

# Summer Semester 2023

## Assignment 1

PHY 112. Section 4

Submission date: 20 June 2023

Use the following constants if necessary. Coulomb constant,  $k=8.987 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2$ . Vacuum permittivity,  $\epsilon_0 = 8.854 \times 10^{-12} \text{ F/m}$ . Magnetic Permeability of vacuum,  $\mu_0 = 12.566370614356 \times 10^{-7} \text{ H/m}$ . Charge of one electron,  $e = -1.60217662 \times 10^{-19} \text{ C}$ . Mass of one electron,  $m_e = 9.10938356 \times 10^{-31} \text{ kg}$ . Unless specified otherwise, each symbol carries its usual meaning. For example,  $\mu\text{C}$  means microcoulomb.

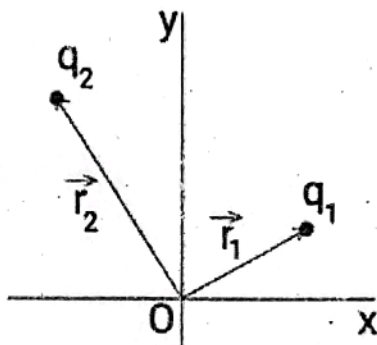
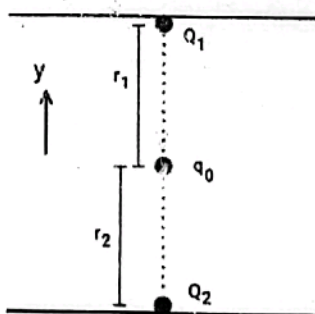


Figure 1

- In figure 1, two point charges  $q_1 = 6 \mu\text{C}$  and  $q_2 = 12 \mu\text{C}$  are located at points  $(5, 4)$  and  $(-6, 10)$ . Find the x and y components of  $\vec{r}_{1,2}$  and  $\vec{F}_{1,2}$  (the Coulomb force on particle 2 due to particle 1). Also, find the x and y components of  $\vec{r}_{2,1}$  and  $\vec{F}_{2,1}$ . Also, find the electric field  $\vec{E}_{12}$  due to particle 1 at the location of the particle 2 and the electric field  $\vec{E}_{21}$  due to the particle 2 at the location of particle 1. From the electric fields find  $\vec{F}_{12}$  and  $\vec{F}_{21}$ . Compare, the expressions for  $\vec{F}_{12}$  and  $\vec{F}_{21}$  obtained earlier applying Coulombs law directly. What is the relation between  $\vec{F}_{1,2}$  and  $\vec{F}_{2,1}$  and what it implies? The symbols have their usual meanings.
- (a) Find the relation between  $r_1$  and  $r_2$  when  $q_0$  is in equilibrium in the following figure. The symbols have their usual meaning



$$q_0 = -10 \text{ nC}$$

$$Q_1 = Q_2 = 20 \mu\text{C}$$

Figure: Test charge in the middle (can move). Other charges are fixed (cannot move).

- (b) Find the relation between  $r_1$  and  $r_2$  if now  $Q_1 = 10 \mu\text{C}$  and  $Q_2 = 30 \mu\text{C}$