Sri Chaitanya IIT Academy, India

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

A right Choice for the Real Aspirant

ICON CENTRAL OFFICE, MADHAPUR-HYD

Sec: Sr. IPLCO **Date: 12-09-15**

Time: 9:00 AM to 12:00 Noon **RPTM-6** **Max.Marks: 360**

KEY SHEET

MATHS		PHYSICS		CHEMISTRY	
Q.NO	ANSWER	Q.NO	ANSWER	Q.NO	ANSWER
1	3	31	1	61	2
2	2	32	2	62	3
3	4	33	2	63	2
4	2	34	1	64	1
5	1	35	1	65	4
6	4	36	3	66	2
7	4	37	2	67	1
8	1	38	3	68	4
9	3	39	4	69	2
10	3	40	1	70	3
11	1	41	3	71	4
12	2	42	4	72	1
13	3	43	2	73	3
14	3	44	2	74	1
15	4	45	3	75	2
16	4	46	3	76	3
17	2	47	2	77	4
18	3	48	3	78	2
19	2	49	1	79	1
20	1	50	2	80	4
21	4	51	4	81	2
22	2	52	4	82	2
23	1	53	4	83	3
24	4	54	1	84	1
25	1	55	3	85	1
26	1	56	1	86	2
27	3	57	3	87	2
28	4	58	1	88	3
29	4	59	1	89	3
30	2	60	1	90	2

PHYSICS

31. By Law of conservation of Angular momentum

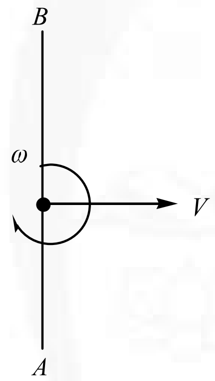
$$mvr = \left(I_{system}\right)\omega$$

$$\Rightarrow mvr = \left(I + mR^2\right)\omega$$

$$\Rightarrow \omega = \frac{mvr}{I + mR^2}$$

32. Let V be the linear velocity of centre of mass of rod just after collision and ω be its angular velocity, then by Law of conservation of linear momentum, we have

$$mv_0 = Mv \qquad \text{.... (1)}$$



By law of conservation of angular momentum about centre of rod, we get

$$mv_0 x = \left(\frac{ML^2}{12}\right)\omega \qquad \text{.... (2)}$$

For A to be at rest just after collision, we have

$$\frac{L}{2}\omega = V \qquad \text{.... (3)}$$

Solving equations (1), (2) and (3), we get $x = \frac{L}{6}$

33. Net external torque is zero. Therefore, angular momentum of system will remain conserved i.e.,

$$L_1 = L_1$$

Initial angular momentum $L_1 = 0,$ so final angular momentum should also be zero

$$\Rightarrow \begin{pmatrix} \text{Angular momentum} \\ \text{of Man in CW sense} \end{pmatrix} + \begin{pmatrix} \text{Angular momentum} \\ \text{of Platform in CCW sense} \end{pmatrix} = 0$$

$$\Rightarrow mvr - \left(I_{platform}\right)\omega = 0$$

$$\Rightarrow \omega = \frac{mv_0 r}{I} = \frac{(70)(1)(2)}{200}$$

$$\Rightarrow \omega = 0.7 rads^{-1}, \omega_{rel} = 1.2 rad/\text{sec}$$

34. Since, $\tau_{ext} = 0$

$$\Rightarrow I\omega = \text{constant}$$

$$\Rightarrow \Delta(I\omega) = 0$$

$$\Rightarrow \frac{\Delta\omega}{\omega} = \frac{\Delta I}{I}$$

Now, volume $V = \frac{4}{3}\pi R^2$

$$\Rightarrow \frac{\Delta V}{V} \text{x} 100 = 3\frac{\Delta R}{R} \text{x} 100$$

Percentage increase in volume is 3%, so percentage increase in radius will be %

Further, $I = \frac{2}{5} mR^2$

$$\Rightarrow \frac{\Delta I}{I} = \frac{2\Delta R}{R}$$

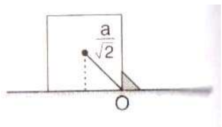
$$\Rightarrow \frac{\Delta\omega}{\omega} = -\frac{\Delta I}{I} = -\frac{2\Delta R}{R} = -2\%$$

35. By law of conservation of angular momentum

$$mv\left(\frac{a}{2}\right) = \left(I_{\substack{system \\ about\,O}}\right)\omega$$

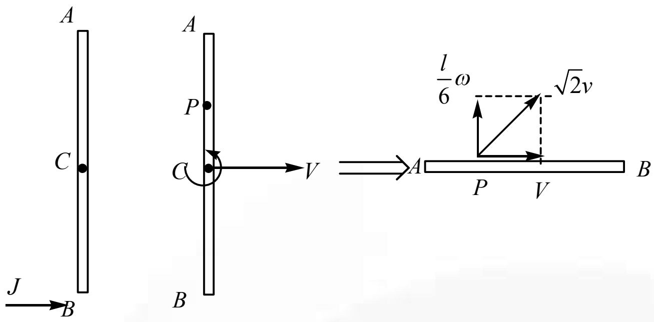
$$mv\left(\frac{a}{2}\right) = \left[\frac{1}{6}Ma^2 + M\left(\frac{a}{\sqrt{2}}\right)^2\right]\omega$$

$$\Rightarrow \omega = \frac{3V}{4a}$$



36. Let v and ω be the linear and angular speeds of the rod after applying an impulse J at B. Then

Impulse = change in momentum



$\Rightarrow mv = J$

$\Rightarrow v = \frac{J}{m}$ .... (1)

Also, $\begin{pmatrix}\text{Angular}\\ \text{impulse}\end{pmatrix} = \begin{pmatrix}\text{Change in angular}\\ \text{momentum}\end{pmatrix}$

$\Rightarrow I\omega = J\left(\frac{l}{2}\right)$

$\Rightarrow \frac{ml^2}{12}\omega = J\left(\frac{l}{2}\right)$

$\Rightarrow \omega = \frac{6J}{ml}$ .... (2)

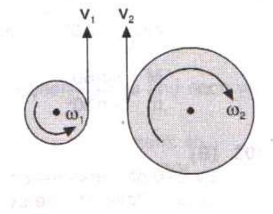
After the given time $t = \frac{\pi ml}{12J}$, the rod will rotate an angle

$\theta = \omega t = \left(\frac{6J}{ml}\right)\left(\frac{\pi ml}{12J}\right) = \frac{\pi}{2}$

$\Rightarrow v = \left(\frac{l}{6}\right)\omega = \left(\frac{l}{6}\right)\left(\frac{6J}{ml}\right) = \frac{J}{m}$

$\Rightarrow \left|\bar{V}_P\right| = \sqrt{2}v = \sqrt{2}\frac{J}{m}$

37. Let ω_1 and ω_2 be the final angular velocities when the slipping has ceased. Then



$v_1 = v_2$

$\Rightarrow \omega_1 R = \omega_2 (2R)$

$\Rightarrow \omega_2 = \frac{\omega_1}{2}$ .... (1)

Since, $\begin{pmatrix} \text{Angular} \\ \text{impulse} \end{pmatrix} = \begin{pmatrix} \text{Change in Angular} \\ \text{momentum} \end{pmatrix}$, so

$JR = I\omega_1$ .... (2)

and $2JR = 4I(\omega_0 - \omega_2)$ .... (3)

where, J is the linear impulse due to friction which acts tangentially and is equal for both the cylinder.

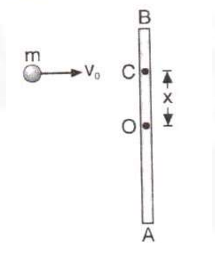
Solving equations (1), (2) and (3), we get

$\omega_1 = \omega_0 \ and \ \omega_2 = \frac{\omega_0}{2}$

38. Since, impulse = change in momentum, so

J = (2m)v

$\Rightarrow v = \frac{J}{2m}$



Also, $\begin{pmatrix} \text{Angular} \\ \text{impulse} \end{pmatrix} = \begin{pmatrix} \text{Change in Angular} \\ \text{momentum} \end{pmatrix}$

$\Rightarrow Jl = (I_{system})\omega$

$\Rightarrow Jl = \left(2ml^2\right)\omega$

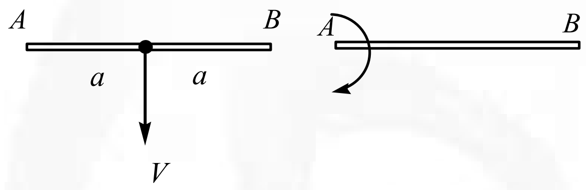
$\Rightarrow \omega = \dfrac{Jl}{2ml^2} = \dfrac{J}{2ml}$

So, $v_A = v + l\omega$

$\Rightarrow v_A = \dfrac{J}{2m} + \dfrac{J}{2m} = \dfrac{J}{m}$

39. Applying law of conservation of angular momentum about A, we get

$L_i = L_f$



$\Rightarrow mva = I\omega$

$\Rightarrow mva = \dfrac{m(2a)^2}{3}\omega$

$\Rightarrow \omega = \dfrac{3v}{4a}$

40. By law of conservation of angular momentum

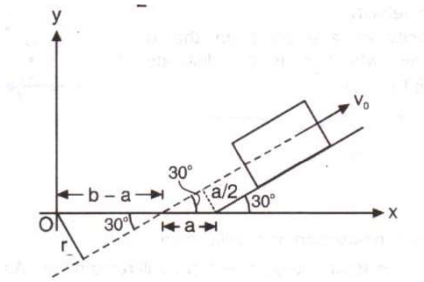
$\sum mvr = \left(I_{system}\right)\omega$

$\Rightarrow mv\dfrac{l}{2} = \dfrac{(2m)(2l)^2}{12}\omega = \dfrac{2m(4l)^2}{12}\omega$

$\Rightarrow \omega = \dfrac{3v}{4l}(anticlockwise)$

41. Since spheres are smooth, so no transfer of angular momentum takes from A to B. However, sphere A only transfers its linear velocity v to sphere B and stops. Hence we conclude that A stops but continues to rotate with same angular speed ω and B moves with speed of A but with zero angular speed.

42. $r_\perp = (b-a)\sin 30^o = \dfrac{b-a}{2}$



$$\Rightarrow L = mv_0 r_\perp = \frac{mv_0(b-a)}{2}$$

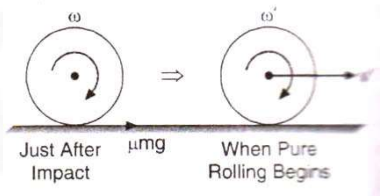
43. By law of conservation of linear momentum, we have

$$mv\hat{i} + mv\hat{j} + mv\left(-\hat{i}\right) + \vec{0} = \vec{P}_{\substack{triangular\\ wedges ABC}} + \vec{0}$$

$$\Rightarrow \vec{P}_{\substack{triangular\\ wedges ABC}} = (mv)\hat{i}$$

Since the net linear momentum imparted to the triangular wedge is along x-axis and is non-zero, so the centre of mass of wedge ABC will move along x-axis.

44. Since both spheres are of equal masses and the second spheres is at rest, so just after collision the first sphere comes to rest and it will have only ω i.e., it will slip backwards. So, friction will be maximum and in forward direction Let v^1 be its linear speed and ω^1 its angular speed when it again starts pure rolling. Friction is passing through its bottommost point, so we can conserve angular momentum about an axis passing through its bottommost point and perpendicular to plane of motion. So,



$$L_i = L_t$$

$$\Rightarrow \frac{2}{5}\left(mR^2\right)\omega = \frac{2}{5}\left(mR^2\right)\omega^i + mv^1R$$

$$\Rightarrow \frac{2}{5}\left(mR^2\right)\omega = \frac{2}{5}\left(mR^2\left(\frac{V^1}{R}\right) + mv^1R\right)$$

$\Rightarrow v^1 = \frac{2}{7}R\omega$

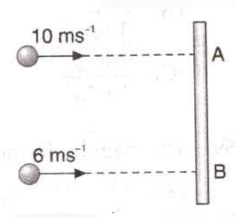
45. By law of conservation of momentum , $V_{cm} = 4m/s^{-1}$

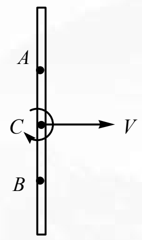
Also, AB = CB = 0.5m

Similarly applying conservation of angular momentum about the point C, we get

$(0.08)(10)(0.5)-(0.8)(6)(0.5) = I_{system}\omega$ ….. (1)

Where, $I_{system} = I_{rod} + I_{two\ particles} = \frac{(1.6)(\sqrt{3})^2}{12} + 2(0.08)(0.5)^2$





$\Rightarrow I_{system} = 0.08kgm^2$

Substituting in equation (1), we get

$\omega = 2rads^{-1}$

46. Applying Law of conservation of linear momentum, we get

$mv_0 = 2mv_1 - mv_2$

$\Rightarrow 2v_1 - v_2 = v_0$ …. (1)

Applying law of conservation of angular momentum about centre of mass C of light rod and the two identical particles, we get

$$mv_0\left(\frac{L}{2}\right)\left(\frac{1}{\sqrt{2}}\right) = 2m\left(\frac{L}{2}\right)^2\omega - mv_2\left(\frac{L}{2}\right)\left(\frac{1}{\sqrt{2}}\right)$$

$\Rightarrow v_0 = \sqrt{2}L\omega - v_2$ ….. (2)

Since the mechanical energy is conserved so, the collision is elastic, hence e = 1 at point of impact along common normal direction.

$$\Rightarrow \begin{pmatrix}\text{Relative speed}\\ \text{of Approach}\end{pmatrix} = \begin{pmatrix}\text{Relative speed}\\ \text{of seperation}\end{pmatrix}$$

$$\Rightarrow v_0 = v_2 + v_1\left(\frac{L}{2}\omega\right)\left(\frac{1}{\sqrt{2}}\right)$$

$\Rightarrow v_0 = v_1 + v_2 + \dfrac{\omega L}{2\sqrt{2}}$ .... (3)

Solving equations (1), (2) and (3), we get $\omega = \dfrac{4\sqrt{2}}{7}\dfrac{v_0}{L}$

47. Sol. $T\sin\theta = mr\omega^2, \Delta l = \dfrac{Tl}{Ay}$

$T\cos\theta = mg$

48. The force at any section is due to the inertia behind the section .The stress there fore increases from zero to maximum at the end where force is applied . Consider a small element of length dx at a distance x from the free end The force

$F_x = ma$

$\left(\dfrac{M}{L}x\right)\times\dfrac{F_0}{M} = \dfrac{F_0 x}{L}$

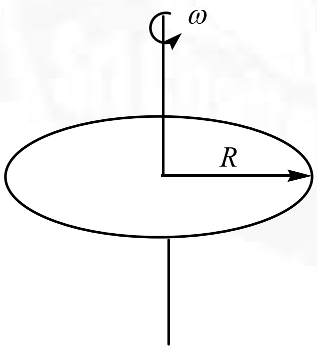
Elongation of the element

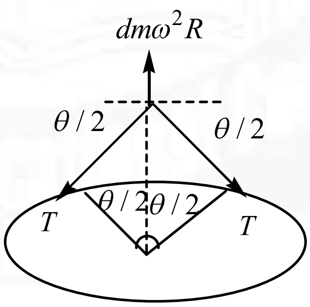
$$dl = \frac{F_x(dx)}{AY} = \frac{\left(\frac{F_0 x}{L}\right)dx}{AY}$$

Total elongation $dl = \int_0^L \dfrac{F_0}{ALY}xdx = \dfrac{F_0}{2ALY}L^2$

Or $\Delta l = \dfrac{F_0 L}{2AY}$

49. Due to rotation each part of ring experiences an outward force (centrifugal force) .Because of this force the ring will rupture





Let us consider small part of ring which subtend angle θ at the centre Mass of the element $(em)\delta dv = \delta(AR\theta)$

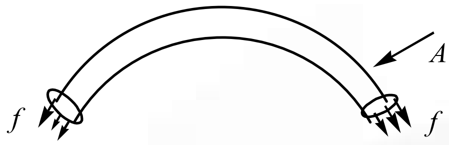
$\therefore 2T\sin\theta/2 = (dm)\omega^2 R$

When θ is small sin $\theta/2 = \theta/2$

$\therefore 2T\times\theta/2 = (\delta AR\theta)\omega^2 R$

$\Rightarrow T = \delta A\omega^2 R^2$

The stress at any section of the ring



$f = \dfrac{T}{A} = \dfrac{\delta A\omega^2 R^2}{A}$

$= \delta\omega^2 R^2$

Rpture takes place when $f = \sigma$

$\sigma = \delta\omega^2 R^2$

$\Rightarrow \omega = \sqrt{\dfrac{\sigma}{\delta R^2}}$

And $n = \dfrac{1}{2\pi}\sqrt{\dfrac{\sigma}{\delta R^2}}$

50. $Y = \dfrac{MgL}{\pi r^2 l}$

$= \dfrac{1\times 9.8\times 2}{\pi\left(0.2\times 10^{-3}\right)^2 \times 0.8\times 10^{-3}}$

$= 2\times 10^{11}$ N/m

Also $\dfrac{\Delta Y}{Y} = 2\dfrac{\Delta r}{r} + \dfrac{\Delta l}{l}$

$= 2\dfrac{0.01}{4} + \dfrac{0.05}{0.8} = 0.2$

51. $\dfrac{\Delta l_{steel}}{\Delta l_{brass}} = \dfrac{F_1 l_1/\pi r_1^2 Y_1}{F_2 l_2/\pi r_2^2 Y_2}$

$= \dfrac{2}{4}\times a\times\left(\dfrac{1}{b}\right)^2 \times\dfrac{1}{c}$

$$=\frac{a}{2b^2c}$$

52. Longitudinal strain

$$e=\frac{f}{Y}=\frac{5\times10^7}{2\times10^{11}}=2.5\times10^{-4}$$

For cylindrical wire $V=\pi r^2 l$

$$\frac{\Delta V}{V}=\frac{2\Delta r}{r}+\frac{\Delta l}{l}$$

Or $\frac{0.02}{100}=2\frac{\Delta r}{r}+2.5\times10^{-4}$

$$\frac{\Delta r}{r}=-0.25\times10^{-4}$$

53. For stress to be equal

$$\frac{T_1}{A_1}=\frac{T_2}{A_2}$$

$$\therefore\frac{T_1}{T_2}=\frac{A_1}{A_2}=\frac{1}{2}$$

54. $\Delta l_{copper}=\Delta l_{steel}$

Or $\frac{F\times2}{\left(1.1\times10^{11}\right)\times2\times10^{-4}}=\frac{F\times L}{2.0\times10^{11}\times1\times10^{-4}}$

55. The strain produced in rods $e_1=\frac{\Delta L_1}{L_1}=\frac{L_1\alpha\Delta t}{L_1}=\alpha_1\Delta t$

Total strain e = e_1+e_2

$$=(\alpha_1+\alpha_2)\Delta t$$

$$=\left(10^{-5}+2\times10^{-5}\right)\times100=3\times10^{-3}$$

If f is the stress induced by preventing this strain then

$$e=\frac{f}{Y_1}+\frac{f}{Y_2}=f\left(\frac{1}{Y_1}+\frac{1}{Y_2}\right)$$

$$\therefore f=\frac{e}{\left(\frac{1}{Y_1}+\frac{1}{Y_2}\right)}$$

$$= \frac{3\times10^{-3}}{\left(\frac{1}{3\times10^{10}}+\frac{1}{10^{10}}\right)}$$

$2.25\times10^{7}\,N/m^{2}$

56. If stresses in brass and steel are f_b and f_s then

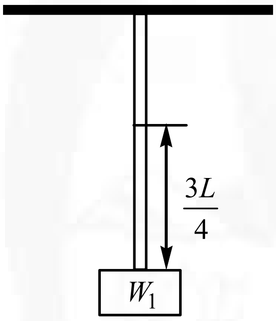
$2f_bA + f_sA = 5000$

The change of length of rods are equal and so

$\Delta L_b = \Delta L_s$

Or $\frac{f_bL_b}{Y_b} = \frac{f_sL_s}{Y_s}$

57. $f = \frac{F}{A} = \frac{W_1 + 3W/4}{s}$



58. In the second case the deforming force is also W

So the elongation of the wire is l

59. The difference in work done in expanding and compressing rubber will appear as heat

60. $Y = \frac{f}{e} = \frac{80/10^{-6}}{4\times10^{-4}} = 2\times10^{11}\,N/m^{2}$