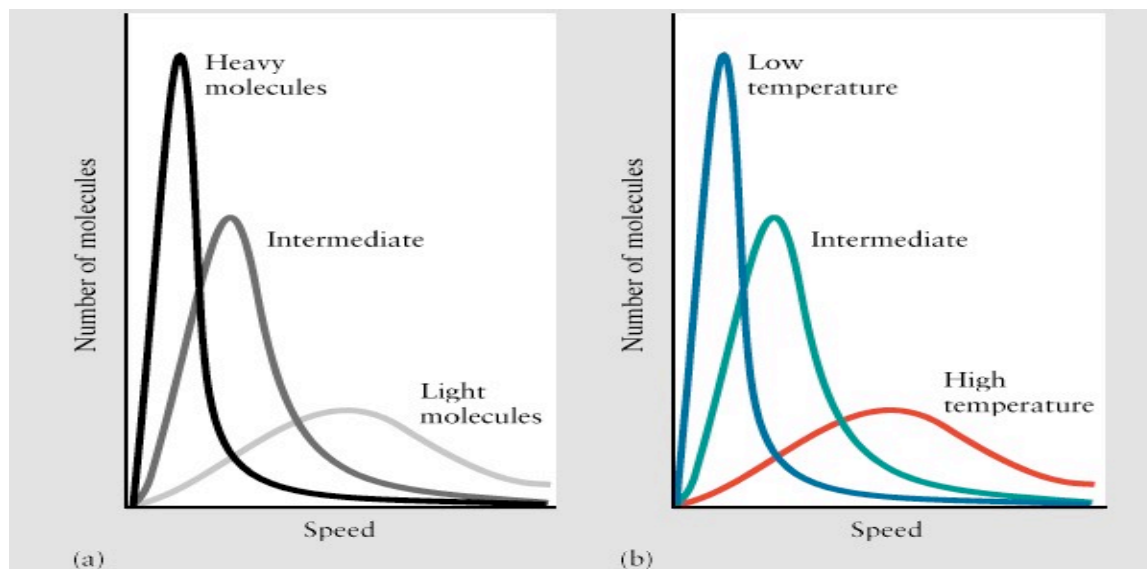
Collecting a gas over water:

3. Hydrogen gas is collected by water displacement until the pressure in the gas collection tube matches the atmospheric pressure of 755 torr at 25°C. What is the pressure of hydrogen gas in the tube if the vapor pressure of the water is 23.76 torr at this temperature?

4. A sample of nitrogen gas is collected over water at 20 Celsius and a total pressure of 760 torr. A total volume of 250.0 mL is collected. What mass of nitrogen was collected? The vapor pressure of water at this temperature is 17.5 torr.

5. What mass of water is present in a sample of wet nitrogen collected at 35°C and 735 torr in a 250.0 mL container? The vapor pressure of water at 35°C is 42.18 torr.

The Kinetic Nature of Matter



What determines how fast molecules move?

Root Mean Square Velocity

Diffusion

Effusion

The ammonia/HCl experiment

Thomas Graham

1. The rate of diffusion for an unknown gas is measured to be 24.0 mL per minute. Under identical conditions methane diffuses at a rate of 47.8 mL/minute. What is the molar mass of the unknown gas?

2. The rate of diffusion of an unknown gas is measured to be 31.50 mL/min. Under the same conditions oxygen gas diffuses at 30.50 mL/min. Is the unknown gas CH_4 , CO , NO , CO_2 or NO_2 ?

3. It took 4.5 minutes for 1.0 L of He to effuse through a porous barrier. How long will it take for 1.0 L of chlorine to effuse under the same conditions?

Ideal Gases versus Real Gases

Four Assumptions:

- 1.
- 2.
- 3.
- 4.

Which assumptions are not correct? Why

If a gas were ideal what would a graph of the ideal gas law look like?

This is what it looks like for real gases:

What can we do to account for this?

Van der Waals

Berthelot

Reidlich and Kwong

Virial Expansion: