TEST

JEE Mains PYQs Mechanical Properties of Solids (Physics Master Academy)

QUESTIONS

SECTIONS

1. Section A - 20 Questions

Section 1 : Section A - 20 Questions

SECTION INSTRUCTIONS

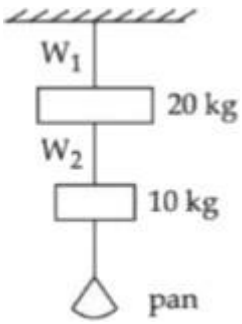
This section contains 20 MCQs. +4 for every correct answer, -1 for every incorrect answer

1 Four identical hollow cylindrical columns of mild steel support a big structure of mass 50×10^3 kg, the inner and outer radii of each column are 50cm and 100cm respectively. Assuming uniform local distribution, calculate the compression strain of each column. [Use Y = 2.0×10^{11} Pa, g = 9.8 m/s^2]

- 3.60×10^{-8}
- 2.60×10^{-7}
- 1.87×10^{-3}
- 7.07×10^{-4}

Correct: +4 · Incorrect: -1

2 Wires W_1 and W_2 are made of same material having the breaking stress of 1.25×10^9 N.m^2. W_1 and W_2 have cross sectional area of 8×10^{-7} m^2 and $4\times10^{-7}m^2$ respectively. Masses of 20kg and 10kg hang from them as shown in kgure. The maximum mass that can be placed in the pan without breaking the wires is___kg. (use g = 10m/s^2)

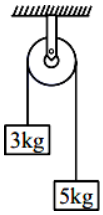


- 10

- 25
- 30
- 40

Correct: +4 · Incorrect: -1

3 Two blocks of masses 3kg and 5kg are connected by material wire going over a smooth pulley. The breaking stress of the metal is $24/\pi \times 10^2 Nm^{-2}$. What is the minimum radius of the wire? (take g = 10 ms^{-2})



- 125cm
- 1250cm
- 12.5cm
- 1.25cm

Correct: +4 · Incorrect: -1

4 A stone of mass 20g is projected from a rubber catapult of length 0.1m and are of cross section $10^{-6}m^2$ stretched by an amount 0.04m. The velocity of the projected stone is___m/s. (Young's modulus of rubber = $0.5\times10^9 N/m^2$)

- 10
- 15
- 20
- 20

Correct: +4 · Incorrect: -1

5 A uniform metallic wire is elongated by a 0.04m when subjected to a linear force F. The elongation of its length and diameter is doubled and subjected to the same force will be___cm.

- 1
- 2
- 3

- 4

Correct: +4 · Incorrect: -1

6 A body of mass m = 10kg is attached to one end of a wire of length 0.3m. The maximum angular speed (in $rads^{-1}$) with which it can be rotated about its other end in space station is (breaking stress of wire = $4.8\times10^{7}Nm^{-2}$ and area of cross section of the wire = $10^{-2}cm^{2}$) is ——

- 1
- 2
- 6
- 4

Correct: +4 · Incorrect: -1

7 A uniform cylindrical rod of length L and radius r is made from a material whose Young's modulus of elasticity equals Y. When this rod is heated by temperature T and simultaneously subjected to a net longitudinal compressional force F, its length remains unchanged. The coefkcient of volume expansion, of the material of the rod, is (nearly) equal to

- $9F/(\pi r^2YT)$
- $6F/(\pi r^2YT)$
- $3F/(\pi r^2YT)$
- $F/(\pi r^2YT)$

Correct: +4 · Incorrect: -1

8 The elastic limit of brass is 379 MPa. What should be the minimum diameter of a brass rod if it is to support a 400N load without exceeding its elastic limit?

- 1.00mm
- 1.16mm
- 0.90mm
- 1.36mm

Correct: +4 · Incorrect: -1

9 A steel wire having a radius 2.0mm, carrying a load of 4kg, is hanging from a ceiling. Given that g = $3.1\,\text{Å}\,ms^{-2}$ what wile b tensile stress that would be developed to the wire?

- $6.2\times10^{6}\ Nm^{-2}$
- $5.2\times10^{6}\ Nm^{-2}$
- $3.1\times10^{6}\ Nm^{-2}$
- $4.8\times10^{6}\ Nm^{-2}$

Correct: +4 · Incorrect: -1

10 Young's modulus of two wires A and B are in the ratio 7:4. Wire A is 2m long and has radius R. Wire B is 1.5m long and has radius 2mm. IF the two wires stretched by the same length for a given load, then the value of R is close to

- 1.5mm
- 1.9mm
- 1.7mm
- 1.3mm

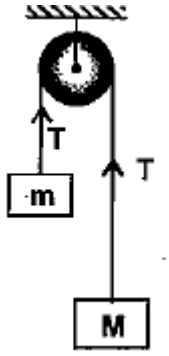
Correct: +4 · Incorrect: -1

11 A thin 1m long rod has a radius of 5mm. AS force of 50 πKN is applied at one end to determine its Young's modulus. Assume that the force is exactly known. IF the least count in the measurement of all lengths is 0.1mm, which of the following statements is false?

- The maximum value of Y that can be determined is $2\times10^{14}N/m^{2}$
- $\frac{\Delta Y}{Y}$ gets minimum contribution from the uncertainty in the length
- $\frac{\Delta Y}{Y}$ gets maximum contribution from the uncertainty in strain
- The kgure of merit is the largest for the length of the rod.

Correct: +4 · Incorrect: -1

12 Two blocks of masses m and M are connected by means of a metal wire of a cross sectional area A passing over a frictionless kxed pulley as shown in kgure. The system is then released. FI M = 2m, then the stress produced in the wire is



- 2mg/3A
- 4mg/3A
- mg/A
- 3mg/4A

Correct: +4 · Incorrect: -1

13 When a rubber is taken to a depth of___m in deep sea, its volume decreases by 0.5%. (The bulk modulus of rubber = 9.8×10^{8} Nm^{-2}. Density of sea water = 10^{4} kgm^{-3}, g = 9.8m/s^{2})

- 100
- 250
- 350
- 500

Correct: +4 · Incorrect: -1

14 An object is located at 2km beneath the surface of the water. If the fractional compression $\Delta V/V$ is 1.36%, the ratio of hydraulic stress to the corresponding hydraulic strain will be___(given density of water is 1000kgm^{-3} and g = 9.8 ms^{-2})

- $1.44\times10^{7}Nm^{-3}$
- $2.26\times10^{9}Nm^{-2}$
- $1.96\times10^{7}Nm^{-2}$
- $1.44\times10^{9}Nm^{-2}$

Correct: +4 · Incorrect: -1

15 The normal density of a material is r and its bulk modulus of elasticity is K. The magnitude of increase in density of material, when a

pressure P is applied uniformly on all sides will be

- $\frac{\rho P}{K}$
- $\frac{\rho K}{P}$
- $\frac{K}{\rho P}$
- $\frac{PK}{\rho}$

Correct: +4 · Incorrect: -1

16 If Y, K and η are the values of Young's modulus, bulk modulus and modulus of rigidity of any material respectively. Choose the correct relation for these parameters.

- $Y=\frac{PK\eta}{3K-\eta}N/m^2$
- $\eta=\frac{3YK}{9K+Y}N/m^2$
- $Y=\frac{9K\eta}{2\eta+3K}N/m^2$
- $K=\frac{U\eta}{9\eta}-3YN/m^2$

Correct: +4 · Incorrect: -1

17 A boy's catapult is made of rubber cord which is 42cm long, with 6mm diameter of cross section and of negligible mass. The boy keeps a stone weighing 0.02kg on it and stretches the cord by 20cm by applying a constant force. When released the stone flies off with a velocity of 20 ms^{-1}. Neglecting the change in the area of cross section of the cord while stretched. The Young's modulus of rubber is closest to

- 10^6 N/m^{-2}
- 10^4 N/m^{-2}
- 10^8 N/m^{-2}
- 10^3 N/m^{-2}

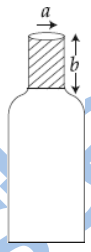
Correct: +4 · Incorrect: -1

18 A solid sphere of radius r made of soft material of bulk modulus K is surrounded by a liquid in a cylindrical container. A massless piston of area of a floats on the surface of the liquid, covering entire cross section of cylindrical container. When a mass m is placed on the surface of the piston to compress the liquid, the frictional decrement in the radius of the sphere (dr/r), is

- $\frac{Ka}{mg}$
- $\frac{Ka}{3mg}$
- $\frac{mg}{3Ka}$
- $\frac{mg}{Ka}$

Correct: +4 · Incorrect: -1

19 A bottle has an opening of radius a and length b. A cork of length b and radius (a + Δa) where (Δa <<a) is compressed to kt into the opening completely (see kg). If the bulk modulus of cork is B and frictional coefkcient between the bottle is μ then the force beeded to push the cork into the bottle is



- (πμBb)a
- (2πμBb)Δa
- (πμBb)Δa
- (4πμBb)Δa

Correct: +4 · Incorrect: -1

20 The bulk modulus of ethanol, mercury and water are given as 0.9, 2.5 and 2.2 respectively in units of $10^9 Nm^{-2}$. For a given value pressure, the fractional compression in volume $\frac{\Delta V}{V}$. Which of the following statements about $\frac{\Delta V}{V}$ for these three liquids is correct?

- Ethanol > Water > Mercury

- ◯ Water > Ethanol > Mercury
- ◯ Mercury > Ethanol > Water
- ◯ Ethanol > Mercury > Water

Correct: +4 · Incorrect: -1

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ANSWERS

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Section 1 : Section A - 20 Questions

1 2.60×10^{-7}

2 40

3 12.5cm

4 20

5 2

6 4

7 $3F/(\pi r^2 YT)$

8 1.16mm

9 $3.1\times10^{6}\ Nm^{-2}$

10 1.7mm

11 The maximum value of Y that can be determined is $2\times10^{14} N/m^2$

12 4mg/3A

13 500

14 $1.44\times10^{9}Nm^{-2}$

15 $\frac{\rho P}{K}$

16 $K=\frac{U\eta}{9\eta}-3\,YN/m^{2}$

17 $10^{6}\ N/m^{-2}$

18 $\frac{mg}{3Ka}$

19 $(4\pi\mu Bb)\Delta a$

20 Ethanol > Water > Mercury