Chapter 21 – Electric Charge

6. In Fig. 21-22, four particles form a square. The charges are $q_1 = q_4 = Q$ and $q_2 = q_4 = q$. (a) What is Q/q if the net electrostatic force on particles 1 and 3 is zero? (b) Is there any value of q that makes the net electrostatic force on each of the four particles zero? Explain.

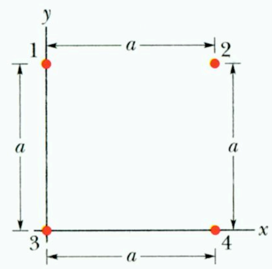

Fig. 21-22 Problems 6, 7, and 45.

20. In Fig. 21-29, particles 1 and 2 of charge $q_1 = q_2 = +3.20 \times 10^{-19}$ C are on a y-axis at distance d = 17.0 cm from the origin. Particle 3 of charge $q_3 = +6.40 \times 10^{-19}$ C is moved gradually along the x-axis from x = 0 to x = +5.0 M. At what values of x will the magnitude of the electrostatic force on the third particle from the other two particles be (a) minimum and (b) maximum? What are the (c) minimum and (d) maximum magnitudes?

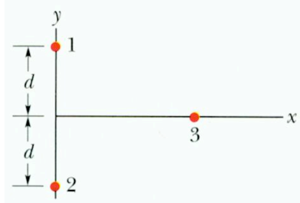

Fig. 21-29 Problem 20.

25. Earth's atmosphere is constantly bombarded by cosmic ray protons that originate somewhere in space. If the protons all passed through the atmosphere, each square meter of Earth's surface would intercept protons at the average rate of 1500 protons per second. What would be the electric current intercepted by the total surface area of the planet?

59. We know that the negative charge on the electron and the positive charge on the proton are equal. Suppose, however, that these magnitudes differ from each other by 0.00010%. With what force would two copper coins, placed 1.0 m apart, repel each other? Assume that each coin contains 3×10^{22} copper atoms. (Hint: A neutral copper atom contains 29 protons and 29 electrons.) What do you conclude?

65. (a) What equal positive charges would have to be placed on Earth and on the Moon to neutralize their gravitational attraction? (b) Why don't you need to know the lunar distance to solve this problem? (c) How many kilograms of hydrogen ions (i.e. protons) would be needed to provide the positive charge calculated in (a)?

66. In Fig. 21-43, two tiny conducting balls of identical mass m and identical charge q hang from non-conducting threads of length L. Assume that θ is so small that tan θ can be replaced by its approximate equal, sin θ. (a) Show that $x = \left(\frac{q^2 L}{2\pi \epsilon_0 mg}\right)^{1/3}$ gives the equilibrium separation x of the balls. (b) if L = 120 cm, m = 10g, and x = 5.0 cm, what is $|q|$?

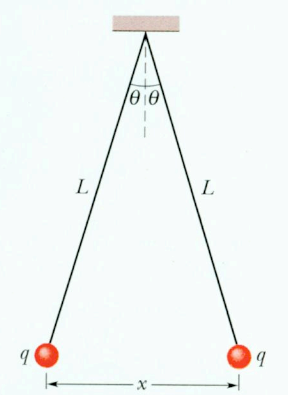

Fig. 21-43 Problems 66 and 67.