Mar 30

Get clickers

Midterm is Wednesday
Practice exam is on website.

Gauss' Law

$$\underbrace{\oint \vec{E} \cdot d\vec{a}}_{\text{flux}} = \frac{Q_{in}}{\epsilon_0}$$

Ponderable: Gauss' Law exercises

Not Another Law!

Discussion: Gauss' Law for Magnetism

$$\oint \vec{B} \cdot d\vec{a} = 0$$

↳ no magnetic charges (monopoles)

no point sources for $\vec{B}$.

Ponderable: Outside the box

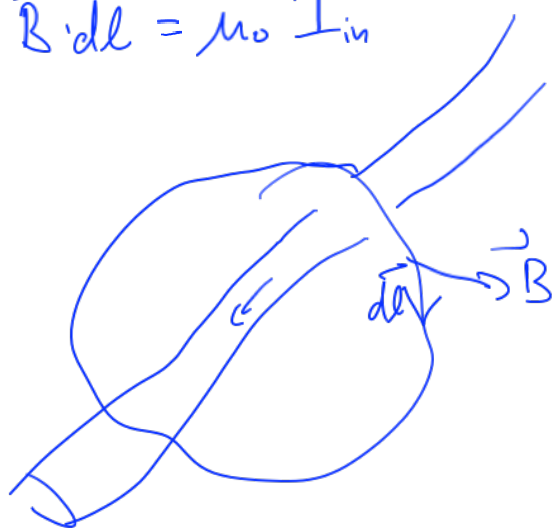
Reflux

$$\oint \vec{E} \cdot d\vec{a}$$

vector pointing out of volume

Discussion: Ampere's Law

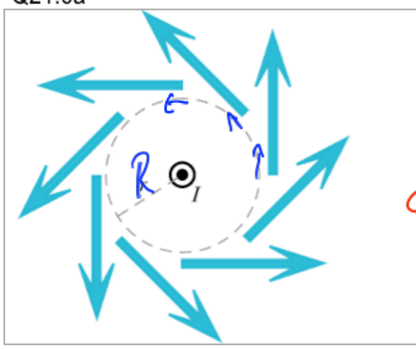
$$\oint \vec{B} \cdot \vec{dl} = \mu_0 I_{in}$$



Ponderable: Ampere's Law and EMField

Clickers: Ampere's Law

Q21.6a



R = 3 cm, B = 1e-5 T

What is I?

A) 0 A

B) 1.9e-1 A

C) 1.9e-6 A

D) 1.5 A

E) 19 A

$\oint \vec{B} \cdot \vec{dl}$

$= B \int dl$

$= B\, 2\pi R = \mu_0 I$

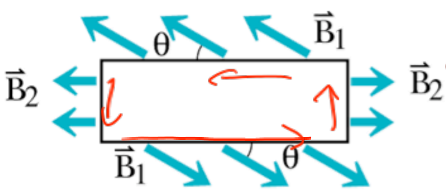
$I = \dfrac{2\pi R B}{\mu_0}$

$\mu_0 = 4\pi \times 10^{-7}$

$\oint \vec{B} \cdot \vec{dl} = \mu_0 I_{in}$

Q21.6b

$\theta = 30°$, B1 = 2e-4 T, B2 = 1e-4 T
Width = 0.5 m, Height = 0.2 m



What is $\oint \vec{B} \bullet d\vec{l}$?

A) 0 T·m
B) 8.7e-5 T·m
C) 1.7e-4 T·m
D) 2.0e-4 T·m
E) 2.1e-4 T·m

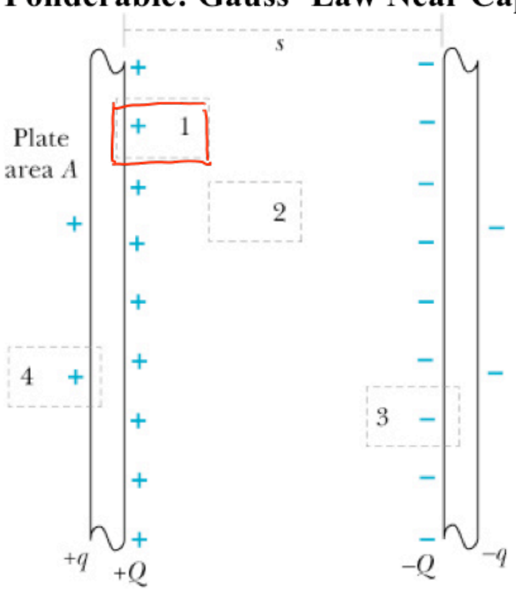
$$\oint \vec{B}\cdot d\vec{l} = \int_{bottom} \vec{B}\cdot d\vec{l} + \int_{right} \vec{B}\cdot d\vec{l} + \int_{top} \vec{B}\cdot d\vec{l} + \int_{left} \vec{B}\cdot d\vec{l}$$

$$= |B| W \cos\theta + 0 + |B| W \cos\theta + 0$$

$$= 2W|\vec{B}|\cos\theta$$

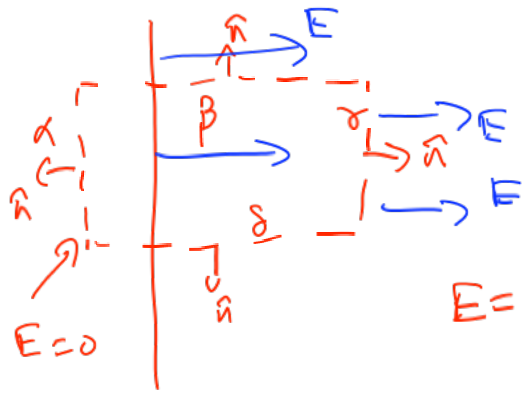
$$= 2 \times 0.5 \times 2e\text{-}4 \cos\theta = 1.7e\text{-}4\ T\cdot m$$

Ponderable: Gauss' Law Near Capacitor



Shoebox or cylinder

$$\oint \vec{E}\cdot\hat{n}\,da = \frac{q_{incl}}{\epsilon_0}$$



$$E = \frac{Q/A}{\epsilon_0}$$

$\int_\alpha \vec{E}\cdot\hat{n}\,da = 0 \Rightarrow$ no E inside conduct

$\int_{\beta,\delta} \vec{E}\cdot\hat{n}\,da = 0 \quad \vec{E}\cdot\hat{n} = 0 \quad \Big| \quad \int_\gamma \vec{E}\cdot\hat{n}\,da = EA = \frac{Q}{\epsilon_0}$

Tangible: Ampere's Law for Solenoid

$$\oint \vec{B}\cdot d\vec{l} = \mu_0 I$$

$$\int_{top} \vec{B}\cdot d\vec{l} + \overset{\vec{B}\cdot d\vec{l}=0}{\cancel{\int_{sides} \vec{B}\cdot d\vec{l}}} + \overset{\vec{B}=0}{\cancel{\int_{bottom} \vec{B}\cdot d\vec{l}}} = \mu_0 I$$

$$B\cdot L = \mu_0 I_{in}$$

$$= \mu_0 I N$$

$$B = \frac{\mu_0 N I}{L} = \mu_0 I (N/L)$$