Chapter 8-2

Pressure

Equation

Pressure = Force / Area

$P = F / A$

Area = pi r^2

SI unit – is the pascal (Pa)

1 Pa = $1 N/m^2$

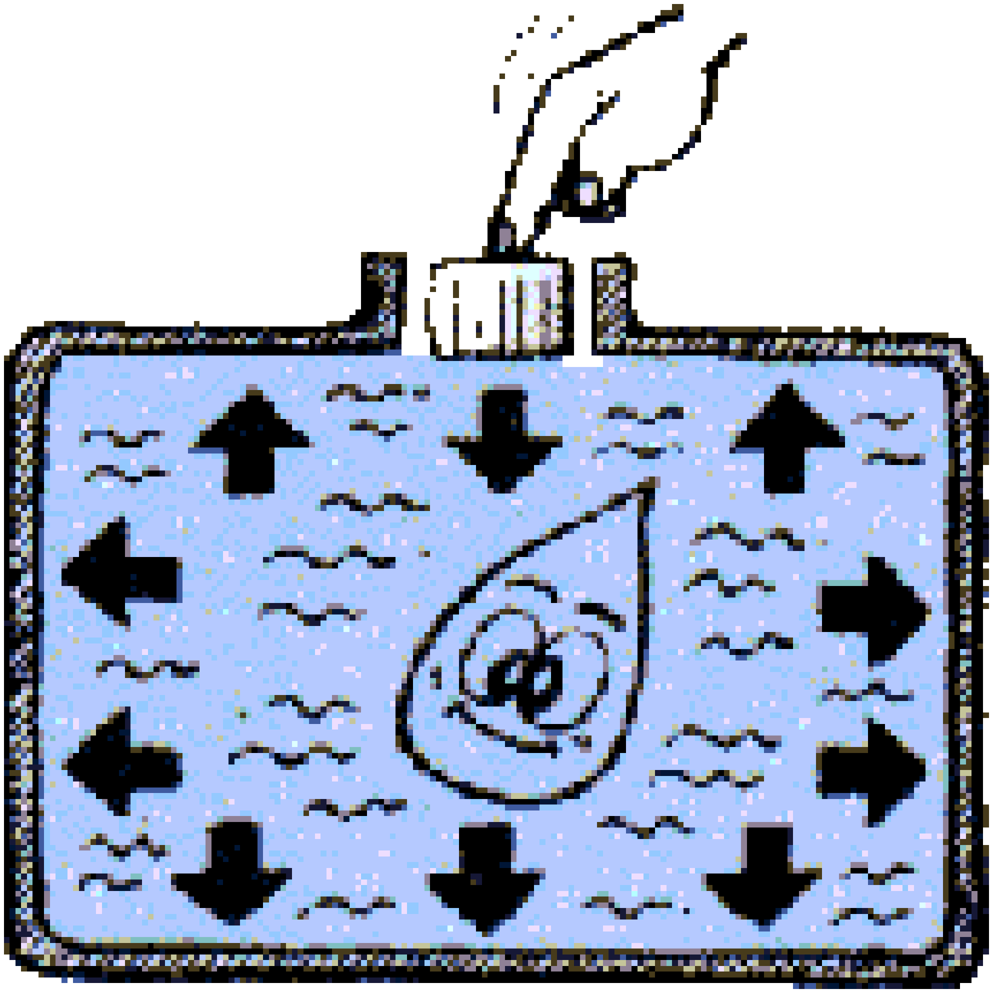
Atmosphere pressure at sea level=$1.01 x 10^5$

Bottomless Bottle Demo

Pascal's Principle

Pascal's Principle – Pressure applied to a fluid in a closed container is transmitted equally to every point of the fluid and to the walls of the container.

$$P = F_1/A_1 = F_2/A_2$$



In a car lift, compressed air exerts a force on a piston with a radius of 10 cm. This pressure is transmitted to a second piston with a radius of 15 cm. How large a force must the compressed air exert to lift a 330 N car?

Atmospheric Pressure

- Atmospheric Pressure is pressure from above. The weight of the air in the upper atmosphere exerts a pressure on the layers below.
- Kinetic Theory of gases describes the origin of gas pressure. Gas particles are like a collection of billiard balls that constantly collide with one another.
- As they collide with the wall, they exert a force and this force per unit area is the gas pressure.

Pressure and Depth

Absolute pressure = atmospheric pressure + (density x gravity x depth)

$$P = P_{atm} + Dgh$$

Temperature

- Kinetic theory predicts that temperature is proportional to the average kinetic energy of the particles in a gas.
- The higher the temperature, the faster the particles move.
- As the speed of the particles increase, the amount they hit the wall increases resulting in a higher force and therefore a higher pressure.
- Therefore, temperature and pressure are related.

Assignment

Unit 8.2 Worksheet

Chapter 8-3 and 8-4

Fluid Flow and Gas Laws

Streamline

Laminar – if every particle that passes a particular point moves along the same smooth path. Also called **streamline**.

Different streamlines cannot cross each other.

At any point in a streamline flow, the direction and velocity of the fluid is the same throughout.

Turbulent

- Turbulent – the flow of a fluid becomes **irregular** above a certain velocity or under conditions that can cause abrupt changes such as obstacles or sharp turns.
- Irregular motions of the fluid, called **eddy currents**, are characteristic of turbulent flows.

Viscosity

The term viscosity refers to the amount of **internal friction** within a fluid.

Internal friction occurs when layers of fluid slides past another layer.

A fluid with a high viscosity flows more slowly through a pipe than does a fluid with a low viscosity.

Ideal Fluid

- Ideal fluids are considered nonviscous, so they don't lose kinetic energy due to friction as they flow.
- Ideal fluids are considered steady flow. The velocity, density, and pressure at each point are constant.
- The flow is nonturbulent, which means no eddy currents.

Continuity / Flow Rate Equation

Area x speed in region 1 = area x speed in region 2 =

$A_1v_1 = A_1v_2$

Bernoulli's Principle

- The speed of fluid depends on cross sectional area.
- The pressure in a fluid is related to the speed of flow.
- Bernoulli's principle – The pressure in a fluid decreases as the fluid's velocity increases.

Bernoulli’s Balloon Demo

Lift on an Airplane

The lift on an airplane wing can be explained with Bernoulli's Principle.

Airplane wings are designed to direct the flow of air so that the air speed above the wing is greater than the air speed below the wing.

This makes the air pressure above the wing less than the pressure below which creates and upward force called lift.

Bernoulli's Equation

- Pressure$_1$ + ½ density x velocity$_1^2$ + density x gravity x height$_1$ = Pressure$_2$ + ½ density x velocity$_2^2$ + density x gravity x height$_2$

$$P_1 + \tfrac{1}{2} Dv_1^2 + Dgh_1 = P_2 + \tfrac{1}{2} Dv_2^2 + Dgh_2$$

2. A liquid with a density of 1650 kg/m3 flows through two horizontal sections of tubing joined end to end. In the first section, the area is .01 m2, the flow speed is 2 m/s, and the pressure is 1.2 x 105 Pa. In the second section, the area is .05 m2. The height is constant. Calculate the flow speed in the smaller section and the pressure in the smaller section.

Ideal Gas Law Equation

- Pressure x volume = number of gas particles x Boltzmann's constant x temperature
- $PV = nk_BT$
- $k_B = 1.38 \times 10^{-23}$ J/K
- The temperature must be expressed in Kelvin only.

Units

- SI units for temperature are Kelvins (written K).
- To convert from Celsius to Kelvin, add 273.
- Room temperature is about 293 K.

Ideal Gas Law Equation 2

If the number of gas particles are constant, the initial and final state of the gas are:

$N_1 = N_2$ then,

$(P_I V_I)/T_I = (P_F V_F)/T_F$

Assignment

8.3 and 8.4 Worksheet