K.L.E. SOCIETY'S
**P. C. JABIN SCIENCE COLLEGE**
**HUBBALLI**
AUTONOMOUS

Semester -'I'

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|---|---|
| B.Sc. | ✓ |
| B.C.A. | |
| M.Sc. | |

Answer Booklet No.
45808

| | |
|---|---|
| Theory Semester End Examination | April/May 20 |
| | Nov./Dec. 20 |

Certified that the entries made by the candidate are found to be correct.
sheell - 26/3/22
Signature of the Room Supervisor with Date

Exam. Reg. No. | 1 | 2 | 1 | P | C | S | 0 | 1 | 6 |

Class : BSc-'I'-sem Subject : Physics Subject Code No.: 115DSC01T-I-22

Paper :

11681025 MPM
121PCS016

## IMPORTANT INSTRUCTIONS TO CANDIDATES

1) On the cover page of answer book compulsorily mention your Register Number, Subject, Course Code and required information.

2) Don't write your name or mark any signs, such answer scripts shall not be assessed and punished.

3) Write your answer from 1st page and don't leave any blank pages and blank space in between.

4) Last page is meant for rough work and on completion put cross mark (x)

5) The candidates are informed strictly to write their answer only with black ink & write on both sides of the answers sheets.

## IMPORTANT INSTRUCTIONS TO CANDIDATES

6) Please mention the Question number in the margin. Answer's without Question number & also with wrong question number shall not be valued.

7) The students are informed to take compulsorily the signature of the room supervisor with date on the answer book.

8) The candidate should be present 20 minutes before the commencement of the examination. After that no students wil be allowed in the examination hall.

9) Use of any electronic gadgets in the examination hall is strictly prohibited.

10) After the last warning bell, no candidate is allowed to leave his/her seat.

11) Indulging in different ways and using different means that lead to malpractice is prohibited.

12) Don't fold the answers sheets & keep the answer sheets clean.

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START WRITING ANSWER FROM HERE BELOW

Unit - I

1. a) Accuracy :-

Accuracy of measurement of quantity tells about at what degree ~~how~~ the accepted value is close to measured value.

Precision :-

Precision tells about the at what limit a quantity is resolved.

or

Precision of measurement of quantity tell how close the measured value with each other.

b) Given:

$m = 100 kg$

$F_a = F_f = 250 N$

$x = 20 m.$

$W = ?$

i) the velocity remains constant,

WKT, By the defination of work done

$W = F \times x$

$W = 250 \times 20$

$\boxed{W = 5000 J}$

ii) the velocity increases from 0 to 5m/sec.

Let $u$ be the initial velocity, $a$ be the acceleration and $t$ be the time taken by the body, then final velocity $v$ is given as

$v^2 = u^2 + 2ax$

$v^2 - u^2 = 2ax$

Substitute $v = 5 m/s$ and $u = 0 m/s$

$5^2 - 0^2 = 2a(20)$

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$$25 = 40\,a$$

$$a = \frac{\cancel{25}\,5}{\cancel{40}\,8}$$

$$a = 0.625\ m/s^2.$$

According to Newton's second law of motion,

$$F_{add} = m\,a$$

$$F_{add} = 1500 \times 0.625$$

$$F_{add} = 937.5\ N.$$

Total force acting on a stone due to additional force is,

$$F_{total} = F_a + F_{add}$$

$$F_{total} = 250 + 937.5$$

$$F_{total} = 1187.5\ N.$$

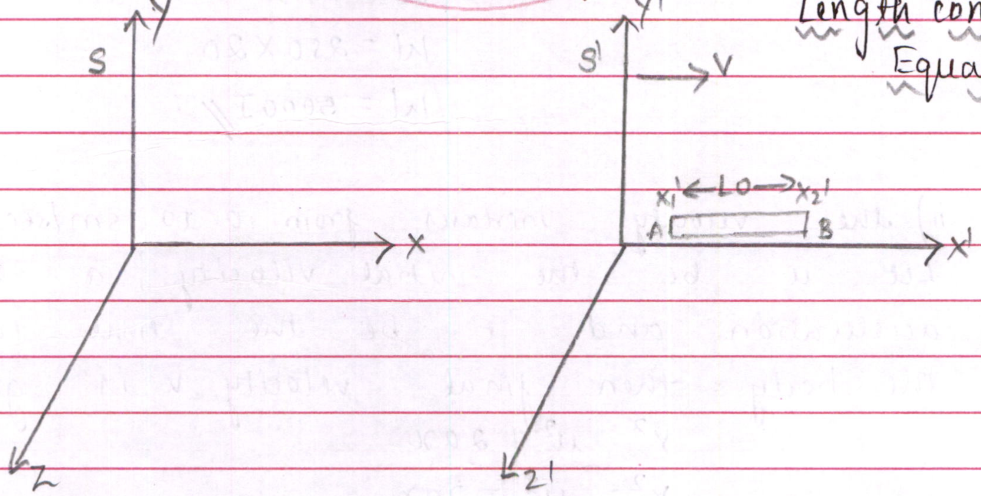
Now, By the defination of work done,

$$W = F_{total} \times x$$

$$W = 1187.5 \times 20$$

$$\boxed{W = 23750\ J}$$

c)




Length contraction Equation

Consider a moving frame of reference S' where Lo be the true length of a rod AP whose

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co-ordinates are $x_1'$ & $x_2'$. The coordinates of moving reference of frame is $x_1'$, $y'$ and $z'$. v be the velocity of moving frame of refrence then Lo is given as,

$$L_0 = x_2' - x_1' \quad \text{-----} (1)$$

Now the rod AB which is placed in a moving frame of refrence is now observed from the stationary frame of reference S. whose co-ordinates are x, y and z. The length L is given as,

$$L = x_2 - x_1 \quad \text{-----} (2)$$

By Lorentz Transformation,

$$x_2' = \frac{x_2 - vt}{\sqrt{1 - \frac{v^2}{c^2}}} \quad \text{---} (3)$$

$$x_1' = \frac{x_1 - vt}{\sqrt{1 - \frac{v^2}{c^2}}} \quad \text{---} (4)$$

Subtract eq'n (4) from (3)

$$x_2' - x_1' = \frac{x_2 - vt}{\sqrt{1 - \frac{v^2}{c^2}}} - \left(\frac{x_1 - vt}{\sqrt{1 - \frac{v^2}{c^2}}}\right)$$

$$x_2' - x_1' = \frac{x_2}{\sqrt{1 - \frac{v^2}{c^2}}} \cancel{- \frac{vt}{\sqrt{1 - \frac{v^2}{c^2}}}} - \frac{x_1}{\sqrt{1 - \frac{v^2}{c^2}}} \cancel{+ \frac{vt}{\sqrt{1 - \frac{v^2}{c^2}}}}$$

$$x_2' - x_1' = \frac{x_2}{\sqrt{1 - \frac{v^2}{c^2}}} - \frac{x_1}{\sqrt{1 - \frac{v^2}{c^2}}}$$

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$$x_2' - x_1' = \frac{x_2 - x_1}{\sqrt{1-\frac{v^2}{c^2}}}$$

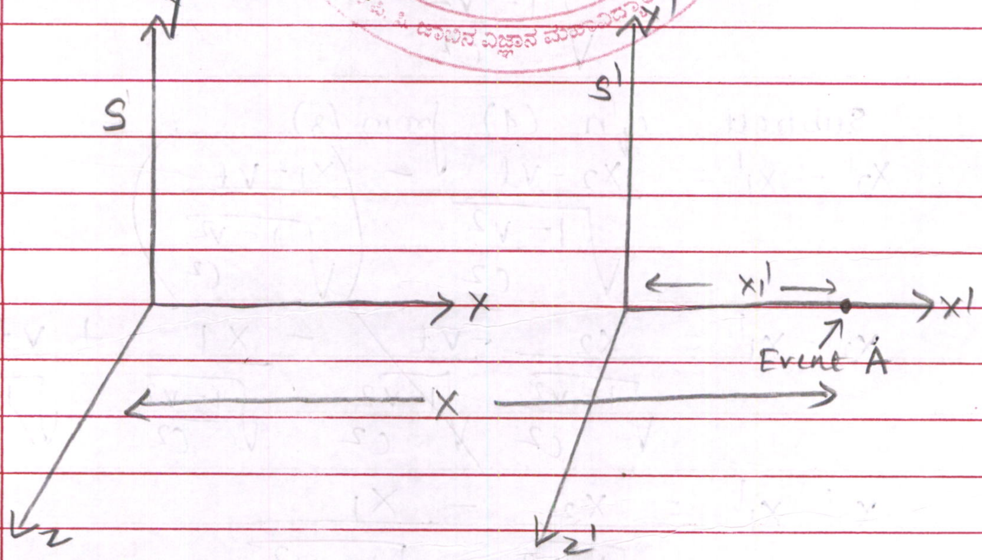
From eq'n (1) & (2) the above eq'n can be rewritten as,

$$\boxed{L_0 = \frac{L}{\sqrt{1-\frac{v^2}{c^2}}}}$$

Conclusion: The length of a rod observed from the stationary frame of reference appears to be contracted by the factor of $\sqrt{1-\frac{v^2}{c^2}}$.

Proper Length: The true length $L_0$ when the body is at rest is known as proper length.

Time-dilation equation.




Consider a moving frame of reference S' whose coordinates are x', y' and z'. When a clock is placed

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in moving frame of reference it gives two ticks $t_2'$ and $t_1'$ then the time $t_0$ is given as

$$t_0 = t_2' - t_1' \quad ----(1)$$

Now the same event A is observed from the stationary frame of reference whose co-ordinates are x, y and z. Even here the clock gives a two ticks $t_2$ and $t_1$ then the time t is given as,

$$t = t_2 - t_1 \quad ---(2)$$

By Lorentz transformation,

$$t_2' = \frac{t_2 - (xv'/c^2)}{\sqrt{1-\frac{v^2}{c^2}}} \quad ---(3)$$

$$t_1' = \frac{t_1 - (xv'/c^2)}{\sqrt{1-\frac{v^2}{c^2}}} \quad ---(4)$$

subtract eq'n (4) from (3)

$$t_2' - t_1' = \frac{t_2 - (xv'/c^2)}{\sqrt{1-\frac{v^2}{c^2}}} - \left(\frac{t_1 - (xv'/c^2)}{\sqrt{1-\frac{v^2}{c^2}}}\right)$$

$$t_2' - t_1' = \frac{t_2}{\sqrt{1-\frac{v^2}{c^2}}} - \cancel{\frac{(xv'/c^2)}{\sqrt{1-\frac{v^2}{c^2}}}} - \frac{t_1}{\sqrt{1-\frac{v^2}{c^2}}} + \cancel{\frac{(xv'/c^2)}{\sqrt{1-\frac{v^2}{c^2}}}}$$

$$t_2' - t_1' = \frac{t_2}{\sqrt{1-\frac{v^2}{c^2}}} - \frac{t_1}{\sqrt{1-\frac{v^2}{c^2}}}$$

$$t_2' - t_1' = \frac{t_2 - t_1}{\sqrt{1-v^2/c^2}}$$

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From eq'n (1) & (2) the above eq'n can be rewritten as

$$\boxed{t_0 = \frac{t}{\sqrt{1-\frac{v^2}{c^2}}}}$$

Conclusion: The time appears to be very slow or lengthened by the factor of $\sqrt{1-\frac{v^2}{c^2}}$ when it is observed from stationary frame of reference.

UNIT-II

4) a) Rigid Body:-
The body which do not undergo any change in shape and volume when an external force is applied on it is known as rigid body.
Ex: Board, Desk etc.

b) Kepler's Second Law states that "the aerial velocity of a planet is always constant".
OR
"The line joining between the planet and the sun sweeps equal area in equal interval of time".

Let us consider a planets which are moving in an elliptical orbit around a sun with sun as a one foci. Let A and B be the

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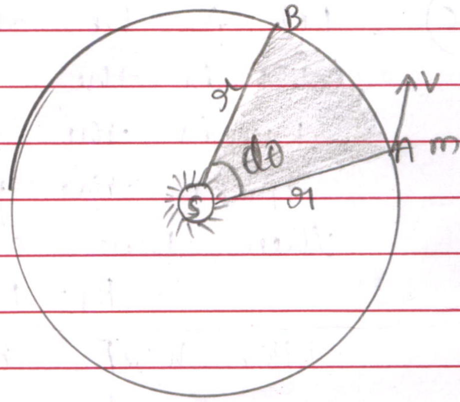


two points on an elliptical orbit At point A m be the mass of the planet moving with velocity 'v'. Let $r d\theta$ be the distance covered by the planet from point A to B on an elliptical orbit.

$$\text{Area} = \frac{1}{2} \times b \times h$$

$$dA = \frac{1}{2} \times b \times h$$

Substitute $b = r$ & $h = r d\theta$ in the above eq'n then we can write it as

$$dA = \frac{1}{2} \times r \times r d\theta$$

$$dA = \frac{1}{2} r^2 d\theta$$

Divide the above eq'n by dt then we will get as,

$$\frac{dA}{dt} = \frac{1}{2} r^2 \frac{d\theta}{dt}$$

WKT, $w = \frac{d\theta}{dt}$ then above eq'n can be rewritten-ed as,

$$\boxed{\frac{dA}{dt} = \frac{1}{2} r^2 w}$$

$\frac{1}{2} r^2 w$ in the above equation is a aerial vector when r decreases and w increases. Therefore, aerial velocity $\frac{1}{2} r^2 w$ is always constant.

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c) Let A be the planet where
$M_1$ is the mass of the planet A
$R_1$ is the radius of the planet A and
$T_1$ is the period of revolution of planet A
Then Force acting on planet A is given as,

$$F_1 = M_1 R_1 W_1^2$$

WKT, $W = \frac{2\pi}{T}$ then the above eq/n can be

rewrittened as

$$F_1 = M_1 R_1 \left(\frac{2\pi}{T_1}\right)^2 \quad \text{---(1)}$$

Let us consider a another planet B where
$M_2$ be the mass of planet B
$R_2$ be the radius of planet B
$T_2$ be the period of revolution of planet B
Then force of attraction acting on planet B is given as,

$$F_2 = M_2 R_2 W_2^2$$

Substitute $W_2 = \frac{2\pi}{T_2}$ in the above eq'n

then it can be rewrittened as,

$$F_2 = M_2 R_2 \left(\frac{2\pi}{T_2}\right)^2 \quad \text{---(2)}$$

Now, divide eq'(1) by (2) we get,

$$\frac{F_1}{F_2} = \left(\frac{M_1}{M_2}\right)\left(\frac{R_1}{R_2}\right)\left(\frac{\cancel{2\pi}}{T_1} \times \frac{T_2}{\cancel{2\pi}}\right)^2$$

$$\frac{F_1}{F_2} = \left(\frac{M_1}{M_2}\right)\left(\frac{R_1}{R_2}\right)\left(\frac{T_2}{T_1}\right)^2 \quad \text{---(3)}$$

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According to kepler's third law of planetary motion.

$$\left(\frac{T_2}{T_1}\right)^2 = \left(\frac{R_2}{R_1}\right)^3 \quad ----(4)$$

From eq'n (4) the eq'n (3) can be rewritten as.

$$\frac{F_1}{F_2} = \left(\frac{M_1}{M_2}\right)\left(\frac{R_2}{R_1}\right)^2$$

$$\frac{F_1 R_1^2}{M_1} = \frac{F_2 R_2^2}{M_2}.$$

$$\therefore \quad F \propto \frac{M}{R^2} \qquad F \propto M \qquad F \propto \frac{1}{R^2}$$

Force of attraction of sun on the planet is directly proportional to the mass of the body and inversely proportional to the square of ~~period~~ distance separated between them.

$$\boxed{\text{i.e,} \quad F = \frac{M}{R^2}}$$

UNIT-III

6. a) Hooke's law

Hooke's law states that "Stress is directly proportional to strain within the elastic limit".

i.e, Stress $\propto$ Strain

Stress = E Strain

where E is the proportionality constant known as modulus of elasticity.

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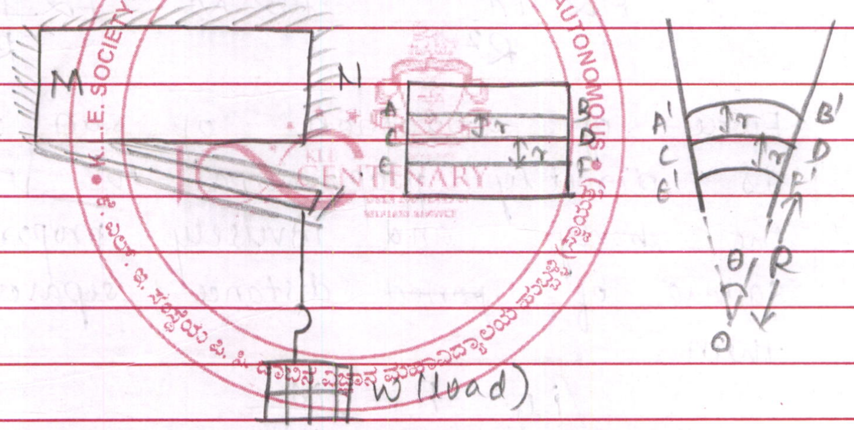
$$E = \frac{Stress}{Strain}$$

Modulus of elasticity is defined as the ratio of stress to the strain.

⇒ Elastic limit is the limit at which the body regains its original shape or size after the removal of deformation force.

b) <u>Bending moment of Beam with rectangular cross-section.</u>




Consider a beam where M be the fixed end of a beam and N be the free end of the beam which is loaded with a load W. When load W is added to free end then it subsequently bends. Beam is made up of number of parallel layers AB, CD and EF. Let A'B' be the elongation of the layer AB and E'F' be the elongation of the layer EF. CD be the neutral axis. The layers form a concentric circles of radius R and r be the distance between successive layer as shown in the

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above figure.

Length of $AB = R\theta$ and length of $A'B'$ is $(R+r)\theta$.

Now, change in length $= A'B' - AB$

$$= (R+r)\theta - R\theta$$

$$= \cancel{R\theta} + r\theta - \cancel{R\theta}$$

$$= r\theta$$

WKT, Linear strain $= \frac{\text{change in length}}{\text{original length}}$

$$= \frac{r\cancel{\theta}}{R\cancel{\theta}} = \frac{r}{R}.$$

WKT, Young's modulus of elasticity is given as,

$$Y = \frac{\text{linear stress}}{\text{linear strain}}$$

$$Y = \frac{F/a}{r/R}$$

$$Y = \frac{FR}{ar}$$

$$F = \frac{Yar}{R}.$$

In the above eq'n ~~taking~~ ~~$\Sigma Yar$~~ force due to neutral axis is, [where r is distance between neutral axis].

$$F = \frac{Yar}{R} \times r$$

$$F = \frac{Yar^2}{R}.$$

Now taking the $\Sigma Yar^2/R$ then,

$$F = \Sigma \frac{Yar^2}{R}$$

$$F = \frac{Y}{R} \Sigma ar^2$$

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$$\boxed{F = \frac{Y I_g}{R}}$$

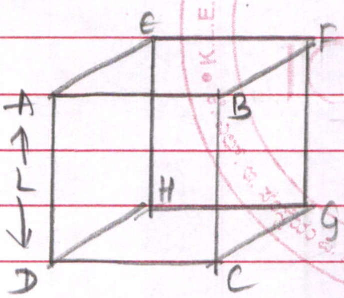
where $I_g = \Sigma a r^2$ is the geometrical moment of inertia.

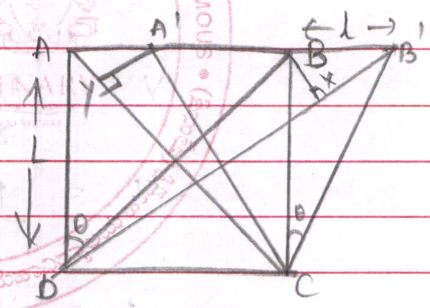
Now if a beam has a rectangular cross-section area then $I_g = \frac{bd^3}{12}$ the above eq'n can be rewritten as

$$\boxed{F = \frac{Y}{R}\left(\frac{bd^3}{12}\right)}$$

where b is breadth and 'd' is thickness of a beam.

c)




Consider a cube whose upper face is ABEF and lower CDGH. In this cube let us take a square ABCD. where 'L' be the length of the square. A shifts to A' and B shifts to B' by making a shearing angle θ of small magnitude. Here B'X is extended and AC is contracted. Now drop a perpendicular to draw B'X ⊥r to B'D and A'Y ⊥r AC as shown in the above figure.

Let α and β be the linear and lateral coefficient which is in the direction of force

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and perpendicular to the force respectively.

Now if tensile stress acts on side BD then it is given as, $= TBD\alpha$ --- (1)

Now stress acts on side BD due to compressive stress is given as $= TBD\beta$ --- (2)

As total length is equal to $B'X$ then from eq'n (1) and (2)

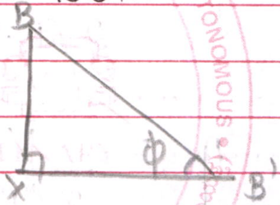
$$B'X = TBD(\alpha+\beta)$$

Substitute $BD = \sqrt{2}L$ in the above eq'n we get

$$B'X = T\sqrt{2}L(\alpha+\beta) \quad \text{---} (3)$$

Now consider a $\Delta$'le $BB'X$.

$$\cos 45' = \frac{B'X}{BB'}$$




$$B'X = BB'\cos 45'$$

$$B'X = \frac{BB'}{\sqrt{2}}$$

$$B'X = \frac{l}{\sqrt{2}} \quad \text{---} (4)$$

Compare eq'n (3) & (4)

$$\frac{l}{\sqrt{2}} = T\sqrt{2}L(\alpha+\beta)$$

$$\frac{l}{TL} = 2(\alpha+\beta)$$

Invert the above eq'n we get,

$$\frac{TL}{l} = 1/2\,(\alpha+\beta)$$

$$\frac{T}{l/L} = \frac{1}{2(\alpha+\beta)}$$

WKT, $l/L = \theta$ then above eq'n is

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$$\frac{T}{\theta} = \frac{1}{2(\alpha+\beta)}$$

WKT, $\eta = T/\theta$ then above eq'n can be writtened as.

$$\boxed{\eta = \frac{1}{2(\alpha+\beta)}}$$

Relation between Young's, bulk modulus and poisson's ratio:

$$\eta = \frac{1}{2\alpha\left(1+\frac{\beta}{\alpha}\right)}$$

$$\eta = \frac{1/\alpha}{2\left(1+\frac{\beta}{\alpha}\right)}$$

$$\eta = \frac{Y}{2(1+\sigma)}$$

$$\eta = \frac{Y}{2(1+\sigma)}$$

$$\boxed{Y = 2\eta(1+\sigma)}$$

Young's Modulus of Elasticity.

Young's modulus of elasticity is defined as the ratio of linear stress to the linear strain within a elastic limit.

i.e, $$Y = \frac{\text{Linear stress}}{\text{Linear strain}}$$

$$Y = \frac{F/a}{l/L}$$

$$Y = FL/al$$

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$$\boxed{Y = \frac{TL}{l}}$$

Rigidity Modulus of Elasticity.
Rigidity Modulus of elasticity is defined as the ratio of shear stress to the shear strain within a elastic limit.

i.e, $\eta = \dfrac{\text{Shear stress}}{\text{Shear strain}}$

$$\eta = \frac{F/a}{l/L}$$

$$\boxed{\eta = \frac{FL}{al}}$$

UNIT - IV.

7. a) Given:

$R = 1mm = 1 \times 10^{-3} m$

$T = 73 \times 10^{-3}$ N/m

$P = ?$

For spherical drop of water,

$$P = \frac{2T}{R}$$

$$P = \frac{2 \times 73 \times \cancel{10^{-3}}}{1 \times \cancel{10^{-3}}}$$

$$\boxed{P = 146\ N/m^2}$$ or Pascal.

b)

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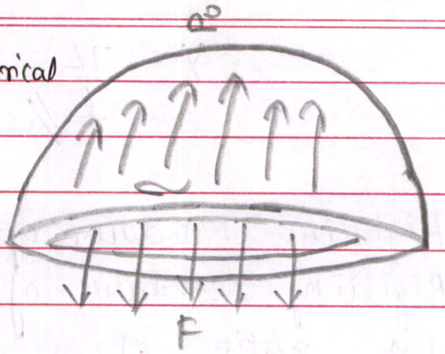


Let us consider a spherical liquid drop which is concave in shape. When a particle is present ~~outside~~ the spherical drop or concave side then due to inward force it is attracted inside the drop. The pressure acting inside the sperical drop is greater than the pressure acting outside the spherical drop. Let R be the radius of a spherical drop.

The upward force acting on ABCD spherical liquid drop is $= P\pi R^2$ ----(1)

The downward force acting on spherical liquid drop due to tension T is given as $= T2\pi R$ ----(2)

From eq'n (1) & (2)

$$P\pi R^2 = T2\pi R$$

$$P = \frac{T2\cancel{\pi}\cancel{R}}{\cancel{\pi}R^{\cancel{2}}}$$

$$\boxed{P = \frac{2T}{R}}$$

The above expression is for the ~~air~~ excess pressure of a air bubble having only one surface.

For soap bubble having two surfaces the excess pressure is given as,

$$\boxed{P = \frac{4T}{R}}$$

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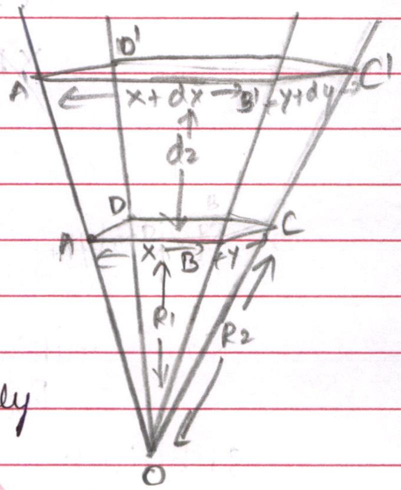
c) Consider a curved surface.
For any curved surface the excess pressure acting on it is balanced by a surface tension T.




Let ABCD be an element and $R_1$ & $R_2$ be the radii of side AB and BC respectively as shown in the figure.

Area of element ABCD $= xy$.

Area of element $A'B'C'D' = (x+dx)(y+dy)$

$= xy + xdy + ydx + dxdy$

$= xy + xdy + ydx$.

Area due to stretching $= A'B'C'D' - ABCD$

$= \cancel{xy} + xdy + ydx - \cancel{xy}$

$= xdy + ydx$

Work due to surface tension $= T(xdy + ydx)$ ---(1)

Work done due to excess pressure is $Pxy$ whereas work done due to element $dz$ can be written as $= Pxydz$ --- (2)

In equilibrium,

$$Pxydz = T(xdy + ydx) \quad ----(3)$$

Now consider two triangles $A'B'O$ and $ABO$,

$$\frac{A'B'}{AB} = \frac{OB'}{OB}$$

$$\frac{A'B'}{OB'} = \frac{AB}{OB}$$

$$\frac{x+dx}{R_1+dz} = \frac{x}{R_1}$$

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$$(x+dx)R_1 = x(R_1+d_2)$$

$$\cancel{xR_1} + dxR_1 = \cancel{xR_1} + xd_2$$

$$dx = \frac{x}{R_1} d_2 \quad \text{---} (4)$$

Similarly, $dy = \frac{y}{R_2} d_2 \quad \text{---} (5)$

Now taking on eq'n (3)

$$Pxyd_2 = T(xdy + ydx)$$

Substitute eq'n (4) & (5) in the above eq'n we get

$$Pxyd_2 = T\left(x\frac{y}{R_2}d_2 + y\frac{x}{R_1}d_2\right)$$

$$Pxy\cancel{d_2} = T\left(\frac{1}{R_1} + \frac{1}{R_2}\right)xy\cancel{d_2}$$

$$\boxed{P = T\left(\frac{1}{R_1} + \frac{1}{R_2}\right)}$$

For asynclaitic surfaces where $R_1$ increases and $R_2$ decreases, the excess pressure P is given as

$$\boxed{P = T\left(\frac{1}{R_1} \sim \frac{1}{R_2}\right)}$$

Special cases:

i) For air bubble where $R_1 = R_2 = R$

$$P = T\left(\frac{1}{R} + \frac{1}{R}\right)$$

$$P = T\left(\frac{2}{R}\right)$$

$$\boxed{P = 2T/R}$$

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ii) For soap bubble where $R_1 = R_2 = R$

$$P = 2T\left(\frac{1}{R} + \frac{1}{R}\right)$$

$$P = 2T\left(\frac{2}{R}\right)$$

$$\boxed{P = \frac{4T}{R}}$$

iii) For a cylinder where $R_1 = R$ & $R_2 = \infty$ having 1 surface is

$$P = 2T\left(\frac{1}{R} - \frac{1}{\infty}\right)$$

$$\boxed{P = \frac{2T}{R}}$$

where $R_1 = R$ and $R_2 = \infty$ having 2 surfaces.

$$P = 4T\left(\frac{1}{R} - \frac{1}{\infty}\right)$$

$$\boxed{P = \frac{4T}{R}}$$

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ಕೆ.ಎಲ್.ಇ. ಸಂಸ್ಥೆಯ ಪಿ. ಸಿ. ಜಾಬಿನ ವಿಜ್ಞಾನ ಮಹಾವಿದ್ಯಾಲಯ ಹುಬ್ಬಳ್ಳಿ
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