Phys 2201 Electricity and Magnetism Homework #2
Due Tuesday, September 29, 2014 by 3pm
(hand in to drop box outside 3L24)

1. (a) Show that the vectors $\mathbf{A} = 9\mathbf{i}+\mathbf{j}-6\mathbf{k}$ and $\mathbf{B} = 4\mathbf{i}-6\mathbf{j}+5\mathbf{k}$ are perpendicular to each other.

   (b) Show that the vectors $\mathbf{A} = \mathbf{i}\cos\alpha + \mathbf{j}\sin\alpha$ and $\mathbf{B} = \mathbf{i}\cos\beta + \mathbf{j}\sin\beta$ are unit vectors in the plane, making angles α and β with the x-axis. By means of the dot product, obtain the formula for $\cos(\alpha - \beta)$.

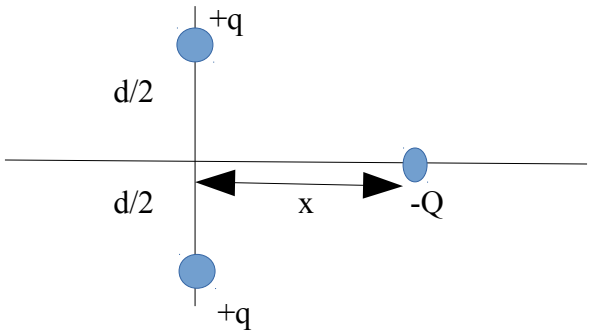
2. Prove the following identities:
   (a) $\mathbf{B}\mathbf{x}\mathbf{A} = -\mathbf{A}\mathbf{x}\mathbf{B}$
   (b) $\mathbf{A}\mathbf{x}(\mathbf{B}+\mathbf{C}) = \mathbf{A}\mathbf{x}\mathbf{B} + \mathbf{A}\mathbf{x}\mathbf{C}$
   (c) $\mathbf{A}\mathbf{x}(\mathbf{B}\mathbf{x}\mathbf{C}) = (\mathbf{A}\cdot\mathbf{C})\mathbf{B} - (\mathbf{A}\cdot\mathbf{B})\mathbf{C}$
   (d) Under what conditions does $\mathbf{A}\mathbf{x}(\mathbf{B}\mathbf{x}\mathbf{C}) = (\mathbf{A}\mathbf{x}\mathbf{B})\mathbf{x}\mathbf{C}$, where **A**, **B** and **C** are non-zero?

3. Two point charges are located on the x axis. The first is a charge +Q at x=-a. The second is an unknown charge located at x=+2a. The net electric field these charges produce at the origin has a magnitude $3k_eQ/a^2$. What are the two possible values of the unknown charge?

4. (Electric field, and simple harmonic motion review problem). Two identical particles, each having charge +q are fixed in space and separated by a distance d. A third point charge -Q is free to move and lies initially at rest on the perpendicular bisector of the two fixed charges (see Figure below).

   (a) Show that if x is small compared with d, the motion of -Q will be simple harmonic along the perpendicular bisector. Determine the period of the motion.

   (b) How fast will the charge -Q be moving when it is at the midpoint between the two fixed charges, if initially it is released at a distance A<<d from the midpoint.



5. A continuous line of charge lies along the x-axis, extending from $x=+x_0$ to positive infinity. The line charge has a uniform charge density of λ_0. What are the magnitude and direction of the electric field at the origin?