Lecture 5

Weds / Thurs : Labs

Fri : HW due by 5pm

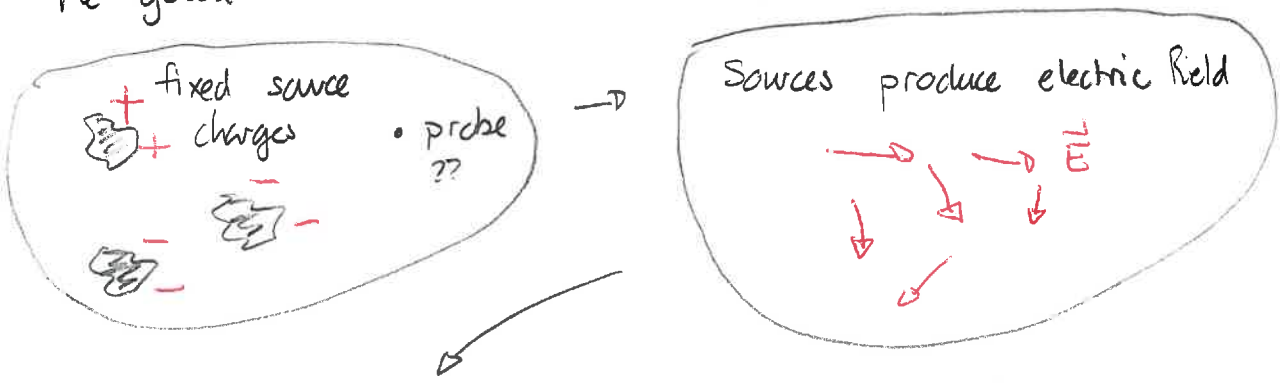
Supp Ex 12, 13, 14, 16, 18, 19, 21

Ch 20 Prob 23

Mon Warm Up 3 DL

Electric fields + forces

The general framework for electric fields is



Field describes force on another charged object (not source)

* take field vector at probe location, $\vec{E}$.

* force on probe is $\vec{F} = q_{probe}\vec{E}$ (charge of probe)

We now need to find ways to determine electric fields.

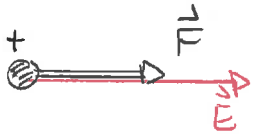
First consider directions. These can be determined from the forces exerted on probe charges.

positive probe

$\vec{F} = q_{probe}\vec{E}$

pos

$\vec{F}, \vec{E}$ same direction



negative probe

$\vec{F} = q_{probe}\vec{E}$

negative

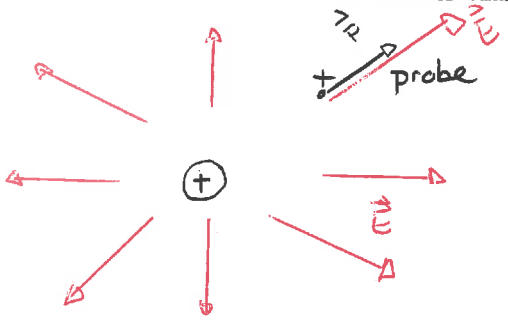
$\vec{F}, \vec{E}$ opposite directions

Generally its convenient to use a positive probe.

Field produced by a point charge.

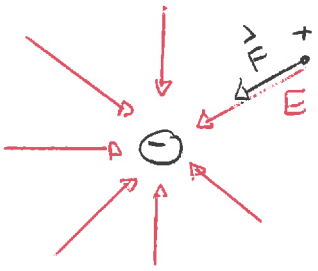
Consider a point source charge. We can determine the field by considering the force that this exerts on a positive probe

positive source charge



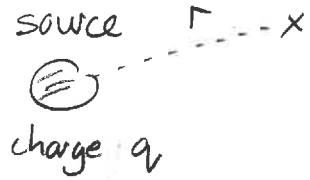
The electric field produced by a positive source charge points radially outward from the source

negative source charge



The electric field produced by a negative source charge points radially inward to the source

In order to ensure that $F = q_{probe} E$ gives the correct rule for the magnitude of the electric field, we must have:

> The magnitude of the electric field produced by a point source charge is
>
> $$E = \frac{k|q|}{r^2}$$
>
> 
>
>
> where r is the distance from the source to the location at which the field is determined.

Fields produced by multiple point sources

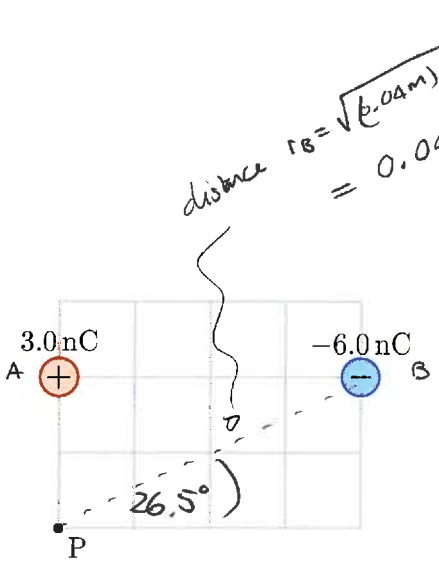
With multiple sources:

> The net electric field produced by a collection of point sources is the (vector) sum of the fields produced by the individual sources.

Quiz 1 40% – 90%

24 Electric field produced by two point charges

Two charged particles are held fixed as illustrated; the grid units are each 0.010 m. The aim of this exercise will be to determine the field at point P.



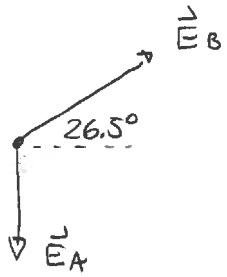
a) Indicate the directions of the electric fields produced by each source charge at point P.

b) Determine the magnitude of the electric field produced by each source charge at point P.

c) Using vector components add the two electric fields. ~~Express the total electric field in terms of standard unit vectors.~~ Sketch the vector + determine its magnitude

Answer: a) Label charges A, B.

Then fields are as shown



and

$$\vec{E} = \vec{E}_A + \vec{E}_B$$

b) $E_A = k\frac{|q_A|}{r^2} = 9.0\times10^9 \frac{N\,m^2}{C^2} \frac{3.0\times10^{-9}\,C}{(0.02m)^2} = 67500\,N/C$

$E_B = k\frac{|q_B|}{r^2} = 9.0\times10^9 \frac{N\,m^2}{C^2} \frac{6.0\times10^{-9}\,C}{(0.0447m)^2} = 27000\,N/C$

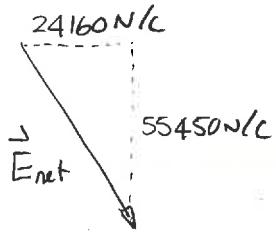
c) $E_{Bx} = E_B \cos 26.5^\circ$

$= 27000\,N/C \cos 26.5^\circ$

$E_{By} = E_B \sin 26.5^\circ = 27000\,N/C \sin 26.5^\circ$

$= 12050\,N/C$

	x	y
$\vec{E}_A$	0 N/C	−67500 N/C
$\vec{E}_B$	24160 N/C	12050 N/C
	24160 N/C	−55450 N/C



$E_{net} = \sqrt{(55450\,N/C)^2 + (24160\,N/C)^2} = 60500\,N/C$