PHYSICS Max Marks : 60

SECTION – I
(SINGLE CORRECT ANSWER TYPE)

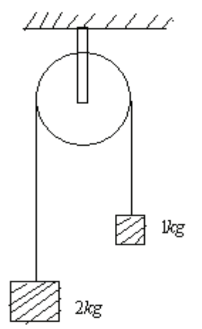
This section contains 10 multiple choice questions. Each question has 4 options (A), (B), (C) and (D) for its answer, out of which ONLY ONE option can be correct.

Marking scheme: +2 for correct answer, 0 if not attempted and 0 in all other cases.

1. A piece of copper wire has twice of the radius of a piece of steel wire. Young's modulus for steel is twice that for the copper. One end of the copper wire is joined to one end of the steel wire so that both can be subjected to the same longitudinal force. By what percentage of its length will the steel have stretched when the length of the copper has increased by 1%?

A) 1% B) 2% C) 2.5% D) 3%

2. Two blocks of masses 1kg and 2kg are connected by a metal wire going over a smooth pulley as shown. The breaking stress of the metal is $\frac{40}{3\pi}\times10^6\,N/m^2$. If g=10m/s^2 then what should be the minimum radius of the wire used if it is not to break?



A) 0.5 mm B) 1mm C) 1.5 mm D) 2mm

3. A 5 kg rod of square cross section of edge length 5cm and 1m long is pulled along a smooth horizontal surface by a force applied at one end . The rod has a constant acceleration of $2m/s^2$. Determine the elongation in the rod. (Young's modulus of the material of the rod is $5\times10^9 N/m^2$)

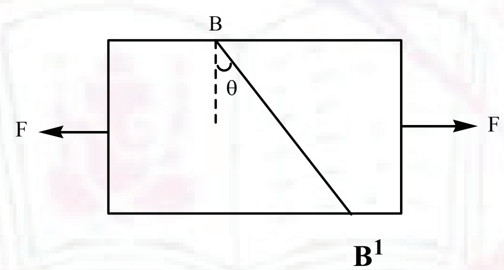
A) Zero as for elongation to be there equal and opposite forces must act on the rod

B) Non – zero but can't be determine from the given situation

C) 0.4 μm

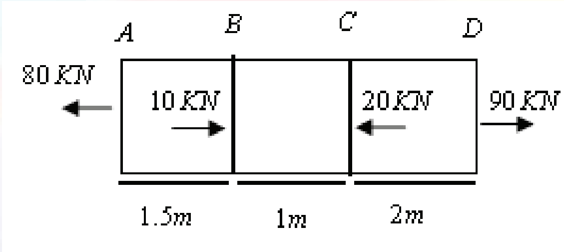
D) $16\mu m$

4. A bar of cross section A is subjected to two equal and opposite tensile forces as shown. Consider a cross section BB^1 is shown in figure. The shearing stress on surface BB^1 is



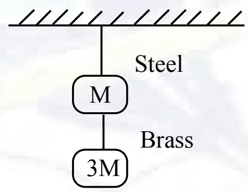
A) $\frac{F\cos^2\theta}{A}$ B) $\frac{F}{A}$ C) $\frac{F\sin 2\theta}{2A}$ D) zero

5. A steel rod of cross-sectional area 1 m^2 is acted upon by forces shown in figure. Determine the elongation of the length BC of the bar. Take $Y = 2.0\times10^{11} N/m^2$
(10KN acts at B and 20 KN acts at C)



A) $13\times10^{-7} m$ B) $4.5\times10^{-7} m$ C) $5\times10^{-7} m$ D) $3.5\times10^{-7} m$

6. The ratio of length, radii and Young's modulii of steel and brass wires a,b,c respectively. Then the corresponding ratio of increases in their length in the shown in figure would be



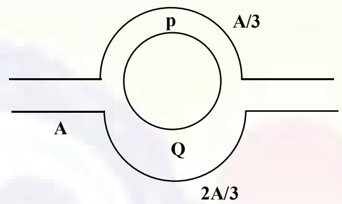
A) $\dfrac{2a^2c}{b}$ B) $\dfrac{4a}{3b^2c}$ C) $\dfrac{3ac}{4b^2}$ D) $\dfrac{3c}{2ab^2}$

7. A mass m kg is whirled in a vertical plane by tying it at the end of a flexible wire of length l and area of cross section 'A'. When the mass is at its lowest position where its velocity $v = \sqrt{5gl}$, the strain produced in the wire is, [Young modulus of the wire is 'Y']

A) $\dfrac{AY}{6mg}$ B) $\dfrac{6mg}{AY}$ C) $\dfrac{5mg}{AY}$ D) $\dfrac{AY}{5mg}$

8. Figure shows a liquid flowing through a tube at the rate of $0.1\, m^3/s$ .The tube is branched into two semicircular tubes of cross sectional area A/3 and 2A/3. The velocity of liquid at 'Q' is (the cross section of the main tube is

$A = 10^{-2} m^2 \quad and \ Vp = 20 m/s$



A) 5m/s B) 30 m/s C) 35 m/s D) 10 m/s

9. A wide vessel with a small hole at the bottom is filled with water and kerosene. Neglecting viscosity, find the velocity of the water flow if thickness of water layer is 0.3m and that of kerosene layer is 0.2 m (specific gravity of kerosene =0.8)

A) 2 m/s B) 3 m/s C) 5 m/s D) 2.5 m/s

10. A stone is dropped from a height equal to nR, where R is the radius of Earth, from the surface of the Earth. The velocity of the stone on reaching the surface of the Earth is [neglect air resistance]

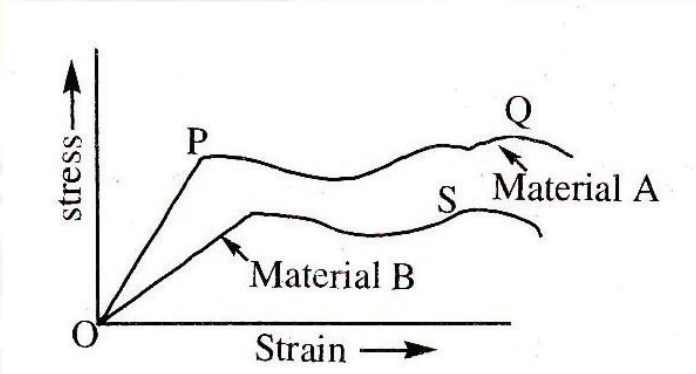
A) $\sqrt{\frac{2g(n+1)R}{n}}$ B) $\sqrt{\frac{2gR}{n+1}}$ C) $\sqrt{\frac{2gnR}{n+1}}$ D) $\sqrt{2gnR}$

SECTION – II
(MULTIPLE CORRECT ANSWER TYPE)

This section contains 5 multiple choice questions. Each question has 4 options (A), (B), (C) and (D) for its answer, out of which ONE OR MORE than ONE option can be correct.

Marking scheme: +4 for correct answer, 0 if not attempted and -1 in all other cases.

11. The figure shows the stress – strain graphs for material A and B. From the graph it follows that



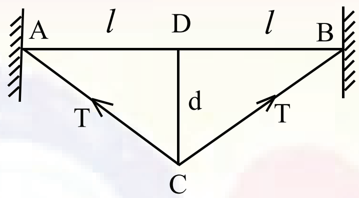
A) Material A has a higher Young's modulus

B) Material B is more ductile

C) Material A can withstand greater stress

D) Material B can withstand greater stress

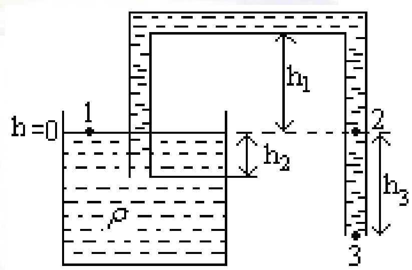
12. A wire AB of length $2l$ and cross – section area $\boldsymbol{a}$ is stretched without tension between fixed points A and B. The wire is pulled at the centre into shape ACD such that $d << l,$ the tension in the string is T and the elongation produced in it is ε. If the Young's modulus of the material of wire is Y, then



A) $\varepsilon = \dfrac{d}{2l}$ B) $\varepsilon = \dfrac{d^2}{2l^2}$ C) $T = aY\dfrac{d}{2l}$ D) $T = aY\dfrac{d^2}{2l^2}$

13. Figure shows a siphon, tube cross section is uniform. Choose the correct statement.

(P_0 Is atmospheric pressure)



A) When siphon works $h_3 > 0$ B) Pressure at point 2 is $P_2 = P_0 - \rho g h_3$

C) Pressure at point 2 is $P_2 = P_0 - \rho g h_2$ D) Pressure at point 3 is P_0

14. When a body of mass M is attached to lower end of a wire (of length L) whose upper end is fixed, then the elongation of the wire is l. In this situation, mark out the correct statement(s)

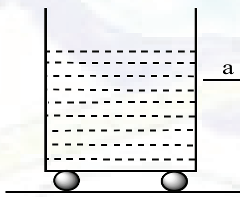
A) Loss in gravitational potential energy of M is Mgl ($\rho =$ density of wire $Y =$ Youngs modulus of the wire $r =$radius of the wire)

B) Elastic potential energy stored in the wire is $\dfrac{Mgl}{2}$

C) Elastic potential energy stored in the wire is $\dfrac{\rho^2 g^2 L^3 \pi r^2}{6Y}$

D) Elastic potential energy stored in the wire is $Mgl/3$

15. An open vessel containing liquid is moving with constant acceleration a on a level horizontal surface. For this situation mark but the correct statement(s)



A) The maximum pressure is at the left most bottom corner

B) Along a horizontal line within the liquid as we move from left to right the pressure decreases

C) The pressure at all points on a line making an angle of $\tan^{-1}\left(\dfrac{a}{g}\right)$ with horizontal would be same

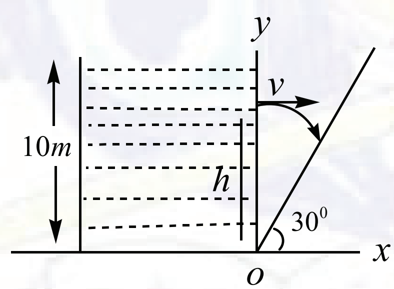
D) Along a horizontal line within the liquid as we move from left to right, the pressure remains constant.

SECTION – III
INTEGER TYPE

(This section contains **5 questions.** The answer to each question is a single digit integer ranging from 0 to 9. The correct digit below the question number in the ORS is to be bubbled).

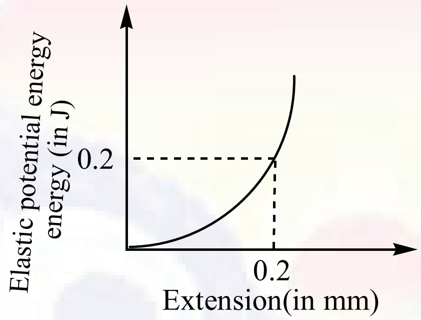
Marking scheme +4 for correct answer, 0 if not attempted and -1 in all other cases.

16. A rectangular tank of height 10m filled with water is placed near the bottom of a plane inclined at an angle 30^0 with horizontal. At height h from bottom a small hole is made (as shown in figure) such that the stream coming out from hole, strikes the inclined plane normally. The value of 'h' is $\frac{(x)^2}{3}$. Find the value of 'x' in meters



17. A solid sphere of radius R made of a material of bulk modulus B is surrounded by a liquid in a cylindrical container. A massless piston of area A (the area of container is also A) floats on the surface of the liquid. When a mass M is placed on the piston to compress the liquid, fractional change in radius of the sphere is $\frac{Mg}{\alpha AB}$. Find the value of α.

18. Figure shows the graph of elastic potential energy (U) stored *versus extension*, for a steel wire $(Y = 2\times10^{11}\,Pa)$ of volume $200cc$. Find the original length of the wire.



19. There are two identical small holes on the opposite sides of a tank containing a liquid. The tank is open at the top. The difference in height between the holes is h. As the liquid comes out to the two holes, the tank will experience a net horizontal force proportional to h^N.N is equal to

20. A rod AB of mass M and length L is lying on a horizontal frictionless surface. A particle of mass m travelling along the surface hits one end A of the rod with a velocity v_0 in a direction perpendicular to AB. The collision is elastic. After the collision the particle comes to rest.

Find the ratio M/m.

Sri Chaitanya IIT Academy., India.

A.P, TELANGANA, KARNATAKA, TAMILNADU, MAHARASHTRA, DELHI, RANCHI

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ICON CENTRAL OFFICE, MADHAPUR - HYD

Sec: JR.Super60 **WTA-21** **Date:26-09-16**

Time: 07:30 AM – 10:30 AM **(2013-P1)** **Max.Marks:180**

KEY SHEET

PHYSICS

1	**B**	2	**B**	3	**C**	4	**C**	5	**D**
6	**B**	7	**B**	8	**A**	9	**B**	10	**C**
11	**AC**	12	**BD**	13	**ABD**	14	**ABC**	15	**ABC**
16	**5**	17	**3**	18	**2**	19	**1**	20	**4**

CHEMISTRY

21	**A**	22	**B**	23	**A**	24	**A**	25	**C**
26	**B**	27	**D**	28	**C**	29	**D**	30	**D**
31	**AC**	32	**CD**	33	**AB**	34	**ABD**	35	**ABC**
36	**5**	37	**7**	38	**1**	39	**2**	40	**5**

MATHS

41)	**B**	42)	**B**	43)	**C**	44)	**D**	45)	**A**
46)	**C**	47)	**D**	48)	**A**	49)	**B**	50)	**B**
51)	**ABD**	52)	**AD**	53)	**ACD**	54)	**ACD**	55)	**AC**
56)	**6**	57)	**2**	58)	**1**	59)	**6**	60)	**3**

SOLUTIONS:

PHYSICS:

1. $\Delta l = \frac{Fl}{\pi r^2 Y} or \frac{\Delta l}{l} \propto \frac{1}{r^2 Y}$

$$\frac{\left(\frac{\Delta l}{l}\right)_s}{\left(\frac{\Delta l}{l}\right)_{Cu}} = \frac{r_{Cu}{}^2{}_{Cu}}{r_S{}^2 Y_3} = \frac{4r_s{}^2 \frac{Y_s}{2}}{r_S{}^2 Y_s} = 2$$

$$\therefore \left(\frac{\Delta l}{l}\right)_S = 2\left(\frac{\Delta l}{l}\right)_{Cu}$$

2. $T = \frac{2m_1 m_2}{m_1 + m_2} g = \frac{2\times1\times2}{1+2}\times10N = \frac{40}{3}N$

If r is the minimum radius then

Breaking stress = $\frac{3}{\pi r^2}$ or $\frac{40}{3\pi}\times10^6 = \frac{40}{3\pi r^2}$

$r^2 = \frac{1}{10^6} or \ \mathrm{r} = \frac{1}{10^3}m$

$r = \frac{1}{10^3}\times10^3 m = 1mm$

3. Let the force applied be p: then

$P = ma = 5\times2 = 10N$

$T = \frac{m}{l}(l-x)\times a$

$= \frac{5}{1}(1-x)\times2 = 10(1-x)$

Elongation in dx is $\frac{\Delta(dx)}{dx} = \frac{T/A}{A}$

$\Delta(dx) = \frac{10(1-x)}{\left(5\times10^{-2}\right)^2}\times\frac{1}{5\times10^9}dx$

Total elongation

$\Delta l = \int_0^1 \frac{10(1-x)}{25\times10^{-4}}\times\frac{1}{5\times10^9}dx$

$= 0.4\times10^{-6}m$

4. Cross –sectional area of the section is $A' = \frac{A}{\cos\theta}$

Shearing stress = $\frac{F\sin\theta}{A'} = \frac{F\sin 2\theta}{2A}$

5. The bar is at equilibrium. The net force from right or left of a section of BC is 70KN.We know that the extension due to external forces Fis given

$\Delta_{BC} = \frac{\left(70\times10^3\right)\times1}{1\times2\times10^{11}} = 3.5\times10^{-7}m$

6. $e = \frac{Fl}{AY}$

7. Strain $=\dfrac{Fl}{Ay}$ $\quad F=\dfrac{mv^2}{r}+mg=m.\dfrac{5lg}{L}+mg=6g$

8. From the equation of continuity

$Rate=r=A/3V_p+(A-A/3)VQ$

$V_p+2VQ=3r/A=\dfrac{3\times 0.1}{10^{-2}}=30M/S$

$As\ V_P=20M/S, SO\ VQ=5m/s$

9. Let ρ_1 *and* ρ_2 be the densities of water and kerosene, respectively, the liquid force exerted by in the vessel is given by $m\rho_1 ag+h_2\rho_2 ag$, where a=area of cross section , $h_1=$thickness of water , h_2=thickenss of kerosene. Let this height be equivalent to a water layer of thickness h

Then,

$h\rho ag=h_1\rho_1 ag+h_2\rho_2 ag\Rightarrow h=\left(h_1+\dfrac{h_2\rho_2}{\rho_1}\right)$

According to Toricelli's theorem we have

$V=\sqrt{2gh}=\sqrt{2g\left(h_1+\dfrac{h_2\rho_2}{\rho_1}\right)}$

Substituting the numerical values, we have

$V=\left[2(9.8)\left[0.3+\dfrac{0.2\times 0.8\times 10^3}{10^3}\right]\right]^{1/2}=3m/s$

10. Use conservation of energy

$G.E_{height}=T.E_{on\,surface}$

$\dfrac{-GMm}{R+nR}=\dfrac{-GMm}{R}+\dfrac{1}{2}mv^2$

11. slope $=\dfrac{stress}{strain}=Y$

12. $\varepsilon=2\sqrt{l^2+d^2}-2l$

$=2\left[l^2\left(1+\dfrac{d^2}{l^2}\right)\right]^{\frac{1}{2}}-2l$

$=2l\left(1+\dfrac{1}{2}\dfrac{d^2}{l^2}-1\right)=\dfrac{d^2}{2l}$

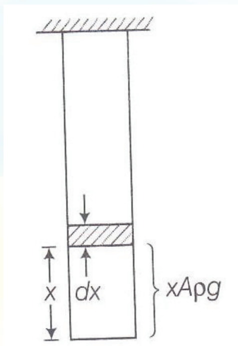
13. Apply Bernoulli's theorem

$$P_3 + \frac{1}{2}\rho V_3^2 = P_1 + \rho g h_3$$

$$V_3 = \sqrt{2gh_3}$$

Use principle of siphon

14. Consider an element as shown in the figure.



Stress in the element $= \frac{Force}{Area} = \frac{xA\rho g}{A} = x\rho g$

Now, elastic potential energy stored in the wire is

$$dU = \frac{1}{2}(Stress)(Strain)(Volume)$$

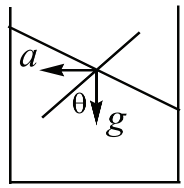
$$= \frac{1}{2}.\frac{(Stress)^2}{Y}(Volume)$$

$$dU = \frac{1}{2}.\frac{(x\rho g)^2}{Y}Adx = \frac{1}{2}.\frac{\rho^2 g^2 A}{Y}x^2 dx$$

Total elastic potential energy $= \frac{1}{2}.\frac{\rho^2 g^2 A}{Y}\int_0^L x^2 dx$

$$= \frac{\rho^2 g^2 A L^3}{6Y}$$

15. Towards left pressure increases



$\Rightarrow a$

16. $v=\sqrt{2g\left(10-h\right)}$

Component of its velocity parallel to the plane is $v\cos 30^0$

Let the stream strike the plane after time t. Then $0=v\cos 30^0-g\sin 30^0 t$

$\therefore \quad t=\dfrac{v\cot 30}{g}$

Further $\quad x=vt=\dfrac{v^2\cot 30^0}{g}$

$=\sqrt{3}y$

Or $\quad \dfrac{v^2\cot 30^0}{g}=\sqrt{3}\left(h-\dfrac{1}{2}gt^2\right)$

$\therefore \quad \dfrac{\sqrt{3}v^2}{g}=\sqrt{3}\left(h-\dfrac{g}{2}\dfrac{v^2\cot^2 30^0}{g^2}\right)$

Or $\quad \dfrac{v^2}{g}=h-\dfrac{3}{2}\dfrac{v^2}{g}\Rightarrow\dfrac{5}{2}\dfrac{v^2}{g}=h$

$\dfrac{v^2}{4}=\dfrac{x^2}{3}\Rightarrow x=5$

17. Increase in pressure is $\Delta p=\dfrac{Mg}{A}$

Bulk modulus is $B=\dfrac{\Delta p}{\left(\Delta V/V\right)}$

$\therefore \quad \dfrac{\Delta V}{V}=\dfrac{\Delta p}{B}=\dfrac{Mg}{AB} \quad$ …..(i)

Also, the volume of the sphere is $V = \frac{4}{3}\pi R^3 \Rightarrow \frac{\Delta V}{V} = \frac{3\Delta R}{R}$

Or $\frac{\Delta R}{R} = \frac{1}{3}.\frac{\Delta V}{V}$,

Using Eq.(i) we get

$\frac{\Delta R}{R} = \frac{Mg}{3AB} \Rightarrow \therefore \alpha = 3$

18. $U = \frac{1}{2}kx^2$. It is a parabola symmetric about

$U - axis$

At $x = 0.2mm, U = 0.2J$ (from the figure)

$\therefore \quad 0.2 = \frac{1}{2}k\left(2\times10^{-4}\right)^2$

$\Rightarrow \quad k = 10^7\,Nm^{-1}$

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

$\Rightarrow \quad \frac{A}{L} = \frac{k}{Y} = \frac{10^7}{3\times10^{11}} = 5\times10^{-1}$ …….(i)

$AL = volume = 200\times10^{-6}\,m^3$ …….(ii)

On solving equations i) and ii) , we get $A = 10^{-4}\,m^2$ and $L = 2$

19. $F = av^2d$

$F = a\left(v_2^2 - v_1^2 d\right)$

$= a2g\left(h_2 - h_1\right)d$

$= 2aghd$

20. Applying conservation of angular momentum about COM of rod, we get

$$mv_0\left(\frac{L}{2}\right)=I\omega$$

Or $$mv_0\frac{L}{2}=\frac{ML^2\omega}{12}$$

Or $$mv_0=\frac{ML\omega}{6}$$

Since, the collision is elastic, kinetic energy is also conserved.

$$\therefore \quad \frac{1}{2}mv_0^2=\frac{1}{2}Mv^2+\frac{1}{2}I\omega^2$$

Or $$mv_0^2=Mv^2+\frac{ML^2}{12}\omega^2$$

$$\frac{M}{m}=4$$

CHEMISTRY:

21. Conceptual

22 Conceptual

23. $$E=0-\frac{0.059}{2}\log\frac{0.4}{(0.1)^2}\cdot\frac{(10^{-2})^2}{0.2}$$

$$=-\frac{0.059}{2}\log\frac{4\times10^{-5}}{10^{-3}\times2}=0.05$$

24. $$Z=\frac{a^3\times d\times N_A}{M}$$

Fcc $4=\dfrac{a_1^3\times d\times N_A}{m}$ ………….. (i)

Bcc $2=\dfrac{a_2^3\times d\times N_A}{m}$ …………… (ii)

Dividing equation (i) by (ii)

$$2=\left(\frac{a_1}{a_2}\right)^3 \quad \frac{a_1}{a_2}=2^{1/3}$$

FINAL KEY

S.NO	SUB	Q.NO	GIVEN KEY	FINALIZED KEY	EXPLANATION
1	PHY	12	BD	D	Key change
2	PHY	14	ABC	AB	Option C is wrong