INDIAN INSTITUTE OF TECHNOLOGY PATNA

PH103 : Physics Tutorial 1

1. Determine the velocity and acceleration vector if for a particle having constant r and $\theta = \omega t + \frac{\alpha t^2}{2}$ where ω and α are angular velocity and angular acceleration (both are constants in this problem) respectively in (a) polar co-ordinate and(b) cartesian co-ordinate systems

2. Find the angle between two vectors $\vec{A}$ and $\vec{B}$, If
   (a) $\left|\vec{A}\right| = \left|\vec{B}\right| = \left|\vec{A} + \vec{B}\right|$
   (b) $(\vec{A} \times \vec{B}) \times \vec{A} = \vec{B} \times (\vec{B} \times \vec{A})$ and $\left|\vec{A}\right|^2 = \left|\vec{B}\right|^2$

3. A particle is subjected to a radial force $\vec{F} = f(|\vec{r}|)\hat{e}_r$. Determine the vector $\vec{V} = \vec{F} \times \vec{L}$, the cross product of this radial force with the angular momentum of the particle on which the force acts. Find the components of $\vec{V}$ along $\hat{e}_r$ and along $\hat{e}_\perp$ where $\hat{e}_r$ and $\hat{e}_\perp$ are orthogonal to each other.

4. Imagine a particle moving outward along a spiral. The trajectory is given by r=Bθ, where B is a constant. B=$\frac{1}{\pi}$ m/rad, θ increases according to $\theta = \frac{\alpha t^2}{2}$, where α is a constant.
   (a) Sketch the motion, and indicate the velocity and acceleration at a few points
   (b) Show that the radial acceleration is zero when $\theta = \frac{1}{\sqrt{2}}$ rad
   (c) At what angles do the radial and tangential accelarations have equal magnitude?

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.