

Boyle's Law	Charles' Law	Guy-Lassac's Law	Combined Gas Law
For a given mass of gas at constant temperature, the volume of a gas varies inversely with pressure	The volume of a fixed mass of gas is directly proportional to its Kelvin temperature if the pressure is kept constant.	The pressure of a gas is directly proportional to the Kelvin temperature if the volume is kept constant.	Combines Boyle's, Charles', and the Temperature-Pressure relationship into one equation. Each of these laws can be derived from this law.
$PV = k$  $P_1V_1 = P_2V_2$	$\frac{V}{T} = k$  $V_1T_2 = V_2T_1$  $\frac{V_1}{T_1} = \frac{V_2}{T_2}$	$\frac{P}{T} = k$  $P_1T_2 = P_2T_1$  $\frac{P_1}{T_1} = \frac{P_2}{T_2}$	$\frac{PV}{T} = k$  $V_1P_1T_2 = V_2P_2T_1$  $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

Dalton's Law	Ideal Gas Law	Graham's Law
At constant volume and temperature, the total pressure exerted by a mixture of gases is equal to the sum of the pressures exerted by each gas,	The Ideal Gas Law relates the pressure, temperature, volume, and mass of a gas through the gas constant "R".	The rate of effusion/diffusion of two gases (A and B) are inversely proportional to the square roots of their formula masses. <i>[It can be a ratio of molecular speeds, effusion /diffusion times, distance traveled by molecules, or amount of gas effused]</i>
$P_{\text{total}} = P_1 + P_2 + P_3 + \dots P_n$	$PV = nRT$	$\frac{\text{Rate}_A}{\text{Rate}_B} = \frac{\sqrt{\text{molar mass}_B}}{\sqrt{\text{molar mass}_A}}$

Abbreviations	Standard Conditions
atm = atmosphere mm Hg = millimeters of mercury torr = another name for mm Hg Pa = Pascal    kPa = kilopascal K = Kelvin °C = degrees Celsius	$0^\circ\text{C} = 273 \text{ K}$ $1.00 \text{ atm} = 760.0 \text{ mm Hg} = 76 \text{ cm Hg} = 101.325 \text{ kPa} = 101, 325 \text{ Pa} = 29.9 \text{ in Hg}$
Conversions	Gas Law's Equation Symbols
$\text{K} = ^\circ\text{C} + 273$ $\text{F}^\circ = 1.8^\circ\text{C} + 32$ $\text{C}^\circ = \frac{\text{F}^\circ - 32}{1.8}$ $1 \text{ cm}^3 \text{ (cubic centimeter)} = 1 \text{ mL (milliliter)}$ $1 \text{ dm}^3 \text{ (cubic decimeter)} = 1 \text{ L (liter)} = 1000 \text{ mL}$	Subscript (1) = old condition or initial condition Subscript (2) = new condition or final condition Temperature must be in Kelvins $n$ = number of moles = grams/Molar mass $R = 8.31 \text{ L}\cdot\text{kPa}/\text{mol}\cdot\text{K} = 0.0821 \text{ L}\cdot\text{atm}/\text{mol}\cdot\text{K} = 62.4 \text{ L}\cdot\text{Torr}/\text{mol}\cdot\text{K}$ You must have a common set of units in the problem

1. Convert the following temperatures to K.

a) 104 C

b) -3 C

2. Convert the following temperatures to C.

a) 67 K

b) 1671 K

3. A sample of nitrogen gas has a volume of  $478 \text{ cm}^3$  and a pressure of 104.1 kPa. What volume would the gas occupy at 88.2 kPa if the temperature remains constant?

4.  $8.98 \text{ dm}^3$  of hydrogen gas is collected at  $38.8 \text{ }^\circ\text{C}$ . Find the volume the gas will occupy at  $-39.9 \text{ }^\circ\text{C}$  if the pressure remains constant.

5. A sample of gas has a volume of  $215 \text{ cm}^3$  at  $23.5 \text{ }^\circ\text{C}$  and 84.6 kPa. What volume will the gas occupy at STP?

<p>6. At a certain temperature, molecules of methane gas, <math>\text{CH}_4</math> have an average velocity of 0.098 m/s. What is the average velocity of carbon dioxide molecules at this same temperature?</p>	
<p>7. Find the relative rate of diffusion for the gases chlorine, <math>\text{Cl}_2</math> and ethane, <math>\text{C}_2\text{H}_6</math>.</p>	
<p>8. <math>495 \text{ cm}^3</math> of oxygen gas and <math>877 \text{ cm}^3</math> of nitrogen gas, both at <math>25.0 \text{ }^\circ\text{C}</math> and <math>114.7 \text{ kPa}</math>, are injected into an evacuated <math>536 \text{ cm}^3</math> flask. Find the total pressure in the flask, assuming the temperature remains constant.</p>	
<p>9. A sample of gas is transferred from a 75 mL vessel to a 500.0 mL vessel. If the initial pressure of the gas is 145 atm and if the temperature is held constant, what is the pressure of the gas sample in the 500.0 mL vessel?</p>	
<p>10. A sample of gas occupies a volume of 450.0 mL at 740 mm Hg and <math>16^\circ\text{C}</math>. Determine the volume of this sample at 760 mm Hg and <math>37^\circ\text{C}</math>.</p>	

11. One mole of  $\text{H}_2\text{S}$  gas escapes from a container by effusion in 77 seconds. How long would it take one mole of  $\text{NH}_3$  gas to escape from the same container?

12. Convert a pressure of 0.0248 mm Hg to the equivalent pressure in pascals (Pa).

13. Air in a closed cylinder is heated from  $25^\circ\text{C}$  to  $36^\circ\text{C}$ . If the initial pressure is 3.80 atm, what is the final pressure?

14. A bubble of helium gas has a volume of 0.650 mL near the bottom of a large aquarium where the pressure is 1.54 atm and the temperature is  $12^\circ\text{C}$ . Determine the bubble's volume upon rising near the top where the pressure is 1.01 atm and  $16^\circ\text{C}$ .

15. At what temperature Celsius will 19.4 g of molecular oxygen,  $\text{O}_2$ , exert a pressure of 1820 mm Hg in a 5.12 L cylinder?

## CHEMISTRY

## GAS LAW'S WORKSHEET

16. A sample of nitrogen gas,  $N_2$ , is collected in a 100 mL container at a pressure of 688 mm Hg and a temperature of  $565^\circ C$ . How many grams of nitrogen gas are present in this sample?

17. What is the pressure in mm of Hg, of a gas mixture that contains 1 g of  $H_2$ , and 8.0 g of Ar in a 3.0 L container at  $27^\circ C$ .

18. To what temperature must  $32.0 \text{ ft}^3$  of a gas at  $2^\circ C$  be heated for it to occupy  $1.00 \times 10^2 \text{ ft}^3$  at the same pressure?

19. What is the pressure in atm exerted by 2.48 moles of a gas in a 250.0 mL container at  $58^\circ C$ ?

20. Determine the molar mass of a gas that has a density of 2.18 g/L at  $66^\circ C$  and 720 mm Hg.

*(Hint: the number of moles of a substance is its mass/molecular mass and density is mass/volume.)*

**Key**

- 1 a) 377 K  
b) 270 K
- 2 a) -206 C  
b) 1398 C
3. 564 cm<sup>3</sup>
4. 6.71 dm<sup>3</sup>
5. 165 cm<sup>3</sup>
6. 0.059 m/s
7. rate Cl<sub>2</sub> : C<sub>2</sub>H<sub>6</sub> = 0.650
8. 294 kPa
9. 21.8 atm
- 10.. 470 mL
11. 54 sec
12. 3.31 Pa
13. 3.94 atm
14. 1.00 mL
15. - 27°C
16. 0.0368 g
17. 4332 mm Hg
18. 586°C
19. 270 atm
20. 64 g/mole