CHEMISTRY

IMAT REVIEW COURSE 2024

Imat Alpha

By AlphaMed

GAS LAWS

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UNITS OF VALUE

Definition: Volume measures the amount of space an object or substance occupies.

METRIC SYSTEM

- Milliliter (mL):
  - Commonly used in laboratories and for measuring liquids.
  - 1 mL is equivalent to 1 cubic centimeter (cm^3).
- Liter (L):
  - Standard unit of volume in the metric system.
  - 1 L = 1,000 mL.
- Cubic meter (m^3):
  - Measures large volumes, especially in industrial settings.
  - 1 m^3 = 1,000,000 mL or 1,000 L.

TEMPERATURE

Kelvin (K)

- Definition: The Kelvin (K) is the base unit of temperature in the International System of Units (SI). It begins at absolute zero, the theoretically lowest possible temperature where particles have minimal motion.
- Relation to Celsius: The Kelvin and Celsius scales are directly related. The conversion formula is K=°C+273.15K = \text{°C} + 273.15K=°C+273.15. This means that 0°C is equal to 273.15K.
- Absolute Zero: Absolute zero is 0 K, which corresponds to -273.15°C. At this temperature, the motion of particles is at its minimum, theoretically reaching zero kinetic energy.
- Usage: The Kelvin scale is widely used in scientific fields, particularly in physics and thermodynamics, due to its direct relationship with absolute temperature and energy.

TEMPERATURE

- Definition: A measure of the average kinetic energy of particles within a substance.
- Celsius (°C):
  - Definition: A temperature scale with 0°C as the freezing point of water and 100°C as its boiling point under standard atmospheric pressure.
  - Usage: Widely used in weather forecasting, cooking, and various scientific contexts.

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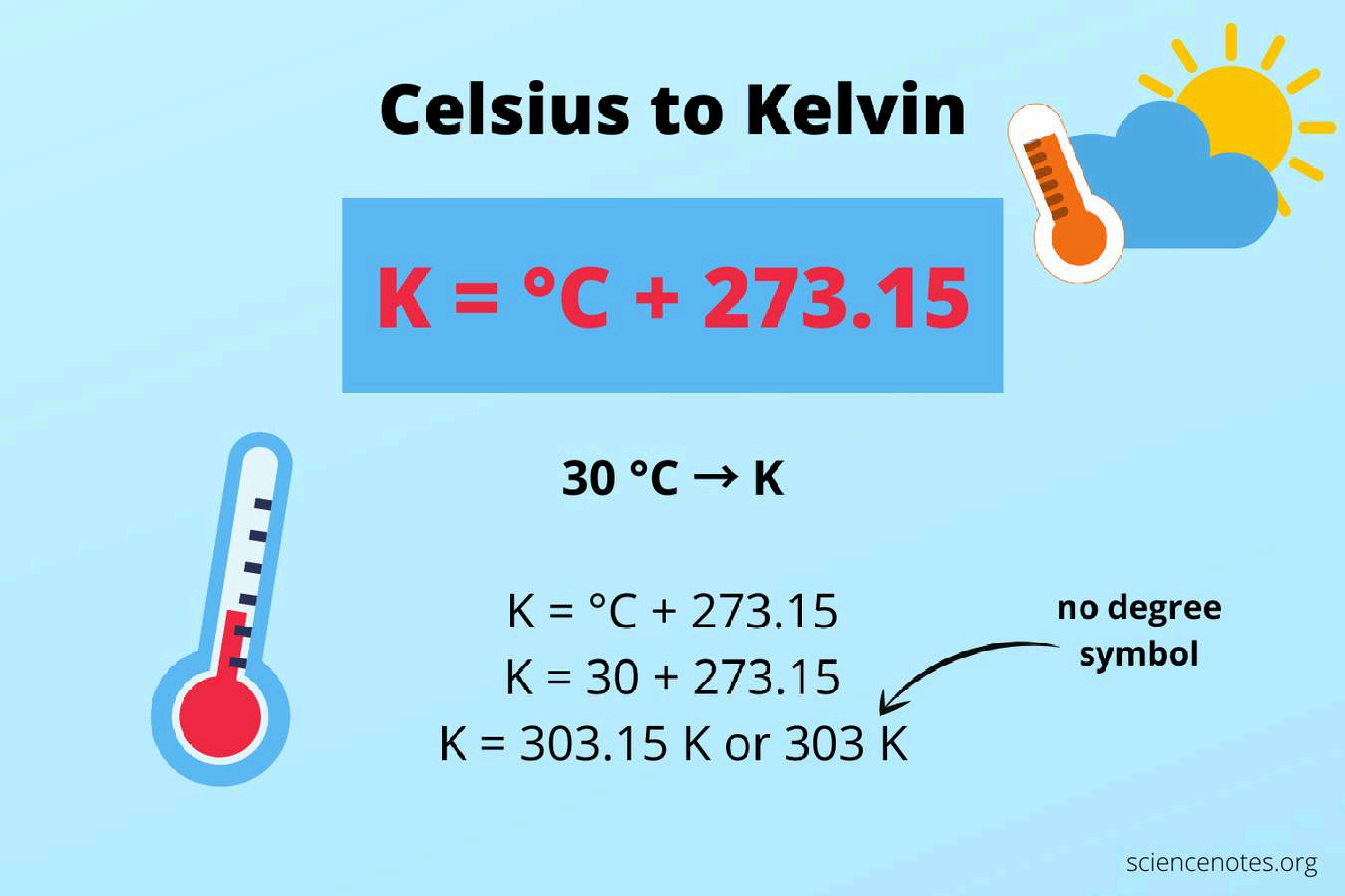
TEMPERATURE

- No Negative Values in Kelvin: The Kelvin scale starts at absolute zero, meaning there are no negative temperatures in Kelvin. This is because absolute zero represents the point at which particles have minimal kinetic energy.
- Why Kelvin in Science?: The Kelvin scale is used extensively in science, especially in physical laws and equations like the ideal gas law, because it is an absolute scale. This absolute nature makes it directly related to thermal energy and essential for accurate scientific calculations.

TEMPERATURE



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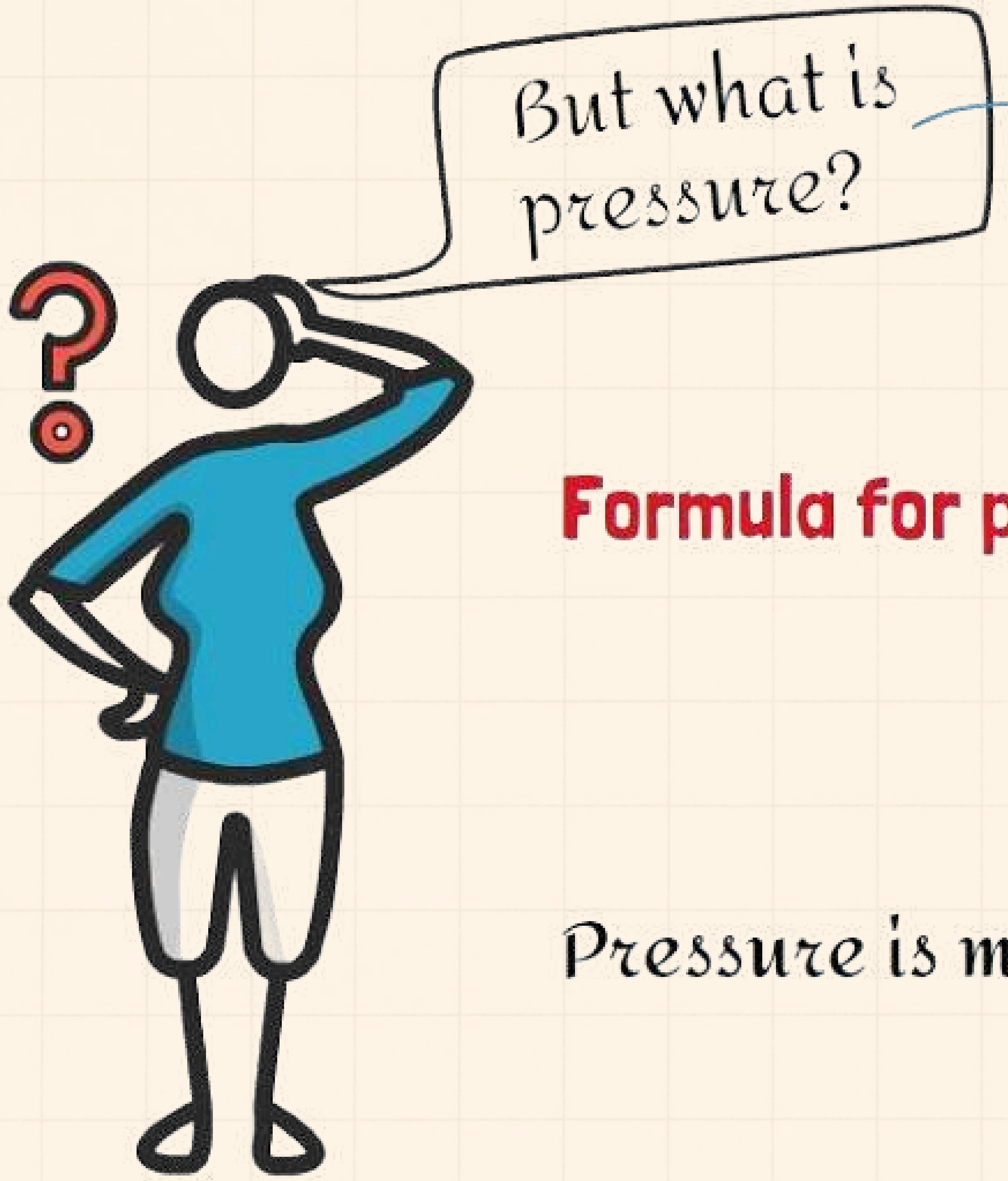
PRESURE

Definition: Pressure is the force exerted per unit area.

- Units of Pressure:
  - Pascal (Pa): The SI unit of pressure, where 1 Pa = 1 Newton per square meter (N/m^2).
  - Atmosphere (atm): A unit often used in atmospheric studies and chemistry, where 1 atm = 101,325 Pa.
  - Bar: Another unit of pressure, where 1 bar = 100,000 Pa.
  - Torr or mmHg: Commonly used in measuring atmospheric pressure, particularly in meteorology and medicine. 1 Torr ≈ 133.322 Pa.
  - Pound per square inch (psi): A unit commonly used in the United States, especially for tire pressure, where 1 psi ≈ 6,894.76 Pa.

Pressure Formula



Pressure is defined as the force applied per unit area.

Formula for pressure

$$P = \frac{F}{A}$$

Force

Pressure

Area

Pressure is measured in units called Pascals

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INTRODUCTION TO GAS LAWS

Definition: Gas laws describe the behavior of gases under various conditions, providing relationships between key properties such as volume, pressure, temperature, and the amount of gas.

Key Relationships:

- Volume (V): The space that the gas occupies.
- Pressure (P): The force exerted by the gas on the walls of its container.
- Temperature (T): The measure of the average kinetic energy of gas particles.
- Amount of Gas (n): Typically measured in moles, representing the quantity of gas particles.

Avogadro's Number and Gas Laws

- Avogadro's Principle: This principle states that the volume of a gas is directly proportional to the number of moles, provided the temperature and pressure remain constant.
- Molar Volume: At standard conditions (0°C and 1 atm), 1 mole of any ideal gas occupies approximately 22.7 liters. This is a direct result of Avogadro's number, which relates the number of particles in a mole to the volume of gas.

Avogadro's Number and Gas Laws

- Equal Volumes, Equal Molecules
- Avogadro's Number: Avogadro's number, 6.022×10236.022 \times 10^{23}6.022×1023, is a fundamental constant in chemistry. It states that equal volumes of gases, when measured at the same temperature and pressure, contain an equal number of molecules. This principle underpins much of gas law theory and helps explain the consistent behavior of gases under various conditions.

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BOYLE'S LAW

- Concept: Boyle's Law states that pressure and volume are inversely proportional to each other when the temperature remains constant. This means that as the volume of a gas decreases, its pressure increases, and vice versa, provided the temperature is unchanged.

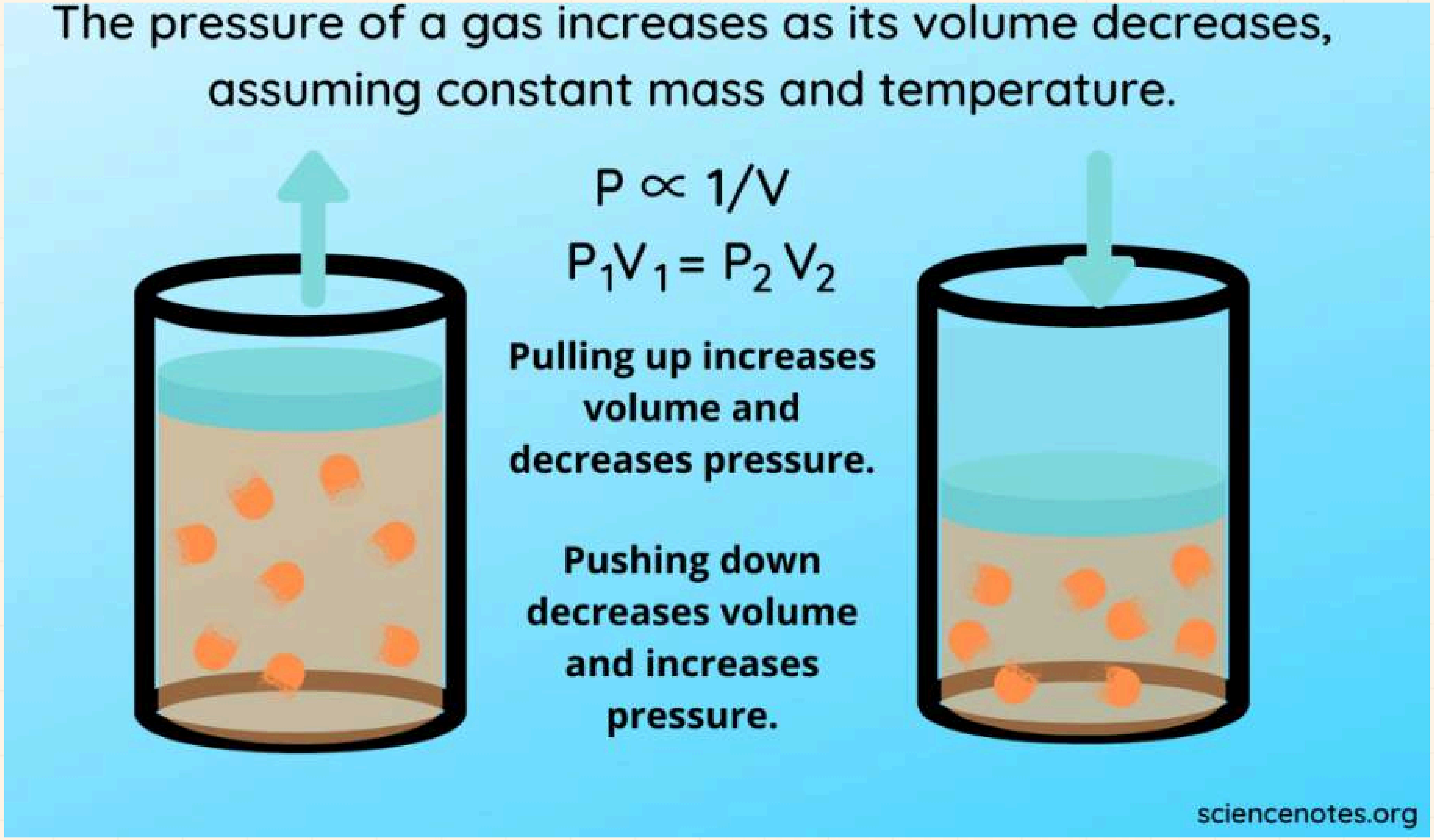
Formula:

$$P_1V_1 = P_2V_2$$

Where:

- P1 and P2 are the initial and final pressures.
- V1 and V2 are the initial and final volumes.
- Units: The units for pressure and volume in Boyle's Law can vary (e.g., atmospheres, pascals, liters, cubic meters), but they must be consistent within the equation.

BOYLE'S LAW


The pressure of a gas increases as its volume decreases, assuming constant mass and temperature.
P ∝ 1/V
P1V1 = P2 V2
Pulling up increases volume and decreases pressure.
Pushing down decreases volume and increases pressure.
sciencenotes.org

CHARLES' LAW

- Concept: Charles's Law states that the volume of a gas is directly proportional to its temperature, provided the pressure remains constant. This means that as the temperature of a gas increases, its volume also increases, and vice versa, as long as the pressure does not change.

Formula:

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

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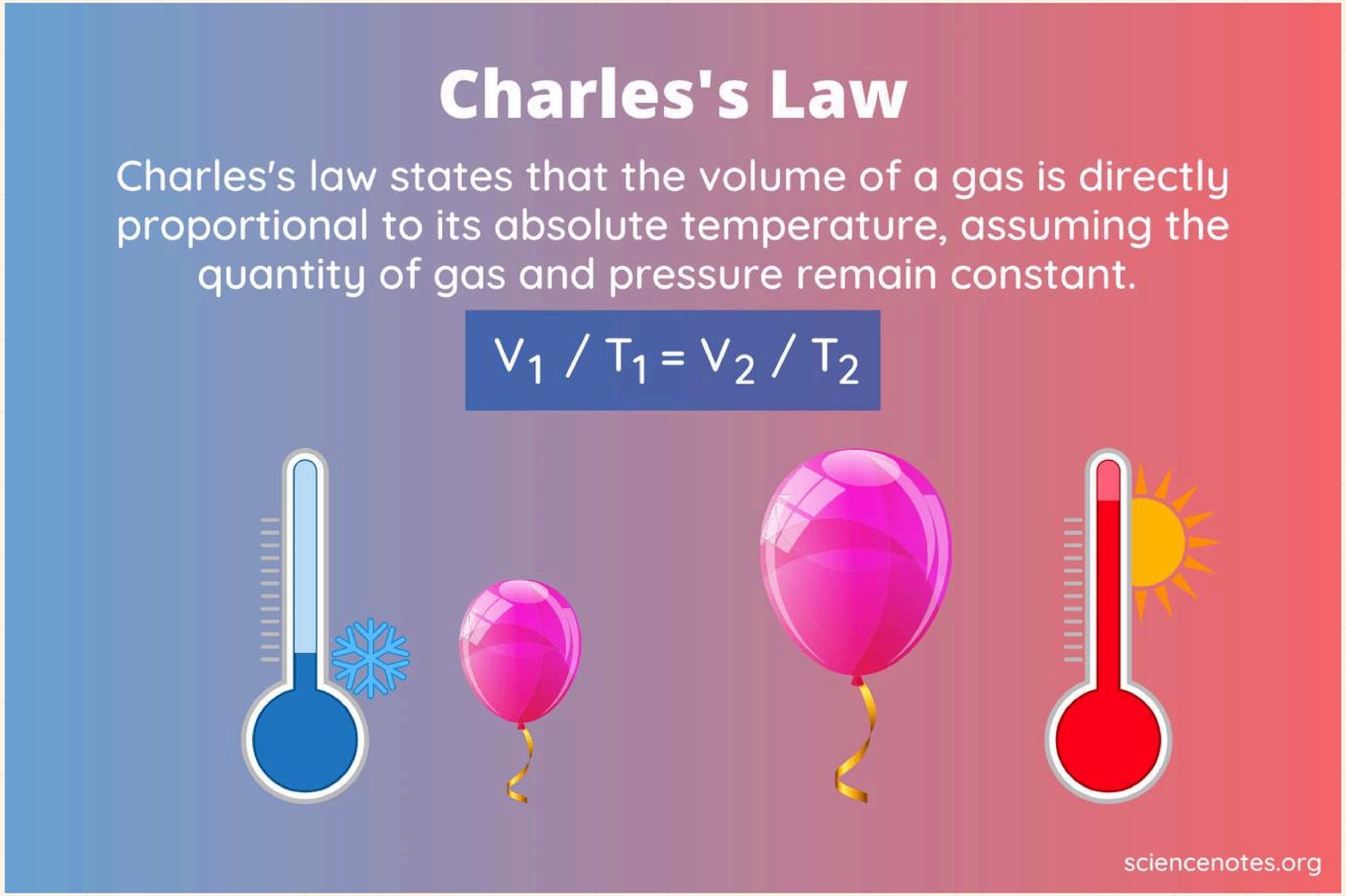
CHARLES' LAW


Charles's Law
Charles's law states that the volume of a gas is directly proportional to its absolute temperature, assuming the quantity of gas and pressure remain constant.
$V_1 / T_1 = V_2 / T_2$
sciencenotes.org

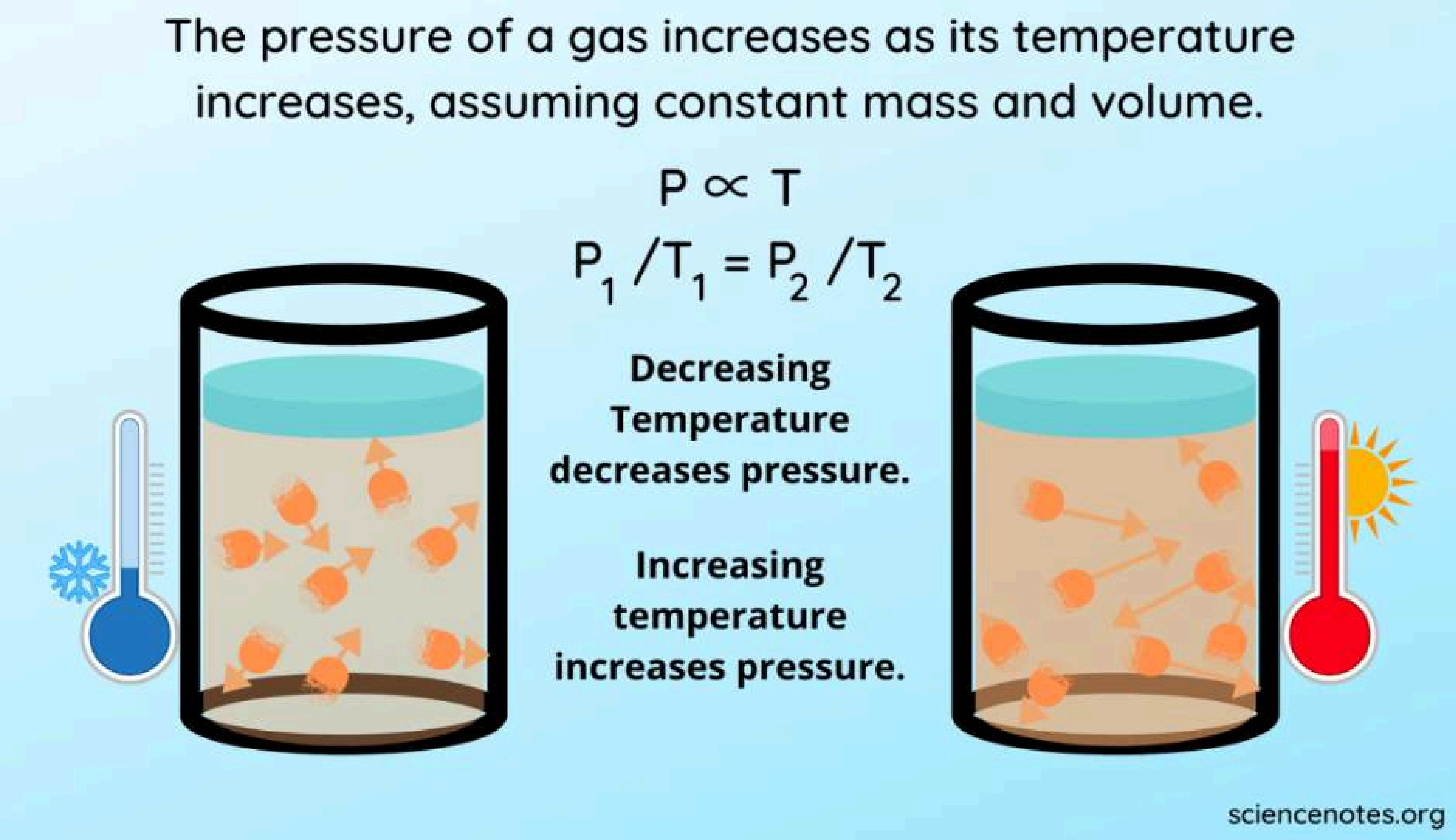
GAY-LUSSAC'S LAW

- Concept: Gay-Lussac's Law states that the pressure of a gas is directly proportional to its temperature when the volume remains constant. This means that as the temperature of a gas increases, its pressure also increases, and vice versa, as long as the volume does not change.

Formula:

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

GAY-LUSSAC'S LAW



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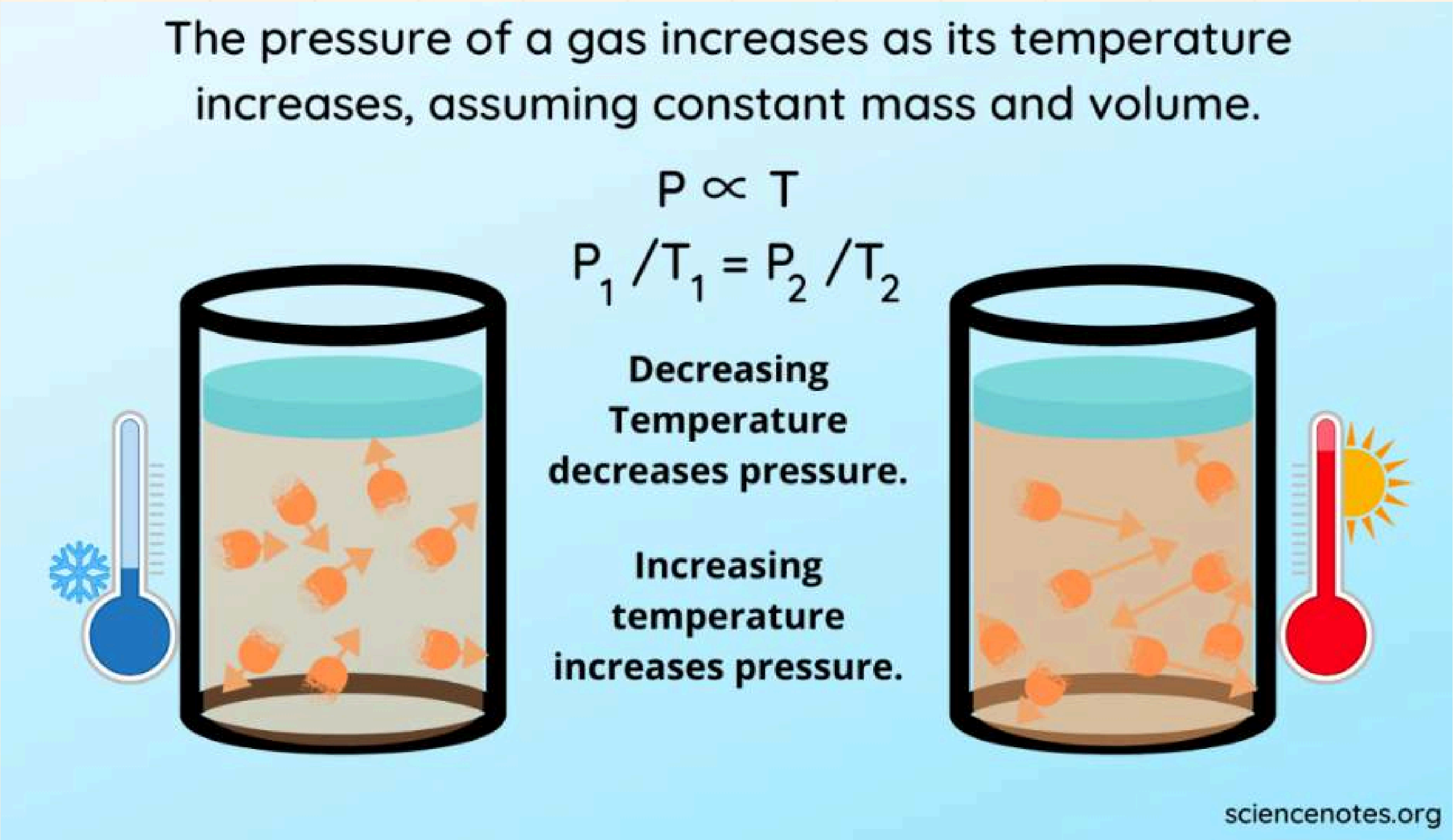
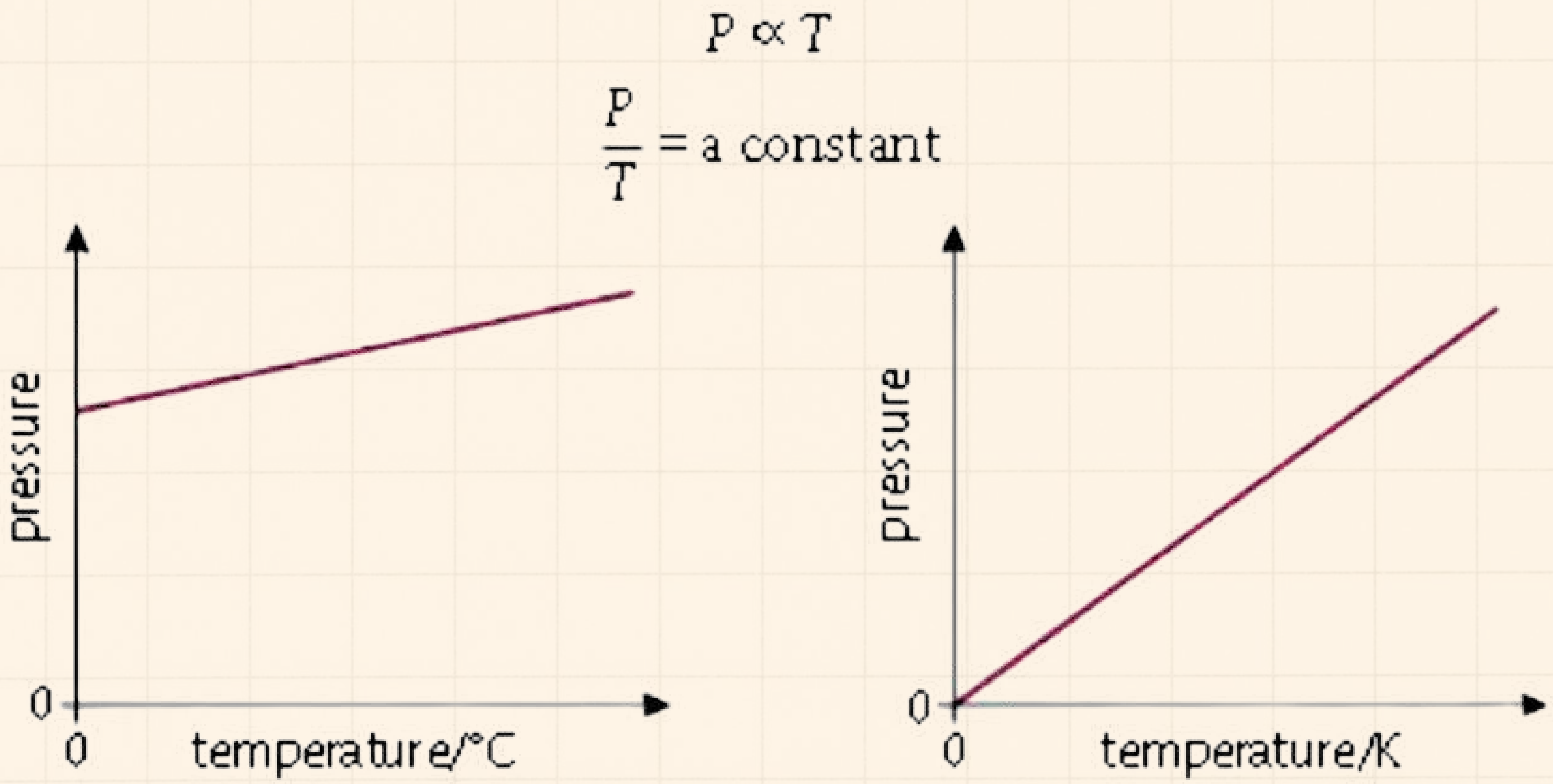
GAY-LUSSAC'S LAW





AVOGADRO'S LAW

- Avogadro's Law states that the volume of a gas is directly proportional to the number of moles of gas, provided the pressure and temperature remain constant.

Formula:

$$\frac{V_1}{n_1} = \frac{V_2}{n_2}$$

When temperate and pressure are constant, this equation is used to compare different conditions on the same substance

$$V \propto n$$

Volume is directly proportional to the amount of gas (in moles)

$$\frac{V}{n} = k$$

Volume divided by the amount of gas equals the k constant

(k = proportionality constant)

V = Volume
n = Amount of Gas (moles)

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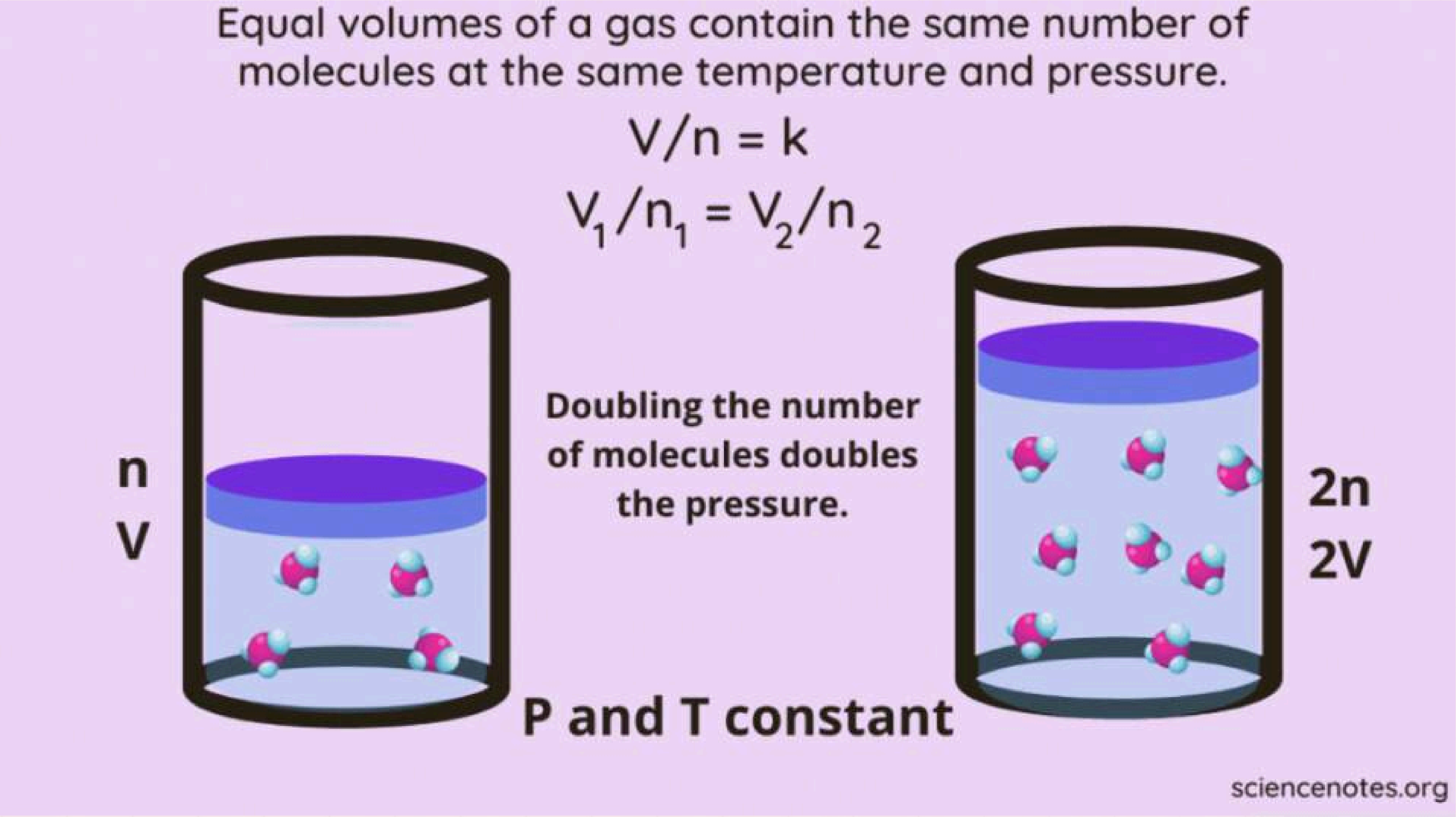
AVOGADRO'S LAW



AVOGADRO'S LAW

- All gases share a common characteristic:
- Under the same temperature and pressure conditions,
  - One mole of any gas occupies the same volume.
  - This volume is known as the molar volume.
  - This property is consistent across different types of gases.

$$\text{number of moles of gas } (n) = \frac{\text{volume } (V)}{\text{molar volume}}$$

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IDEAL GAS

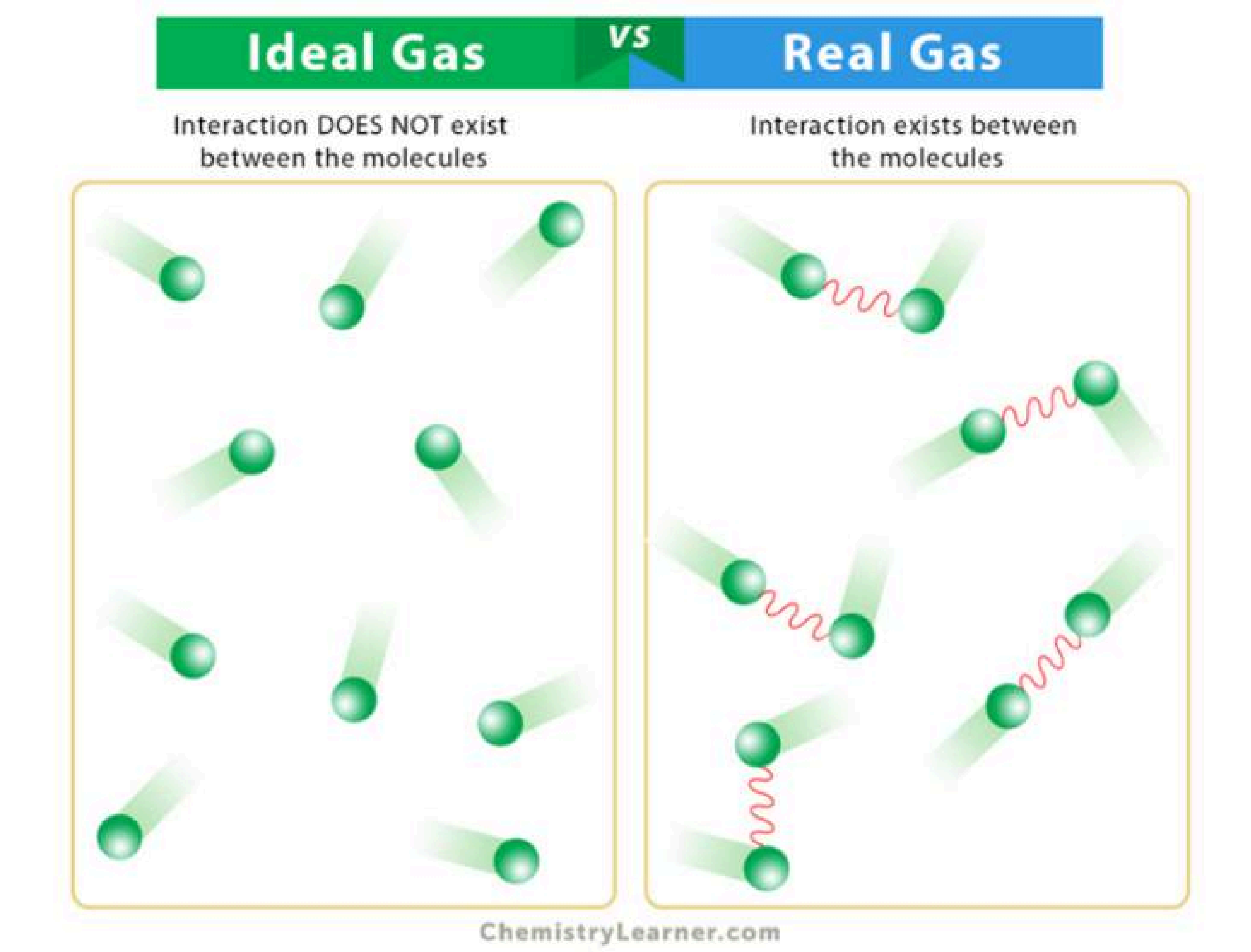
Real vs. Ideal Gases:

- Real gases approximate ideal behavior mainly at high temperatures and low pressures.

Purpose:

- The concept of an ideal gas simplifies calculations and offers a framework for understanding the behavior of real gases.

IDEAL GAS



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IDEAL GAS LAW

- Concept: Connects the pressure, volume, temperature, and amount of gas.

Number of moles

Pressure in Pascal (Pa)

Temperature in Kelvin (K)

$$pV = nRT$$

Volume in m^3

Gas constant $= 8.314\ JK^{-1}mol^{-1}$

- P: The pressure of the gas
- V: The volume of the gas
- n: The number of moles of the gas
- R: The ideal gas constant
- T: The absolute temperature of the gas, measured in Kelvin

COMBINED GAS LAW

- Concept: Integrates Boyle's Law, Charles' Law, and Gay-Lussac's Law.

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

- P: The pressure of the gas
- V: The volume of the gas
- T: The absolute temperature of the gas, measured in Kelvin

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FORMULA	DESCRIPTION
Density Formula	Density = Mass / Volume
Mass Formula	Mass = Density X Volume
Volume Formula	Volume = Mass / Density
Molarity Formula	Molarity = Moles of solute / Volume of solution
Boyle's Law	P1V1 = P2V2 (Pressure and volume relationship)
Charles's Law	V1/T1 = V2/T2 (Volume and temperature)
Avogadro's Law	V1/n1 = V2/n2 (Volume and moles)
Ideal Gas Law	PV = nRT (Pressure, volume, moles, and temp)
pH Formula	pH = -log10[H+] (Acidic/Basic concentration)

Combined Gas Law

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

Finding T_1

$$T_1 = \frac{P_1T_2V_1}{P_2V_2}$$

When T_1 equals T_2

$$P_1V_1 = P_2V_2$$

Finding T_2

$$T_2 = \frac{P_2T_1V_2}{P_1V_1}$$

Finding P_1

$$P_1 = \frac{P_2 T_1 V_2}{T_2 V_1}$$

When P_1 equals P_2

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

Finding P_2

$$P_2 = \frac{P_1 T_2 V_1}{T_1 V_2}$$

Finding V_1

$$V_1 = \frac{P_2 T_1 V_2}{T_2 P_1}$$

When V_1 equals V_2

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

Finding V_2

$$V_2 = \frac{P_1 T_2 V_1}{P_2 T_1}$$

ANY QUESTIONS?

MESSAGE ON WHATSAP

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