Phys 132 2022

Review III

Thurs: Exam III

Covers Ch 29, 30, 31.6-31.7. Waves.

Lectures 20 → 31

HW 7, 8, 9

Bring - Previous two single side 3"x5" cards
- New single side 3"x5" card
- Calculator

Study - Previous exams
2017 Exam II Q5-Q8
2017 Exam III Q1 → Q3
2018 Exam III All Q.

Chapter 29 $\vec{B} = \frac{\mu_0}{4\pi} \frac{I \Delta\vec{s} \times \hat{r}}{r^2}$ $\vec{A} \times \vec{B}$ cross product rules

infinite wire $B = \frac{\mu_0}{2\pi}\frac{I}{r}$ loop center $B = \frac{\mu_0 I}{2r}$

solenoid $B = \mu_0 n I$.

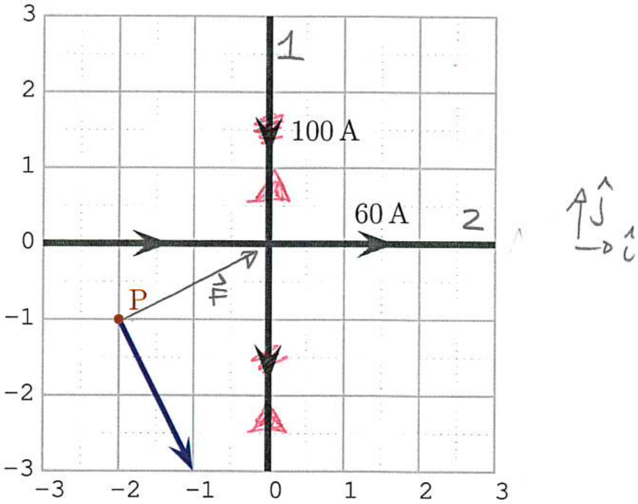
Dipole moment $\mu = IA$ plus direction. $\vec{\tau} = \vec{\mu} \times \vec{B}$

$\vec{F} = q\vec{v} \times \vec{B}$ $\vec{F} = I\vec{l} \times \vec{B}$ $F = \frac{\mu_0 l I_1 I_2}{2\pi d}$ parallel wires

Example Quiz 1 80%

197 Proton near two straight wires

Two infinitely long wires are oriented as illustrated and carry currents as illustrated. A proton is at the location labeled P and travels with velocity $6.0 \times 10^5\,\mathrm{m/s}$ in the illustrated direction. The grid units are 0.0010 m.



a) Determine the net magnetic field at P.

b) Determine the net force acting on the proton when it is at P.

Answer: a) $\vec{B} = \vec{B}_{\text{from }1} + \vec{B}_{\text{from }2}$

Then $\vec{B}$ from 1 is out $(+\hat{k})$

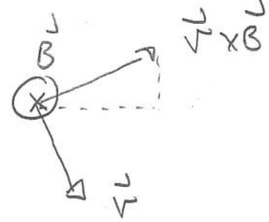
$\vec{B}$ from 2 is in. $(-\hat{k})$

The magnitudes are

$$B_1 = \frac{\mu_0 I_1}{2\pi r_1} = \frac{4\pi\times10^{-7}\,\mathrm{Tm/A}}{2\pi} \cdot \frac{100\,\mathrm{A}}{0.0020\,\mathrm{m}} = 0.010\,\mathrm{T}$$

$$B_1 = \frac{\mu_0 I_2}{2\pi r_2} = \frac{4\pi\times10^{-7}\,\mathrm{Tm/A}}{2\pi} \, \frac{60\,\mathrm{A}}{0.0010\,\mathrm{m}} = 0.012\,\mathrm{T}$$

$$\vec{B} = 0.010\,\mathrm{T}\,\hat{k} + 0.012\,\mathrm{T}\,(-\hat{k}) = 0.002\,\mathrm{T} \ \text{(into page)}$$



b) $\vec{F} = q\vec{v}\times\vec{B}$

$= e\vec{v}\times\vec{B}$

$F = evB\sin\theta = 1.6\times10^{-19}\,\mathrm{C} \times 6.0\times10^{5}\,\mathrm{m/s} \times 0.002\,\mathrm{T}\,\sin 90^\circ$

$= 1.9\times10^{-16}\,\mathrm{N}$. The direction is indicated in the diagram

<u>Example:</u> Quiz 2 → 30%

<u>Chapter 30.1 → 30.5, 30.7</u>

$$\Phi_M = \vec{A} \cdot \vec{B} = AB\cos\theta$$

$$|\mathcal{E}| = \left|\frac{d\Phi_M}{dt}\right|$$ Lenz's Law

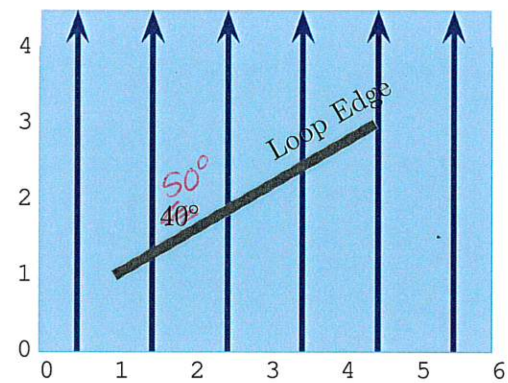
<u>Example:</u> Quiz 3 – 40% – 70%

198 Loop in a time-varying field

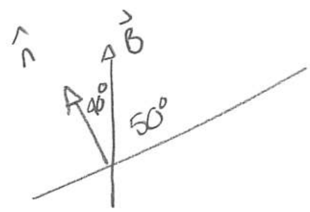
A square loop is placed in a region of uniform magnetic field. The loop axis lies in the plane of the page and one edge is visible. The sides of the loop are 30 cm long and the field varies with time according to

$$\vec{\mathbf{B}}(t) = \left(20\,\mathrm{T/s^2}t^2 - 20\,\mathrm{T/s^3}t^3\right)\hat{\mathbf{j}}.$$

Determine the EMF produced around the loop at $t = 1.0\,\mathrm{s}$.



$$\mathcal{E} = \left|\frac{d\Phi_m}{dt}\right|$$



$$\Phi_m = AB\cos\theta$$

$$= L^2 B \cos 40^\circ \quad \text{where } L = \text{length of side.}$$

$$= L^2\left[20\,\mathrm{T/s^2}\,t^2 - 20\,\mathrm{T/s^3}\,t^3\right]\cos 40^\circ$$

$$\frac{d\Phi_m}{dt} = L^2\left[2t\;20\,\mathrm{T/s^2} - 3t^2\;20\,\mathrm{T/s^3}\right]\cos 40^\circ$$

At $t = 1.0\,\mathrm{s}$ $$\frac{d\Phi_m}{dt} = (0.30\,\mathrm{m})^2\left[40\,\mathrm{T/s} - 60\,\mathrm{T/s}\right]\cos 40^\circ$$

$$= -1.38\,\mathrm{V}$$

$$\Rightarrow \quad \mathcal{E} = 1.4\,\mathrm{V}$$

Chapter 31.6 - 31.7, Waves

Meaning of wavelength, frequency $f = \frac{1}{T}$, $k = \frac{2\pi}{\lambda}$ $\omega = 2\pi f$

$v = \omega / k = \lambda f$

Use of $y(x,t) = A \sin(kx - \omega t + \phi)$

$I = P/A$, $I = \frac{1}{2} c \epsilon_0 E_0^2$ $I = \frac{P_{source}}{4\pi r^2}$

unpol inc. $I_{trans} = \frac{1}{2} I_0$

pol inc $I_{trans} = I_0 \cos^2 \theta$.

199 Traveling sinusoidal wave

A sinusoidal wave on a string is described by the displacement

$$y(x,t) = 5.0\,\mathrm{mm}\sin\left(5.0\,\mathrm{m}^{-1}x - 30\,\mathrm{s}^{-1}t + \pi/2\right).$$

A snapshot at $t = 0\,\mathrm{s}$ shows a crest, labeled A, at $x = 0\,\mathrm{m}$.

a) Determine the speed of the wave.

b) Determine the time taken for the crest A to reach the $x = 24\,\mathrm{m}$ mark.

a) This has the form $y = A\sin(kx - \omega t + \phi)$

where $k = 5.0\,\mathrm{m}^{-1}$

$\omega = 30\,\mathrm{s}^{-1}$

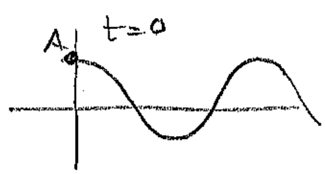
$\phi = \pi/2$

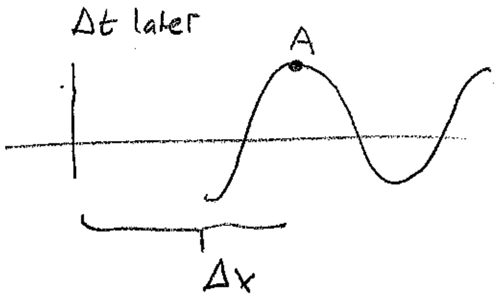
$A = 5.0\,\mathrm{mm}$.

Then $v = \omega/k = \dfrac{30\,\mathrm{s}^{-1}}{5.0\,\mathrm{m}^{-1}} = 6.0\,\mathrm{m/s}$.

b) Use $v = \dfrac{\Delta x}{\Delta t} \Rightarrow \Delta t = \dfrac{\Delta x}{v} = \dfrac{24\,\mathrm{m}}{6.0\,\mathrm{m/s}}$

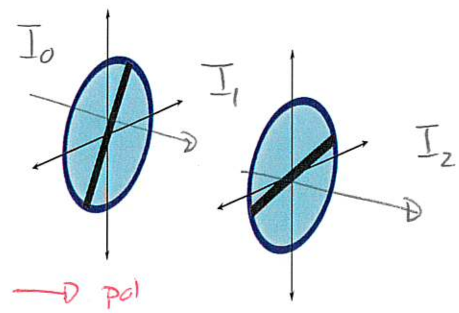
$= 4.0\,\mathrm{s}$

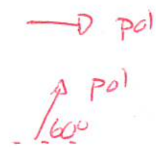




200 Two polarizers: incident light unpolarized

Horizontally polarized ~~Unpolarized~~ light with intensity I_0 is incident from the left on a polarizer, whose transmission axis 60° from the horizontal. This transmitted light is later incident on a second polarizer, whose transmission axis 15° from the horizontal. Determine an expression for the intensity of the light transmitted by the second polarizer (in terms of I_0).



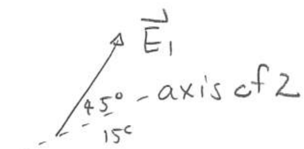


Answer: Let I_0 = Intensity of incident

I_1 = " after first

I_2 = " after second.

Then $I_1 = I_0 \cos^2 60°$



$$I_2 = I_1 \cos^2 (60° - 15°)$$

$$= I_0 \cos^2 (60°) \cos^2 45°$$

$$= I_0 \left(\frac{1}{2}\right)^2 \left(\frac{1}{\sqrt{2}}\right)^2$$

$$I_2 = \frac{1}{8} I_0$$