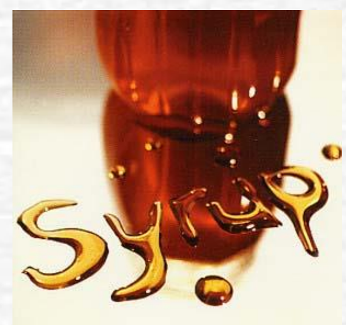
Properties of Fluids

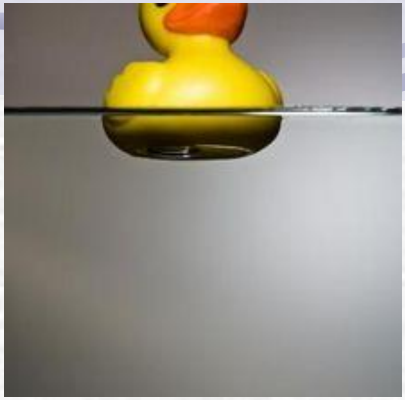
Why do ships float and planes fly?

Fluids

- A **liquid** or a **gas**
- Has the **ability to *flow***
- Some fluids flow better than others – this is due to their ***viscosity-***
  - The **resistance to flow** by a fluid



Buoyancy

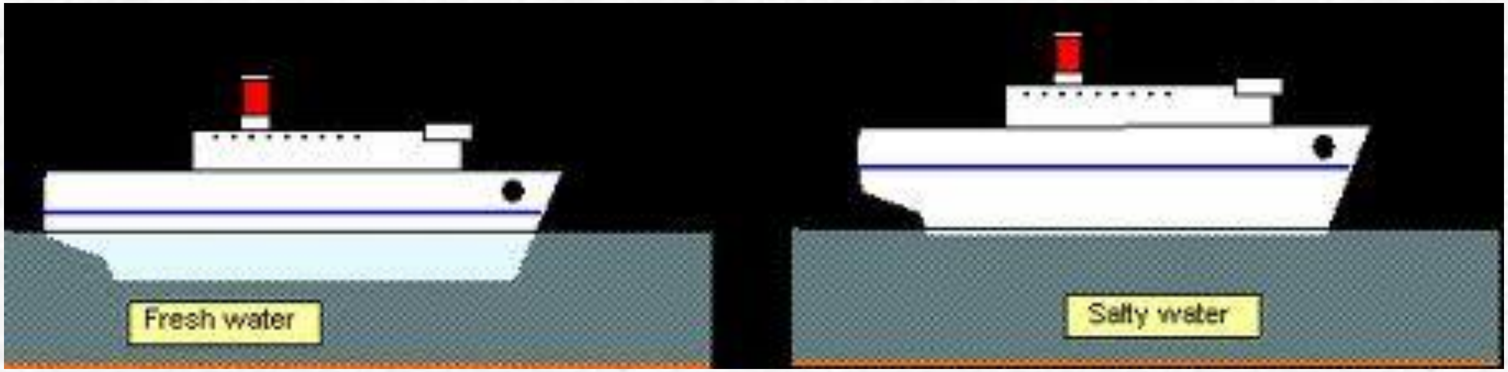


- **The ability of a fluid to exert an upward force on an object immersed in it**
- The **upward force** is called the **buoyant force**.

Buoyancy

- **The relationship between buoyant force and the weight of the object determines whether the object sinks of floats:**
  - If the buoyant force is less than the object's weight, the object will sink.
    - Buoyant Force < Weight
  - If the buoyant force is equal to the object's weight, the object will float
    - Buoyant Force ≥ Weight

Buoyancy



Loaded down cargo ship in Mississippi river barely floats but when it enters salt water it will float much higher due to the **density of salt water is greater**

Density and Buoyancy

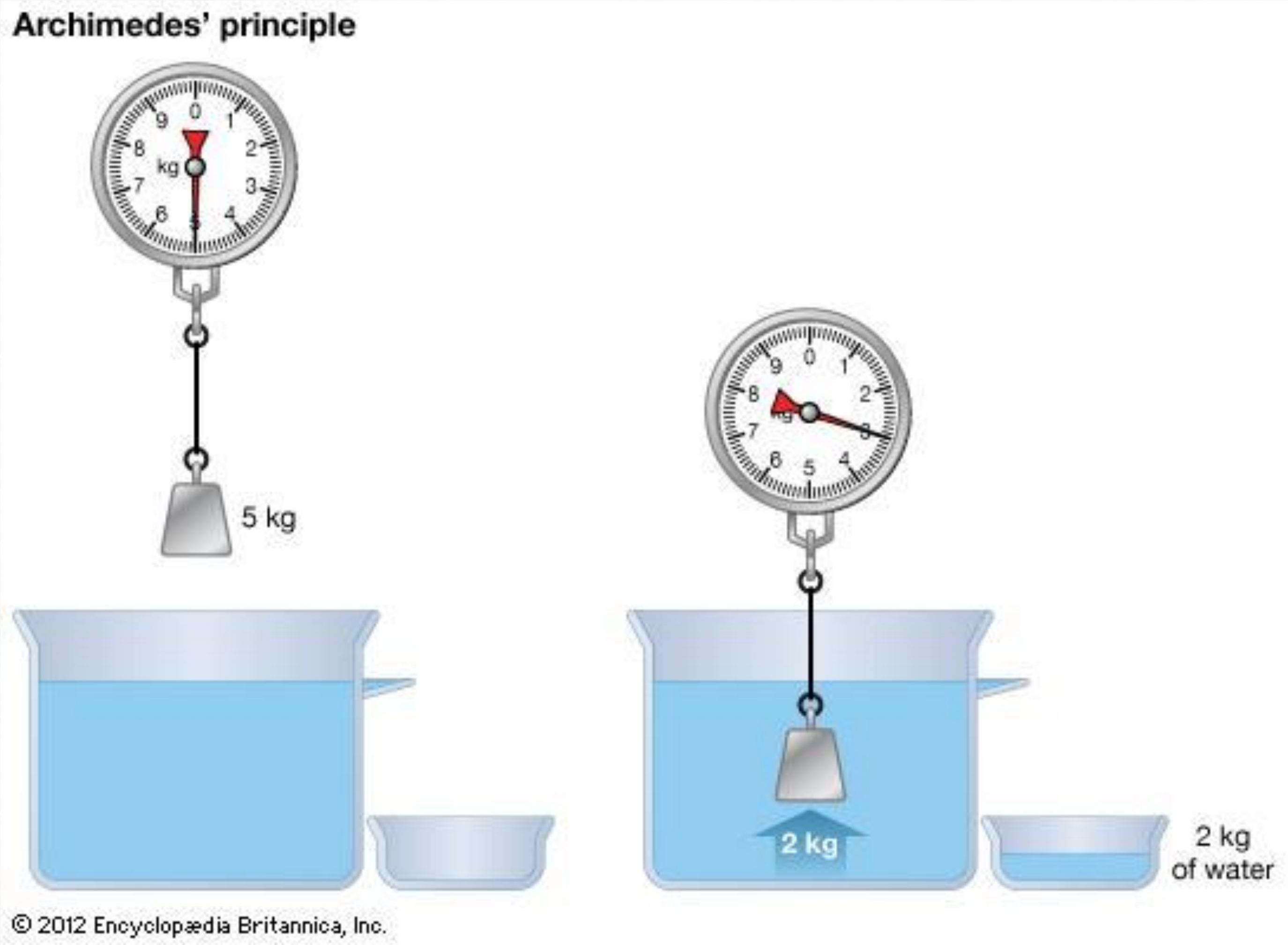
- Density: **how much *stuff*** is in a *space*
- **Density = mass divided by volume**
  - **D = m/V**
- Again, an object **will sink** in a fluid if the **density** of that object is **more** than the **density of the fluid!**
- An object **will float** in a fluid if the **density** of that object is **less** than the **density of the fluid!**

1. Archimedes' Principle

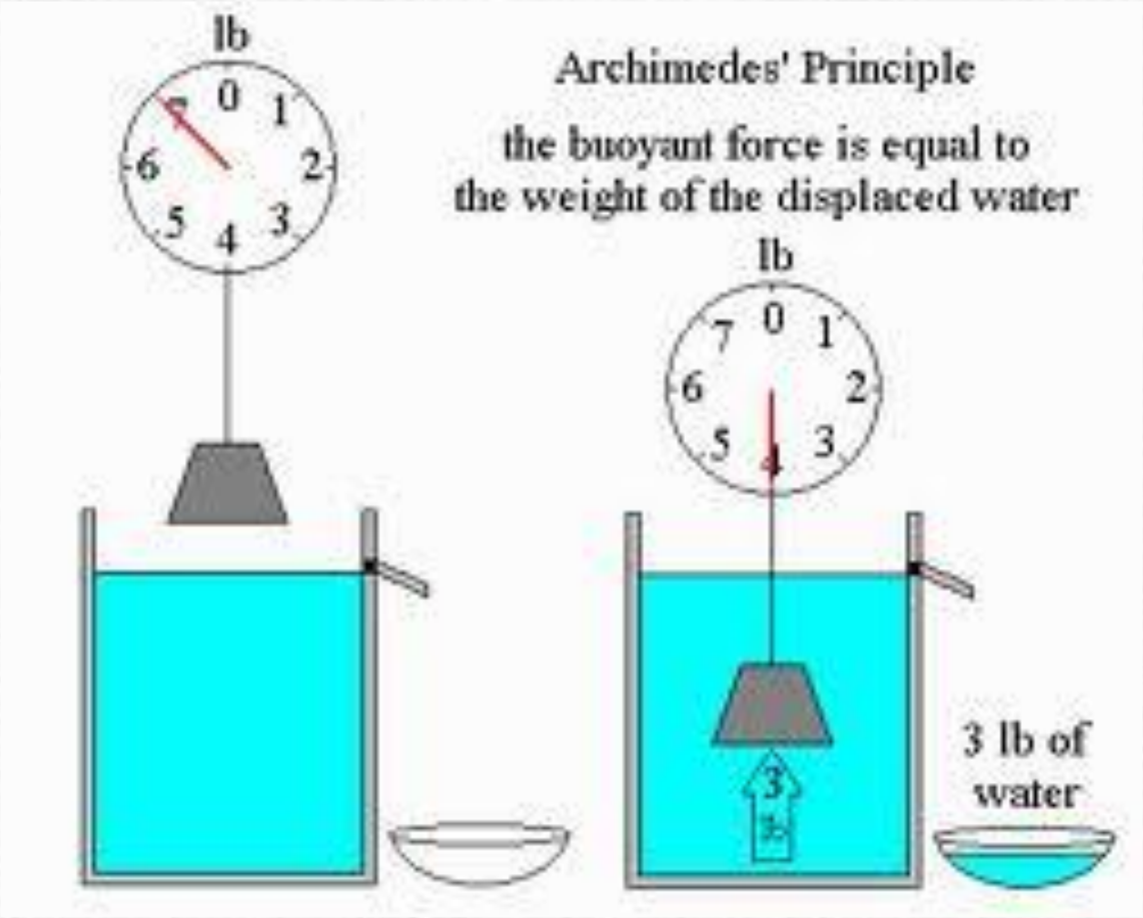
- **States that the buoyant force on an object is equal to the weight of the fluid displaced by the object**

Ex. – if you get into a bathtub that is full to the top, what happens to the water?

Archimedes' Principle



Archimedes' Principle



Archimedes’ Principle

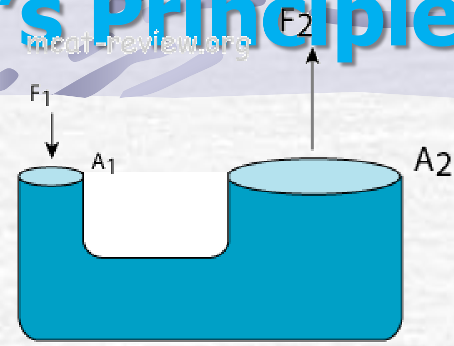
If you collect the spilled water and weigh it – you would find that the water’s mass is equal to the buoyant force of the water in the tub.

2. Pascal's Principle

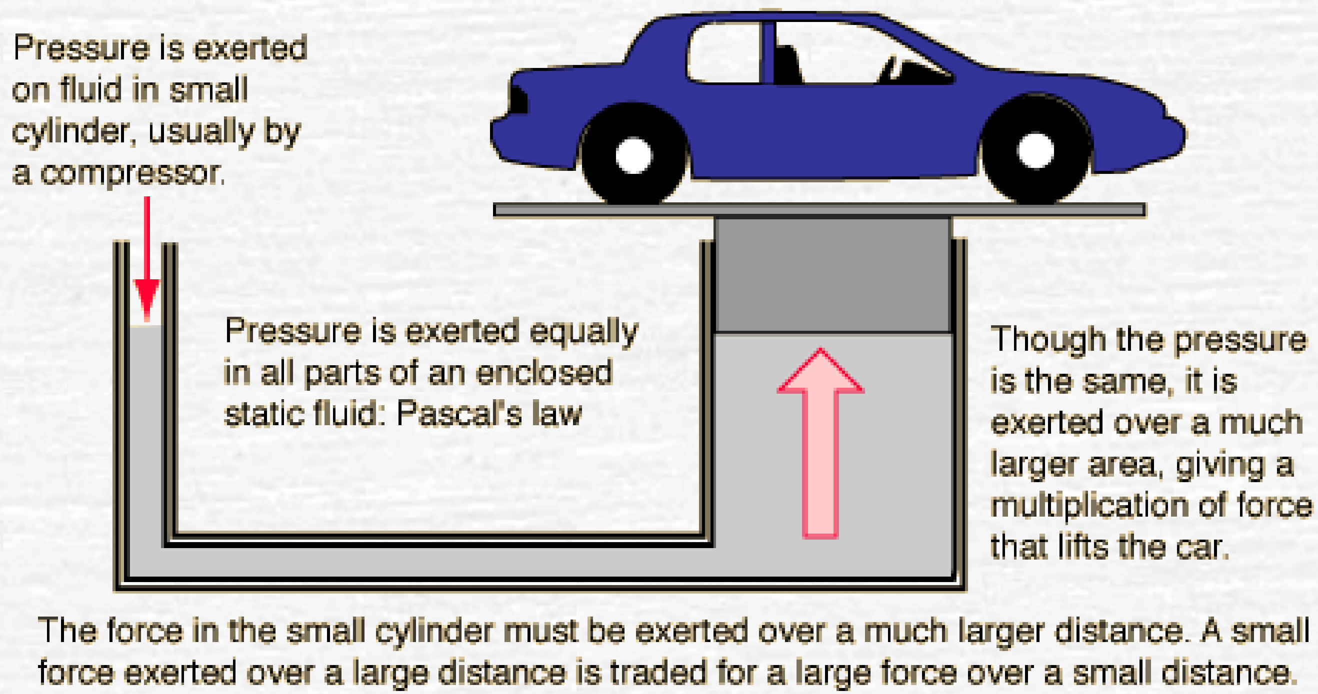
- **Pressure applied to a fluid is transmitted throughout the fluid**
- What is pressure?
  - **Pressure is the force exerted per unit area**
    - P = F/A
    - The SI unit for pressure is the **Pascal or (P).**
    - ✓ **Example: Hydraulic machines use Pascal's Principle to lift heavy objects**

Examples of Pascal’s Principle

Hydraulic machines use Pascal’s Principle to lift heavy objects



$$\frac{F_1}{A_1} = \frac{F_2}{A_2}$$



Examples of Pascal’s Principle

Squeezing toothpaste from the tube

Pressure applied to a fluid is transmitted throughout the fluid.

Squeezing a balloon

3. Bernoulli's Principle

- **States that as the velocity of a fluid increases, the pressure exerted by the fluid decreases**
- Get out a piece of paper –blow air over the top of the paper and see what happens!

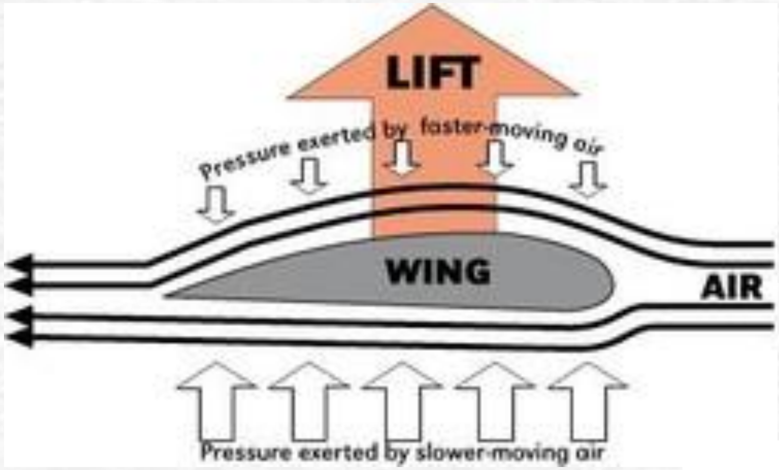
Bernoulli's Principle

Bernoulli's Principle

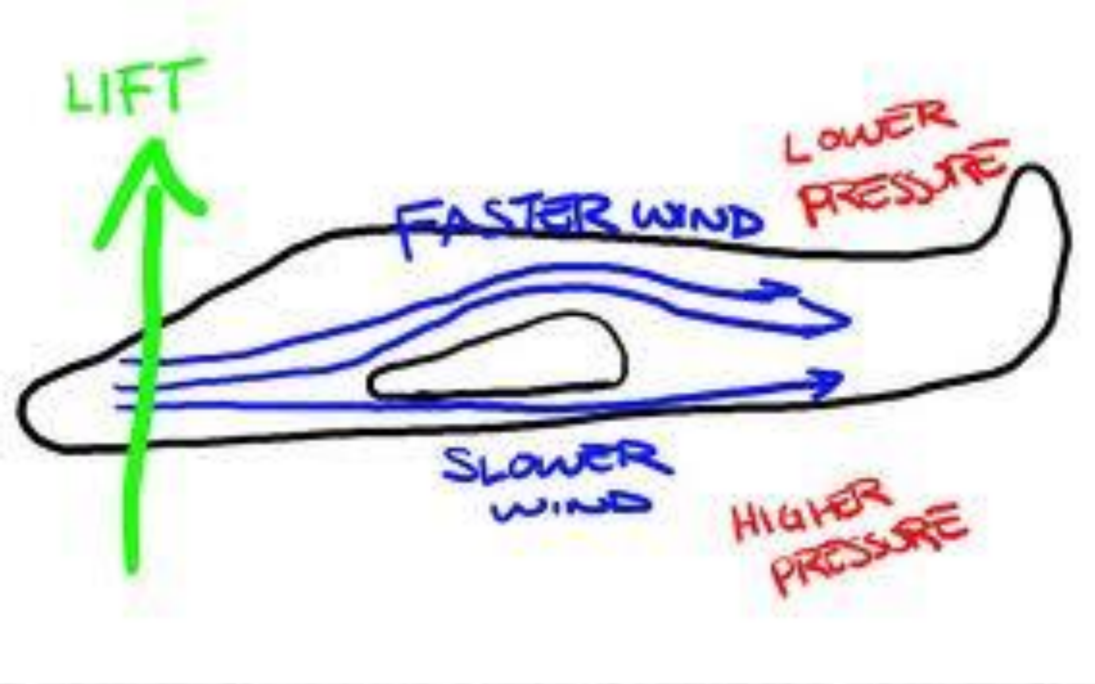
Shower curtain ever attacked you?

Why???

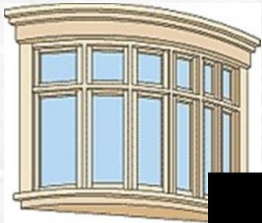
Bernoulli's Principle



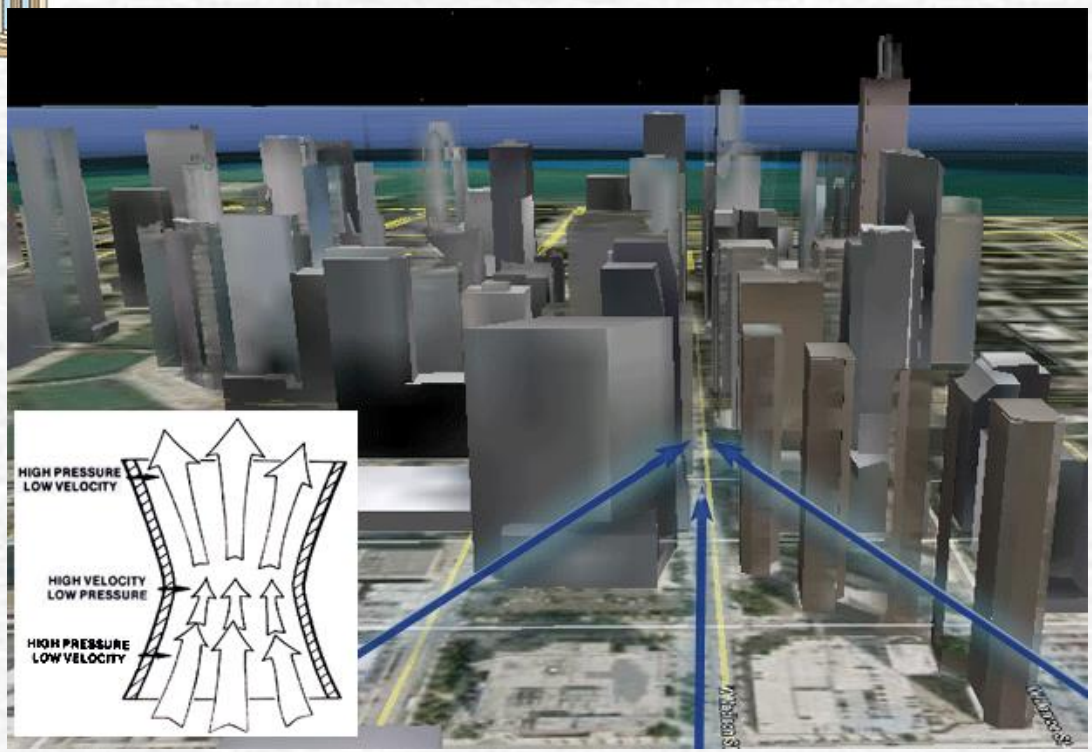
Reason why planes can fly



Venturi Effect – example of Bernoulli's



Strong winds between tall buildings can cause windows to blow out



Gas Laws

Behavior of Gases

- Collisions of particles in air result in **atmospheric pressure**
- Moving particles colliding with the inside walls of a container result in **gas pressure.**

1. Boyle's Law

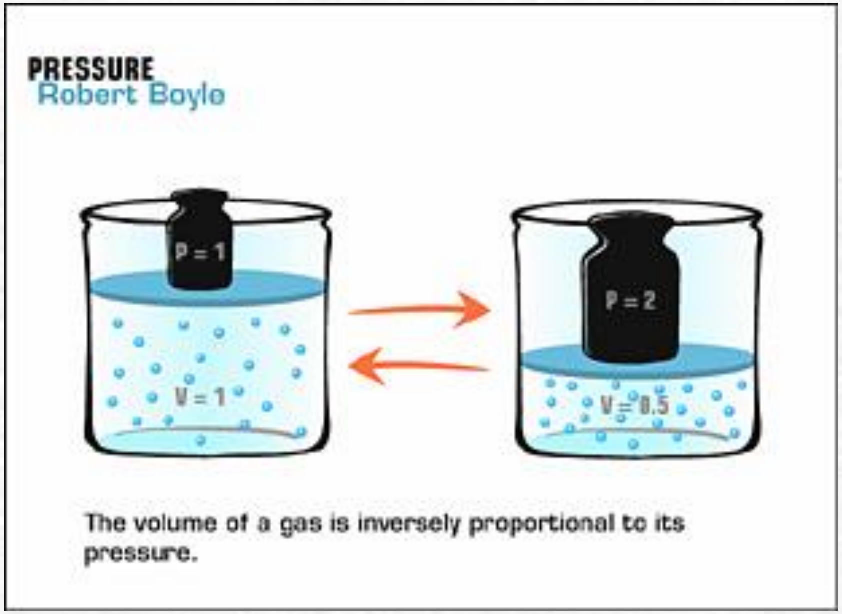
- Relates **pressure** and **volume**
  - **Volume decreases** as **pressure increases**

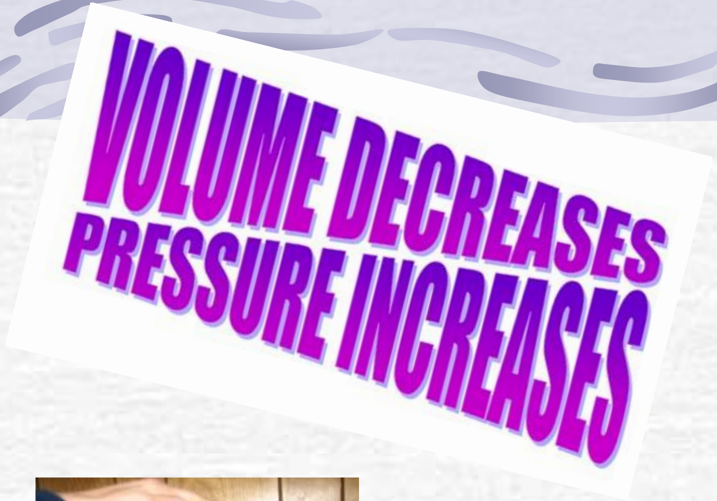
or

  - Pressure decreases as volume increases

❖ This is true if **temperature** remains **constant**

Examples of Boyle's Law





Examples of Boyle's Law

Weather balloons

2. Charles' Law

- Relates **temperature** and **<u>volume</u>**
  - **Volume decreases** as **temperature decreases**

    or
  - Temperature increases as volume increases

❖ This is true if **pressure** remains **constant**

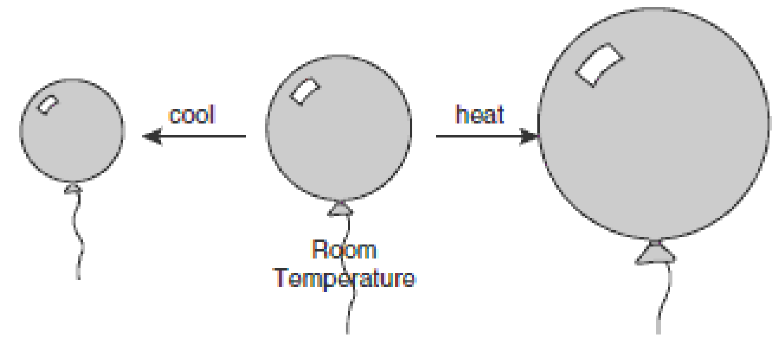
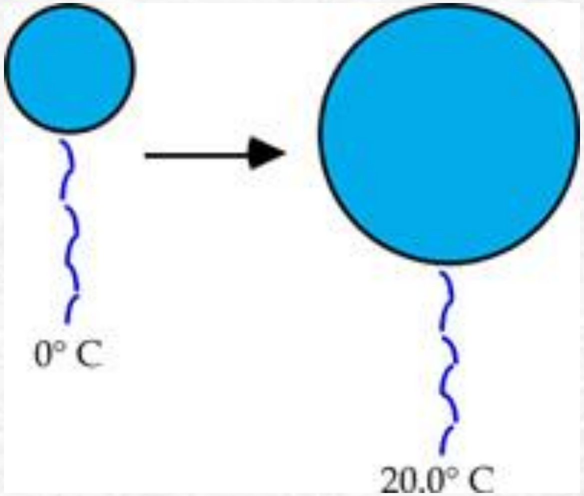
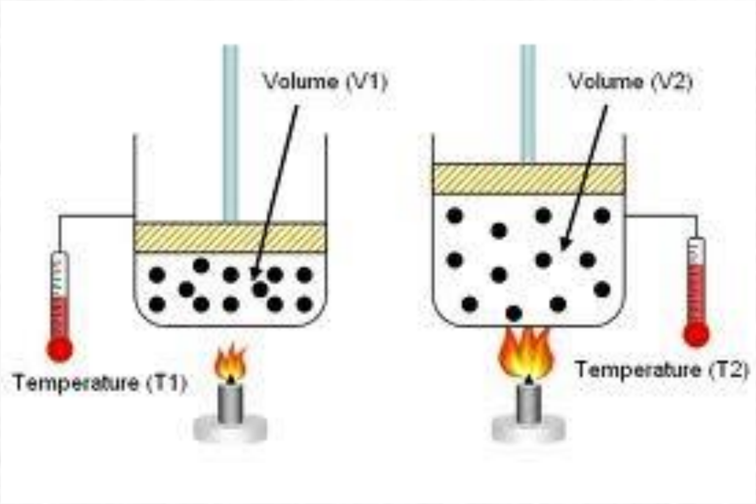


Figure 8.4 Volume–temperature relationship for gases.

Examples of Charles' Law



increase temp. = increase volume



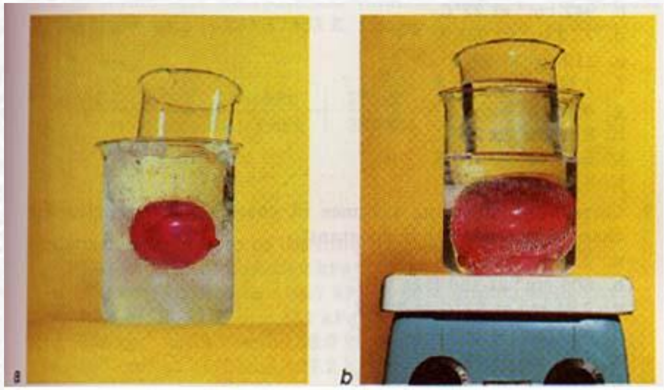
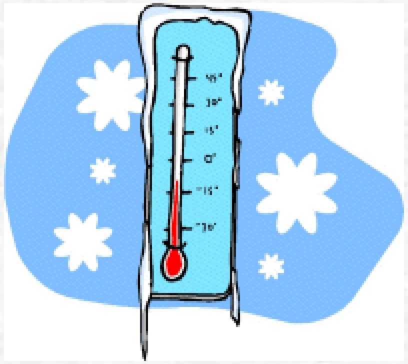


FIGURE 18-6. Note how the vol
ume of the balloon change
from the ice bath (a) to the ho
water bath (b).

Examples of Charles' Law

decrease temp. = decrease in volume

Examples of Charles' Law



decrease temp = decrease volume

Examples of Charles' Law

3. Gay-Lussac's Law

- Relates **temperature** and **pressure**

  - **pressure decreases** as **temperature decreases**

    or

  - Temperature increases as pressure increases

- This is true if **volume** remains constant

Gay-Lussac's Law

$$P/T = k_g \quad \text{or} \quad P_1/T_1 = P_2/T_2$$

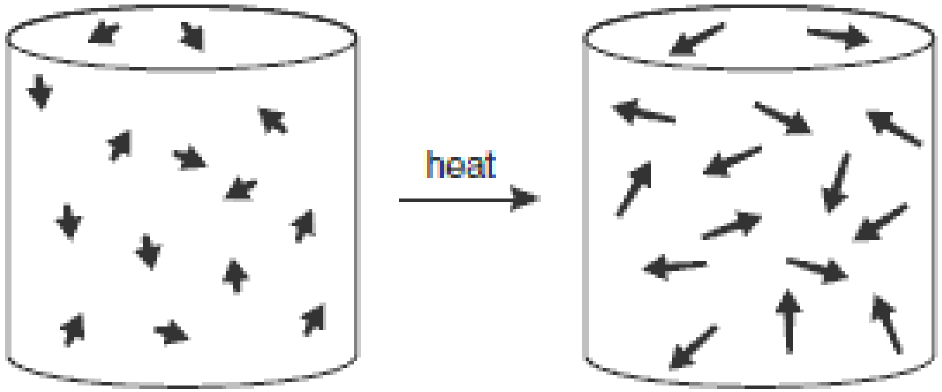


Figure 8.5 Pressure–temperature relationship for gases. As the temperature increases, the gas particles have greater kinetic energy (longer arrows) and collisions are more frequent and forceful.

Gay-Lussac's Law