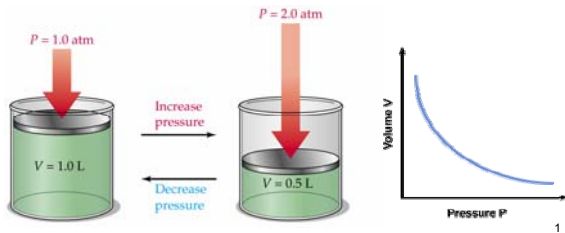


10-3 Gas Laws

Boyle's Law - Volume varies inversely with pressure

$$PV = k$$

$V \downarrow$ $P \uparrow$ and $V \uparrow$ $P \downarrow$



1

10-3 Gas Laws

Boyle's Law

$$\frac{P_1}{V_2} = \frac{P_2}{V_1} \quad \text{or} \quad P_1V_1 = P_2V_2$$

A sample oxygen gas has a volume of 150 mL and pressure of 0.947 atm. What will the volume be at a pressure of 0.987 atm?

Solve for the variable (V_2)

$$P_1V_1 = P_2V_2 \quad \rightarrow \quad \frac{P_1V_1}{P_2} = V_2$$

$$\frac{P_1V_1}{P_2} = \frac{(0.947 \text{ atm})(150 \text{ mL})}{0.987 \text{ atm}} = 144 \text{ mL O}_2$$

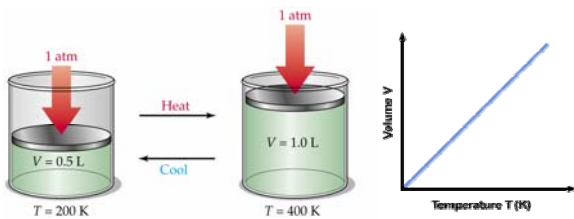
2

10-3 Gas Laws

Charles's Law - Volume varies directly with temperature (Kelvin)

$$V = kT$$

$T \uparrow$ $V \uparrow$ and $T \downarrow$ $V \downarrow$



3

10-3 Gas Laws

Kelvin Scale – starts at -273.15°C with a value of 0 K. This is the lowest possible temperature and is called **Absolute Zero**.

To convert $^\circ\text{C}$ to K

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

A thermometer has a reading of 25°C . What is this in Kelvins?

$$K = 25 + 273 = 298 \text{ K}$$

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10-3 Gas Laws

Charles's Law

$$\frac{V_1}{V_2} = \frac{T_1}{T_2} \quad \text{or} \quad \frac{V_1}{T_1} = \frac{V_2}{T_2}$$

A sample of neon gas occupies a volume of 752 mL at 25°C . What volume will the gas occupy at 50°C ?

Convert Temperatures to Kelvin (T_1 and T_2)

$$T_1 = 25 + 273 = 298 \text{ K} \quad T_2 = 50 + 273 = 323 \text{ K}$$

Solve for the variable (V_2)

$$\frac{V_1T_2}{T_1} = V_2 = \frac{(752 \text{ mL})(323 \text{ K})}{298 \text{ K}} = 815 \text{ mL Ne}$$

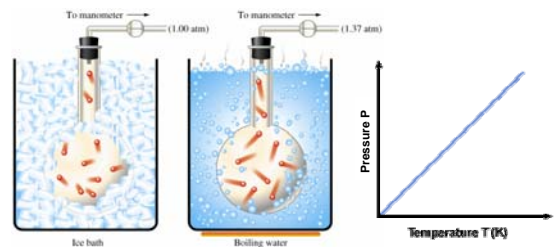
5

10-3 Gas Laws

Gay-Lussac's Law - Pressure varies directly with temperature (Kelvin)

$$P = kT \quad (\text{Temperature must be in Kelvin!!!})$$

$T \uparrow$ $P \uparrow$ and $T \downarrow$ $P \downarrow$



6

10-3 Gas Laws

Gay-Lussac's Law

$$\frac{P_1}{P_2} = \frac{T_1}{T_2} \quad \text{or} \quad \frac{P_1}{T_1} = \frac{P_2}{T_2}$$

A gas in an aerosol can is at a pressure of 3.00 atm at 25°C. What is the pressure if the can is heated to 52°C?

Convert Temperatures to Kelvin (T_1 and T_2)

$$T_1 = 25^\circ + 273 = 298 \text{ K} \quad T_2 = 52^\circ + 273 = 323 \text{ K}$$

Solve for the variable (P_2)

$$\frac{P_1 T_2}{T_1} = P_2 = \frac{(3.00 \text{ atm})(323 \text{ K})}{298 \text{ K}} = 3.27 \text{ atm}$$

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10-3 Gas Laws

Combined Gas Law - Relationship of pressure, volume, temperature (K)

This one Equation will handle three gas laws!

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

Temperature must be in Kelvin!!!

8

10-3 Gas Laws

Combined Gas Law

A balloon has a volume of 50.0 L at 25°C and 1.08 atm. What is the volume at 0.855 atm and 10°C?

Convert Temperatures to Kelvin (T_1 and T_2)

$$T_1 = 25^\circ + 273 = 298 \text{ K} \quad T_2 = 10^\circ + 273 = 283 \text{ K}$$

Solve for the variable (V_2)

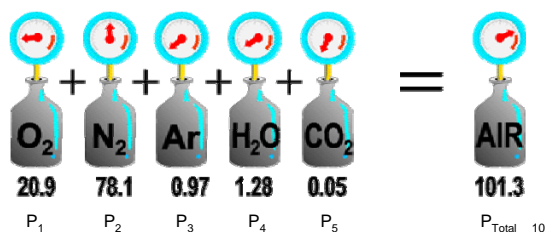
$$\frac{P_1 V_1 T_2}{P_2 T_1} = V_2 = \frac{(1.08 \text{ atm})(50.0 \text{ L})(283 \text{ K})}{(0.855 \text{ atm})(298 \text{ K})} = 60 \text{ L}$$

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10-3 Gas Laws

Dalton's Law of Partial Pressure- total pressure of a mixture of gases is equal to a total of partial pressures of each component gas

$$P_{\text{Total}} = P_1 + P_2 + P_3 \dots$$



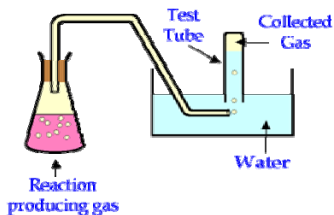
10

10-3 Gas Laws

Water Vapor Pressure - Partial pressure of water vapor at a specific temperature. This can be looked up on Table A-8.

$$P_{\text{atm}} = P_{\text{gas}} + P_{\text{H}_2\text{O}}$$

Gases are often collected by water displacement. To find the pressure of the collected gas you must subtract the pressure of water vapor.



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10-3 Gas Laws

Water Displacement

Oxygen is collected from a reaction using water displacement. The pressure is 731 torr and the temperature is 20°C. What is the partial pressure of oxygen collected?

Find partial pressure of water from Table A-8

$$\text{At } 20^\circ\text{C } P_{\text{H}_2\text{O}} = 17.5 \text{ torr}$$

$$P_{\text{atm}} = P_{\text{O}_2} + P_{\text{H}_2\text{O}}$$

$$P_{\text{O}_2} = P_{\text{atm}} - P_{\text{H}_2\text{O}} = 731 \text{ torr} - 17.5 \text{ torr} = 713.5 \text{ torr}$$

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