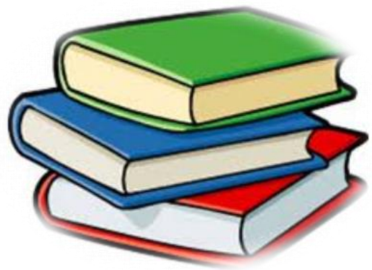
Physics



Chapter 1

1-The main definitions:-

Displacement: The distance of the vibrating body at any instant from its rest or equilibrium position.

Amplitude (A): The maximum displacement of the vibrating object from rest position , or the distance between two points along the path of the object , where the velocity at one point is maximum and zero at the other .

Frequency (U): The number of complete vibrations made by the vibrating Body in one second .

Periodic Time (T): The time taken by the vibrating body to make one Complete vibration. Or the time taken by the vibrating body to pass by a certain point on its path twice successively in the same direction .

Simple harmonic motion: It is is the simplest form of vibrational motion in straight line .

Waves are disturbance that spread and carry along energy .

There are two types of waves :

a) **Mechanical Waves**: these are a disturbance transmitted from the source to the all parts of the medium. Water and sound waves are examples of Mechanical waves .

b) Electromagnetic Waves: These are generating due to vibrating Electromagnetic fields, where no medium is required (can propagate in Vacuum and in medium but with different velocities.

There are two types of mechanical waves:

a) **Longitudinal waves:** The waves in which the particles of the medium Oscillate about their equilibrium positions along the direction of

Propagation of the wave. It is consisted of compressions and rarefactions .

b) Transverse waves: The waves in which the particles of the medium Oscillate about their rest positions in a direction perpendicular to the Direction of propagation of the wave. It is consisted of crests and troughs .

Crest: The point of maximum displacement upwards in the (+ve) direction .

Trough: The point of maximum displacement downwards in the (-ve).Direction.

The wavelength: The distance between two successive crests or two Successive troughs .

II) The main laws :

a) The relation between the frequency (∪) and the periodic time (T):

$$\nu = \frac{1}{T}$$

b) The relation between frequency (V), wavelength (λ) and velocity of propagation (V):

$$\nu = \frac{\lambda}{T} = \lambda\nu$$

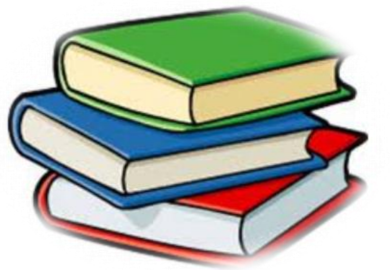
c) The relation between frequency (v), wavelength (λ) at constant velocity of Propagation (V):

$$\therefore \frac{\nu_1}{\nu_2} = \frac{\lambda_2}{\lambda_1}$$

<u>III) Give reasons for:</u>

1. If you move a water in container by using wooden sticks, transverse Waves on the surface of the water are produced, while longitudinal Waves at the bottom

The particles on the surface oscillate up ward and down ward Perpendicular to the direction of propagation. This means that they Produce transverse wave due to the strong cohesive force between these



Particles on the surface. The deep particles in the water have weak Cohesive force and they can oscillate in the same direction of Propagation. Therefore, they produce longitudinal wave.

2. As the frequency of the wave increases its wavelength decreases (Assume constant velocity of propagation).

This is because the frequency is inversely proportional to the Wavelength ($2 \propto \frac{1}{\lambda}$).

3. Electromagnetic waves do not need medium to be transferred.

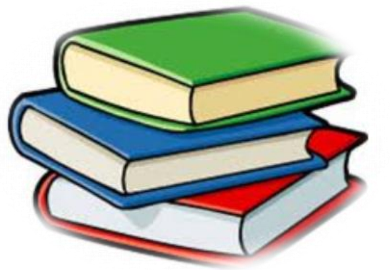
This is because electromagnetic waves are generated due to vibrating Electric and magnetic fields, not due to vibrating medium particles like in Case of mechanical waves.

4. Sound waves propagate in gases as longitudinal waves.

This because cohesive force between gas molecules are very small due to The far distance in between. Therefore as the source vibrate it will stress On the near molecules then moving away producing rarefaction i.e. Longitudinal wave.

5. Sound waves propagate in solid and liquids as transverse waves.

This because cohesive force between gas molecules is strong due to the Near distance in between.



Problems

Ex1: If the wavelength of sound waves emitted from certain source is 0.5m and its frequency 666 Hz, calculate the propagation velocity of sound in air.

Solution :-

$$V = \mathcal{V} \times \lambda = 666 \times 0.5 = 333 \text{ m/sec}$$

Ex2: If the sound velocity in air 340 m/sec , Calculate the wave length of sound wave that has a frequency 255 Hz

Solution :-

$$\lambda = \frac{V}{\nu} = \frac{340}{255} = \frac{4}{3} \text{ m}$$

Ex3: Light wave has a wavelength 6000 A° propagates in the free space with velocity 300000 Km / sec. Calculate the frequency (1A° = 10^{-10} m)

Solution :-

$$\mathbf{V} = \frac{V}{\lambda} = \frac{300000 \times 1000}{6000 \times 10^{-10}} \quad 5 \times 10^{14} \text{ Hz}$$

Ex4: Two waves have frequencies 512 Hz and 256 Hz in certain medium. Calculate the ratio between their wavelengths.

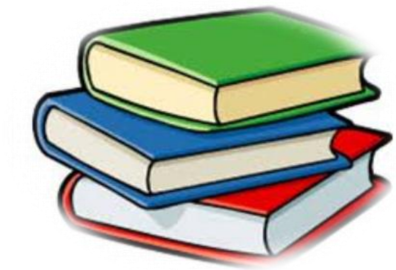
Solution :-

$$\frac{\lambda_1}{\lambda_2} = \frac{V_2}{v_1} = \frac{256}{512} = \frac{1}{2}$$

Ex5: Transverse waves have propagated in a thin wire with velocity 600m/sec. If the distance between two successive crests equals 3m, calculate the frequency of these waves.

Solution :-

$$\text{v} = \frac{V}{\lambda} = \frac{600}{3} \quad 200 \text{ Hz}$$



Chapter 2

(I) Definitions:

1) **Reflection:** The rebound (return back) of the light waves to the same medium when they meet a reflecting surface (interface between two media of different optical density).

2) **Laws of Reflection**

i. The angle of incidence is equal the angle of reflection.

ii. The incident ray, the reflected ray and the normal to the reflecting surface at the point of incidence all lie in one plane normal to the reflecting surface.

3) **Refraction:** The change in the path of the light ray when passes from a medium to another medium of different optical density.

4) **Laws of refraction:**

i. The ratio between the sine of the angle of incidence in the 1st medium (φ) to the sine of angle of refraction in the 2nd medium (θ) is equal to the ratio between the speed of light in the two media.

ii. The incident ray, the refracted ray and the normal to the separating surface (interface) at the point of incidence all lie in one plane perpendicular to the separating surface.

5) **Relative Refractive index ($_1n_2$):** The ratio between the Speed of light in the 1^{st} medium to the speed of light in the 2^{nd} medium.

6) **Absolute Refractive Index for A medium (n):** The ratio between the speed of light in space (or air) to the speed of light in this medium.

$$n = \frac{c}{V}$$

7) **Total internal reflection:** When a light ray travels from an optically dense medium (water or glass) to a less dense medium (air), then the refracted ray bends away from the normal.

8) **Critical Angle (φc):** The angle of incidence in the denser medium corresponds an angle of refraction in the less dense medium equals 90^o.

9) **Angular dispersion:** It is the difference between the minimum deviation of the blue color and red color in a thin prism.

10) **Interference:** The combinations of separate waves in the same region of space have the same frequency, amplitude and phase (Coherent sources) to produce a resultant wave.

11) **Coherent Source:** Light sources emit light waves have equal frequency and amplitude and have the same phase.

12) **Diffraction:** A change (bending) in the path of light waves when passing through a small slit (or an aperture) compared to the wavelength, or when passing by sharp edges in the same medium.

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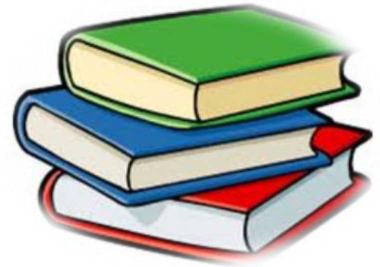
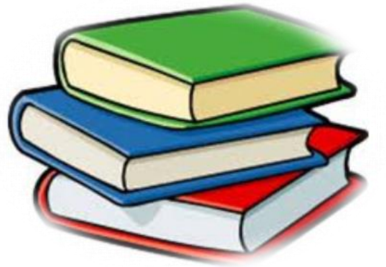


(II) The main formulas (laws):

• **Relative Refractive index** $${}_1n_2 = \frac{\sin\varphi}{\sin\theta} = \frac{V_1}{V_2}$$ • **Absolute Refractive Index &Critical angle for A medium** $$sin\varphi_c = \frac{1}{n_1}$$ • **The angle of deviation in thin prism:** $$\alpha_o = A(n-1)$$ • **The dispersion power:** $$\omega_\alpha = \frac{(\alpha_o)_b-(\alpha_o)_r}{(\alpha_o)_y} = \frac{n_b-n_r}{n_y-1}$$ • **The distance between 2 successive fringes:** $$\Delta y = \frac{\lambda R}{d}$$	• **Absolute Refractive Index for A medium** $$n = \frac{c}{V}$$ • **The angle of deviation in a prism:** $$\hat{\alpha} = \widehat{\varphi_1} + \widehat{\theta_2} - A$$ • **The Apex angle:** $$\therefore \hat{A} = \widehat{\theta_1} + \widehat{\varphi_2}$$ • **At minimum angle of division:** $\varphi_1 = \theta_2 = \varphi_o$ $\theta_1 = \varphi_2 = \theta_o$ $$n = \frac{\sin(\frac{\alpha_o + A}{2})}{\sin(\frac{A}{2})}$$ • **Angular dispersion** $$\alpha_o = A(n-1)$$



(III) **<u>Give the reason for</u>:**

(1) Theabsolute refractive index for medium always larger than one.

This is because speed of light in vacuum is larger than that in any medium $(n = \frac{c}{V})$. Since C>V then n>1.

(2) The relative refractive index between two media may lower than one.

Since ${}_1n_2 = \frac{n_2}{n_1}$ and n_2 may larger or smaller than n_1, therefore ${}_1n_2$ *may lower than one*.

(3) As light penetrates through double narrow slit, bright and dark fringes are observed on suitable distance screen.

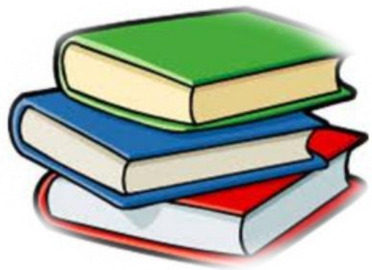
This is because constructive interference between two waves have the same amplitude, wavelength and have same phase may occur to produce bright fringe at certain regions on the screen while destructive interference will occur between out of phase waves to produce dark fringes.

(4) In young double slit experiment the fringes become more clear (more separate) as the slits separation decrease.

Since the fringes separation $\Delta y = \frac{\lambda R}{d}$, as (d) decreases Δy will increases, then the fringes will be more resolved (separated).

(5) Optical fibers are used to transmit light and direct it to the regions inside the body.

As light entering the optical fiber at one end, the angle of incident at any part of the wall of the fiber always lager than the critical angle. Therefore multi total internal reflection occurred till the light emerging from the other end. Optical fibers can bend easily to be used in endoscopes.



(6) When the prism at the minimum angle of deviation, the angle of refraction θ_1 equals the second angle of incident φ_2.

$$n = \frac{\sin\varphi_1}{\sin\theta_1} = \frac{\sin\theta_2}{\sin\varphi_2}$$

At minimum angle of deviation $\varphi_1 = \theta_2$ and $\theta_1 = \varphi_2$

(7) To resolve white light into its seven components, the prism should be at the minimum deviation condition.

This is because at the minimum deviation condition the dispersion angle is small so we can see all colors in limited region.

(8) The deviation angle for violet light is larger than that for red light at the minimum angle of deviation.

The deviation angle is directly proportional to the refractive index which is inversely proportional to the wavelength. Therefore violet has smallest wavelength and large refractive index and large deviation angle.

(9) Glass parallel rectangles cannot resolve white light into its components.

Because incident white light on one face of glass parallel rectangles will twice refracted on the two opposite faces, and light will emerges parallel to its the incident direction.

Example (1): Find the critical angle for an air–water boundary. (Assume the index of refraction of water is 1.33.)

Solution

$$\because \boldsymbol{sin\varphi_c} = \frac{\mathbf{1}}{\boldsymbol{n_1}} = \frac{\mathbf{1}}{\mathbf{1.33}} = \mathbf{0.7519}$$

$$\therefore \boldsymbol{\varphi_c} = \mathbf{48^{o}45^{\backslash}}$$

Example (2): If the critical angle for certain medium with respect to air is 45^o then the refractive index of this medium is:

(a) 1.5 (b) 2 (c) 1.7 (d) $\sqrt{2}$

Solution

$$\mathbf{n} = \frac{1}{\sin\varphi_c} = \frac{1}{\sin 45^o} = \frac{1 \times \sqrt{2}}{1} = \sqrt{2}$$

Example (3): If the refractive indices for glass and water are 1.6 and 1.33 respectively, calculate the critical angle for glass water boundary.

Solution

$$\because \sin\varphi_c = \frac{n_2}{n_1} = \frac{1.33}{1.6} = 0.8313$$

$$\therefore \varphi_c = 56^o 12^\backslash$$

Example (4): If the angle of incidence on a rectangular prism of 45^o apex angle is 60^o, and the refractive index is $\sqrt{3}$. Calculate the emerging and deviation angles.

Solution

$$n = \frac{\sin\varphi_1}{\sin\theta_1}$$

$$1.732 = \frac{\sin 60}{\sin\theta_1}$$

$$\theta_1 = 30^o$$

$A = \theta_1 + \varphi_2$ $45^o = 30^o + \varphi_2$ $\varphi_2 = 15^o$

Also $n = \frac{\sin\theta_2}{\sin\varphi_2}$

$1.732 = \frac{\sin\theta_2}{0.2588}$ $\theta_2 = 26^o 34^\backslash$

$$\hat{\alpha} = \widehat{\varphi_1} + \widehat{\theta_2} - A = 60 + 26 - 45 = 41^0 34^\backslash$$

Example (5): If the minimum angle of devision for a prism of equal sides is 40^o. Calculate the refractive index of the prism.

Solution:

$$n = \frac{\sin(\frac{\alpha_o + A}{2})}{\sin(\frac{A}{2})} = \frac{\sin(50^o)}{\sin(30^o)} = 1.532$$

Example (6): Experimentall it was found that, the minimum angle of devision for a prism is $48^o.2$. If its apex angle equal $58^o.8$ Calculate the refractive index of the prism.

Solution

$$n = \frac{\sin(\frac{\alpha_o + A}{2})}{\sin(\frac{A}{2})} = \frac{\sin(\frac{48.2 + 58.8}{2})}{\sin(\frac{58.8}{2})} = \frac{\sin(53^o.5)}{\sin(29^o.4)} = \frac{0.8039}{0.4909} = 1.64$$

Example (7): Thin prism has 5^o apex angle and its refractive index is 1.6. Calculate the angle of devision.

Solution

$$\because \alpha_o = A(n-1) = 5(1.6-1) = 3^o$$

Example (8): Thin prism deviate the incident rays by 4^o. If it has 8^o apex angle, calculate the refractive index.

Solution

$$\because \alpha_o = A(n-1)$$

$$4 = 8(n-1) \qquad \therefore n = 1.5$$

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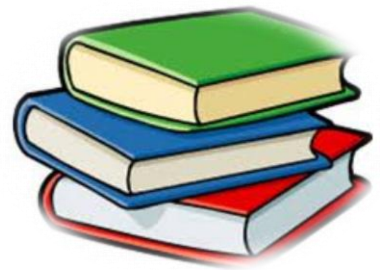


Unit two

Chapter 4: Hydrostatics

Define

1 –Density:

The mass per unit volume of substance

2 – Relative density:

The ratio between the density of material to the density of water at the same temp. (OR) the ratio between the mass of a certain volume of the material to the mass of same volume of water at the same temperature.

3 – Pressure at a point:

the average force which acts normal to unit area surrounding the point

4 – Liquid pressure at a point

Equivalent to the weight of vertical column of unit cross-section area from this point to the liquid surface.

5 – The atmospheric pressure at point:

Equivalent to the weight of vertical air column of unit cross- section area from this point to the end of atmosphere.

6 – The manometer:

The device is used to measure the pressure of an enclosed gas or to measure the difference between the pressure of trapped gas and the atmospheric pressure.

7 – Pascal's Principle:

The pressure applied to liquid enclosed in a container is transmitted completely to all parts of the liquid as well as to the walls of the container.

8 – Mechanical Advantage of hydraulic press(η_{fs}):

The ratio between the force on the large piston and the force on the small piston. (OR) the ratio between the area of large piston and the area of small piston. (OR) the ratio between the distance covered by the small and the distance covered by the large piston.

9 – Efficiency of hydraulic press:

The ratio between the output work done by the large piston to the input work done by the small piston.

Give reason for each of the following:

1 – Needles, nails and knives have sharp edges.

Since p α 1/A, therefore when area is small the pressure will be high and nails and needles can penetrate easily and knives can cut easily.

2 – Under inflated tire becomes hot after a short drive.

Because Pα1/A and if pressure decreases the area of contact (A) with the ground increases and frication with the road increases, so it becomes hot.

3 – The thickness of the dam base is higher than the thickness of its top.

Because the pressure inside a liquid increases as the depth increases thus the force acting on the dam base is large , so the base must be thicker.

4 – The pressure inside a liquid increases with increasing the depth

As the depth increases the weight of the liquid column above the unit area surrounding the point increases and since

$P = h\rho g + Pa$, thus the pressure increases

5 – Points that lie in the same horizontal level inside a static liquid have the same pressure.

Because the pressure at a point inside a liquid $P = h\rho g + Pa$

Depends only on the depth (h) and liquid density (ρ)

6 – The Hg height in the barometer doesn't depend on tube area.

Because $P = \rho gh$ the pressure inside the liquid doesn't depend on area

7 – Absence of Torricelli vacuum in a barometer at sea level.

Because the length of the used tube is less than or equal to 76 cm or the tube is tilted to a large extend.

8 – Mercury is preferred than water for barometers.

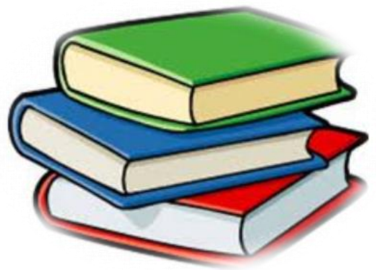
Because:

I)Hg has very high density so the length of tube is suitable and not very long

II)Hg has very low vapour pressure ,so pressure inside Torricelli vacuum can be considered = 0 , but for water this pressure ≠ 0.

9 – The atmospheric pressure decreases as the height over sea level increases.

Because as height increases the weight of the vertical air column of unit Cross-sectional area to the end of atmosphere decreases.



10 – The reading of barometer decreases as the height over sea level increases.

Because as the height increases the atmospheric pressure decreases as the weight of vertical air column decreases.

11 – Pascal's is not applied for gases.

Because gases are compressible and a part of the work done by small piston is lost in compressing the gas rather than moving the large piston so pressure applied at the small piston is not transmitted completely to the large piston.

12 – On increasing the pressure on a press inside a container filled with a liquid the press doesn't move down.

Because liquids are uncompressible.

What meant by:

1 – Relative density of Al. = 2.7

The ratio between the density of(Al.) and the density of water is 2.7 at constant temp.

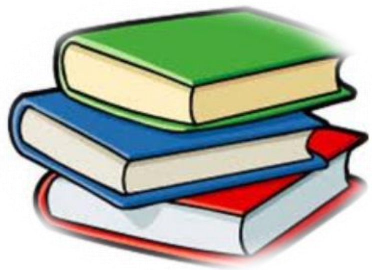
2 – The density of iron 7800kg/m^3

The mass per unit of volume of iron is 7800kg.

3 – The pressure at point = 4×10^2pascal.

The average normal force acting on unit area surrounding this point equals 4×10^2 Newton.

4 – The pressure of liquid at a point inside it = 2×10^5pascal



2×10^5 Newton is the weight of vertical liquid column of unit cross-section area surrounding that point and of height from that point to the liquid surface.

5 – The mechanical advantage of hydraulic press = 200

the ratio between force acting on large piston and the force acting on small piston = 200.

Solved problems:

1. A cube of length (L) completely filled with a liquid calculate the ratio between.

a) The force of the pressure of the liquid acts on the upper half of the vertical side .to that acts on the lower half of the same side.

b) 2 –The force of the pressure of the liquid acts on the all vertical side to that acts on the base of the cube.

Solution

The force acts on the upper half side

$F_1 = P \times A = \rho\, g\, h \times A$

$= \rho\, g \times \frac{1}{4} L \times \frac{1}{2} A$

$= \rho\, g \times L \times A \times \frac{1}{8}$--------- (1)

The force acts on the lower half side

$F_2 = P \times A = \rho\, g \times \frac{3}{4} L \times \frac{1}{2} A$

$= \rho\, g \times L \times A \times \frac{3}{8}$ ---------- (2)

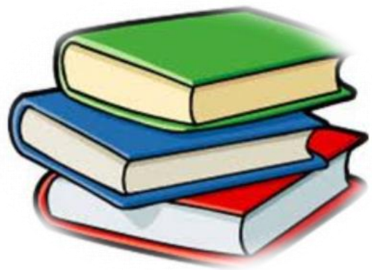
$F_1 : F_2 = \frac{1}{8} : \frac{3}{8} = 1 : 3$

$F_3 = P \times A = \rho\, g \times \frac{1}{2} L \times A$

$= \rho\, g \times L \times A \times \frac{1}{2}$

$F_4 = P \times A = \rho\, g \times L \times A$

$F_3 : F_1 = \frac{1}{2} : 1 = 1 : 2$



2. Cylindrical container of 1.5m height and the diameter of its base is 8m, and contains oil of density 920 kg/m^3, the atmospheric pressure = 76 cm Hg, the density of mercury = 13600 kg/m^3, and g = 10m/sec^2. Calculate:

a) The pressure of the oil on the base of container.

b) The total pressure on the base container.

c) The total pressing force acts on the base of container.

Solution

a) $P_{oil} = (\rho \ g \ h)_{oil}$

$$= 920 \times 10 \times 1.5 = 1.38 \times 10^4 \ N/m^2$$

b) $Pa = (\rho \ g \ h) \ Hg.$

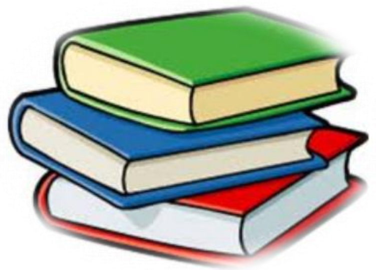
$$= 13600 \times 10 \times 0.76 = 10.336 \times 10^4 \ N/m^2$$

$$P_{total} = P_{oil} + Pa = 1.38 \times 10^4 + 10.336 \times 10^4$$

$$= 11.716 \times 10^4 \ N/m^2$$

c) $F = P \times A = P_t \times \pi \ r^2$

$$= 11.716 \times 10^4 \times 3.14 \times 4^2 = 588.6 \times 10^4 \ N.$$



3. A tire has 3.039×10^5 N/ m^2pressure difference. Find the absolute value of the air pressure inside the tire in unit of atmospheric Pressure. (Pa = $1.013\times10^5 N/m^2$).

Solution

ΔP= P (inside the tire) – Pa

P (inside the tire) = ΔP + Pa = $3.039\times10^5 + 1.013\times10^5 = 4.052\times10^5\ N/m^2$

P= $4.052\times10^5/1.013\times10^5$=4 atm

4. The small area of a hydraulic press is 2 cm^2 a force of 100 N. is applied to it. If the cross sectional area of the large piston is $800cm^2$. And g =10 m/sec^2,calculate:

I) The maximum mass applied to the large piston.

II) The mechanical advantage of the piston.

III) The distance covered by the small piston to move the large one by 1cm.

IV) The pressure at the small piston.

Solution

I) $\frac{F}{f}=\frac{A}{a}$, $\frac{F}{100}=\frac{800}{2}$, **F=40000N, m=F/g=40000/10=4000kg**

II) $\eta=\frac{800}{2}=400$

III) $400=\frac{y_s}{1}$, $y_s=400cm$

IV) $P=\frac{F}{A}=\frac{f}{a}=\frac{100}{2\times10^{-4}}=50\times10^{-4}N/m^2$