

Gases & Kinetic-Molecular Theory

Unit: Gases

NGSS Standards/MA Curriculum Frameworks (2016): HS-PS2-8(MA)

Mastery Objective(s): (Students will be able to...)

- Explain how each aspect of Kinetic-Molecular Theory applies to gases.

Success Criteria:

- Descriptions account for behavior at the molecular level.
- Descriptions account for measurable properties, *e.g.*, temperature, pressure, volume, *etc.*

Tier 2 Vocabulary: kinetic, gas, ideal, real

Language Objectives:

- Explain how gas molecules behave and how their behavior relates to properties we can measure.

Notes:

Recall the following definitions:

- solid: molecules rigidly bonded (definite shape & volume)
- liquid: molecules bonded (definite volume), but loosely. Bonds continually breaking & re-forming (indefinite shape)
- gas: molecules not bonded (indefinite volume & shape)
- plasma: heat of surroundings > ionization energy, so electrons are loosely bonded & continually dissociate from and re-associate with ions. Electrical charge is fluid and in continual motion.

evaporation: conversion of liquid to gas.

boiling point: the temperature at which a liquid completely evaporates.

normal boiling point: the boiling point of a liquid when the pressure is 1 atm (average atmospheric pressure at sea level).

Use this space for summary and/or additional notes:

Kinetic-Molecular Theory

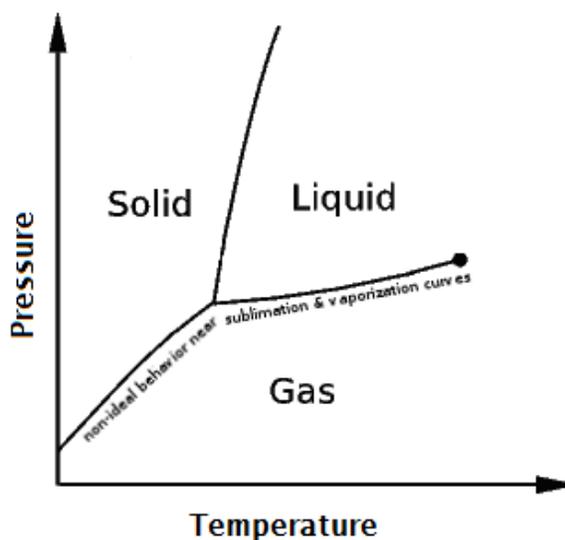
Kinetic-Molecular Theory (KMT) is a theory, developed by James C. Maxwell and Ludwig Boltzmann, that predicts the behavior of gases by modeling them as moving molecules. The theory states that:

- Gases are made of very large numbers of molecules
- Molecules are constantly moving (obeying Newton's laws of motion), and their speeds are constant
- Molecules are very far apart compared with their diameter
- Molecules collide with each other and walls of container in elastic collisions
- Molecules behaving according to KMT are not reacting* or exerting any other forces (attractive or repulsive) on each other.

temperature: a measure of the average kinetic energy of the molecules of a substance

ideal gas: a gas whose molecules behave according to KMT. Most gases are ideal under *some* conditions (but not all).

real gas: a gas that is not behaving according to KMT. This can occur with all gases, most commonly at temperatures and pressures that are close to the solid or liquid sections of the phase diagram for the substance.



* Of course, reactions can occur, but chemical reactions are part of collision theory, which is separate from KMT.

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Measurable Properties of Gases

All gases have the following properties that can be measured:

Property	Variable	Units	Description
amount	n	moles (mol)	amount of gas (1 mol = 6.02×10^{23} molecules)
volume	V	liters (L)	space that the gas takes up
temperature	T	kelvin (K)	ability to transfer heat (proportional to the average kinetic energy of the molecules)
pressure	P	bar, atm, kPa, mm Hg (torr), etc.	average force on the walls of the container due to collisions between the molecules and the walls

Notes about calculations:

- Temperature must be absolute, which means you must use Kelvin. A temperature of 0 in a gas laws calculation can only mean absolute zero.
- Pressures must be absolute. (For example, you can't use a tire gauge because it measures "gauge pressure," which is the difference between atmospheric pressure and the pressure inside the tire.) A pressure of 0 in a gas laws calculation can only mean that there are no molecules colliding with the walls.

Use this space for summary and/or additional notes: