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Problems set # 1 **Physics 167** January 31, 2023

1. *(i)* Compare the electric force holding the electron in orbit ($r = 0.53 \times 10^{-10}$ m) around the proton nucleus of the hydrogen atom, with the gravitational force between the same electron and proton. What is the ratio of these two forces. *(ii)* Would life be different if the electron were positively charged and the proton were negatively charged? Does the choice of signs have any bearing on physical and chemical interactions? Explain.

2. The nucleus of ^{8}Be, which consists of 4 protons and 4 neutrons, is very unstable and spontaneously breaks into two alpha particles (helium nuclei, each consisting of 2 protons and 2 neutrons). *(i)* What is the force between the two alpha particles when they are 5.00×10^{-15} m apart, and *(ii)* what will be the magnitude of the acceleration of the alpha particles due to this force? Note that the mass of an alpha particle is 4.0026 u.

3. A charge of 6.00×10^{-9} C and a charge of -3.00×10^{-9} are at a distance of 60.0 cm. Find the position at which a third charge of 12.0×10^{-9} C can be placed so that the net electrostatic force on it is zero.

4. An electron is released a short distance above Earth's surface. A second electron (directly below it) exerts an electrostatic force on the first electron just great enough to cancel the gravitational force on it. How far below the first electron is the second?

5. Eight point charges, each of magnitude q, are located on the corners of a cube of edge s, as shown in Fig. 1 *(i)* Determine the x, y, and z components of the resultant force exerted by the other charges on the charge located at point A. *(ii)* What are the magnitude and direction of this resultant force? *(iii)* Show that the magnitude of the force on a charge q at the center of any face of the cube has a value of $2.18\frac{1}{4\pi\epsilon_0}\frac{q^2}{s^2}$. *(iv)* What is the direction of the force at the center of the top face of the cube?

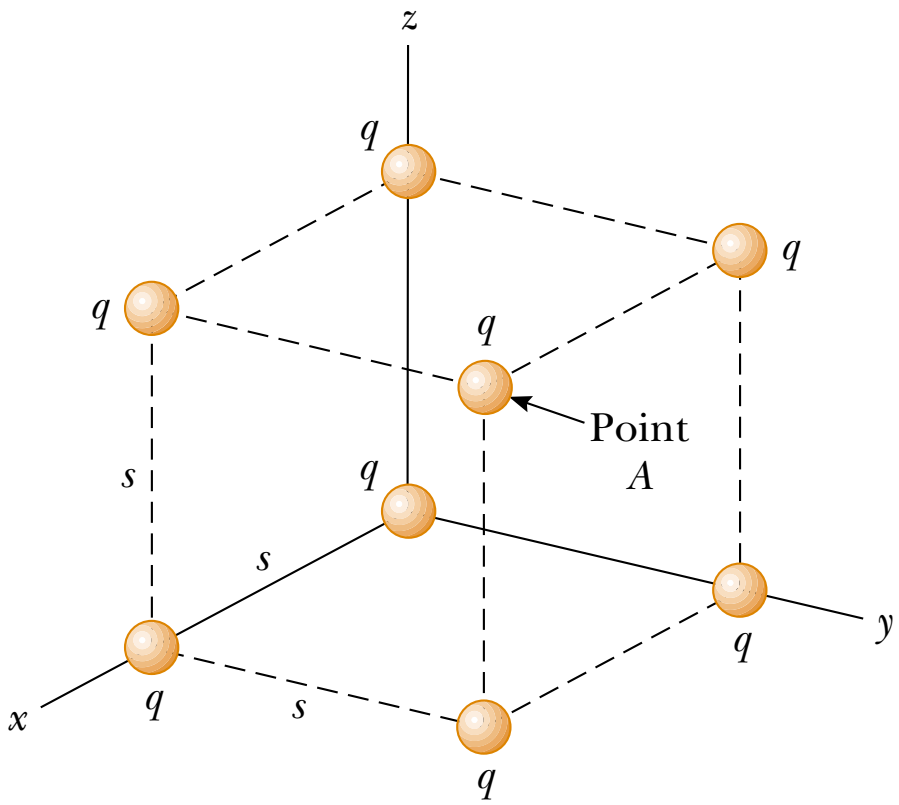

Figure 1: Problem 5.