PH 223 Week 2

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Activities 2 and 3 are borrowed/adapted from Chapter 23 of *Physics for Scientists and Engineers*, as well as its associated *Student Workbook*.

Activity 1

(a) To derive Kepler's 3rd law, one can start by equating the gravitational force and the centripetal force necessary for uniform circular motion:

$$F_g = \frac{GMm}{r^2} = \frac{4\pi^2 mr}{T^2} = F_c,$$

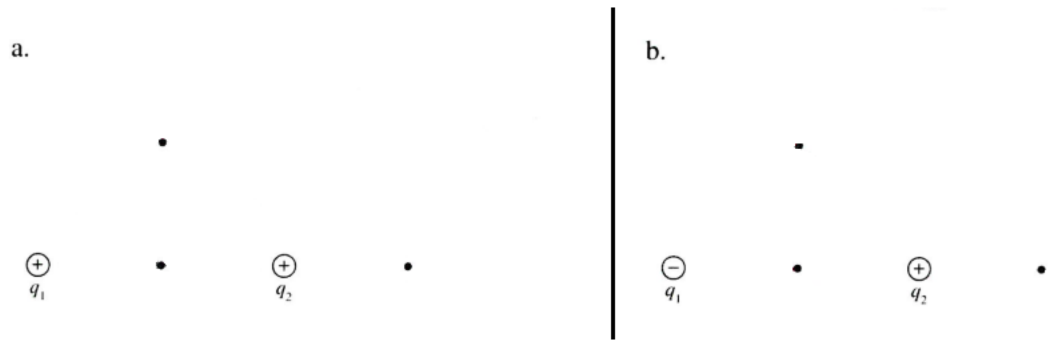
where we have made use of the substitution $\omega = 2\pi f = \frac{2\pi}{T}$. Let us model protons and electrons as classical point particles, with the electron in uniform circular motion around the proton. How would we change the above condition to account for the effects of charge?

(b) Let $e = 1.60 \times 10^{-19}$ C be the magnitude of charge on a proton or electron, $M = 1.67 \times 10^{-27}$ kg be the mass of the proton, and $m = 9.11 \times 10^{-31}$ kg be the mass of an electron. Compare GMm and Ke^2 in terms of order of magnitude (the powers of 10 in scientific notation). Are they similar, or is one much larger than the other?

(c) Take your modified expression from part (a) and remove the gravitational term. If we take the distance between the proton and the electron to be $r = 5.29 \times 10^{-11}$ m (the Bohr radius), then what order of magnitude is the rotational frequency of the electron? What SI prefix should I be appending to hertz when I express this frequency?

Activity 2

At each of the dots, use a **black** pen or pencil to draw and label the electric fields $\vec{E}_1$ and $\vec{E}_2$ due to the two point charges. Make sure that the *relative* lengths of your vectors indicate the strength of each electric field. Then use a **red** pen or pencil to draw and label the net electric field $\vec{E}_{net}$ at each dot.



Activity 3

For each of the figures, use dots to mark any point or points (other than infinity) where $\vec{E} = \vec{0}$.

a.

b.