NB-15 (NEET) PHYSICS TWT ANS KEY & SOLUTIONS DT. 16-03-2023

: ANSWER KEY :

1)	b	2)	b	3)	b	4)	b	29)	b	30)	a	31)	a	32)	a
5)	a	6)	a	7)	a	8)	a	33)	b	34)	d	35)	a	36)	b
9)	a	10)	d	11)	d	12)	b	37)	d	38)	d	39)	d	40)	c
13)	d	14)	c	15)	d	16)	a	41)	a	42)	c	43)	a	44)	c
17)	a	18)	d	19)	a	20)	d	45)	d	46)	d	47)	c	48)	b
21)	a	22)	b	23)	b	24)	a	49)	b	50)	a				
25)	d	26)	b	27)	b	28)	d								

: HINTS AND SOLUTIONS :

Single Correct Answer Type

2 **(b)**

If radius of earth decreases then its M.I. decreases

As $L = I\omega \;\therefore \omega \propto \frac{1}{I}$ [L = constant]

$i.e.$ angular velocity of the earth will increase

3 **(b)**

$I = MK^2 = \sum mR^2$

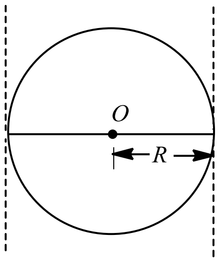
where M is the total mass of the body.

This means that

$$K = \sqrt{\left(\frac{I}{M}\right)}$$

According to thermo of parallel axis

$$I = I_{CG} + M(2R)^2$$



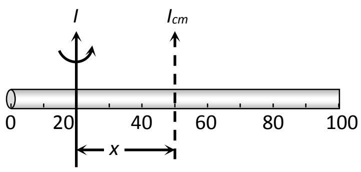
where, I_{CG} is moment of inertia about an axis through centre of gravity.

$\therefore \quad I = \frac{2}{5}MR^2 + 4MR^2 = \frac{22}{5}MR^2$

or $\quad MK^2 = \frac{22}{5}MK^2$

$\therefore \quad K = \sqrt{\frac{22}{5}}R$

4 **(b)**



$$I = I_{cm} + mx^2 = \frac{ml^2}{12} + mx^2 = m\left(\frac{(1)^2}{12} + (0.3)^2\right)$$

$$= 0.6\left(\frac{1}{12} + 0.09\right) = 0.104\ kg - m^2$$

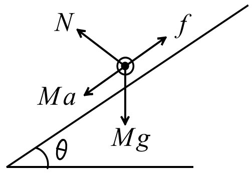
5 **(a)**

Force does not produce any torque because it passes through the centre (Point of rotation) and we know that if $\tau = 0$ then L = constant

6 **(a)**

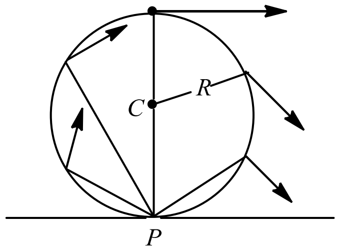
$Mg\sin\theta - f = Ma$

$fR = I\dfrac{a}{R} \Rightarrow \; a = \dfrac{g\sin\theta}{\left(1 + \frac{I}{MR^2}\right)}$



7 **(a)**

The circular disc of radius R rolls without slipping. Its centre of mass is C and P is point where body is in contact with the surface at any instant. At this instant, each particle of the body moving at right angles to the line which joins the particle with point P with velocity proportional to distance. In other words, the combined translational and rotational motion is equal to



pure rotation and body moves constant in magnitude as well as direction.

8 **(a)**

Since there is no external force acting on the particle, Hence

$y_{\text{CM}} = \frac{m_1y_1 + m_2y_2}{m_1 + m_2} = 0$, hence

$\left(\frac{m}{4}\right) \times (+15) + \left(\frac{3m}{4}\right)(y_2) = 0 \Rightarrow y_2 = -5$ cm

9 **(a)**

Since net momentum of the composite system is zero, hence resultant velocity of the composite system should also be zero.

10 **(d)**

When a body rolls down an inclined plane, it is accompanied by rotational and translational kinetic energies.

Rotational kinetic energy $= \frac{1}{2}I\omega^2 = K_R$

Where I is moment of inertia and ω the angular velocity.

Translational kinetic energy

$$= \frac{1}{2}mv^2 = K_r = \frac{1}{2}m(r\omega)^2$$

where m is mass, v the velocity and ω the angular velocity.

Given,

Translational KE=rotational KE

$$\frac{1}{2}mv^2 = \frac{1}{2}I\omega^2$$

Since, $\quad v = r\omega$

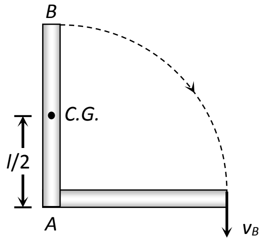
$\therefore \quad \frac{1}{2}m(r^2\omega^2) = \frac{1}{2}I\omega^2$

$\Rightarrow \qquad I = mr^2$

We know that mr^2 is the moment of inertia of hollow cylinder about its axis is where m is mass of hollow cylinderical body and r the radius of cylinder.

12 **(b)**

Initially rod stand vertically its potential energy = $mg\frac{l}{2}$



When it strikes the floor, its potential energy will convert into rotational kinetic energy

$$mg\left(\frac{l}{2}\right) = \frac{1}{2}I\omega^2$$

[Where, $I = \frac{ml^2}{3}$ = M.I. of rod about point A]

$$\therefore mg\left(\frac{l}{2}\right) = \frac{1}{2}\left(\frac{ml^2}{3}\right)\left(\frac{v_B}{l}\right)^2 \Rightarrow v_B = \sqrt{3gl}$$

13 **(d)**

$L = I\omega$

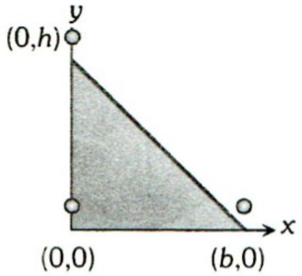
14 **(c)**

We can assume that three particles of equal mass m are placed at the corners of triangle

$\vec{r}_1 = 0\hat{\imath} + 0\hat{\jmath}, \vec{r}_2 = b\hat{\imath} + 0\hat{\jmath}$

and $\vec{r}_3 = 0\hat{\imath} + h\hat{\jmath}$

$$\therefore \overrightarrow{r_{cm}} = \frac{m_1\vec{r}_1 + m_2\vec{r}_2 + m_3\vec{r}_3}{m_1 + m_2 + m_3}$$

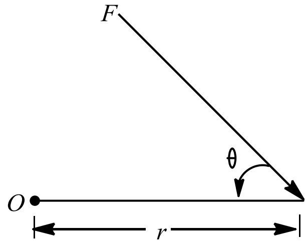


$$= \frac{b}{3}\hat{\imath} + \frac{h}{3}\hat{\jmath}$$

$i.e.$ coordinates of centre of mass is $\left(\frac{b}{3}, \frac{h}{3}\right)$

15 **(d)**

Torque is a measure of how much a force acting on an object causes that object to rotate. The object rotates about an axis (O). The distance from O is r, where forces acts, hence torque $\tau = \mathbf{F} \times \mathbf{r}$. It is a vector quantity and points from axis of rotation to the point where the force acts.



16 **(a)**

Total KE at bottom;

$$= \frac{1}{2}mv^2\left[1 + \frac{K^2}{R^2}\right]$$

$$= \frac{1}{2}mv^2\left[1 + \frac{2}{5}\right] = \frac{7}{10}\,mv^2$$

18 **(d)**

Torque acting on a body in circular motion is zero.

19 **(a)**

$K = \frac{1}{2}mv^2 = \frac{1}{2} \times \frac{m(mv^2)}{2} = \frac{(mv)^2}{m} = \frac{(mv)^2}{2m}$ or $K = \frac{p^2}{2m}$

$\therefore \frac{K_1}{K_2} = \frac{p_1^2}{2m_1} \times \frac{2m_2}{p_2^2}$ or $\frac{3}{1} = \frac{p_1}{p_2} \times \frac{6}{2}$

$\therefore p_1 : p_2 = 1 : 1$

20 **(d)**

If M mass of the square plate before cutting the holes, then mass of portion of each hole,

$$m = \frac{M}{16R^2} \times \pi R^2 = \frac{\pi}{16}M$$

$\therefore$ Moment of inertia of remaining portion

$$I = I_{\text{square}} - 4I_{\text{hole}}$$

$$= \frac{M}{12}(16R^2 + 16R^2) - 4\left[\frac{mR^2}{2} + m\left(\sqrt{2}R\right)^2\right]$$

$$= \frac{M}{12} \times 32R^2 - 10mR^2$$

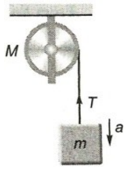
$$= \frac{8}{3}MR^2 - \frac{10\pi}{16}MR^2 \; I = \left(\frac{8}{3} - \frac{10\pi}{16}\right)MR^2$$

21 **(a)**

$$\tau = \frac{dL}{dt} = \frac{L_2 - L_1}{\Delta t} = \frac{5L - 2L}{3} = \frac{3L}{3} = L$$

22 **(b)**

When pulley has a finite mass M and radius R, then tension in two segments of string are different.



Here, $ma = mg - T$

$$a = \frac{m}{m + \frac{M}{2}}g = \frac{2m}{2m + M}g$$

23 **(b)**

The speed acquired by block, on account of collision of bullet with it, be v_0 ms^{-1}. Since the block rise by 0.1 m, hence

$0.1 = \frac{v_0^2}{2g}$

$\Rightarrow \; v_0^2 = 2 \times g \times 0.1$ or $v_0 = \sqrt{2}\,\text{ms}^{-1}$

Now as per conservation of momentum law for collision between bullet and block,

$mu = mu + Mv_0$

$\Rightarrow v = u - \frac{M}{m}v_0 = 500 - \frac{2kg}{0.01kg} \times \sqrt{2}\,\text{ms}^{-1}$

$= \left(500 - 200\sqrt{2}\right)\text{ms}^{-1}$

$= 220\text{ms}^{-1}$

24 **(a)**

Torque is defined as rate of change of angular momentum

$\therefore \quad \tau = \frac{dJ}{dt} = \frac{d(I\omega)}{dt}$

Given, $\tau = 40$ Nm, $I = 5$ kgm^2, $\omega = 24$ rads^{-1}

$$dt = \frac{d(I\omega)}{\tau} = \frac{5\times 24}{40} = 3\text{ s}$$

25 **(d)**

Total kinetic energy $= \frac{1}{2}mv^2\left(1 + \frac{K^2}{R^2}\right) = 32.8\,J$

$\Rightarrow \frac{1}{2} \times 10 \times (2)^2\left(1 + \frac{K^2}{(0.5)^2}\right) = 32.8 \Rightarrow K = 0.4\,m$

26 **(b)**

Since there is no external force acting on rifle bullet system, hence

$p_b = p_g$ and hence $\frac{K_b}{K_g} = \frac{m_g}{m_b} = \frac{2\text{kg}}{50\text{g}} = \frac{4}{1}$

Or $K_g = \frac{K_b}{4}$

Now total energy $K_b + K_g$ or $+\frac{K_b}{40} = \frac{41}{40}, K_b = 2050$

$\Rightarrow \; K_b = \frac{2050\times 40}{41} = 2000\text{J}$

And $K_g = 2050 - 2000 = 50\text{J}$.

27 **(b)**

$I = mr^2 = 10 \times (0.2)^2 = 0.4kg - m^2$

$\omega = 2\pi\,n = 2\pi \times \frac{2100}{60}rad/s$

$\therefore L = I\omega = \frac{0.4 \times 2\pi \times 210}{6} = 88kg - m^2/s$

28 **(d)**

In the absence of external torque for a body revolving about any axis, the angular momentum remains constant. This is known as law of conservation of angular momentum, $\vec{\tau} = \frac{d\vec{L}}{dt}$

As $\vec{\tau} = 0 \;\therefore \frac{d\vec{L}}{dt} = 0$ or $\vec{L} =$ constant

29 **(b)**

$m_1 v = (m_1 + m_2)v/3$

$3m_1 v = m_1 v + m_2 v$

$3m_1 v - m_1 v = m_2 v$

$2m_1 v = m_2 v$

$\therefore \; \frac{m_2}{m_1} = 2$

30 **(a)**

$\mathbf{v}_{\text{CM}} = \frac{m_1\mathbf{v}_1 + m_2\mathbf{v}_2}{m_1+m_2} = \frac{\mathbf{v}_1+\mathbf{v}_2}{2}$ (as $m_1 = m_2$)

and $\quad \mathbf{a}_{\text{CM}} = \frac{m_1\mathbf{a}_1 + m_2\mathbf{a}_2}{m_1+m_2}$

$= \frac{\mathbf{a}_1+0}{2} = \frac{\mathbf{a}_1}{2}$

The centre of mass of two particles will move with the mean velocity of two particles having common acceleration $\frac{\mathbf{a}}{2}$.

Hence, path of CM will be a straight line.

31 **(a)**

When the sphere 1 is released from horizontal position, then from energy conservation, potential energy at height l_0 = kinetic energy at bottom

Or $mgl_0 = \frac{1}{2}mv^2$

Or $v = \sqrt{2gl_0}$

Since, all collisions are elastic, so velocity of sphere 1 is transferred to sphere 2, then from 2 to 3 and finally from 3 to 4. Hence, just after collision, the sphere 4 attains a velocity equal to $\sqrt{2gl_0}$

32 **(a)**

By the theorem of perpendicular axes, the moment of inertia about the central axis I_C, will be equal to the sum of its moments of inertia about two mutually perpendicular diameters lying in its plane.

Thus, $\quad I_d = I = \frac{1}{2}MR^2$

$\therefore \quad I_C = I + I$

$= \frac{1}{2}MR^2 + \frac{1}{2}MR^2$

$= I + I = 2I$

33 **(b)**

$\frac{L_{\text{Total}}}{L_B} = \frac{(I_A + I_B)\omega}{I_B.\omega}$ (as ω will be same in both cases)

$= \frac{I_A}{I_B} + 1 = \frac{m_A r_A^2}{m_B r_B^2} + 1$

$= \frac{r_A}{r_B} + 1$ (as $m_A r_A = m_B r_B$)

$= \frac{11}{2.2} + 1$ (as $r \propto \frac{1}{m}$)

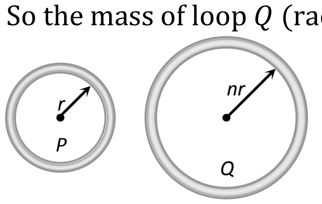
$= 6$

$\therefore$ The correct answer is 6.

34 **(d)**

Let the mass of loop P (radius $= r$)$= m$

So the mass of loop Q (radius $= nr$) $= nm$



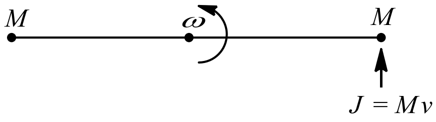
Moment of inertia of loop $P, I_P = mr^2$

Moment of inertia of loop $Q, I_Q = nm(nr)^2 = n^3mr^2$

$\therefore \dfrac{I_Q}{I_P} = n^3 = 8 \Rightarrow n = 2$

35 **(a)**

Let ω be the angular velocity of the rod. Applying , Angular impulse = change in angular momentum about centre of mass of the system



$J.\frac{L}{2} = I_c\omega$

$\therefore \quad (Mv)\left(\frac{L}{2}\right) = (2)\left(\frac{ML^2}{4}\right).\omega$

$\therefore \quad \omega = \frac{v}{L}$

36 **(b)**

As net horizontal force acting on the system is zero, hence momentum must remain conserved. Hence

$mu + 0 = 0 + mv_2 \Rightarrow v_2 = \dfrac{mu}{M}$

As per definition,

$$e = -\frac{(v_1 - v_2)}{(u_2 - u_1)} = \frac{v_2 - 0}{o - u} = \frac{v_2}{u} = \frac{\frac{mu}{M}}{u} = \frac{m}{M}$$

37 **(d)**

For a ring $K^2 = r^2$ then

$$v^2 = \sqrt{\frac{2gh}{1+\frac{K^2}{r^2}}}$$

$$\therefore \quad v^2 = \frac{2gh}{2} = gh$$

$$v = \sqrt{gh}$$

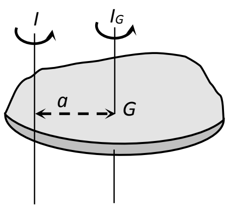
38 **(d)**

Angular velocity is a axial vector

40 **(c)**

M.I. of body about centre of mass $= I_{cm} = mK^2$

M.I. of a body about new parallel axis



$I_{new} = I_{cm} + ma^2 = mK^2 + ma^2$

$I_{new} = m(K^2 + a^2)$

$K_R = \dfrac{1}{2}I_{new}\omega^2 = \dfrac{1}{2}m(K^2 + a^2)\omega^2$

41 **(a)**

Here $m_1 = u, m_2 = Au, u_1 = u$ and $u_2 = 0$

$$\therefore \quad v_1 = \frac{(m_1 - m_2)u_1}{(m_1 + m_2)} + \frac{2m_2u_2}{(m_1 + m_2)} = \left(\frac{1-A}{1+A}\right)u$$

$$\Rightarrow \quad \frac{v_1}{u} = \left(\frac{1-A}{1+A}\right)$$

$$\therefore \quad \frac{K_{\text{final}}}{K_{\text{initial}}} = \left(\frac{v_1}{u}\right)^2 = \left(\frac{1-A}{1+A}\right)^2$$

42 **(c)**

Rotational kinetic energy $E = \frac{L^2}{2I} \therefore L = \sqrt{2EI}$

$$\Rightarrow \frac{L_A}{L_B} = \sqrt{\frac{E_A}{E_B} \times \frac{I_A}{I_B}} = \sqrt{100 \times \frac{1}{4}} = 5$$

44 **(c)**

$I = I_{CM} + Mh^2$ (Parallel axis theorem)

45 **(d)**

$$\frac{1}{2}mv^2\left(\frac{K^2}{R^2}\right) = 40\% \ \frac{1}{2}mv^2 \Rightarrow \therefore \frac{K^2}{R^2} = \frac{40}{100} = \frac{2}{5}$$

i.e. the body is solid sphere

46 **(d)**

We know that angular momentum of spin $= I\omega$

By the conservation of angular momentum

$$\frac{2}{5}MR^2.\frac{2\pi}{T} = \frac{2}{5}M\left(\frac{R}{4}\right)^2.\frac{2\pi}{T'}$$

$$T' = \frac{T}{16} = \frac{24}{16} = 1.5\text{h}$$

47 **(c)**

$$I = \frac{2}{5}MR^2 = \frac{2}{5}\left(\frac{4}{3}\pi R^3\rho\right)R^2 = \frac{8}{15} \times \frac{22}{7}R^5\rho$$

$$I = \frac{176}{105}R^5\rho$$

48 **(b)**

$$K_N = \frac{1}{2}mv^2\left(1 + \frac{K^2}{R^2}\right) = \frac{1}{2} \times 0.41 \times (2)^2 \times \left(\frac{3}{2}\right)$$

$$= 1.23\,J$$

50 **(a)**

$\text{K. E.} = \dfrac{L^2}{2I}$

$\because$ From angular momentum conservation about centre

$L \rightarrow$ constant

$I = mr^2$

$\text{K. E.}' = \dfrac{L^2}{2(mr'^2)} \quad r' = \dfrac{r}{2}$

K.E'. = 4 K.E.

K.E. is increased by a factor of 4