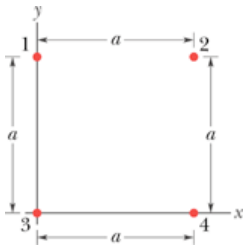
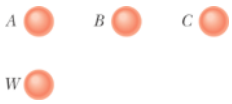
Chapter 23 – Problem Day

7. Two identical conducting spheres, fixed in place, attract each other with an electrostatic force of 0.108 N when their center-to-center separation is 50.0 cm. The spheres are then connected by a thin conducting wire. When the wire is removed, the spheres repel each other with an force of 0.0360 N. The spheres have an initial positive net charge. What was (a) the initial negative charge on one of them and (b) the initial positive charge on the other?

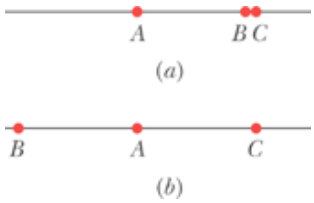


8. In the figure, four particles form a square. The charges are $q_1=q_4=Q$ and $q_2=q_3=q$. (a) What is Q/q if the net electrostatic force on particles 1 and 4 is zero? (b) Is there any value of q that makes the net electrostatic force on each of the four particles zero? Explain.

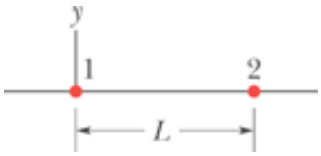
12. The figure shows four identical conducting spheres that are actually well separated from one another. Sphere W (with an initial charge of zero) is touched to sphere A and then they are separated. Next, sphere W is touched to sphere B (with an initial charge of -32e) and then they are separated. Finally, sphere W is touched to sphere C (with an initial charge of +48e), and then they are separated. The final charge on sphere W is +18e. What was the initial charge on sphere A?



16. In figure *a*, three positively charged particles are fixed on an x axis. Particles B and C are so close to each other that they can be considered to be at the same distance from particle A. The net force on particle A due to B and C is 2.014×10^{-23} N in the negative direction of the x axis. In figure *b*, particle B has been moved to the opposite side of A but is still at the same distance from it. The net force on A is now 2.877×10^{-24} N in the negative direction of the x axis. What is the ratio q_C/q_B?

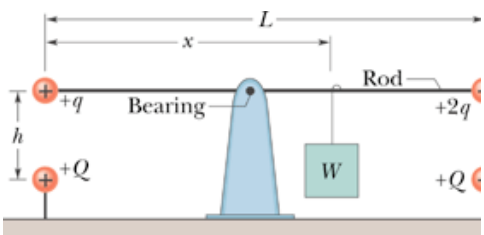


19. In the figure, particle 1 of charge $+q$ and particle 2 of charge $+4q$ are held at separation L = 9 cm on an x-axis. If particle 3 of charge q_3 is to be located such that the three particles remain in place when released, what must be the (a) x and (b) y coordinates of particle 3, and (c) the ratio q_3/q?



40. A particle of charge Q is fixed at the origin of an x-y coordinate system. At t = 0 a particle (m = 0.8 g, q = 4.0 μC) is located on the x axis at x = 20 cm, moving with a speed of 50 m/s in the + y direction. For what value of Q will the moving particle execute circular motion? (Neglect gravity.)

44. The figure shows a long, non-conducting, massless rod of length L, pivoted at its center and balanced with a block of weight W at a distance x from the left end. At the left and right ends of the rod are attached small conducting spheres with positive charges q and $2q$, respectively. A distance h directly beneath each of these spheres is a fixed sphere with positive charge Q. (a) Find the distance x when the rod is horizontal and balanced. (b) What value should h have so that the rod exerts no vertical force on the bearing when the rod is horizontal and balanced?



85. Imagine for a minute that the Moon is held in its orbit about the Earth by electrical forces rather than by gravitation. What electrical charges $-Q$ on the Earth and $+Q$ on the Moon are necessary to hold the Moon in a circular orbit with a period of 27.3 days? The Earth-Moon distance is 384 000 km and the mass of the Moon is 7.35×10^{22} kg.

Chapter 23 Answers

7a) -1 μC
7b) +3 μC

8a) -2.83

12) +16e

16) 1.33

19a) 3 cm
19b) 0 cm
19c) $-\frac{4}{9}$

40) -11.1 μC

44a) $x = \frac{L}{2}\left(1 + \frac{1}{4\pi\varepsilon_0}\frac{qQ}{h^2 W}\right)$

44b) $h = \sqrt{\frac{1}{4\pi\varepsilon_0}\frac{3qQ}{W}}$

85) 5.73×10^{13} C