

$$\begin{aligned}
 \vec{F}_{31} &= F_{31} \cos \theta \hat{i} + F_{31} \sin \theta \hat{j} \\
 \vec{F}_{32} &= -F_{32} \cos \theta \hat{i} + F_{32} \sin \theta \hat{j}
 \end{aligned}$$

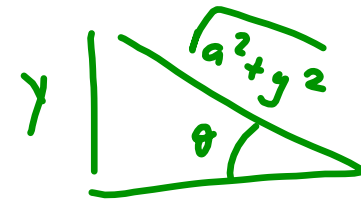
\hat{i} x
 \hat{j} y
 \hat{k} z

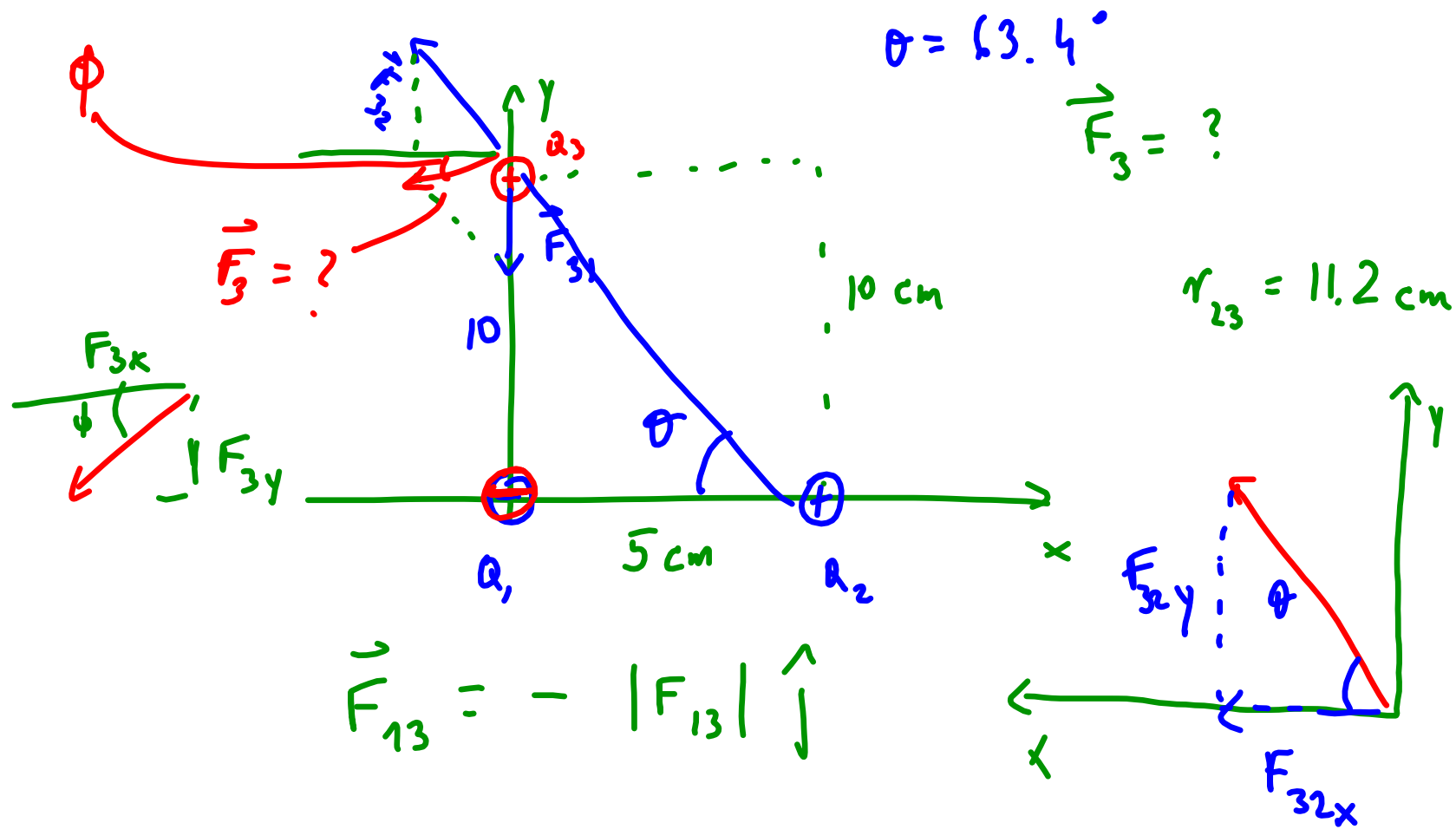
$$|F_{31}| = |F_{32}|$$

$$\begin{aligned}
 \vec{F}_{\text{net}} &= \left(\cancel{F_{31} \cos \theta} - \cancel{F_{32} \cos \theta} \right) \hat{i} + \\
 &\quad \left(F_{31} \sin \theta + F_{32} \sin \theta \right) \hat{j} = 2F_{31} \sin \theta \hat{j}
 \end{aligned}$$

$$\begin{aligned}
 \vec{F}_{\text{net}} &= 2 F_{13} \sin \theta \hat{j} = \\
 &= 2 \cdot k \frac{Q_1 Q_3}{r^2} \sin \theta \hat{j} \\
 &= 2 k \frac{Q_1 Q_3}{a^2 + y^2} \sin \theta \hat{j} \\
 &= 2 k \frac{Q_1 Q_3 y}{(a^2 + y^2)^{3/2}} \hat{j}
 \end{aligned}$$

$$\sin \theta = \frac{y}{\sqrt{a^2 + y^2}}$$





$$\vec{F}_3 = (-4.38 \hat{i} - 3.84 \hat{j}) \cdot 10^{-4} \text{ N}$$

What is the magnitude & direction of \vec{F}_3

$$|\vec{F}_3| = \sqrt{F_{3x}^2 + F_{3y}^2}$$

$$\phi = \tan^{-1} \left| \frac{F_{3y}}{F_{3x}} \right|$$

below negative
x axis

Electric field \vec{E}

Field model

- 1) Some charges which we will call source charges alter the space around them by creating an electric field \vec{E}

2) A separate charge in the electric field experiences a force \vec{F} exerted by the field (test charge)

The electric field at any point is the force per unit charge that would be experienced by a charge (test) at that point

$$\vec{E} = \frac{\vec{F}}{q} \quad [N/C]$$

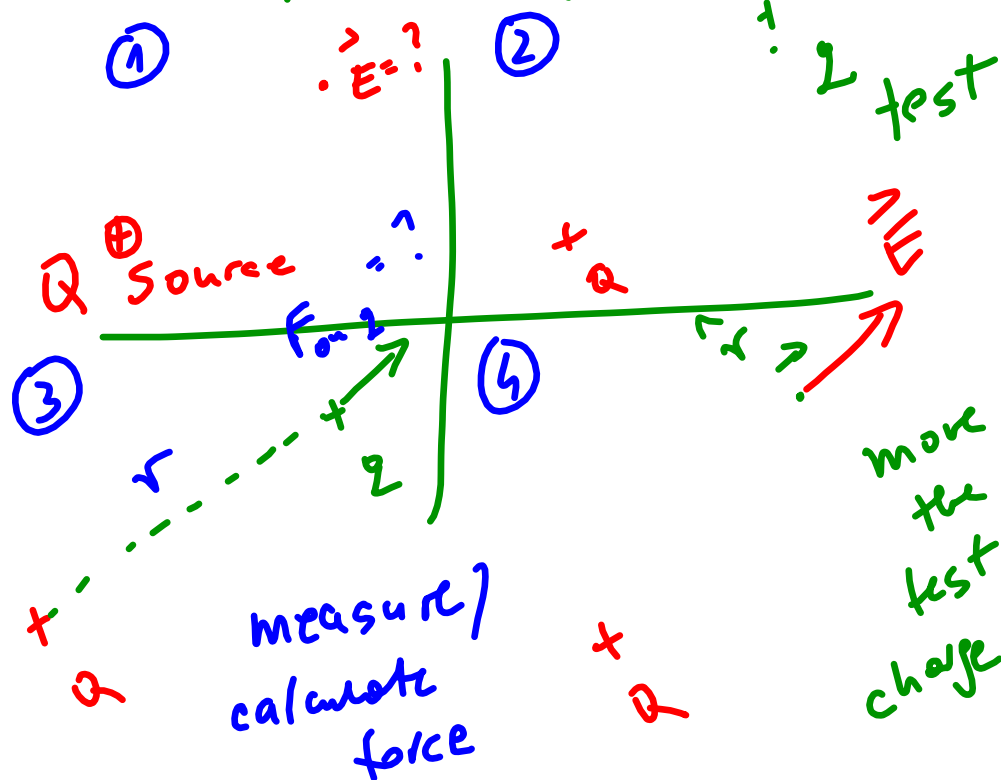
$$\vec{E} = \frac{\vec{F}}{q}$$

$$\vec{F} = q \vec{E}$$

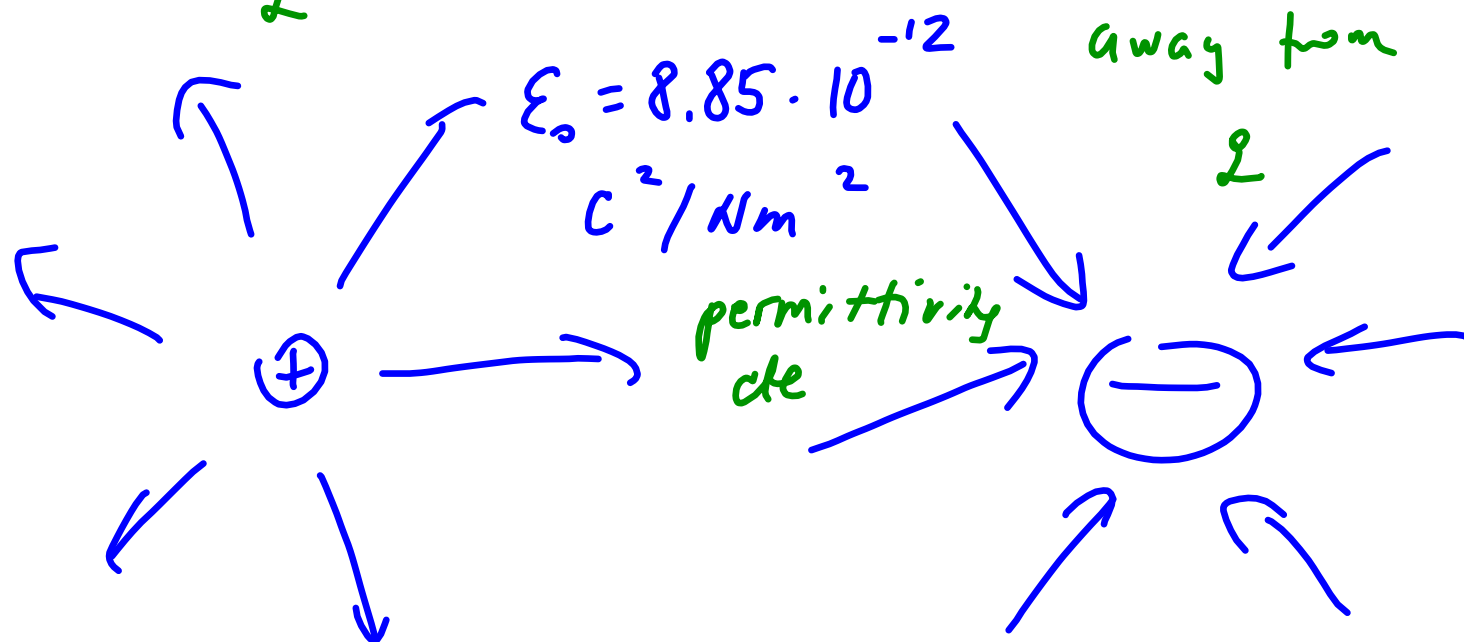
$$F_{on\ q} = \frac{1}{4\pi\epsilon_0} \frac{Qq}{r^2}$$

$$E = \frac{F}{q}$$

Electric field of a point charge



$$\vec{F} = \frac{\vec{F}_{on q}}{q} = \frac{1}{4\pi\epsilon_0} \frac{Q}{r^2} \hat{r}$$



q positive (test) \vec{F} & \vec{E} are in the
same direction

q negative \vec{F} & \vec{E} are in the
opposite direction

$$\vec{F} = q \vec{E}$$

$$\vec{E} = \vec{E}_1 + \vec{E}_2 + \dots$$

(the same as for \vec{F})

superposition principle