

Gas Conversion Factors

Unit: Gases

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

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

- Choose conversion factors based on the units needed for a calculation or conversion.

Success Criteria:

- Conversion factor has the same units as other numbers in a chosen word problem or situation.

Tier 2 Vocabulary: conversion, absolute, standard, vacuum

Language Objectives:

- Explain and defend the choice of a conversion factor or constant for use in a problem involving gases.

Notes:

absolute zero: the temperature at which molecules are moving so slowly that they can't transfer energy to other molecules. Absolute zero is $-273.15\text{ }^{\circ}\text{C} = 0\text{ K}$

vacuum: the absence of gas molecules. In a total vacuum, the Pressure = 0

"Standard Pressure" = 1 bar*

"Standard Temperature" = $0^{\circ}\text{C} = 273.15\text{ K}$

S.T.P. ("Standard Temperature and Pressure") = 0°C and 1 bar.

"Room Temperature" = $25^{\circ}\text{C} = 298\text{ K}$

1 mole of an ideal gas has a volume of 22.7 L at S.T.P.

* In 1982, the IUPAC defined standard pressure to be exactly 1 bar (= 100 kPa = 0.987 atm). However, many chemists and many standardized assessments still use 1 atm.

Use this space for summary and/or additional notes:

Conversion Factors

Pressure:

$$1 \text{ atm} \equiv 101.325 \text{ kPa} \equiv 0.101325 \text{ MPa} \equiv 1.01325 \text{ bar}$$

$$\equiv 101325 \frac{\text{N}}{\text{m}^2} \equiv 101325 \text{ Pa}$$

$$1 \text{ atm} \equiv 760 \text{ mm Hg} \equiv 760 \text{ torr} = 29.92 \text{ in. Hg}$$

$$1 \text{ atm} = 14.696 \frac{\text{lb.}}{\text{in.}^2} = 14.696 \text{ psi ("psi" = "pounds per square inch")}$$

Volume:

$$1 \text{ mL} \equiv 1 \text{ cm}^3$$

$$1 \text{ L} \equiv 1000 \text{ mL}$$

Moles:

$$1 \text{ mol} = 22.7 \text{ L at S.T.P.}^*$$

Use dimensional analysis to turn the molar mass of a compound (measured in $\frac{\text{g}}{\text{mol}}$) into a conversion factor between grams and moles.

Temperature:

$$\text{K} \equiv ^\circ\text{C} + 273.15$$

$$^\circ\text{F} \equiv (1.8 \times ^\circ\text{C}) + 32$$

$$^\circ\text{R} \equiv ^\circ\text{F} + 459.67$$

The Gas Constant:

The gas constant R is a natural constant that appears in several relationships in chemistry, including the ideal gas law (which we will study in a subsequent class).

$$R = 0.0821 \frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}}$$

$$R = 8.31 \frac{\text{L}\cdot\text{kPa}}{\text{mol}\cdot\text{K}} = 8.31 \frac{\text{J}}{\text{mol}\cdot\text{K}} = 8.31 \times 10^{-3} \frac{\text{kJ}}{\text{mol}\cdot\text{K}}$$

$$R = 62.4 \frac{\text{L}\cdot\text{torr}}{\text{mol}\cdot\text{K}} \qquad R = 1.987 \frac{\text{cal}}{\text{mol}\cdot\text{K}} \equiv 1.987 \frac{\text{BTU}}{\text{lb}\cdot\text{mol}\cdot^\circ\text{R}}$$

* Massachusetts assessments still use the outdated definition of S.T.P. The volume of one mole of an ideal gas at 1 atm and 0 °C is 22.4 L.

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