PHYSICS

BOOKS - CHHAYA PHYSICS (BENGALI ENGLISH)

ELASTICITY

Examples

1. An 8kg mass is suspended from one end of an iron wire of length 2 m and diameter 1mm.

IF the young's modulus of iron is 2×10^{12} dyn. cm^{-2}, then what is the increase in length of the wire? $[g = 980 cm. s^{-2}]$

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2. The volume of 1 litre of glycerine decrease by $0.42 cm^3$ on application of a pressure of $20 kg. cm^{-2}$.Calculate the bulk modulus of glycerine.

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3. The upper surface of an aluminium cube of side 10 cm is displaced by 0.03 cm with respect to its firmly held lower surface by a tangential force of $7.5 \times 10^{10} dyn$. Calculate the modulus of rigidity of aluminium.

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4. A metallic wire of length 3 m is stretched to produce an elongation of 2 mm. IF the diameter of the wire is 1mm, then find the decrease in its diameter due to this elongation.Poisson's ratio for the material of the wire is 0.24.

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5. When a body of mass 5kg is hung from a wire of length 1 m and radius 2mm,the length increases by 0.1 mm, IF the poisson's ratio is 0.4 , what will be the change in the radius of the wire? If the load is reduced to 2kg,how will the radius change?

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6. The change in length of a wire of a circular cross section is found to be 0.01% due to longitudinal stress, IF the poisson's ratio for the material is 0.2, what is the percentage change in volume?

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7. A metallic wire of length and diameter 3 m and 0.001 m respectively is stretched by a load of 10 kg.Young's modulus and Poisson's ratio of the material of the wire are respectively $20 \times 10^{10} N. m^{-2}$ and 0.28 . Calculate the decrease in the diameter of the wire. ($g = 9.8m. s^{-2}$)

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8. A wire of length 2m and diameter 2cm is suspended vertically with its top end fixed. Its poisson's ratio and Young's modulus are 0.2 and $1.8 \times 10^{11} N. m^{-2}$ respectively.What will be its lateral strain if a load of 1000kg is suspended at its lower end ?

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9. A rubber cord of length 10 m is suspended vertically. How much does it stretch under its own weight? Density of rubber $= 1.5 \times 10^3 kg. m^{-3}$, Young's modulus of rubber $= 6 \times 10^6 gf. cm^{-2}$, g=$9.8 m. s^{-2}$

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10. A force of $10^6 N. m^{-2}$ is required for breaking a material. IF the density of the material is $3 \times 10^3 kg. m^{-3}$, then what should be the length of the wire made of this material , so that it breaks due its own weight? [$g = 9.8m. s^{-2}$]

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11. A copper wire of negligible mass of length 1 m and cross sectional area $10^{-6} m^2$ is kept on a smooth horizontal table with one end fixed.

A ball of mass 1 kg is attached to the other end. The wire and the ball are revolving with an angular velocity of $20 rad. s^{-1}$. IF the elongation in the length of the wire is $10^{-3} m$, obtain the Young's modulus. IF on increasing the angular velocity to $100 rad. s^{-1}$ the wire breaks down, obtain the breaking stress.

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12. A steel cable with a radius of 1.5 cm supports a chair-lift at a ski area. IF the maximum stress does not exceed $10^8 N.m^{-2}$, what is the maximum load that the cable can support?

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13. What amount of work must be done in stretching a wire, of length 1 m and of cross sectional area $1 mm^2$, by 0.1mm? Young's modulus for the material $= 2 \times 10^{11} N.m^{-2}$.

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14. When the load on a wire is increased from 3kg to 5kg, the elongation of the wire increases from 0.6mm to 1mm.How much work is done during this extension of the wire?

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15. For a uniform wire of length 3 m and cross sectional area $1mm^2$, 0.021 J of work is necessary to stretch it through 1mm. Calculate the Young's modulus for its material.

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16. Two uniform wires of length 3m and 4m respectively are made of the same material To stretch both these wires by the same length, 0.03J and 0.05 J of work on necessary. Calculate the ratio of the cross sectional area of the two wires.

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17. When a mass of 4 kg is hung from the lower and of a spring.IF elongates by 1cm.(i) What is the force constant of the spring? (ii) If a load of 2kg is hung from the lower end of the spring , then find its elongation.

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18. The force constant of a spring is k. The spring is cut into three equals parts. Find the force constant of each part.

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19. The force constant of a spring of length l is k. the spring is cut into two parts of lenghts l_1 and l_2. IF $l_1 = nl_2$, then find the spring constants k_1 and k_2 of the two parts.n is an integer.

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20. To increase the length of an electric string of radius 3.5 mm by $\frac{1}{20}$ the of its initial length, within its elastic limit, a 10N force is required, Calculate the Young's modulus for the material of the string.

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21. Two wires of the same length but of difference materials have diameter of 1mm and 3mm respectively.IF both of them are stretched by the same force,then the elongation of the first wire becomes thrice that of the second. Compare their Young's modull.

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22. IF the elastic limit of a typical rock is $3 \times 10^8 N.m^{-2}$ and its mean density is $3 \times 10^3 kg.m^{-3}$, estimate the maximum height of a mountain on the earth. ($g = 10m.s^{-2}$)

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23. Two equal and opposite forces are applied tangentially to two mutually opposite faces of an aluminium cube of side 3 cm to produce a shear of 0.01°. IF the modulus of rigidity for aluminium is $7 \times 10^{10} N.m^{-2}$, then calculate the force applied.

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24. A rubber cord of length 20 m is supplied from a rigid support by one of its ends it hangs vertically. What will be the elongation of the cord due to its own weight? The density of rubber=$1.5 g. cm^{-3}$ and Young 's modulus= $49 \times 10^7 N. m^{-2}$.

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25. A steel wire of diameter 0.8 mm and length 1m is clamped firmly at two points A and B which are 1 m apart in the same horizontal line. A body is hung from the middle point of the wire such that the middle point sags 1 cm from the original position. Calculate the mass of the body.

$[Y = 2 \times 10^{12} dyn. cm^{-2}]$

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26. IF the work done in stretching a uniform wire, of cross section $1mm^2$ and length 2m, by 1mm is 0.05 joule, find the young's modulus for the material of the wire.

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27. A cylindrical pipe of uniform cross section and of length 120 cm is closed at one end and is completely filled with water. Kept upright, the cylinder is stretched to increase its length. It elongates by 1 cm, but the length of the water-column increases by 0.7 cm. Calculate the Poisson's ratio of the material of the pipe.

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28. A light bar of length 2 m is suspended horizontally by means of two wires of equal lengths connected to its two ends. One wire is of steel having a cross sectional area of $0.1 cm^2$, the other is of brass with a cross sectional area of $0.2 cm^2$,Find the point on the bar from where a weight must be suspended so that both the wires experience (i) the same stress,(ii) the same strain, Given the young's modulus for steel $= 2 \times 10^{11} N.m^{-2}$ and that for brass $= 10 \times 10^{10} N.m^{-2}$.

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29. A sphere of mass 25 kg and radius 0.1 m is hung from the celling of a room with the help of a steel wire. The height of the ceiling from the floor is 5.21 m. When the sphere is hung just like a pendulam, its lower surface touches the floor of the room. What will be the velocity of the sphere at the lowest points of its oscillation? The young's modulus for steel = $2 \times 10^{11} N.m^{-2}$, the initial length of the wire =5 m and the radius of the wire $= 5 \times 10^{-4} m$.

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30. Two blocks A and B are connected to each other by a string and spring , the string passes over a frictionless pulley as shown in fig.1.16 Block B slides over the horizontal top surface of a stationary block C and the block A slides along the vertical side of C, both with the same uniform speed. the coefficient of friction between the surfaces of the blocks is 0.2. THe force constant of the spring is $1960 N. m^{-1}$. IF the mass of the block A is 2kg, calculate the mass of the block B and the energy stored in the spring.

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31. On application of a pressure of $21 kg. cm^{-2}$, the volume of 1 litre of an oil decreases by $840 mm^3$.Calculate the bulk modulus and compressibility of the oil.

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32. A 0.5 kg block slides from a point A [fig.1.17] on a horizontal track with an initial speed of $3m.\ s^{-1}$ towards a weightless horizontal spring of length 1 m and of force constant $2N.\ m^{-1}$. The part AB of the track is frictionless and the part BC has coefficients of static and kinetic friction as 0.22 and 0.2 respectively. If the distance AB and BD are 2 m and 2.14 m respectively. Find the total distance covered by the black before it comes to rest ($g = 10m.\ s^{-2}$)

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33. The bodies A and B of masses m and 2m respectively are put on a smooth floor. They are connected by a spring . A third body C of mass m moves with a velocity v_0 along the line joining A and B and collides elastically with A as shown in fig1.18.At a certain instant of time t_0 after the collision, it is found that the instantaneous velocities of A and B are the same. Further,at this instant the compression of the spring is found to be x_0. FInd out the common velocity of A and B at time t_0 and (ii) the force constant of the spring.

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34. The bodies A and B of masses m and 2m respectively are put on a smooth floor. They are connected by a spring . A third body C of mass m moves with a velocity v_0 along the line joining A and B and collides elastically with A as shown in fig1.18.At a certain instant of time t_0 after the collision, it is found that the instantaneous velocities of A and B are the same. Further,at this instant the compression of the spring is found to be x_0. FInd out the force constant of the spring.

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35. IF the tension in a wire increases gradually to 6kg, the elongation of the wire becomes 1.13mm. Calculate the work done.

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36. A body of mass 4 kg and density $2.5g.cm^{-3}$, suspended by a metallic wire of length 1 m and diameter 2mm, is kept completely immersed in water. What will be the increase in the length of the wire? Young's modulus of the metal $= 2 \times 10^{11} N.m^{-2}$ and $g = 9.8m.s^{-2}$.

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37. A 0.1 kg mass is suspended from a wire of negligible mass. The length of the wire is 1 m and its cross sectional area is $4.9 \times 10^{-7} m^2$. IF the mass is pulled a little in the vertically downward direction and released, it performs simple harmonic motion of angular frequency $140 rad. s^{-1}$. If the young's modulus of the material of the wire is $n \times 10^9 N. m^{-2}$ Calculate the value of n.

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38. Stress-strain graph of an elastic material is shown in fig.1.18.Using the graph find the young's modulus of the material.

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39. A 3kg of mass is hanging from one end of a vertical copper wire of length 2 m and of diameter 0.5 mm, due to this the elongation produced in the wire is 2.38 mm. Find young's modulus of copper.

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40. Six external forces, each of magnitude F, are applied on all the faces of a unit cube. Considering its elastic modulus ,calculate the longitudinal strain and the volume strain on the unt cube.

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41. One end of a horizontal thick copper wire of length 2 L and radius 2R is welded to an end of another horizontal thin copper wire of length L and radius R. When the arrangement is stretched by applying forces at two ends, find the ratio of the elongation in the thin wire to that in the thick wire.

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Higher Order Thinking Skill Hots Question

1. What is more elastic-steel or diamond?

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2. Explain why the temperature of a wire under tension will charge if it snaps suddenly?

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3. Two bodies M and N of equal mass are hung separtely from two lightweight springs. Force constants of the springs are k_1 and k_2. The bodies are set to vibrate so that their maximum velocities are equal. Find the ratio of the amplitudes of vibration of the two bodies.

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4. Springs are usually made of steel but not of copper why?

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5. On the basis of the moduli of elasticity , distinguish between solid, liquid and gaseous substances.

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6. The poisson' s ratio of a wire of σ. Show that if e is the longitudinal strain due to an applied forces, the volume strain will be $e(1-2\sigma)$.

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7. In the case of an elastic body which one is more fundamental -stress or strain?

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8. "Within elastic limit the Poisson's ratio depends only on the nature of the material but not on the stress applied"-explain.

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9. For a steel wire, if the diameter is larger , it can with stand a greater load. Why?

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10. In fig.1.21 load-elongation of two wires made of two different materials A and B are shown. The wires have the same length and the same area of cross section. Which material has a greater value of Y?

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11. Load-elongation graphs of two wires A and B, made of the same material and of equal initial length are shown in the fig.1.21. Which wire is thicker?

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12. Young moduli of two rods of equal length and equal cross section and Y_1 and Y_2. These rods are joined end to end forming a composite rod-system. Prove that the equivalent Young's modulus of the composite system of rods $= \dfrac{2Y_1Y_2}{Y_1+Y_2}$

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13. State whether the values of Young's moduli for thin and thick iron wires of equal length will be different.

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14. Can a steel wire be elongated to twice its initial length by hanging a load from its end?

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15. How does the value of modulus of elasticity change due to increase in temperature?

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16. A hanging wire of length L is elongated by an amount l with a load M attached to its free end. Prove that the elastic potential energy stored in the wire is $\frac{1}{2}Mgl$.

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17. A spring balance gives erroneous readings if it is used frequently over a long period of time. Explain.

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18. An elastic wire is cut into two equals halves. Determine whether there will be any change in the maximum load that each half can carry.

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19. The breaking force for a wire is F.What will be the breaking force for two parallel wires of same size

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20. The breaking force for a wire is F.What will be the breaking force for a single wire of double the thickness?

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Exercise Multiple Choice Questions

1. The most elastic among the following substances is

A. rubber

B. glass

C. steel

D. copper

Answer: C

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2. Which is most elastic?

A. iron

B. copper

C. quartz

D. wood

Answer: C

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3. The ratio of the lengths of two wires made of the same metal and of equal radius is 1:2 IF both the wires are stretched by the same force, then the ratio of the strains will be

A. $1:1$

B. $1:2$

C. $2:1$

D. $1:4$

Answer: A

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4. Shearing strain is expressed by

A. shearing force

B. angle of shear

C. increase in area

D. decrease in volume

Answer: B

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5. Breaking stress of a wire depends on

A. the radius of the wire

B. the length of the wire

C. the shape of the cross-section

D. the nature of its material

Answer: D

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6. Elongation of an elastic material is very low. What should be the shape of a body for which the longitudinal strain will be appreciable?

A. a thin but long wire

B. a thick block having any cross section

C. a thin block having rectangular cross section

D. a thin and short wire

Answer: A

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7. The unit of elastic modulus is

A. $N.\, m^{-3}$

B. $N.\, m^{-2}$

C. $N.\, m^{-1}$

D. N.m

Answer: B

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8. Four wires made of the same material are stretched by the same load. Their dimensions are given below. Which one will be elongated most?

A. length 1m, diameter 1mm

B. length 2m, diameter 2mm

C. length 3m, diameter 3mm

D. length 4m, diameter 0.5 mm

Answer: D

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9. Keeping the length of a wire unchanged, its diameter is doubled. Young's modulus for the material of the wire will

A. increase

B. decrease

C. remain the same

D. none of these

Answer: C

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10. Keeping one end of a wire of length L and radius r fixed, a force F is applied at the other end to elongate it by l. Another wire made of same material but of length 2L and radius 2r is stretched by a force 2F. Its increase in length will be

A. l

B. 2l

C. $\frac{l}{2}$

D. 4l

Answer: A

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11. The ratio of the length and diameters of two metallic wires A and B of the same material are 1:2 and 2 :1 respectively. IF both the wires are stretched by the same tension, then the ratio of the elongations of A and B will be

A. $1:2$

B. $4:1$

C. $1:8$

D. $1:4$

Answer: C

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12. A uniform rod weights W, has length L and cross sectional area a. The rod is suspended from one of its ends. The young's modulus of its material is Y. Increase in length of the rod will be

A. zero

B. $\frac{WL}{2aY}$

C. $\frac{WL}{aY}$

D. $\frac{2WL}{aY}$

Answer: B

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13. Two rods of equal length and cross-sectional area have their Young's moduli Y_1 and Y_2 respectively. IF the rods are joined end to end, then the equivalent Young's modulus of the combined rod system is

A. $\frac{2Y_1Y_2}{Y_1 + Y_2}$

B. $\frac{Y_1Y_2}{Y_1 + Y_2}$

C. $\frac{1}{2(Y_1 + Y_2)}$

D. $Y_1 + Y_2$

Answer: A

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14. A rubber string of length 8 m is hanging vertically with one end fixed. If the density of rubber is $1.5 \times 10^3 kg. m^{-3}$ and young's modulus is $5 \times 10^6 N. m^{-2}$, then increase of its length due to its own weight will be [$g = 10m. s^{-2}$]

A. $9.6 \times 10^{-2} m$

B. $19.2 \times 10^{-3} m$

C. $9.6 \times 10^{-3} m$

D. 9.6 m

Answer: A

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15. Modulus of rigidity of steel is n and its Youngs's modulus is Y. A steel wire of cross sectional area A is so elongated that its area of cross section becomes $\frac{A}{10}$. As a result

A. Y increase but n decrease

B. Y and n both remain the same

C. Y decreases but n increases

D. both Y and n will increase

Answer: B

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16. In stretching a wire, the amount of work done per unit volume of the wire is

A. stress $\times$ strain

B. $\frac{1}{3} \times stress \times strain$

C. $\frac{stress}{strain}$

D. $\frac{1}{2} \times stress \times strain$

Answer: D

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17. A stretched rubber has

A. increased kinetic energy

B. increased potential energy

C. decreased kinetic energy

D. decreased potential energy

Answer: B

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18. A wire of initial length L and area of cross section A has Young's modulus Y of its material. The wire is stretched by a stress 5 within its elastic limit. The stored energy density in the wire will be

A. $\frac{5}{2Y}$

B. $\frac{2Y}{5^2}$

C. $\frac{5^2}{2Y}$

D. $\frac{5^2}{Y}$

Answer: C

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19. A wire of initial length L and area of cross section A, having young's modulus Y of its material, is stretched to be elongated by an amount x. Work done in stretching the wire is

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

B. $YA\frac{x^2}{L}$

C. $YA\frac{x}{2L}$

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

Answer: A

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20. One end of a wire is rigidly fixed and a force of 200 N is applied at its other end. The wire undergoes an elongation of 1mm. The potential energy stored in the wire is

A. 0.1J

B. 0.2J

C. 10J

D. 20J

Answer: A

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21. Two wires A and B are made of the same metal. Diameter of A is double that of B and the length of A is thrice that of B. IF both the wires are stretched by the same force to elongate them equally within elastic limit, then the ratio of energy stored in the wires A and B will be

A. $2:3$

B. $3:4$

C. $3:2$

D. $6:1$

Answer: B

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22. A spring of force constant k is cut into two equal parts The force constant of each part of the spring will be

A. $\frac{k}{2}$

B. k

C. 2k

D. 4k

Answer: C

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23. Force constants of two springs are k_1 and k_2 One end of a spring is connected with one end of the other. Equivalent force constant of the spring system will be

A. $\frac{k_1 + k_2}{2}$

B. $2(k_1 + k_2)$

C. $\frac{k_1 + k_2}{k_1 k_2}$

D. $\frac{k_1 k_2}{k_1 + k_2}$

Answer: D

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24. A wire of length L are area of cross section

A. Having young's modulus Y of its material, behaves like a spring of force constant k. the value of k will be

A. $k = \frac{YA}{L}$

B. $k = \frac{2YA}{L}$

C. $k = \frac{YA}{2L}$

D. $k = \frac{YL}{A}$

Answer: A

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25. An elastic spring of length L and of force constant k is stretched to increase its length by an amount x. The spring is further stretched to elongate it by y. The amount of work done in stretching the spring in the second case (x and y are very small) is

A. $\frac{1}{2}ky^2$

B. $\frac{1}{2}k\left(x^2+y^2\right)$

C. $\frac{1}{2}k(x+y)^2$

D. $\frac{1}{2}ky(2x+y)$

Answer: D

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26. An ideal spring with spring constant k is hung from the ceiling and a block of mass M is attached to its lower end. The mass is released when the spring is initially unstretched. Then the maximum extension in the spring is

A. $\frac{4Mg}{k}$

B. $\frac{2Mg}{k}$

C. $\frac{Mg}{k}$

D. $\frac{Mg}{2k}$

Answer: B

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27. Two springs P and Q of force constant k_p and k_q $\left(k_Q = \frac{k_P}{2}\right)$ are stretched by applying forces of equal magnitude. IF the energy stored in Q is E, then the energy stored in P is

A. E

B. 2E

C. $\frac{E}{4}$

D. $\frac{E}{2}$

Answer: D

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28. Before snapping a wire can bear a load of 100kg. The wire is cut into two parts .Now the maximum load that can be withstood by each part of the wire is

A. 100kg

B. 40kg

C. 200kg

D. 50kg

Answer: A

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29. A uniform wire of length L and weight W is rigidly fixed at one end and a load W_1 is applied at its othe end. IF the area of cross section of the wire is S, then stress developed In the wire at a distance $\frac{3L}{4}$ from its lower end will be (assume that increase in length of the wire is very small)

A. $\frac{W_1}{S}$

B. $\frac{\left(\frac{3W}{4}\right)}{S}$

C. $\frac{\left(W_1 + \frac{3W}{4}\right)}{S}$

D. $\dfrac{\left(W_1 + \frac{W}{4}\right)}{S}$

Answer: C

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30. A steel ring of radius r and cross section A is fitted on to a wooden disc of radius $R(R > r)$. IF young's modulus be E, then the force with which the steel rings is expanded is

A. $AE\dfrac{R}{r}$

B. $\dfrac{Er}{AR}$

C. $\dfrac{E}{A}\left(\dfrac{R-r}{A}\right)$

D. $AE\left(\dfrac{R-r}{r}\right)$

Answer: D

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Exercise Very Short Answer Type Questions

1. Between rubber and steel-which one is more elastic?

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2. Which one is more elastic- steel or diamond?

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3. State whether elasticity of a metallic substance increases or decreases with the rise in temperature.

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4. Strain has no unit'- state whether the statement is true or false.

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5. Write down the dimensions of stress.

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6. Can the length of a steel wire be doubled by hanging a load from its end?

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7. Under which kind of stress, does a body undergo a change in shape without changing its volume?

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8. Which property of a spring is represented by its force constant?

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9. Between steel and copper-which one is usually used to make springs?

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10. Write down the dimensions of force constant.

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11. Can liquid and gaseous substances withstand shearing strain?

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12. Which property of a metal is manifested when a compressional stress more than the yield point is developed?

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13. On what factory does the breaking stress of a wire depend?

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14. State whether a body undergoes a change in volume due to shearing stress only.

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15. Young's modulus depends on temperature'- state whether it true or false?

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16. Write down the dimensions of elastic limit.

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17. A wire is halved by cutting it. Would there by any change in the breaking load due to this?

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18. All bodies are_____elastic is reality.[Fill in the blanks]

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19. Strain is a____quantity.[Fill in the blanks]

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20. During change in length of a wire or change in volume of a body,_____stress is developed.[Fill in the blanks]

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21. During change in shape of a body,______stress is developed.[Fill in the blanks]

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22. Compressibilities of solids and liquids are very_____but that of a gaseous substance in much____[Fill in the blanks]

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23. Modulus of rigidity is a characteristic of _____[Fill in the blanks]

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24. Poisson's ratio depends on the _____of a body.[Fill in the blanks]

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25. Loss in elastic ability of a body due to rapid change in the load applied on it is called____[Fill in the blanks]

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26. What is the SI unit of force constant?

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27. _____are usually made of ____not of copper.

[Fill in the blanks]

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28. The magnitude of the _____per unit cross sectional area on a body is the breaking stress.

[Fill in the blanks]

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29. Write the name of a substance whose elasticity does not change with the change in temperature.

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30. What is defined by dividing stress by strain within elastic limit?

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31. For which kind of substance is Young's modulus physically meaningful?

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32. The iron wires of equal length are taken. One of them is thick and the other is thin. In which case will young's modulus be greater?

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33. What is the Poisson's ratio of the substance whose volume remains unchanged under elastic strains?

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34. A wire is cut into two parts.What will be the change in Young'modulus of the parts?

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35. What is the range of theoretical values of Poisson's ratio?

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36. Write down the dimension of Poisson's ratio with respect to M,L and T.

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

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38. Name the reciprocal of bulk modulus.

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39. What is the dimension of elastic modulus?

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40. What is the relation between Y,K and σ?

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41. What is the relation between Y,n and σ?

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42. What is the value of Young's modulus for a perfectly plastic body?

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43. What will be the change in temperature of a stretched wire if snaps suddenly?

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44. Which type of energy is stored when as elastic wire is elongated by stretching.

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45. In a stretched wire, potential energy stored per unit volume $=\frac{1}{2}\text{times}\_\_\_\_\_\text{times}\_\_\_\_\_$

[Fill in the blanks]

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46. Force constant of two springs are k_1 and $k_2(k_1 > k_2)$ (i) The springs are elongated by the same amount and (ii) the springs are elongated by applying the same force. Then for which of the springs is more work performed?

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47. Force constants of two springs are k_1 and k_2. What will be the equivalent force constant of the spring system when the springs are joined in a parallel combination?

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Exercise Short Answer Type Questions I

1. A horizontal bar fixed rigidly at one end is called a cantilever. When a load is hung at its free end the cantilever (i) bends (ii) inclines at an angle with the horizontal without bending .What will be the nature of strain in each case?

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2. In case of liquids and gases bulk modulus is the only meaningful modulus of elasticity'- what do you mean by this statement?

Watch Video Solution

3. Modulus of rigidity is meaningful only in the case of a solid substances'-explain.

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4. Between steel and diamond which one is more elastic? Explain with reason.

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5. IF the volume of a body remains unchanged when subjected to a tensile strain, what will be its Poisson's ratio?

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6. The stress-strain graphs for material A and B are shown in fig.1.25.

The graphs are drawn to the same scale.

(a) Which of the materials has greater Young's modulus?

(b) Which of the two is the stronger material?

View Text Solution

Exercise Short Answer Type Questions Ii

1. Why is it necessary to do work to increase the length of a wire by stretching it? Which form is this work converted into?

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Exercise Problem Set I

1. How much load should be hung from the end of a steel wire of length 3.14 m and of diameter 1 mm so that it increases in length by 1mm? Y for steel is 2×10^{11} SI unit.

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2. When a load of 10 kg is hung from one end of a wire of length 5 m, the wire elongates by 5 mm. IF the young modulus for the material of the wire is $9.8 \times 10^{10} N. m^{-2}$, then find the area of cross section of the wire. $[g = 9.8 m. s^{-2}]$

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3. A steel wire of uniform diameter has length 2.5 m, mass 0.016 kg and density $7.9 \times 10^{3} kg. m^{-3}$. What will be the Young's modulus of steel if a load of 12 kg is needed to elongate the wire by 1.8 mm?

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4. What will be the increase in length of a steel wire of length 10 m and of diameter 2mm when subjected to a tension due to application of a load of 168 kg on it? Young's modulus of steel=$21 \times 10^{10} N. m^{-2}$.

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5. A load of 20 kg is hung from one end of a wire of length 6 m and of cross sectional area $1mm^2$. IF the load is withdrawn, the length of the wire becomes 5.995 m. Calculate the (i) longitudinal strain, (ii) longitudinal stress and (iii) Young's modulus for the material of the wire.

Watch Video Solution

6. When a load of 3 kg is hung from one end of a copper wire of length 2 m and diameter 0.5 mm, it increases in length by 2.38 mm, Find the young's modulus for the material of the wire.

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7. A load of 5kg hangs from one end of a vertical wire of length 1 m and of radius 1 mm. IF young's modulus of the material of the wire is $2 \times 10^{11} N.\ m^{-2}$, find the length of the wire when no load is acting on it.

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8. Cross sectional area of a steel wire is $1 cm^2$ .How much force is required to increase its length to twice its initial length? Young's modulus for steel is $2 \times 10^{12} dyn. cm^{-2}$.

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9. The length of a wire of diameter 0.8 mm is 2.5 m, IF the breaking stress for the material of the wire is $3 \times 10^{7} kg. m^{-2}$, then find the load that should be hung from the end of that wire so that it snaps.

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10. Young's modulus for the material of a substance is $7.25 \times 10^{10} N.m^{-2}$ and its bulk modulus is $11 \times 10^{10} N.m^{-2}$. Find modulus of rigidity of the substance.

Watch Video Solution

11. What will be the increase in length of a wire of length 10 m undergoing a strain of 0.001%? If the cross sectional area of the wire $2mm^2$ and the load applied at its end is 1 kg, then calculate the stress developed in $dyn.cm^{-2}$.

Watch Video Solution

12. Calculate the change in length of a wire of length 5 m undergoing a strain of 1% of 0.1. IF the area of cross section of the wire is $1mm^2$ and the load applied on it is 10 kg then find the ratio of stress to strain.

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13. Volume of a substance at normal atmospheric pressure is $3500 \times 10^{-6} m^3$. What will be its change in volume at the pressure of 25 standard atmosphere? Given that bulk modulus of the substance is $10^{11} N. m^{-2}$.

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14. Compressibility of an oil is $20 \times 10^{-6} atm^{-1}$. A hydraulic press contains

$0.5m^3$ of this oil. What will be the decrease in volume of oil if a pressure of 100 standard atmosphere is applied on it?

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15. Young's modulus of silver is $7.25 \times 10^{10} N. m^{-2}$ and its bulk modulus is $11 \times 10^{10} N. m^{-2}$. Find the poisson's ratio for silver.

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16. Young modulus of a material is $12.65 \times 10^{10} dyn. cm^{-2}$ and its modulus of rigidity is $4.425 \times 10^{10} dyn. cm^{-2}$.Calculate Poisson's ratio for the material.

Watch Video Solution

17. Young modulus of a material $= 18.5 \times 10^{10} N. m^{-2}$ and its poisson's ratio is 0.238. Determine the bulk modulus and modulus of rigidity for the material.

Watch Video Solution

18. The value of Young's modulus for a material is $24 \times 10^{11} dyn. cm^{-2}$. What will be the range of the value of its modulus of rigidity?

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19. Two wires of the same length are made of different materials. Diameter of the one is 2 mm and that of the other is 4 mm. When these two wires are stretched by the same force, the first one's elongation is twice the second's.compare their Young's modulus.

Watch Video Solution

20. A metallic wire of length and diameter 300 cm and 0.1 cm. respectively is stretched by a load of 10 kg. Young's modulus and Poisson's ratio for the material of the wire are $20 \times 10^{11} dyn. cm^{-2}$ and 0.26 respectively Calculate the decrease in diameter of the wire.

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21. $200cm^3$ of air is kept at 760 mm of mercury pressure. Keeping the temperature constant, if the pressure or that air is increased by 1mm of mercury, then its volume decreases by $0.263cm^3$. Calculate the bulk modulus of air.

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22. When a load of 20 kg is hung from a wire of cross sectional area $1mm^2$, its elongated length is 600.5 cm. IF the load is withdrawn the wire shrinks by 0.5 cm in length. Calculate the young's modulus for the material of the wire.

View Text Solution

23. A wire of length 2m and of cross sectional area $1mm^2$ is elongated by 1 mm by application of a load at its one end. IF Young's modulus for the material of the wire is $2 \times 10^{11} N.m^{-2}$. Then calculate the work done.

View Text Solution

24. A wire of length 4 m and of cross sectional area $4mm^2$ is elongated by 0.1 mm by the applications of a force. IF young's modulus for the material of the wire is $2 \times 10^{12} N.m^{-2}$, then calculate the amount of energy stored in the wire.

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25. A wire of length L and cross sectional area a is stretched by l, where $l < L$. Show that if the elastic limit is not exceeded, the potential energy of the wire increases by $\frac{Yal^2}{2L}$

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26. 29.4 N force is required to compress a spring by 1 cm. How much work should be done to compress the spring by 20 cm?

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27. Two ends of a plank are placed on two wedges. The plank gets depressed by 1mm when a load of 2 kg is hung from its mid-point. What will be the depression of the plank if a load of 5 kg is hung from its mid-point.

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28. A mild steel wire of length 1.0 m and cross sectional area $0.50 \times 10^{-2}(cm)^2$ is stretched , well within its elastic limit, horizontally between two pillars. A mass of 100 g is suspended from the mid-point of the wire. Calculate the depression at the mid -point.

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29. Initial length of a wire is L and its area of cross section is A. The wire is elongated by applying a stress τ within its elastic limit. Prove that the potential energy density in the wire due to elongation is $\frac{\tau^2}{2Y}$ [Y=Young's modulus]

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30. Calculate the maximum length of a vetica steel wire just before its snaps. Breaking stress of steel is $7.9 \times 10^9 N. m^{-2}$ and density of steel is $7.9 \times 10^3. m^{-3}$.

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31. A horizontal aluminium rod of diameter 4.8 cm remains projected 5.3 cm outwards from a wall. A load of 1200 kg is hung from the free end of the rod. If the modulus of rigidity of aluminium is $3 \times 10^{10} N. m^{-2}$ and the mass of the rod is negligible , then calculate the shearing stress and normal displacement of the free end of the rod.

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32. A boy stretches the rubber cord of his catapult by 6 cm. IF 0.588 N of force is required for stretching the cord by 1 cm, then calculate the average force acting on the cord of the catapult. With what velocity will a stone of mass 8 g be projected under such condition?

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Exercise Problem Set Ii

1. The length of a metallic wire is l_1 metre when the tension is 4 N and l_2 metre when the tension is 6N respectively. Find the length when the tension is 9N and the actual length of the wire.

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2. A copper rod of length L and radius r is suspended from the ceiling by one of its ends. What will be elongation of the rod due to its own weight when ρ and Y and the density and the Young's modulus of copper respectively?

Watch Video Solution

3. A cube of side 40 mm has its upper face displaced by 0.1 mm by a tangential force of 8 kN. Find the shearing modulus of the cube.

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4. A wire suspended vertically from one of its ends is stretched by attaching a weight of 200 N to the lower ends. The weight stretches the wire by 1 mm. What is the elastic energy stored in the wire?

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5. A solid sphere of radius R made of material of bulk modulus K is surrounded by a liquid in a cylindrical container. A massless piston of area A floats on the surface of the liquid. When a mass M is placed on the piston to compress the liquid , find the frictional charge in the radius of the sphere.

View Text Solution

6. A load of 1kg.wt is attached to one end of a steel wire of area of cross section $3mm^2$ and Young's modulus $10^{11}N.m^{-2}$. The other end is suspended vertically from a hook on a wall. Then the load is pulled horizontally and released. When the load passes through its lowest position, find the frictional charge in the length of the wire.{take $g = 10m.s^{-2}$)

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Exercise Hots Numerical Problems

1. A light rod of length 300 cm and of radius 3 cm is hung vertically from one end. Young's modulus and Poisson's ratio for the material of the rod are $2 \times 10^{12} dyn. cm^{-2}$ amd 0.3 respectively. IF a load of 1200 kg is suspended from the other end of the rod , find the lateral strain in the rod.

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2. When a load is applied to stretch a wire of length 200 cm, it gets elongated by 2 mm. IF the diameter of its cross section is 1 mm, then calculate the decrease in its diameter due to stretching , Poisson's ratio for the material of the wire is 0.24 .

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3. A pillar of height 10 m carries a load of 80 tonne.Calculate the contractions in length and in volume of the pillar. Area of cross section of the pillar is $100 cm^2$, Poisson's ratio of the material =0.2 and Young 's modulus = $1.96 \times 10^{11} N.m^{-2}$.

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4. A body of mass 2kg and density $2.7 g.cm^{-3}$ is suspended by a steel wire of length 1 m and radius 1 mm. IF the body is completely immersed In water, what will be the change in length of the wire? Y of steel $= 2 \times 10^2 dyn. cm^{-2}$ and $g = 980 cm. s^{-2}$

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5. When a load of 10 kg is suspended from one end of a wire of length 1m, it increases in length by 0.1 cm. IF the Poisson's ratio for the material of the wire is $\frac{1}{3}$, then calculate the change in volume of the wire, cross-sectional area of the wire $= 0.1 cm^2$.

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6. The radius of a copper wire is twice that of a steel wire. One end of the copper wire is joined with one end of the steel wire and the same tensile force is applied on them . If the length of the copper wire increases by 1% , what will be the percentage increase in the length of the steel wire? Given Young's modulus of steel is twice that of copper.

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7. Two rods of different materials but of the same sectional area have lengths L_1 and L_2. IF their Young's moduli are Y_1 and Y_2 respectively. Then calculate the equivalent Young's modulus of the composite system when the two rods are joined along their lengths.

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8. The mariana trench is located in the Pacific Ocean, and at one place it is nearly 11 km beneath the surface of water. The water pressure at the bottom of the trench is about $1.1 \times 10^8 Pa$. A steel ball of initial volume $0.32 m^3$ is dropped into the ocean and it falls to the bottom of the trench. What is the change in the volume of the ball when it reaches the bottom?

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9. A wire AB of radius 0.3 mm and length 300 cm is attached to a fixed support at its ends A and it hangs vertically. The wire carries a load 39.2N attached to its mid-point and also another load of 39.2N at its lower end B. IF Y for the material of the wire is $2 \times 10^{12} dyn.\ cm^{-2}$, find the elongation of the end B.

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10. The length of a spring is L and it elongates through l when a load W is hung from its one end. Assume that the spring is cut into two equal parts and then the same load is hung from one end of any part of the divided spring calculate the increase in length of the spring now.

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11. A steel wire of length 2 m and of diameter 0.8 mm is rigidly fixed at two ends horizontally ,when a load is suspended from the mid-point of the wire, a depression of 1 cm is produced. Calculate the amount of load attached, if Young's modulus for steel is $20 \times 10^{11} dyn. cm^{-2}$.

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12. Length of a wire is 2l and its area of cross section is a. the wire is kept horizontally by fixing its two ends or two rigid supports. A weight W is suspended from its mid-point. IF the mid-point depresses by x $(x < 1)$, then prove that $Y = \frac{Wl^3}{ax^3}$, [Young's modulus for the material of the wire].

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13. A metallic strip has thickness 3 mm and breadth 4 cm. The strip is kept horizontal on two wedges kept 80 cm apart and a mass of 50 g is placed at its middle. Calculate the depression of the mid-point of the strip, Given $Y = 2 \times 10^{12} dyn.\ cm^{-2}$ and $g = 980 cm.\ s^{-2}$

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14. The length of an unstretched elastic string is 2a. It is connected to two pegs A and B kept at a distance 2a. To the mid-point C an elastic string of length a is attached. The other end D of this string is pulled at right angles to AB until C is displaced through a distance equal to $\frac{a}{10}$. Calculate the shift of D assuming the strings have the same moduli of elasticity and the same cross sectional area.

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15. The edge of an aluminium cube is 10 cm long. One face of the cube is firmly 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?

View Text Solution

16. What will be the density of lead at a pressure of $2 \times 10^4 N.m^{-2}$? (Density of lead=

$11.4g. cm^{-3}$ at STP and bulk modulus of lead $=0.8 \times 10^{10} N. m^{-2}$)

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17. One end of a wire of initial length 1.5 is fixed at A and the other end is attached to a load of 19.6 N. the length of the wire is now found to be 1.53 m. the load is then raised up to A and then released.Find the maximum distance it will descend below A.

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18. 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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19. 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 $2 rev. s^{-1}$ 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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20. When a spring is stretched by a distance x, it exerts a force given by F=$(-5x - 6x^3)$ N. Find the work done when the spring is stretched from 0.1 m to 0.2 m.

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21. A uniform cylinder of length L and mass M having cross sectional area A is suspended , with its length vertical, from a fixed point by a massless spring of spring constant k,such that it is half submerged in a liquid of density σ at equilibrium position. What is the extension of the spring when it is in equilibrium?

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22. A load of 31.4 kg is suspended from a wire of radius 10^{-3} m and density $9 \times 10^3 kg/m^3$. Calculate the change in temperature of the wire if 75% of the work done is converted into heat. The Young's modulus and the specific heat capacity of the material of the wire are

$9.8 \times 10^{10} N/m^2$ and $490 J.kg^{-1}.K^{-1}$

respectively.

View Text Solution

Entrance Corner Assertion Reason Type

1. Statement I: Young's modulus for a perfectly plastic body is zero.

Statement II: For a perfectly plastic body, restoring force is zero.

A. Statement I is true, statement II is true, statement II is a correct explanation for statement I.

B. Statement I is true,statement II is true, statement II is not a correct explanation for statement I

C. Statement I is true, statement II is false

D. Statement I is false, Statement II is true

Answer: A

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2. Statement I: IF length of a rod is doubled the breaking load remains unchanged.

Statement II: Breaking load is equal to the elastic limit.

A. Statement I is true, statement II is true, statement II is a correct explanation for statement I.

B. Statement I is true,statement II is true, statement II is not a correct explanation for statement I

C. Statement I is true, statement II is false

D. Statement I is false, Statement II is true

Answer: C

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3. Statement I: Ductile metals are used to prepare thein wires.

Statement II: In the stress-strain curve of ductile metals, the length between the points representing elastic limit and breaking points is very small.

A. Statement I is true, statement II is true, statement II is a correct explanation for statement I.

B. Statement I is true,statement II is true, statement II is not a correct explanation for statement I

C. Statement I is true, statement II is false

D. Statement I is false, Statement II is true

Answer: C

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4. Statement I: The restoring force F on a stretched string at extension x is related to the potential energy U as $F = -\frac{dU}{dx}$

Statement II: F=-kx and $U = \frac{1}{2}kx^2$, where k is the spring constant.

A. Statement I is true, statement II is true, statement II is a correct explanation for statement I.

B. Statement I is true,statement II is true, statement II is not a correct explanation for statement I

C. Statement I is true, statement II is false

D. Statement I is false, Statement II is true

Answer: A

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5. Statement I: Identical springs of steel and copper are equally stretched more work will be done on the steel spring.

Statement II: Steel is more elastic than copper.

A. Statement I is true, statement II is true, statement II is a correct explanation for statement I.

B. Statement I is true,statement II is true, statement II is not a correct explanation for statement I

C. Statement I is true, statement II is false

D. Statement I is false, Statement II is true

Answer: A

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6. Statement I: A hollow shaft is found to be stronger than a solid shaft made of same material.

Statement II: The torque required to produce a given twist is hollow cylinder is greater than that required to twist a solid cylinder of same size and same material.

A. Statement I is true, statement II is true, statement II is a correct explanation for statement I.

B. Statement I is true,statement II is true, statement II is not a correct explanation for statement I

C. Statement I is true, statement II is false

D. Statement I is false, Statement II is true

Answer: A

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7. Statement I: The bridges are declared unsafe after a long use.

Statement II: Elastic strength of bridges decreases with time.

A. Statement I is true, statement II is true, statement II is a correct explanation for statement I.

B. Statement I is true,statement II is true, statement II is not a correct explanation for statement I

C. Statement I is true, statement II is false

D. Statement I is false, Statement II is true

Answer: A

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8. Statement I:Stress is the internal force per unit area of a body.

Statement II: Rubber is less elastic than steel.

A. Statement I is true, statement II is true, statement II is a correct explanation for statement I.

B. Statement I is true,statement II is true, statement II is not a correct explanation for statement I

C. Statement I is true, statement II is false

D. Statement I is false, Statement II is true

Answer: B

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Entrance Corner Multiple Correct Answer Type

1. A wire of length L and cross section A hung from a rigid support is loaded with a mass M The elongation produced is

A. inversely proportional to L

B. directly proportional to M

C. directly proportional to Young's modulus

D. inversely proportional to A

Answer: A::D

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2. Which of the following statements are correct regarding elasticity?

A. Rubber dies not obey Hooke's law

B. Elasticity can be different for tensile and compressive stress

C. Elasticity is independent of temperature

D. Poisson's ratio is a modulus of elasticity

Answer: A::B

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3. Potential energy per unit volume of a stretched wire is

A. $\frac{1}{2}\frac{Stress}{strain}$

B. $\frac{1}{2}\frac{stress}{strain}$

C. $\frac{1}{2}$ Young modulus $\times strain^2$

D. $\frac{1}{2} \times$ Young modulus $\times$ strain

Answer: A::C

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4. Two wires A and B have equal lengths and are made of the same material. But the diameter of A is twice that of wire B. Then for a given load

A. the extension of B will be four times that of A

B. the extension of A and B will be equal

C. the strain in B Is four times that in A

D. the strain in A and B will be equal

Answer: A::C

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5. Two wires A and B have the same cross section and are made of the same material but the length of wire A is twice that of B. Then for a given load

A. the extension of A will be twice that of B

B. the extension of A and B will be equal

C. the strain in A will be half that in B

D. the strains in A and B will be equal

Answer: A::D

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6. Choose the correct statement(s) from the following

A. steel is more elastic than rubber

B. The stretching of a coil spring is determined by the Young's modulus of the wire of the spring

C. The frequency of a tuning fork is determined by the shear modulus of the material of the fork

D. When a material is subjected to a tensile (stretching) stress the restoring force is causd by interatomic attraction

Answer: A::D

View Text Solution

Entrance Corner Comprehension Type

1. According to Hooke's law within the elastic limit $\frac{stress}{strain}$= constant. The constant depends on the type of strain or the type of force acting. Tensile stress might result In compressional or elongative strain, however, a tangential stress can only cause a shearing strain. After crossing the elastic limit. the material undergoes elongation and beyond a stage beaks. All modulus of elastically are basically constants for the materials under stress

Two wires of same material have length and radius l,r and $2l, \frac{r}{2}$ respectively. The ratio of their Young's modulus is

A. $1:2$

B. $2:3$

C. $2:1$

D. $1:1$

Answer: D

View Text Solution

2. According to Hooke's law within the elastic limit $\frac{stress}{strain}$= constant. The constant depends on the type of strain or the type of force acting. Tensile stress might result In compressional or elongative strain, however, a tangential stress can only cause a shearing strain. After crossing the elastic limit. the material undergoes elongation and beyond a stage beaks. All modulus of elastically are basically constants for the materials under stress

After crossing the yield region the material will have

A. reduced stress

B. increased stress

C. breaking stress

D. constant stress

Answer: A::C

View Text Solution

3. According to Hooke's law within the elastic limit $\frac{stress}{strain}$= constant. The constant depends on the type of strain or the type of force acting. Tensile stress might result In compressional or elongative strain, however, a tangential stress can only cause a shearing strain. After crossing the elastic limit. the material undergoes elongation and beyond a stage beaks. All modulus of elastically are basically constants for the materials under stress

If $\frac{stress}{strain}$ is x in elastic region and y in yield region, then

A. x=y

B. $x > y$

C. $x < y$

D. $x = 2y$

Answer: B

View Text Solution

4. A sphere of radius 0.1 m and mass 8π kg is attached to the lower end of a steel wire of length 5 m and diameter $10^{-3}m$. The wire is suspended from 5.22 m high ceiling of a room. When the sphere is made to swing as a simple pendulam. It just grazes the floor at the lowest point. Given Young's modulus of steel is

$1.994 \times 10^{11} N. m^{-2}$

What is the extension of the wire at the mean position when the sphere is oscillating?

A. 0.01 m

B. 0.02 m

C. 0.03m

D. 0.04m

Answer: B

View Text Solution

5. A sphere of radius 0.1 m and mass 8π kg is attached to the lower end of a steel wire of length 5 m and diameter $10^{-3}m$. The wire is suspended from 5.22 m high ceiling of a room.

When the sphere is made to swing as a simple pendulam. It just grazes the floor at the lowest point. Given Young's modulus of steel is $1.994 \times 10^{11} N.\,m^{-2}$

The tension in the wire at the mean position when the sphere is oscillating is

A. $199.4\pi N$

B. $19.94\pi N$

C. $1.994\pi N$

D. $0.1994\pi N$

Answer: C

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6. A light rod of length 2 m is suspended from the ceiling horizontally by means of two vertical wires of equal length tied to its ends. One of the wire is made of steel and is cross section $10^{-3} m^2$ and the other is of brass of cross section $2 \times 10^{-3} m^2$. Young's modulus for steel is $2 \times 10^{11} N. m^{-2}$ and for brass is $10^{11} N. m^{-2}$.

Find out the position along the rod at which a weight may be hung to produce equal stress in both wires.

A. 1.39m

B. 1.30m

C. 1.33m

D. 1.24m

Answer: C

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7. A light rod of length 2 m is suspended from the ceiling horizontally by means of two vertical wires of equal length tied to its ends. One of the wire is made of steel and is cross section $10^{-3} m^2$ and the other is of brass of cross section $2 \times 10^{-3} m^2$. Young's modulus for steel is $2 \times 10^{11} N.m^{-2}$ and for brass is $10^{11} N.m^{-2}$.

Find out the position along the rod at which a weight may be hung to produce equals strains on both wires

A. 1m

B. 1.2m

C. 0.87 m

D. 1.05 m

Answer: A

View Text Solution

8. One end of a string of length L and cross sectional area A is fixed to a support and the other end is fixed to a bob of mas m. The bob is revolved in a horizontal circle of radius r with an angular velocity ω such that the string makes an angle θ with the vertical. Young's modulus is Y.

The angular velocity ω is equal to

A. $\sqrt{\frac{g \sin \theta}{r}}$

B. $\sqrt{\frac{g \cos \theta}{r}}$

C. $\sqrt{\frac{g \tan \theta}{r}}$

D. $\sqrt{\frac{g \cot \theta}{r}}$

Answer: C

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9. One end of a string of length L and cross sectional area A is fixed to a support and the other end is fixed to a bob of mas m. The bob is revolved in a horizontal circle of radius r with an angular velocity ω such that the string makes an angle θ with the vertical. Young's modulus is Y.

The tension T in the string is

A. $\dfrac{mg}{\cos\theta}$

B. $\dfrac{mg}{\sin\theta}$

C. $\dfrac{mg}{\tan\theta}$

D. $m\left(g^2 + r^2\omega^4\right)^{\frac{1}{2}}$

Answer: A::D

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10. One end of a string of length L and cross sectional area A is fixed to a support and the other end is fixed to a bob of mas m. The bob is revolved in a horizontal circle of radius r with an angular velocity ω such that the string makes an angle θ with the vertical. Young's modulus is Y.

The increase ΔL in length of the string is

A. $\frac{TL}{AY}$

B. $\frac{mgL}{AY\cos\theta}$

C. $\frac{mgL}{AY\sin\theta}$

D. $\frac{mgL}{AY}$

Answer: A::B

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11. One end of a string of length L and cross sectional area A is fixed to a support and the other end is fixed to a bob of mas m. The bob is revolved in a horizontal circle of radius r with an angular velocity ω such that the string makes an angle θ with the vertical. Young's modulus is Y.

The stress in the string is

A. $\frac{mg}{A}$

B. $\frac{mg}{A}\left(1-\frac{r}{l}\right)$

C. $\frac{mg}{A}\left(1+\frac{r}{l}\right)$

D. $\frac{mg}{A}\left(\frac{r}{l}\right)$

Answer: A

View Text Solution

Entrance Corner Integer Answer Type

1. A 0.1 kg mass is suspended from a wire of negligible mass. The length of the wire is 1 m and its cross sectional area is $4.9\times10^{-7}m^2$.

IF the mass is pulled a little in the vertically downward direction and released, it performs simple harmonic motion of angular frequency $140 rad. s^{-1}$. IF the young's modulus of the material of the wire is $n \times 10^9 N. m^{-2}$. Find the value of n.

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2. Two wires A and B have the same length and area of cross section. But young's modulus of A is two times the young's modulus of B. Then what is the ratio of force constant of A to that of B?

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3. For a wire of length l, maximum change in length under stress condition is 2mm. What is the change in length (in mm) under same condition when length of wire is halved?

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4. The density of water at the surface is $1030kg.\ m^{-3}$ and bulk modulus of water is $2 \times 10^9 N.\ m^{-2}$. What is the approximate change in density ($Inkg.\ m^{-3}$) of water in a lake at a depth of 400 m below the surface?

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5. A body of mass 3.14 kg is suspended form one end of a wire of length 10.0m. The radius of the wire is changing uniformly from

$9.8 \times 10^{-4} m$ at one end to $5.0 \times 10^{-4} m$ at the other end. Find the change in the length of the wire in mm. Young's modulus of the material of the wire is $2 \times 10^{11} N. m^{-2}$.

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1. A spring is cut into two equal pieces. What is the spring constant of each part if the spring constant of the original spring is k.

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2. Define Poisson's ratio. The poisson's ratio of a material is σ. If a longitudinal strain of a wire made of thin material be a, show that its volume strain is $(1 - 2\sigma)a$

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3. What are the maximum and minimum values of Poisson's ratio?

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4. Show that the elastic potential energy per unit volume of a rod stretched longitudinally is $\frac{1}{2} \times stress \times strain.$

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5. Force constants of two springs are k_1 and k_2 . One end of a spring is connected with one end of the other. Equivalent force constant of the spring system will be

A. $\frac{(k_1 + k_2)}{2}$

B. $2(k_1 + k_2)$

C. $\frac{(k_1 + k_2)}{k_1 k_2}$

D. $\frac{k_1 k_2}{k_1 + k_2}$

Answer: D

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6. A spring having spring constant k is cut into two parts in the ratio 1:2 Find the spring constants of the two parts.

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1. The length of a metal wire is L_1, when the tension is T_1 and l_2 when the tension is T_2. The unstretched length of the wire is

A. $\dfrac{L_1 + L_2}{2}$

B. $\sqrt{L_1 L_2}$

C. $\dfrac{T_2 L_1 - T_1 L_2}{T_2 - T_1}$

D. $\frac{T_2L_1 + T_1L_2}{T_2 - T_1}$

Answer: C

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2. A liquid of bulk modulus k is compressed by applying an external pressure such that its density increased by 0.01% . The pressure applied on the liquid is

A. $\frac{k}{10000}$

B. $\frac{k}{1000}$

C. 1000 k

D. 0.01 k

Answer: A

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3. The stress along the length of a rod (with rectangular cross section) is 1% of the Young's modulus of its material. What is the approximate percentage of change of its volume ? (Poisson's ratio of the material of the rod is 0.3)

A. 0.03

B. 0.01

C. 0.7%

D. 0.4%

Answer: D

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1. When a rubber band is stretched by a distance x, it exerts a restoring force of magnitude $F = ax + bx^2$ where a and b are constants. The work done in stretching the unstretched rubber band by L is

A. $aL^2 + bL^3$

B. $\frac{1}{2}(aL^2 + bL^3)$

C. $\frac{aL^2}{2} + \frac{bL^3}{3}$

D. $\frac{1}{2}\left(\frac{aL^2}{2} + \frac{bL^3}{3}\right)$

Answer: C

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2. A man grows into a giant such that his linear dimensions increase by a factor of 9. Assuming the his dimensity remains same, the stress in the leg will change by a factor of

A. 9

B. $\frac{1}{9}$

C. 81

D. $\frac{1}{81}$

Answer: A

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3. An external pressure P is applied on a cube at $0^\circ C$ so that it is equally compressed from all sides . K is the bulk modulus of the material of the cube and a is its coefficient of linear expansion. Suppose we want to bring the cube to its original size by heating . The temperature should be raised by

A. $\frac{P}{3aK}$

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

C. $\frac{3a}{PK}$

D. 3PKa

Answer: A

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4. A solid sphere of radius r made of a soft material of bulk modulus K is surrounded by a liquid in a cylinderical container. A massless piston of area a floats on the surface of the liquid, convering entire cross section of cylindrical container. When a mass m is placed on the surface of the piston to compress the liquid, the fractional decrement in the radius of the sphere , $\left(\frac{dr}{r}\right)$ is

A. $\frac{mg}{3Ka}$

B. $\frac{mg}{Ka}$

C. $\frac{Ka}{mg}$

D. $\frac{Ka}{3mg}$

Answer: A

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1. 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 Δl , which of the following graphs is a straight line?

A. Δl versus $1/l$

B. Δl versus l^2

C. Δl versus $1/l^2$

D. Δl versus l

Answer: B

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2. The approximate depth of an ocean is 2700 m. The compressibility of water is $45.4 \times 10^{-11} Pa^{-1}$ and density of water is $10^3 kg/m^3$. What fractional compression of water will be obtained at the bottom of the ocean?

A. 0.8×10^{-2}

B. 1.0×10^{-2}

C. 1.2×10^{-2}

D. 1.4×10^{-2}

Answer: C

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1. The density of a metal at normal pressure is ρ, Its density when it is subjected to an excess pressure ρ is ρ' IF B is bulk modulus of the metal, the ratio of $\frac{\rho'}{\rho}$ is

A. $1 + \frac{B}{p}$

B. $\frac{1}{1-\frac{p}{B}}$

C. $1+\frac{p}{B}$

D. $\frac{1}{1+\frac{p}{B}}$

Answer: B

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2. 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 3A. 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?

A. 4F

B. 6F

C. 9F

D. F

Answer: C

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1. Which substances are called elastomers? Given one example.

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2. Bridges are declared unsafe after long use Why?

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3. What are elastomers? Given two examples for the same.

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4. State Hooke's law.

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5. What is the value of rigidity modulus of elasticity for an incompressible liquid?

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6. Which type of energy is stored in the spring of wrist watch?

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7. The stress strain graph for materials A and B are as shown in the graphs are drawn to the same scale, which graph represents property of ductile materials? Justify your answer.

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8. A two wires A and B of length l, radius r and length 2 l, radius 2r having same Young's modulus Y are hung with a weight mg as shown in figure. What is the net elongation in the two wires?

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

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10. Define stress. A heavy wire is suspended from a roof and no weight is attached to its lower end. Is it under stress.

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