Chapter Ten: Properties of Matter

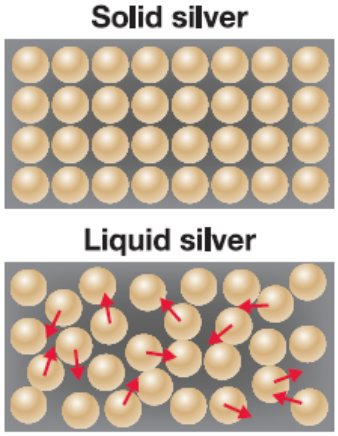
- 10.1 Density
- 10.2 Properties of Solids
- 10.3 Properties of Fluids
- 10.4 Buoyancy

Chapter 10.3 Learning Goals

- Explain how pressure is created in fluids.
- Discuss differences between the density of solids and fluids.
- Apply Bernoulli's principle to explain how energy is conserved in fluids.

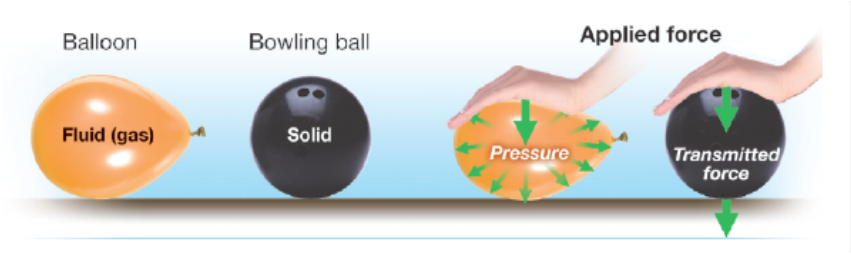
10.3 Properties of Fluids

- A fluid is defined as any matter that flows when force is applied.
- Liquids like water or silver are kinds of fluid.



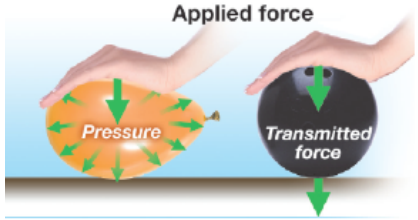
10.3 Forces in fluids

- Forces in fluids are more complicated than forces in solids because fluids can change shape.



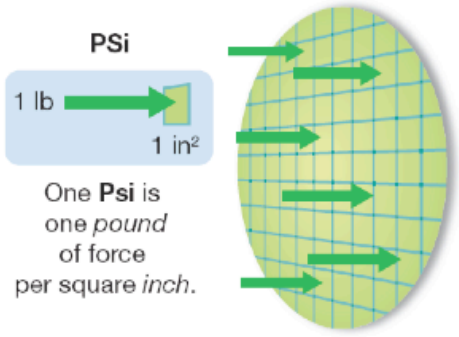
10.3 Pressure

- A force applied to a fluid creates pressure.
- Pressure acts in all directions, not just the direction of the applied force.



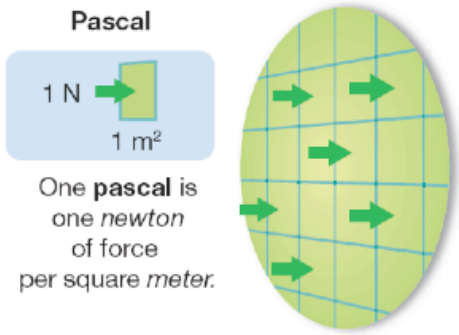
10.3 Units of pressure

- The units of pressure are force divided by area.
- One psi is one pound per square inch.



10.3 Units of pressure

- The S.I. unit of force is the pascal.
- One pascal (unit of force) is one newton of force per square meter of area (N/m^2).



Units of Pressure

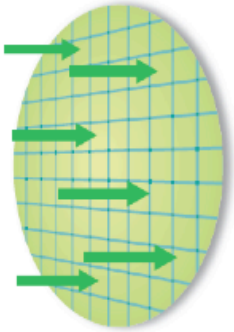
Pressure is force per unit of area.

PSi

1 lb

1 in^2

One **Psi** is one *pound* of force per square *inch*.

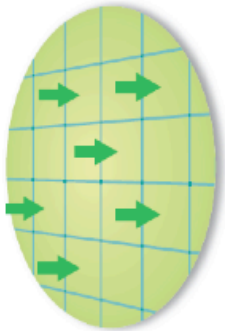


Pascal

1 N

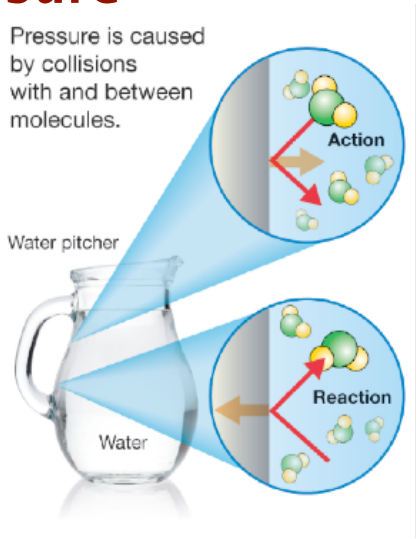
1 m^2

One **pascal** is one *newton* of force per square *meter*.

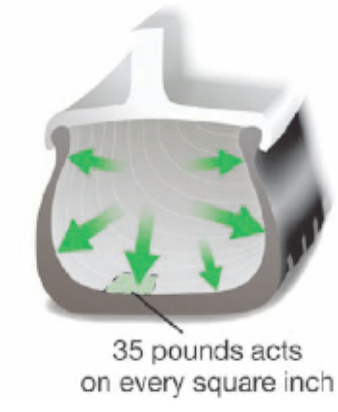


10.3 Pressure

- On the microscopic level, pressure comes from collisions between atoms.
- Every surface can experience a force from the constant impact of trillions of atoms.
- This force is what we measure as pressure.



10.3 Pressure

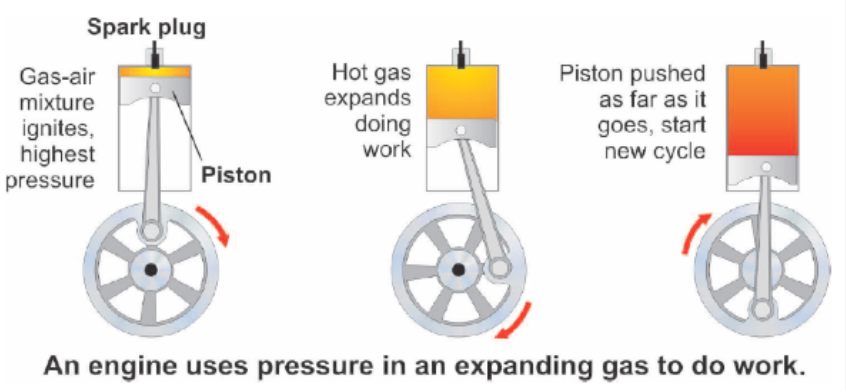


- If your car tires are inflated to 35 pounds per square inch (35 psi), then a force of 35 pounds acts on every square inch of area inside the tire.

What might happen if you over-inflate a tire?

10.3 Pressure

- In a car engine high pressure is created by an exploding gasoline-air mixture.



An engine uses pressure in an expanding gas to do work.

10.3 Energy conservation and Bernoulli's Principle

- Streamlines are imaginary lines drawn to show the flow of fluid.
- Bernoulli's principle tells us that the energy of any sample of fluid moving along a streamline is constant.

10.3 Bernoulli's Principle

Form of energy	Potential energy	Kinetic energy	Pressure energy	=	Constant along any streamline in a fluid
Variable	height	speed	pressure		

- Bernoulli's principle says the three variables of height, speed and pressure are related by energy conservation.

10.3 Three Variables and Bernoulli's Principle

Form of energy	Potential energy	Kinetic energy	Pressure energy	=	Constant along any streamline in a fluid
Variable	height	speed	pressure		

- If one variable increases along a streamline, at least one of the other two must decrease.
- For example, if speed goes up, pressure goes down.

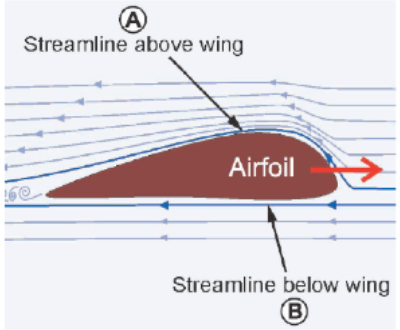
10.3 Bernoulli's Principle

Form of energy	Potential energy	Kinetic energy	Pressure energy	=	Constant along any streamline in a fluid
Variable	height	speed	pressure		

- **Bernoulli's principle says the three variables of height, speed and pressure are related by energy conservation.**

10.3 The air foil

- One of the most important applications of Bernoulli's principle is the airfoil shape of wings on a plane.



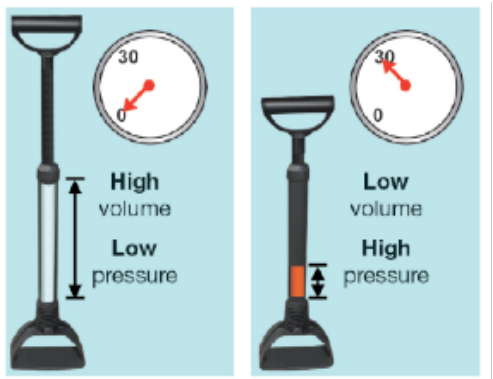
- When a plane is moving, the pressure on the top surface of the wings is lower than the pressure beneath the wings.
- The difference in pressure is what creates the lift force that supports the plane in the air.

10.3 Boyle's Law

- When you squeeze a fixed quantity of gas into a smaller volume the pressure goes up.
- This rule is known as Boyle's law.

10.3 Boyle's Law

- The formula for Boyle's law relates the pressure and volume of gas.
- If the mass and temperature are kept constant, the product of the pressure multiplied by the volume stays the same.



Solving Problems: Boyle's Law

BOYLE'S LAW

Initial volume — New pressure

Initial pressure — $P_1V_1 = P_2V_2$ — New volume

Mass and temperature remain constant

Solving Problems

A kit used to fix flat tires consists of an aerosol can containing compressed air and a patch to seal the hole in the tire.

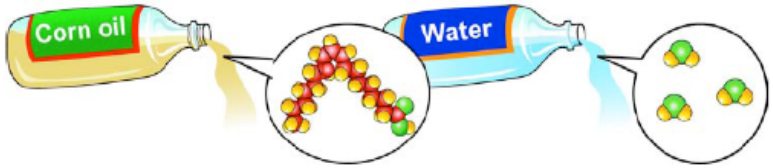
Suppose 5 liters of air at atmospheric pressure (1 atm) is compressed into a 0.5 liter aerosol can. What is the pressure of the compressed air in the can?

Assume no change in temperature or mass.

Solving Problems

1. **Looking for:**
   - …final pressure in atmospheres (P_2)
2. **Given**
   - …V_1 = 5 L , P_1= 1 atm, V_2 = .5 L
3. **Relationships:**
   - Boyle's Law: $P_1V_1 = P_2V_2$
4. **Solution**
   - Rearrange equation so $P_2 = P_1V_1 / V_2$
   - P_2 = 1atm x 5.0 L/ 0.5 L = **10 atm.**

10.3 Viscosity



- **Viscosity** is the property of fluids that causes friction.
- Viscosity is determined in large part by the shape and size of the particles in a liquid.

10.3 Viscosity and temperature

- As the temperature of a liquid increases, the viscosity of a liquid decreases.
- Increasing the kinetic energy of the substance allows the particles to slide past one another more easily.

Investigation 10B

Buoyancy

- **Key Question:**
  Can you make a clay boat?