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India's Number 1 Education App

PHYSICS

BOOKS - MBD

MECHANICAL PROPERTIES OF SOLIDS

Example

1. What is the value of Young's modulus for a perfectly rigid body?

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2. What is meant by elasticity?

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3. What is plastic? What are its different types?

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4. State Hooke's law.

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5. Which of the two forces deforming or restoring is responsible for elastic behaviour of a substance?

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6. What is the value of Young's modulus for a perfectly rigid body?

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7. What is stress ? Give its S.I. Unit.

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8. Why springs are made of steel and not of copper?

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9. Why do we prefer steel to manufacture a spring?

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10. On what factors, the modulus of elasticity depends?

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11. On what fctors, the elastic limit of a material depends?

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12. Our knowledge about crystalline solids be better than amorphous solids. why?

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13. When does a body acquire a permanent set?

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14. Which of the three elastic moduli possible in all the three states of matter?

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15. Which of the solids are the hardest?

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16. WRite copper, steel, rubber and glass in the increasing order of their elasticity.

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17. An elastic wire is cut to half its original length. How would it affect the maximum load that the wire can support?

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18. Some work has to be done in streching a wire. Why? What happens to the energy given to the wire in this process?

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19. Why do spring balances show wrong readings after they have been used for a long time?

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20. A steel wire of length 4.7 m and cross-sectional area $3.0 \times 10^{-5} m^2$ stretches by the same amount as a copper wire of length 3.5 m and cross-sectional area of $4.0 \times 10^{-5} M^2$ under a given load. What is the ratio of the Young's modulus of steel to that of copper?

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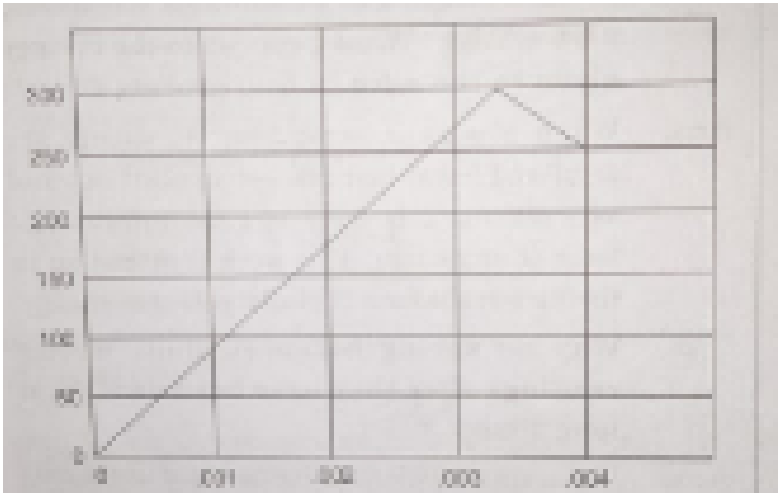
21. The given figure shows the strainstress curve for a given material. What are Young's

modulus



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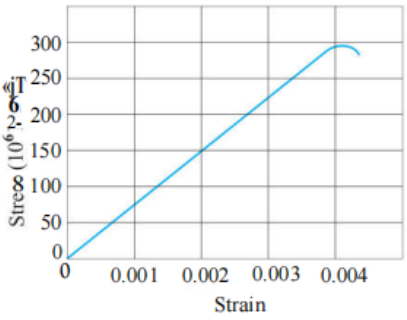
22. Figure 9.11 shows the strain-stress curve for a given material. What are approximate yield

strength for this material:



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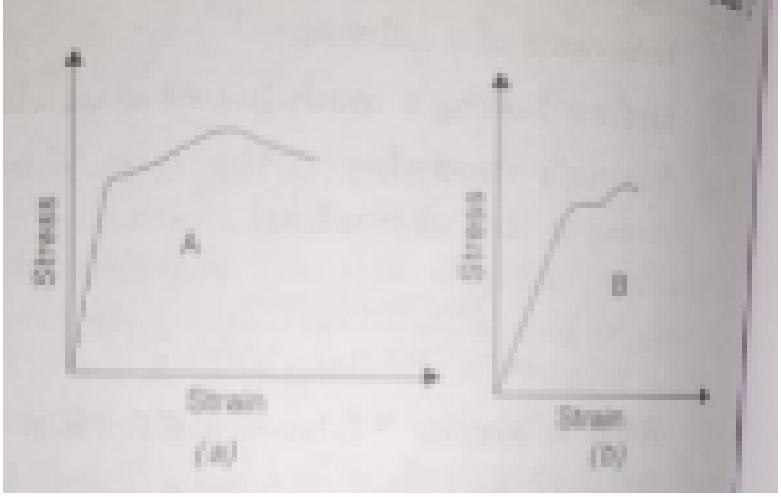
23. The stress-strain graphs for materials A and B for two materials are show in the figure



Which material has greater Young's modulus?

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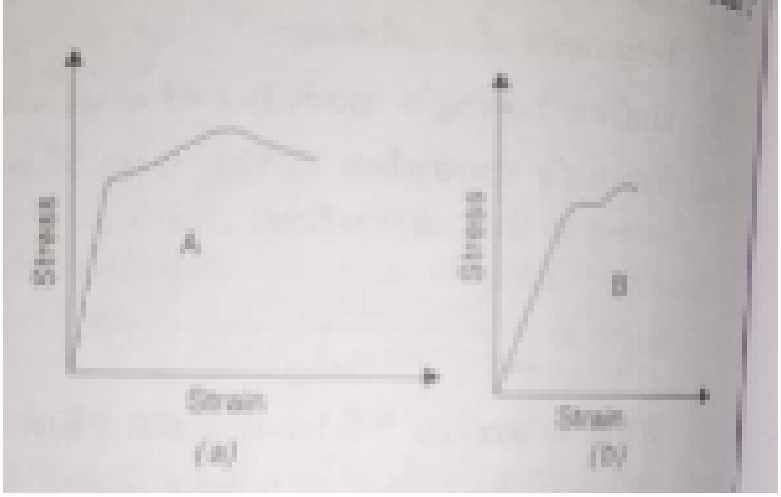
24. The stress-strain graphs for materials A and B for two materials are show in the figure



Which of the two is the stronger material?

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25. Read the following two statements below carefully and state, with reasons, if it is true or false. The Young's modulus of rubber is greater than that of steel,

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26. Read the following two statements below carefully and state, with reasons, if it is true or false. The stretching of a coil is determined by its shear modulus.

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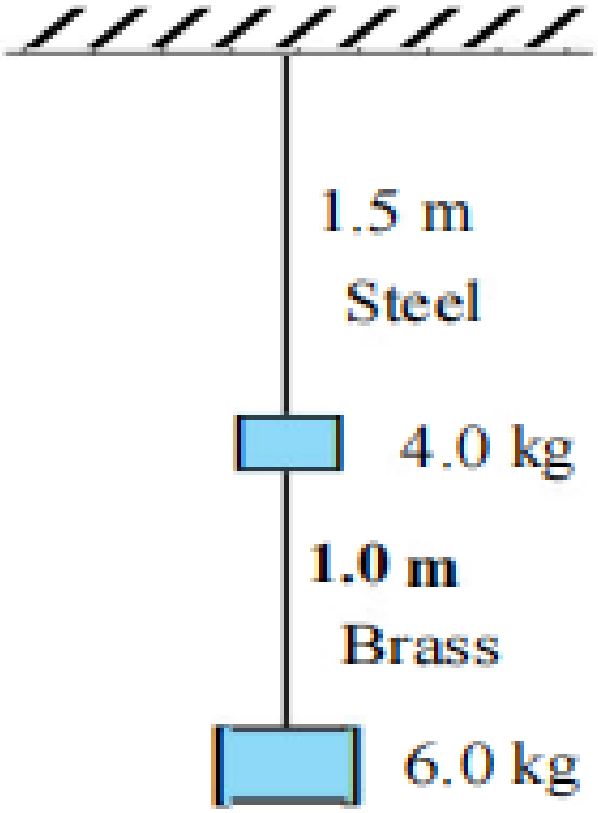
27. Two wires of diameter 0.25 cm, one made of steel and the other made of brass are loaded

as shown in Fig. 9.13. The unloaded length of steel wire is 1.5 m and that of brass wire is 1.0 m. Compute the elongations of the steel and the brass wires:



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28. The edge of an aluminium cube is 10 cm long. One face of the cube isfirmly fixed to a vertical wall. A mass of 100 kg is then attached to the opposite face of the cube. The shear modulus of aluminium is 25 GPa. What is the vertical deflection of this face?

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29. Four identical hollow cylindrical columns of mild steel support a big structure of mass

50,000 kg. The inner and outer radii of each column are 30 and 60 cm respectively. Assuming the load distribution to be uniform, calculate the compressional strain of each column.

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30. A piece of copper having a rectangular cross-section of $15.2mm \times 19.1mm$ is pulled in tension with 44,500 N force, producing only

elastic deformation. Calculate the resulting strain?

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31. A steel cable with a radius of 1.5 cm supports a chairlift at a ski area. If the maximum stress is not to exceed $10^8 Nm^{-2}$, what is the maximum load the cable can support ?

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32. A rigid bar of mass 15 kg is supported symmetrically by three wires each 2.0 m long. Those at each end are of copper and the middle one is of iron. Determine the ratios of their diameters if each is to have the same tension.

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33. A 14.5 kg mass, fastened to the end of a steel wire of unstretched length 1.0 m, is whirled in a vertical circle with an angular

velocity of 2 rev/s at the bottom of the circle. The cross-sectional area of the wire is 0.065 cm^2. Calculate the elongation of the wire when the mass is at the lowest point of its path.

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34. Compute the bulk modulus of water from the following data: Initial volume = 100.0 litre, Pressure increase = 100.0 atm (1 atm = 1.013×10^5 Pa). Final volume = 100.5 litre.

Compare the bulk modulus of water with that of air (at constant temperature). Explain in simple terms why the ratio is so large.

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35. What is the density of water at a depth where pressure is 80.0 atm, given that its density at the surface is $1.03 \times 103 kgm^{-3}$?

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36. Compute the fractional change in volume of a glassslab, when subjected to a hydraulic pressure of 10 atm.

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37. Determine the volume contraction of a solid copper cube, 10 cm on an edge, when subjected to a hydraulic pressure of 7.0×10^6 Pa.

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38. How much should the pressure on a litre of water be changed to compressit by 0.10%?

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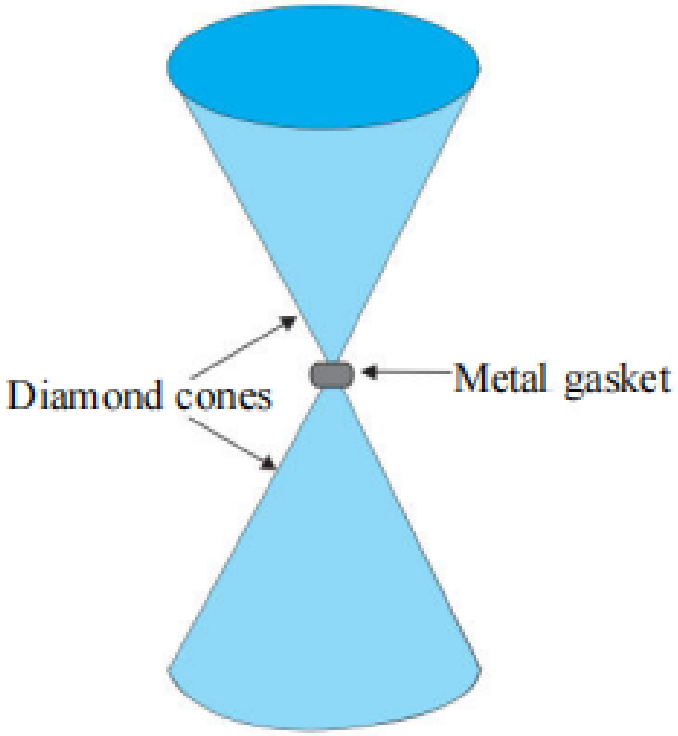
39. Anvils made of single crystals of diamond, with the shape as shown in Fig. 9.14, are used to investigate behaviour of materials under very high pressures. Flat faces at the narrow end of the anvil have a diameter of 0.50 mm, and the wide ends are subjected to a

compressional force of 50,000 N. What is the pressure at the tip of the anvil?:



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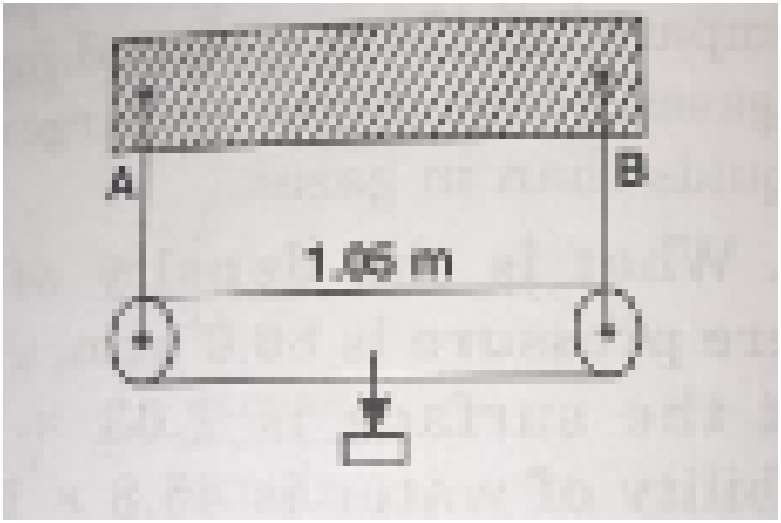
40. A rod of length 1.05 m having negligible mass is supported at its ends by two wires of steel (wire A) and aluminium (wire B) of equal length as shown in the figure The cross sectional area of wires A and B are $1.0mm^2$ and $2.0mm^2$, respectivley. AT wat point along the rod should a mass m be suspended in

order to produce .equal stresses.



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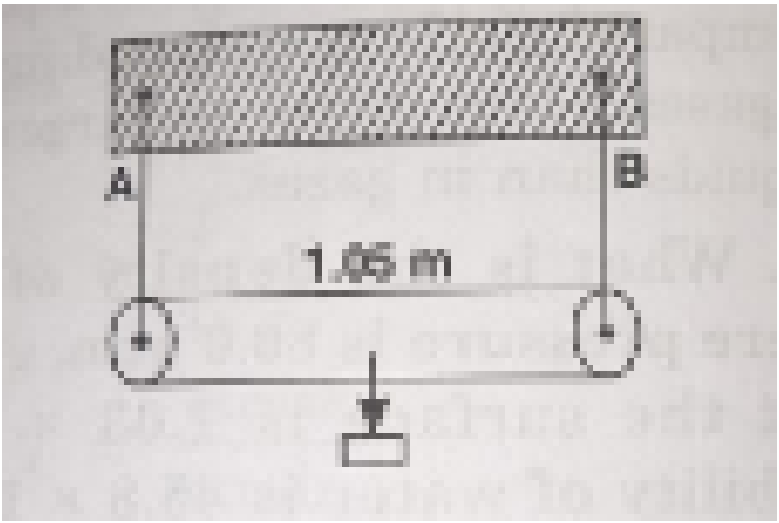
41. A rod of length 1.05 m having negligible mass is supported at its ends by two wires of steel (wire A) and aluminium (wire B) of equal length as shown in the figureThe cross

sectional area of wires A and B are $1.0mm^2$ and $2.0mm^2$, respectivley. AT wat point along the rod should a mass m be suspended in order to produce equal strains in both steel and aluminium wires?



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42. A steel wire of length 4.7 m and cross-sectional area $3.0 \times 10^{-5} m^2$ stretches by the same amount as a copper wire of length 3.5 m and cross-sectional area of $4.0 \times 10^{-5} M^2$ under a given load. What is the ratio of the Young's modulus of steel to that of copper?

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43. Two strips of metal are riveted together at their ends by four rivets, each of diameter 6.0

mm. What is the maximum tension that can be exerted by the riveted strip if the shearing stress on the rivet is not to exceed 6.9×10^7 Pa? Assume that each rivet is to carry one quarter of the load.

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44. The Marina trench is located in the Pacific Ocean, and at one place it is nearly eleven km beneath the surface of water. Hie water pressure at the bottom of the trench is about

1.1×10^8 Pa. A steel ball of initial volume $0.32m^3$ is dropped into the ocean and falls to the bottom of the trench. What is the change in the volume of the ball when it reaches to the bottom?

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45. Modulus of rigidity of ideal liquids is

A. infinity

B. zero

C. unity

D. some finite small non-zero constnat value.

Answer:

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46. The maximum load a wire can withstand without breaking, when its length is reduced to three times of its original length, will

A. be double

B. be half

C. be four times

D. remains same.

Answer:

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47. The temperature of a wire is doubled. The Young's modulus of elasticity

A. will aslo double

B. will become four times

C. will remains same

D. will decrease.

Answer:

Watch Video Solution

48. A spring is strecthed by applying a load to its free end. The strain produced in the spring is

A. volumetric

B. shear

C. longitudnal and shear

D. longitudinal.

Answer:

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49. A rigid bar of mass 15 kg is supported symmetrically by three wires each 2.0 m long. Those at each end are of copper and the

middle one is of iron. Determine the ratios of their diameters if each is to have the same tension.

A. Y_{copper} / Y_{iron}

B. $\sqrt{\frac{Y_{iron}}{Y_{copper}}}$

C. $\frac{Y_{iron}^2}{Y_{copper}^2}$

D. $\frac{Y_iron}{Y_{-c}opper}$

Answer:

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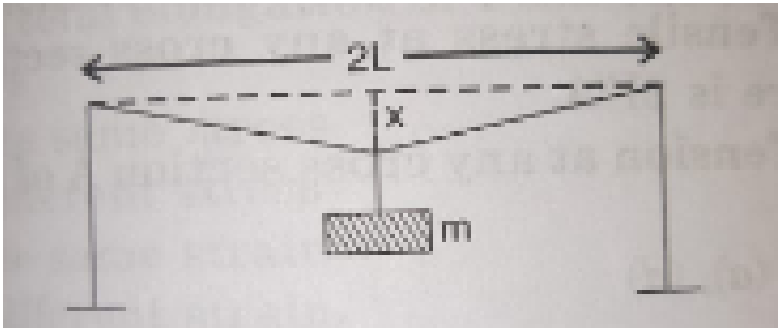
50. A mild steel wire of length 2L and cross-sectional area A is stretched, well within elastic limit, horizontally between two pilars show in the figure A mass m is suspended from the mid point of the wire. Strain in the wire is .



A. $\frac{x^2}{2L^2}$

B. $\frac{X}{L}$

C. $\frac{X^2}{L}$

D. $\frac{x^2}{2L}$

Answer:

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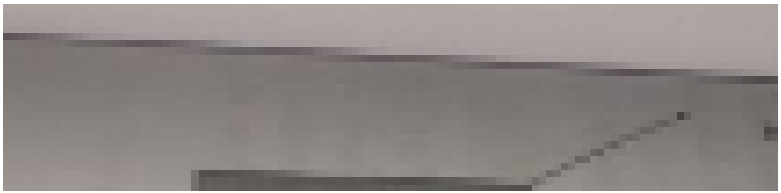
51. A rectangular frame is to be suspended symmetrically by two strings of equal length on two supports (Shown in the figure) It can be done in one of the following three ways:



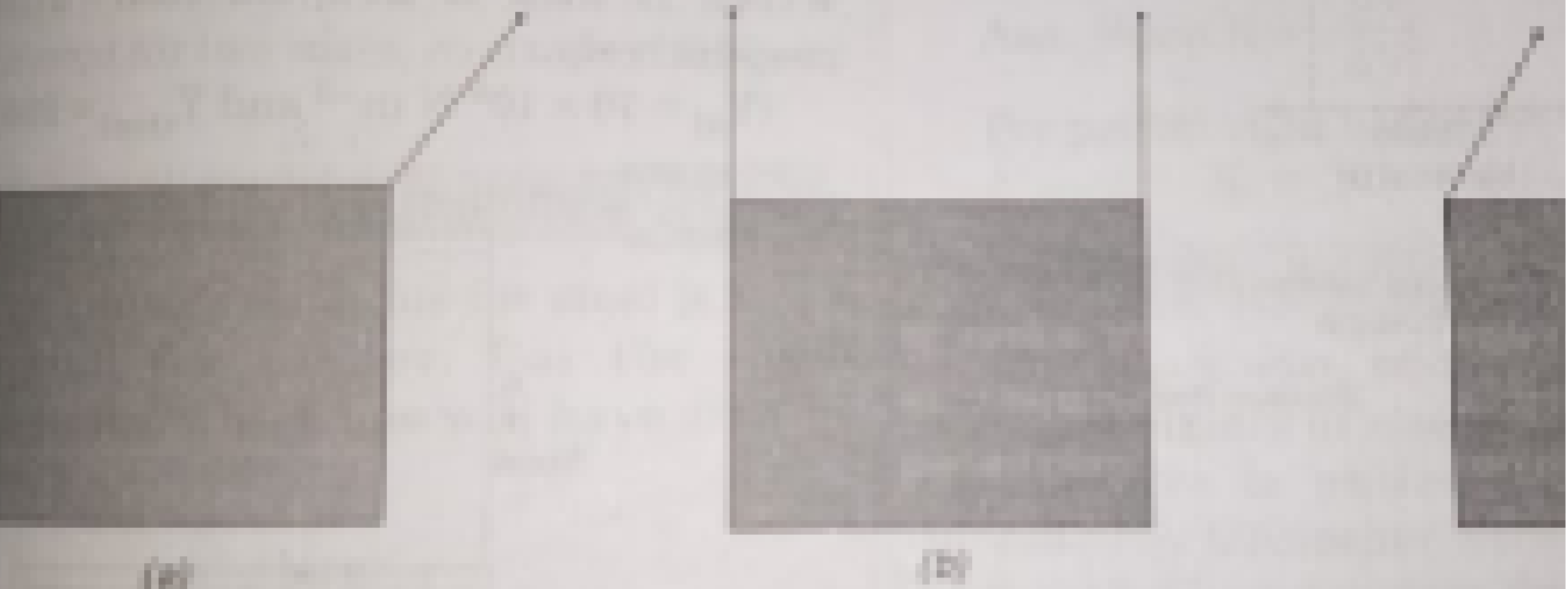
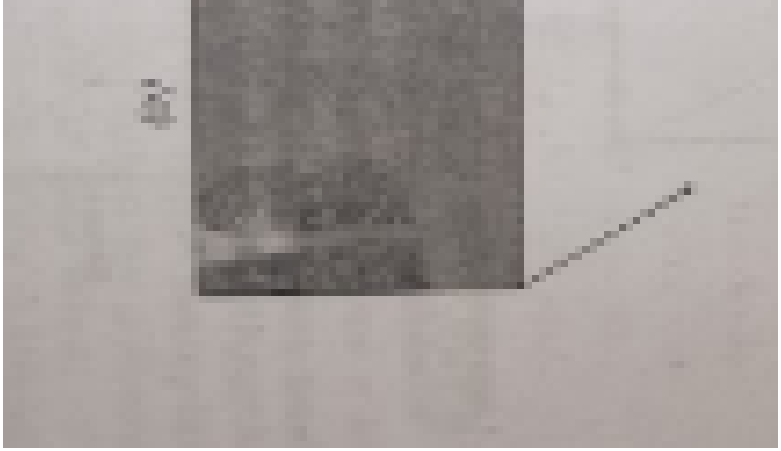


Fig. 9.10



A. the same in all cases

B. least in (A)

C. least in (B)

D. least in (C)

Answer:

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52. Consider two cylindrical rods of identical dimensions, one of rubber and the other of steel. Both the rods are fixed rigidily at one end of the roof. A mass M is attached to each of the free ends aat the centre of the rods

A. Both the rods will elongate but there shall be no perceptible change in shape

B. The steel rod will elongate and change shape but the rubber rod will only elongate.

C. The steel rod will elongate without any perceptible change in shape, but the rubber rod will elongate and the shape of the bottom edge will change to an ellipse.

D. The steel rod will elongate, without any perceptible change in shape, but the rubber rod will elongate with the shape of the bottom edge tapered to a tip at the centre.

Answer:

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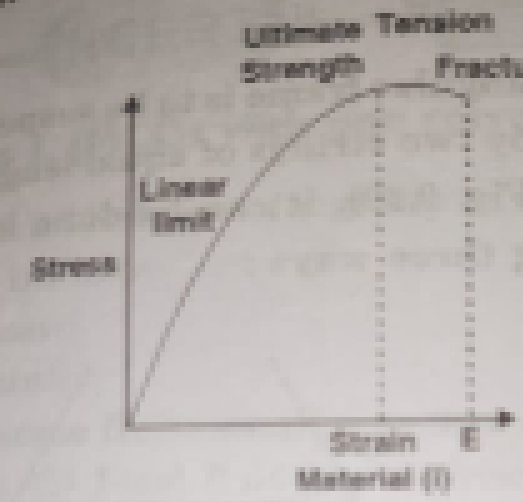
53. The stress-strain graphs for two materials are shown in the figure (assume same scale).

(c).


Ultimate Tension Strength
Fracture Point
Linear limit
Stress
Strain
E
Material (i)

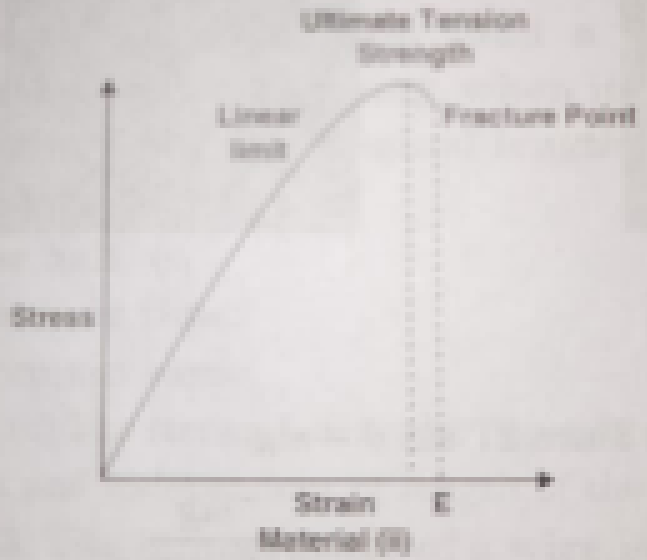

Ultimate Tension Strength
Linear limit
Fracture Point
Stress
Strain
E
Material (ii)

Fig. 9.11

A. Material (ii) is more elastic than material (i) and hence material (ii) is more brittle.

B. Material (i) and (ii) have the same elasticity nd the same brittleness.

C. Material (ii) is elastic over a larger region of strain as compared to (i)

D. Material (ii) is more brittle than material (i)

Answer:

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54. A wire is suspended from the ceiling and strecthed under the action of a weight F suspended form its other end. Teh force exerted by the ceiling on it is equal and opposite to the weight.

A. Tensile stress at any cross section A of the wire is F/A

B. Tensile stress at any cross section is zero

C. Tensile stress at any cross section A of the wire is 2F/A.

D. Tension at any cross section A of the wire is F.

Answer:

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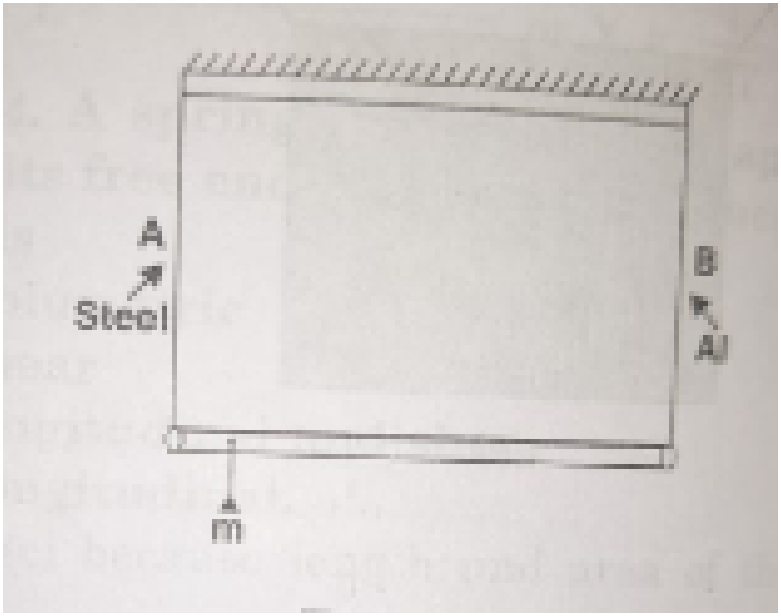
55. A rod of length l and negligible mass is suspended at its two ends by two wires of steel (wire A) and aluminium (wire B) of equal

length (shown in the figure)



The cross-sectional areas of wires A and B are 1.0 mm^2 and 2.0 mm^2, respectively. $\left(Y_{AL} = 70 \times 10^9 Nm^{-2}\right.$ and $\left. y_{steel} = 200 \times 10^9 Nm^{-2}\right)$

A. Mass m should be suspended close to wire A to have equal stresses in both the wires.

B. Mass m should be suspended close to B to have equal stresses in both the wires

C. Mass m should be suspended at the middle of the wires to have equal stresses in both the wires

D. Mass m should be suspended close to wire A to have equal strain in both wires.

Answer:

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56. For an ideal liquid

A. the bulk modulus is infinite

B. the bulk modulus is zero.

C. the bulk modulus is infinite

D. the bulk modulus is the shear modulus is zero.

Answer:

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57. A copper and a steel wire of the same diameter are connected end to end. A deforming force F is applied to this composite wire which causes a total elongation of 1 cm. The two wies will have

A. the same stress

B. different stress

C. te same strain

D. different strain

Answer:

Watch Video Solution

58. The Young's modulus for steel is much more than that for rubber. For the same longitudinal strain, which one will have greater tensile stress?

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59. Is stress a vector quantity?

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60. Identical springs of steel and copper are equally stretched. On which, more work will have to be done??

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61. What is the value of Young's modulus for a perfectly rigid body?

Watch Video Solution

62. What is bulk modulus for a perfect rigid body?

Watch Video Solution

63. A wire of length L and radius r is clalmped rigidly at one end. When the other end of the wire is pulled by force f, its length increaes by l. Another wire of the same material of length 2 L and radius 2 r, is pulled by a force 2 f. Find the increase in length of this wire.

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64. A steel rod $\left(Y = 2.0 \times 10^{11} Nm^{-2}\right)$ and $\alpha = 10^{-5}$ ^ $\circ C^{-1}\right)$ of length 1 m and area

of cross-section $1cm62$ is heated form $0^\circ C$ to $200^\circ C$, without being allowed to extend or bend. What is the tension produced in the rod?

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65. To what depth must a rubber ball be taken in deep sea so that its volume is decreased by 0.1%. (The bulk modulus of rubber is $9.8 \times 10^8 Nm^{-2}$, and hte density of sea water is $10^3 km^{-3}$).

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66. A truck is pulling a car out of a ditch by means of a steel cable that is 9.1 m long and has a radius of 5 mm. When the car just begins to move, the tension in the cable is 800 N. How much has the cble streched ? (Young's modulus for steel is $2 \times 10^{11} Nm^{-2}$).

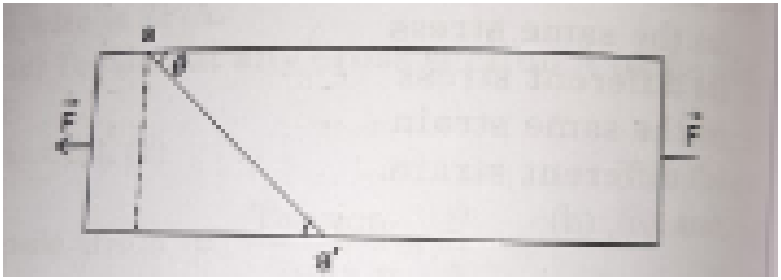
Watch Video Solution

67. Two identical solid balls, one of ivory and the other of wet-clay, are dropped form the same height on the flor. Which one will rise to a greater height after striking the floor and why?

Watch Video Solution

68. Consider a long steel bar under a tensile stress due to forces $\overrightarrow{F}$ acting at the edge a along the length of the bar (show in the

figure)



Consider a plane making an angle θ with the length. What are the tensile and shearing stresses on this plane?

For what angle is the tensile stress a maximum?

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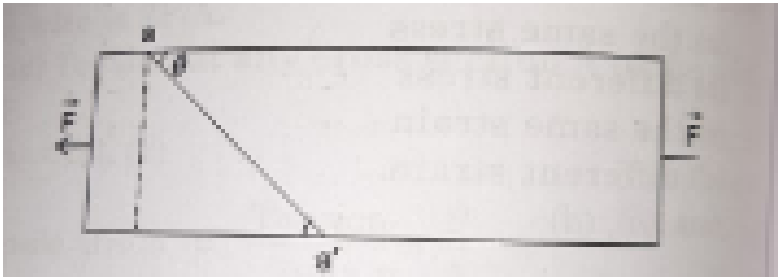
69. Consider a long steel bar under a tensile stress due to forces $\overrightarrow{F}$ acting at the edge a along the length of the bar (show in the figure)



Consider a plane making an angle θ with the length. What are the tensile and shearing stresses on this plane?

For what angle is the shearing stress a maximum?

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70. A steel wire of mass μ per unit length with a circular cross section has a radius of 0.1 cm. The wire is of length 10 m when measured lying horizontal, and hangs from a hook on the wall. A mass of 25 kg is hung from the free end of the wire. Assuming the wire to be uniform and lateral strains < < longitudinal strains, find the extension in the length of the wire. The density of steel is 7860 kgm^{-3} (Young's modulues $Y = 2 \times 10^{11} Nm^{-2}$)

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71. In the above problem, If the yield strength of steel is $2.5 \times 10^8 Nm^{-2}$, what is the maximum weight that can be hung at the lower end of the wire?

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72. A steel rod of length 2l, cross sectional area A and mass M is set rotating in a

horizontal plane about an axis passing through the centre. If Y is the Young's modulus for steel, find the extension in the length of the rod. (assume the rod is uniform).

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73. An equilateral triangle ABC is formed by two Cu rods AB and BC and one Al rod. It is heated in such a way taht temperature of each rod increases by ΔT. Find change in the angle

ABC. [Coeff. of linear expansion for Cu is a_1, Coeff. of linear expansion for Al is $a_2 l$

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74. In nature, the failure of structural members usually result from large torque because of twisting or bending rather than due to tensile or compressive strains. This process of structural breakdown is called buckling and in cases of tall cylindrical structureslike trees, the torque is caused by its

own weight bending the structure. Thus the vertical through the centre of gravity does not fall within the base. The elastic torque caused because of this bending about the central axis of the tree is given by $\frac{Y\pi r^4}{4R}$. Y is the Young's modulus, r is the radius of the trunk and R is the radius of curvature of the bent surface along the height of the tree containing the centre of gravity (the neuttral surface). EStimate the critical height of a tree for a given radius of the trunk.

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75. A stone of mass and spring constant k. The unstrecthed length of the string is L and has negligible mass. The other end of the string is fixed to a nail at a point P. Initially the stone is at the same level as the point P. The stone is dropped vertically from point P.

Find the distance y from the top when the mass comes to rest for an instant, for the first time.

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76. A stone of mass and spring constant k. The unstrecthed length of the string is L and has negligible mass. The other end of the string is fixed to a nail at a point P. Initially the stone is at the same level as the point P. The stone is dropped vertically from point P.

Find the distance y from the top when the mass comes to rest for an instant, for the first time.

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77. A stone of mass and spring constant k. The unstrecthed length of the string is L and has negligible mass. The other end of the string is fixed to a nail at a point P. Initially the stone is at the same level as the point P. The stone is dropped vertically from point P.

Find the distance y from the top when the mass comes to rest for an instant, for the first time.

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78. With the rise of temperature the Young's modulus of elasticity:

A. decreases

B. increases

C. changes erratically

D. remains unchanged

Answer:

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79. What is bulk modulus for a perfect rigid body?

A. infinity

B. zero

C. some finite value

D. non zero constant.

Answer:

Watch Video Solution

80. The shear modulus of elasticity of a liquid is

A. infinity

B. Unity

C. Some finite, none zero constnat

D. Zero

Answer:

Watch Video Solution

81. The reciprocal of bulk modulus of a substance is called its

A. Compressibility

B. Rigidity

C. Viscosity Modulus of elasticity

D.

Answer:

Watch Video Solution

82. If a metal wire is stretched a little beyond its elastic limit (or yield point), and released, it will

A. not contract

B. lose its elastic property completely

C. contract only up its length at the elastic limit

D. contract, but its final length will be greater than its initial length.

Answer:

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83. A copper and a steel wire of the same diameter are connected end to end. A deforming force F is applied to this composite wire which causes a total elongation of 1 cm. The two wies will have

A. same stress and strain

B. different stress and strain

C. different stress and same strain

D. same stress and different strain.

Answer:

Watch Video Solution

84. The potential energy of a stretched spring is proportional to

A. the square of the force constant

B. the sqare of amount of strectch

C. the square of the original length

D. None of these.

Answer:

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85. The volume elasticity is possessed by

A. solids only

B. liquids only

C. gases only

D. All the three states of matter.

Answer:

Watch Video Solution

86. The breaking stress of a wire depends upon

A. length of the wire

B. radius of the wire

C. material of the wire

D. shape of cross-section

Answer:

Watch Video Solution

87. Which of the following affects the elasticity of a substance?

A. Hammering and annealing

B. Change in temperature

C. Impurity in substance

D. All of these

Answer:

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88. Fill in the blanks:

Plastic deformation also allows a metal to be _____.

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89. Fill in the blanks:

___ can be subjected to large value of strain.

Watch Video Solution

90. Fill in the blanks:

_____ is the ratio of change in dimension.

Watch Video Solution

91. Fill in the blanks:

Units of Young's modulus are _____ or _____.

Watch Video Solution

92. Fill in the blanks:

The _____ stress is the stress at the breaking point.

Watch Video Solution

93. Fill in the blanks:

A material, which breaks on applying a small deforming fore is called _____ material.

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94. What is deforming force?

Watch Video Solution

95. What is a plasticity?

Watch Video Solution

96. "Stress is the force per unit area." Is it correct?

Watch Video Solution

97. What is elastic limit?


Watch Video Solution

98. What are ductile materials?


Watch Video Solution

99. What are elastomers?


Watch Video Solution

100. A heavy wire is suspended from a roof but no weight is attached to it lower end. Is it under stress. Explain?

Watch Video Solution

101. What is the expression for Young's modulus of elasticity?

Watch Video Solution

102. A wire stretched a certain amount under a load. If the load and diameter are both increased to three times, find the stretched caused in the wire.

Watch Video Solution

103. What is more elastic : water or air, why?

Watch Video Solution

104. Some work has to be done in streching a wire. Why? What happens to the energy given to the wire in this process?

Watch Video Solution

105. Why are electric poles given hollow structure?

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106. Name factors which affect the property of elasticity of a solid.

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107. _____ body is that body which returns to its original shape after the removal of deforming force.

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108. More rigid a body, more __ it is said to be.

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109. Nobody is perfectly _____ or perfectly ___.

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110. When a deforming force acts on a body. It undergoes change in its __.

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111. The _____ is the stress, when the material begins plastic behaviour.

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112. Fill in the blanks:

The _____ stress is the stress at the breaking point.

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113. The susbtances having large molecular structure are called _____

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114. Rubber is elastic for very large _____.

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115. Why does a body regain its shape or size when deforming forces are removed? Explain it on the basis of atomic view of elasticity.

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116. What is the cause of elasticity?

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117. A cable is replaced by another of the same length and material but of twice diameter. How does this affect elongation under a given load?

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118. A cable is replaced by another of the same length and material but of twice diameter. How many times will be the maximum load

supported by the latter as compared to the former?

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119. Give units and dimensions of compressibility.

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120. What is Poisson's ratio? Give its expression. What are its units?

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121. What is compressibility? Give its units and dimensions.

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122. What do you mean by elastomers? How does stress strain graph take shape in case of rubber?

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123. What are brittle materials?

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124. What is elastic after effect and elastic fatigue?

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125. Define the term elasticity in physics.

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126. Define stress and strain. What are the units in which these quantities are measured?

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127. On what factors, the modulus of elasticity depends?

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128. What is elastic limit?

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129. State Hooke's law.

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130. Discuss stress-strain graph.

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131. Discuss application of elasticity.

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132. The potential energy of a stretched spring is proportional to

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133. What force is frquired to stretch a steel wire 1 sq. cm in cross-section to 1.1 times? $Y = 2 \times 10^{11} Nm - 2$

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134. A one metre long wire having area of cross-section $1mm^2$ is stretched by a mass of 3 kg. Calculate the increase in length. Take $Y = 2 \times 10^{11} Nm^{-2}$

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135. A stress of $10^7 Nm^{-2}$ is required to break a material of density $4 \times 10^4 kgm^{-3}$. Calculate

the length of a wire of this material, which can break under its own weight.

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136. The length of a metallic wire is L_1 : when tension on the wie is T_1 , and length is L_2, when the tension in the wire is T_2 , Find original length of the wire.

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137. Calculate the % increase in the length of a wire of diameter 2.5 mm stretched by a force of 100 kg f. Y for the wire $= 12.5 \times 10^{11}$ dyne cm^{-2}

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138. The Young's modulus for Steel is $2.0 \times 10^{11} Nm^{-2}$. If the interatomic spacing for the metal is $2.8\overset{\circ}{A}$, find the increase in the interatomic spacing for a force of $10^{9} Nm^{-2}$

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139. A wire loaded by a weight of density $7.6gcm^{-3}$ is found to be of length 90 cm. On immersing the weight in water, the length decreased by 0.18 cm. Find the original length of the wire.

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140. Compare the densities of water at the surface and bottom of a lake 100 m deep,

given that the compressibility is $\frac{10^{-3}}{22}$ per atm and 1 atm $= 1.015 \times 10^5 Pa$.

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Exercise

1. On what factors, the modulus of elasticity depends?

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2. On what factors, the modulus of elasticity depends?

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3. Two wires of different materials are suspended from a rigid support. They have same length and diameter and carry the sameload at the free ends. Will extension, strain and stress be different?

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4. Why springs are made of steel and not of copper?

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5. An elastic wire is cut to half its original length. How would it affect the maximum load that the wire can support?

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6. What is an elastomer?

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7. Distinguish between elasticity and plasticity.

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8. Elasticity has different meaning in physics and in our daily life. Comment.

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9. A wire stretches by a certain amount under a load. If the load and radius both increased to four times, find the streatch caused in the wire.

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10. Steel is more elastic than rubber. Explain why?

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11. When is a body called elastic and when is it called plastic? Explain elastic limit.

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12. Draw stress-strain curve for aa loaded steel wire and hence define te terms permanent set, elastic limit, yield point and tensile strength.

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13. Define Young's modulus of elasticitiy. normal stress and longitudinal strain. Give unit of each of them. Derive an expression for the elastic potential energy of a wire, when stretched.

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14. Derive an expression for the electric potential at a point along the axial line of an electric dipole.

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