Rigid Body

A body in which distance between any two point remains same.

→ No body is perfectly rigid practically.

{Intermolecular force}

r_0

$\leftarrow r_0 \rightarrow \leftarrow r_0 \rightarrow$

equilibrium

Collision

Body

Elastic	Inelastic	Perfectly Inelastic Plastic
Regain its shape after removing deforming force	Partially regain its shape	Does not regain its shape

Steel is more elastic

Rubber is more elastic than steel → false

Elasticity → Property due to which it regain its shape.

QUESTION

Given below are two statements : one is labelled as Assertion (A) and the other is labelled as Reason (R)

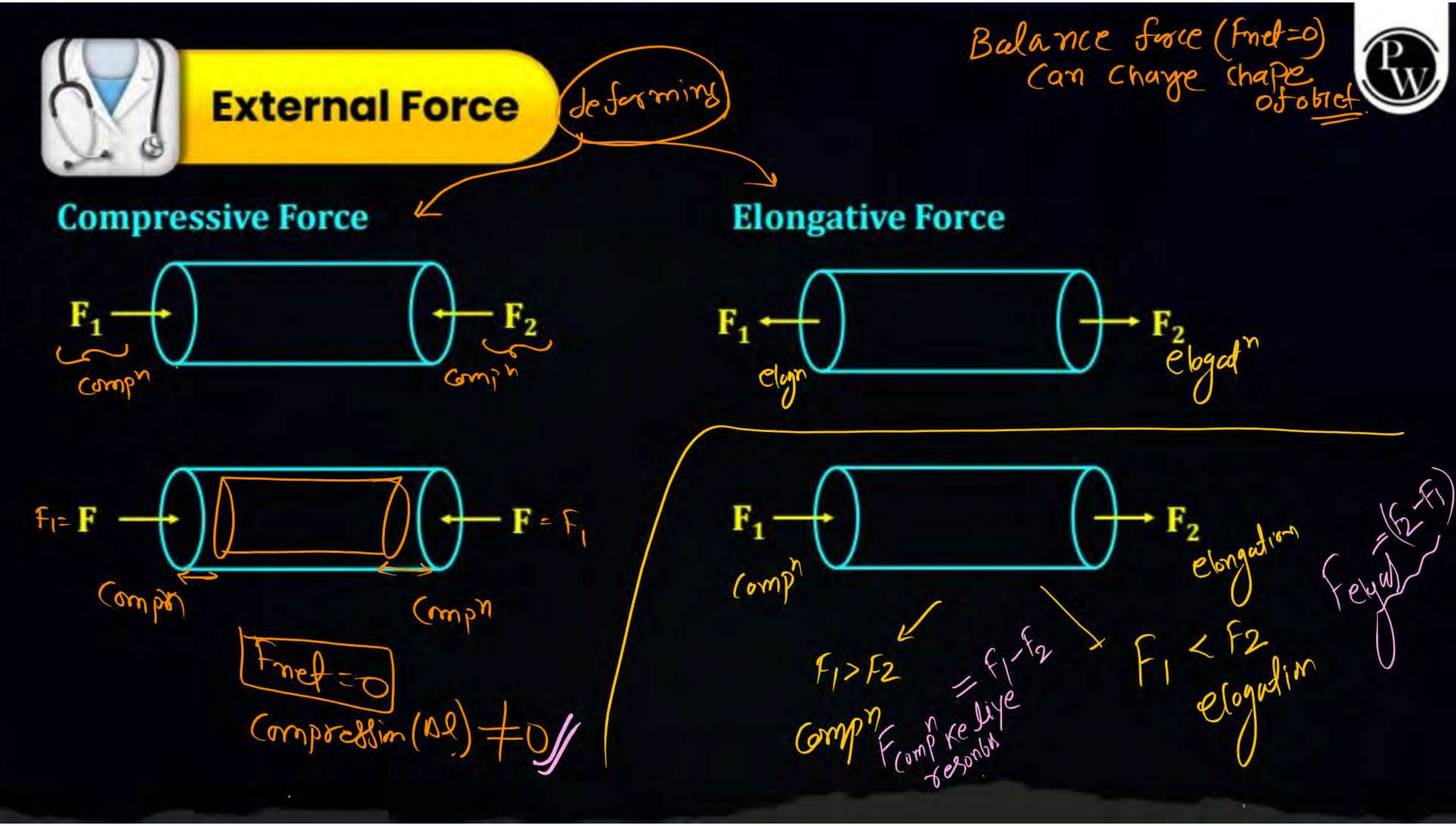
Assertion (A) : The property of body, by virtue of which it tends to regain its original shape when the external force is removed, is Elasticity.

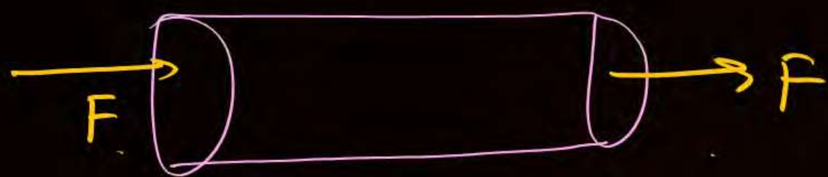
correct

Reason (R) : The restoring force depends upon the bonded inter atomic and inter molecular force of solid.

In the light of the above statements, choose the correct answer from the options given below :

1. (A) is false but (R) is true
2. (A) is true but (R) is false
3. Both (A) and (R) are true and (R) is the correct explanation of (A)
4. Both (A) and (R) are true and (R) is not the correct explanation of (A)


External Force
deforming
Balance force (Fnet=0)
Can change shape of object
Compressive Force
Elongative Force
F1
F2
compn
compn
F1
F2
elgn
elongatn
F1 = F
F = F1
compn
compn
Fnet = 0
Compression (Δl) ≠ 0
F1
F2
compn
elongation
F1 > F2
compn
Fcompn = F1 - F2
compn ke liye responsible
F1 < F2
elogation
Felgn = (F2 - F1)

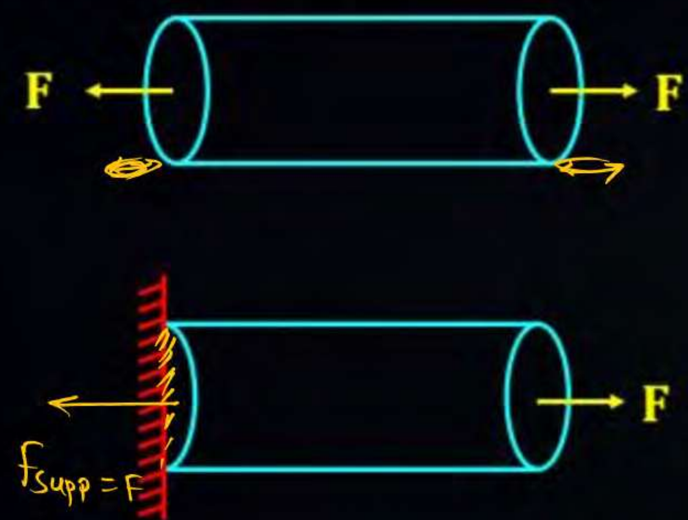


F_{net} for comp^n/elongation $= 0$

$\{\Delta l = 0)$

* $\boxed{F_{net} = 2F}$ $a_{net} \neq 0$

❖ Balance force can charge shape and size of object:



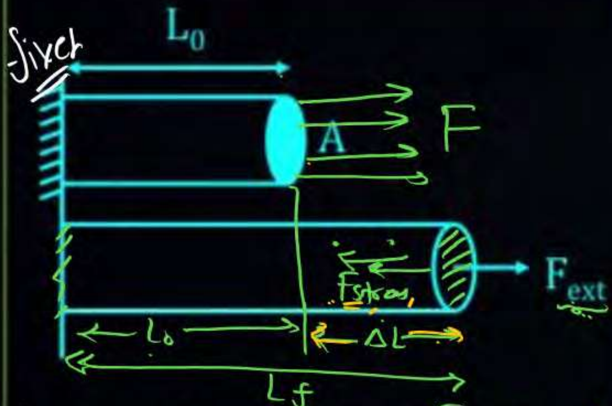
$(F_{net} = 0)$

Elongation in both case $\rightarrow$ $\boxed{\text{Same}}$

Δl_1 $\quad$ Δl_2

Normal/Longitudinal Stress (only for solid)	Tangential Stress/Shear (only for solid)	Volumetric Stress (for liquid, gas, solid)

Normal/Longitudinal Stress (only for solid)



Normal Stress (logitudinal) = $\dfrac{F_{elastic}}{A}$

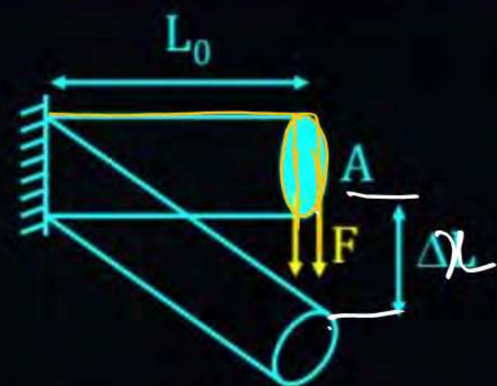
Strain (Normal) = $\left(\dfrac{\Delta L}{L_0}\right)$ unit less/dim^n less

Hooks Law:
Stress ∝ Strain

$\boxed{\text{Stress} = Y\ \text{strain}}$

↳ Young modulus.

Tangential Stress/Shear (only for solid)



Shear Stress = $\dfrac{F}{A}$

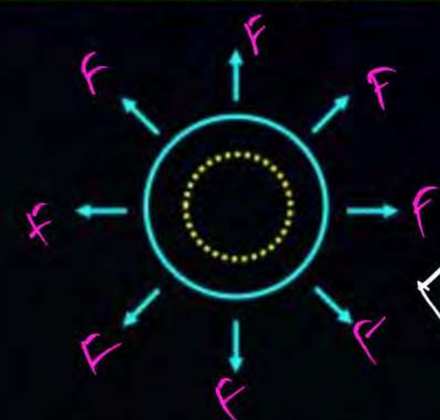
Shear Strain = $\theta = \dfrac{\Delta x}{L}$

Hooks Law: $\dfrac{F}{A} = \eta \dfrac{\Delta x}{L}$

↳ Modulus of rigidity

Volumetric Stress (for liquid, gas, solid)

→ Volume



$\boxed{K\ (\text{compressibility}) = \dfrac{1}{\beta}}$

Volumetric Strain = $\dfrac{\Delta V}{V}$

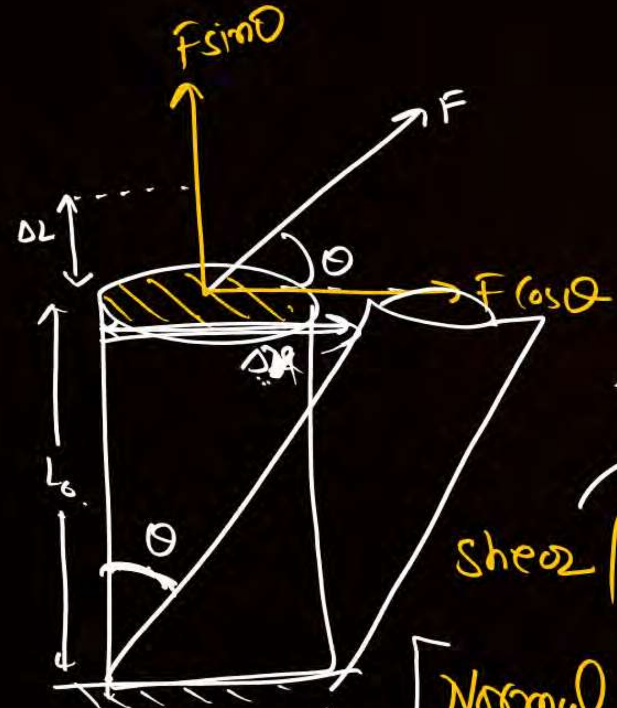
Volumetric stress = $\dfrac{F}{A}$

$\boxed{\dfrac{F}{A} = -\beta \dfrac{\Delta V}{V}}$

↳ Bulk modulus

stress ∝ strain ✓

$\boxed{\text{Strain} \propto \text{stress}}$ ✗



$$\text{shear strain } (\theta) = \frac{\Delta x}{L_0}$$

$$\text{shear / tangen stress} = \frac{F\cos\theta}{A}$$ ✓

$$\text{Normal stress} = \frac{F\sin\theta}{A}$$

↳ $\text{Normal strain} = \frac{\Delta L}{L}$

QUESTION

Dimensions of stress are: [2020]

1. $[ML^0T^{-2}]$
2. $[ML^{-1}T^{-2}]$ Ans
3. $[MLT^{-2}]$
4. $[ML^2T^{-2}]$

Stress $= \frac{F}{A} = \frac{MLT^{-2}}{L^2}$

$= ML^{-1}T^{-2}$

Energy density $= \frac{E}{\text{Volume}}$

→ stress

→ Young modulus (modulus of rigidity)

→ pressure

$\frac{1}{2}$ stress×strain $= \frac{B^2}{2\mu_0} = \frac{1}{2}\varepsilon_0 E^2$

Young modulus (Y)

stress = Y strain

dim^n less

QUESTION

Correct pair is

1. Change in shape – Longitudinal strain
2. Change in volume – Shear strain
3. Change in length – Bulk strain
4. Reciprocal of Bulk modulus - Compressibility

Ans (4)

JIT-2024

QUESTION

Match List-I with List-II :

List-I		List-II	
(A)	A force that restores an elastic body of unit area to its original state stress = $\frac{F}{\text{Area}}$	(I)	Bulk modulus
(B)	Two equal and opposite forces parallel to opposite faces	(II)	Young's modulus
(C)	Forces perpendicular everywhere to the surface per unit area same everywhere	(III)	Stress
(D)	Two equal and opposite forces perpendicular to opposite faces	(IV)	Shear modulus

Choose the correct answer from the options given below :

1. (A)-(IV), (B)-(II), (C)-(III), (D)-(I)
2. (A)-(III), (B)-(IV), (C)-(I), (D)-(II)
3. (A)-(II), (B)-(IV), (C)-(I), (D)-(III)
4. (A)-(III), (B)-(I), (C)-(II), (D)-(IV)

Ans

QUESTION

The physical quantity that has the same dimensional formula as pressure is:

1. Coefficient of viscosity
2. Force
3. Momentum
4. Young's modulus of elasticity

MR* NEET

stress $= Y$ strain

Hook चाचा ka Law

$$\boxed{\frac{F}{A} = Y\frac{\Delta L}{L}}$$

$$\frac{F}{A \times A} = Y\frac{\Delta L}{L \times A}$$

$$\boxed{\frac{F}{A^2} = \frac{Y\Delta l}{\text{Volume}}}$$

10 physical $\rightarrow$ quantity

$$\frac{F}{\pi r^2} = Y\frac{\Delta L}{L}$$

$$\boxed{\frac{F}{A} = Y\frac{l_f - L_i}{L_i}}$$

QUESTION

If the length of a wire is made double and radius is halved of its respective values. Then, the Young's modules of the material of the wire will: [JEE Mains-2022]

1. Remains same ($Y \rightarrow$ Prop of Solid)
2. Become 8 times its initial value
3. Become 1/4 of its initial value
4. Become 4 times its initial value

$L_f = 2L_0$

$\Delta L = 2L_0 - L_0 = L_0$

$r = r_0/2$

QUESTION

The ratio of radii of two wires of Young modulus same is 2 : 1. If these wires are stretched by equal force, the ratio of stresses produced in them is

1. 2 : 1
2. 1 : 2
3. 1 : 4
4. 4 : 1

$\frac{r_1}{r_2} = \frac{2}{1}$

$\text{stress} = \frac{F}{\pi r^2}$

$\frac{\text{stress}_1}{\text{stress}_2} = \frac{\cancel{F}\, r_2^2}{r_1^2 \cdot \cancel{F}} = \frac{1}{4}$

QUESTION

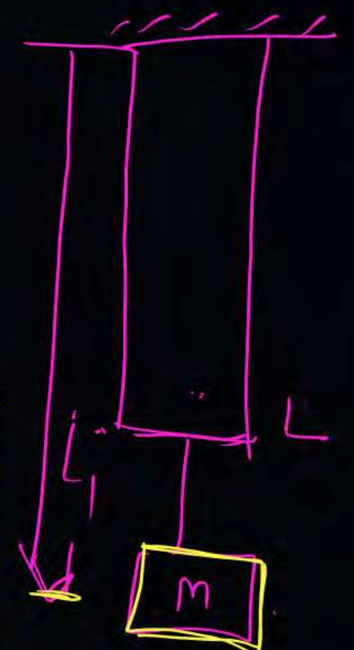
A wire of length L area of cross section A is hanging from a fixed support. The length of the wire changes to L_1 when mass M is suspended from its free end. The expression for Young's modulus is: (2020)

(NEET)

1. $\dfrac{Mg(L_1 - L)}{AL}$
2. $\dfrac{MgL}{AL_1}$
3. $\dfrac{MgL}{A(L_1 - L)}$ ✓
4. $\dfrac{MgL_1}{AL}$

$$\left\{ \frac{F}{A} = Y\frac{\Delta L}{L} \right\}$$

$$Y = \frac{FL}{A\,\Delta L} = \frac{MgL}{A(L_1 - L)}$$



QUESTION

The following four wires are made of the same material. Which of these will have the largest extension when the same tension is applied? [MR*] (2013)

γ = Same.

Δl

1. Length = 300 cm, diameter = 3 mm $\left(\frac{300}{9}\right)$

$D = 2r$

$r = D/2$

2. Length = 50 cm, diameter = 0.5 mm $\frac{50}{(1/2)^2} = 50 \times 4$

3. Length = 100 cm, diameter = 1 mm $\frac{100}{(1)^2}$

4. Length = 200 cm, diameter = 2 mm $\frac{200}{(2)^2} = \frac{200}{4} = 50$

$$\frac{F}{A} = \gamma \frac{\Delta l}{l}$$

$$\Delta l = \frac{F l}{\gamma A}$$

$$\Delta l \propto \left(\frac{l}{r^2}\right) = \frac{l}{\left(\frac{D}{2}\right)^2}$$

$$\boxed{\Delta l = \frac{l}{D^2}}$$

QUESTION

$\left\{\frac{F}{A} = Y\frac{\Delta l}{l}\right\}$

$\rightarrow A = 10^{-4} m^2$ $\boxed{1cm = 10^{-2} m}$

The force required to stretch a wire of cross section $1\ cm^2$ to double its length will be: (Given Young's modulus of the wire = $2 \times 10^{11}\ N/m^2$) [JEE Mains-2022]

1. 1×10^7 N
2. 1.5×10^7 N
3. 2×10^7 N ✓
4. 2.5×10^7 N

$l_f = 2l_0$

$\boxed{\Delta l = l_0}$

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

$$F = 10^{-4} \times 2 \times 10^{11} \left(\frac{\cancel{l_0}}{\cancel{l_0}}\right)$$

$$= \underline{2 \times 10^7}$$

QUESTION

γ = same

same volume

Two wires are made of the same material and have the same volume. The first wire has cross-sectional area A and the second wire has cross-sectional area 3 A. If the length of the first wire is increased by Δl on applying a force F, how much force is needed to stretch the second wire by the same amount? [MR*] (2018)

(NEET)

elongation same

1. 4 F
2. 6 F
3. 9 F
4. F

A→9

$$\frac{F}{A} = \gamma \frac{\Delta l}{l} \rightarrow \text{same}$$

$$F = \frac{\gamma \Delta l \, A}{l \times} \left(\frac{A}{A}\right)$$

volume

$F \propto A^2$

QUESTION

H/W

A 100 m long wire having cross-sectional area $6.25 \times 10^{-4}\ m^2$ and Young's modulus is $10^{10}\ Nm^{-2}$ is subjected to a load of 250 N, then the elongation in the wire will be [JEE Mains-2023]

F

A

1. 6.25×10^{-3} m
2. 4×10^{-4} m
3. 6.25×10^{-6} m
4. 4×10^{-3} m

$$\boxed{\frac{LF}{YA} = \Delta l}$$

QUESTION

The Young's modulus of steel is twice that of brass. Two wires of same length and of same area of cross section, one of steel and another of brass are suspended from the same roof. If we want the lower ends of the wires to be at the same level, then the weights added to the steel and brass wires must be in the ratio of:

(2015 Re)

1. 1 : 1
2. 1 : 2
3. 2 : 1
4. 4 : 1

Ans

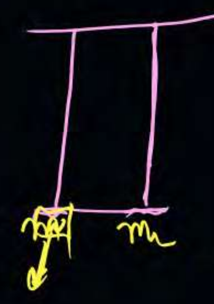
$Y_S = 2Y_B$

$l, A \rightarrow$ same

$\Delta l =$ same

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

$$\frac{F_S}{F_B} = \frac{Y_S}{Y_B} = \frac{2\cancel{Y_B}}{\cancel{Y_B}}$$

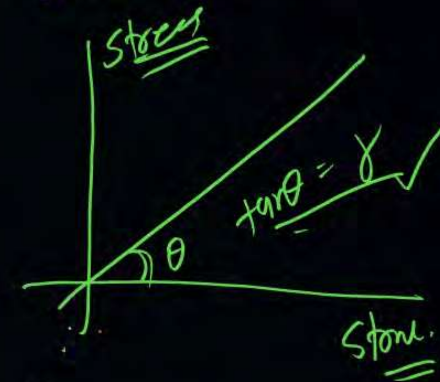


- Value of η, γ and β for perfectly elastic body is infinite.
- $\boxed{\eta \text{ and } \gamma}$ is not defined for fluid (liquid and gas)
- $\boxed{\beta_{solid} > \beta_{liquid} > \beta_{gas}}$
- Young modulus may increase or decrease by adding impurities.
- Slope of stress to strain curve is modulus of elastity
- $\boxed{\text{Young Modulus} \propto \dfrac{1}{\text{Temperature}} \propto \text{Slope}}$

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

$y = mx$

Stress $= Y$ strain



QUESTION

Select the incorrect statement about Bulk modulus of elasticity.

1. It is defined for solids, liquids and gases.

2. $B_{solid} > B_{liquid} > B_{gas}$

3. The bulk of gas is different for different processes.

4. Almost for all materials, the bulk modulus increases with the rise in temperature (Wrong)

QUESTION

With rise in temperature, the Young's modulus of elasticity

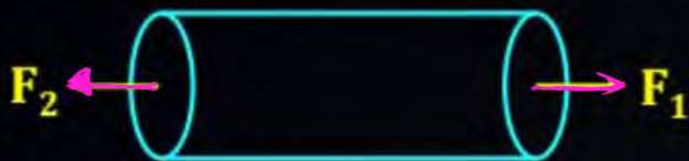
1. changes erratically
2. decreases
3. increases
4. remains unchanged

QUESTION

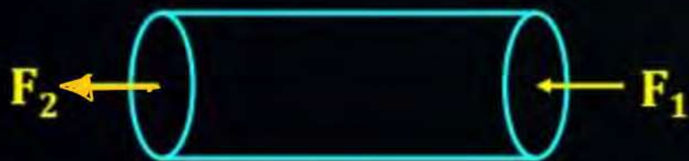
Find elongation in different case

$$\Delta l = \left(\frac{F+F}{2}\right) \times \frac{L}{A\gamma}$$

$$\boxed{\Delta l = \frac{FL}{A\gamma}}$$

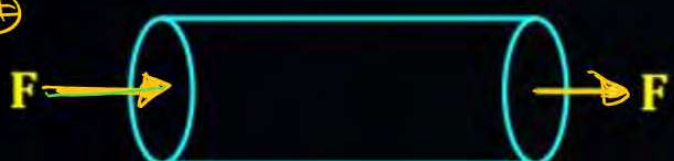


$$\boxed{\Delta l = \left(\frac{F_1+F_2}{2}\right)\frac{L}{A\gamma}}$$

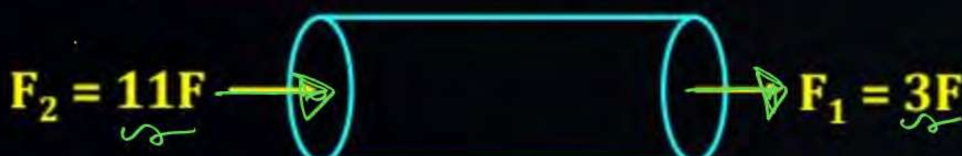


$$\Delta l = \left(\frac{F_1-F_2}{2}\right)\frac{L}{A\gamma}$$

#



$\Delta l = 0$



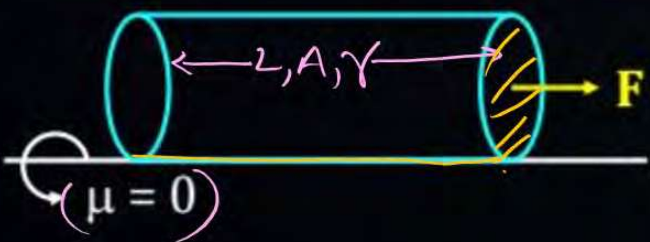
$$\Delta l = \left(\frac{11F-3F}{2}\right)\frac{L}{A\gamma}$$

$$\Delta l = \frac{4FL}{A\gamma}$$

QUESTION

Rod (M, L, γ)

Find elongation object placed on smooth surface.



$$\Delta l = \left(\frac{F+0}{2}\right)\frac{L}{A\gamma}$$

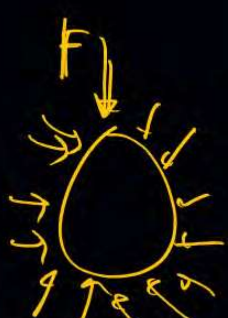
$$\Delta l = \frac{FL}{2A\gamma}$$

$$\boxed{\Delta l = 0}$$

$$\Delta l = \left(\frac{F_1 \pm F_2}{2}\right)\frac{L}{A\gamma}$$

Bulk Modulus in Different Process

Isobaric Process	Isochoric Process	Isothermal	Adiabatic Process
P = constant	V = constant	T = constant	$P\gamma^{r}$ = constant
$\Delta P = 0$	$\Delta V = 0$	PV = constant	$\beta = \gamma P$
$\beta = -\dfrac{\Delta P}{\Delta V/V} = 0$	β = Infinite	$\beta = P = \dfrac{\Delta P}{\left\lvert\frac{\Delta V}{V}\right\rvert}$	adiabatic



$$\frac{F}{A} = -\beta \frac{\Delta V}{V}$$

$$\boxed{\Delta P = -\beta \frac{\Delta V}{V}}$$

extra

$$\beta = \frac{\Delta P}{\left\lvert \frac{\Delta V}{V} \right\rvert}$$

QUESTION

If a rubber ball is taken at the depth of 200 m in a pool, its volume decreases by 0.1%. If the density of the water is $1 \times 10^3\ kg/m^3$ and $g = 10\ m/s^2$, then the volume elasticity in will be

1. 10^8
2. 2×10^8
3. 10^9
4. 2×10^9 ✓

JEE-2025

$$\boxed{\Delta P = -\beta\left(\frac{\Delta V}{V}\right)}$$

$$\frac{\Delta V}{V} \times 100 = 0.1$$

$$\frac{\Delta V}{V} = \frac{0.1}{100}$$

$$\beta = \frac{\Delta P}{\frac{\Delta V}{V}} = \frac{\rho g h}{1/1000} = 10^3 \times 10 \times 200 \times 10^3$$

$$= 2 \times 10^9$$

QUESTION

The bulk modulus of a spherical objects is 'B'. If it is subjected to uniform pressure 'P', the fractional decrease in radius is: (2017-Delhi)

NEET

1. $\frac{B}{3P}$

2. $\frac{3P}{B}$

3. $\frac{P}{3B}$

4. $\frac{P}{B}$

$V = \frac{4}{3}\pi R^3$

error arm

$\frac{\Delta V}{V} = 3\left(\frac{\Delta R}{R}\right)$

$\Delta P = \beta \frac{\Delta V}{V}$

$\Delta P = \beta\, 3\left(\frac{\Delta R}{R}\right)$

$\Delta P = \beta \frac{\Delta V}{V}$

$\frac{\Delta V}{V} = \frac{\Delta P}{\beta} = 3\left(\frac{\Delta R}{R}\right)$

$\frac{P}{3\beta} = \frac{\Delta R}{R}$

QUESTION

The approximate depth of an ocean is 2700 m. The compressibility of water is 45.4×10^{-11} Pa^{-1} and density of water is 10^3 kg/m^3. What fractional compression of water will be obtained at the bottom of the ocean? [MR*] (2015)

NEET

1. 1.0×10^{-2}
2. $\boxed{1.2 \times 10^{-2}}$ MR* Ans
3. 1.4×10^{-2}
4. $\cancel{0.8 \times 10^{-2}}$

$K = \frac{1}{\beta} = 45.4 \times 10^{-11}$ $P = \rho g h$

$\frac{\Delta P}{\beta} = \frac{\Delta V}{V}$

$(\rho g h K) = \left(\frac{\Delta V}{V}\right)$

$\frac{\Delta V}{V} = 10^3 \times 10 \times 2700 \times 10^{-11} \times 45.4$

$= 27 \times 45.4 \times 10^{-5}$

454 × 27 = 3178 + 908 = 12258

2

QUESTION

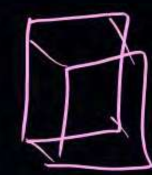
H/W $= 4\times10^{9}$ Pa

A cube of metal is subjected to a hydrostatic pressure of 4 GPa. The percentage change in the length of the side of the cube is close to (Given bulk modulus of metal, $B = 8 \times 10^{10}$ Pa)

[JEE Mains-2020]

1. 0.6
2. 20
3. 1.67
4. 5

$P = 4\times10^{9}$ Pa



$P = \beta \times 3\frac{\Delta l}{l}$

$V = l^3$

$\frac{\Delta V}{V} = \frac{3\Delta l}{l}$

$\frac{\Delta l}{l} = \frac{P}{3\beta} = \frac{4\times10^{9}}{3\times8\times10^{10}}$

$= \frac{1}{6\times10}$

$= \frac{100}{60}\times10^{-2} = 1.67\times10^{-2}$

$100 \times \frac{\Delta l}{l} = 1.67\times10^{-2}\times100$

QUESTION

H/W

The bulk modulus of a liquid is $3 \times 10^{10}\ Nm^{-2}$. The pressure required to reduce the volume of liquid by 2% is: [JEE Mains-2022]

1. $3 \times 10^{8}\ Nm^{-2}$
2. $9 \times 10^{8}\ Nm^{-2}$
3. $6 \times 10^{8}\ Nm^{-2}$
4. $12 \times 10^{8}\ Nm^{-2}$

$100 \times \frac{\Delta V}{V} = 2$

$\frac{\Delta V}{V} = \frac{2}{100}$

$\Delta P = \beta \frac{\Delta V}{V}$

$= 3 \times 10^{10} \times \frac{2}{\cancel{100}}$

$= 6 \times 10^{8}$

QUESTION

H/W

The increase in pressure required to decrease the volume of a water sample by 0.2% is $P \times 10^5 Nm^{-2}$. Bulk modulus of water is $2.15 \times 10^9 Nm^{-2}$. The value of P is ______.

JEE-2025

Same question

1. 107.5
2. 232.5
3. 43
4. 430

QUESTION

H/W

The volume contraction of a solid copper cube of edge length 10 cm, when subjected to a hydraulic pressure of 7×10^6 Pa, would be____ mm^3. (Given bulk modulus of copper $= 1.4 \times 10^{11}\ N\ m^{-2}$)

(JEE-2025)

1. $200\ mm^3$
2. $100\ mm^3$
3. $198\ mm^3$
4. $50\ mm^3$

H/W
Sol → 36

QUESTION

H/W

JEE-2025

The fractional compression $\left(\frac{\Delta V}{V}\right)$ of water at the depth of 2.5 km below the sea level is ________ %. Given, the Bulk modulus of water $= 2 \times 10^9\ N\,m^{-2}$, density of water $= 10^3 kgm^{-3}$, acceleration due to gravity $= g = 10\ ms^{-2}$.

1. 1.25
2. 1.0
3. 1.25 $\times 10^{-2}$ ✓
4. 1.0

$$\frac{\Delta V}{V} = \frac{P}{\beta}$$

$$= \frac{\rho g h}{\beta} = \frac{\cancel{10^3} \times \cancel{10} \times 2.5 \times \cancel{10^3}}{2 \times \cancel{10^9}\ 10^2}$$

$$= \frac{1.25}{10^2}$$

$h = 2.5 \times 10^3\ m$

$B = 2 \times 10^9$

$P = \rho g h$

(NEET)

Elongation in a massless wire due to attached weight

Wire (A, L, γ)

mass of wire = 0

Stress $= \frac{mg}{A}$

same at all Point of Rod

$$\Delta l = \frac{Fl}{A\gamma}$$

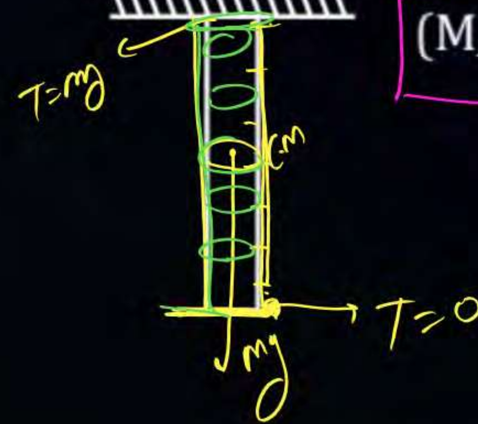
$$\boxed{\Delta l = \frac{mgl}{A\gamma}}$$

NEET - 2020

Elongation in a massive rod, due to its own weight

(M, A, L, γ)

Wire have mass



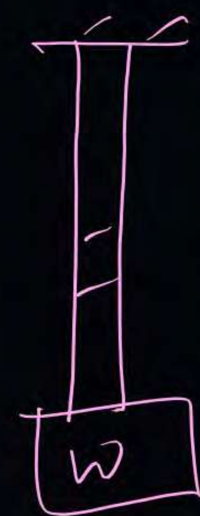
$$\Delta l = \left(\frac{F_1 + F_2}{2}\right)\frac{L}{A\gamma}$$

$$\boxed{\Delta l = \frac{mgL}{2A\gamma}}$$

QUESTION

Let a wire be suspended from the ceiling (rigid support) and stretched by a weight W attached at its free end. The longitudinal stress at any point of cross-sectional area A of the wire is: (2023)

1. Zero ✗
2. $\frac{2W}{A}$
3. $\frac{W}{A}$ ✓ → W_{ext} weigh ✓
4. $\frac{W}{2A}$



QUESTION

A rod of uniform cross sectional area A and length L has a weight W. It is suspended vertically from a fixed support. If Young's modulus for rod is Y, then elongation produced in rod is

1. $\frac{WL}{YA}$

2. $\frac{WL}{2YA}$

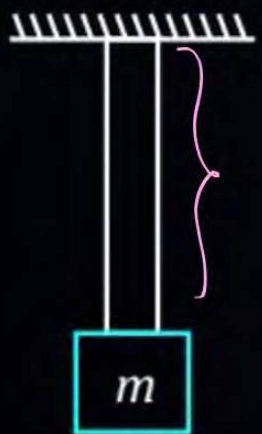
3. $\frac{WL}{4YA}$

4. $\frac{3WL}{4YA}$

QUESTION

Wire (M, A, L, γ)

Find elongation in wire.

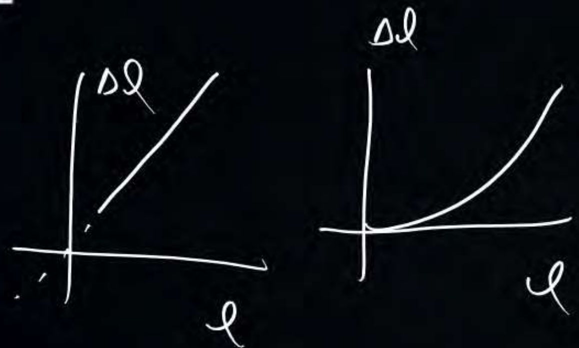


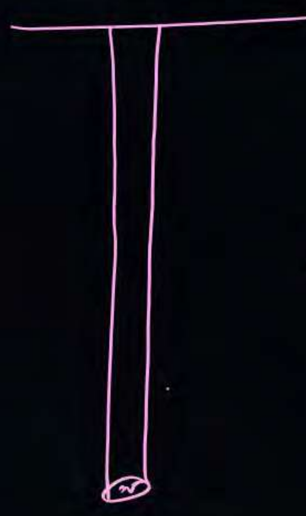
$$\Delta l = \underbrace{\frac{mgL}{A\gamma}}_{\text{extern}} + \underbrace{\frac{MgL}{2A\gamma}}_{\text{own wei}} = \frac{gL}{A\gamma}\left(m+\frac{M}{2}\right)$$

QUESTION

Copper of fixed volume V is drawn into wire of length l. When this wire is subjected to a constant force F, the extension produced in the wire is D_1. Which of the following graphs is a straight line? (2014)

1. Δl versus $1/l$
2. Δl versus l^2
3. Δl versus $1/l^2$
4. Δl versus l^3





$$\Delta l = \frac{Fl}{AY} = \frac{mgl}{2AY}$$

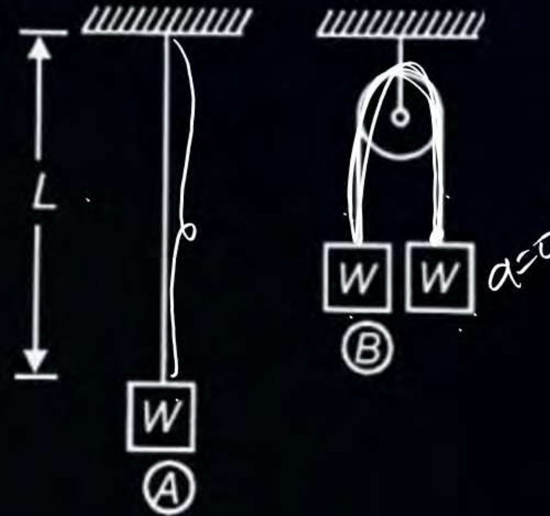
$$\Delta l = \frac{mgl}{2AY} \times \left(\frac{l}{l}\right)$$

$$\boxed{\Delta l \propto l^2} \quad \Delta l = \frac{mg\, l^2}{2 \cdot \text{Volum}\, Y}$$

QUESTION

If in case A, elongation in wire of length L is l, then for same wire elongation in case B will be

1. $4l$
2. $2l$
3. l
4. $l/2$



QUESTION

NEET-2019

Two wires of diameter 0.25 cm, one made of steel and other made of brass, are loaded as shown in the figure. The unloaded length of the steel wire is 1.5 m and that of brass is 1.0 m. Young's modulus of steel is 2.0×10^{11} Pa and that of brass is 1.0×10^{11} Pa. Compute the ratio of elongations of steel and brass wires.

$\frac{\Delta l_{steel}}{\Delta l_{brass}} = ?$

1. 0.8
2. 1.25
3. 1
4. 0.5

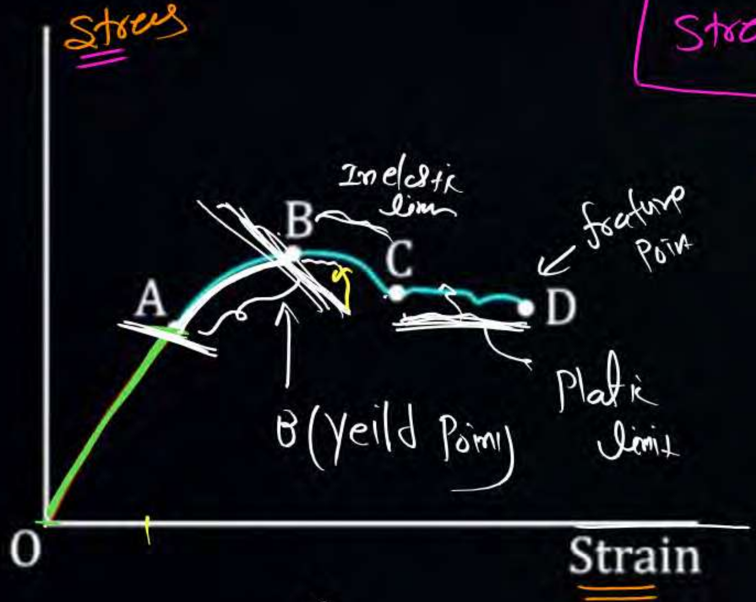
$\Delta l_s = \frac{Fl}{AY}$

$= \frac{10g(1.5)}{A\,2\times10^{11}}$

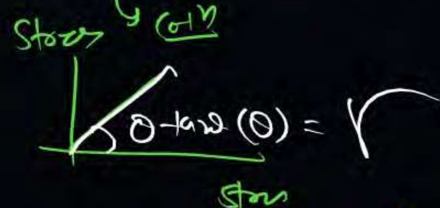
$\Delta l_B = \frac{6g(1)}{A\times1\times10^{11}}$

$= \frac{5}{4} = 1.25$

Stress – Strain - Curve



$$\boxed{\text{Stress} = Y\ \text{strain}}$$



$\tan(\theta) = Y$

OA → Propotion limit
Hooks law valid ✓

A → B (elastic limit)
→ Shape regain

(CD) lge → Ductile
(CD) small → Brittle material

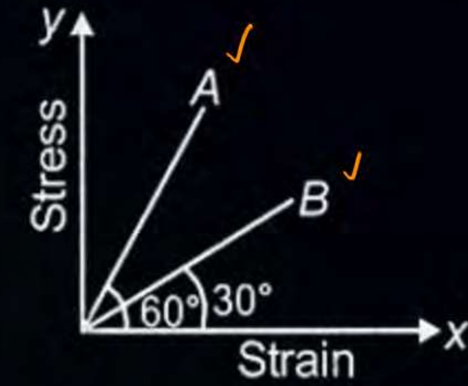
?? why not this ??

	OA	AB	BC	CD
Region name	Propotional Limit	Elastic Limit	Inelastic	Plastic Region
Hooks चाचा	Valid	Not valid	Not valid	No
Elastic force	Conservative	Conservative	Non-conservative	Non-conservative
Shape	Compt. Region	Compt. Region	Partial region	No region

QUESTION

The stress versus strain graph for wires of two materials A and B are as shown in the figure. If Y_A and Y_B are the Young's moduli of the materials, then

1. $Y_B = 2Y_A$
2. $Y_A = 3Y_B$
3. $Y_B = 3Y_A$
4. $Y_A = Y_B$



$$\frac{Y_A}{Y_B} = \frac{\tan 60°}{\tan 30°} = \frac{\sqrt{3}}{1/\sqrt{3}}$$

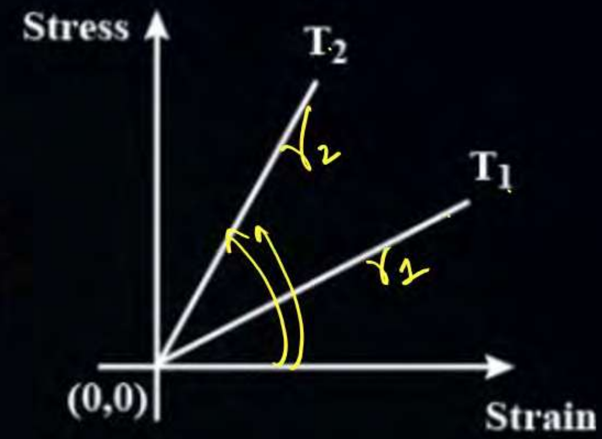
$$\frac{Y_A}{Y_B} = \frac{3}{1}$$

QUESTION

Figure shows graph between stress and strain for a uniform wire at two different temperatures. Then

1. $T_1 > T_2$
2. $T_2 > T_1$
3. $T_1 = T_2$
4. None of these

$\gamma \propto \frac{1}{\text{stress}} \propto \text{slope}$

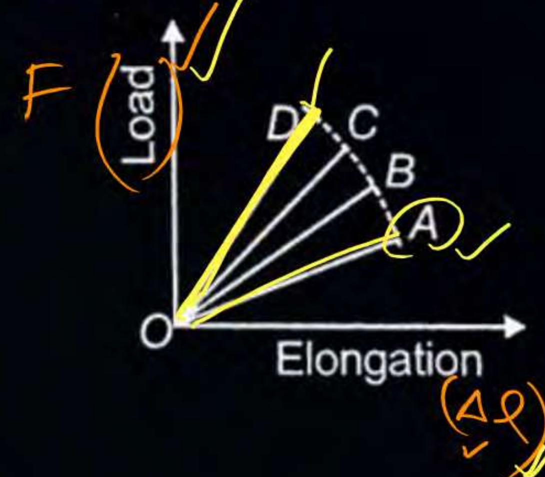


QUESTION

The load versus elongation graph for four wires of same length and the same material is shown in figure. The thinnest wire is represented by line .

पतला wire

1. OC
2. OD
3. OA
4. OB



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

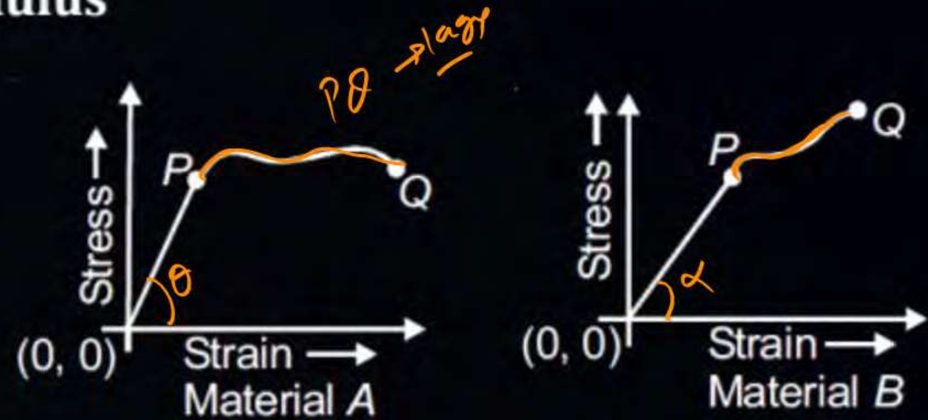
$$\text{Slope} = \left(\frac{F}{\Delta l}\right) = \frac{AY}{l}$$

same

QUESTION

The stress-strain graphs for two materials A and B are shown in figure. The graphs are drawn to the same scale. Select the correct statement

1. Material A has greater Young's Modulus
2. Material A is ductile
3. Material B is brittle
4. All of these



$\boxed{\theta > \alpha}$

A + (4)

QUESTION

The stress-strain curves are drawn for two different materials X and Y. It is observed that the ultimate strength point and the fracture point are close to each other for material X but are far apart for material Y. We can say that materials X and Y are likely to be (respectively) [Odisha NEET 2019]

1. Ductile and brittle
2. Brittle and ductile
3. Brittle and plastic
4. Plastic and ductile

D

X → Britl

Y → ductile

Breaking Force and Breaking Stress

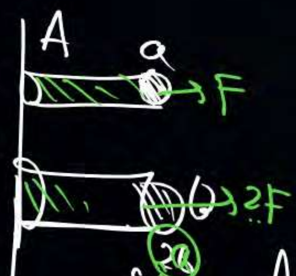
$\boxed{\text{Breaking Force} \propto \text{Area}}$

$F = \sigma A$

$\boxed{\sigma = F/A}$ → Proto.

→ Breaking stress properties of material does not depends on area.

Breaku force ∝ Area



Breaku force = σ Area

$\sigma = \frac{\text{Break F}}{\text{Area (A}}$

Propter (of)' (material depen)

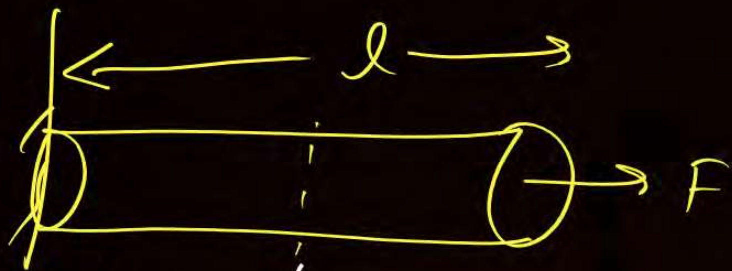
Same mater (Break stress)

QUESTION

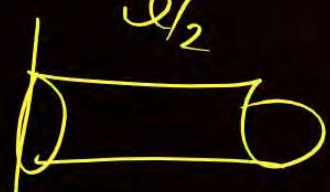
A force F is needed to break a copper wire having radius R. The force needed to break a copper wire of radius 2R will be:

1. $F/2$
2. $2F$
3. $4F$
4. $F/4$

$F \propto$ Area $= \pi R^2$



Break in Half

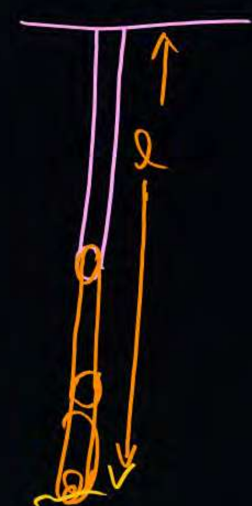


→ Break force (F)

QUESTION

The breaking stress of aluminium is $\boxed{7.5 \times 10^7\ \text{N}}\ \text{m}^{-2}$. The greatest length of aluminium wire that can hang vertically without breaking is
(Density of aluminium is $2.7 \times 10^3\ \text{kg m}^{-3}$

1. 283×10^3 m
2. 28.3×10^3 m
3. 2.83×10^3 m Ans
4. 0.0283×10^3 m



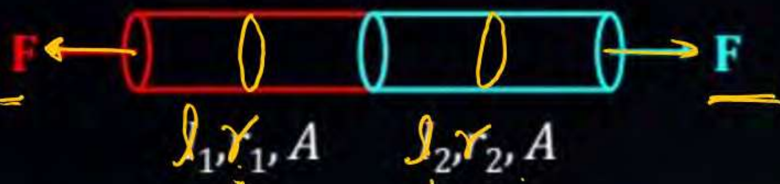
$$\text{stress} = \frac{(mg)}{A}$$

$$\text{stress} = \frac{\rho \cancel{A} L g}{\cancel{A}}$$

$$L_{max} = \frac{\text{stress}}{\rho g}$$

$$= \frac{7.5 \times 10^7}{2.7 \times 10^3 \times 10}$$

Series Combination of Rod



Stress same, elongation different

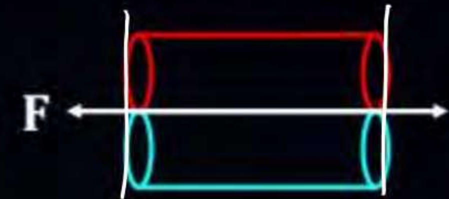
$$\boxed{r_{eq} = \frac{2r_1 r_2}{r_1 + r_2}}$$

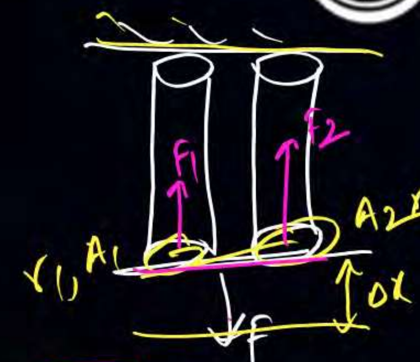
$\Delta l = \Delta l_1 + \Delta l_2$

MR Rod

Poissio rah

Parallel Combination





Same Elongation /Strain,
(different stress)

$$\boxed{r_q = \frac{r_1 + r_2}{2}}$$

$F = F_1 + F_2$

Parallel

Not imp for (NEET)

QUESTION

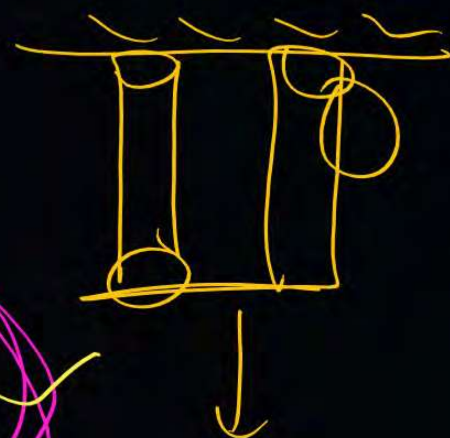
Wires of equal length and cross-sectional area are suspended as shown in figure. Their Young's moduli are Y, and Y, respectively. The equivalent Young's moduli will be

1. $Y_1 + Y_2$

2. $\dfrac{Y_1 Y_2}{Y_1 + Y_2}$

3. $\dfrac{Y_1 + Y_2}{2}$

4. $\sqrt{Y_1 Y_2}$



MR*

$Y_1 = Y_2 = Y$

$Y_{eq} = Y$

QUESTION

A copper wire and a steel wire of the same diameter and length are connected end to end a force is applied, which stretches their combined length 1 cm. The two wires will have → series

elongation → diff

Stress →

1. Different stresses and strains
2. The same stress and strain
3. The same strain but different stresses
4. The same stress but different strains

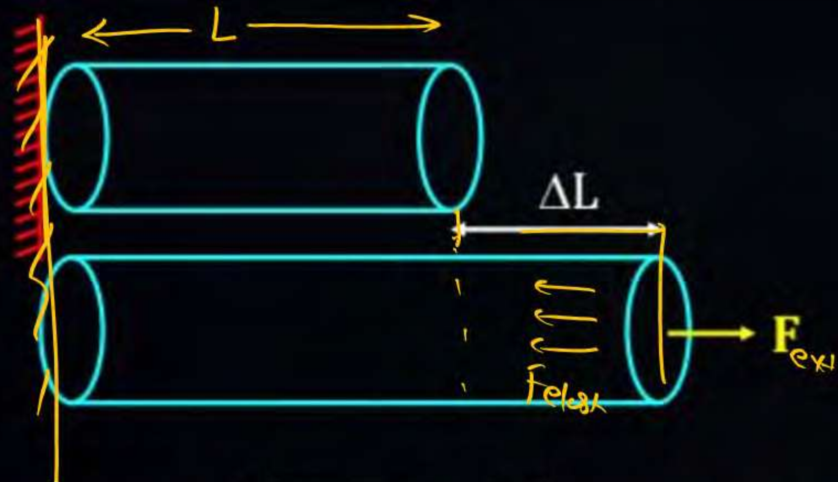
Ans (4)

QUESTION

A wire can sustain a weight of 15 kg. If it cut into four equal parts, then each part can sustain a weight

1. 5 kg
2. 45 kg
3. 15 kg → Ans ✓
4. 30 kg

Elastic Potential Energy



direct

work by ela. $= \frac{1}{2} F \Delta l$

Work done by elastic force from elongate 0 to ΔL

$\boxed{\text{Work} = \frac{1}{2} F\Delta L}$ = $\underbrace{\text{Stored Potential Energy}}$

❖ MR* → Dimension of Stress, Energy density, Young modulus is same

MR* dimⁿ same

$$E = \frac{1}{2} F \Delta l^{*}$$

divided by (AL) both side

$$\frac{E}{AL} = \frac{1}{2} \frac{F}{A} \times \frac{\Delta l}{l}$$

$$\boxed{\text{energy density } U = \frac{1}{2}\, \text{stress} \times \text{strain}}$$

F → elastic force = Fel

Δl = elongation

total energy

$AL\,U = \frac{1}{2}$ stress × strain × AL ✓

$$\boxed{U = \frac{1}{2}\, \text{stress} \times \text{strain}}$$

Hooks stress = Y strain

$$U = \frac{1}{2} Y \cdot (\text{strain})^2$$

$$\boxed{U = \frac{1}{2} \frac{(\text{stress})^2}{Y}}$$

$$U = \frac{1}{2}\ \text{stress} \times \text{strain}$$

$$U = \frac{1}{2}\frac{(\text{stress})^2}{Y}$$

$$\boxed{U = \frac{1}{2}(\text{strain})^2\, Y}$$

QUESTION

A wire $\boxed{2\ \text{m}}$ in length suspended vertically stretches by 10 mm when mass of 10 kg is attached to the lower end. The elastic potential energy gain by the wire is (take $g = 10\ \text{m/s}^2$)

Δl

1. 0.5 J ✓
2. 5 J
3. 50 J
4. 500 J

$F = mg$

$U = \frac{1}{2} mg(\Delta L)$

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

$= \frac{1}{2} = 0.5\ \text{J}$

QUESTION

NEET → 2021

When a block of mass M is suspended by a long wire of length L, the length of the wire becomes $(L + l)$. The elastic potential energy stored in the extended wire is:

$\Delta l = l$

1. $\frac{1}{2}MgL$
2. Mgl
3. MgL
4. $\frac{1}{2}Mgl$

$E = \frac{1}{2} mg l$

A-2

QUESTION

When a uniform metallic wire is stretched the lateral strain produced in it is β. If v and Y are the Poisson's ratio and Young's modulus for wire, then elastic potential energy density of wire is

1. $\frac{Y\beta^2}{2}$

2. $\frac{Y\beta^2}{2v^2}$

3. $\frac{Yv\beta^2}{2}$

4. $\frac{Yv^2}{2\beta}$

$\sigma = \frac{\left(\frac{\Delta R}{R}\right)}{\left(\frac{\Delta l}{l}\right)} = \frac{\text{lateral strain}}{\text{logitu...}}$

Y/v

$U = \frac{1}{2}(\text{strain}) \times \text{stress}$

QUESTION

Energy stored per unit volume in a stretched wire having Young's modulus Y and stress 'σ' is

1. $\frac{Y\sigma}{2}$

2. $\frac{\sigma^2 Y}{2}$

3. $\frac{\sigma^2}{2Y}$

4. $\frac{\sigma}{2Y}$

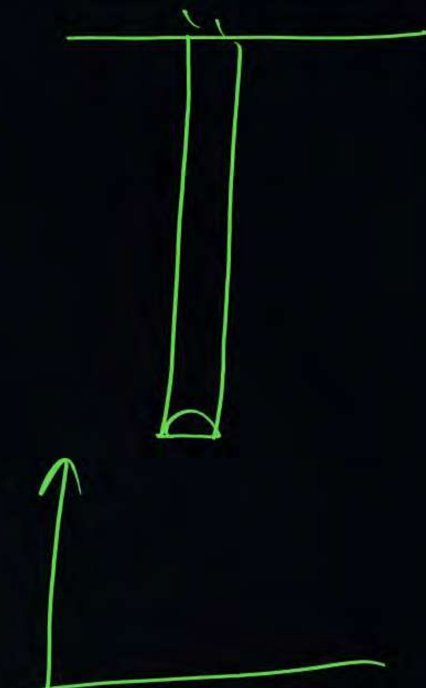
$dim^n \longrightarrow$

QUESTION

H/W

A 5 metre long wire is fixed to the ceiling. A weight of 10 kg is hung at the lower end and is 1 metre above the floor. The wire was elongated by 1 mm. The energy stored in the wire due to stretching is:

1. Zero
2. 0.05 joule
3. 100 joule
4. 500 joule



$$E = \frac{1}{\cancel{2}} \times \overset{5}{\cancel{10}} \times 10 \times 10^{-3}$$

$$= 5 \times 10^{-2}$$

QUESTION

H|W

If E is the energy stored per unit volume in a wire having Young's modulus of the material Y, then stress applied is:

1. $\sqrt{2EY}$
2. $2\sqrt{EY}$
3. $\frac{1}{2}\sqrt{EY}$
4. $\frac{3}{2}\sqrt{EY}$

$E = \frac{\text{str}^2}{2Y}$

$\text{str} = \sqrt{2EY}$

Elongation and Compression

B/H curve
magnet & Demag

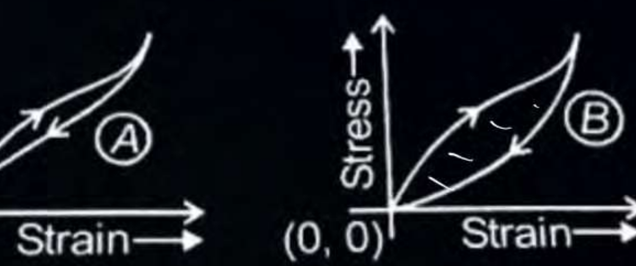
With elastic region (Atora)
(Aorta)

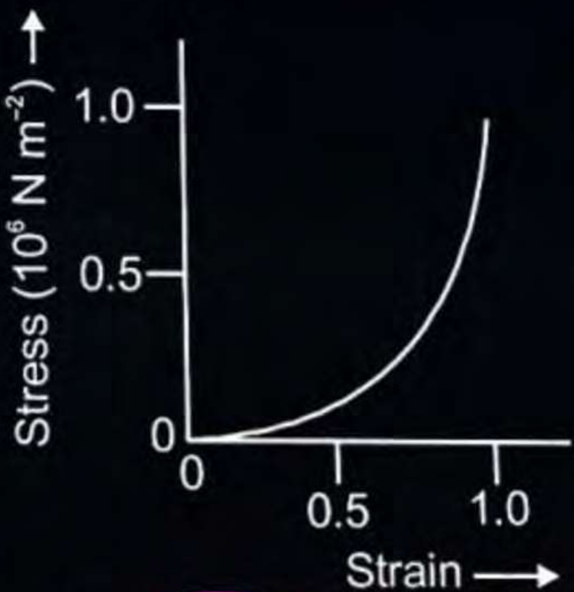
Area = energy loss

QUESTION

Two different types of rubber are found to have the stress-strain curves as shown. Then

1. A is suitable for shock absorber
2. B is suitable for shock absorber
3. B is suitable for car tyres
4. None of these

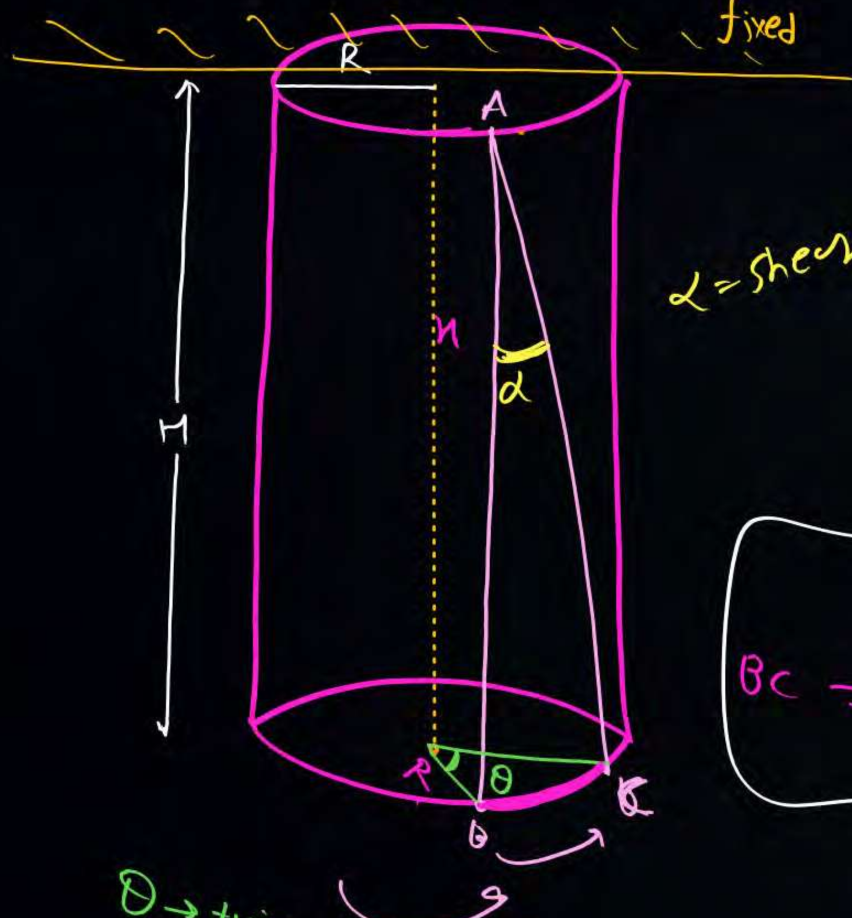




Stress-strain curve for the elastic tissue of Aorta, the large tube (vessel carrying blood from the heart).

❖ Relation between Shear Angle and Twist Angle

(Not for NEET)



α = shear Angle

$\theta \rightarrow$ twist Angle

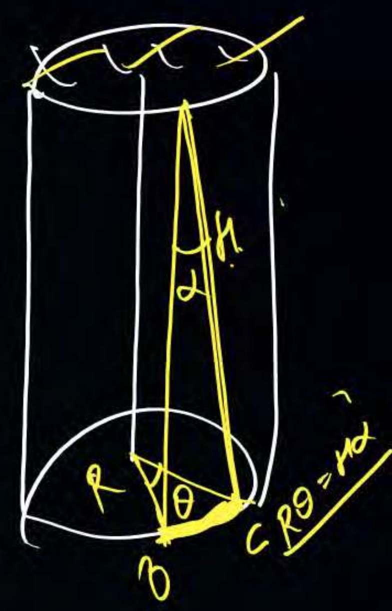
$$BC = R\theta = H\alpha$$

twist Angle

Shear Angle

$$U = \frac{1}{2} C \theta^2$$

torsion



$C \quad R\theta = H\alpha$

QUESTION

Two equal and opposite forces each of magnitude F is applied along a rod of transverse sectional area A. The normal stress to a section PQ inclined to transverse section is

normal (logic)

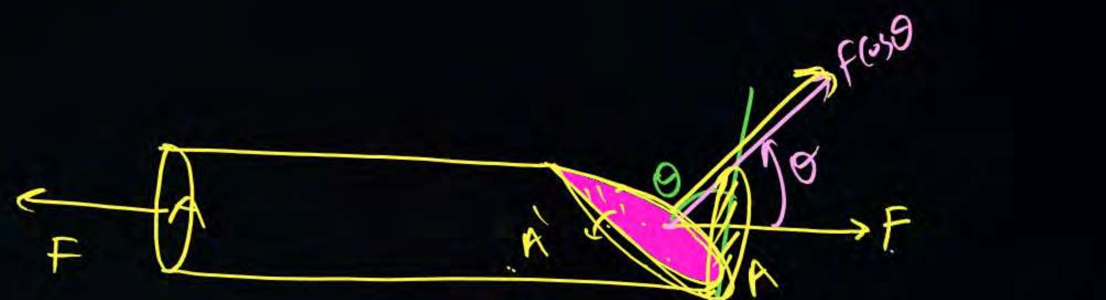
1. $\frac{F\sin\theta}{A}$

2. $\frac{F}{A}\cos\theta$

3. $\frac{F}{2A}\sin 2\theta$

4. $\frac{F}{A}\cos^2\theta$

Ans

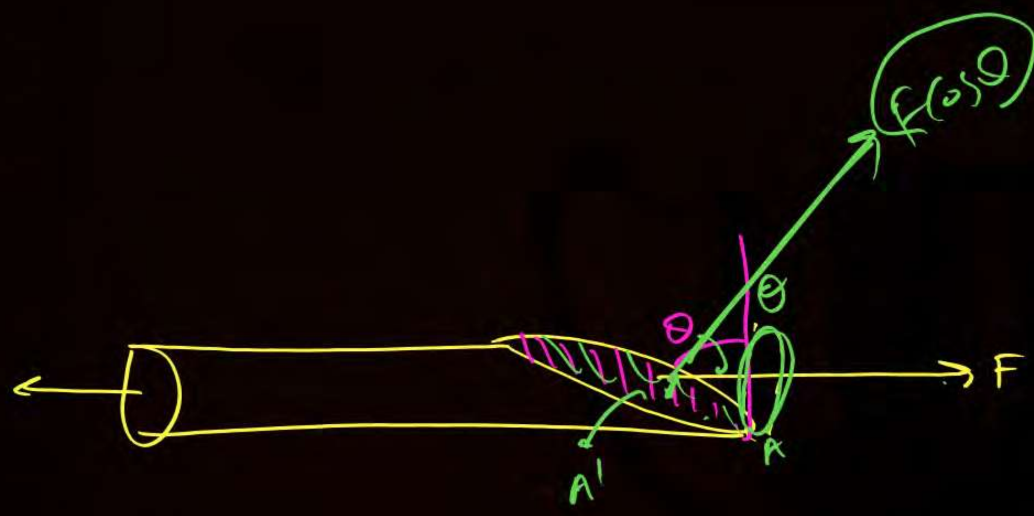


$\cancel{A\cos\theta = A'}$

$\boxed{A'\cos\theta = A}$

$A' = \frac{A}{\cos\theta}$

$\text{Stress} = \frac{F\cos\theta}{A'} = \frac{F\cos\theta}{A/\cos\theta} = \frac{F\cos^2\theta}{A}$



$$\text{Stress} = \frac{F\cos\theta}{A'}$$

$$= \frac{F\cos\theta}{A/\cos\theta}$$

$$= \frac{F}{A}\cos^2\theta$$

$$A'\cos\theta = A$$

$$A' = \frac{A}{\cos\theta}$$