Al-Mustaqbal University Colleg
Medical Physics Department

General Physics/ lecture 6

First stage

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Lecture 6

Outline

- **Fluid properties**
- **Pressure.**
- **Viscosity.**
- **Surface tension.**

Fluid properties

- A fluid ***is a collection of molecules that are randomly arranged and held together by weak cohesive forces and by forces exerted by the walls of a container.*** المائع أي مادة قابلة للانسياب تحت تأثير إجهاد القص وتأخذ شكل الإناء الحاوي لها. الموائع اسم شامل للسوائل والغازات
- The force exerted by a static fluid on an object is always ***perpendicular*** to the surfaces of the object**.**
- Fluid properties: ***pressure***, ***viscosity***, ***surface tension.***

Pressure

- Density is ***mass per unit volume.*** ***الكثافة هي كتلة وحدة الحجوم***

$$Density = \rho = mass/volume$$

- Typical units are: ***Kg/m³, g/cm³***
- Relative density, or specific gravity ***is the density of a material relative to density of water and is a ratio with no units.***

$$\text{Specific gravity} = \frac{\text{Density of the object}}{\text{Density of water}} = \frac{\rho_{object}}{\rho_{H_2O}}$$

Example (1)

A 250 cm^3 bottle of oil has a net mass of 189 g. Calculate the density and relative density of the oil and state whether the oil will float or sink in water?

Solution:

Mass, m = 189 g

Volume, V = 250 cm^3

$$Density = \frac{Mass}{Volume}$$

$$\rho = \frac{m}{V}$$

$$\rho = \frac{189\ g}{250\ cm^3}$$

$$\therefore \rho = 0.756\ g/cm^3$$

$$Relative\ Density = \frac{Density\ of\ Oil}{Density\ of\ Water}$$

$$Relative\ Density = \frac{0.756\ g/cm^3}{1\ g/cm^3}$$

$$Relative\ Density = 0.756$$

Since, 0 < Relative Density < 1; the oil will float in water.

Example (2)

A mechanical pencil has a density of 3 grams per cubic centimeter. The volume of the pencil is 15.8 cubic centimeters. What is the mass of the pencil in kilo grams?

Solution:

Density, $\rho = 3\ g/cm^3$

Volume, $V = 15.8\ cm^3$

$$Density = \frac{Mass}{Volume}$$

$$Mass = Density \times Volume$$

$$m = \rho \times V$$

$$m = 3\ g/cm^3 \times 15.8\ cm^3$$

$$m = 47.4\ g$$

Convert 47.4 g to kg

$$1\ 000\ g = 1\ kg$$

$$1\ g = \frac{1}{1\ 000}\ kg$$

$$47.4 \times 1\ g = 47.4 \times \frac{1}{1\ 000}\ kg$$

$$47.4\ g = 0.0474\ kg$$

- Density of a material is a function of temperature
  - ✓ In general, density decreases with increasing temperature.
  - ✓ Volume per unit weight increases with increasing temperature.
  - ✓ ***Thermal expansion*** is the name for this effect of temperature on density.
  - ✓ ***Types of Thermal expansion:***
    1. Linear thermal expansion (thermal expansion in one dimension)
    2. Area thermal expansion (thermal expansion in two dimension)
    3. Volume thermal expansion (thermal expansion in three dimension)

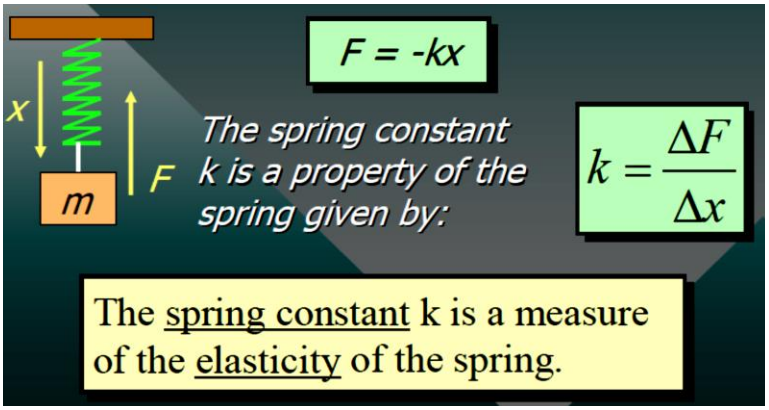
Elasticity المرونة

- Elasticity: ***ability of a deformed material body to return to its original shape and size when the forces causing the deformation are removed***.

- Modulus of elasticity ***the ratio of the stress in a body to the corresponding strain***
- There are three types of modulus of elasticity, ***Young's modulus***, ***Shear modulus***, and ***Bulk modulus***.
- A spring is an example of an elastic body that can be deformed by stretching.

Hooke's Law

When a spring is stretched, there is a restoring force that is proportional to the displacement.



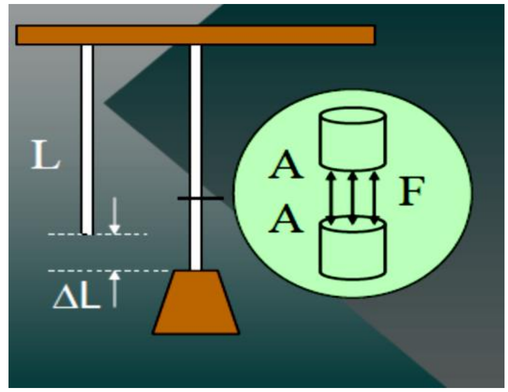
Stress and Strain

- Stress ***is the ratio of an applied force F to the area A***

$$Stress = \frac{F}{A} \qquad Units: \ \mathrm{Pa} = \frac{\mathrm{N}}{\mathrm{m}^2} \ \text{or} \ \frac{\mathrm{lb}}{\mathrm{in.}^2}$$

- Strain is ***the relative change in the dimensions or shape of a body as the result of an applied stress.***

$$Strain = \frac{\Delta L}{L}$$



Example 1. A steel wire 10 m long and 2 mm in diameter is attached to the ceiling and a (200 N) weight is attached to the end. What is the applied stress?

First find area of wire:

$$A = \frac{\pi D^2}{4} = \frac{\pi\ (0.002\ m)^2}{4}$$

$$A = 3.14 \text{ x } 10^{-6}\ \text{m}^2$$

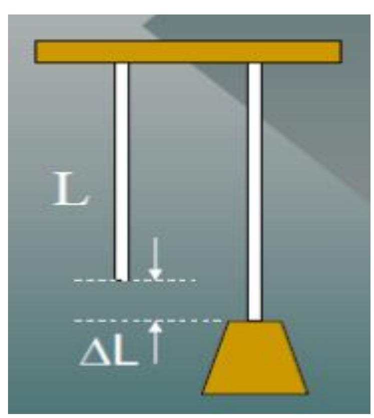
$$\text{Stress} = \frac{F}{A} = \frac{200\ \text{N}}{3.14\ \text{X}\ 10^{-6}\text{m}^2} = 6.37\ \text{x}10^{7}\ \text{Pa}$$

Example 2: 10 m steel wire stretches 3.08 mm due to the 200 N load. What is the longitudinal strain?

$L = 10$ m, $\Delta L = 3.08$ mm

Strain = $\Delta L / L = 0.00308$ m/ 10m

$= 308 \text{ x } 10^{-4}$



❖ An elastic deformation (strain) is directly proportional to the magnitude of the applied force per unit area (stress).

$$Modulus\ of\ Elasticity = \frac{stress}{strain}$$

Example 3. The stress applied to the steel wire was 6.37 x 10^7 Pa and the strain was 3.08 x 10^{-4} find the modulus of elasticity for steel.

Modulus of Elasticity = $\frac{\text{stress}}{\text{strain}} = \frac{6.37 \text{ x } 10^7 \text{ Pa}}{3.08 \text{ X } 10^{-4}}$ = 207 x 10^9 Pa