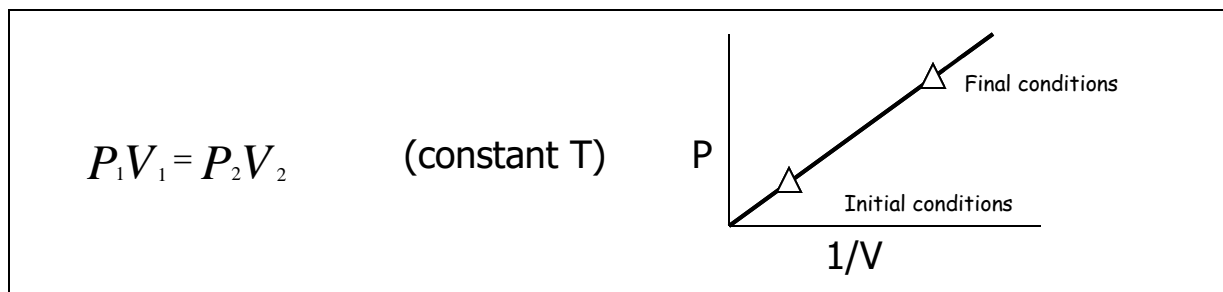
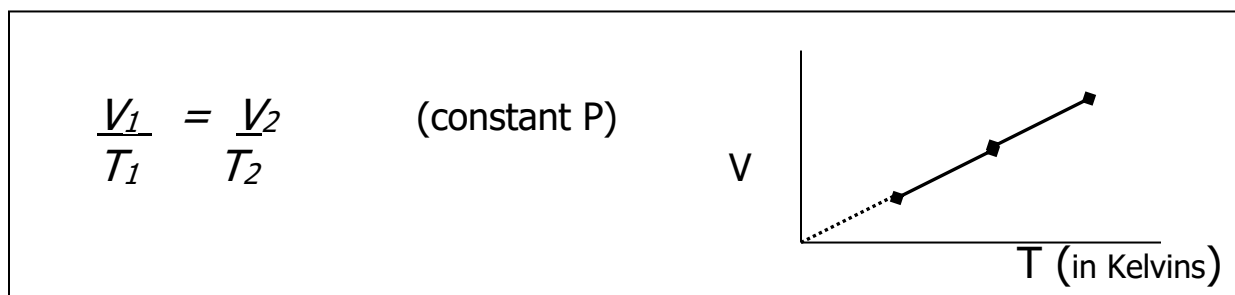


## COMBINED GAS LAW

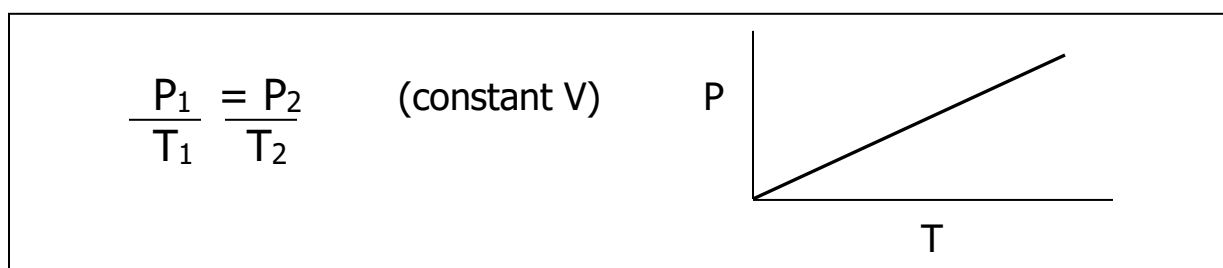
**Boyle's Law:** establishes that volume and pressure are inversely proportional



**Charles's Law:** establishes that volume and temperature are directly proportional.



**Gay-Lussac's Law:** establishes that pressure and temperature are directly proportional.



The relationship between volume, temperature, and pressure is expressed mathematically by the **Combined Gas Law**.

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

Sample Problem

Q: A balloon containing hydrogen gas at 20°C and a pressure of 100kPa has a volume of 7.50L. Calculate the volume of the balloon after it rises 10km into the upper atmosphere where the temperature is -36°C and the outside air pressure is 28kPa. Assume that no hydrogen gas escapes and that the balloon expands, etc.

Given:  $T_1 = 20^\circ\text{C} = 293\text{K}$   
 $P_1 = 100\text{kPa}$   
 $V_1 = 7.50\text{L}$   
 $V_2 = ?$   
 $T_2 = -36^\circ\text{C} = 237\text{K}$   
 $P_2 = 28\text{kPa}$

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

Solution:  $V_2 = \frac{P_1 V_1 \times T_2}{T_1 P_2}$   
 $= \frac{100 \text{ kPa} \times 7.50 \text{ L} \times 237 \text{ K}}{293 \text{ K} \times 28\text{kPa}}$

$V_2 = 22 \text{ L}$

Paraphrase: Therefore the new volume of the balloon is 22 L.