EXAM #3

Thin films	2	questions	16 questions "new" material
Mirrors/Lens	3	questions	
Refraction	3	questions	
E.M Waves	3	questions	
Faraday/Lenz	5	questions	
$\vec{B}$ fields (Sources, Forces)	5	questions	14 questions
DC Circuits	1	question	
E fields/Force/Gauss Voltage/P.E.	6	questions	
Heat Engines (Freezers, Heat pump)	2	questions	

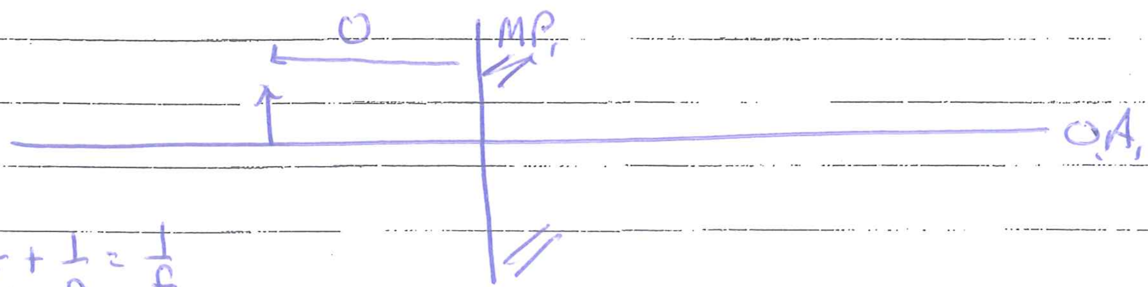
30 QUESTIONS.

From the Cue :

34.14 Convex Mirror $f = -12\,cm$

$h_i = \frac{1}{2} h_o$ *

Find object distance 'o'.



$f = -12\,cm$

$\boxed{1}$ $\frac{1}{i} + \frac{1}{o} = \frac{1}{f}$

$\boxed{2}$ $M = -\frac{i}{o}$

* $M = \frac{h_i}{h_o} = \frac{\frac{1}{2} h_o}{h_o} = \frac{1}{2}$

$\therefore \boxed{2} \Rightarrow \frac{1}{2} = -\frac{i}{o}$

$\therefore i = -\frac{o}{2}$ use this in eqtn. $\boxed{1}$.

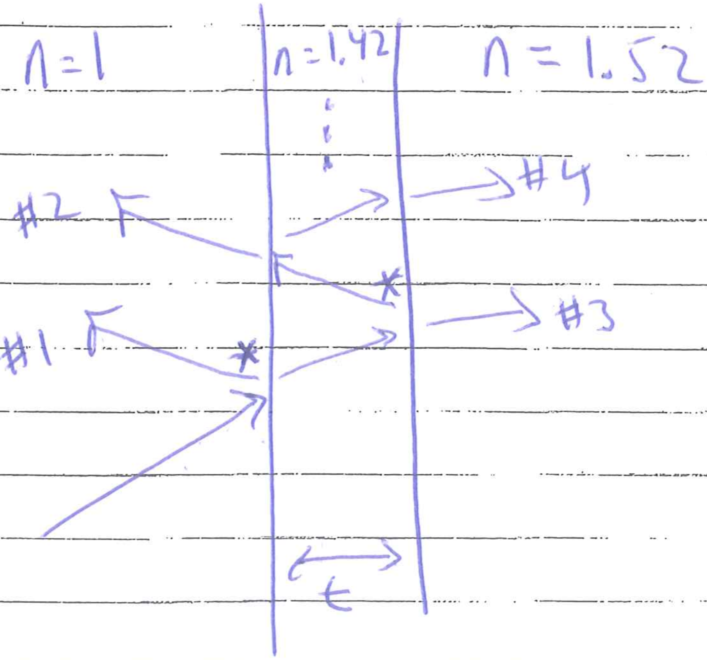
$\boxed{1} \Rightarrow -\frac{2}{o} + \frac{1}{o} = -\frac{1}{12}$

$\frac{-2+1}{o} = -\frac{1}{12}$

$\therefore o = +12\,cm$

These are NOT notes. They are a visual aid(20%) for a verbal explanation(80%). 3

35.23



$\lambda_{film} = \frac{650\,nm}{1.42} = 457.7\,nm$

- Reflection (#1, #2)
- Destructive
- 2 phase changes.

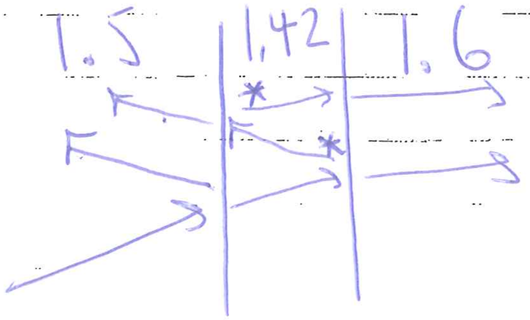
$\Delta L = \frac{\lambda}{2}, \frac{3\lambda}{2}, \frac{5\lambda}{2} \dots$ (?) "traditional"

$\Delta L = \frac{\lambda_{film}}{2}$ "Thinnest"

$2t = \frac{\lambda_{film}}{2}$

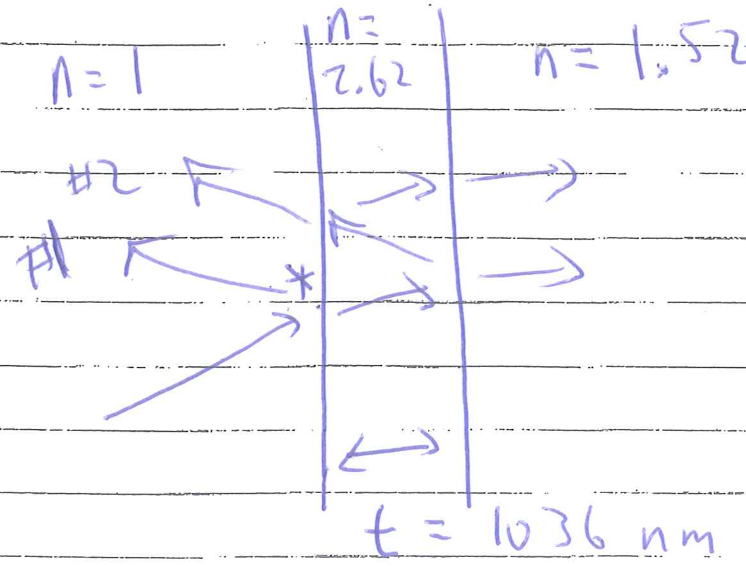
$t = \frac{\lambda_{film}}{4} = 114.4\,nm$ Answer.

1 phase change
#1, #2



2 phase changes
#3, #4

35.27



$\lambda_{film} = \frac{520\,nm}{2.62} = 198.5\,nm$

"increase thickness so that reflected light cancels"

- Reflection (#1, #2)
- Destructive
- 1 phase change

$\therefore \Delta L = 0, \lambda_{film}, 2\lambda_{film}, 3\lambda_{film}, \ldots$

$2t_1 = \lambda_{film}$

$\therefore t_1 = \frac{\lambda_{film}}{2} = 99.24$

$\vdots$

$2t_{10} = 10\lambda_{film}$

$t_{10} = 10\left(\frac{\lambda_{film}}{2}\right) = 992.4$

$2t_{11} = 11\lambda_{film}$

$t_{11} = 11\left(\frac{\lambda_{film}}{2}\right) = 1091.64$

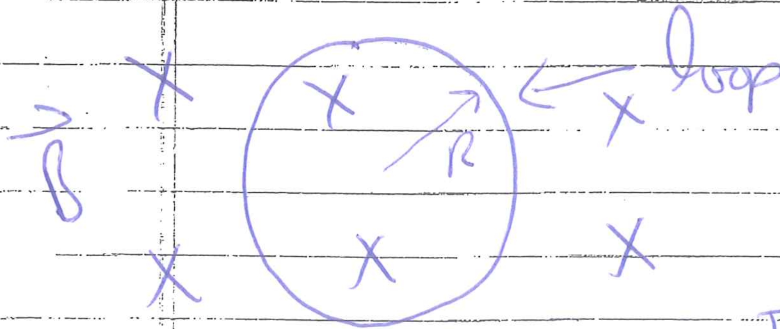
ANSWER

$\underbrace{1091.64 - 1036}$

55.64 nm needs to be added :)

29.9) Wire loop in presence of a uniform, constant $\vec{B}$.

$|\vec{B}| = 0.5$ tesla $\boxed{\text{IN}}$



[Circumference of loop is decreasing @ a rate of 0.12 m/s.]

[At t=0, circumference is 1.65 meters]

Find |induced voltage| 9 seconds after the loop begins to shrink and direction of current.

$$\Phi_B = \int \vec{B}\cdot d\vec{A} = \int |\vec{B}||d\vec{A}|\cos(0) = |\vec{B}| \underbrace{\int |d\vec{A}|}_{\pi r^2}$$

function of time!!

$$\left| \Delta V \right| = \left| -\frac{d\Phi_B}{dt} \right| = \pi B \frac{d}{dt}\left(r(t)^2\right)$$

$$= \left| \pi B\, 2r \frac{dr}{dt} \right|$$

Aside:

$$C = 2\pi r$$

$$\frac{dC}{dt} = 2\pi \frac{dr}{dt}$$

$\frac{dc}{dt}$ is Given !!

$$\therefore \frac{dr}{dt} = \frac{1}{2\pi}\frac{dc}{dt} = \frac{1}{2\pi}(0.12)$$

$$|\Delta V| = \left|\pi B 2 \left(\frac{0.12}{2\pi}\right) r\right|$$

@ 9 seconds? @ 9 seconds?

Aside: $C(t) = C_0 - 0.12(t)$

$$C(t=9) = 1.65 - 0.12(9) = 0.57$$

$$\therefore 2\pi r\big|_{t=9} = 0.57$$

$$r\big|_{t=9} = \frac{0.57}{2\pi}$$

Yea!!

$$|\Delta V| = \left|\pi B 2 r\big|_{t=9} \frac{dr}{dt}\right| = 5.46 \times 10^{-3} \text{ volts}$$

Answer.

I is clockwise (Lenz)

29.58 Circular ring in x-y plane

$r_0 = 0.042$ m.

$$\vec{B} = B_0\left(1 - \frac{3t^2}{t_0^2} + \frac{2t^3}{t_0^3}\right)\hat{k} \quad \Bigg\| \quad t_0 = 0.01 \text{ seconds}, \quad B_0 = 0.08\ T$$

Flux through the loop is

$$\Phi_B = \int \vec{B}\cdot d\vec{A} = \int B_0\left(1 - \frac{3t^2}{t_0^2} + \frac{2t^3}{t_0^3}\right) dA\ \hat{k}\cdot\hat{k}$$

$d\vec{A}$: $\boxed{+\hat{k}}$ or $\cancel{-\hat{k}}$

Answer (a)

$$\Phi_B = B\left(1 - \frac{3t^2}{t_0^2} + \frac{2t^3}{t_0^3}\right)\underbrace{\int dA}_{\pi r_0^2} = \pi B r_0^2\left(1 - \frac{3t^2}{t_0^2} + \frac{2t^3}{t_0^3}\right)$$

(b)

$$\Delta V = -\frac{d\Phi_B}{dt} = -\pi r_0^2 B\left(-\frac{6t}{t_0^2} + \frac{6t^2}{t_0^3}\right)$$

$$\Delta V\Big|_{t=5\times10^{-3}} = ☺$$

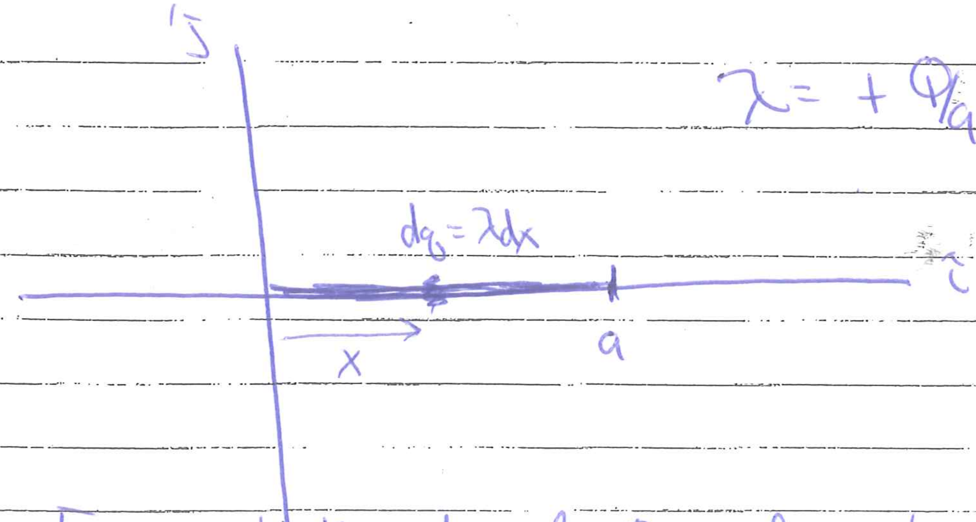
Polarity??

$$\left.\frac{d\vec{B}}{dt}\right|_{t=5\times10^{-3}} = -12 \frac{\text{tesla}}{\text{second}}$$

$$\vec{B}\Big|_{t=5\times10^{-3}} = +0.04\ \hat{k}$$

21.79

$\lambda = +Q/a$ coulombs/meter



a.) Find E on both sides of the line charge (x-axis)

for $x > a$ (to right)

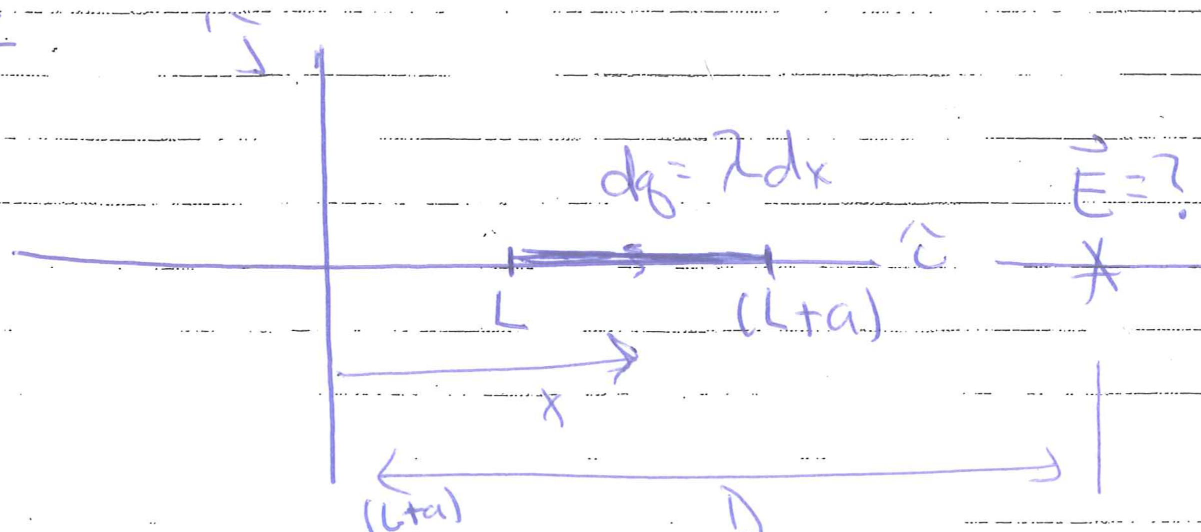
$|d\vec{E}| = \frac{k|dq|}{r^2}$

$$d\vec{E} = \frac{k\,dq}{x^2}\,\hat{i}$$

$|\vec{E}_{pt\,ch.}| = \frac{k|q|}{r^2}$ radial into out of

$$\int d\vec{E} = \int \frac{k\,dq}{x^2}\,\hat{i}$$

$$\vec{E} = k\lambda \int_0^a \frac{dx}{x^2}\,\hat{i} \Rightarrow$$ SET UP INTEGRALS YOU CAN DO !!!!



$$\int |d\vec{E}| = \int_L^{(L+a)} \frac{k|dq|}{(D-x)^2}$$

EM waves

$$\vec{S} = \frac{1}{\mu_0}\vec{E}\times\vec{B}$$

in +x direction

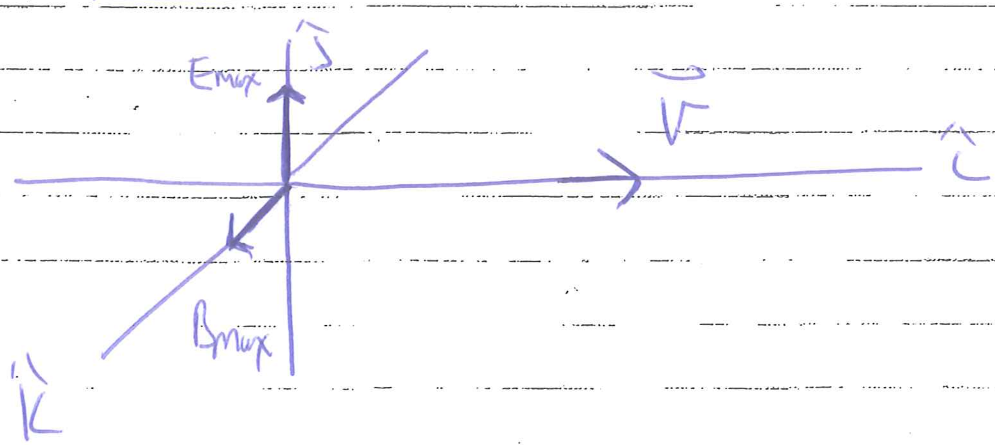
$$\vec{E}(x,t) = E_{max}\cos(kx - \omega t)\ \hat{j}\ (\text{or } \hat{k})$$

wave propagates along x-axis

$$\boxed{E(z,t) = E_{max}\cos(kz + \omega t)}$$

along z-axis

in (−z) direction



Ampere: $\oint \vec{B}\cdot d\vec{\ell}$ path integral