INDIAN INSTITUTE OF TECHNOLOGY PATNA

PH103 : Physics
Tutorial 1

1. Let $\vec{A}$ be an arbitrary vector and let $\hat{n}$ be a unit vector in some fixed direction. Show that $\vec{A} = (\vec{A} \cdot \hat{n})\hat{n} + (\hat{n} \times \vec{A}) \times \hat{n}$.

2. A particle moves with $\dot{\theta} = \omega =$ constant and $r = r_0 e^{\beta t}$, where r_0 and β are constants. Show that for certain values of β, the particle moves with $a_r = 0$.

3. A bead moves along the spoke of a wheel at constant speed u m s^{-1}. The wheel rotates with uniform angular velocity $\dot{\theta} = \omega$ rad s^{-1} about an axis fixed in space. At $t = 0$ the spoke is along x axis, and the bead is at origin. Find the velocity and acceleration at time t.

   - In polar coordinates

   - In cartesian coordinates.
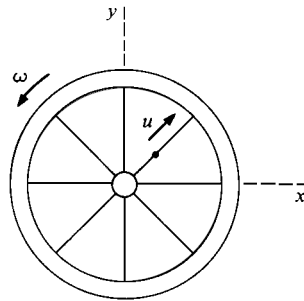   Also plot the velocity vector at different time (t).

Figure 1: Bead in the spoke

4. The rate of change of acceleration is sometimes known as "jerk". Find the direction and magnitude of jerk for a particle moving in a circle of radius R at angular velocity ω. Draw a vector diagram showing the instantaneous position, velocity, acceleration and jerk.

5. A tire rolls in a straight line without slipping. Its center moves with constant speed V. A small pebble lodged in the tread of the tire touches the road at $t = 0$. Find the pebble's position, velocity, and acceleration as functions of time.