Prof. Anchordoqui

**Problems set # 2** **Physics 167** February 7, 2023

1. Figure 1 shows the electric field lines for two point charges separated by a small distance. *(i)* Determine the ratio $q_1/q_2$. *(ii)* What are the signs of $q_1$ and $q_2$?

2. An ion milling machine uses a beam of gallium ions ($m = 70u$) to carve microstructures from a target. A region of uniform electric field between parallel sheets of charge is used for precise control of the beam direction. Single ionized gallium atoms with initially horizontal velocity of $1.8 \times 10^4$ m/s enter a 2.0 cm-long region of uniform electric field which points vertically upward, as shown in Fig. 2. The ions are redirected by the field, and exit the region at the angle $\theta$ shown. If the field is set to a value of $E = 90$ N/C, what is the exit angle $\theta$?

3. Two 2.0-g spheres are suspended by 10.0-cm-long light strings, see Fig. 3. A uniform electric field is applied in the $x$ direction. If the spheres have charges of $-5.0 \times 10^{-8}$ C and $5.0 \times 10^{-8}$ C, determine the electric field intensity that enables the spheres to be in equilibrium at $\theta = 10°$.

4. Three charges of equal magnitude $q$ are fixed in position at the vertices of an equilateral triangle (Fig. 4). A fourth charge $Q$ is free to move along the positive $x$ axis under the influence of the forces exerted by the three fixed charges. Find a value for $s$ for which $Q$ is in equilibrium. You will need to solve a transcendental equation.

5. Eight solid plastic cubes, each 3.00 cm on each edge, are glued together to form each one of the objects *(i, ii, iii, iv)* shown in Fig. 5. *(a)* Assuming each object carries charge with uniform density 400 nC/m$^3$ throughout its volume, find the charge of each object. *(b)* Assuming each object carries charge with uniform density 15.0 nC/m$^2$ everywhere on its exposed surface, find the charge on each object. *(c)* Assuming charge is placed only on the edges where perpendicular surfaces meet, with uniform density 80.0 pC/m, find the charge of each object.

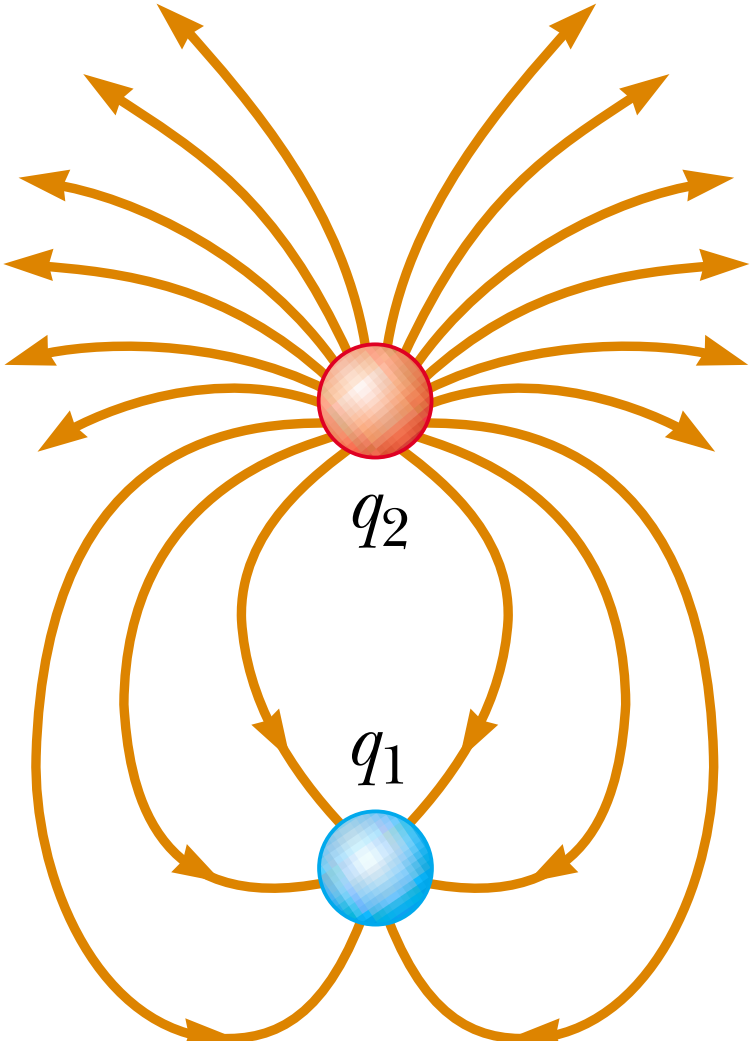


Figure 1: Problem 1.

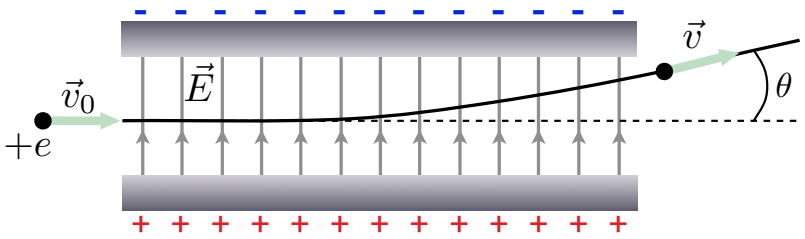


Figure 2: Problem 2.

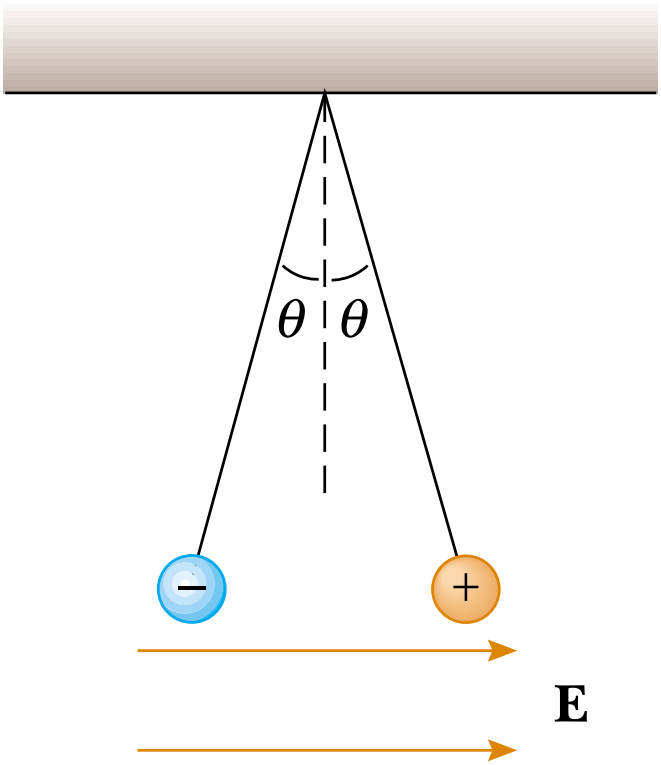


Figure 3: Problem 3.

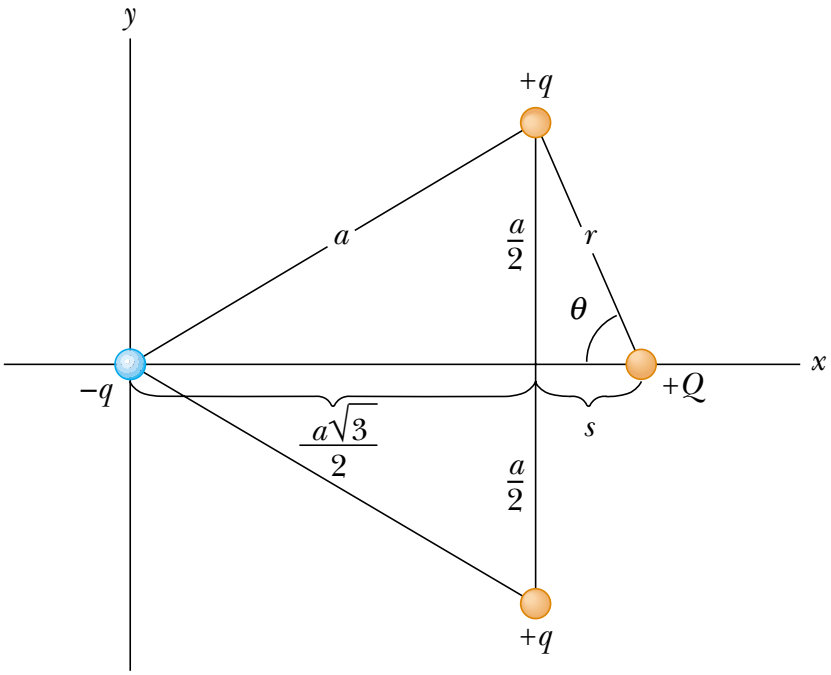


Figure 4: Problem 4.

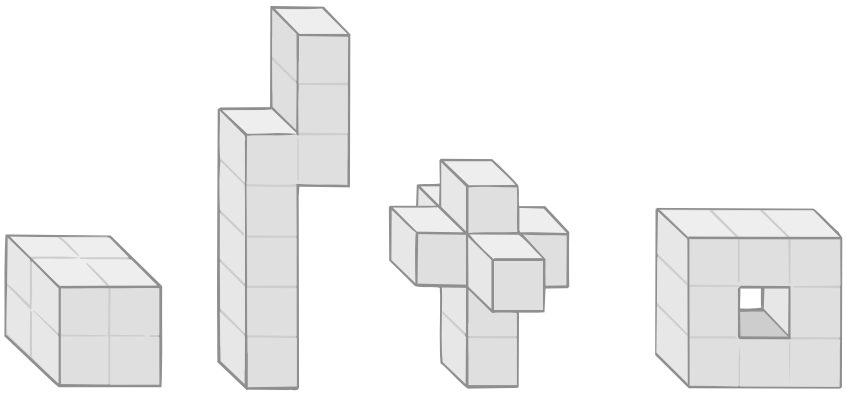


Figure 5: Problem 5.