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Subject :- Physics

Q # 1

Kinetic Energy:-

consider a sphere rolling without slipping down along an inclined plane so that it has both translational as well as rotational motion. So it will have both translational and rotational K.E.

$$K.E_t = \frac{1}{2} mv$$

$$K.E_{rot} = \frac{1}{2} I\omega^2$$

For sphere $I = \frac{2}{5} mr^2$

$$K.E_{rot} = \frac{1}{2} I\omega^2 = \frac{1}{2}\left(\frac{2}{5} mr^2\right)\omega^2$$

$$K.E_{rot} = \frac{1}{5} mr^2\omega^2 = \frac{1}{5} m(r\omega)^2$$

$$K.E_{rot} = \frac{1}{5} mv^2$$

Total K.E of the sphere can be calculated a

$$KE_T = KE_{tran} + KE_{rot} = \frac{1}{2}mv^2 + \frac{1}{5}mv^2$$

$$= \frac{5mv^2 + 2mv^2}{10} \Rightarrow \frac{7mv^2}{10}$$

$$KE_T = \frac{7}{10} mv^2$$

Calculation For Speed:-

Let the sphere start from the top of inclined plane of height h and reaches the bottom with speed v. According to the law of conservation of energy:

PE at the top = KE at bottom

$$\cancel{m}gh = \frac{7}{10}\cancel{m}v^2 \Rightarrow 10gh = 7v^2$$

$$\frac{10}{7}gh = v^2 \Rightarrow \sqrt{v^2} = \sqrt{\frac{10}{7}gh}$$

$$v = \sqrt{\frac{10}{7}gh}$$

Q # 2

$$a_c = g \quad \text{---(i)}$$

$$a_c = v^2/g \quad \text{---(ii)}$$

comparing (i) & (ii)

$$g = v^2/R$$

$$gR = v^2$$

$$V = \sqrt{gR}$$

$$V = \sqrt{9.8 \times 6.4 \times 10^6}$$

$v = \sqrt{62.72 \times 10^6}$

$V = 7.9 \times 10^3 m/s$

$V = 7.9 Km/s.$

Q # 4

$$T = \frac{2\pi R}{V} = 2 \times 3.14 \times 390400 km \times \frac{1}{1.01 kms^{-1}} \times \frac{1 \, day}{60 \times 60 \times 24}$$

$$= 2 \times 3.14 \times 390400 km \times (0.99009) \times \frac{1 \, day}{86400}$$

$$\approx 27.5 \text{ days.}$$

Q # 5

Find the height h of G.S:-

$G = 6.673 \times 10^{-11} Nm^2/kg^2$, $M = 6 \times 10^{24} kg$

$\pi = 3.14$, $T = 24hr = 24 \times 3600s = 86400 sec$

$$r = \left[\frac{GMT^2}{4\pi^2}\right]^{1/3}$$

$$r = \left[\frac{6.673 \times 10^{-11} \times 6 \times 10^{24} \times (86400)^2}{4(3.14)^2}\right]^{1/3}$$

$r = 4.23 \times 10^7 m$

$r = 42.3 \times 10^6 m$

Altitude

Here $r = R + h$

$h = r - R$

$h = 42.3 \times 10^6 - 6.4 \times 10^6$

$h = 35.9 \times 10^6 m$

$h = 3.59 \times 10^7 m$

Q # 6

Given :

Diameter = $S = 2.50\,m$

Distance = $r = 3.8 \times 10^8\,m$

Find : Angle = $\theta = ?$

$S = r\theta$

$\theta = \frac{S}{r} \Rightarrow \frac{2.50}{3.8 \times 10^8}$

$\theta = \frac{2.5}{3.8} \times 10^8$

$\theta = 657 \times 10^{-8} \Rightarrow 6.57 \times 10^9$

$\theta = 6.6 \times 10^{-9}$ radian.

Q #. 7

Given :-

(Distance b/w moon & earth) = $r_o = 3.85 \times 10^8\,m$

(Radius of moon) = $r_s = 1.74 \times 10^6\,m$

Find :- Spin angular Mom = $L_s = ?$

orbital angular Mom L_o

For spin angular mom = $L_s = I_s \omega_s$

For orbital angular mom = $L_o = I_o \omega_o$

$\frac{L_s}{L_o} = \frac{I_s \omega_s}{I_o \omega_o}$

$\because \omega_s = \omega_o = \omega$ (side of moon faces the earth)

$I_s = \frac{2}{5} m r_s^2$ (spin motion).

$I_o = mr_o^2$ (orbital motion)

$$\frac{L_s}{L_o} = \frac{I_s \omega_s}{I_o \omega_o} = \frac{\frac{2}{5} \cancel{m} r_s^2 \cancel{\omega}}{\cancel{m} r_o^2 \cancel{\omega}}$$

$$\frac{L_s}{L_o} = \frac{2 r_s^2}{5 r_o^2} = \frac{2(1.74 \times 10^6)^2}{5(3.85 \times 10^8)^2}$$

$$\frac{L_s}{L_o} = \frac{2 \times 1.74 \times 1.74}{5 \times 3.85 \times 3.85} \times \frac{10^{12}}{10^{16}}$$

$$L_s/L_o = 0.0817 \times 10^{12-16}$$

$$= 0.0817 \times 10^{-4}$$

$$= 8.17 \times 10^{-6}$$

$$\frac{L_s}{L_o} = 8.2 \times 10^{-6}$$