Combines Boyle’s, Charles’, and the Temperature-Pressure relationship into one equation. Each of these laws can be derived from this law.

\[
\frac{PV}{T} = k
\]

\[
P_1V_1 = P_2V_2
\]

\[
\frac{V_1}{T_1} = \frac{V_2}{T_2}
\]

The pressure of a gas is directly proportional to the Kelvin temperature if the volume is kept constant.

\[
\frac{P}{T} = k
\]

\[
P_1T_2 = P_2T_1
\]

\[
\frac{P_1}{T_1} = \frac{P_2}{T_2}
\]

The volume of a fixed mass of gas is directly proportional to its Kelvin temperature if the pressure is kept constant.

\[
\frac{V}{T} = k
\]

\[
V_1T_2 = V_2T_1
\]

\[
\frac{V_1}{T_1} = \frac{V_2}{T_2}
\]

The temperature of a gas is directly proportional to its Kelvin temperature if the pressure is kept constant.

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.

\[
P_{\text{total}} = P_1 + P_2 + P_3 + ...P_n
\]

\[
PV = nRT
\]

The rate of effusion/diffusion of two gases (A and B) are inversely proportional to the square roots of their formula masses. [It can be a ratio of molecular speeds, effusion/diffusion times, distance traveled by molecules, or amount of gas effused]

\[
\text{Rate}_A = \frac{\sqrt{\text{molar mass}_B}}{\sqrt{\text{molar mass}_A}}
\]

\[
\text{Rate}_B = \frac{\sqrt{\text{molar mass}_A}}{\sqrt{\text{molar mass}_B}}
\]

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 L-kPa/ mol-K = 0.0821 L-atm/mol-K = 62.4 L-Torr/mol-K
You must have a common set of units in the problem

Abbreviations

| atm = atmosphere | Standard Conditions |
| mm Hg = millimeters of mercury | 0°C = 273 K |
| torr = another name for mm Hg | 1.00 atm = 760.0 mm Hg = 76 cm Hg =101.325 kPa = 101, 325 Pa = 29.9 in Hg |
| Pa = Pascal | K = °C + 273 |
| kPa = kilopascal | F° = 1.8C° + 32 |
| K = Kelvin | C° = \frac{F° - 32}{1.8} |
| °C = degrees Celsius | 1 cm³ (cubic centimeter) = 1 mL (milliliter) |
| 1 dm³ (cubic decimeter) = 1 L (liter) = 1000 mL | Gas Law’s Equation Symbols |

Conversions

| K = °C + 273 | Subscript (1) = old condition or initial condition |
| F° = 1.8C° + 32 | Subscript (2) = new condition or final condition |
| C° = \frac{F° - 32}{1.8} | Temperature must be in Kelvins |
| 1 cm³ (cubic centimeter) = 1 mL (milliliter) | n = number of moles = grams/Molar mass |
| 1 dm³ (cubic decimeter) = 1 L (liter) = 1000 mL | R = 8.31 L-kPa/ mol-K = 0.0821 L-atm/mol-K = 62.4 L-Torr/mol-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 cm³ 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 dm³ of hydrogen gas is collected at 38.8 °C. Find the volume the gas will occupy at -39.9 °C if the pressure remains constant.

5. A sample of gas has a volume of 215 cm³ at 23.5 °C and 84.6 kPa. What volume will the gas occupy at STP?
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<tbody>
<tr>
<td>6.</td>
<td>At a certain temperature, molecules of methane gas, CH₄ have an average velocity of 0.098 m/s. What is the average velocity of carbon dioxide molecules at this same temperature?</td>
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<tr>
<td>7.</td>
<td>Find the relative rate of diffusion for the gases chlorine, Cl₂ and ethane, C₂H₆.</td>
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<tr>
<td>8.</td>
<td>495 cm³ of oxygen gas and 877 cm³ of nitrogen gas, both at 25.0 °C and 114.7 kPa, are injected into an evacuated 536 cm³ flask. Find the total pressure in the flask, assuming the temperature remains constant.</td>
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<tr>
<td>9.</td>
<td>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?</td>
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<tr>
<td>10.</td>
<td>A sample of gas occupies a volume of 450.0 mL at 740 mm Hg and 16°C. Determine the volume of this sample at 760 mm Hg and 37°C.</td>
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<td>11. <strong>One mole of H₂S gas escapes from a container by effusion in 77 seconds. How long would it take one mole of NH₃ gas to escape from the same container?</strong></td>
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<td>12. <strong>Convert a pressure of 0.0248 mm Hg to the equivalent pressure in pascals (Pa).</strong></td>
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<td>13. <strong>Air in a closed cylinder is heated from 25°C to 36°C. If the initial pressure is 3.80 atm, what is the final pressure?</strong></td>
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<tr>
<td>14. <strong>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°C. Determine the bubble’s volume upon rising near the top where the pressure is 1.01 atm and 16°C.</strong></td>
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<tr>
<td>15. <strong>At what temperature Celsius will 19.4 g of molecular oxygen, O₂, exert a pressure of 1820 mm Hg in a 5.12 L cylinder?</strong></td>
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<td>16. A sample of nitrogen gas, N₂, is collected in a 100 mL container at a pressure of 688 mm Hg and a temperature of 565 °C. How many grams of nitrogen gas are present in this sample?</td>
<td></td>
</tr>
<tr>
<td>17. What is the pressure in mm of Hg of a gas mixture that contains 1 g of H₂, and 8.0 g of Ar in a 3.0 L container at 27°C?</td>
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<tr>
<td>18. To what temperature must 32.0 ft³ of a gas at 2°C be heated for it to occupy 1.00 x 10² ft³ at the same pressure?</td>
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<tr>
<td>19. What is the pressure in atm exerted by 2.48 moles of a gas in a 250.0 mL container at 58°C?</td>
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</tbody>
</table>
| 20. Determine the molar mass of a gas that has a density of 2.18 g/L at 66°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 cm³
4. 6.71 dm³
5. 165 cm³
6. 0.059 m/s
7. rate Cl₂ : C₂H₆ = 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