midterm 2 - physics Unit 4

9) $emf = -L \frac{\Delta I}{\Delta t}$

$emf = 500V$
$L = 2\times10^{-3}H$
Δt = time in (s)

$$\Delta t = -\frac{(2\times10^{-3}H)(0.100A)}{500} = -4\times10^{-7}s$$

$\boxed{\Delta t = 4\times10^{-7}(s)}$

12) $X_L = 2\pi f L$
a) $X_L = 2\times10^3\ \Omega$
$f = 15\times10^3\ Hz$

$$L = \frac{2\times10^3\ \Omega}{(2\pi)(15\times10^3)} = 21.24mH$$

b) $f = 60.0Hz$
$L = 21.24mH = 21.24\times10^{-3}$
$X_L = (2\pi)(60)(21.24\times10^{-3})$
$= \boxed{25.316\ \Omega}$

6a) $E_{peak} = 18V$, $A = 3\times10^{-4}\ m^2$, $B = 0.640T$,
$w = 1875\ rad/s$

$$N = \frac{18}{(3\times10^{-4}m^2)(0.640)(1875)}$$

b) $T = 2\pi/w$ OR $2\pi/1875$

1/2/4/5/13

3) $\varepsilon = -\frac{d\Phi}{dt}$ } rate of change of magnetic flux over time.

$= \frac{\Delta\Phi}{\Delta t}$ } webers per second (wb/s)

now we can conclude that represents the rate of change of magnetic flux = induced voltage, measured in Volts

7a) $\frac{N_1}{N_2} = \frac{V_1}{V_2}$ (using 240V to 120V)

$\frac{N_1}{N_2} = \frac{240V}{120V} = 2$ So, it's a 2:1 ratio

7b) $P_{input} = P_{output}$

$P = VI$

$\frac{I_1}{I_2} = \frac{V_2}{V_1} = \frac{120V}{240V} = \frac{1}{2}$ the output current is 1:2

7c) The NZ would need to plug in the transf. into a 120V outlet. Then they would plug their 240V appliances into the transformer. The transformer converts 120V input from the U.S. 240V outlet. It's then safe to use

1) Coil 2 is opposite of coil 1
coil 1 increases
coil 2 decreases

2) There's no current when it's closed
when open, coil 2 decreases

b) ~~no~~ There's no current closed, when
open, coil 1 decreases

c) There's no current when closed. When
open, coil 2 decreases

4) $\Delta B = B_f - B_i = 2 - 0 = 2$

$$EMF_i = \frac{-12(\pi(\frac{4}{2}\times10^{-2})\cos(\theta)}{0.28}$$

a) $-3.04 \times 10^{-3} V$

5) $\Phi \vec{B} \cdot \vec{A}$

$$\frac{\Delta\Phi}{\Delta t} = \frac{d\Phi}{dt} = \frac{d(Bl)}{dt}$$

$$eMF = -\frac{d(Bl)}{dt} = -B\frac{dl}{dt}$$

$$V = \frac{dl}{dt} = \cancel{S}\ V \cdot \sin\theta$$

$$EMF = -B(v\sin\theta) = Blv\sin\theta$$

13) $X_c = \frac{1}{2\pi fC} =$

$V_{in} - iR - V_{out} = 0$

$V_{out} - \cancel{?}\ I X_C = 0$

$$X_C = \frac{1}{2\pi(100 \times 2\pi RC)} = R$$

$$\frac{10R}{10R + R} = \frac{10}{11}$$

$$X_C = \frac{1}{2\pi(0.1 \times 2\pi RC)} = 10R$$

16) $f_{carry} = 1.4\,Hz$

$f_{upper} = f_c + f_a = 1.4 + 10$

$f_{lower} = f_c - f_a = 1.4 - 10\,kHz$

Unit 5: waves, optics, medical physics

1a) $I = \frac{\Delta Q}{\Delta t} = \frac{200 \times 10^{-9} C}{2 \times 10^{-6} s} = 0.1 A$

$B \times (2\pi \times 0.01m) = (4\pi \times 10^{-7} T \cdot m/A)(0.1A)$

$B = \frac{(4\pi \times 10^{-7})(0.1A)}{(2\pi)(0.01m)} = 2 \times 10^{-4} T = 0.2mT$

b) The charge current of the capacitor is responsible. It's not a direct (DC) flow but it's a current flow that generates a mag field.

2a) $10 \mu s \rightarrow 2 \times 10 \mu s = 20 \mu s$

speed of pulse is speed of light $= 3 \times 10^8 m/s$

$d = v \times t$

$d = (3 \times 10^8 m/s)(20 \times 10^{-6} s)$

$d = 6000 m$

2b) $\lambda = \frac{v}{f}$ $\quad v = (3 \times 10^8 m/s)$

$\quad f = (100 \times 10^6 Hz)$

$\lambda = \frac{3 \times 10^8 m/s}{100 \times 10^6 Hz} = 3m \quad 3m/2 = 1.5m$

2c) $P_{received} = \frac{P_{transmitted}}{(distance)^2} = \frac{100}{(150)^2} = 0.0044W$

2d)

3a) $I = \frac{P}{A} = \frac{1000}{0.001} = 1 \times 10^6 \text{ W/m}^2$

$t = d/c = 1/3 \times 10^8 = 3.33 \times 10^{-9}$

3b) $E_{peak} = \sqrt{\frac{2I}{c \cdot \epsilon}} = \sqrt{\frac{2(1 \times 10^6)}{(3 \times 10^8)(8.85 \times 10^{-12})}} =$

274.5 V/m

3c) $I_2 = I_1 \left(\frac{r_1}{r_2}\right)^2$

$I_2 = 1 \times 10^6 \left(1/2\right)^2 = 2.5 \times 10^5 \text{ W/m}^2$

4a)

4b)

4c)

4d)

5a) $n = \frac{c}{v}$ $\frac{v_{ice}}{v_{snow}} = \frac{c}{c} = 1$ the speed of light in ~~s~~ ice is the same as the speed of light in snow.

5b) $n_1 \sin(\theta_1) = n_2 \sin(\theta_2)$

$\theta_1 = 30^\circ$ $(n_{ice} / n_{snow}) = 1$

$n_{ice}/n_{snow} = 1$, $n_{ice} = n_{snow}$

$\sin(30^\circ) = \sin(\theta_2)$

$\theta_2 = \sin^{-1}(\sin(30^\circ))$

$\theta_2 = 30^\circ$ so the transmitted angle is also 30°

6a) $\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$

$m = \frac{h_i}{h_o} = -\frac{d_i}{d_o} = m = \frac{f}{f-d_o}$

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

6b) want $f-d_o$ to approach 0, when $d_o = f$

$m \to \infty$ when the object is placed at = focal length when $d_o = f$

6c) $\frac{d_o = f}{\cancel{d}f - d_o} = 0$ $\Big\}$ this approaches ∞

d_i also goes to infinity. The image is upright and highly magnifide.

7) $I = I_0 e^{-\mu x}$

$\mu = \frac{\sigma}{N_A \rho}$ $\quad N_A = 6.022 \times 10^{23}$ atoms/mol

200 barns $= 2 \times 10^{-23} cm^2$

density $= 11.34\ g/cm^3$

$$\mu = \frac{2 \times 10^{-23}\ cm^2}{(6.022 \times 10^{23}\ atoms/mol)(11.34\ g/cm^3)}$$

$\mu = 2.77 \times 10^{-3}\ cm^{-1}$

$I = I_0 e^{-\mu x}$

$I = I_0 e^{-2.77 \times 10^{-3}} = 0.9972$ OR 99.72%

$\frac{1}{2} = e^{-\mu x} \quad \ln(\frac{1}{2}) = \ln(e^{-\mu x})$

$\ln(1/2) = -\mu x$

$x = \frac{\ln(2)}{2.77 \times 10^{-3}} \approx \boxed{250.1\ cm}$

8) $\mu \propto \sigma$ If $\sigma_\gamma = 1$ barn then

$\frac{1}{200} \times \mu$

$x_\gamma = \frac{\ln(2) \times 200}{2.77 \times 10^{-3}} = 50040$ cm OR 500.4 m

9) number of half lives $= \frac{\text{total time}}{\text{Half-time}}$

$n = \frac{1 \text{ hour}}{611 \text{ seconds}} \times \frac{3600 \text{ sec}}{1 \text{ hr}} = 5.892$

fraction $= \left(\frac{1}{2}\right)^n \rightarrow (1/2)^{5.892} = 0.0240$

OR 2.40% of neutrons remaining after 1 hour.

10a) $\text{Dose (rads)} = \frac{\text{energy deposited (J)}}{\text{Mass (kg)}}$

$250 \text{ mJ} = 250 \times 10^{-3} \text{ J} = 0.25 \text{ J}$

$\frac{0.25 \text{ J}}{60 \text{ kg}} = 0.00417 \text{ J/kg}$

10b) 2.0kg of tissue

$\text{Dose (rads)} = \frac{0.25 \text{ J}}{2.0 \text{ kg}} = 0.125 \text{ J/kg}$

10c) a dose of 0.125Sv is a low dose. However, long exposure overtime might increase risk of radiation related health issues.