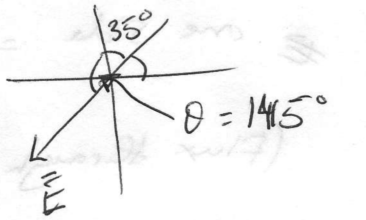
1. $E = 1800$ N/C

$\Phi = \int \vec{E} \cdot d\vec{S}$

where θ is ∡ between $\vec{E}$ and normal to surface:

$= \underbrace{(1800 \cos\theta)}_{\text{normal component of } \vec{E}}(3.2\times10^{-3})(3.2\times10^{-3})$



3. a) $\vec{E} = 6\hat{x}$ N/C , $\hat{n} = \hat{j}$

$\Phi = (6\hat{x})\cdot(1.4\,\hat{j})^2$

$= 0$ (∵ no normal component through surface

b) $E = -2\hat{j}$ N/C

$\Phi = (-2)(1.4)^2$

$= -3.92$ Nm²/C

c) $\vec{E} = -3\hat{x} + 4\hat{z}$

$\Phi = \vec{E}\cdot\hat{n}$

$= 0$

d) $\Phi = 0$ since field enters one face and leaves another so net flux $= 0$

5. For single charge, fields radiate out symmetrically

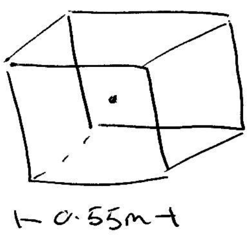
so use $q_{encl} = \oint \bar{D} \cdot d\bar{S} = \epsilon_0 \oint \bar{E} \cdot d\bar{S} = \epsilon_0 \Phi$

$\because$ one side of cube has $\frac{1}{6}$ of its total area, flux through one side $= \frac{1}{6}$(flux through entire cube)

and (Flux through entire cube) $= \dfrac{q_{encl}}{\epsilon_0}$

so ANS $= \dfrac{q_{encl}}{6\epsilon_0}$

7.



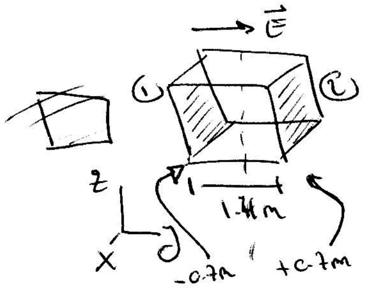
$q = 1.8\,\mu C$

$\epsilon_0 \Phi = q_{encl}$

$\Phi = \dfrac{1.8\,\mu C}{\epsilon_0}$

9. $\vec{E} = \hat{j}3y\,\hat{j}$ N/C

only ~~cond~~ consider faces that are normal to $\hat{j}$ since other terms are 0.



a) $\Phi_1 = \hat{j}(3)(-0.7)(1.4)^2(-\hat{j})$

$\Phi_2 = \hat{j}(3)(+0.7)(1.4^2)\hat{j}$

$\Phi_{Total} = \Phi_1 + \Phi_2$
$= 8.23\ Nm^2/C$

b) $q_{encl} = \epsilon_0 \Phi$
$=$

8

9. c) $\vec{E} = -4\hat{x} + (6+3y)\hat{z}$ N/C

$\vec{E}$ has x, z components only, so look at x, z faces:

$-$ve x face $\quad \Phi_{-x} = \int \vec{E} \cdot d\vec{S}$

$= (-4\hat{x}) \cdot (1.4^2)(-\hat{x})$

+ve x face $\quad \Phi_{+x} = (-4\hat{x}) \cdot (1.4^2)(+\hat{x})$

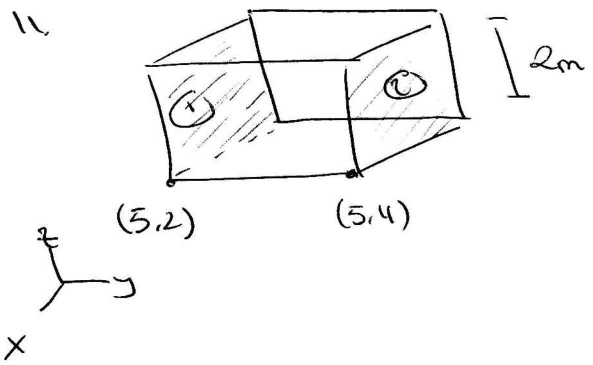
$-$ve z face $\quad \Phi_{-z} = (6+3y)\hat{z}\,(1.4)^2(-\hat{z})$

+ve z face $\quad \Phi_{+z} = (6+3y)\hat{z}\,(1.4)^2(+\hat{z})$

so $\Phi_{Total} =$

d) $q_{encl} = \varepsilon_0 \Phi$

11.



$\vec{E} = -3\hat{x} - 4y^2(\hat{y}) + 3\hat{z}$ N/C

Flux through +ve x, $-$ve x, +ve z, and $-$ve z faces will cancel since normals are oppositely directed.

$-$ look at y faces

$\Phi_1 = [(-4)(2)^2(\hat{y})][4(-\hat{y})] = \int \vec{E} \cdot d\vec{S} =$

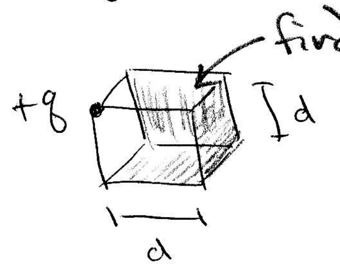
$\Phi_2 = [-4(4)^2\hat{y}][4(+\hat{y})] =$

$\Phi_{Total} = -192$ Nm²/C

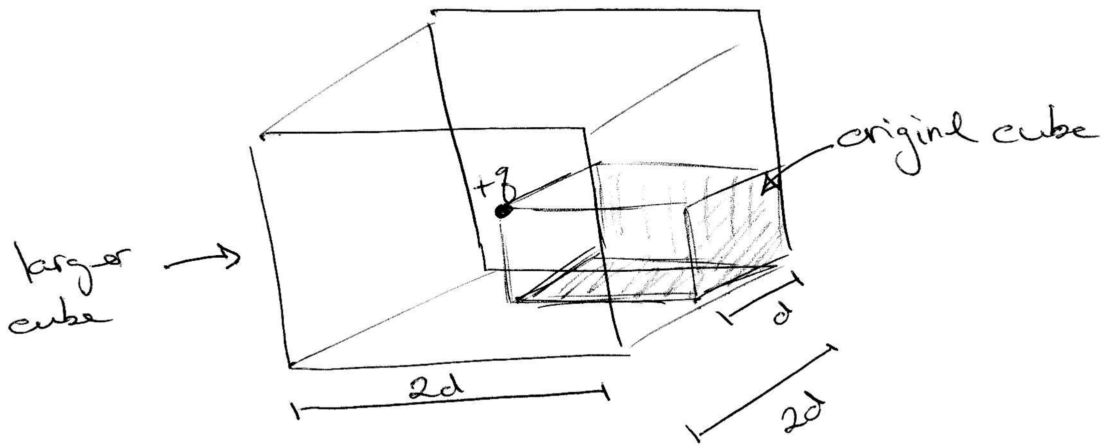
$q_{encl} = \Phi \varepsilon_0$

$= -1.7 \times 10^{-9}$ C

15. original situation:



$\Rightarrow$ take new Gaussian surface and put q in middle of larger cube:



Surface Area of big cube $= (6)(2d)^2 = 24d^2$

Surface Area of shaded faces of original cube $= 3(d^2)$

$\therefore$ ratio is $\frac{24}{3}$

so flux through big cube is $q_{encl} = \epsilon_0 \Phi$

$$\Phi = \frac{q_{encl}}{\epsilon_0}$$

$$= \frac{q}{\epsilon_0}$$

$\therefore$ flux through $\frac{3}{24}$ of surface is $\left(\frac{q}{\epsilon_0}\right)\left(\frac{3}{24}\right)$

and through each face is $\left(\frac{q}{\epsilon_0}\right)\left(\frac{1}{24}\right)$ $\leftarrow$ ANS(b)

a) these surfaces don't enclose any charge in big cube, so

$$\Phi = \frac{q_{encl}}{\epsilon_0} = 0$$

Chap 23

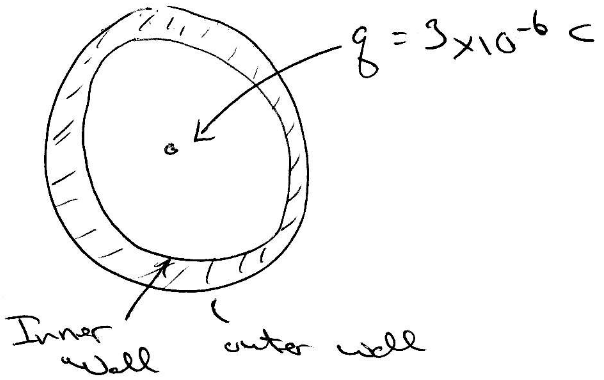
#17 a) Area $= 4\pi r^2$

So total charge $q =$ (Area) σ , $\sigma = 8.1\,\mu C/m^2$

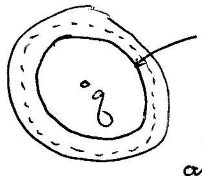
$=$

b) $\Phi = \dfrac{q_{encl}}{\epsilon_0}$

21.



a) Take Gaussian surface as sphere between inner and outer walls



∴ no $\vec{E}$ in conductor, q_{encl} must $= 0$

and so charges on inner wall and q must cancel.

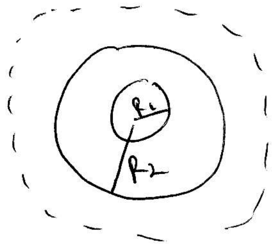
$\Rightarrow$ charge on wall $= -q = -3\times10^{-6}$ c

b) Net charge is 10×10^{-6} c and inner wall has -3×10^{-6} c, so outside surface is $(10+3) = 13\times10^{-6}$ c

25. eqn 23-12: $E = \dfrac{\lambda}{2\pi\epsilon_0 r}$

$$4.5\times10^4 = \frac{\lambda}{2\pi\epsilon_0 (2)}$$

29.



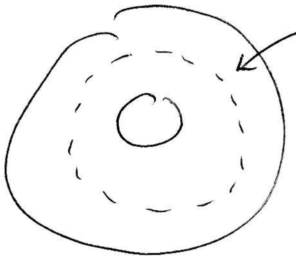
Draw cylindrical Gaussian surface at $2R_2$

$$\int_S \epsilon_0 \bar{E} \cdot d\bar{S} = q_{encl} = q_{rod} + q_{shell} = -Q_1$$

$$\epsilon_0 E(2\pi r L) = -Q_1$$

a) $$|E| = \frac{Q_1}{\epsilon_0 2\pi (2R_2) L}$$

b) and field points inward since net charge is $-$ve



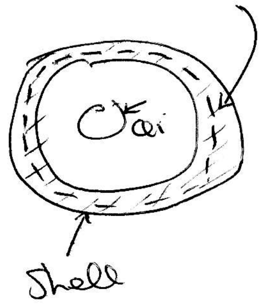
c) for $r = 5R_1$

$$\int \epsilon_0 \bar{E} \cdot d\bar{S} = q_{encl} = Q_1$$

$$|E| = \frac{Q_1}{2\pi(5R_1)\epsilon_0 L}$$

(d) and field points outward since charge is +ve

e) Draw Gaussian surface through middle of shell



$\because$ $\bar{E}$ in shell $= 0$

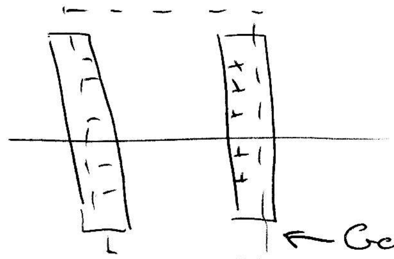
$$\int \bar{E} \epsilon_0 \cdot d\bar{S} = q_{encl}$$

$$0 = q_{encl}$$

so charge on inner surface must cancel charge on rod $\rightarrow$ $= \underline{\underline{-Q_1}}$

f) $\because$ net charge on shell is $-2Q_1$, outer surface must be $-Q_1$ so that $Q_{outer} + Q_{inner} = -2Q_1$

33.



← Gaussian surface

$q_{encl} = \int \bar{D} \cdot ds$

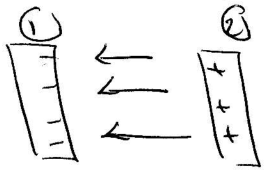
$= \epsilon_0 \int \bar{E} \cdot d\vec{s}$

since charge densities have equal mag and opposite signs, $q_{encl} = 0$

and so no $\vec{E}$ leaving surface.

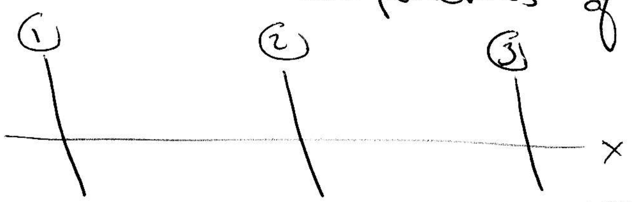
$\therefore$ to left and right, $\underline{\underline{\vec{E} = 0}}$.

c) in middle, sum up individual $\vec{E}$ fields:



$|E_1| = \dfrac{\sigma}{2\epsilon_0}$ $\quad |E_2| = \dfrac{\sigma}{2\epsilon_0}$ $\quad \rightarrow \quad E_T = \dfrac{2\sigma}{2\epsilon_0}(-\hat{x})$

35. Normal components of $\vec{D} = \epsilon_0 \vec{E}$ must be continuous



$\bar{E}_{12}$ $\quad \bar{E}_{23}$ $\quad \bar{E}_{3+}$

$\hat{n} \cdot \vec{E}_{23}\epsilon_0 - \hat{n} \cdot \cancel{\vec{E}_{3+}}^{\,0} \epsilon_0 = \sigma_3$

$\sigma_3 = 6 \times 10^5 \epsilon_0 \quad C/m^2$

$\hat{n} \cdot \bar{E}_{12}\epsilon_0 - \hat{n} \cdot \vec{E}_{23}\epsilon_0 = \sigma_2$

$2 \times 10^5 \epsilon_0 - 6 \times 10^5 \epsilon_0 = \sigma_2$

$\sigma_2 = -4 \times 10^{-5} \epsilon_0 \quad C/m^2$

ratio is $\underline{\underline{-1.5}}$

41. $\vec{E}$ from conducting plate is

$$\vec{E} = \frac{\sigma}{\epsilon_0}$$

Force on e^- from field is $\vec{F} = q\vec{E}$ and this force slows particle

$$\therefore |\vec{F}| = ma = q|\vec{E}|$$

$$a = \frac{q|\vec{E}|}{m}$$

$$= \frac{q\sigma}{m\epsilon_0}$$ (and q is $-ve$)

Using $v_f^2 = v_i^2 + 2ad$ where $v_f = 0$ and

$d = 0.44\,mm$ Kinetic energy $K_e = \frac{1}{2} m v_i^2$

$\hookrightarrow v_i = 5.9 \times 10^6\ m/s$

chp 24

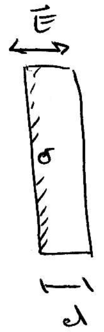
1. from chp 21, 1 C = 1 A·s

a) so 84 A·h $= \cancel{A}\,(84)(3600)$ A·s

$= 3.02\times10^{5}$ C

b) $\Delta V = \dfrac{\Delta U}{q} \Rightarrow \Delta U = 3.6\times10^{6}$ J

5. $\vec{E} = \dfrac{\sigma}{2\epsilon_0}$

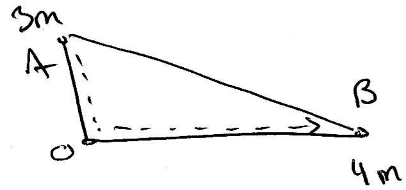


$V = \int_0^{l} \bar{E}\cdot d\bar{l}$

$= |E|d$

d =

7.



$\vec{E} = 4x\,\hat{x}$

$U_{B-A} = -\int_A^B \vec{E}\cdot d\vec{l}$

free to choose integration path, so use ① A → O and ② O → B

① $-\int_{A=3m}^{0} (4x\hat{x})\cdot\hat{y}\,dy = 0$

② $-\int_{0}^{B=4m} (4x\hat{x})\,\hat{x}\,dx = -2x^2\Big|_0^4$

$= -32$ V

(15)

9. Work done by Force on particle is $W = F \cdot d$, $\bar{F} = q\bar{E}$

a) $W = q\bar{E} \cdot \bar{d}$ and $|E| = \dfrac{\sigma}{2\epsilon_0}$

$= 1.8 \times 10^{-21}$ J

b) $\Delta V = V_f - V_i = \dfrac{-W}{q}$ (moving from i ~~fo~~ to f)

$= -0.0117$ V