Chapter - 9

Mechanical Properties of Solids.

1) Deforming force :-
2) Elastic Bodies :-
3) Elasticity
4) limit of Elasticity
5) Plastic bodies
6) Plasticity
7) difference b/w elastic bodies and plastic bodies.
8) Brittle bodies

9) **Stress** :- force acting on a unit area is called stress.

$\Rightarrow$ $\boxed{\text{Stress} = \dfrac{\text{Force}}{\text{Area}}}$

$\Rightarrow$ **unit** :- N/m^2

$\Rightarrow$ **dimension** :- $ML^{-1}T^{-2}$

Types of stress.

A) Normal stress or longitudinal stress :-

This is also divided in 3 Parts :-

i) Tensile stress
ii) compressional stress
iii) Hydrostatic stress.

B) <u>Shearing stress or Tangential stress</u> :-

10) <u>Strain</u> :- The ratio of change in lenghth and orignal lenghth is called Strain.

or

The ratio of change in dimension and orignal dimension.

$$\Rightarrow \boxed{\text{strain} = \frac{\Delta L}{L}}$$

or

$$\Rightarrow \text{strain} = \boxed{\frac{\text{change in dimension}}{\text{Orignal dimension}}}$$

Strain is 3 Types :-

A) <u>linear or longitudional strain</u> -

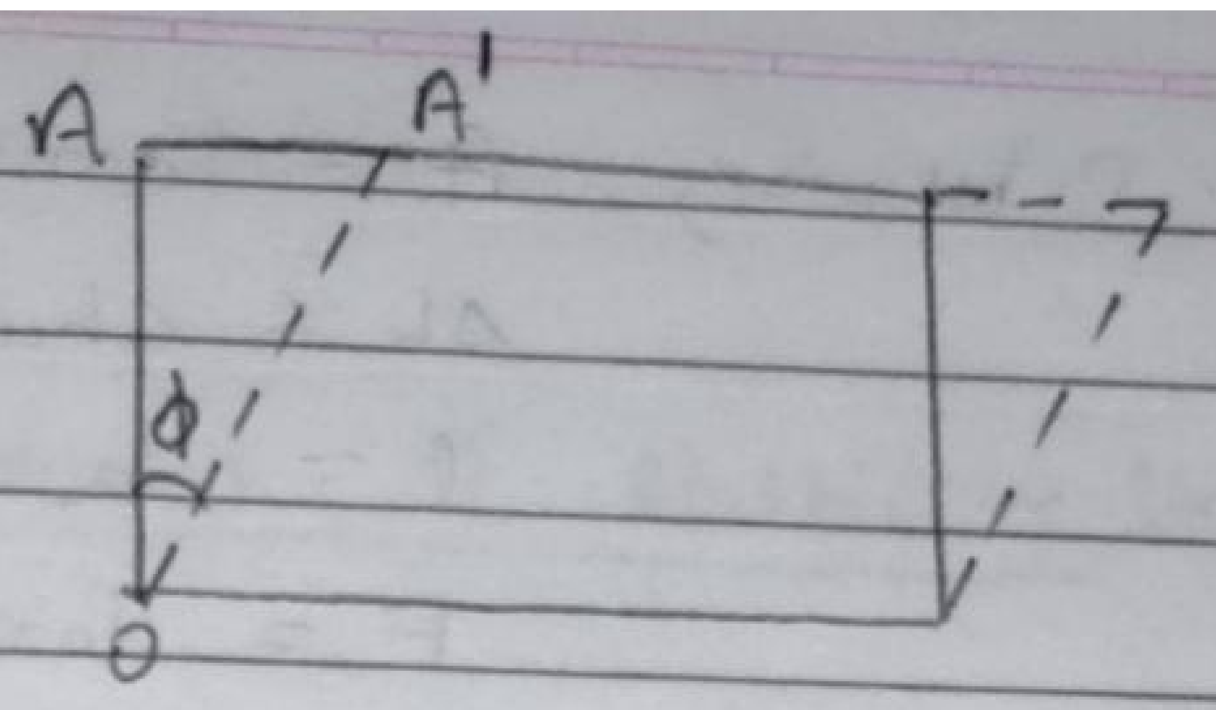
$$\Rightarrow \text{Strain} = \frac{\Delta l}{l} \Rightarrow \left[\frac{\text{change in lenght}}{\text{orignal lenghth}}\right]$$

B) <u>Volume strain or Bulk strain</u> :-

$$\text{strain} = \frac{\Delta V}{V} \Rightarrow \left[\frac{\text{change in Volume}}{\text{orignal Volume}}\right]$$

C) Shearing strain :- The ratio of perpendicular and base is known as shearing strain.

$$\tan\phi = \frac{AA'}{OA}$$



limit of elasticity ⇒

Hooke's law :- Within the elastic limit stress is directly proportional to strain.

$$\Rightarrow \boxed{\text{Stress} \propto \text{strain}}$$

Modulas of elasticity ⇒ The ratio of stress and strain is called Modulas of elasticity.

According to Hooke's law,

$$\Rightarrow \text{stress} \propto \text{strain}$$
$$\Rightarrow \text{stress} = E.(\text{strain})$$
$$\Rightarrow \boxed{E. = \frac{\text{Stress}}{\text{strain}}}$$

A) Young Modulas of elasticity (y) :-

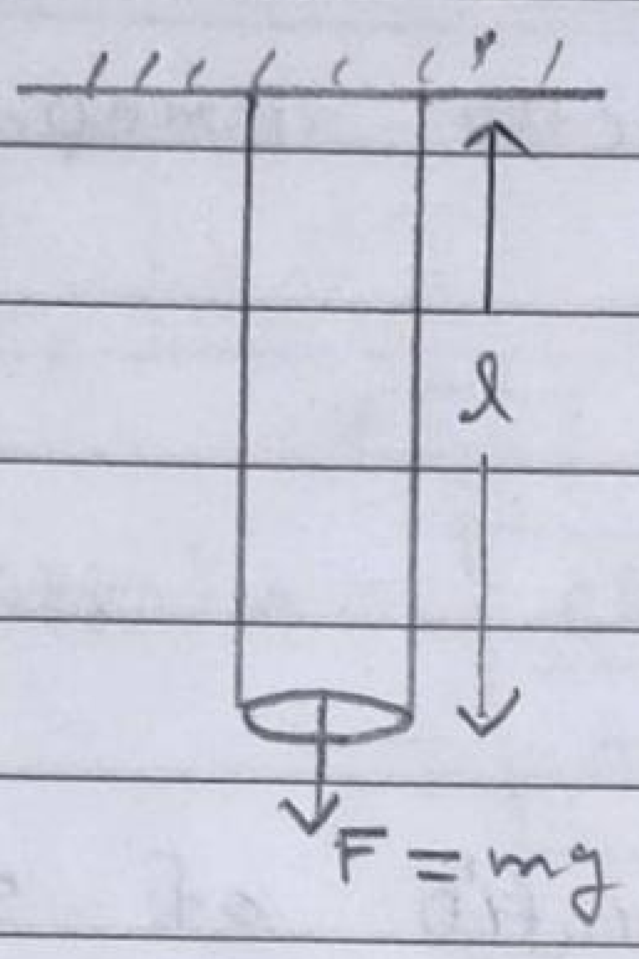
$$y = \frac{\text{Normal stress}}{\text{longitudinal strain}}.$$

$$y = \frac{F/A}{\Delta l/l}$$

$$\boxed{Y = \frac{Fl}{A.\Delta L}}$$

where, A = cross section area
ΔL = change in lenghth
l = orignal lenghth
F = force
Y = Young Modulas.

B) Young Modulas of a wire ⇒



$$Y = \frac{\frac{F}{A}}{\frac{\Delta l}{l.}}$$

$$Y = \frac{Fl}{(\Delta l) A}$$

$$Y = \frac{(mg)\, l}{(\Delta l)\, \pi r^2}$$

$$\boxed{Y = \frac{mgl}{\pi r^2 \Delta l}}$$

S.I Unit and dimension :-

$$\Rightarrow Y = \frac{\frac{F}{A}}{\frac{\Delta l}{l}} = \frac{\frac{N}{m^2}}{\frac{\cancel{m}}{\cancel{m}}} = N/m^2$$

Q 11. What is Poisson's ratio ?

12) Bulk Modulas of Elasticity (K) :-

$\Rightarrow$ $K = \dfrac{\text{Normal stress}}{\text{Volume strain}}$

$\Rightarrow$ $K = \dfrac{\frac{F}{A}}{-\frac{\Delta V}{V}}$

$\Rightarrow$ $K = -\dfrac{FV}{A\Delta V}$

$\Rightarrow$ $\boxed{K = \dfrac{-PV}{\Delta V}}$ $\left[\because \; P = \dfrac{F}{A}\right]$

Unit and dimension :-

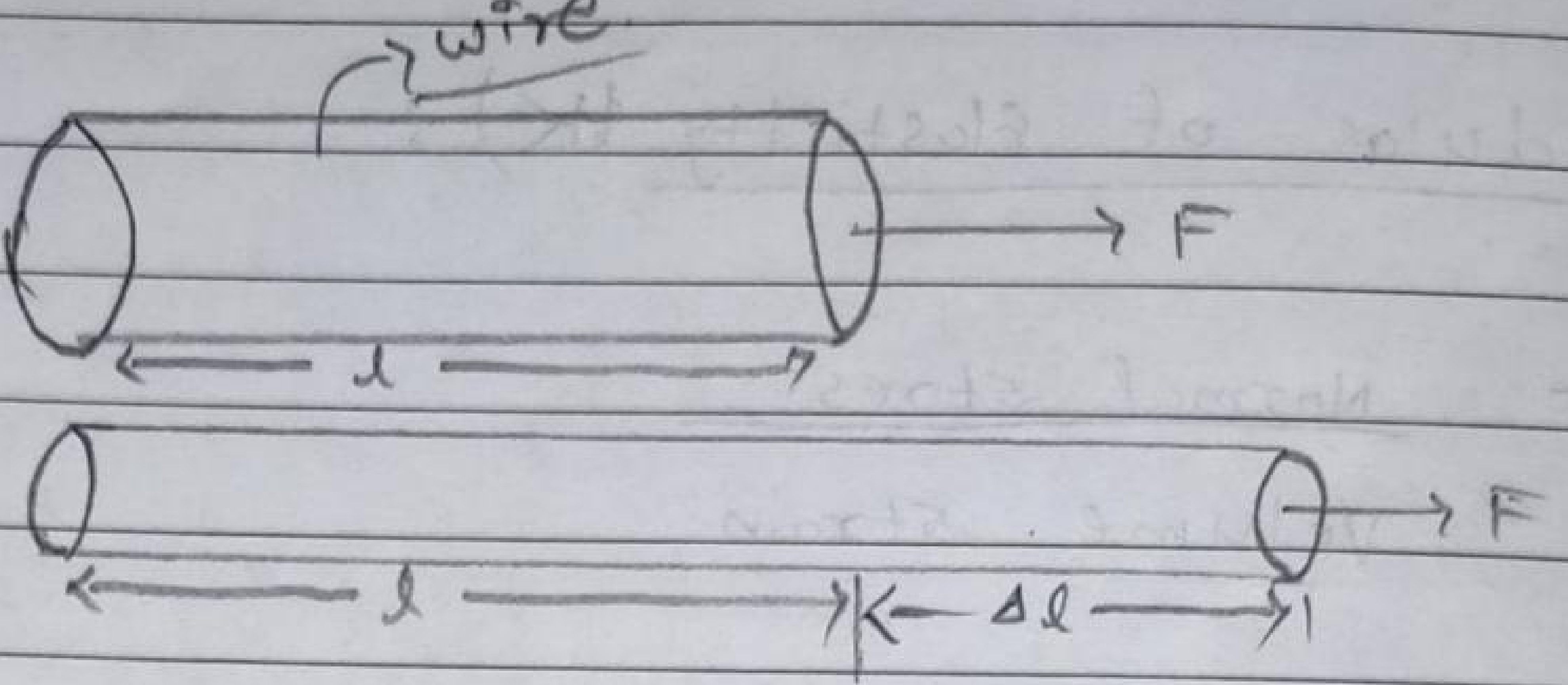
Modulas of rigidity or shear Modulas $\Longrightarrow$

$\Rightarrow$ $\eta = \dfrac{\text{Tangential stress}}{\text{shearing strain}}$

$= \dfrac{F/A}{\phi}$

$\boxed{\eta = \dfrac{F}{A\phi}}$

11) Poisson's Ratio (σ) ⇒



⇒ lateral strain → β

⇒ longitudinal strain → α

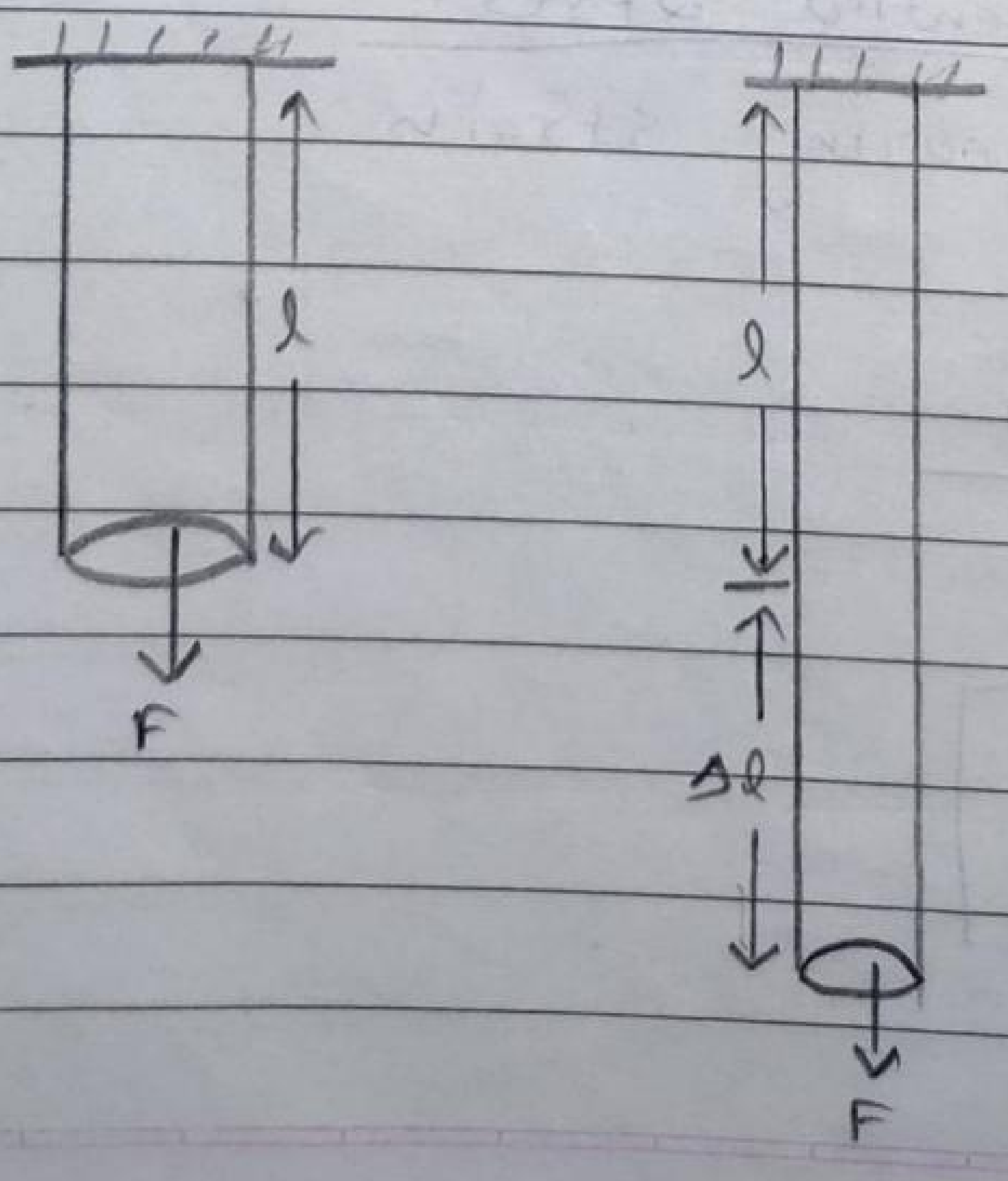
→ poisson's ratio (σ) = $\dfrac{\text{lateral strain } (\beta)}{\text{longitudinal strain } (\alpha)}$

13) Derive the expression for work done to strech a wire.

or

Derive the expression for elastic PE of a streched wire.

⇒ Elastic PE of a streched wire :-



Work = $F . \Delta l$

$\Rightarrow \quad F_{initial} = 0$

$\Rightarrow \quad F_{Final} = F$

$\Rightarrow \quad F_{Average} = \frac{0 + F}{2}$

$\Rightarrow \quad F_{average} = \frac{F}{2}$

$\Rightarrow \quad Work\ (W) = F \cdot \Delta l$

$\Rightarrow \quad Work\ (W) = \frac{F}{2} \cdot \Delta l$

$\Rightarrow \quad W = \frac{1}{2} \cdot F \cdot \Delta l \cdot \frac{Al}{Al} \qquad \left[\because \text{multiply } \frac{Al}{Al} \right]$

$\Rightarrow \quad W = \frac{1}{2} \frac{F}{A} \frac{\Delta l}{l} \cdot Al.$

$\Rightarrow \quad W = \frac{1}{2} \times \text{stress} \times \text{strain} \times \text{Volume}$

$\Rightarrow \quad \boxed{P.E = \frac{1}{2} \times \text{stress} \times \text{strain} \times \text{Volume}}$