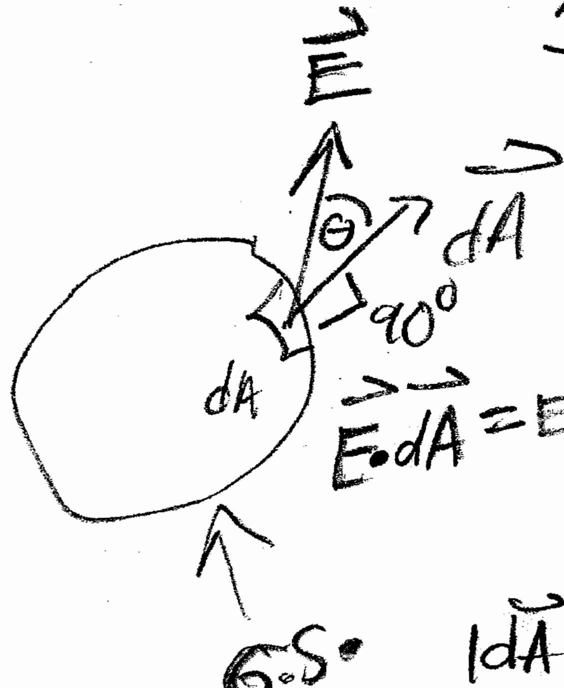
2-12 supplementary Notes

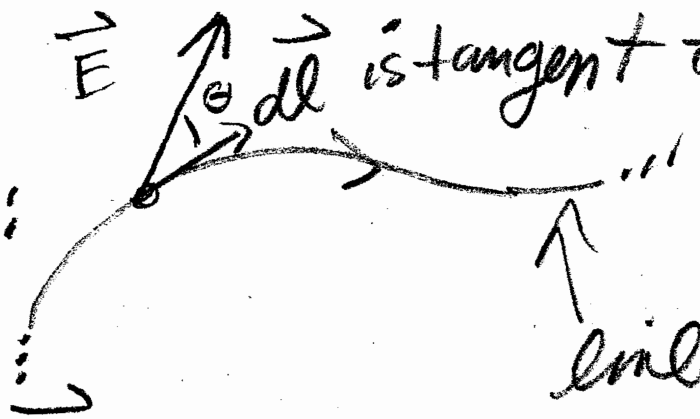
Review definition of $\vec{E}\cdot d\vec{A}$:



$\vec{E}\cdot d\vec{A} = E\,dA\cos\theta$

$|d\vec{A}| = dA$

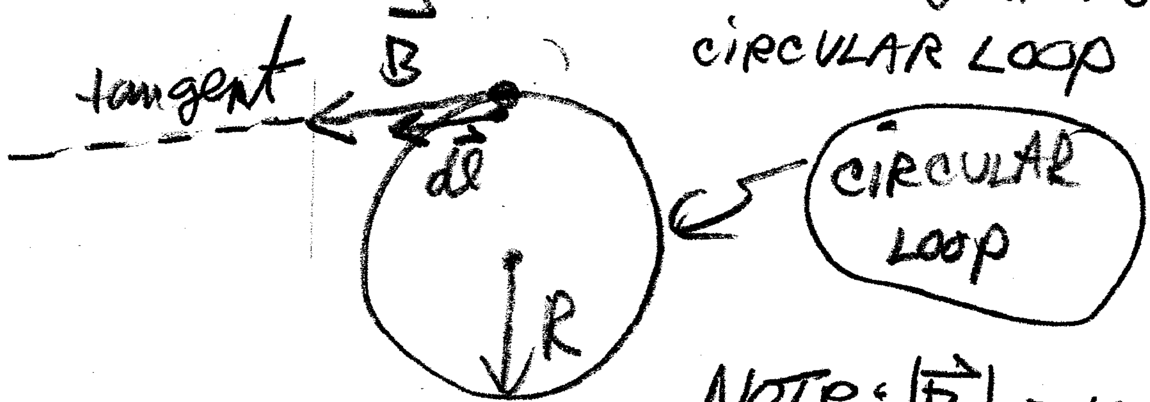
Review line integrals:



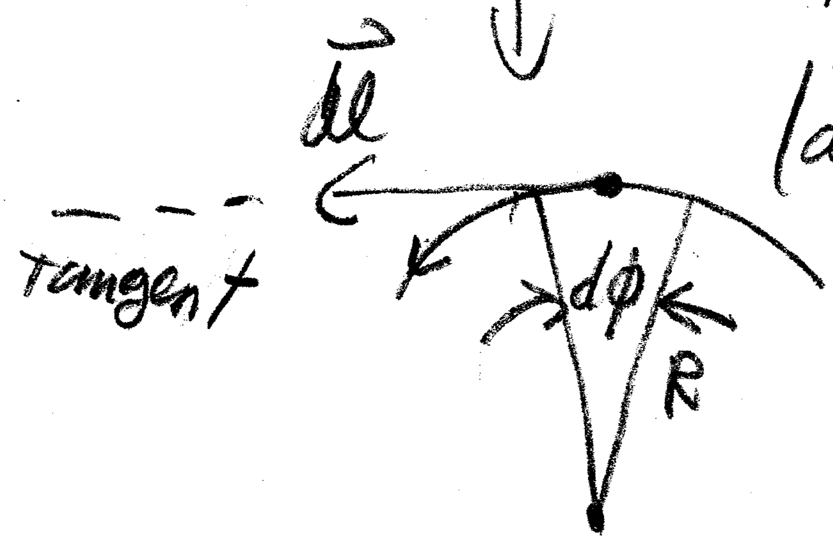
$d\vec{l}$ is tangent to line

$\vec{E}\cdot d\vec{l} = E\,dl\cos\theta$

CH 29, 30 Example when $\vec{B}$ is tangent TO CIRCULAR LOOP.



NOTE: $|\vec{B}|$ = constant on the loop.



$|\vec{dl}|$ = arc length = $R\,d\phi$

$$\vec{B}\cdot\vec{dl} = B\,dl\,\overbrace{\cos 0}^{1}$$

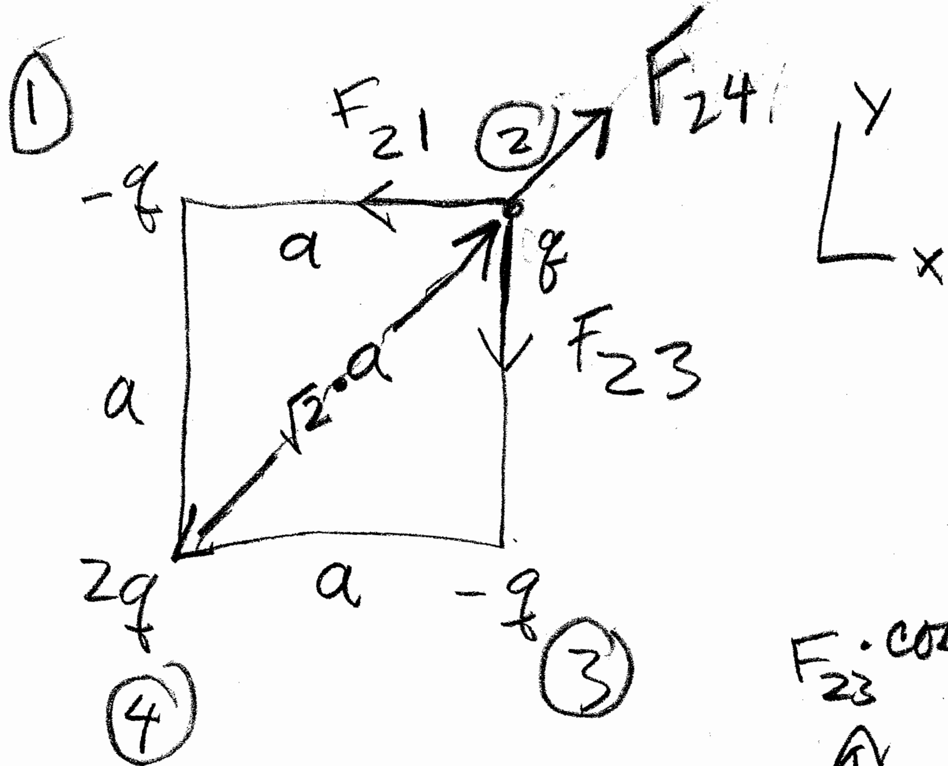
$$\oint_{LOOP} \vec{B}\cdot\vec{dl} = \oint B\,dl = B\oint dl$$

$$= B\oint R\,d\phi$$

$$= BR\int_0^{2\pi} d\phi = B\cdot R\cdot 2\pi$$

$$= B(2\pi R)$$

Sample T2, #2 (Fall 2000)



$F_{23} \cdot \cos(-90)$

(a)
(b)

$$F_{net_x} = F_{21_x} + F_{24x} + F_{23x}$$

$$= F_{21} \cdot \underbrace{\cos 180}_{-1} + F_{24} \cdot \cos 45 + 0$$

$$= -F_{21} + \frac{\sqrt{2}}{2} \cdot F_{24}$$

$$\cos 45 = \sin 45 = \frac{\sqrt{2}}{2}$$

$$F_{21} = \frac{k \cdot (q \cdot q)}{a^2} = \frac{kq^2}{a^2}$$

$$F_{24} = \frac{k (q \cdot 2q)}{(\sqrt{2} a)^2} = \frac{kq^2}{a^2}$$

$$F_{net_x} = -\frac{kq^2}{a^2} + \frac{\sqrt{2}}{2}\cdot\frac{kq^2}{a^2}$$

$$= \frac{kq^2}{a^2}\cdot\left[-1 + \frac{\sqrt{2}}{2}\right] < 0$$

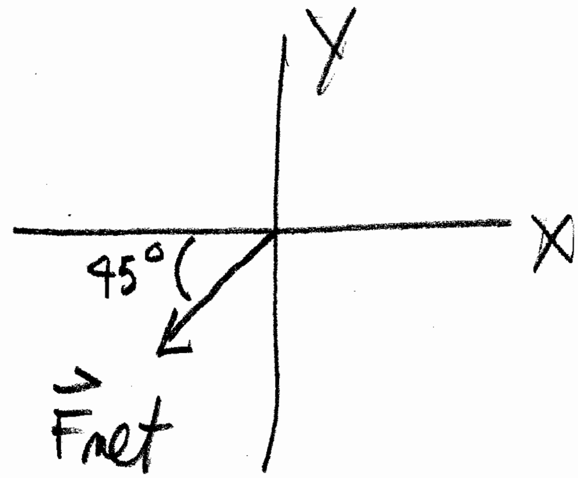
$$F_{net_y} = F_{21_y} + F_{24y} + F_{23}y$$

$$= F_{21}\cdot \sin 180 + F_{24}\cdot \sin 45 + F_{23}\cdot \sin(-90)$$

$$= 0 + \frac{\sqrt{2}}{2}\cdot F_{24} - F_{23}$$

$$F_{23} = \frac{kq^2}{a^2} \Rightarrow F_{net_y} = \frac{\sqrt{2}}{2}\cdot\frac{kq^2}{a^2} - \frac{kq^2}{a^2}$$

$$= \frac{kq^2}{a^2}\cdot\left[\frac{\sqrt{2}}{2} - 1\right] < 0$$



$$\left.\begin{array}{l} F_{net\,x} < 0 \\ F_{net\,y} < 0 \end{array}\right) \underline{\text{QUADRANT 3}}$$

and $|F_{net\,x}| = |F_{net\,y}|$

$$F_{net} = \sqrt{F_{net\,x}^2 + F_{net\,y}^2}$$

$$= \sqrt{\left(\frac{kq^2}{a^2}\right)^2 \left[1 + \frac{\sqrt{2}}{2}\right]^2 + \left(\frac{kq^2}{a^2}\right)^2 \cdot \left[\frac{\sqrt{2}}{2} - 1\right]^2}$$

$$= \frac{kq^2}{a^2} \cdot \sqrt{2 \cdot \left[\frac{\sqrt{2}}{2} - 1\right]^2}$$

$$F_{net} = \sqrt{2} \cdot \frac{kq^2}{a^2} \cdot \left(1 - \frac{\sqrt{2}}{2}\right)$$

$$\sqrt{\left(\frac{\sqrt{2}}{2} - 1\right)^2} = \sqrt{\left(1 - \frac{\sqrt{2}}{2}\right)^2} = \left(1 - \frac{\sqrt{2}}{2}\right)$$

$$F_{net} = 1.41 \cdot \frac{(9\times10^{9})(1\times10^{-9})^2}{(0.10)^2} \cdot (0.293)$$

$$= 3.7\times10^{-7}\ (N)$$

Sample T2 #3

$\lambda > 0$

$\uparrow qE$

$\downarrow mg$

$$\Sigma F_y = 0$$

$$\Rightarrow qE = mg$$

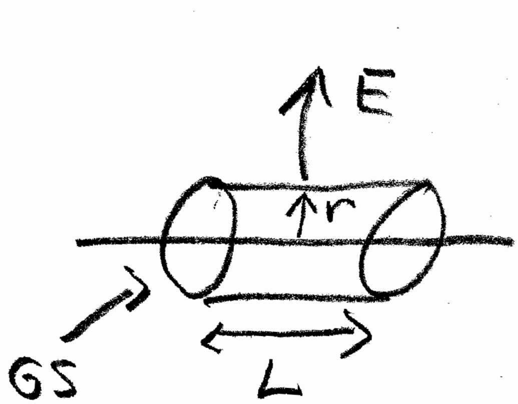
||| ——————————————— |||

(a) $m = ?$

FIND E

$$\int E\,dA\cos\theta = q_{encl}/\varepsilon_0$$

$$E(2\pi r \cdot L) = \frac{\lambda \cdot L}{\varepsilon_0}$$



$$\rightarrow E = \frac{\lambda}{2\pi\varepsilon r}$$

$$\Rightarrow qE = mg$$

$$\frac{q\cdot\lambda}{2\pi\varepsilon_0 r} = mg$$

$$\Rightarrow m = \frac{q\cdot\lambda}{2\pi\varepsilon_0\cdot g\cdot r}$$

plug in #5

$$m = \frac{(10^{-9})(1\times10^{-6})}{2\pi(8.85\times10^{-12})(9.8)(1.0)}$$

$$= (1.84\times10^{-3})\times10^{-3} = 1.84\times10^{-6}\,kg$$

$$= 1.84\,\mu g$$