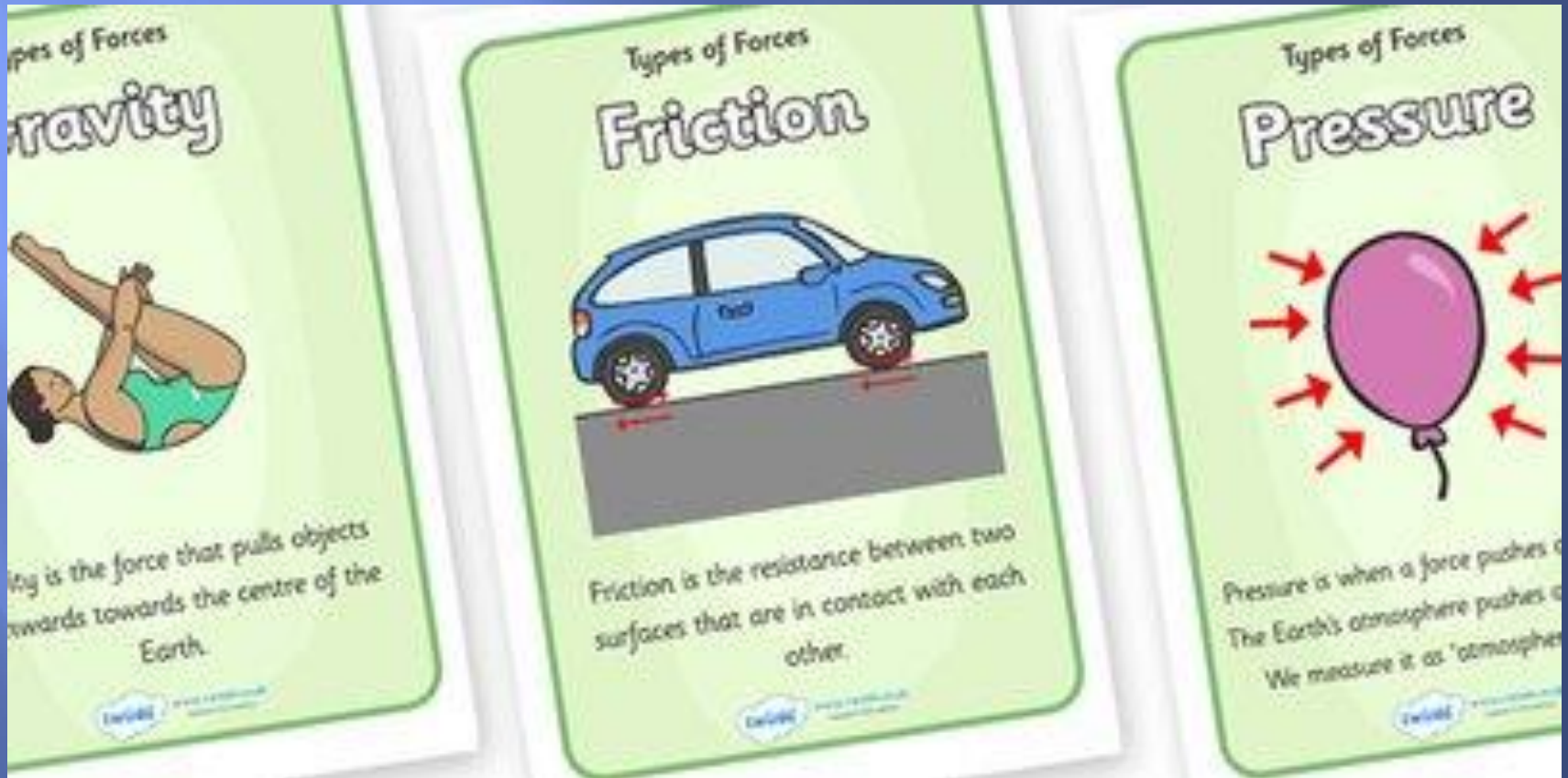
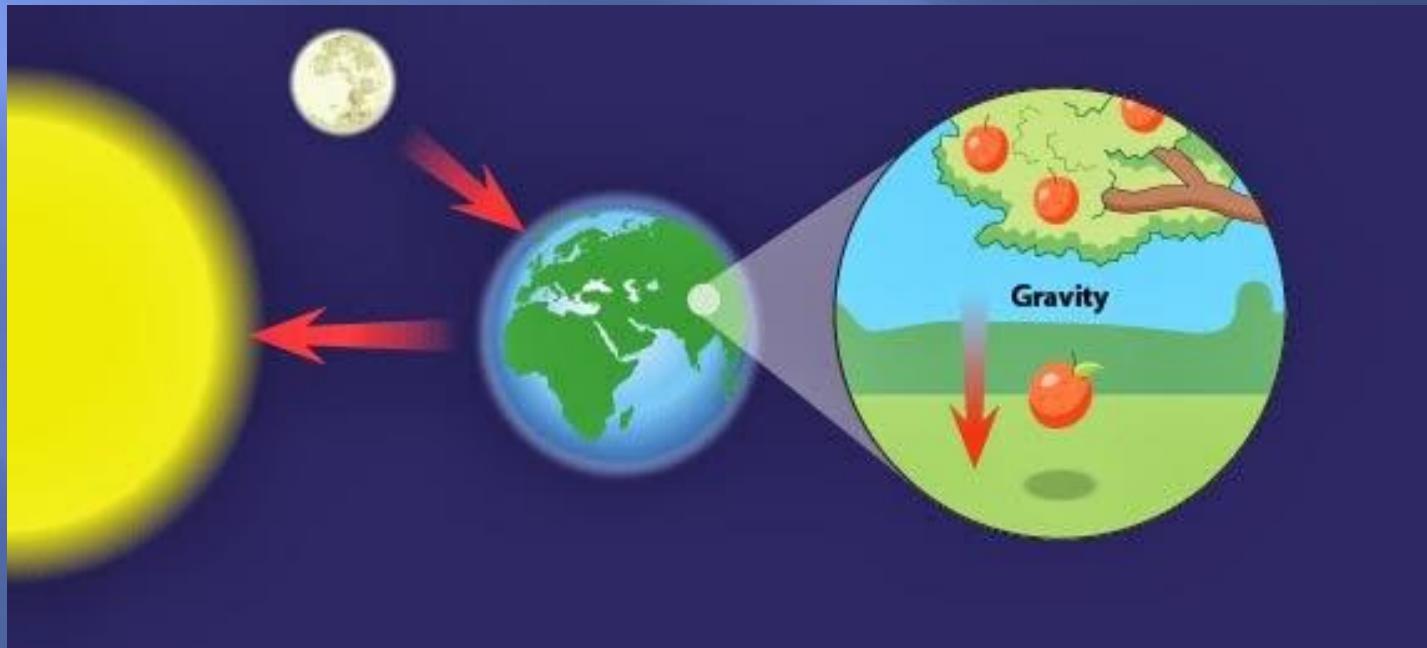


# Ch 12 Gravity, Friction, and Pressure

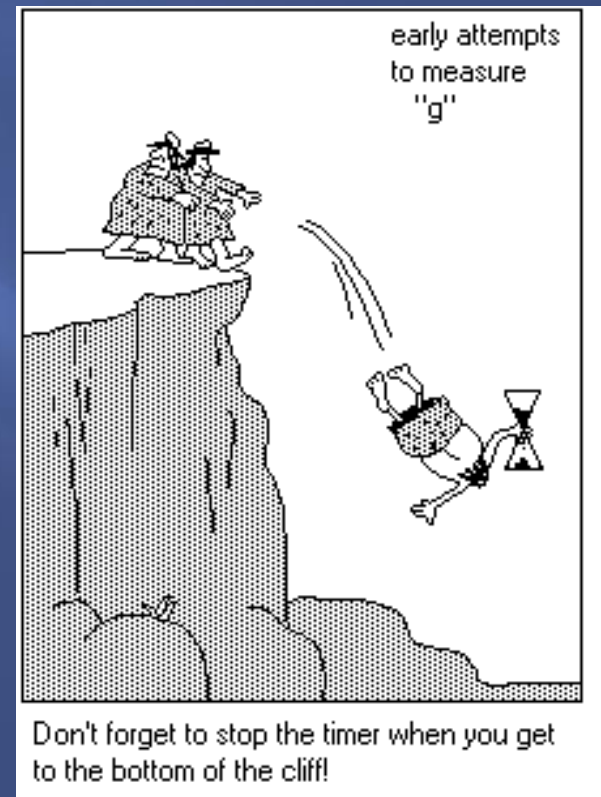


# 12.1 Gravity is a force exerted by masses

- ▣ Masses attract each other — the strength of the gravitational force is proportional to the product of the masses divided by the distance between them squared

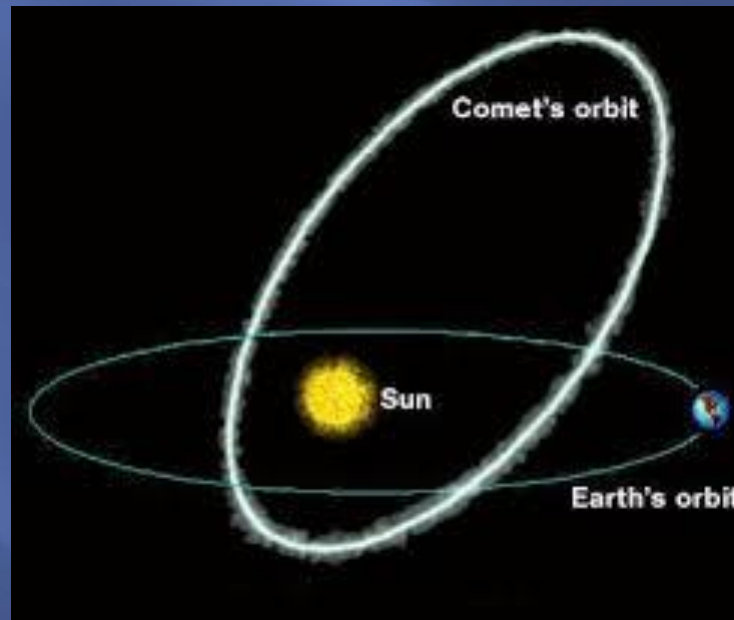


- ▣ Gravitational acceleration is symbolized by  $g$  and equals  $9.8 \text{ m/s}^2$  at Earth's surface
  - Mass is the amount of matter
  - Weight is the effect of gravity on the object



# Gravity keeps objects in orbit

- ▣ Orbit — elliptical path that an object takes around another object
- ▣ Orbital path — result of the speed of the orbiting body and the gravitational pull between the 2 objects



- ▣ Escape velocity — speed an object must have to escape the gravitational pull of another body (like a spacecraft leaving a planet)



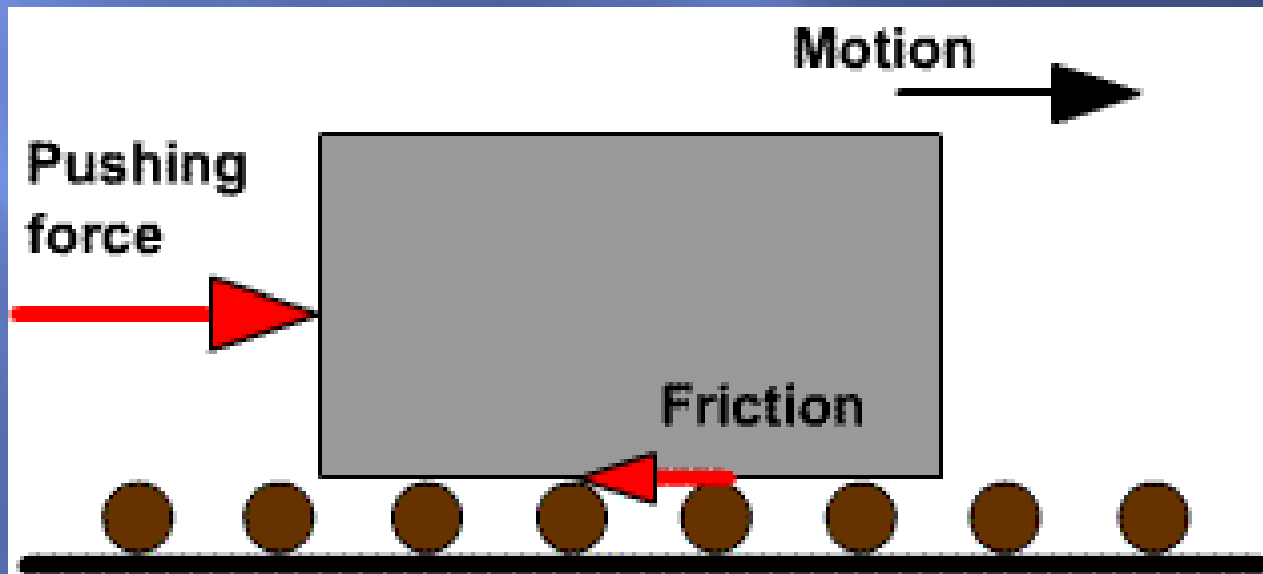


- ▣ Free fall — speeds lower than the escape velocity will result in a orbit (can't feel gravity)

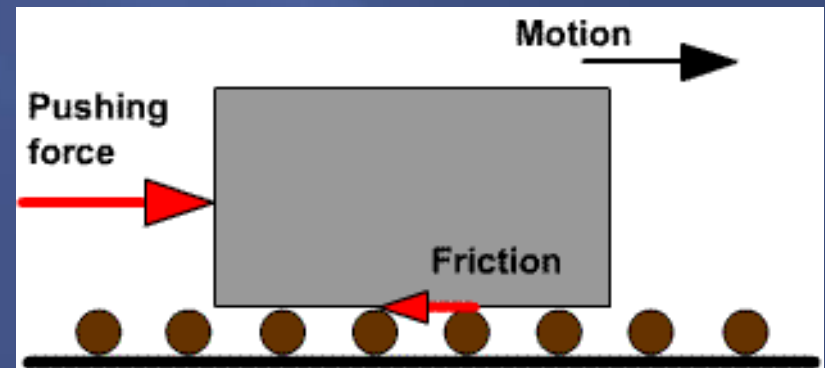


## 2.2 Friction is a force that opposes motion

- ▣ Friction occurs when surfaces slide against each other
  - Amount of friction may be determined by the type of surface (rough causes more friction)



- Motion of the surfaces affects friction
  - Static friction – force needed to start an object moving
  - Sliding friction – force needed to keep an object moving
- As the force pressing the surfaces together increases, friction increases
- Friction between surfaces produces heat





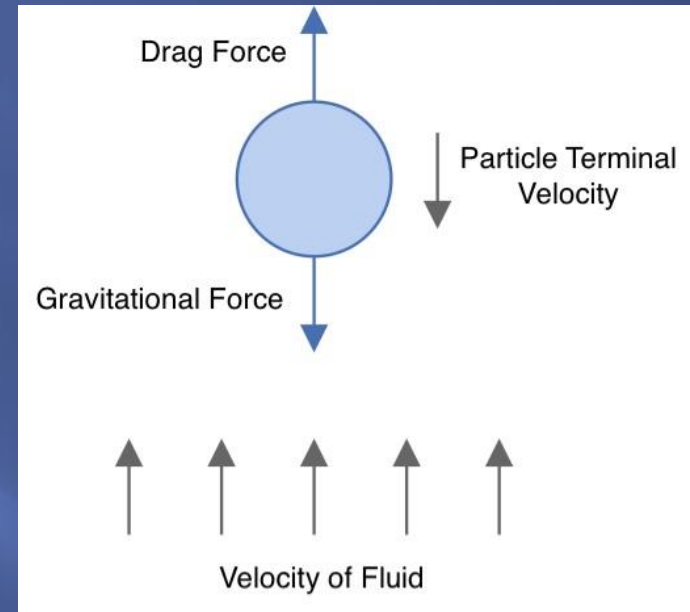
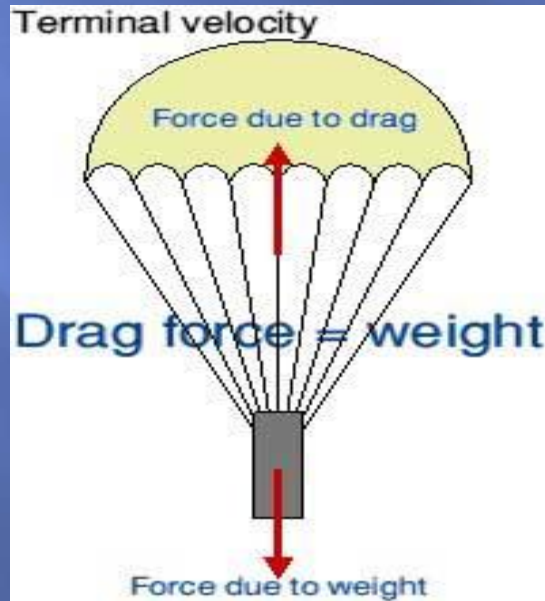
# Motion through fluids produces friction

- ▣ Fluid — substance that flows easily (liquids & gases)

- ▣ Air resistance — friction caused by an object moving through air
  - Amount is based on the surface area of the object and the speed at which it moves

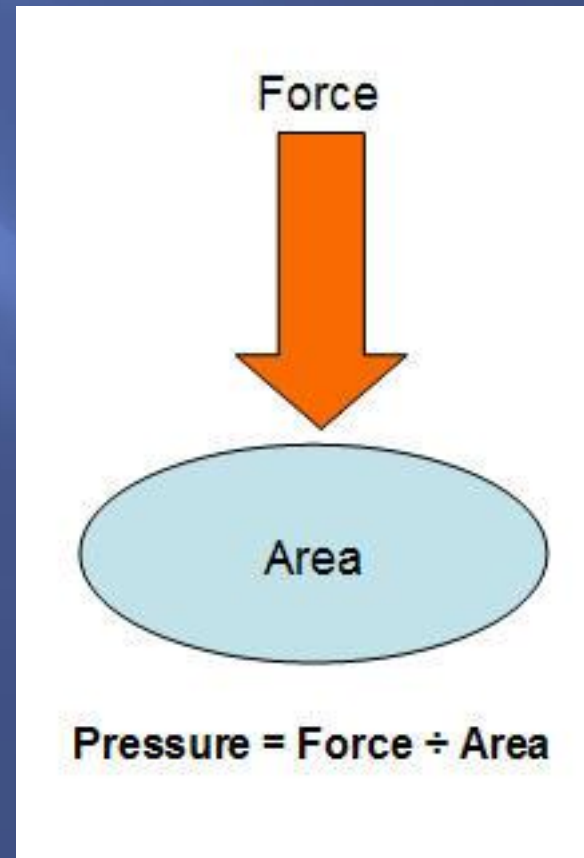
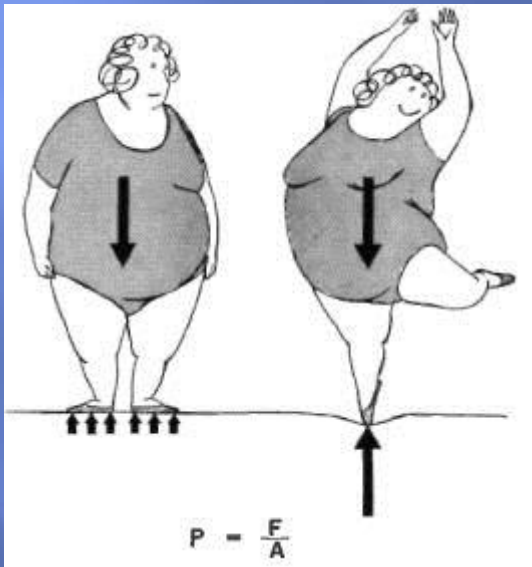


- Terminal velocity – maximum speed of an object falling through the air because air resistance balances gravity

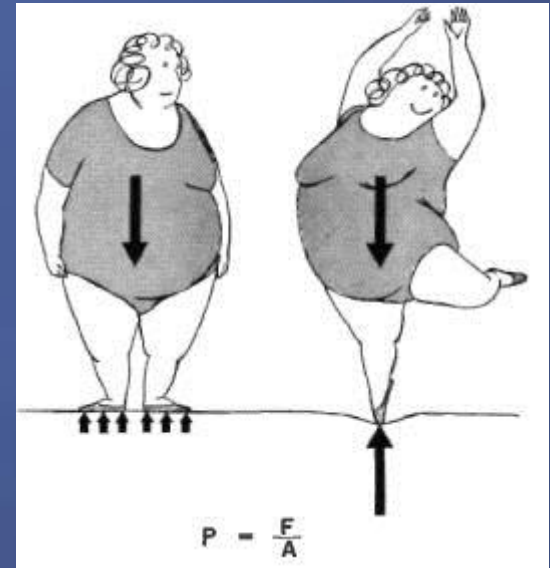


# 12.3 Pressure depends on force and area

- Pressure describes how a force is spread over an area



- Pressure increases when the force stays the same but acts on a smaller area



- It increases when the area stays the same but force increases

$$P = F/A$$

- Pascal — unit for pressure (force should be in Newtons and area in square meters)



# Other Units

- ▣ Mb = millibar
- ▣ PSI = pounds per square inch
- ▣ mmHg = millimeters of mercury

Inches of Mercury → ("Hg)

Atmospheres → (atm)

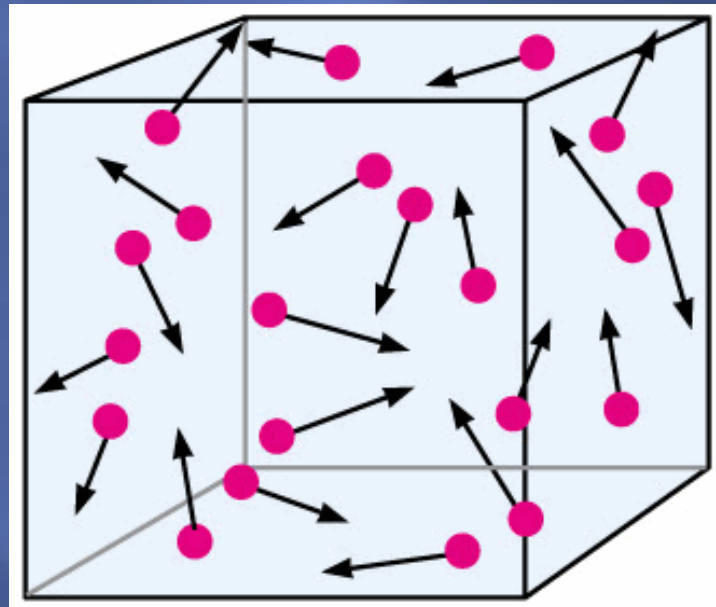
Kilopascals → (kPa)

Millibars → (mb)

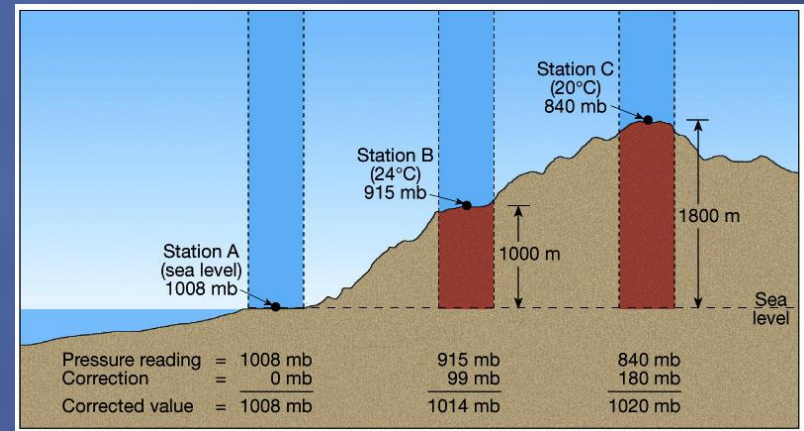
29.92 "Hg = 1.0 atm = 101.325 kPa = 1013.25 mb

# Pressure acts in all directions in fluids

- ▣ Particles in a fluid move constantly and rapidly
- ▣ They collide with objects they come in contact with the fluid, applying pressure to the surface of the object



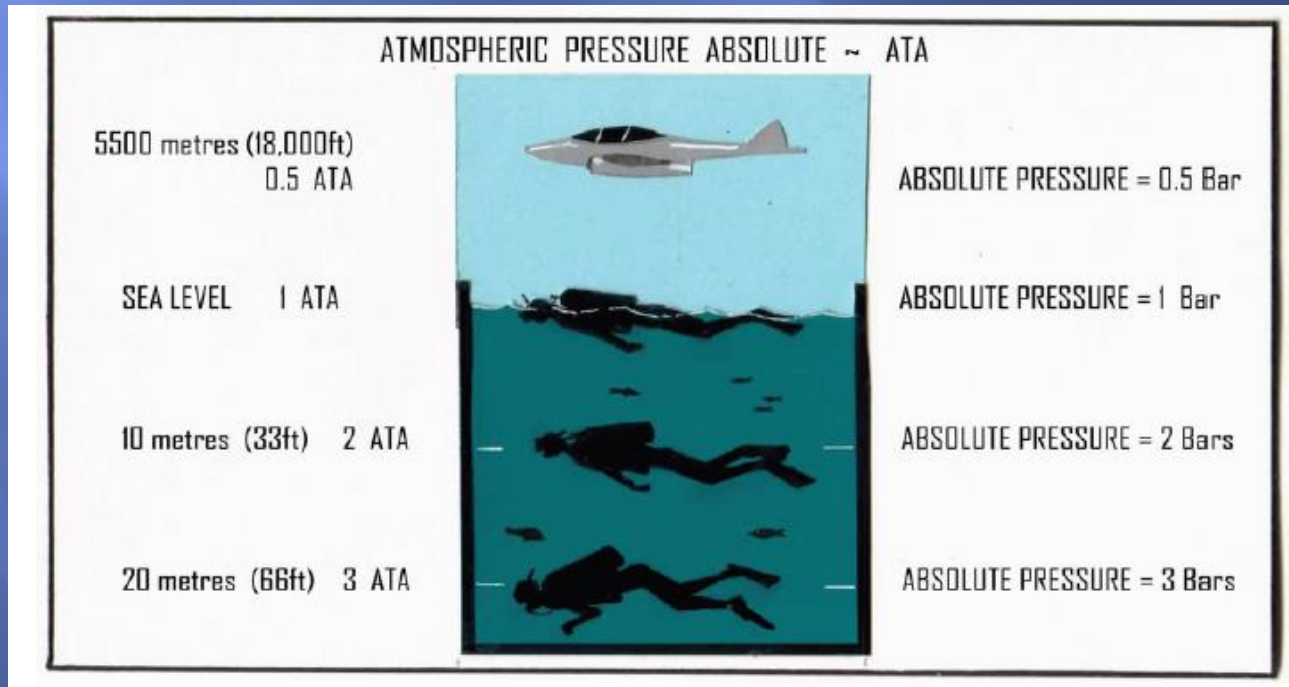
▣ Amount of pressure is proportional to the density & depth of the fluid



- ▣ Air exerts pressure on all objects
  - It is more dense at lower elevations
  - It is less dense at higher elevations
  - The denser the air, the more pressure it exerts
  - Water is more dense than air & exerts more pressure than air

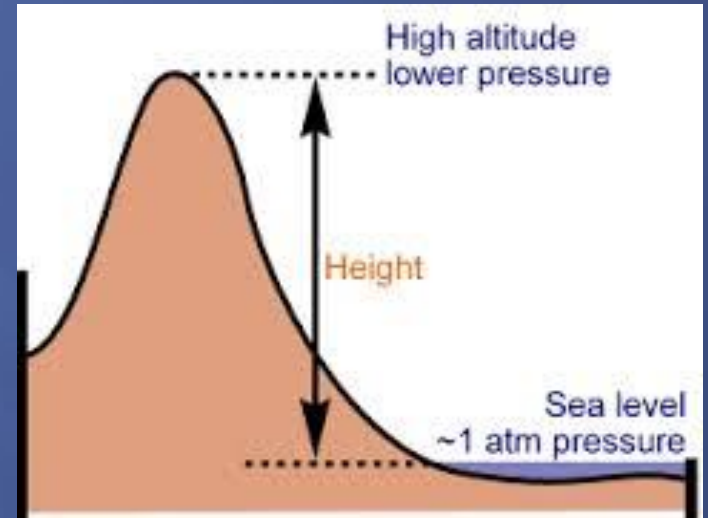
# Pressure in fluids depends on depth

- ▣ The pressure a fluid exerts depends on depth and density of the fluid
- ▣ At sea level, air exerts a pressure called atmospheric pressure





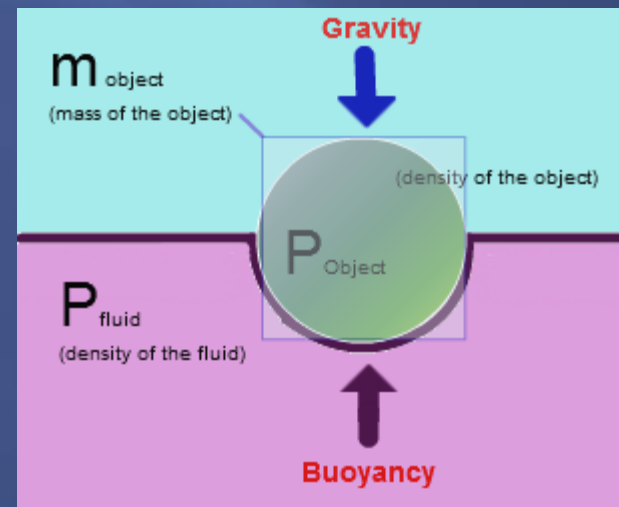
- ▣ Air has weight
  - The more air above you, the greater the weight of the air
  - Air at higher elevations weighs less
  - Air at lower elevations is more compressed (more dense, more weight)
  
- ▣ Water has a greater density than air so exerts more pressure on objects than air





# 12.4 Fluids can exert a force on objects

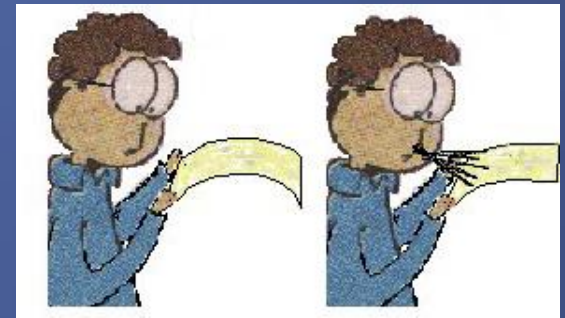
- ▣ Fluids can exert an upward force on objects
  - On Earth objects are subject to forces from all directions, but the forces may not be balanced
  - The difference in water pressure at different depths produces an upward force called buoyant force
    - ▣ this force directly relates to the amount of fluid the object replaces



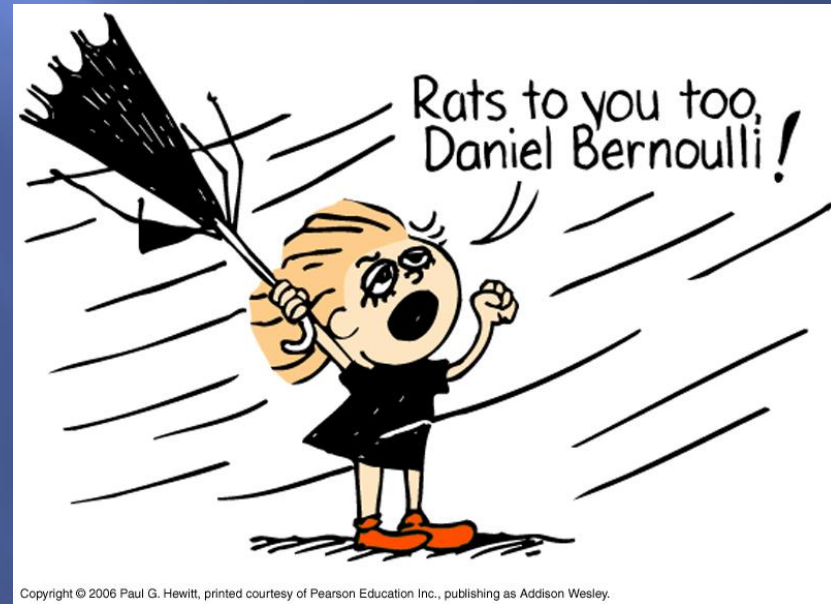
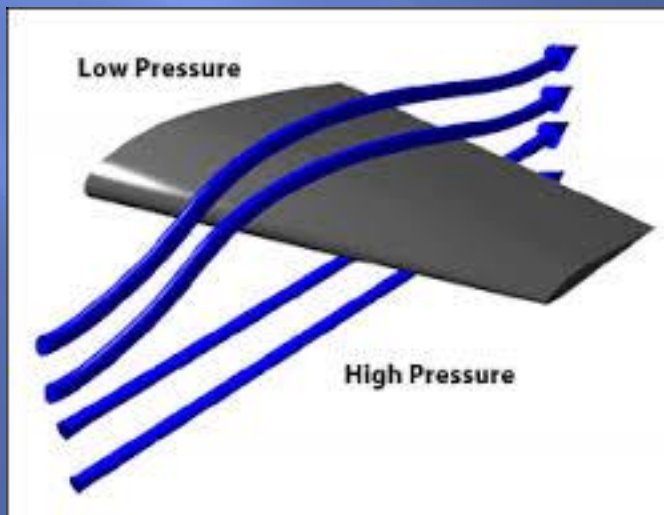
- ▣ Density is the amount of matter per unit of volume
- ▣  $D = M/V$
- ▣ Buoyancy enables a less dense material to float on another denser material



# The motion of a fluid affects its pressure

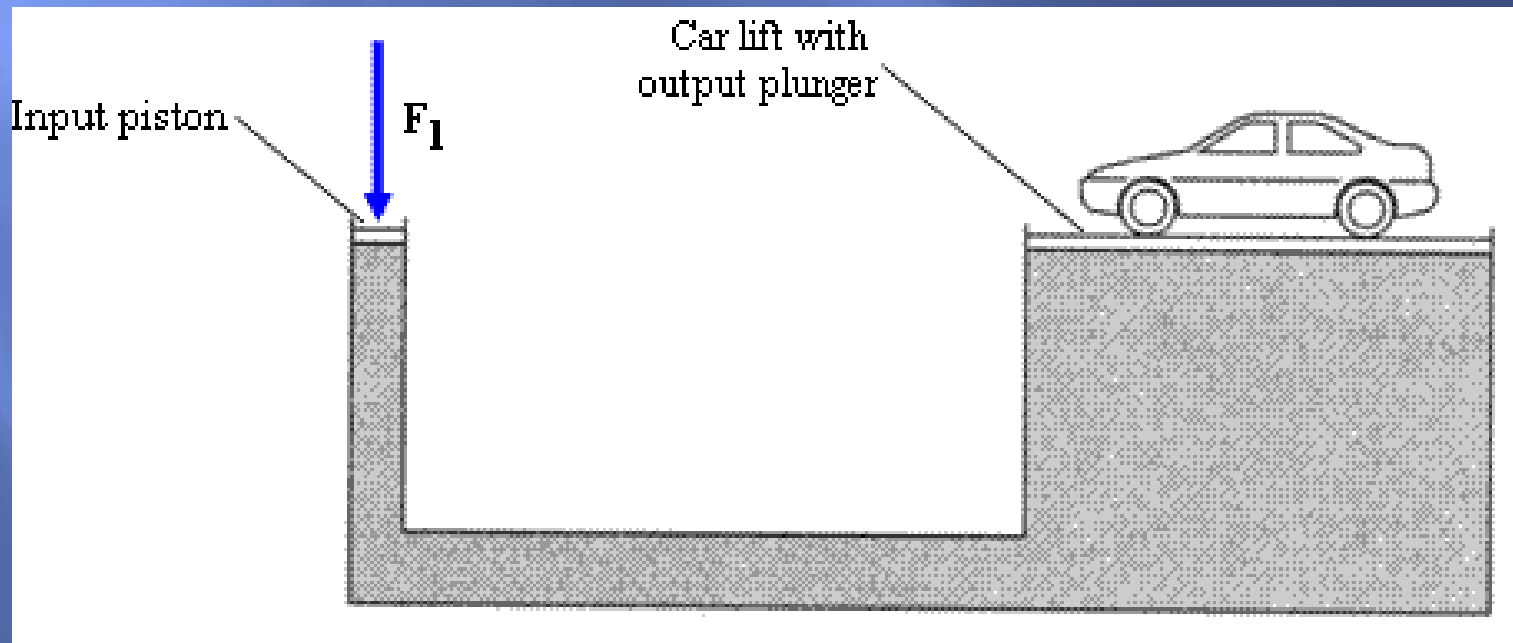


- ▣ Bernoulli's principle — as speed of a fluid increases, the pressure inside the fluid decreases



# Forces can be transmitted through fluids

- ▣ Pascal's principle – when outside pressure is applied to a fluid in a container, the pressure is transmitted equally throughout the entire fluid



- ▣ Hydraulic machines use liquids to transmit forces (gases would be less effective because they change volume when force is applied)

