proprep™

Physics 1

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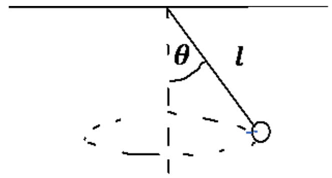
Circular Motion

Circular Motion

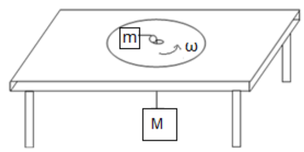
1) Circular Motion.



A pendulum with the length l is rotating around the axis perpendicular to the ceiling at a constant angle θ.
The values of θ and l are given.
Find the frequency and period time of one full rotation.

Centrifugal Force

2) Mass on a Spinning Table.



Mass m is sitting on a spinning disk on a table.
The disc is spinning at the constant angular velocity ω.
The mass is connected to a string that passes through a hole in the center of the disc via a pulley and connects to the mass M. Given Values: μ, m, ω, μ_s.
Between mass and the disc there is a cofficient to static friction μ_s.
What are the minimal and maximal radii that mass m can sit on without moving radially?

Position, Velocity and Acceleration Vectors

3) Constant Tangential Acceleration.
A body rtavels in a circle of Radius R with a constant tangential acceleration of a_t and no initial velocity.
Calculate the radial acceleration:
   a. As a function of time.
   b. As a function of angle.

4) Angle Changing in Time.
The angular position of a point on the edge of a spinning wheel is given by: $\phi = 5t + 3t^2 - 2t^3$.
   a. What is the angular velocity at $t = 2$ and at $t = 4$?
   b. What is the average angular acceleration between them?
   c. What is the instantaneous angular acceleration at the time in part a?

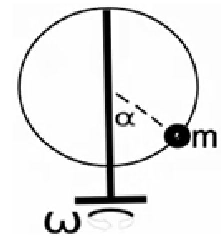
End of Chapter Questions

5) Bead Threaded on Rotating Hoop.

A bead is threaded on to a rotating hoop.

a. What is the frequency of rotation?

b. What should be the frequency of rotation in order for the angle, α, to be at $90°$?



6) Mass Rotating Around Axis.

A pole holds up at mass, m, attached to a rope of length d, and the system spins with an angular velocity of ω.

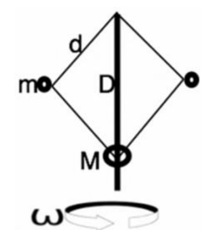
a. What is the distance of the mass from the main pole?

b. How will the height of the mass be affected if the length of the string, d, were to be doubled?

7) Three Masses.

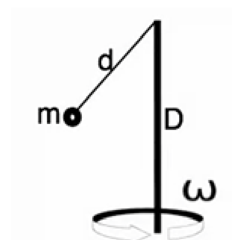
Three masses are rotating around an axis while attached to rods. $\mathrm{M, m, D}$ and d are given.

Find the angular velocity, ω.



8) Rock Thrown into a Hole.

A mass is tied by a rope of length d to a pole of length D. The pole is rotating at a speed ω. The rope disconnects. What will be the displacement of the mass by the time it hits the ground?

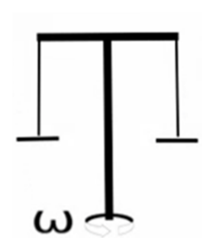


9) Carrousel.

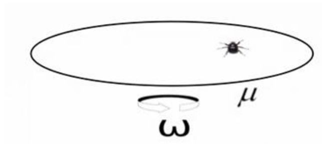
The diagram is of a carrousel. The height of the seat from the ground is H, the length of the rope is D and the distance of the seat from the center pole is R. A boy of mass m sits on the seat.

a. What will the boy's height off the ground when the carrousel will rotate?

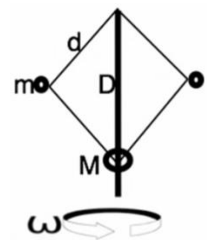
b. If a coin would drop out of the boy's pocket whilst the carrousel is spinning, how far away from the center pole will the coin land?



10) Ladybird on a Rotating Disk.
We are given a rotating disk with some coefficient of friction. What is the furthest distance that ladybird can be from the center of the disk without it sliding off?

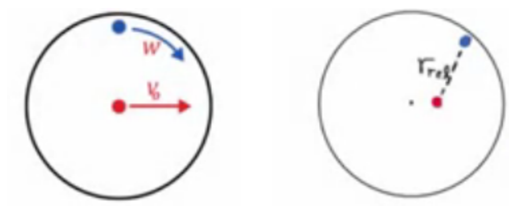


11) Two Rotating Masses.
In the diagram we are given two strings attached to a pole. A mass is attached to the midpoint of each string. The pole and the strings have no mass. D, d, m, M and ω are given. What is the tension in the strings?



End of Chapter Questions (Advanced)

12) Bird and Policeman.
A bird flies from a rotating disk towards the x-axis at a given velocity.
The radius of the disk is R.
At that exact moment, a policeman mounts the disk and rotates with the disk towards the bird.
What velocity will the policeman's speedometer measure if it is known that his speedometer only measures the velocity in his direction?



Answer Key:

1) $f=\dfrac{\omega}{2\pi},\quad T=\dfrac{2\pi}{\omega}$

2) $r_{\max}=\dfrac{M_g+\mu_s mg}{m\omega^2},\quad r_{\min}=\dfrac{M_g-\mu_s mg}{m\omega^2}$

3) a. $a_r=\dfrac{(a_t t)^2}{R}$ b. $a_r=2\theta a_t$

4) a. $\omega=\begin{cases}t=2:-7\dfrac{\text{rad}}{\text{sec}}\\ t=4:-67\dfrac{\text{rad}}{\text{sec}}\end{cases}$ b. $\bar{\alpha}=-30\dfrac{\text{rad}}{\text{sec}^2}$ c. $\alpha=\begin{cases}t=2:-18\dfrac{\text{rad}}{\text{sec}^2}\\ t=4:-42\dfrac{\text{rad}}{\text{sec}^2}\end{cases}$

5) a. $\omega=\sqrt{\dfrac{mg}{R\cos\alpha}}$ b. $\omega=\infty$

6) a. $\cos\alpha=\dfrac{r}{d}$ b. Will not be affected.

7) Refer to the video.

8) $x=\omega\cdot d\cos a\cdot\sqrt{\dfrac{2d\sin\alpha}{g}}$

9) a. $a=\sqrt{D^2-(r-R)^2}$ b. $hyp=\sqrt{r^2+\left(\omega r\sqrt{\dfrac{2(H+a)}{g}}\right)^2}$

10) $r=\dfrac{mg}{\omega^2}$

11) Refer to the video.

12) $m_2a_2\hat{y}=T_2-m_2g$

13) $v_{II}=\dfrac{v_0^2t-v_0R\left[\sin(\omega t)+\omega t\cos(\omega t)\right]}{R^2+v_0^2t^2-2v_0t\sin(\omega t)}$