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1. (Total 30 points) Two point charges, q_1 and q_2 , are fixed in space. The distance between the two charges is d . Here $q_1 = 2.0 \mu\text{C}$, $q_2 = 8.0 \mu\text{C}$, and $d = 9.0 \text{ cm}$. $1 \mu\text{C} = 10^{-6} \text{ C}$. (a, 20 points) Find the point in space that is close to the two charges where the electric field is 0. (b, 10 points) Now you move a charge q_3 from infinitely far away to this point, how much work you have to do during this process when $q_3 = 1.0 \mu\text{C}$? The Coulomb constant $k_e = 8.99 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2$. (c, bonus 5 points, do it when you have time in the end) Is q_3 in a stable or unstable equilibrium condition? Would your answer change if $q_3 = -1.0 \mu\text{C}$?

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2. (30 points) Two infinitely large plates made of insulating material (ignore its dielectric property) are placed distance D apart, parallel to each other. The thickness of each plate is d . One plate has a volume charge density ρ (assuming positive charge), the other $-\rho$. Here $D = 10.0$ mm, $d = 1.0$ mm, and $\rho = 1.0$ $\mu\text{C}/\text{mm}^3$. (a, 20 points) Find the electric field (magnitude and direction) between the two plates (excluding the plates volume) (b, 10 points) Find the electric fields (magnitude and direction) inside the plates, as a function of distance from the center of the plates. The permittivity of free space $\epsilon_0 = 8.85 \times 10^{-12}$ $\text{C}^2/\text{N} \cdot \text{m}^2$.

3. (40 points) A circuit shown in the figure where the switch has been closed for a long time. Find (a, 20 points) the current through each resistor, (b, 5 points) the power consumed by the 4.0 ohm resistor, (c, 5 points) the energy stored in the capacitor. (d, 10 points) If we start the time when the switch S is thrown open (this is the moment when $t_0 = 0$), calculate the current in each resistor as a function of time t , with $t \geq 0$.

