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# Midterm 2: Physics 2

① ⓐ - If the current in coil 1 increases, then the direction in coil 2 will be counterclockwise.

- If the current in coil 1 decreases, then the direction in coil 2 will be clockwise.

ⓑ

- If the current in the wire increases, the direction will go counterclockwise.
- If the current in the wire decreases, the direction will go clockwise.

② ⓐ When the switch is closed, coil 1's current will go counterclockwise.

- If closed for a long time, there will be no current.
- If opened, it will go clockwise.

Ⓑ For coil 2,

→ First closed: direction → counterclockwise

→ closed long time: no direction b/c no current

→ just opened: direction → clockwise

Ⓒ For coil 3,

→ first closed: direction → none

→ closed long time: no direction

→ just opened: no direction

③ $$\frac{\Delta\Phi}{\Delta t} = \frac{T \cdot m^2}{s} = \frac{\frac{N}{C \cdot m/s} \cdot m^2}{s} = \frac{N \cdot s \cdot m^2}{C \cdot m \cdot s} = \frac{N \cdot m}{C} = \frac{J}{C} = \text{Volts} \checkmark$$

④

Ⓐ $$EMF = \frac{-1\,2\left[\pi\left(\frac{2.20}{2}\times10^{-2}\right)^2\right]\cos(0)}{0.25s}$$

$$= -3.04\times10^{-3}\ V$$

(b) $I = \dfrac{3.04 \times 10^{-3} V}{0.01 \Omega}$

$= 0.304 A$

(c) $P = 0.304 A * (3.04 \times 10^{-3} V)$

$= 9.2 \times 10^{-4} W$

(5) $emf = \dfrac{-\Delta \Phi}{\Delta t}$

$\Phi = \vec{B} \cdot \vec{A}$

$\Delta \Phi = \vec{B} \cdot \Delta \vec{A} \rightarrow \Delta \Phi = \vec{B} \cdot (\vec{v} \cdot \Delta \vec{l}) =$

$(\vec{B} \cdot \vec{v}) \cdot \Delta \vec{l} = (Bv\cos\theta) \cdot \Delta l$

$\rightarrow \Delta \Phi = (Bv\cos\theta)(v\Delta t) = Bv^2\cos\theta \cdot \Delta t$

$\rightarrow emf = \dfrac{-\Delta \Phi}{\Delta t} = -(-Bv^2\cos\theta) = Bv^2\cos\theta$

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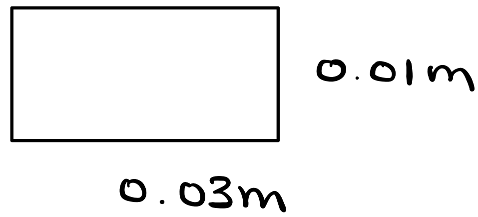
a




$$N = \frac{18.0\,V}{(3\times10^{-4}\,m)(0.64\,T)(1875\,rad/s)}$$

$0.01 \times 0.03 =$

$3 \times 10^{-4}$

$N = 50$ turns

b

$$T = \frac{2\pi}{1875\,rad/s}$$

$= 3.35 \times 10^{-3}$ seconds

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$$\frac{N_p}{N_s} = \frac{240\,V}{120\,V} = 2$$

b

$$\frac{I_p}{I_s} = \frac{120\,V}{240\,V} = \frac{1}{2}$$

c One would need to plug in the output of one, and it would become the input for the other.

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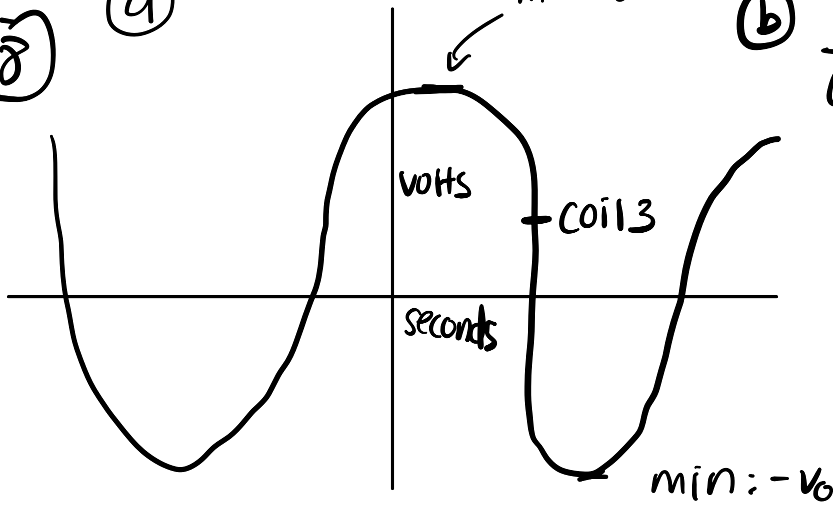
(a)




(b) $\frac{1}{6} V_0 \sin(\omega t)$

(c) $V(t)=0$ when sine wave crosses the x-axis

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$$\Delta t = \frac{(2\times10^{-3}\ H)(0.100A)}{500\ V_{emf}}$$

$$\Delta t = 4\times10^{-7}\text{ seconds}$$

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(a)

$$EMF = 25H\left(\frac{100A}{8.0\times10^{-2}s}\right)$$

$$= 3.13\times10^{4}\ V$$

(b)

$$E = \frac{1}{2}(25\ H)(100A)^2$$

$$= 1.25\times10^{5}\ J$$

(c)

$$P = \frac{1.25\times10^{5}J}{8.0\times10^{-2}s} = 1.56\times10^{6}\ W$$

(d)

(11)

(a) $5\times10^6\,\Omega(20\times10^{-9}\,s)=L$

$L = 0.1\ H$

(b)

$$R=\frac{0.1\ H}{1\times10^{-9}\,s}$$

$$=1\times10^{8}\ \Omega$$

(c)

$$I\,(3.00\,ns)=I_0\times\left(1-e^{-\frac{3.00\times10^{-9}}{1.00\times10^{-9}}}\right)$$

$$=I_0\times(1-e^{-3})$$

$$=\frac{I\,(3.00\,ns)}{I_0}$$

(d)

$$X_L=2\pi\times10{,}000\ Hz\times100\,H$$

$$=2\pi\times10^{6}$$

$$=6.3\times10^{6}\ \Omega$$

(12) (a)

$$L = \frac{2\times10^3\ \Omega}{2\pi(15\times10^3\ Hz)} =$$

$$2.1\times10^{-2}\ H$$

(b)

$$X_L = 2\pi(60\ Hz)(2.1\times10^{-2})$$
$$= 7.92\ \Omega$$

(13)

I don't know :(

(14) (a)

$$f_0 = \frac{1}{2\pi\sqrt{(10\times10^{-3}H)\times(1\times10^{-6}F)}}$$

$$= \frac{1}{2\pi\times10^{-4}}$$

$$= \frac{10^4}{2\pi}$$

$$= 1591.6\ Hz$$

$$\Delta f = \frac{1\times10^2\ \Omega}{2\pi(10\times10^{-3}H)}$$

$$= 15.9\ Hz$$

$$\frac{15.9\ Hz}{1591.6\ Hz} = 9.9\times10^{-3}$$

(b)

$$X_L = 2\pi\times\frac{0.1}{10}\times10\times10^{-3}$$

$$= 0.2\pi\ \Omega$$

$$X_C = \frac{1}{2\pi \times 0.1 \times \frac{1}{10_4}}$$

$$= \frac{1}{2\pi \times 10^{-3}} = 1000\,\Omega$$

$$Z = \sqrt{(1\times 10^2)^2 + (0.2\pi - 1000)^2}$$

$$\sqrt{10{,}000 + (0.2\pi - 1000)^2}$$

$$= 100\,\Omega$$

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$f = 10 f_0 = 10 \times 15.92\,Hz = 159.2\,Hz$

$X_L = 2\pi \times 159.2 \times 0.05 = 50.24\,\Omega$

$X_C = \frac{1}{2\pi \times 159.2 \times 8 \times 10^{-5}} = 19.86\,\Omega$

$Z = \sqrt{200^2 + (50.24 - 19.86)^2}$

$= 202.24\,\Omega$

$I_{rms} = \frac{120}{202.24} = 0.6\,A$

$P_{rms} = (0.6A)^2 \times 200$

$= 72\,W$

$f_0 = 0.1 \times 15.92\,H_z = 1.592\,H_z$

$X_L = 2\pi \times 1.592 \times 0.05 = 0.5\,\Omega$

$X_C = \frac{1}{2\pi \times 1.592 \times 8 \times 10^{-5}} = 124.97\,\Omega$

$Z = \sqrt{200^2 + (0.5 - 124.97\,\Omega)}$

$= 235.68\,\Omega$

$I_{rms} = \frac{120}{235.68} = 0.509\,A$

$P_{rms} = (0.509)^2 \times 200 = 51.9\,W$

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(a) $f_{USB} = 1.4 \times 10^6 \, Hz + 10^4 \, Hz$

$= 1.41 \times 10^6 \, Hz$

$f_{LSB} = 1.4 \times 10^6 \, Hz - 10^4 \, Hz$

$= 1.39 \times 10^6 \, Hz$

LSB $= 1.39 \times 10^6 \, Hz$

carrier $= 1.4 \times 10^6 \, Hz$

USB $= 1.41 \times 10^6 \, Hz$

(b) If we want to recover the audio signal, we need to increase the resistance of the receiver circuit.

2: Unit 5: Waves, Optics, Medical Physics

① a) $\frac{d\Phi_E}{dt} = \frac{2 \times 10^{-11} C}{2 \times 10^{-6} s} = 100 \text{ A/s}$

$B = \frac{(4\pi \times 10^{-7} T \cdot m/A) \times 8.85 \times 10^{-12} C^2/N \cdot m^2) \cdot 100 \text{ A/s}}{2\pi \times 0.01 m}$

$B = 1.77 \times 10^{-16} T$

b) $I_d = (8.85 \times 10^{-12} C^2/N \cdot m^2) \cdot 100 \text{ A/s}$
$= 8.85 \times 10^{-10} A$

②

ⓐ $\frac{(10 \cdot 10^{-6} s)(3 \times 10^8 m/s)}{2}$

$= 1.5 \times 10^3 m$

ⓑ $\lambda = \frac{3 \times 10^8 m/s}{1 \times 10^8 Hz}$

$= 3 \text{ m}$

$\frac{\lambda}{2} = 1.5$ meters

(c) $\frac{\sigma}{4\pi} = \frac{1}{4\pi}$

(d) $P_{recieved} = \frac{P_{transmitted} \cdot A_{transmitted} \cdot A_{recieved} \cdot \text{Reflection coeff}}{4\pi\, d_2}$

$= \frac{100\,W \cdot 1 \cdot 1 \cdot \frac{1}{4\pi}}{4\pi(1.5 \times 10^3)}$

$= \frac{7.957}{18{,}849.5}$

$= 4.22 \times 10^{-4}\ W$

(3)

(a) $\text{Intensity} = \frac{1000\,W}{10 \times 10^{-4}\,m^2}$

$= 10^5\ W/m^2$

(b) $\frac{1m}{3 \times 10^8\,m/s} = \text{time}$

$\text{time} = 3.3 \times 10^{-9}\,s$

(c)

$$E_{peak} = \sqrt{\frac{2 \times 10^5 \ W/m^2}{8.85 \times 10^{-12} F/m \times 3 \times 10^8 m/s}}$$

$$= \sqrt{7.91 \times 10^{15}}$$

$$= 8.9 \times 10^7 \ V/m$$

(d)

$$\text{Intensity} = \frac{10^5 \ W/m^2}{2^2}$$

$$= \frac{10^5}{4} \ W/m^2$$

$$= 2.5 \times 10^4 \ W/m^2$$

(5)

(a) $$\frac{n_{snow}}{n_{ice}} = \frac{1.33}{1.31}$$

$$= 1.02$$

(b) $1.33 \sin(30°) = 1.31 \sin(x)$

$$\sin(x) = \frac{1.33}{1.31} \sin(30°)$$

$$= \frac{1.33}{1.31} \times 0.5$$

$$= 0.507$$

$$x = \sin^{-1}(0.507)$$

$$x = 30.9°$$

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(a) thin lens formula:

$$\frac{1}{d_i} + \frac{1}{d_o} = \frac{1}{f}$$

$$m = \frac{d_i}{d_o}$$

$$d_i = -md_o$$

$$\frac{1}{-md_o} + \frac{1}{d_o} = \frac{1}{f}$$

$$\frac{1}{md_o} = \frac{1}{d_o} - \frac{1}{f}$$

$$= \frac{f - d_o}{fd_o}$$

$$md_o = \frac{fd_o}{f - d_o}$$

$$m = \frac{f_o}{f - d_o}$$

(b) When we set the denominator to zero, then we find $f - d_o = 0 \rightarrow d_o = f$. This means that the object distance is the same length to the focal length, and the magnification is infinite.

(c) The image distance is infinite, and therefore, the image forms an infinity.

4 was skipped → this is 4

(a) $n_1 \sin(\theta_1) = n_3 \sin(\theta_3)$

$\sin(\theta_1) = \sin(\theta_3)$

$\theta_1 = \theta_3$ shows that the angles of incidence and refraction are equal

(b) $\frac{1}{15.0} = \frac{1}{13.5} + \frac{1}{d_i} \rightarrow \frac{1}{d_i} = \frac{1}{15.0} - \frac{1}{13.5}$

$\frac{1}{d_i} = \frac{13.5 - 15.0}{13.5 \times 15.0} \rightarrow \frac{1}{d_i} = \frac{-1.5}{202.5} \rightarrow \frac{1}{d_i} = -\frac{1}{135}$

$d_i = -135\,cm$

(c) 135 cm from the lens

(d) $m = \frac{-135}{13.5} \rightarrow m = -10$

(e) size of image $= -10 \times 1.0\,cm$

$= -10\,cm$

the size of the image of the 1.0 cm diameter ear hole is 10 cm

(7) (a) $\mu = \frac{200 \times 10^{-24}}{11340 \times 6.022 \times 10^{23}}$

$= 2.938 \times 10^{-4}\,m^{-1}$

$e^{-2.938 \times 10^{-4} \times 0.01}$

$= 0.999$

99.9% of xrays pass through the vest

(b) $\frac{1}{2} = e^{-2.938 \times 10^{-4} x}$

$\ln\left(\frac{1}{2}\right) = \ln\left(e^{-2.938 \times 10^{-4} x}\right)$

$= -2.938 \times 10^{-4} x$

$x = -\frac{\ln\left(\frac{1}{2}\right)}{2.938 \times 10^{-4}}$

$= 2362.6\,m$

(8) $\mu = \dfrac{1\times10^{-24}}{11340\times6.022\times10^{23}}$

$= 1.469\times10^{-31}\ m^{-1}$

$\frac{1}{2} = e^{-1.469\times10^{-31}x}$

$\ln(\frac{1}{2}) = \ln(e^{-1.469\times10^{-31}x})$

$= -1.469\times10^{-31}x$

$x = -\dfrac{\ln(\frac{1}{2})}{1.469\times10^{-31}}$

$= 4.723\times10^{30}\ m$

(10)

(a)

$\dfrac{250\times10^{-3}\ J}{60\ kg} = 4.167\times10^{-3}\ Gy$

(b)

$\dfrac{250\times10^{-3}\ J}{2.0kg} = 0.125\ Gy$