CBSE

MECHANICAL PROPERTIES OF SOLIDS WS 4

Class 11 - Physics

Section A

1. A 200-kg load is hung on a wire with a length of 4.00 m, a cross-sectional area of 0.200×10^{-4} m^2, and Young's modulus of 8.00×10^{10} N/m^2. What is its increase in length? **[1]**

   a) 4.70 mm
   b) 4.90 mm
   c) 5.00 mm
   d) 4.80 mm

2. Which one of the following is not a unit of Young's modulus? **[1]**

   a) dyne cm^{-2}
   b) Nm^{-1}
   c) Nm^{-2}
   d) mega pascal

3. A steel wire 10 m long and 10^{-5} m^2 in crosssectional area elongates by 0.01 m under a tension of 2500 N. Young's modulus for steel from this data is computed as **[1]**

   a) 2.5×10^{9} Nm^{-2}
   b) 2.5×10^{11} Nm^{-2}
   c) 2.5×10^{12} Nm^{-2}
   d) 2.5×10^{7} Nm^{-2}

4. A piece of copper having a rectangular cross-section of 15.2 mm $\times$ 19.1 mm is pulled in tension with 44,500 N force, producing only elastic deformation. Calculate the resulting strain. (Take Young's modulus of copper as 11 $\times 10^{10}$Pa) **[1]**

   a) 0.06×10^{-2}
   b) 0.11×10^{-2}
   c) 0.04×10^{-2}
   d) 0.14×10^{-2}

5. Modulus of rigidity of ideal liquids is **[1]**

   a) infinity
   b) zero
   c) some finite small non-zero constant value
   d) unity

6. A specimen of oil having an initial volume of 600 cm^3 s subjected to a pressure increase of 3.6×10^{6} Pa and the volume is found to decrease by 0.45 cm^3 what is the compressibility of the material? **[1]**

   a) 2.3×10^{-10} Pa^{-1}
   b) 2.1×10^{-10} Pa^{-1}
   c) 1.7×10^{-10} Pa^{-1}
   d) 1.9×10^{-10} Pa^{-1}

7. Liquids have no Poisson's ratio, because **[1]**

   a) they have definite shape
   b) they have no definite shape
   c) they have greater volume
   d) they have lesser density than solid

8. For a constant hydraulic stress on an object, the fractional change in the object's volume ($\frac{\Delta V}{V}$) and its bulk **[1]**

modulus (B) are related as:

a) $\frac{\Delta V}{V} \propto B$ b) $\frac{\Delta V}{V} \propto \frac{1}{B}$

c) $\frac{\Delta V}{V} \propto B^{-2}$ d) $\frac{\Delta V}{V} \propto B^2$

9. The relation between Young's modulus (Y), bulk modulus (κ) and modulus of elasticity (η) is **[1]**

a) $\frac{3}{Y} = \frac{1}{n} + \frac{3}{\kappa}$ b) $\frac{1}{Y} = \frac{3}{\eta} + \frac{1}{3\kappa}$

c) $\frac{1}{Y} = \frac{1}{\kappa} = \frac{3}{\eta}$ d) $\frac{1}{n} = \frac{3}{\gamma} + \frac{1}{3k}$

10. The temperature of a wire is doubled. The Young's modulus of elasticity **[1]**

a) will become four times b) will also double

c) will remain same d) will decrease

11. **Assertion (A):** Identical springs of steel and copper are equally stretched. More work will be done on the steel spring. **[1]**

Reason (R): Steel is more elastic than copper.

a) Both A and R are true and R is the correct explanation of A. b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false. d) A is false but R is true.

12. **Assertion:** Water is more elastic than air. **[1]**

Reason: Air is more compressible than water.

a) Assertion and reason both are correct statements and reason is correct explanation for assertion. b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

c) Assertion is correct statement but reason is wrong statement. d) Assertion is wrong statement but reason is correct statement.

13. **Assertion (A):** A hollow shaft is found to be stronger than a solid shaft made of same material. **[1]**

Reason (R): The torque required to produce a given twist in hollow cylinder is greater than that required to twist a solid cylinder of same size and material.

a) Both A and R are true and R is the correct explanation of A. b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false. d) A is false but R is true.

14. **Assertion (A):** Stress is the internal restoring force per unit area of a body. **[1]**

Reason (R): Rubber is more elastic than brass.

a) Both A and R are true and R is the correct explanation of A. b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false. d) A is false but R is true.

15. **Assertion:** The size of a hydrogen balloon increases as it rises in air. **[1]**

Reason: The material of the balloon can be easily stretched.

a) Assertion and reason both are correct statements and reason is correct explanation b) Assertion and reason both are correct statements but reason is not correct

for assertion.

explanation for assertion.

c) Assertion is correct statement but reason is wrong statement.

d) Assertion is wrong statement but reason is correct statement.

16. **Assertion (A):** The strain produced in a stretched spring is shearing **[1]**

Reason (R): When spring is stretched, the length of wire of spring increases.

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

17. **Assertion:** Young's modulus for a perfectly plastic body is zero. **[1]**

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

a) Assertion and reason both are correct statements and reason is correct explanation for assertion.

b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

c) Assertion is correct statement but reason is wrong statement.

d) Assertion is wrong statement but reason is correct statement.

18. **Assertion:** Steel is more elastic than rubber. **[1]**

Reason: Under given deforming force, steel is deformed less than rubber.

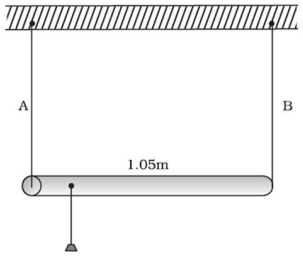
a) Assertion and reason both are correct statements and reason is correct explanation for assertion.

b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

c) Assertion is correct statement but reason is wrong statement.

d) Assertion is wrong statement but reason is correct statement.

19. A rod of length 1.05 m having negligible mass is supported at its ends by two wires of steel (wire A) and aluminum (wire B) of equal lengths as shown in Figure. The cross-sectional areas of wires A and B are 1.0 mm^2 and 2.0 mm^2, respectively. At what point along the rod should a mass m be suspended in order to produce equal stresses? Take Young's modulus of steel as 200 GPa, for aluminum 70 GPa. **[1]**



a) 0.8 m from steel wire

b) 0.7 m from steel wire

c) 0.6 m from steel wire

d) 0.9 m from steel wire

20. Two identical solid balls, one of ivory and the other of wet-clay, are dropped from the same height on the floor. Which one will rise to a greater height after striking the floor and why? **[1]**

21. What is the Bulk modulus for a perfect rigid body? **[1]**

22. What is the Young's modulus for a perfect rigid body? **[1]**

23. State the two factors on which the modulus of elasticity depends. **[1]**

24. How does Young's modulus change with the rise of temperature? **[1]**

25. Define bulk modulus of elasticity. Give its units and dimensions. **[1]**

26. What is the value of modulus of rigidity for an incompressible liquid? **[1]**

27. An elastic wire is cut to half its original length. How would it affect the maximum load that the wire can support? **[1]**

28. The spherical ball contracts in volume by 0.1% when subjected to a uniform normal pressure of 100 atmosphere. Calculate the bulk modulus of material of ball. **[1]**

29. For solids with elastic modulus of rigidity, the shearing strss is proportional to shear strain. On what factor does it depend in case of fluids? **[1]**

Section B

30. How much should the pressure on a litre of water be changed to compress it by 0.10%? **[2]**

31. Two exactly similar wires of steel and copper are stretched by equal forces. If the total elongation is 1 cm, find by how much is each wire elongated? Given Y for steel = 20×10^{11} dyne cm^{-2} and Y for copper = 12×10^{11} dyne cm^{-2}. **[2]**

32. Define modulus of elasticity and write its various types. **[2]**

33. A wire elongates by 9 mm when a load of 10 kg is suspended from it. What is the elongation when its radius is doubled, if all other quantities are same as before? **[2]**

34. A stress of 1 kg mm^{-2} is applied to a wire of which Young's modulus is 10^{11} Nm^{-2}. Find the percentage increase in length. **[2]**

35. 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? **[2]**

36. If a wire of length 4 m and cross-sectional area of $2m^2$ is stretched by a force of 3 kN, then determine the change in length of the wire due to the applied force. Given Young's modulus of material of the wire is110×10^9 N/m. **[2]**

37. A copper wire is stretched by 10N force. If radius of wire decreases by 2%. How will Young's modulus of wire be affected? **[2]**

38. A uniform wire of steel of length 2.5 m and density 8.0 gcm^{-3} weighs 50 g. When stretched by a force of 10 kgf, the length increases by 2 mm. Calculate Young's modulus of steel. **[2]**

39. 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 N m^{-2}, what is the maximum load the cable can support? **[2]**

40. The shear modulus of a material is always considerably smaller than the Young's modulus for it. What does it signify? **[2]**

41. Identical springs of steel and copper are equally stretched. On which, more work will have to be done? **[2]**

42. Which is more elastic rubber or steel? Explain. **[2]**

43. If the Young's modulus of steel is 2×10^{11} Nm^{-2}, calculate the work done in stretching a steel wire 100 cm in length and of cross-sectional area 0.03 cm^2 when a load of 20 kg is slowly applied without the elastic limit being reached. **[2]**

44. Young's modulus of the material of a wire is Y. On pulling the wire by a force F, the increase in its length is x. What will be the potential energy of the stretched wire? **[2]**

45. A spherical ball contracts in volume by 0.0098% when subjected a pressure of 100 atmospheres. Calculate its bulk modulus, Given that 1-atmosphere pressure, is 1.013×10^5 Pa. **[2]**

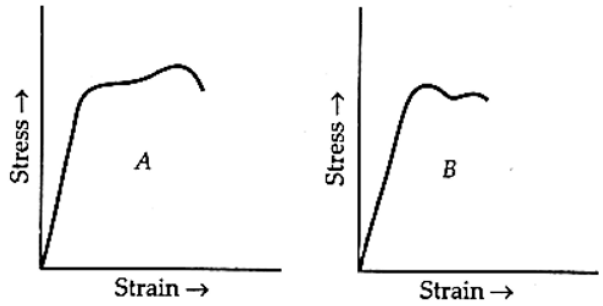
46. Why does modulus of elasticity of most of the materials decrease with the increase of temperature? **[2]**

47. Compute the bulk modulus of water from the following data: Initial volume = 100.0 litre, pressure increase = **[2]**

100.0 atm final volume = 100.5 litre (1 atm = 1.013×10^5 pa).

Section C

48. The stress-strain graphs for materials A and B are shown in the figure. **[3]**



The graphs are drawn to the same scale.

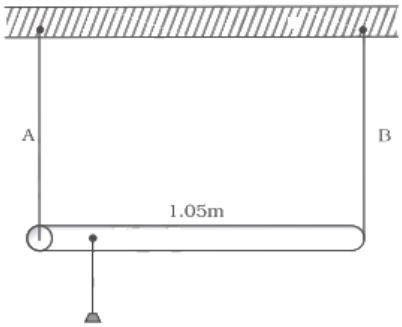
i. Which of the material has greater Young's modulus?

ii. Which material is more ductile?

iii. Which is more brittle?

iv. Which of the two is stronger material?

49. 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 lengths as shown in Figure. The cross-sectional areas of wires A and B are 1.0 mm^2 and 2.0 mm^2, respectively. At what point along the rod should a mass m be suspended in order to produce **[3]**



a. equal stresses and

b. equal strains in both steel and aluminium wires

50. Determine the volume contraction of a solid copper cube, 10 cm on an edge, when subjected to a hydraulic pressure of 7×10^6 Pa. Bulk modulus for copper = 140×10^9 Pa. **[3]**

51. After a fall, a 95 kg rock climber finds himself dangling from the end of a rope that had been 15 m long and 9.6 mm in diameter but has stretched by 2.8 cm. For the rope, calculate **[3]**

i. the strain,

ii. the stress and

iii. the modulus of elasticity.

52. A rigid bar of mass 15 kg is supported symmetrically by three wires each 2m long. These at each end are of copper and middle one is of iron. Determine the ratio of their diameters if each is to have the same tension. Young's modulus of elasticity for copper and steel are 110×10^9 N/m^2 and 190×10^9 N/m^2, respectively. **[3]**

53. 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 9.8×10^8 Nm^{-2}; and the density of sea water is 10^3 kg m^{-3}.) **[3]**

Section D

54. Define Young's modulus, bulk modulus and modulus of rigidity. Write mathematical expressions for these moduli. What is compressibility? **[5]**

55. A stone of 0.5 kg mass is attached to one end of a 0.8 m long aluminium wire of 0.7 mm diameter and suspended vertically. The stone is now rotated in a horizontal plane at a rate such that the wire makes an angle of 85^o with the vertical. Find the increase in the length of the wire. The Young's modulus of aluminium = 7×10^{10} Nm^{-2}, sin 85^o = 0.9962, cos 85^o = 0.0872). **[5]**

56. A wire of cross-sectional area A is stretched horizontally between two clamps located at a distance 2l metres from each other. A weight W kg is suspended from the midpoint of the wire. If the vertical distance through which the mid-point of the wire moves down be x <1, then find **[5]**

i. the strain produced in the wire,

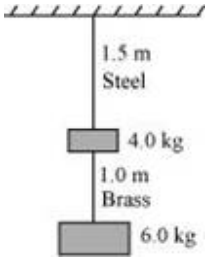
ii. the stress in the area,

iii. If Y is Young's modulus of wire, then find the value of x.

57. Define Young's modulus of elasticity. Describe an experiment for the determination of Young's modulus of the material of a wire. **[5]**

58. What is the density of water at a depth where pressure is 80.0 atm, given that its density at the surface is 1.03×10^3 kg/m^3, compressibility of water is 45.8×10^{-11} Pa^{-1}? **[5]**

59. Two wires of diameter 0.25 cm, one made of steel and the other made of brass are loaded as shown in the figure. 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. **[5]**



Section E

60. **State True or False:** **[7]**

(a) Dimensional formula of modulus of elasticity is same as that of the stress or pressure. **[1]**

(b) The stretching of a coil is determined by its shear modulus. **[1]**

(c) Shear modulus for ideal liquid is zero. **[1]**

(d) Materials having larger Young modulus are easily stretchable and we can deform them easily. **[1]**

(e) The modulus of elasticity of most of the materials decreases with the increase of temperature. **[1]**

(f) Modulus of elasticity of a body is independent of its dimensions (i.e. length, area, volume etc.). **[1]**

(g) Bulk modulus for a perfect rigid body and ideal liquid is infinite. **[1]**

Section F

61. **Fill in the blanks:** **[9]**

(a) Modulus of rigidity is the ratio of _____ stress to the _____ strain within the elastic limit. **[1]**

(b) _____ modulus is relevant for all three states of matter. **[1]**

(c) The Young's modulus for a perfect rigid body is _____. **[1]**

(d) The value of bulk modulus for an incompressible liquid is _____. **[1]**

(e) Bulk modulus for a perfectly rigid body is _____. **[1]**

(f) The reciprocal of bulk modulus of a material is called its _____. **[1]**

(g) The Young's modulus of a wire of length L and radius r is Y. If the length is reduced to $\frac{L}{2}$ and radius $\frac{r}{4}$, then its Young's modulus will be _____. **[1]**

(h) Young's modulus and shear modulus are relevant only for _____. **[1]**

(i) The value of modulus of rigidity for an incompressible liquid is _____. **[1]**