

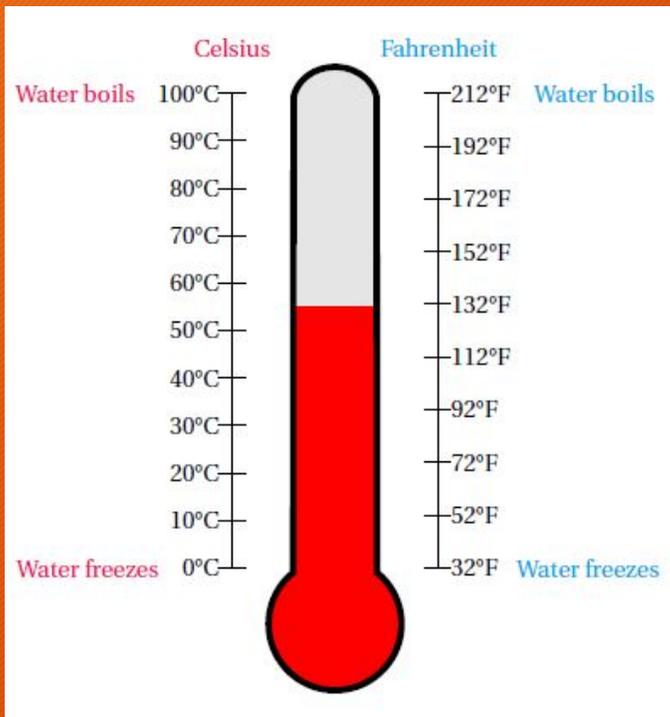
# Chapter 3: Solids, Liquids, and Gases

## 3.3 Gas Behavior

When working with a gas, it is helpful to know its volume, temperature, and pressure.

Volume is the amount of space that matter fills. It can be measured in cubic centimeters, milliliters, and liters. It can fill the same volume of its container.

Temperature is the measure of the average energy of random motion of the particles.



higher temperatures

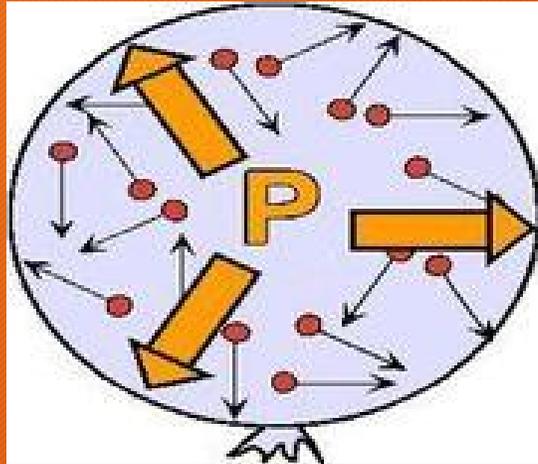
greater energy =

faster moving particles =

At room temperature, gas particles can travel about 500 meters per second. More than twice the cruising speed of a jet.

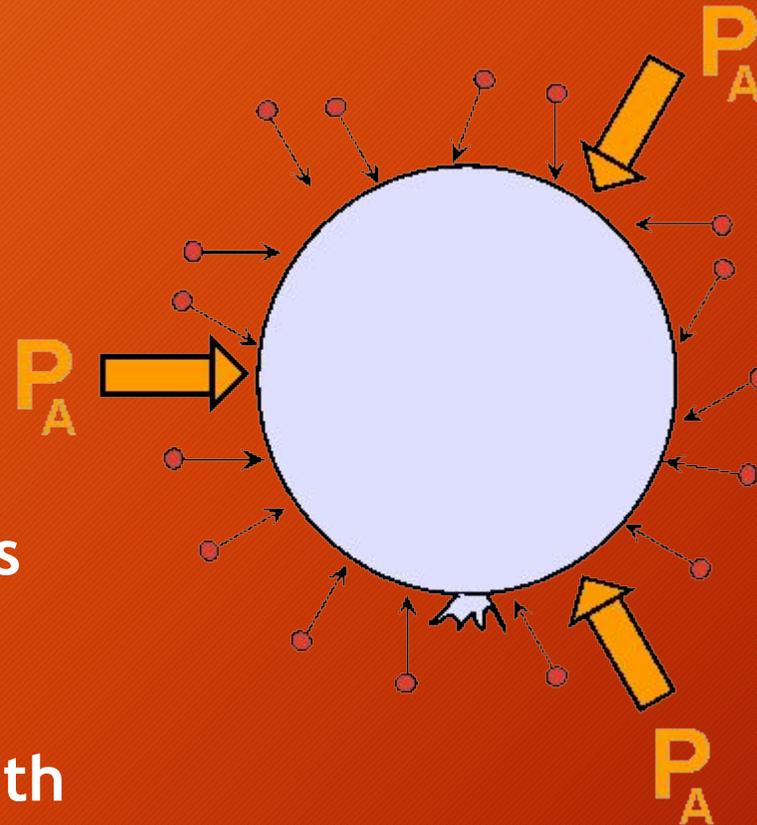


When gas is inside a balloon, it is pushing outward as the particles collide with the surface, creating pressure against the walls of the balloon.



Although the gas particles travel randomly, they actually travel in straight lines until they collide with other particles or objects.

Air on the outside of the balloon is creating pressure against it as well.



What would happen if the inflated balloon was poked with a pin? Why?



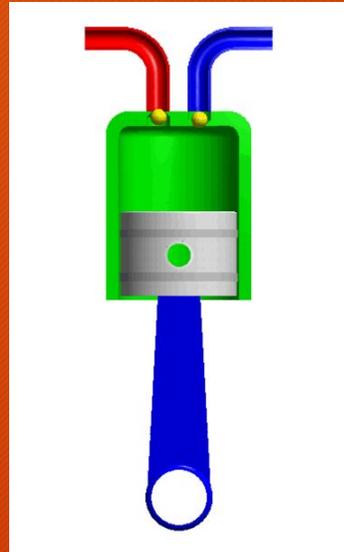
$$\text{Pressure} = \frac{\text{Force}}{\text{Area}}$$

Force is measured in newtons (N).

Pressure is measured in pascals (Pa) or kilopascals (kPa).

$$1\text{kPa} = 1,000 \text{ Pa}$$

A machine exerts a force of 252 N on a piston having an area of  $0.430 \text{ m}^2$ . What is the pressure on the piston in Pa?



$$\text{Pressure} = \frac{252 \text{ N}}{0.430 \text{ m}^2}$$

$$\text{Pressure} = 586 \text{ Pa}$$

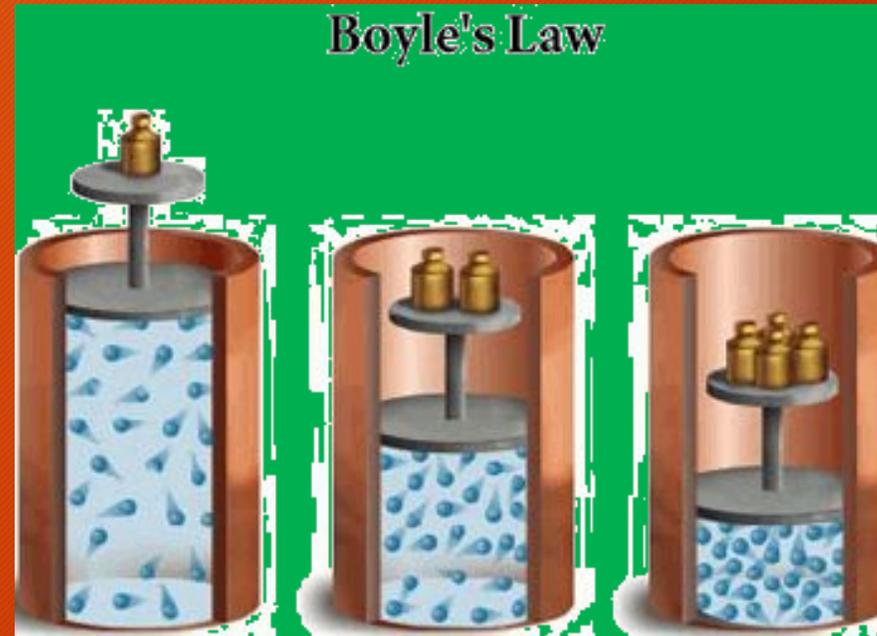
Boyle's Law states that when the pressure of a gas at constant temperature is increased, the volume of the gas decreases.

Decreasing volume increases collisions and increases pressure.

As more weights are added, what happens to the pressure caused by the plunger? It increases.

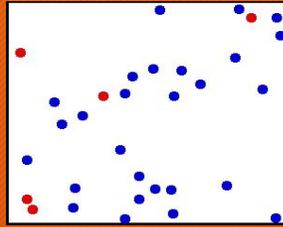
What happens to the space between gas particles?

It decreases.



What has happened to the gas volume?  
It decreased.

The faster the gas particles move, the more frequently they collide with the walls of their container, creating a greater force of the collisions.



Can you tell Ms. Boyer really likes this clip art?

When the **temperature** of a gas at constant volume (in a closed, rigid container) is increased, the pressure of the gas increases. Vice versa.

Why would that be so? Higher temperatures mean faster-moving particles.  
Faster moving particles increase pressure.

Why should people check the air pressure in their tires in the winter?

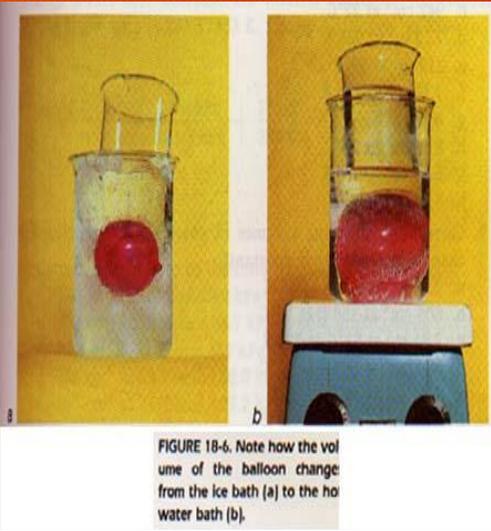
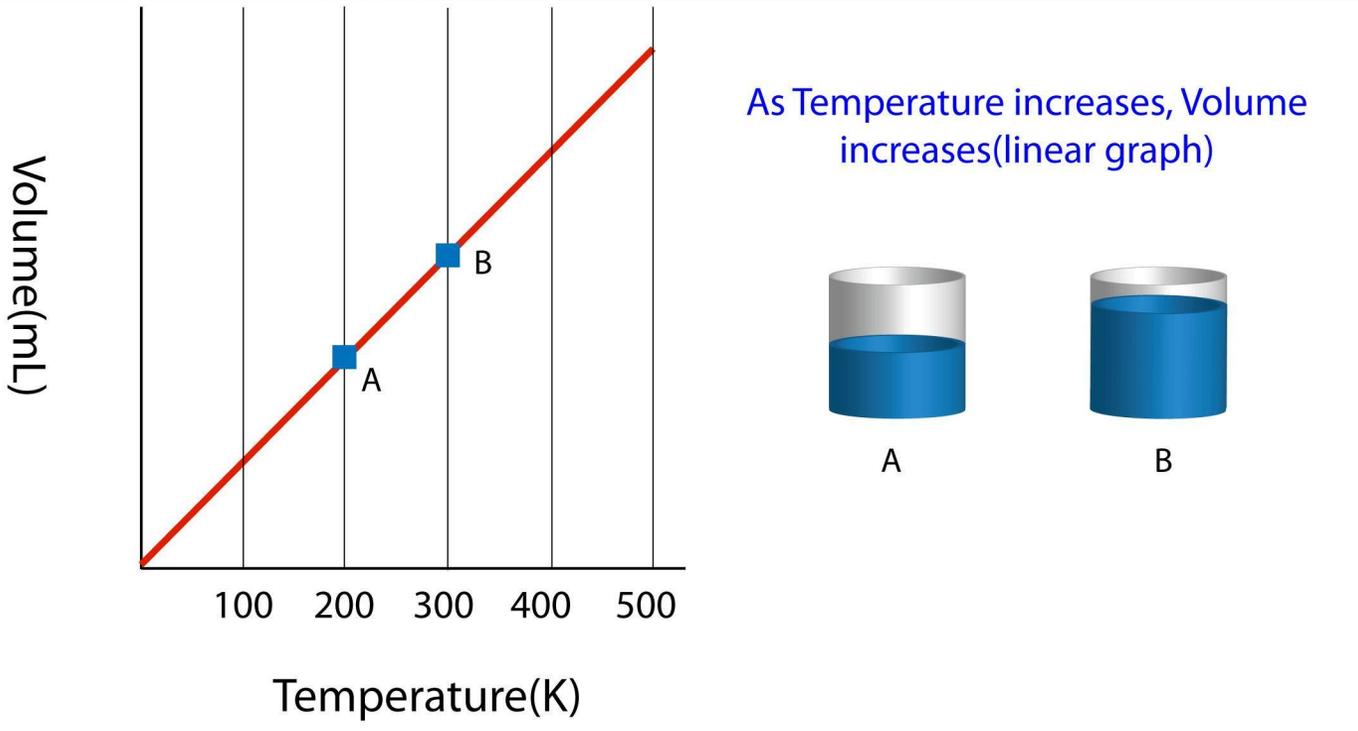


Why do we, in Arizona, need to check our tire pressure often, especially in the summer?

Air pressure will decrease because of decreased temperature, and the tires may be too soft.



# Charles's Law



A changeable volume allows the pressure to remain constant.

When the temperature of a gas is increased at constant pressure, its volume increases. Vice versa.



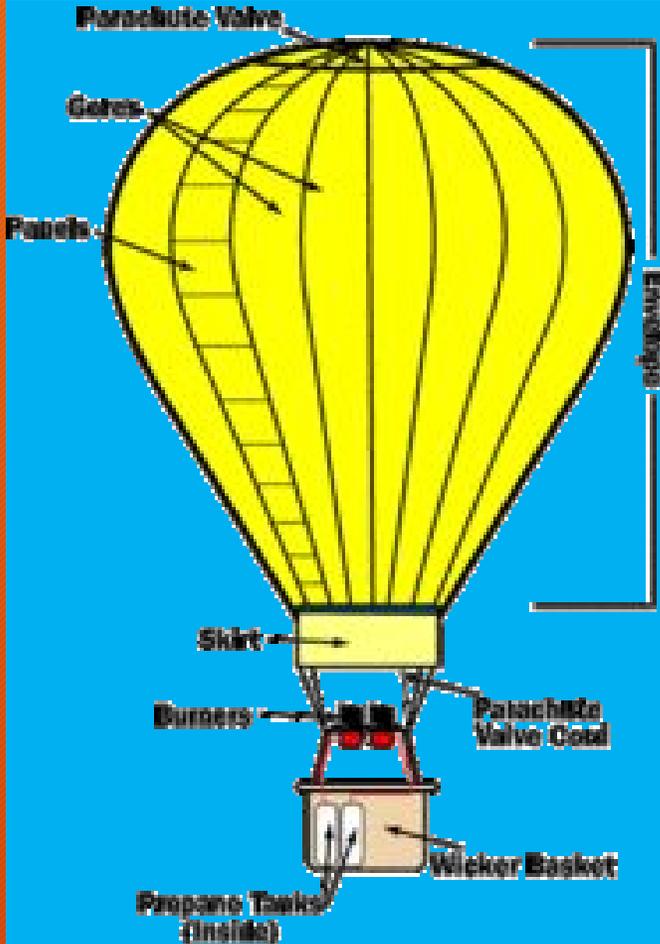
# Boyle's Law

PRESSURE ↓ VOLUME ↑



As the air pressure continues to decrease, the volume of the gas increases.

As the balloon rises, the air pressure from the outside decreases.



BP V

# Charles's Law

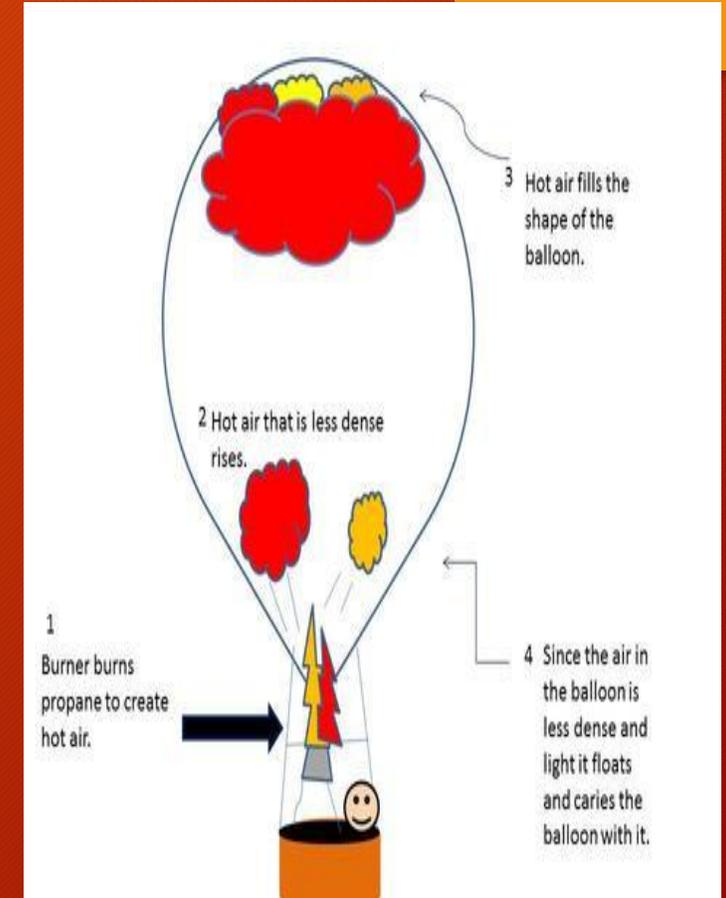
TEMPERATURE ↑ VOLUME ↑



The air inside is less dense than that outside, so the balloon rises.

Pressure remains constant as some warm air leaves through the bottom of the balloon.

Heating causes the air inside the balloon to expand.



CT V