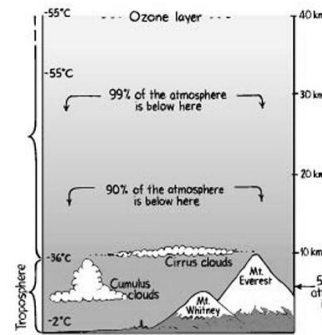


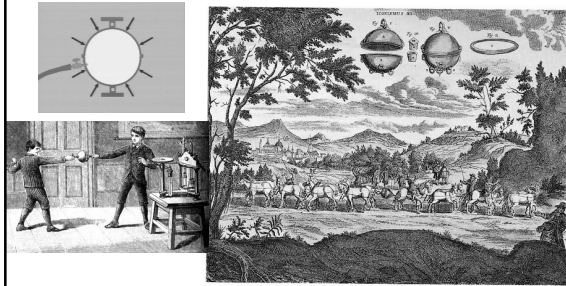
Gases and Plasmas

Earth's Atmosphere



- Balance of
 - ← Gravity
 - ← Energy
- More compressed at sea level than at higher altitudes
- Moon has no atmosphere

Magdeburg Hemispheres



- Two teams of horses couldn't pull the evacuated hemispheres apart.

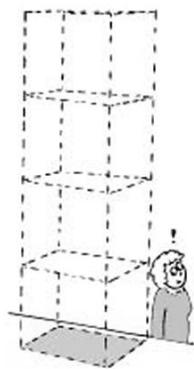
Weight of Air

- mass of air that would occupy a thin bamboo pole that extends 30 km up—to the "top" of the atmosphere—is about 1 kg.
- This air weighs about 10 N.



Weight of Air

- weight of air bearing down on a one-square-meter surface at sea level is about 100,000 N
- atmospheric pressure is about 10^5 N/m^2 , or about 100 kPa.
- At sea level, 1 cubic meter of air has a mass of about 1 1/4 kilograms



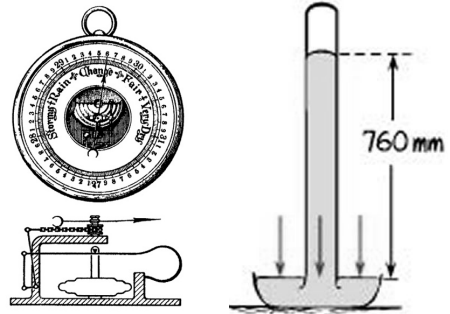
Check Yourself

- About how many kilograms of air occupy a classroom that has a 200-m² floor area and a 4-m-high ceiling? (Assume a chilly 10°C temperature.)

Check Yourself

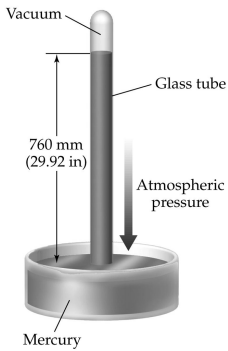
- Why doesn't the pressure of the atmosphere break windows?

Barometers



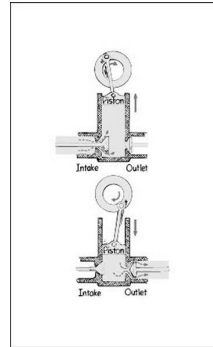
- Barometer - instrument for measuring atmospheric pressure

Mercury Barometer



- The barometer "balances" when the weight of liquid in the tube exerts the same pressure as the atmosphere outside
- Whatever the width of the tube, a 76-centimeter column of mercury weighs the same as the air that would fill a super-tall 30-kilometer tube of the same width
- mercury is literally pushed up into the tube of a barometer by the weight of the atmosphere.

Vacuum



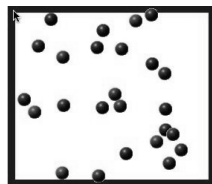
- air pressure is repeatedly lowered by piston and valve action
- best vacuums attainable with mechanical pumps are about 1 pascal.
- Better vacuums, down to 10^{-8} Pa, are attainable with vapor diffusion or vapor jet pumps.
- Sublimation pumps can reach 10^{-12} Pa. Greater vacuums are very difficult to attain

Gas Molecules

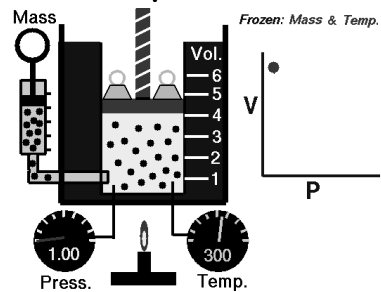
- Behavior of Gas Molecules
- Kinetic Theory Applet
- Gas molecules are perpetually moving



Robert Boyle (1627-1691)



Boyle's Law



$$P_1V_1 = P_2V_2$$

Check Yourself

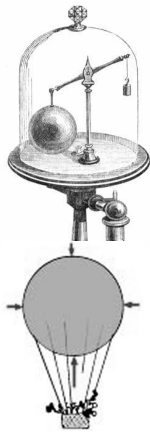
- A piston in an airtight pump is withdrawn so that the volume of the air chamber is increased three times. What is the change in pressure?

Check Yourself

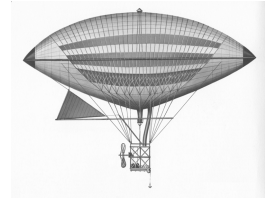
- A scuba diver 10.3 m deep breathes compressed air. If she were to hold her breath while returning to the surface, by how much would the volume of her lungs tend to increase?

Buoyancy of Air

- Archimedes' principle holds for air just as it does for water: An object surrounded by air is buoyed up by a force equal to the weight of the air displaced.
- a cubic meter of air at ordinary atmospheric pressure and room temperature has a mass of about 1.2 kilograms
- its weight is about 12 newtons
- any 1-cubic-meter object in air is buoyed up with a force of 12 newtons.



Dirigibles & Blimps



Hindenberg used hydrogen instead of helium

- Large dirigible airships are designed so that when loaded they will slowly rise in air
- their total weight is a little less than the weight of air displaced.

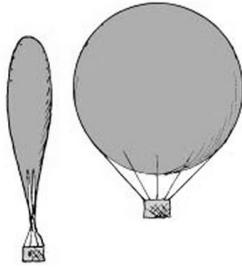
Check Yourself

- Is there a buoyant force acting on you? If there is, why are you not buoyed up by this force?

Check Yourself

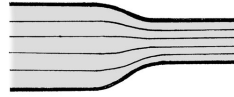
- How does buoyancy change as a helium-filled balloon ascends?

Rising Balloon



- (Left) At ground level the balloon is partially inflated.
- (Right) The same balloon is fully inflated at high altitudes where surrounding pressure is less.

Fluid Flow



Water speeds up when it flows into the narrower pipe.

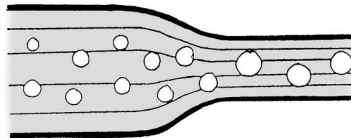
- The motion of a fluid in steady flow follows imaginary streamlines, represented by thin lines
- Streamlines are visible when smoke or other visible fluids are passed through evenly spaced openings, as in a wind tunnel.
- Streamlines are the smooth paths, or trajectories, of bits of fluid.
- One small bit of fluid follows along the same path as a bit of fluid in front of it
- The lines are closer together in narrower regions, where the flow speed is greater.

Bernoulli's Principle



Daniel Bernoulli
1700-1782

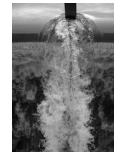
Where the speed of a fluid increases, internal pressure in the fluid decreases.



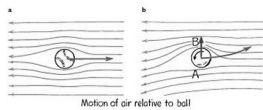
- Internal pressure is greater in slower moving water in the wide part of the pipe, as evidenced by the more squeezed air bubbles.
- The bubbles are bigger in the narrow part because internal pressure there is less.

Bernoulli's Principle

- Bernoulli's principle applies to a smooth, steady flow (called laminar flow) of constant-density fluid.
- At speeds above some critical point, however, the flow may become chaotic (called turbulent flow) and follow changing, curling paths called eddies.



Bernoulli Applications



(a) The streamlines are the same on either side of a non-spinning baseball.

(b) A spinning ball produces a crowding of streamlines. The resulting "lift" (red arrow) causes the ball to curve as shown by the blue arrow.

The vertical vector represents the net upward force (lift) that results from more air pressure below the wing than above the wing. The horizontal vector represents air drag.

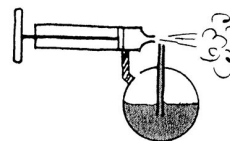


Air pressure above the roof is less than air pressure beneath the roof.



Wing lift

Bernoulli Applications



When you squeeze the bulb, air rushes across the open end of a tube that sticks into the perfume. This reduces pressure in the tube, whereupon atmospheric pressure on the liquid below pushes it up into the tube where it is carried away by the stream of air.

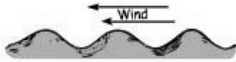


Pressure is greater in the stationary fluid (air) than in the moving fluid (water stream). The atmosphere pushes the ball into the region of reduced pressure.

Bernoulli Applications



The troughs of the waves are partially shielded from the wind, so air travels faster over the crests.



Pressure there is therefore lower than down below in the troughs.

The greater pressure in the troughs pushes water into the even higher crests.

Plasma

- Plasma - 4th phase of matter - electrified gas
- Least common in everyday world
- Most prevalent in the universe - stars
- Also found in gas inside operating
 - ← fluorescent light tubes
 - ← neon sign tubes
 - ← vapor lights
- MagnetoHydroDynamic Power