Forces in Fluids

Objectives

- **Describe** how fluids exert pressure.

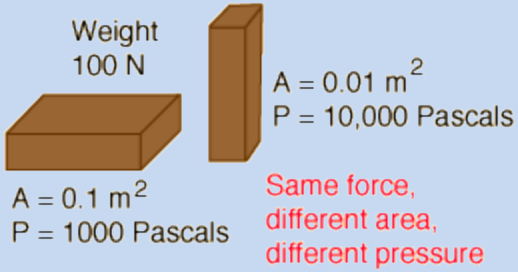
- **Explain** the relationship between fluid pressure and buoyant force.

- **Describe** the relationship between pressure and fluid speed.

I. Fluids Exert Pressure

A. Calculating Pressure: Pressure equals force divided by area.

$$Pressure = \frac{Force}{Area} = \frac{F}{A}$$



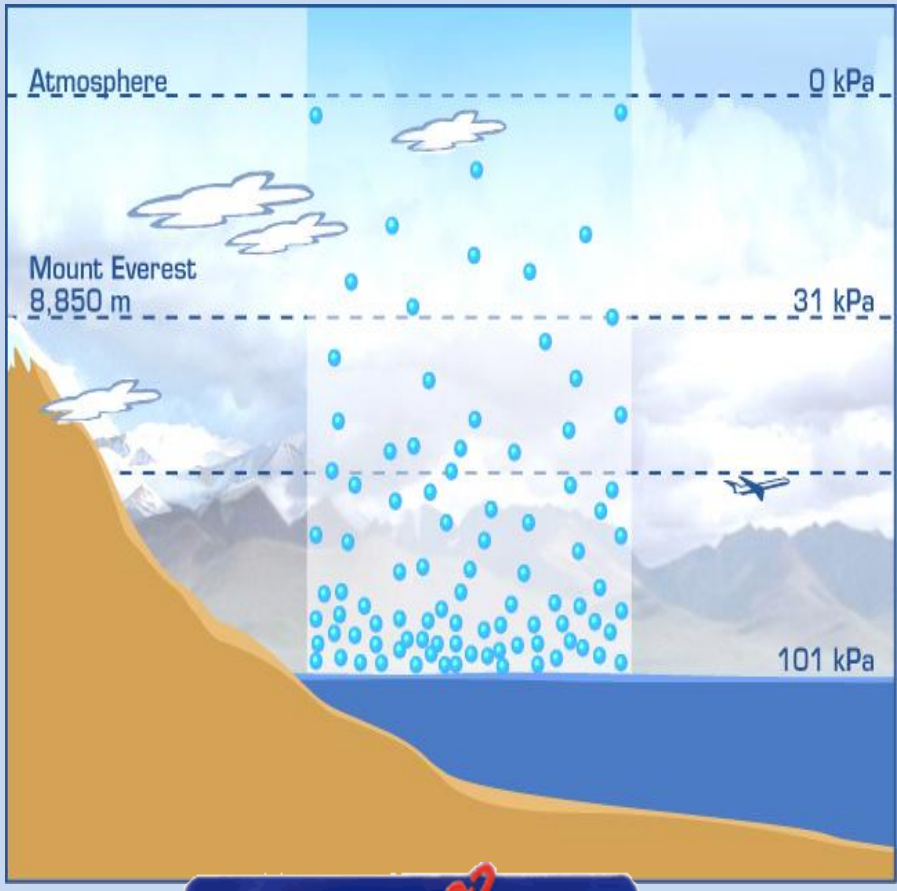
B. **Pressure and Bubbles:** The shape of the bubble partly depends on an important property of fluids: Fluids exert pressure evenly in all directions. The air you blow into the bubble exerts pressure evenly in all directions. So, the bubble expands in all directions to create a sphere.

II. Atmospheric Pressure

A. Variation of Atmospheric Pressure The atmosphere stretches about 150 km above Earth's surface, but about 80% of the atmosphere's gases are found within 10 km. At the top of the atmosphere, pressure is almost nonexistent.

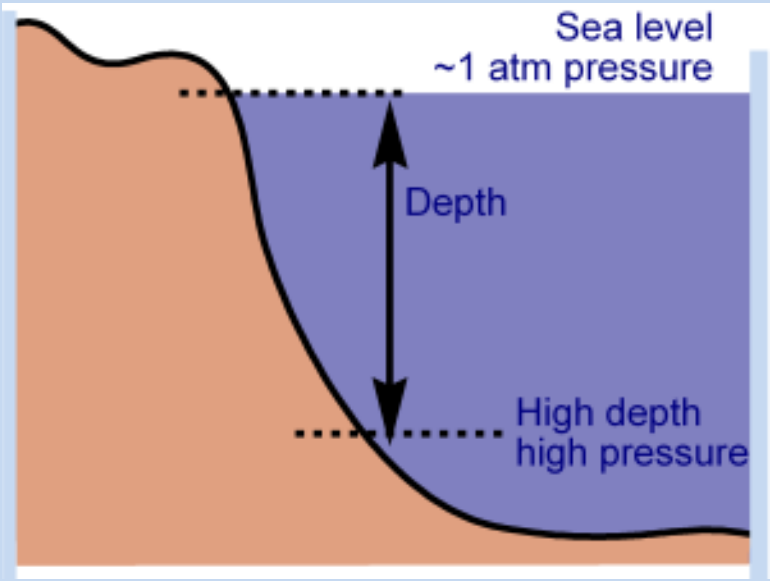
B. **Atmospheric Pressure and Depth** Notice how atmospheric pressure changes as you travel through the atmosphere. The further down through the atmosphere you go, the greater the pressure is.

C. Pressure Changes and Your Body If you travel to higher or lower points in the atmosphere, the fluids in your body have to adjust to maintain equal pressure.



III. Water Pressure

A. Water Pressure and Depth Like atmospheric pressure, water pressure depends on depth.

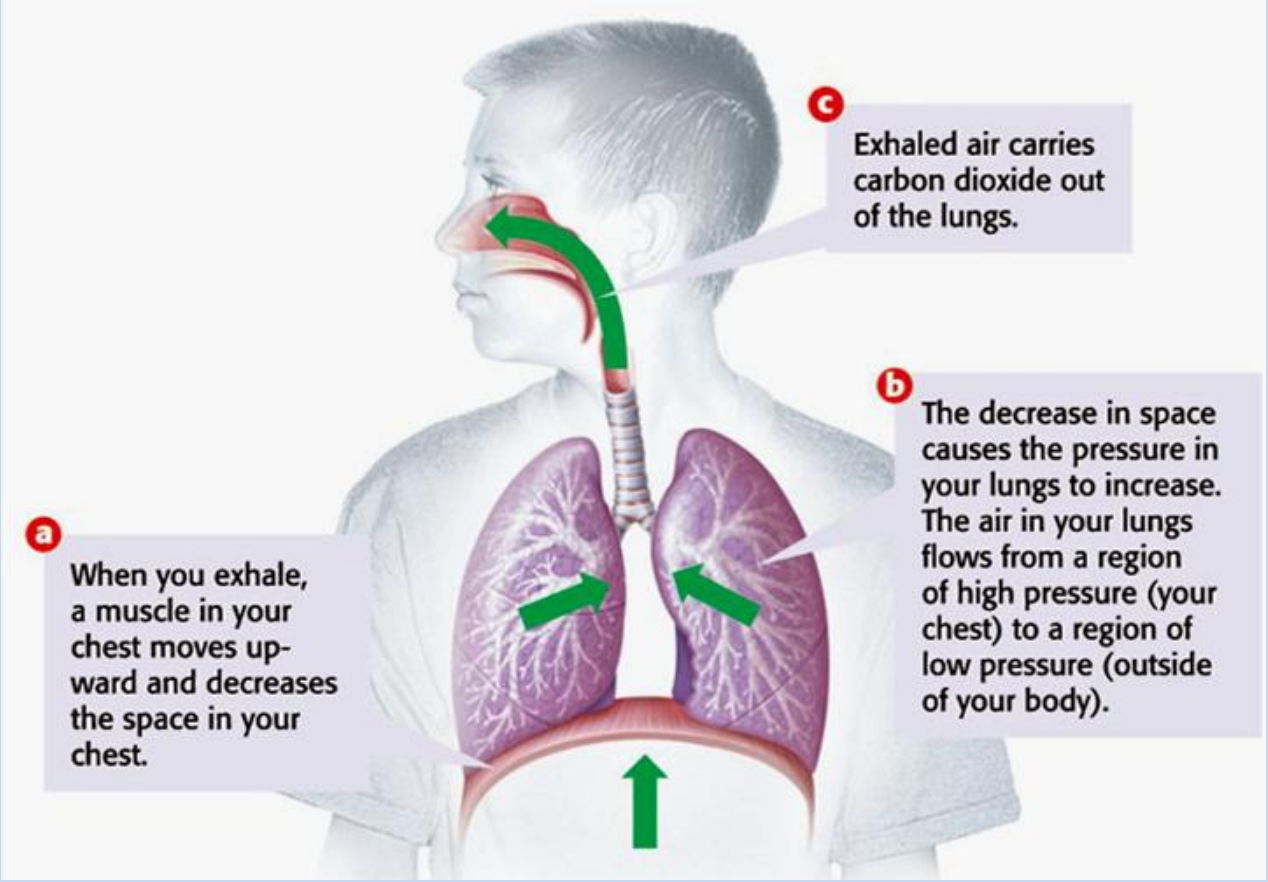


B. Density Making a Difference Because water is more dense than air, a certain volume of water has more mass—and weighs more—than the same volume of air.

IV. Pressure Differences

A. Pressure Differences and Breathing

Exhaling causes fluids to flow from high to low pressure.



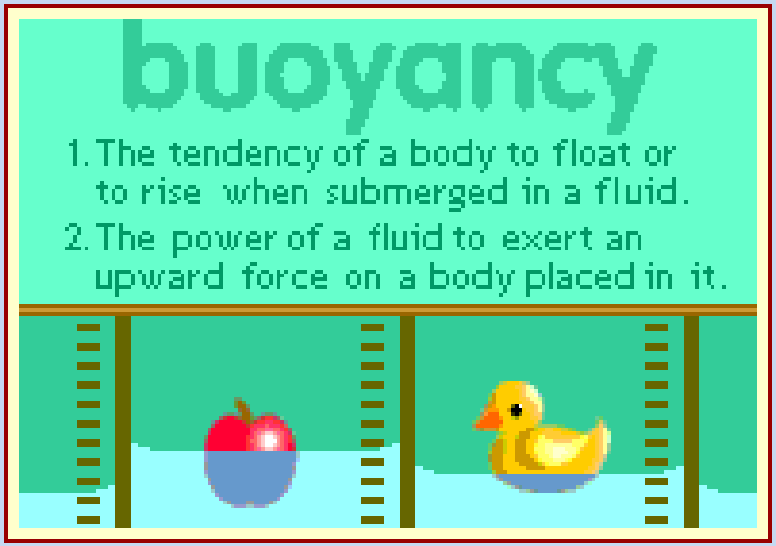
IV. Pressure Differences

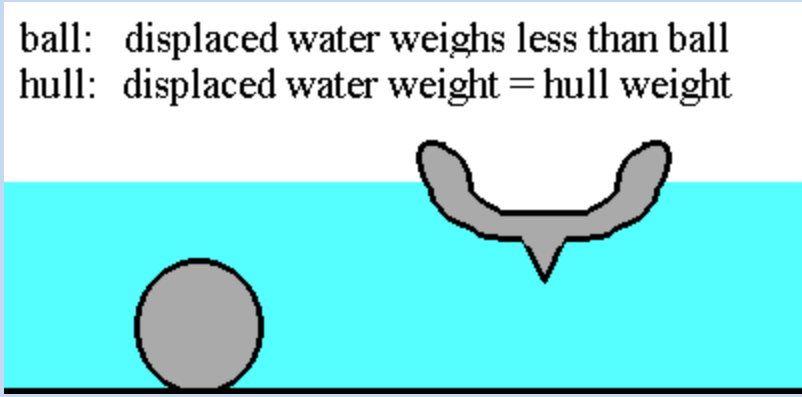
B. Pressure Differences and Tornadoes The air pressure inside a tornado is very low. Because the air pressure outside of the tornado is higher than the pressure inside, air rushes into the tornado.

V. Buoyant Force and Fluid Pressure

A. What Is a Buoyant Force? Buoyant force is the upward force that fluids exert on all matter.

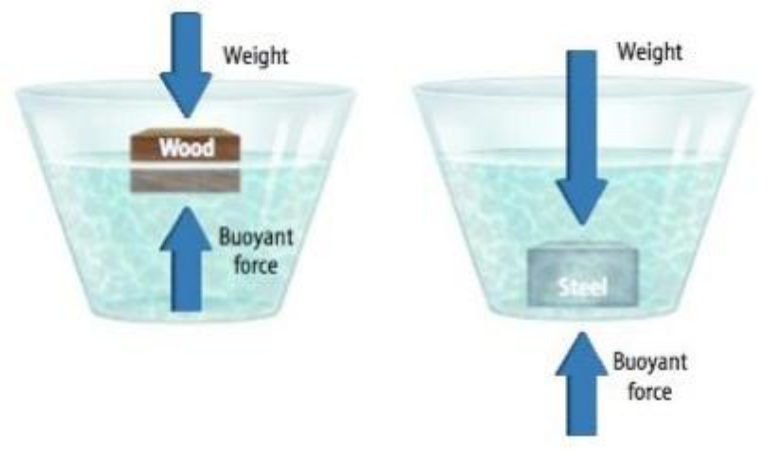
B. Determining Buoyant Force Archimedes' principle states that the buoyant force on an object in a fluid is an upward force equal to the weight of the fluid that the object takes the place of, or displaces.





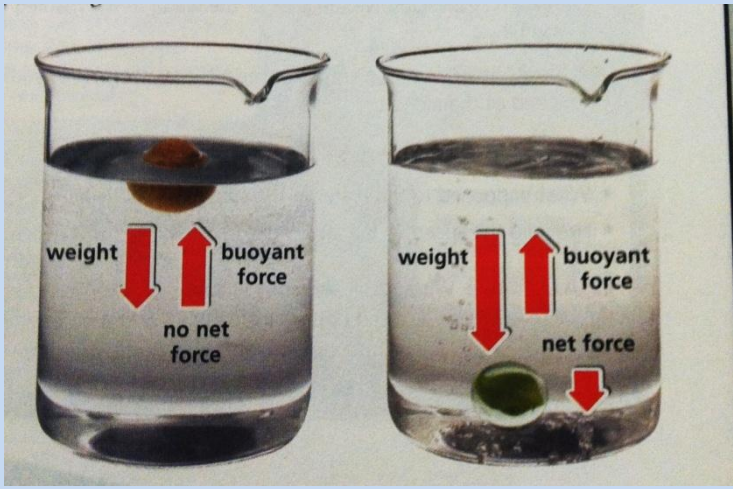
VI. Weight vs. Buoyant Force

A. Sinking Archimedes' principle says that the buoyant force is equal to the weight of the displaced water. If the an object weighs more than the weight of displaced water, it will sink.



B. **Floating** If an object's weight equals the weight of displaced water, it will float.

C. **Buoying Up** When the buoyant force on an object is greater than the object's weight, the object is *buoyed up* (pushed up)in water.



VII. Floating, Sinking, and Density

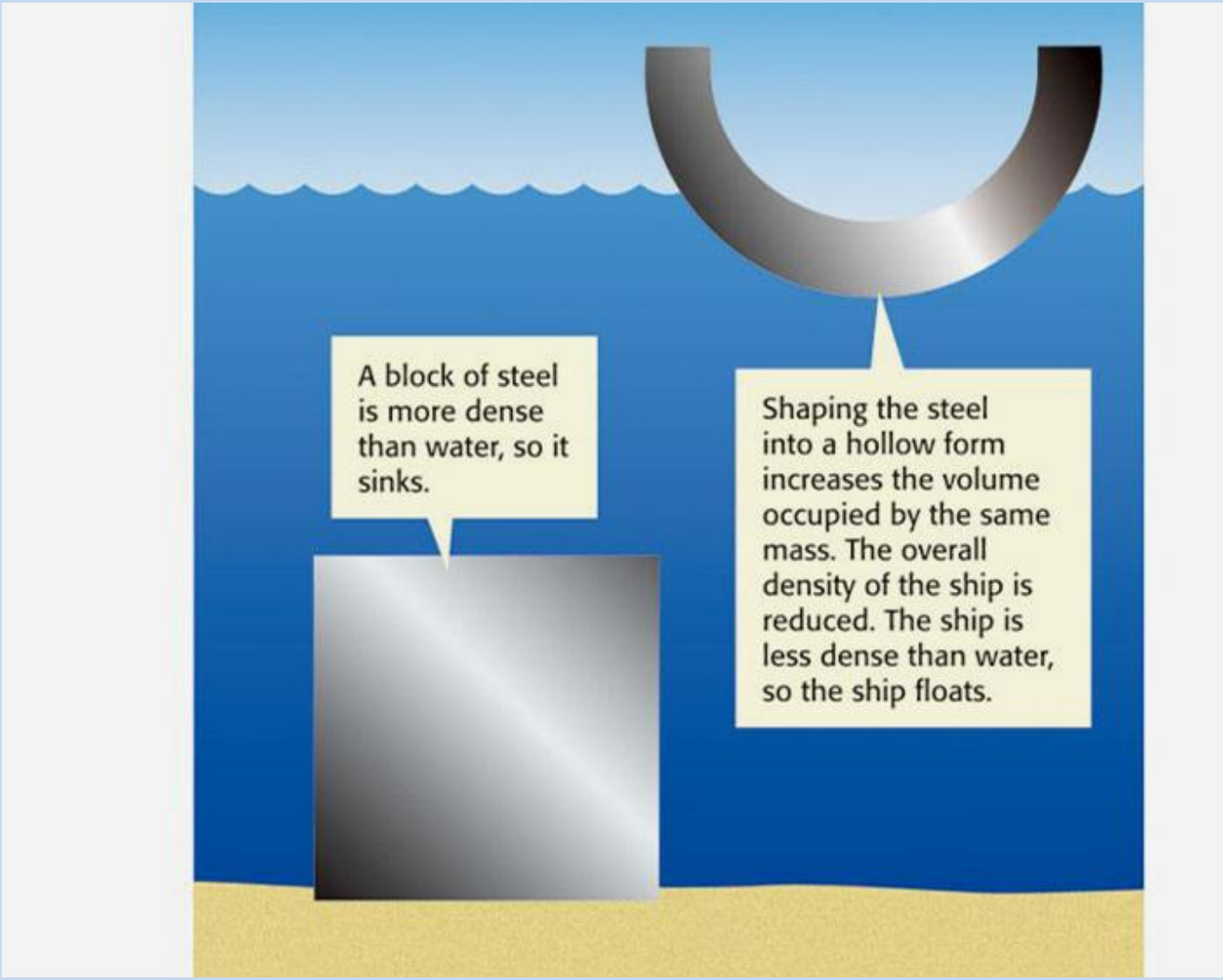
A. More Dense Than Air An ice cube floats on water because it is less dense than water. But most substances are *more* dense than air. So, there are few substances that float in air.

B. **Less Dense Than Air** One substance that is less dense than air is helium, a gas. In fact, helium is about 7 times less dense than air. A given volume of helium displaces an equal volume of air that is much heavier than itself. So, helium floats in air.

VIII. Changing Overall Density

A.

Changing Shape: The secret of how a ship floats is in the shape of the ship.



VIII. Changing Overall Density

B. Changing Mass A submarine is a special kind of ship that can travel both on the surface of the water and underwater.

C. **Changing Volume** Like a submarine, some fish adjust their overall density to stay at a certain depth in the water. Most bony fishes have an organ called a swim bladder, which helps them change volume.

When a submarine is floating on the ocean's surface, its ballast tanks are filled mostly with air.

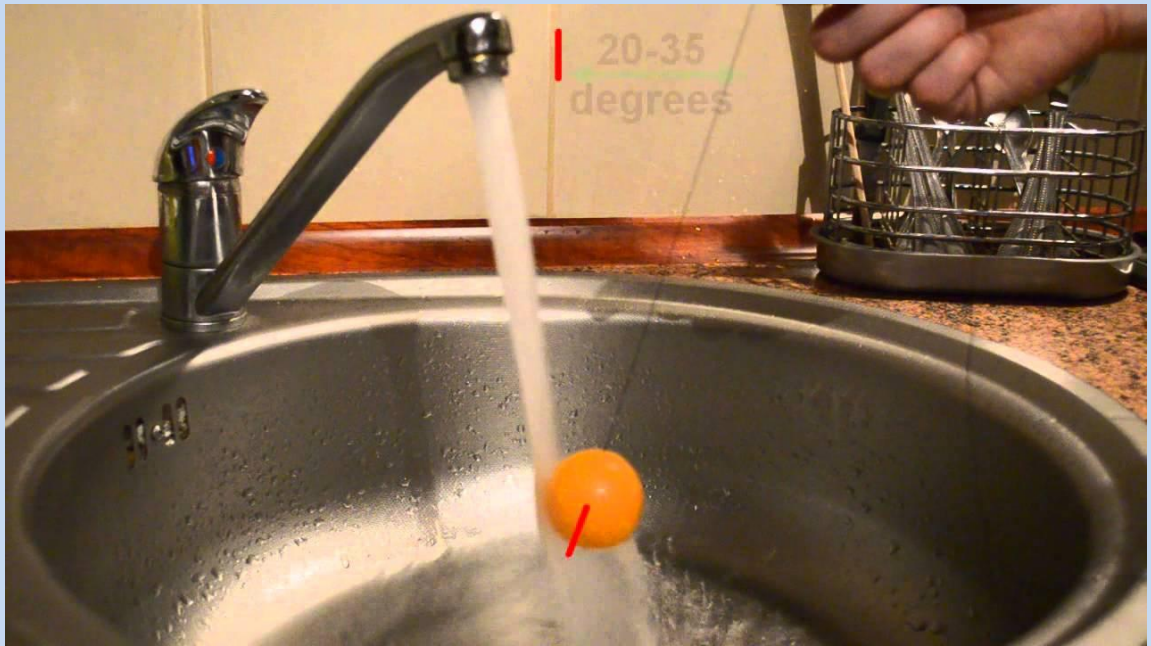
Vent holes on the ballast tanks are opened to allow the submarine to dive. Air escapes as the tanks fill with water.

Vent holes are closed, and compressed air is pumped into the ballast tanks to force the water out, so the submarine rises.

IX. Fluid, Speed, and Pressure

A. Bernoulli's Principle Bernoulli's principle states that as the speed of a moving fluid increases, the fluid's pressure decreases.

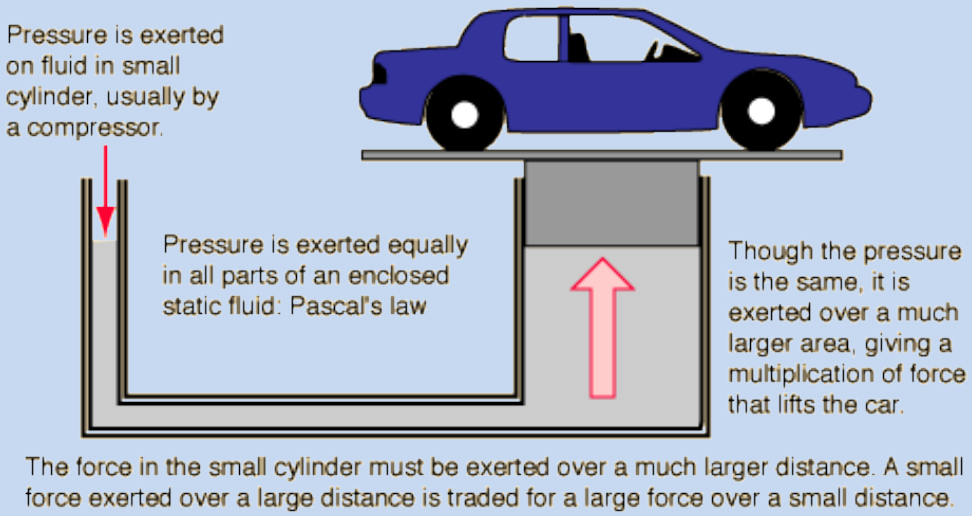
B. **Science in a Sink** A table-tennis ball is attached to a string and swung into a stream of water. Instead of being pushed out of the water, the ball is held in the water. Why? The water is moving faster than the air around it, so the water has a lower pressure than the surrounding air. The higher air pressure pushes the ball into the area of lower pressure—the water stream.



X. Pascal's Principle

A. What Is Pascal's Principle?
Pascal's principle states that a change in pressure at any point in an enclosed fluid will be transmitted equally to all parts of that fluid.

B. **Pascal's Principle and Motion** Hydraulic devices use Pascal's principle to move or lift objects. Liquids are used in hydraulic devices because liquids cannot be easily compressed, or squeezed, into a smaller space.



The force in the small cylinder must be exerted over a much larger distance. A small force exerted over a large distance is traded for a large force over a small distance.