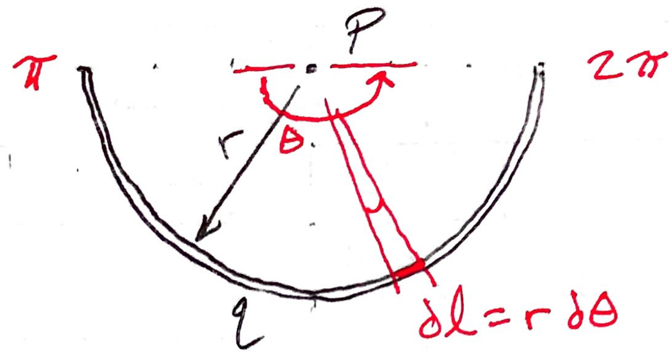
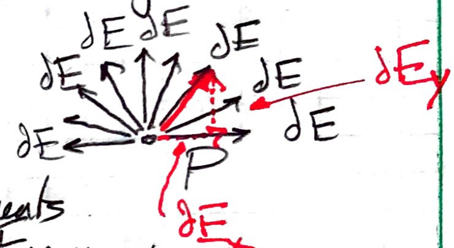
5.84



If charge per unit length is λ (constant), Find E field at P.

$$E = \int \frac{k\,dq}{r^2}\hat{r}$$

r is constant, so we're just integrating dq. The vector is problematic, though.



Each dq produces a dE pointing in a different direction. From the components shown here, we can see that dE_x components will all cancel out, but dE_y components — $dE \sin\theta$ — will all add. So:

$$E = \int k\frac{dq}{r^2}\sin\theta$$

See diagram above

$$= \frac{k}{r^2}\int dq \sin\theta \; ; \quad dq = \lambda\, dl$$

$$dq = \lambda r\, d\theta$$

$$E = \frac{kr\lambda}{r^2}\int_{\pi}^{2\pi} \sin\theta\, d\theta$$

$$= \frac{k\lambda}{r}\cos\theta\Big|_{\pi}^{2\pi} \rightarrow \frac{k\lambda}{r}(\cos 2\pi - \cos\pi)$$

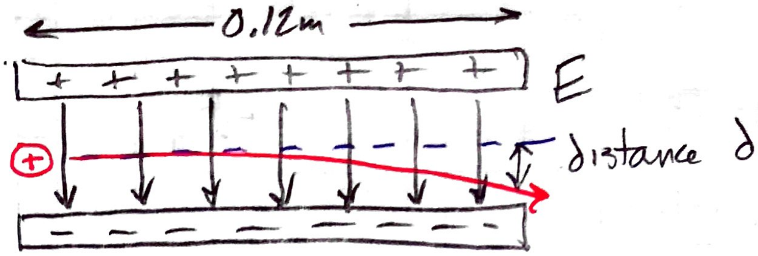
$$\frac{k\lambda}{r}(1 - -1)$$

$$= \boxed{\frac{2k\lambda}{r}} \quad \boxed{\text{up}}$$

Noting that $k = \frac{1}{4\pi\varepsilon_0}$ we could also express as

$$\frac{2\lambda}{r}\left(\frac{1}{4\pi\varepsilon_0}\right) = \boxed{\frac{\lambda}{2\pi r\varepsilon_0}}$$

5.94



E field = 4.0e5 N/C down, as shown. proton w/ mass = 1.67e-27 kg & charge 1.602e-19 C flies into field with initial velocity 1.5e7 m/s. How far has it deflected by the time it leaves the E field?

It's a projectile problem, yes? Vertical acceleration caused by ~~gravity field~~ electric field doesn't affect horizontal motion. So...

Horizontal time in field?

$$v_x = \frac{\Delta x}{\Delta t} \rightarrow \Delta t = \frac{\Delta x}{v_x} = \frac{0.12\,m}{1.5e7\,m/s} = 8.0e\text{-}9\,s$$

Vertical time to displace = 8.0e-9 s

$$\Delta y = v_i t + \frac{1}{2} a t^2$$

what is acceleration in field?

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

$$ma = qE \rightarrow a = \frac{qE}{m}$$

$$a = \frac{(1.602e\text{-}19)(4e5\,N/C)}{1.67e\text{-}27} = 3.84e13\,N/C$$

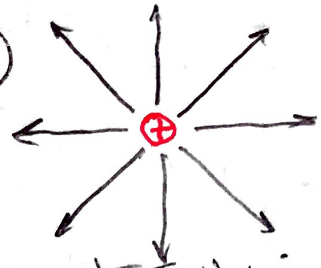
$$d = 0t + \frac{1}{2}(3.84e13)(8.0e\text{-}9\,s)^2$$

$$= \boxed{0.00123\,m} = 1.23\,mm$$

(Typo in solution guide? 4.5e5 N/C vs. 4.0e5 in text.)

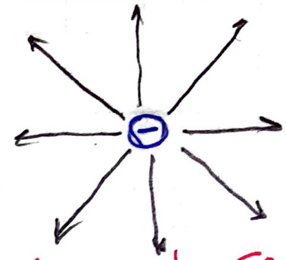
5,100

a)



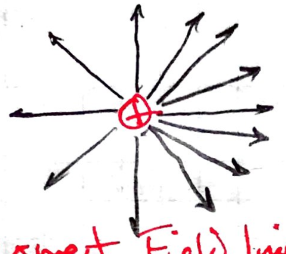
Correct. Field lines point away from +, symmetrically arranged.

b)



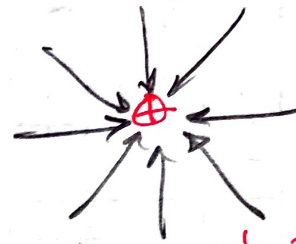
Incorrect. Field lines should point toward a negative charge.

c)



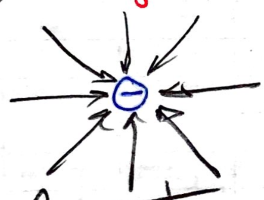
Incorrect. Field lines should be symmetric (unless there is something happening to right side).

d)



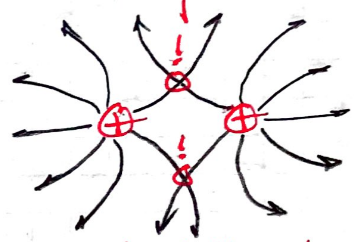
Incorrect. Field lines should point away from positive charge.

e)



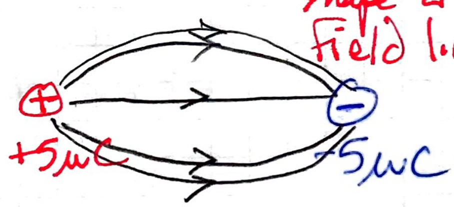
Correct

f)



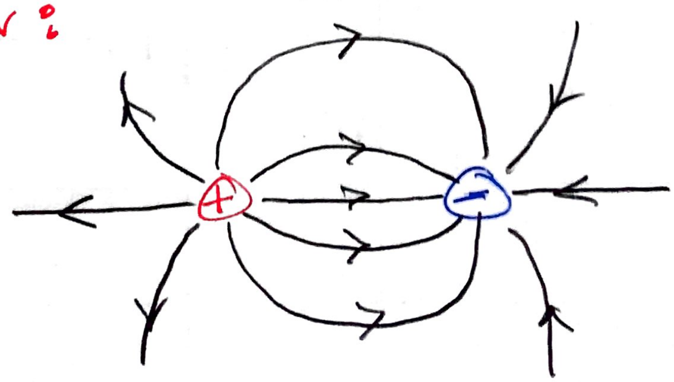
Incorrect. Although general shape of lines is good, field lines don't cross.

g)

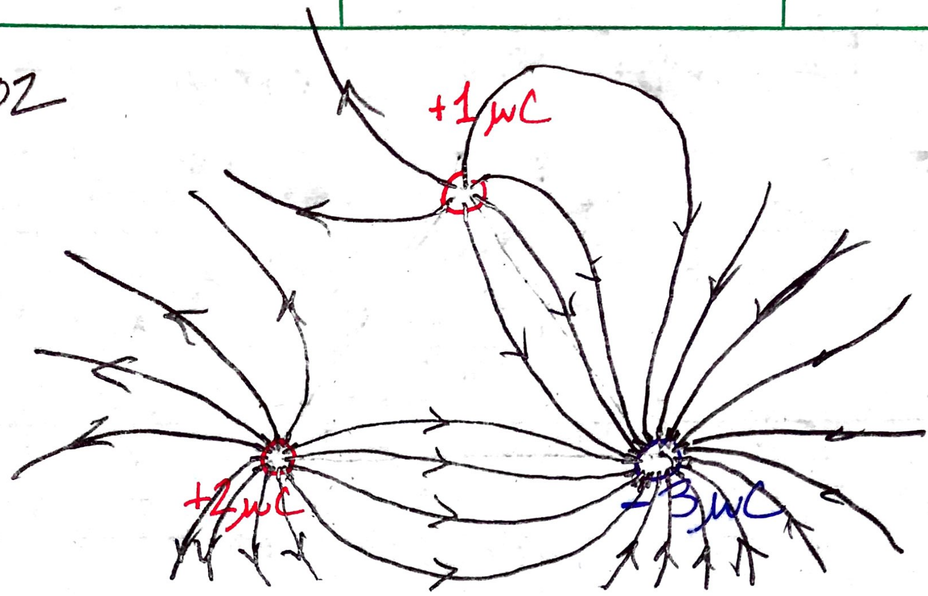


Incorrect. Although field lines point in correct direction, they get farther apart as you get farther away from dipole.

Better:



5.102



Field lines need to be drawn with a number for each charge proportional to the magnitude of the charge.

I'll choose six lines / μC : 6, 12, & 18 "tics" on each charge.