Course 141: MECHANICS

Problem Set 3

Date Issued: November 7, 2007
Date Due: November 14, 2007

1. (5 points) Simplify: $\vec{a} \times (\vec{b} \times \vec{c}) + \vec{b} \times (\vec{c} \times \vec{a}) + \vec{c} \times (\vec{a} \times \vec{b})$.

2. (5 points) Two particles 1 and 2 are moving along x- and y-axis with respective velocities $\vec{v}_1 = 2m\hat{i}/s$ and $\vec{v}_2 = 3m\hat{j}/s$. At $t = 0$ they are at $x_1 = -3m, \quad y_1 = 0$ and $x_2 = 0, \quad y_2 = -3m$, respectively (here s and m are parameters).

   (a) Sketch the positions of the particles at $t = 0$, the direction of their velocities, and the vector $\vec{r}_2 - \vec{r}_1$ which represents the position of the particle 2 with r espect to particle 1.

   (b) Find $\vec{r}_2 - \vec{r}_1$ as a function of time.

   (c) When and where are these particles closest?

3. (5 points) A uniformly accelerated car passes two telephone poles with velocities 10 km/hr and 20 km/hr, respectively. Calculate its velocity when it is halfway between the poles. Let $a =$ car$'$s acceleration.

4. (10 points) A spring gun fires two shots, the velocity in each case being v_0. In the first case the shot if fired at an angle of elevation α and in the second case at an angle α'. Show that the time interval between the two firing such that two shots will collide in mid-air is
$$\delta t = \frac{2v_0}{g} \frac{\sin(\alpha - \alpha')}{\cos\alpha + \cos\alpha'}$$

5. (5 points bonus problem) Three small snails are each at at vertex of an equilateral triangle of side 60 cm. The first sets out towards the second, the second towards the third, and the third towards the first, with an uniform speed of 5 cm/min. During their motion each of them always heads towards its respective target snail. How long does it take for them to meet?

6. (5 points bonus problem) In problem 5 how many revolutions do the snails make before they meet? Assume point-like snails.