

I'm not a robot





























Two small metallic spheres, each of mass 0.20 g, are suspended as pendulums by light strings from a common point as shown in the figure I attached. The spheres are given the same electric charge, and it is found that they come to equilibrium when each string is at an angle of 5.0 degrees with the vertical. If each string is 30.0 cm long, what is the magnitude of the charge on each sphere? Homework Equations Coulomb's Law The Attempt at a Solution I've drawn a force diagram for the first ball and I find that it's  $F_g = .00196$ , the tension,  $T$ , is  $.00197$ , and the Force of ball 2 on ball one,  $F_{21}$ , is  $1.71 \times 10^{-4}$ . When I plug into this equation:  $F = (k|q|)/r^2$ , I get  $5.1 \times 10^{-9}$ . However, I know this is wrong because the correct answer is 7.2nC. How do I do this correctly? Last edited: Aug 27, 2011 Notice that  $F = K * q * q / r^2$ ... Your formula lacks one q... Maybe that's where it fell? I'm too tired to make the calculation :) Ok I've made sure that I account for both q's. In order to solve this, do I have to break the vectors into components and set them equal to each other? Yes. It seems to me you did everything properly. You get the tension from comparing the y-axis forces: Gravity and  $T \sin 5$ . Then by comparing the x-axis forces:  $T \cos 5 = Kq^2 / r^2$  you can isolate q, notice that  $r = 0.3 * \sin 5 * 2$ . It should work. If you still get the same answer, then the book's wrong... I'm not sure if you took the time to actually solve it (I wouldn't blame you if you didn't) but for my final answer I got 6.88nC. If the book's answer is 7.2nC would it be safe to say this is accurate? I'm getting the book's answer after trying. You get the equation:  $0.00197 * \sin 5 = 9 * 10^{-9} * q^2 / (0.3 * (\sin 5)^2)^2$  solving it leads to  $q = 7.22$  nano C. (Problem 2.38 From Griffith's Electrodynamics): A metal sphere of radius R, carrying charge q, is surrounded by a thick concentric metal shell (inner radius a, outer radius b). The shell carries no net charge. Find the surface charge density  $\sigma_a$  at R, a, and b. Homework Equations  $\sigma = \frac{Q}{A}$  The Attempt at a Solution Since the metal sphere of radius R contains charge q, in order for the electric field to be 0 inside the conducting shell there must be charge -q at radius a which implies charge +q at radius b as the shell carries no net charge which gives  $\sigma_a = -\frac{q}{4\pi a^2}$  and  $\sigma_b = \frac{q}{4\pi b^2}$  Now what I'm confused about is that it just mentions that the metal sphere of radius R carries charge q and not whether it is a surface charge distribution or volume charge distribution. In the solutions manual they just give  $\sigma = \frac{q}{4\pi R^2}$  as if all the charge is on the surface although I'm not sure this makes sense. (Problem 2.38 From Griffith's Electrodynamics): A metal sphere of radius R, carrying charge q, is surrounded by a thick concentric metal shell (inner radius a, outer radius b). The shell carries no net charge. Find the surface charge density  $\sigma_a$  at R, a, and b. Homework Equations  $\sigma = \frac{Q}{A}$  The Attempt at a Solution Since the metal sphere of radius R contains charge q, in order for the electric field to be 0 inside the conducting shell there must be charge -q at radius a which implies charge +q at radius b as the shell carries no net charge which gives  $\sigma_a = -\frac{q}{4\pi a^2}$  and  $\sigma_b = \frac{q}{4\pi b^2}$  Now what I'm confused about is that it just mentions that the metal sphere of radius R carries charge q and not whether it is a surface charge distribution or volume charge distribution. In the solutions manual they just give  $\sigma = \frac{q}{4\pi R^2}$  as if all the charge is on the surface although I'm not sure this makes sense. Can charge reside within the volume of the metal sphere? You are missing a very important property of conductors under electrostatic conditions. Likes Potatochip911 and NFuller Can charge reside within the volume of the metal sphere? You are missing a very important property of conductors under electrostatic conditions. I thought that charge only entirely resided on the surface of conductors otherwise why would they mention this as a property of conductors and not just in general? After looking around it seems like the charge will always distribute across the surface of anything in order to minimize the potential energy. After looking around it seems like the charge will always distribute across the surface of anything in order to minimize the potential energy. Is that the case if charge is given to an insulator? Will charge reside on the surface of a non conductor as well? By the way, is there any confusion in the metal sphere being a conductor? Likes Potatochip911 is that the case if charge is given to an insulator? Will charge reside on the surface of a non conductor as well? By the way, is there any confusion in the metal sphere being a conductor? So in an insulator the electrons can't flow freely therefore they won't be able to redistribute across the surface? Yes, is it just a conductor because it's metal? So in an insulator the electrons can't flow freely therefore they won't be able to redistribute across the surface? Yes. Charges aren't mobile in an insulator unlike conductors. In conductors, whatever charge is given ends up on the surface. Likes Potatochip911 The measure of electric charge accumulated in a particular field is called charge density. We can determine it in terms of volume, area, or length. We can divide the charge density formula into three types depending on its nature: (i) Linear (ii) charge density ( ) (iii) Surface charge density ( ) (iv) Volume charge density ( ). Volume charge density is the quantity of charge per unit volume. Charge density measures the electric charge per unit measurement of the space. The space of measurement may be one, two, or three dimensional. Like mass density, charge density also varies with position. Thus, it can be positive or negative. What is Linear Charge Density? The quantity of charge per unit length, measured in coulombs per meter (cm1), at any point on a line charge distribution, is called linear charge density ( ). Suppose q is the charge and l is the length over which it flows, then the formula of linear charge density is  $q/l$ , and the S.I. unit of linear charge density is coulombs per meter (cm1). Example: Q. A 50cm long thin rod has a total charge of 5mC uniformly distributed over it. What is the linear charge density? Solution:  $q = 5 \text{ mC} = 5 \times 10^{-3} \text{ C}$ ,  $l = 50 \text{ cm} = 0.5 \text{ m}$  We have to find  $\sigma = q/l = 5 \times 10^{-3} / 0.5 = 10^{-2} \text{ cm}^{-1}$  What is Surface Charge Density? The quantity of charge per unit area, measured in coulombs per square meter (Cm2), at any point on a two-dimensional surface, is called the surface charge density ( ). Suppose q is the charge and a is the area of the surface over which it flows, then the formula of surface charge density is  $q/A$ , and the S.I. unit of surface charge density is coulombs per square meter (cm2). Example: Q. A sphere has a charge of 12 C and radius 9 cm. Calculate the linear charge density? Solution: Given, Charge  $q = 12 \text{ C}$ , Radius  $r = 9 \text{ cm}$ . The surface charge density formula is given by,  $\sigma = q / 4\pi r^2 = 4 / (0.09)^2 = 0.1017 \text{ m}^{-2}$  Surface charge density,  $\sigma = q / A = 12 / (0.1017)^2 = 117.994$  Therefore,  $\sigma = 117.994 \text{ cm}^{-2}$  What is Volume Charge Density? The quantity of charge per unit volume, at any point in a three-dimensional body, is called volume charge density ( ). Suppose q is the charge and V is the volume over which it flows, then the formula of volume charge density is  $q/V$  and the S.I. unit of volume charge density is coulombs per cubic meter (Cm3). Example: Q. A sphere of radius 1.85 cm has a charge of -260e spread through the volume uniformly. The sphere has a volume charge density of? Solution: We are given, The charge in the sphere,  $Q = -260e$  The radius of the sphere,  $r = 1.85 \text{ cm}$  If Q is the total charge distributed over a volume V, then the volume charge density is given by the equation:  $\rho = Q/V$  The volume of a sphere:  $V = \frac{4}{3}\pi r^3$  The volume charge density of the sphere is:  $\rho = Q / (\frac{4}{3}\pi r^3) = \frac{-260e}{(1.85 \text{ cm})^3} = -9.8 \text{ ecm}^{-3}$  (Image to be added soon) Solved Examples: 1. Calculate the Charge Density of an Electric Field When a Charge of 6 C / m is Flowing through a Cube of Volume 3 m3. Solution: Given the parameters are as follows, Electric Charge,  $q = 6 \text{ C}$  / m Volume of the cube,  $V = 3 \text{ m}^3$  The volume charge density formula is:  $\rho = q / V = 6 / 3 = 2 \text{ C per m}^3$ . 2. Find the Volume Charge Density if the Charge of 10 C is Applied Across the Area of 2m3. Solution: Given, Charge  $q = 10 \text{ C}$  Volume  $v = 2 \text{ m}^3$ . The volume charge density formula is,  $\rho = q / v = 10 \text{ C} / 2 \text{ m}^3 = 5 \text{ C/m}^3$  Using integration calculate the total charge on the sphere radius R Volume charge density at the surface of the sphere  $\rho = \rho_0 r / R$  I started with  $dq = 4\pi r^2 dr (\rho_0 r / R)$  but I am not sure how to integrate (in terms of what variable I would assume  $r=0$  to  $r=R$ ) but I am not sure I set up the question right Last edited: Feb 6, 2012 SammyS Using integration calculate the total charge on the sphere radius R Volume charge density at the surface of the sphere  $\rho = \rho_0 r / R$  I started with  $dq = 4\pi r^2 dr (\rho_0 r / R)$  but I am not sure how to integrate (in terms of what variable I would assume  $r=0$  to  $r=R$ ) but I am not sure I set up the question right I presume that you mean  $\rho = 0(r/R)$  is the volume charge density for a sphere of radius, R, where 0 is the volume charge density at the surface of the sphere. The volume element is  $dV = 4\pi r^2 dr$ . So that  $dq = 4\pi r^2 dr (\rho_0 r / R)$  dr.  $\rho_0$ , 0, and R are all constants. Integrate that over the entire sphere. r goes from 0 to R. That makes sense so if I was asked to find the E field using gauss's law for r