Electrostatics & Fields

1. You have access to three mobile charges of arbitrary sign and size. Come up with a *simple*, systematic procedure that could be used to ensure that an equilibrium point will exist in a known location in the plane of these charges. Explain clearly with a diagram. (You don't know ahead of time what the charges will be or which point will be chosen as the equilibrium point. Your procedure must work no matter what charges or point is chosen.)

2. For a science project Schmedrick constructs a *gi*-normous parallel plate capacitor with a capacitance of 0.3 F. It is tilted 21° with respect to the horizontal. The top (red) plate is positive, and it's 5 m from the negative plate, which has a huge excess charge of 45 C. A 0.4 kg projectile (green) with a -0.5 C charge is shot horizontally at 3.7 m/s from a position halfway between the plates. Assuming the plates are very long, which plate does it eventually hit and where? Don't ignore gravity. *Hints: Draw the E field. Draw the* $m\mathbf{g}$ *and* $q\mathbf{E}$ *vectors. Find the net horizontal force and the net vertical force. Find the horizontal <u>and</u> vertical accelerations. Write parametric equations; that is, write both* x *and* y *as separate functions of* t*, with kinematics in mind (in particular, the* Δx *equation). I recommend choosing the starting point of the charge as the origin. Find parametric equations that describe each line (plate) as well. (To do this, figure out the lower left point of each line using a little geometry/trig and write each in* $y = mx + b$ *form. The slope of a line is the tangent of the angle made relative to the horiz.) One way to parameterize* $y = 2x - 5$*, for example, is* $x = t$ *and* $y = 2t - 5$*.) Put all three sets of parametric equations into your calculator and graph them to find your answer. Use the trace feature to determine the impact site. Answers:* $V = 150$ *V,* $E = 30$ *N/C;* $a_{vertical} = 25.2\ m/s^2$*;* $a_{horizontal} = -13.4\ m/s^2$ *(up and right being positive); parametric equations for charge:* $x = 3.7t - 6.7t^2$*,* $y = 12.6t^2$*; impact site: (0.25, 2.77) in meters.*