

Chapter 17

Properties of Matter

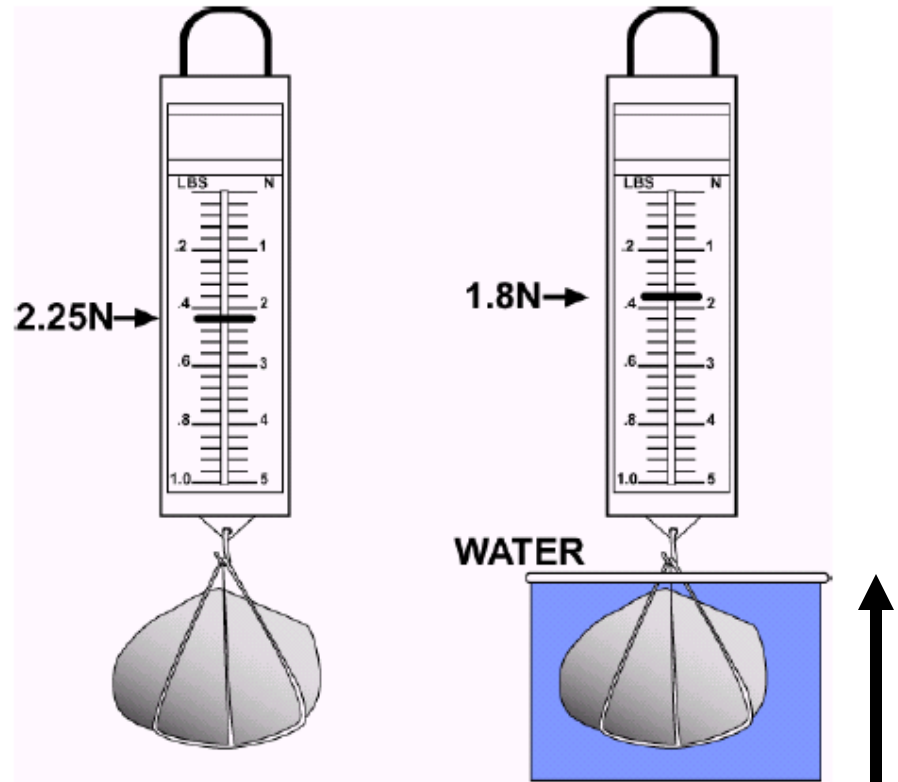


Section 17.3

Buoyancy of Fluids

What is buoyancy?

- Buoyancy - measure of the upward pressure (force) a fluid exerts on an object.



Archimedes' Principle

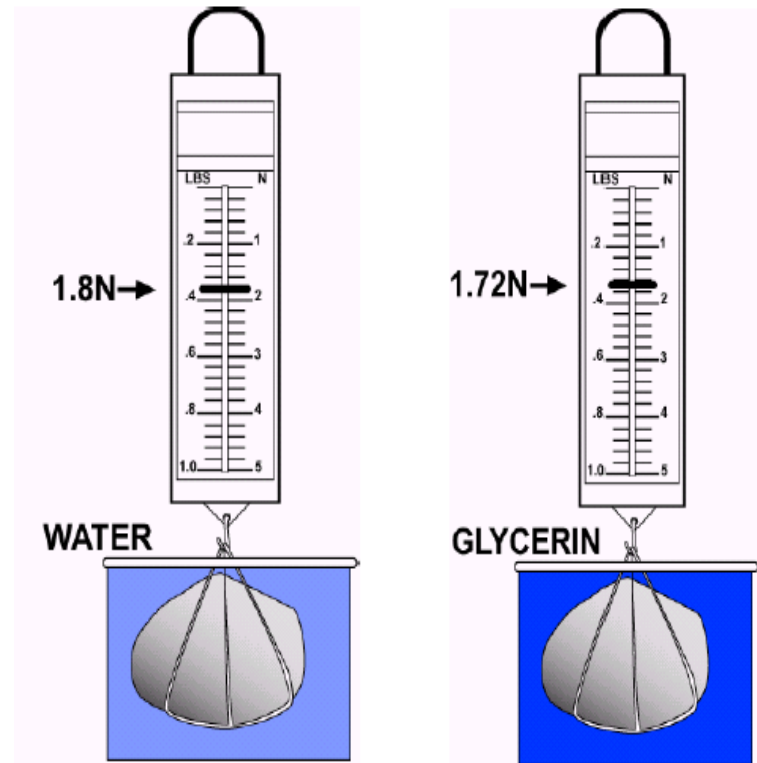


- The force exerted on an object is equal to the weight of the fluid displaced by the object. The metric unit for force or weight is newtons (N).



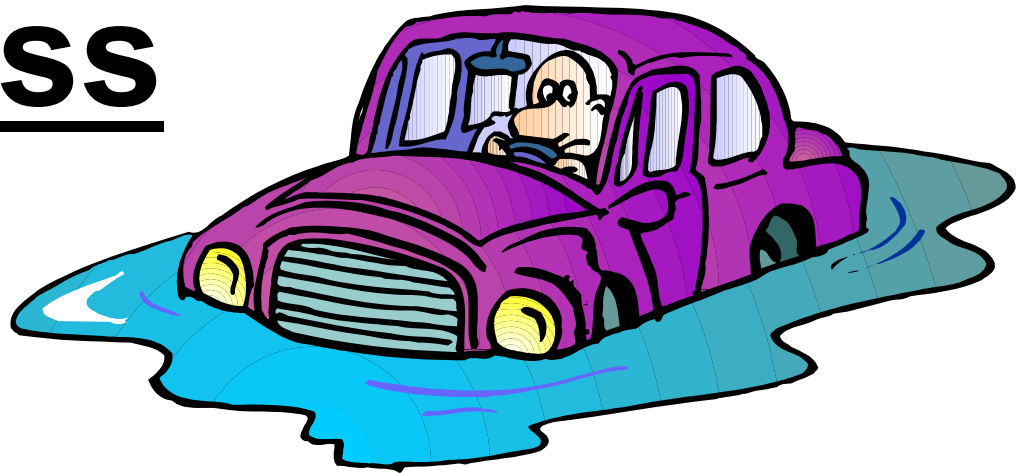
Do all fluids exert the same buoyant force on an object?

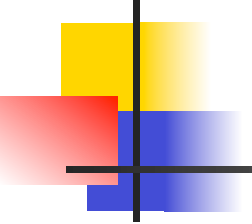
- No...it depends on the weight of the displaced fluid.



Why objects sink and float:

- An object sinks when the buoyant force is less than its weight.



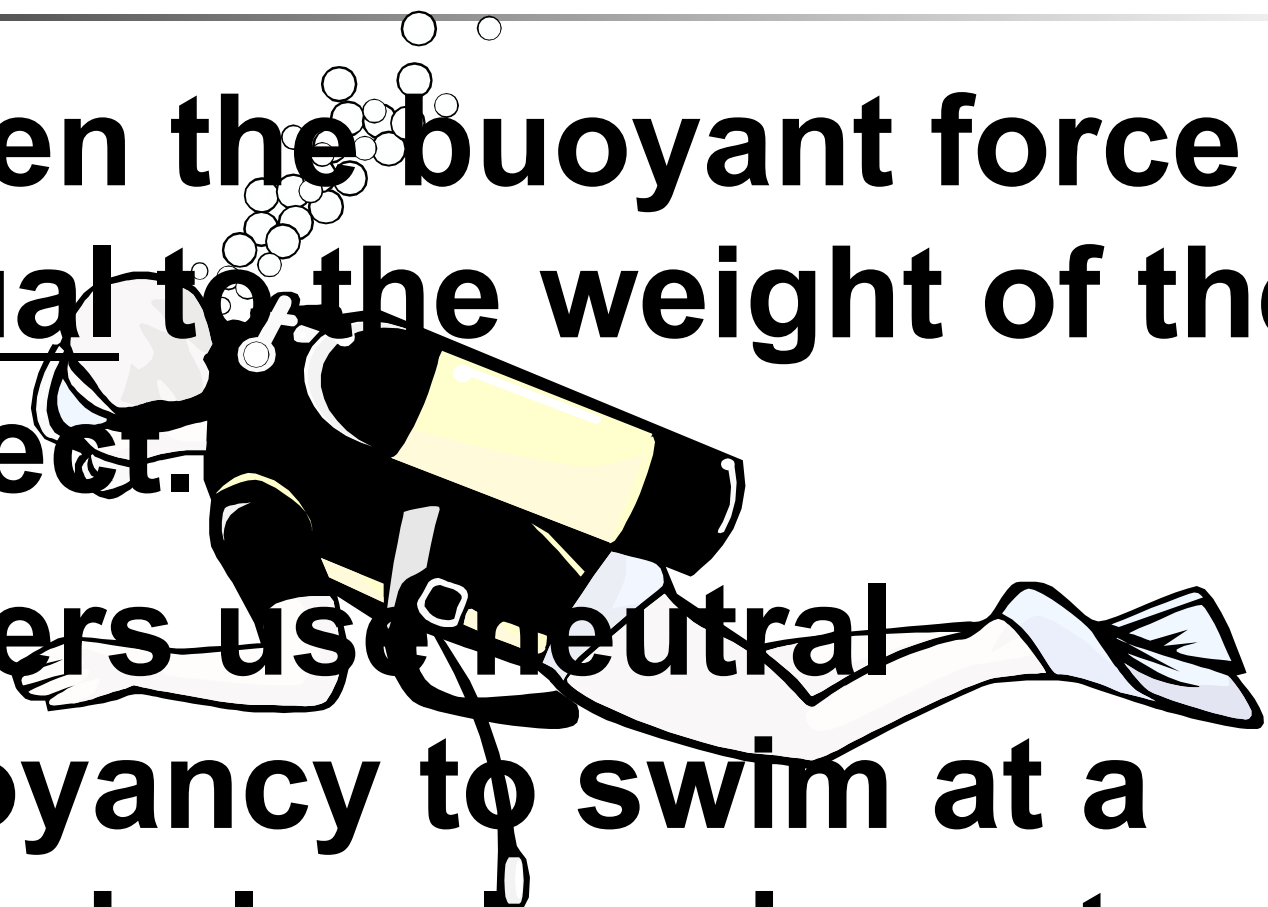


If the buoyant force
is greater than the
object's weight, it
will float.

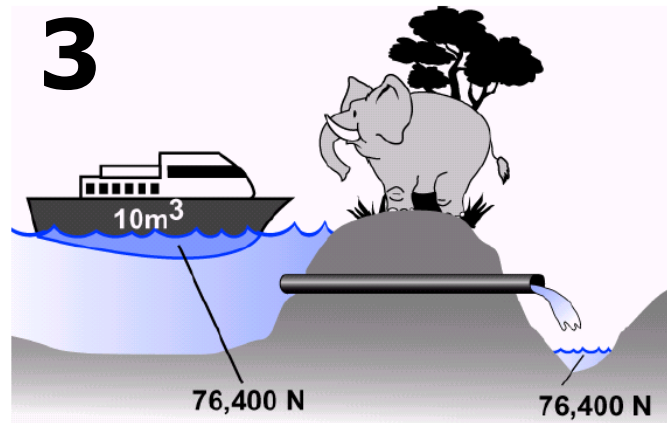
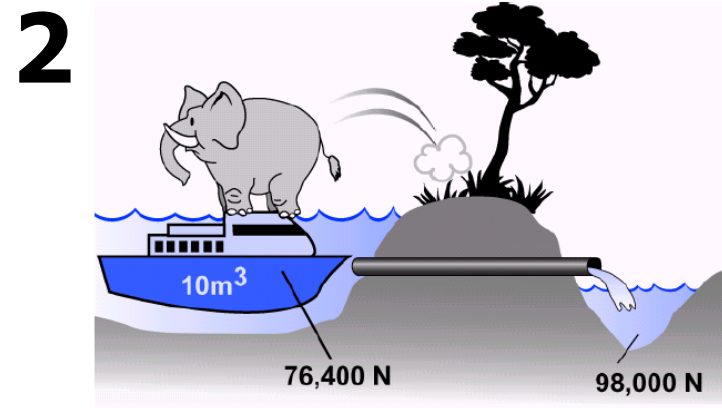
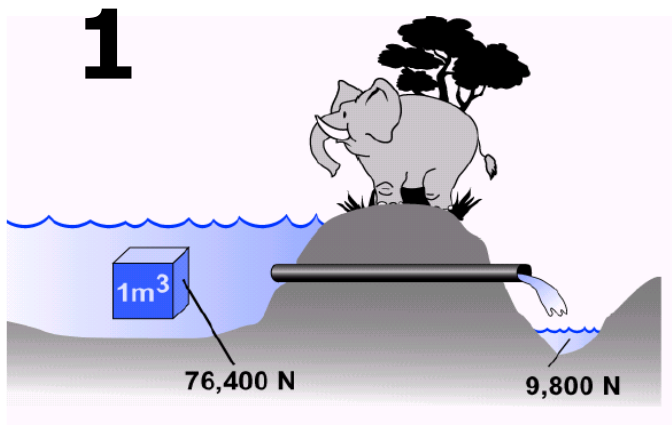


Neutral buoyancy...

- When the buoyant force is equal to the weight of the object.
- Divers use neutral buoyancy to swim at a steady level underwater.



Why does a steel block sink and a boat float?



Buoyancy is also a property of gases.

- **Balloons (hot air, helium, etc.) will float when the volume of air displaced weighs more than the balloon, gondola, and rider(s) combined.**



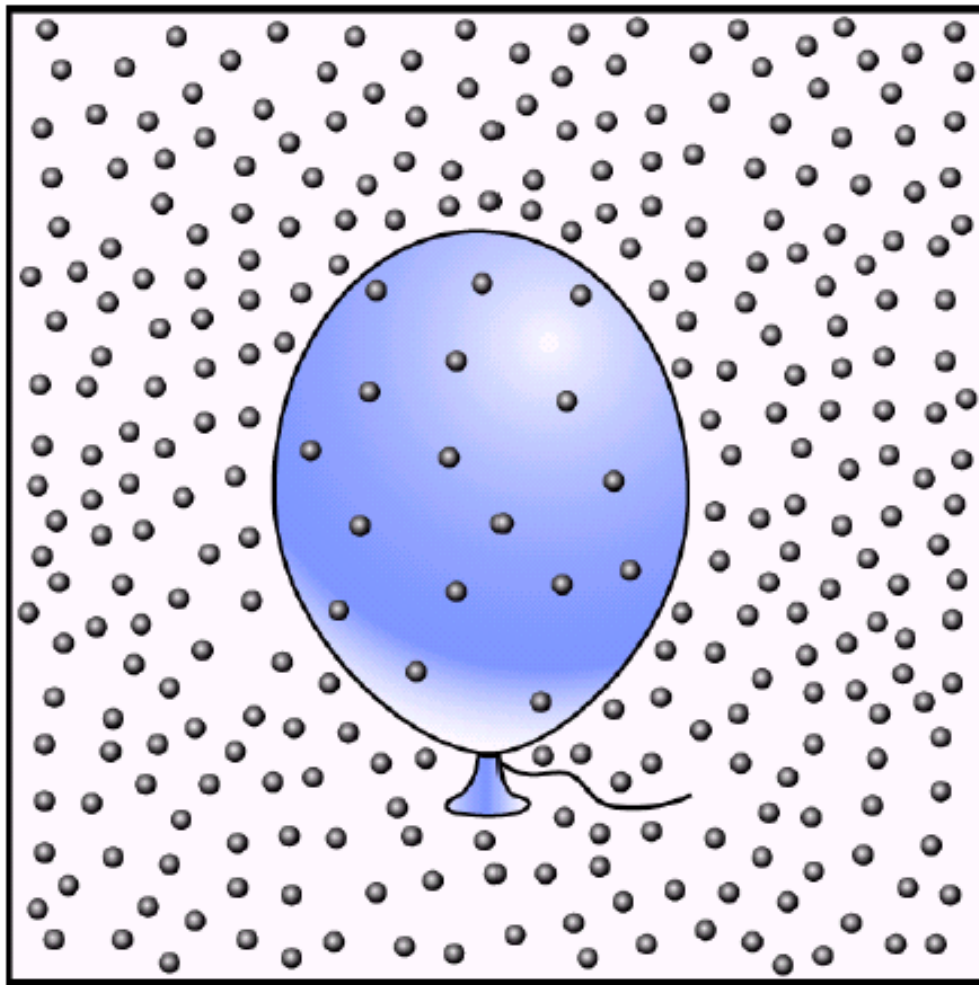


Figure 17.15: *A balloon will float when the volume of air displaced weighs more than the balloon weighs.*

Charles' law:



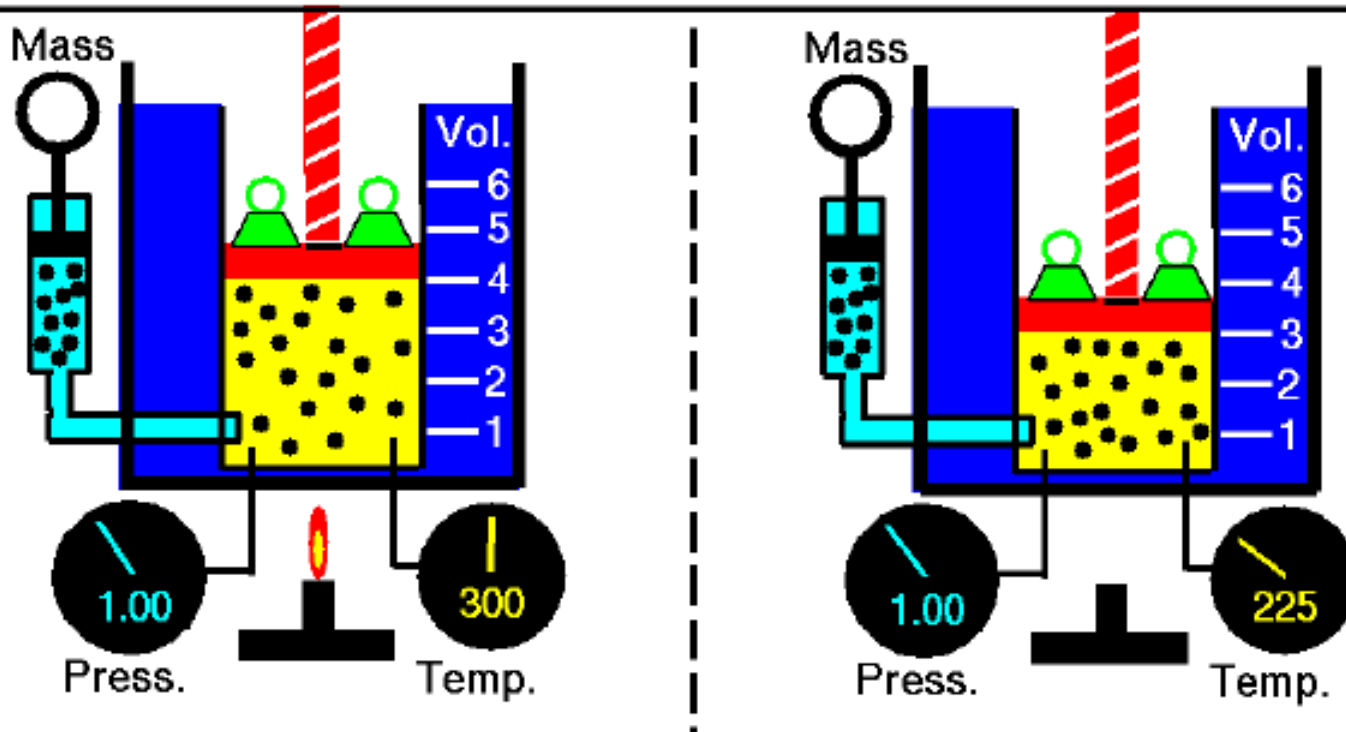
When pressure remains constant, then...

- The **volume** of a gas increases with *increasing temperature* and **volume** decreases with *decreasing temperature*.



Charles and Gay-Lussac's Law

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For a given mass, at constant pressure, the volume is directly proportional to the temperature

$$V = CT$$

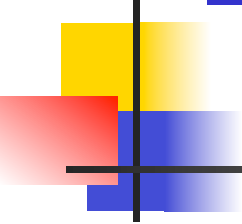
Click to see animated version:

<http://www.grc.nasa.gov/WWW/K-12/airplane/aglussac.html>



Gases and Pressure

- **Pressure** - the force acting on a unit area of surface.
- **Gas pressure** is caused by **collisions** of gas particles with the **walls** of its container.
- The more collisions, the greater the pressure.



- The unit for pressure in the metric (SI) system is the pascal (Pa).

- A pascal is equal to one newton of force acting on one square meter of surface area.

What is atmospheric pressure?

- Each particle of air held in place by gravity collides with and exerts a force against you and everything around you, creating air pressure.





- **At the Earth's surface, the air's pressure is 101,300 pascals (~weight of an elephant!)**

- **Why don't we collapse?**



Atmospheric pressure decreases with altitude.

- **Higher altitude means less gravity and less atmospheric pressure.**
- **Does this explain why your ears pop when you fly?**





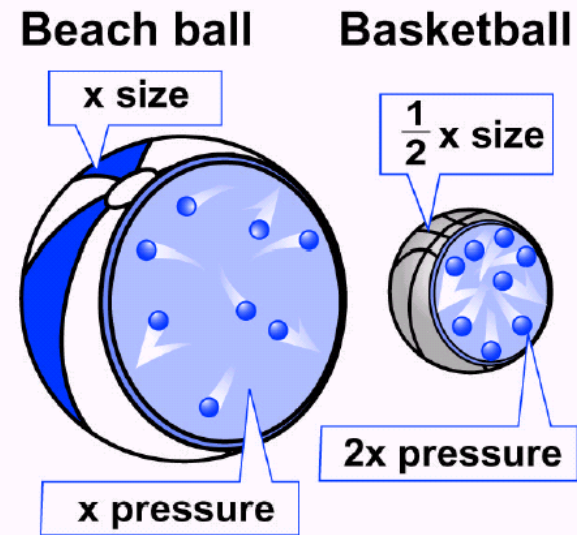
Other common units for atmospheric pressure:

- 101.3 kilopascals (kPa)
- 1.00 atmosphere (atm)
- 14.7 pounds per inch² (psi)
- 760 millimeters of mercury (mm Hg)

Boyle's law:



- Gas pressure increases with decreasing volume.

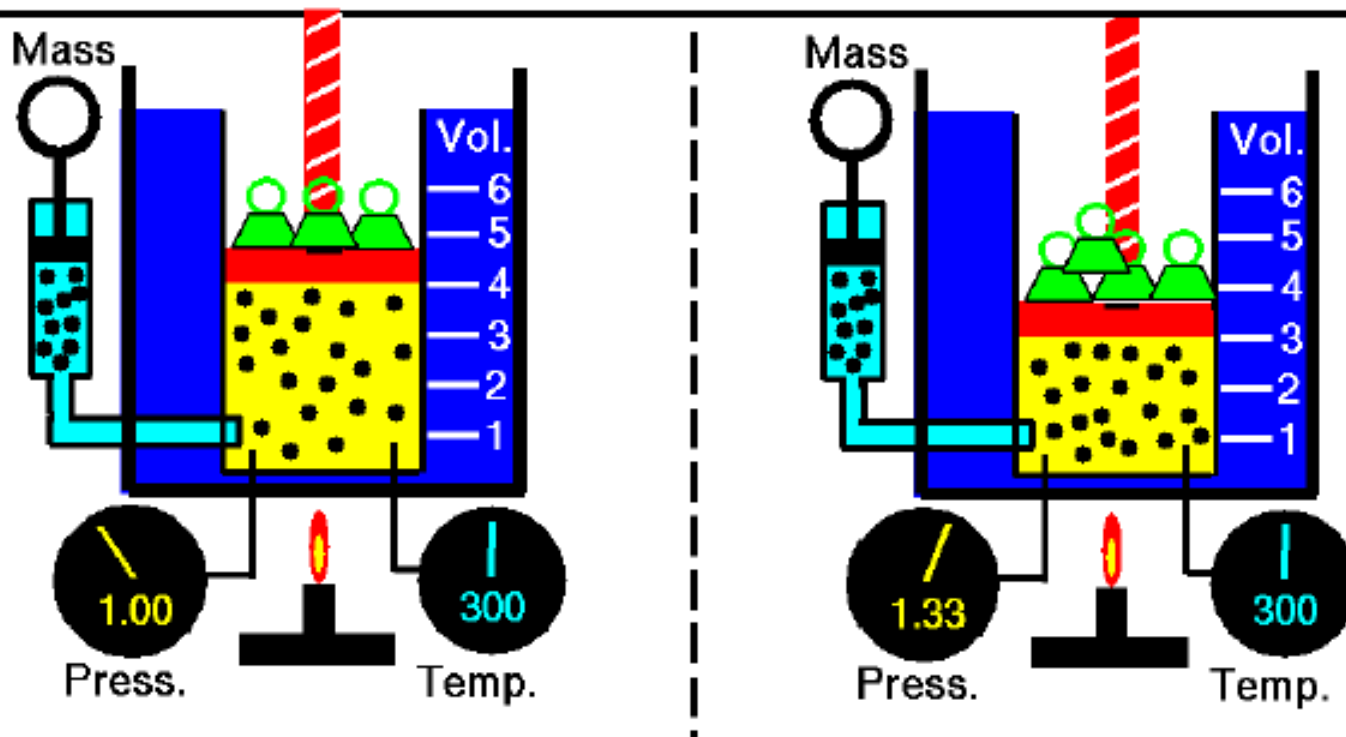


- Gas pressure decreases with increasing volume.



Boyle's Law

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For a given mass, at constant temperature, the pressure times the volume is a constant.

$$p V = C$$

Click to see animated version:

<http://www.grc.nasa.gov/WWW/K-12/airplane/aboyle.html>

Boyle's law equation:

- When temperature remains constant, then

Boyle's law

$$P_1 V_1 = P_2 V_2$$

Initial pressure → P_1 Initial volume → V_1 = P_2 New pressure → P_2 New volume → V_2