Date 18 / 11 / 2024

MON TUE WED THS FRI SAT

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1st Year A

Physics

Assignment

Answer Question

Hoop and Sphere:

Consider a sphere is rolling down to ~~inclided~~ inclined plane without slipping so that it has both translational and rotational motion.

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

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

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

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

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$= \frac{1}{5} mr^2 \omega^2$

$= \frac{1}{5} m(r^2 \omega^2)^2$

$\frac{1}{5} mv^2$

Total K.E = K.E trans + K.E rota

$\Rightarrow \frac{1}{2} mv^2 + \frac{1}{5} mv^2$

Total kinetic energy $= \frac{7}{10} mv^2$

Calculation for Speed:

P.E at top = K.E at bottom

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

$10gh = 7v^2$

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

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

Hence proved.

02

Critical Velocity:-

$v = \sqrt{gR}$

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

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

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

$v = 7.9 \times \ Km/s$

Hence proved.

05

Geostationary Satellite:-

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

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

$M = 6 \times 10^{24}\ kg$

$\pi = 3.14$

$T = 24\ hr$

$= 86400\ sec$

$r = 42.3 \times 10^6\ m$

$r = R + h$

$h = r - R$

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

$h = 35.9 \times 10^6\ m$

$h = 3.59 \times 10^7\ m$

06

A tiny laser...... Earth.

Given:

$S = 2.50\ m$

$\theta = 6.6 \times 10^{-9}\ \cancel{kg}$

Find:

$r = ?$

Solution:

$S = r\theta$

$$r = \frac{S}{\theta}$$

$$r = \frac{2.50}{6.6 \times 10^{-9}}$$

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$r = 0.37 \times 10^{-9}$

$r = 3.8 \times 10^{-9}$

07

The moon orbits ...... 10^6 m.

Solution:

Given:

(Distance b/w moon and Earth) $= r_o$

$= 3.85 \times 10^8\ m$

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

Required:

$$\frac{\text{Spin angular Mom}}{\text{Orbital angular Mom}} = \frac{L_s}{L_o} = ?$$

Formula:

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

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

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So,

$$\frac{L_s}{L_\omega} = \frac{I_s\omega_s}{I_o\omega_o}$$

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

$$I_s = \frac{2}{5} m r_s^2 \quad \text{(Spin motion)}$$

$$I_o = m r_o^2 \quad \text{(Orbital motion)}$$

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

$$\frac{L_s}{L_o} = \frac{2 r_s^2}{5 r_o^2}$$

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

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

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

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

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

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

Result:- Ratio of spin angular momentum of moon about its own axis to the orbital angular momentum is 8.2×10^{-6}.

03

•Weight of a ...... equal to g:-

Elevator at rest: Weight (W) = mass (m) x acceleration due to gravity (g)

$W = mg$.

Elevator Accelerating Upwards: When the elevator accelerates upwards with acceleration 'a' the apparent weight (W-app) is the sum of the weight due to gravity and

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the weight due to acceleration:

$W\text{-}app = mg + ma$

Given that the acceleration 'a' is equal to 'g', we substitute:

$W\text{-}app = mg + mg$

$W\text{-}app = 2\,mg$

Since, $W = mg$, we can rewrite:

$We\text{-}app = 2W$.

Therefore, when the elevator accelerates upwards with acceleration equal to 'g', the apparent weight of the person is indeed 2W, twice their weight when the elevator is rest.

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To find the time taken for one revolution, we need to calculate the period (T) of the satellite.

Formula:

$$T = \frac{2\pi r}{V}$$

Where:

T= period (time for one revolution)
r= orbital radius.
V= orbital speed.

Given values:

r= 390, 400 km
V= 1.01 km/s

Conversion:

Convert radius from km to m:

390, 400 km × 1000

= 390, 400, 000 m.

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Convert speed from km/s to m/s.

$1.01 \text{ km/s} \times 1000$

$= 1010 \text{ m/s}$

Calculation:

$$T = \frac{2\pi \times 390{,}400{,}000 \text{ m}}{1010 \text{ m/s}}$$

$T = 2{,}433{,}211$ seconds.

Convert seconds to days:

$$T = \frac{2{,}433{,}211}{(60 \times 60 \times 24)}$$

$T = 28.2$ days.

Therefore, the satellite will complete one revolution in

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approximately 28.2 days