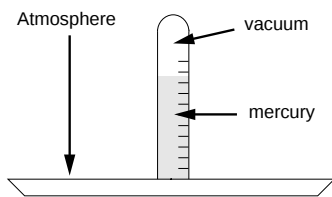
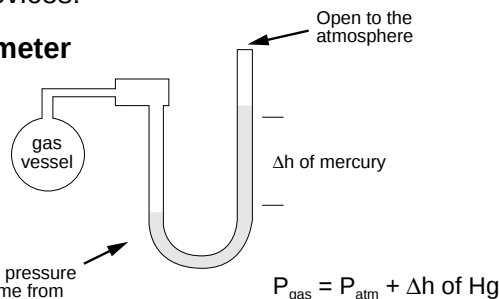


Pressure: Gas pressure is the force per unit area that the gas exerts on a surface. Atmospheric pressure is the weight of the atmosphere, which is about 10 miles high. You should understand two simple pressure measuring devices:

Barometer

The atmosphere pushes down on the Hg in the bowl and forces it up into the evacuated tube.

**Manometer**

Units for pressure are tremendously annoying. You have to be good at converting because ideal gas law problems demand unit consistency. Also remember to always use absolute temperature.

Pressure units:	1 atm	$1.013 \times 10^5 \text{ Pa}$	760 mm Hg	760 Torr
		1 atm	$1.013 \times 10^5 \text{ Pa}$	760 mm Hg

Ideal Gas Law: You can relate Pressure (P), Volume (V), Temperature (T), and moles (n) under the following assumptions that define "Ideal" behavior:

1. Molecules of an ideal gas don't interact with each other.
2. Molecules of an ideal gas have no volume.

$$PV=nRT$$

*Always use absolute temperature

*Always choose R to be consistent with P, V, T.

$$R = .0821 \frac{\text{atm} \cdot \text{L}}{\text{mol} \cdot \text{K}} = 2.05 \frac{\text{cm}^3 \cdot \text{atm}}{\text{mol} \cdot \text{K}} = 8.31 \times 10^3 \frac{\text{Pa} \cdot \text{L}}{\text{mol} \cdot \text{K}} = 8.31 \frac{\text{J}}{\text{mol} \cdot \text{K}}$$

- There are other forms of the ideal gas law.

$$\text{moles} = \frac{\text{mass}}{\text{molar mass}} = \frac{m}{MM} = n$$

and

$$\text{density} = \frac{\text{mass}}{\text{volume}} = \frac{m}{V} = d$$

So, $PV = nRT = \frac{m}{MM} RT$

and

$$P = \frac{m}{V} \cdot \frac{RT}{MM} = d \frac{RT}{MM}$$

↗ You can get the molar mass of a gas given P, d and T

The ideal gas law is one big algebra problem with a bunch of potential unknowns (P, V, T, n, d, MM, m), but it's only one equation. You've either got to be given all the variables except one (single-state problems) or you'll be given information about two states that allows you to generate one equation with one unknown.

For two-state problems, group the changing variables on one side of the ideal gas law and the constant terms on the other side. Then just set:

$$(\text{Things that aren't constant})_{\text{State 1}} = (\text{Things that aren't constant})_{\text{State 2}}$$

All those laws, Boyles, Charles, the combined gas law etc., fall out of the ideal gas law.

Gases in Chemical Reactions— In any chemical reaction you've got to react moles of each species. Look at the ideal gas law:

$$n = \frac{PV}{RT} = \left(\frac{P}{RT} \right) V$$

Two things can happen:

1. If P and T are constant then you can react volumes like they are moles since $n \propto V$ ($\propto$ means proportional).
2. Or you may just have to take the conditions of the problem and use the ideal gas law to find the moles of the reactants, perform the reaction, get the moles of products formed, and then often use the ideal gas law to convert moles of products to volumes of products.

Dalton's Law/Gas Mixtures

For a mixture of ideal gases, the total pressure is just the sum of the individual pressure of each gas (the partial pressure of each gas). The partial pressure of each gas, P_A , in a mixture is just the mole fraction, X_A , of the gas times the total pressure, P_{TOT} , of the mixture. So for example if you have a mixture of three gases, A, B, and C there are a bunch of ways of looking at the pressure of the system:

$$P_{TOT} = P_A + P_B + P_C = X_A P_{TOT} + X_B P_{TOT} + X_C P_{TOT}$$

or

$$P_{TOT} = \frac{n_A RT}{V} + \frac{n_B RT}{V} + \frac{n_C RT}{V}$$

- * If you are given the vapor pressure of a pure liquid at a particular temperature that's the same as giving you the partial pressure of the vapor above the liquid. (Usually the liquid is H_2O)

Kinetic Theory of Gases <-- This assumes that gases are made up of hard little balls which are moving very rapidly and often run into each other and the walls of the container. The energy with which they are moving is directly proportional to the temperature of the molecule. <-- What you need to know about kinetic theory is all based upon this.

$$\text{Energy} = \frac{1}{2} m u^2 = \frac{3}{2} \frac{RT}{N}$$

$$\text{Average speed of a particle: } \bar{u} = \left(\frac{3 RT}{MM} \right)^{\frac{1}{2}}$$

$$\frac{\text{rate of effusion of A}}{\text{rate of effusion of B}} = \left(\frac{MM_B}{MM_A} \right)^{\frac{1}{2}}$$

Student Packet: 3.1: Ideal Gases: AssessMe questions

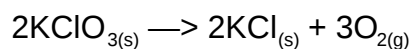
- 1) A sample of pure gas at 27°C and 380 mm Hg occupied a volume of 492 ml. What is the number of moles of gas in this sample? ($R = 0.0821 \text{ L}\cdot\text{atm} / \text{K}\cdot\text{mole}$)
- A) 0.010 moles B) 7.6 moles C) 10 moles D) 6×10^{21} moles E) I'm clueless
- 2) A sample of an ideal gas was heated at constant volume from 25°C to a temperature sufficient to exactly double the pressure. What was the volume of the gas sample? ($R = 0.0821 \text{ L}\cdot\text{atm} / \text{K}\cdot\text{mole}$)
- A) 22.4 liters
B) 20.5 liters
C) 24.4 liters
D) cannot be determined.
E) I'm clueless
- 3) An atom of element X absorbs a photon and an electron is transferred from the ground state to a higher energy level. Which of the following represents such a transition?
- A) $n = 2$ to $n = 1$.
B) $n = 3$ to $n = 1$.
C) $n = 0$ to $n = -5$.
D) $n = 1$ to $n = 3$.
E) I'm clueless
- 4) Which of the following sets of quantum numbers is not possible?
- A) 3, 1, 0, 1/2 B) 1, 1, 0, -1/2 C) 2, 1, 1, 1/2 D) 4, 2, -2, -1/2 E) I'm clueless
- 5) The gas constant, R , is often found in thermodynamic equations multiplied by the temperature, T . Such equations typically deal with energy in units of energy/mole. Which value of R and scale of T are correct to use for such calculations?
- A) $R=0.082 \text{ liter}\cdot\text{atm}\cdot\text{mole}^{-1}\text{K}^{-1}$ and T in degrees Kelvin
B) $R=8.3144 \text{ joules}\cdot\text{mole}^{-1}\cdot\text{K}^{-1}$ and T in degrees Kelvin
C) $R=22.08 \text{ calories}\cdot\text{mole}^{-1}\cdot^\circ\text{C}^{-1}$ and T in degrees Celsius
D) $R=1.9872 \text{ calories}\cdot\text{mole}^{-1}\cdot\text{K}^{-1}$ and T in degrees Celsius
E) I'm clueless
- 6) In thermodynamic discussion it is often necessary to establish a "standard state" in temperature and pressure (STP). The normal temperature condition employed is:
- A) 0°C B) 0K C) 273.15K D) 25°C E) I'm clueless

Student Packet: 3.1: Ideal Gases: ShowMe questions

- 1) The pressure of a gas in a 15.0 L tank at 21°C is 530 mm Hg. What volume would the gas in this tank have at 760 mm Hg if the temperature remains unchanged?

- 2) What is the density of CO gas at 1.2 atm and 70°C?

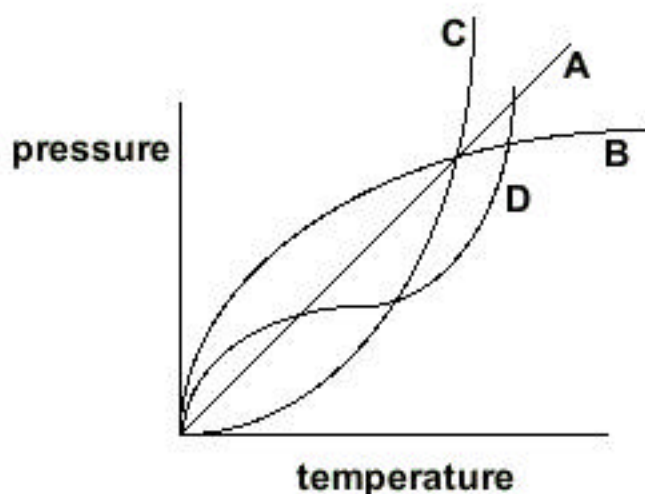
- 3) How many grams of KClO₃ are needed to provide 12 L of O_{2(g)} at 22°C and 777 mm Hg? The molecular weight of KClO₃ is 122.5 g/mol. Use the following equation and assume 100% yield.



- 4) A balloon in the shape of a perfect sphere is filled with helium. The balloon has a diameter of 10 cm. If the temperature of the balloon is 100°C and there are 5 moles of He in it, what is the pressure of the gas in the balloon?

Student Packet: 3.1: Ideal Gases: TestMe questions

- 1) Which of the following lines represent the variation of ideal gas pressure with temperature under constant volume conditions?



- A) A B) B C) C D) D E) None
- 2) An open flask contains 0.4 moles of air. Atmospheric pressure is 0.94 atm and the ambient temperature is 30°C. How many moles are present in the flask if a pressure increase to 1.2 atm results in a temperature of 34°C?
- A) 0.4 moles B) 0.5 moles C) 0.6 moles D) 0.7 moles E) 1.0 moles
- 3) A tank of O₂ has a volume of 10.0 L at a pressure of 2.2 atm. The temperature is 30°C. How many moles of O₂ does the tank contain?
- A) .88 moles B) 2.7 moles C) .44 moles D) 1.76 moles
E) None of the above
- 4) What gas is present in the following container? The pressure in the 1 L container is 0.850 atm at 25°C. The density of the gas is 1.11 g/L.
- A) N₂ B) H₂O C) CO D) O₂ E) None of the above
- 5)
$$2\text{HgO}_{(s)} \longrightarrow 2\text{Hg}_{(l)} + \text{O}_{2(g)}$$

How many liters of O₂ are produced from 10 grams of HgO at 25°C and 1 atm? The molecular weight of HgO is 216.59 g/mol. Assume the reaction goes to completion.

- A) 1.12 L B) 0.56 ml C) 156 L D) 0.56 L E) 1.12 ml