PHYS 113- 2^{nd}-Homework
Due: 18 October 2007

1. Suppose that

$$\vec{A}(t) = \hat{x}\cos\omega t + \hat{y}\sin\omega t \tag{1}$$

where ω is a constant. Find $d\vec{A}/dt$. Show that $d\vec{A}/dt$ is perpendicular to $\vec{A}$ (H. C. Ohanian, 'Physics,' pg. 72, Q33)

2. Define the unit vector $\hat{r}$ as:

$$\hat{r} = \hat{x}\sin\theta\cos\phi + \hat{y}\sin\theta\sin\phi + \hat{z}\cos\theta \tag{2}$$

Then define two other vectors as:

$$\hat{\theta} = \frac{d\hat{r}/d\theta}{|d\hat{r}/d\theta|} \tag{3}$$

$$\hat{\phi} = \frac{d\hat{r}/d\phi}{|d\hat{r}/d\phi|} \tag{4}$$

where $|\vec{V}| = \sqrt{\vec{V}\cdot\vec{V}}$ denotes the magnitude of the vector $\vec{V}$. Show that all three unit vectors are perpendicular to each other. Calculate the vector product $\hat{\theta}\times\hat{\phi}$.

3. Suppose that the acceleration vector of a particle is given by

$$\vec{a} = \hat{x}2\frac{m}{s^2} + \hat{y}(-2)\frac{m}{s^2} + \hat{z}\frac{m}{s^2} \tag{5}$$

If the particle is initially at rest at the point $(x, y, z) = (0, 0, 0)$,

   (a) What is the velocity of this particle as a function of time?

   (b) What is the position of this particle as a function of time?

4. Protons in accelerators typically have momentum around $p \simeq 10^{-19} kgm/s$. What is the velocity of such a proton (ignore relativistic effects)? If a mass of $1kg$ would have the same momentum, what would be its velocity?

5. Show that $\vec{A}\times(\vec{B}\times\vec{C}) = \vec{B}(\vec{A}\cdot\vec{C}) - \vec{C}(\vec{A}\cdot\vec{B})$