Course 141: MECHANICS

Problem Set 1

Date Issued: October 24, 2007
Date Due: October 31, 2007

Each problem counts 5 points

1. Show that is $|\vec{A} - \vec{B}| = |\vec{A} + \vec{B}|$, then $\vec{A} \perp \vec{B}$.

2. Given two vectors $\vec{A}$, 5 units long and $\vec{B}$, 9 units long. What is the angle ϕ between $\vec{A}$ and $\vec{B}$ when $|\vec{A} + \vec{B}| = 7$?

3. Consider two points $\vec{r}_1$ and $\vec{r}_2$ separated by the distance $r = |\vec{r}_1 - \vec{r}_2|$. Find the vector $\vec{R}$ from the origin to a point on the line between $\vec{r}_1$ and $\vec{r}_2$ at a distance kr from the point $\vec{r}_1$, where k is some number such that $0 \leq k \leq 1$. State your answer in therms of $k, \vec{r}_2$ and $\vec{r}_2$ only. Sketch the vectors $\vec{r}_1, \vec{r}_2$ and $\vec{R}$.

4. A particle has the trajectory (in meters with t in seconds)

$$\vec{r}(t) = \cos t\hat{i} + \frac{t^2}{1+t}\hat{j}$$

   (a) Sketch the trajectory for $t \geq 0$.

   (b) What is the maximum speed of the particle?

   (c) What is the maximum accelaration of the particle?

5. A particle, moving in one dimension, has acceleration as shown below. The particle starts from rest at $t = 0$.

   (a) Write down the particle's acceleration, $a(t)$, for $0 \leq t \leq 1$, $1 \leq t \leq 2$ and $t > 2$ seconds.

   (b) Find the particle's velocity, $v(t)$, for any $t \geq 2$ seconds.