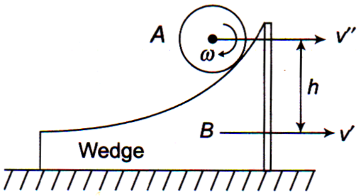
WEEKLY TEST TYJ -1 TEST - 24 B
SOLUTION Date 13-10-2019

[PHYSICS]

1. At the maximum height vertical velocity of cylinder is zero, but horizontal velocity of the wedge and cylinder will be same.



In the absence of friction between the cylinder and the wedge surface, angular velocity of cylinder remains constant. From energy conservation:

$$\frac{1}{2}mv^2+\frac{1}{2}I\omega^2=\frac{1}{2}mv'^2+\frac{1}{2}I\omega^2+\frac{1}{2}mv'^2+mgh \quad ..(i)$$

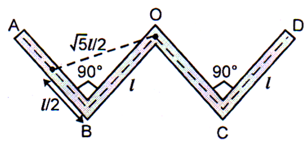
By the conservation of linear momentum

$$mv = 2mv' \Rightarrow v' = v/2 \quad \ldots (ii)$$

From (i) and (ii),

$$h = v^2/4g$$

2. The given structure can be broken into 4 parts



For AB : $I = I_{CM} + m \times d^2 = \frac{m\ell^2}{12}+\frac{5m}{4}\ell^2$; $I_{AB} = \frac{4}{3}ml^2$

For BO : $I = \frac{m\ell^2}{3}$

∴ For composite frame : (by symmetry)

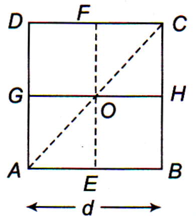
$$I = 2[I_{AB} + I_{OB}] = 2\left[\frac{4m\ell^2}{3}+\frac{m\ell^2}{3}\right] = \frac{10}{3}m\ell^2.]$$

3. Let the each side of square lamina is d.

So, $I_{EF} = I_{GH}$ (due to symmetry)

and $I_{AC} = I_{BD}$ (due to symmetry)

Now, according to theorem of perpendicular axis,



$$I_{AC} + I_{BD} = I_0$$

$\Rightarrow$ $2I_{AC} = I_0$ ...(i)

and $I_{EF} + I_{GH} = I_0$

$\Rightarrow$ $2I_{EF} = I_0$ ...(ii)

From Eqs. (i) and (ii), we get $I_{AC} = I_{EF}$

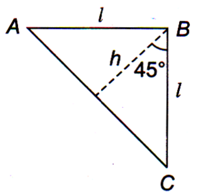
$$\therefore \quad I_{AD} = I_{EF} + \frac{md^2}{4}$$

$$= \frac{md^2}{12} + \frac{md^2}{4} \quad \left(\text{as } I_{EF} = \frac{md^2}{12}\right)$$

So, $I_{AD} = \frac{md^2}{3} = 4I_{EF}$

4. $h = l\cos 45° = \frac{l}{\sqrt{2}}$

$$I_{AC} = \frac{1}{6}Mh^2 = \frac{1}{6}M\left(\frac{l}{\sqrt{2}}\right)^2 = \frac{Ml^2}{12}$$



5. As the disc is in combined rotation and translation, each point has a tangential velocity and a linear velocity in the forward direction.

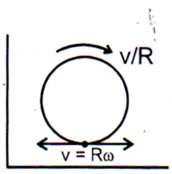
From figure

v_{net} (for lowest point) = v – Rω = v – v = 0.

and Acceleration = $\frac{v^2}{R} + 0 = \frac{v^2}{R}$

(Since linear speed is constant)

Hence (D).



6. Area between curve and displacement axis

$$= \frac{1}{2}\times(12+4)\times 10 = 80 \text{ J}$$

In this time the body acquires kinetic energy = $\frac{1}{2}mv^2$ by the law of conservation of energy

$$\frac{1}{2}mv^2 = 80 \text{ J}$$

$\Rightarrow$ $\frac{1}{2}\times 0.1\times v^2 = 80$

$\Rightarrow$ $v^2 = 1600$

$\Rightarrow$ $v = 40$ m/s

7. We have $\theta = \omega_0 t + \frac{1}{2}\alpha t^2$ ...(ii)

Given, $\alpha = 3.0$ rad/s^2, $\omega_0 = 2.0$ rad/s, $t = 2$s

Hence, $\theta = 2\times 2 + \frac{1}{2}\times 3\times(2)^2$

or $\theta = 4 + 6 = 10$ rad

8. In both the cases, the loss of gravitational potential energy and the resulting gain of 'total kinetic energy' is same.

9. $$x_{CM} = \frac{m_1x_1 + m_2x_2 + m_3x_3}{m_1 + m_2 + m_3}$$

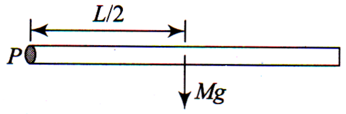
$$= \frac{300(0) + 500(40) + 400(70)}{300 + 500 + 400}$$

$$= \frac{20000 + 28000}{1200} = \frac{48000}{1200} = 40 \text{ cm}$$

10. $$\frac{1}{2}\times 3(4)^2 + \frac{1}{2}\times\frac{(3\times R^2)}{2}\times\left(\frac{4}{R}\right)^2 = \frac{1}{2}Kx^2$$

$\Rightarrow$ $x = 0.6$ m

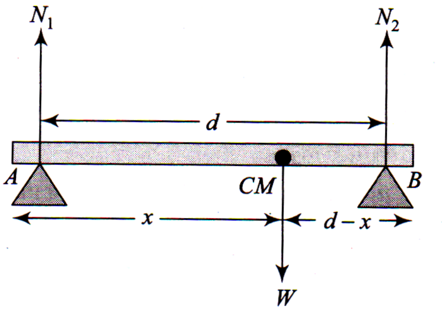
11. Taking torque about P



$$Mg\,\frac{L}{2} = \left(\frac{ML^2}{3}\right)\alpha$$

Hence $\alpha = \frac{3g}{2L}$

12 Taking torque about end A



$$\tau_B = 0$$

$$\Rightarrow \quad N_1 d = W(d-x)$$

$$\Rightarrow \quad N_1 = \frac{W(d-x)}{d}$$

13. Acceleration of sphere when it is slipping down the incline , $a_{\text{slipping}} = g \sin\theta$
Acceleration of sphere when it is rolling down

$$a_{\text{rolling}} = \frac{g\sin\theta}{1+\frac{K^2}{r^2}} = \frac{5}{7} g\sin\theta$$

Hence required ratio $\frac{a_{\text{rolling}}}{a_{\text{slipping}}} = \frac{5}{7}$

14. $\frac{2}{3}MR_h^2 = \frac{2}{5}MR_S^2$ or $\frac{R_h^2}{R_S^2} = \frac{3}{5}$ or $\frac{R_h}{R_s} = \sqrt{\frac{3}{5}}$

15. $v = 36$ km/h $= 10$ m/s

By law of conservation of momentum

$$2 \times 10 = (2+3)V \Rightarrow V = 4 \text{ m/s}$$

$$\text{Loss in K.E.} = \frac{1}{2} \times 2 \times (10)^2 - \frac{1}{2} \times 5 \times (4)^2$$

$$= 60 \text{ J}$$

From law of conservation of momentum, we have

$$m_1u_1 + m_2u_2 = (m_1 + m_2)v$$

$$\Rightarrow \quad v = \frac{m_1u_1 + m_2u_2}{(m_1 + m_2)}$$

Given,

$$m = 2 \text{ kg}, \; u_1 = 36 \times \frac{5}{18} = 10 \text{ m/s},$$

$$m_2 = 3 \text{ kg}, u_2 = 0$$

$$\therefore \quad v = \frac{2 \times 10 + 3 \times 0}{2+3} = 4 \text{ m/s}$$

Loss in kinetic energy is

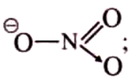
$$\Delta K = \Delta K' - \Delta K''$$

$$= \left\{\frac{1}{2}m_1u_1^2 + \frac{1}{2}m_2u_2^2\right\} - \left\{\frac{1}{2}(m_1 + m_2)v^2\right\}$$

$$= \frac{1}{2} \times 2 \times (10)^2 - \frac{1}{2} \times 5 \times (4)^2$$

$$= 100 - 40 = 60 \text{ J}$$

[CHEMISTRY]

16  ; bond angle in H_2O is 104.5º

17. In B_2H_6, each BH_3 unit has 6 electrons on B-atom

18. Highest product of charges of ions.

19.

20. Ionisation energy of Be(Z = 4, electronic configuration $1s^22s^2$) is greater than that of B(Z = 5, EC $1s^22s^22p^1$). IE of N(Z = 7, EC = $1s^22s^22p_x^12p_y^12p_z^1$) is greaer than that of O(Z = 8, EC $1s^22s^22p_x^22p_y^12p_z^1$)

21. The species are isoelectronic. Higher the charge of nucleus, smaller the size.

22.