e

1) Voltage across top resistor: $\Delta V = IR = (3\text{ A})(12\ \Omega) = 36\text{ V}$

Voltage across bottom resistor: $P = \Delta VI \Rightarrow \Delta V = \frac{P}{I} = \frac{12\text{ W}}{3\text{ A}} = 4\text{ V}$

Loop rule: $\mathcal{E} - 36 - 4 = 0 \Rightarrow \mathcal{E} = \boxed{40.0\text{ V}}$

---

2) In each picture, $\vec{E}$ points away from the + charge.

2 μc ⊕ P, ←.25m→

$$E_2 = k\frac{q_2}{r_2^2} = (8.988\times10^9)\frac{2\times10^{-6}\text{c}}{(.25\text{m})^2} = 2.876\times10^5\ \text{N/c}$$

P ⊕ 5 μc, E_5 ←.30m→

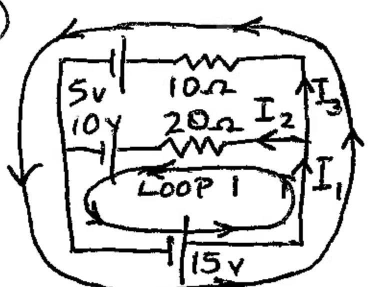
$$E_5 = -(8.988\times10^9)\frac{5\times10^{-6}\text{c}}{(.30\text{m})^2} = -4.993\times10^5\ \text{N/c}$$

POINTS LEFT.

-2.117×10^5 N/c

ANS: $\boxed{2.12\times10^5\ \text{N/c, LEFT}}$

3



loop 1:

$15 - I_2(20\Omega) - 10 = 0$

$5 = 20 I_2$

$I_2 = \frac{5}{20} = .25\text{A}$

loop 2:

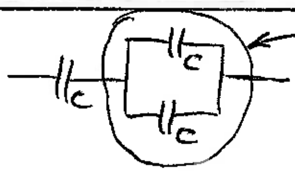
$15 - I_3(10\Omega) - 5 = 0$

$10 = 10 I_3$

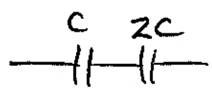
$I_3 = 1.00\text{ A}$

Point Rule: $I_1 = I_2 + I_3 = .25 + 1 = \boxed{1.25\text{ A}}$

4



parallel: $C_{EQ} = C_1 + C_2 \Rightarrow C + C = 2C$



series: $\frac{1}{C_{EQ}} = \frac{1}{C_1} + \frac{1}{C_2}$

$\frac{1}{6} = \frac{1}{C} + \frac{1}{2C}$

$\frac{1}{6} = \frac{2}{2C} + \frac{1}{2C}$

$\frac{1}{6} = \frac{3}{2C}$

ANS

$C = \frac{3}{2}(6) = \boxed{9.0\ \mu\text{F}}$

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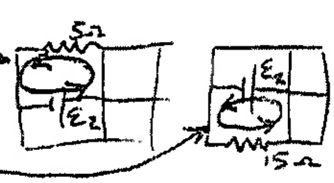
5) a) Same. This loop says the 5 Ω has $\mathcal{E}_2$ volts across it. This loop says the 15 Ω has $\mathcal{E}_2$ volts across it.



b) Positive. Conventional, positive current flows "down," from + to –.

c) 270°. Tangent to the field line at that point.

d) 2.70×10^5. $P = \frac{\Delta PE}{t} \Rightarrow \Delta PE = Pt = (1500\text{ W})(180\text{ s}) = 2.7\times10^5\text{ J}$

e) Stays the same. R depends on how the resistor is made, not the voltage.

PHY 122 - REVIEW OF SEC. 5-8 e

① $I = \frac{\mathcal{E}}{R}\left(1 - e^{-t/\tau}\right)$ $\tau = \frac{L}{R} = \frac{.008H}{25\Omega} = .00032\,SEC$

$I = \frac{9V}{25\Omega}\left(1 - e^{-\frac{.0002}{.00032}}\right) = .360\left(1 - \underbrace{e^{-.625}}_{.53526}\right) = .1673\,A$

$\Delta V = IR = (.1673)(25\Omega) = \boxed{4.18V}$

---

② $\Delta V_L = IX_L \Rightarrow X_L = \frac{\Delta V_L}{I} = \frac{35V}{.27A} = 129.6\Omega$

$X_L = \omega L \Rightarrow L = \frac{X_L}{\omega} = \frac{129.6}{2\pi(80,000)} = 2.579 \times 10^{-4}H = \boxed{.258mH}$

RESONANT $\omega = \frac{1}{\sqrt{LC}} \Rightarrow C = \frac{1}{\omega^2 L} = \frac{1}{[2\pi(80000)]^2(2.579\times10^{-4})}$

$= 1.53 \times 10^{-8}F = \boxed{15.3nF}$

---

③ Find $\Phi = B\cos\theta A = (.35T)\cos 20°(.03m^2) = .009867$

angle between $\vec{B}$ and coil's axis.

Initial $\Phi = (.35T)\cos 0°(.03m^2) = .010500$

$\Delta\Phi = -.000633\,wb$

$\mathcal{E} = -N\frac{\Delta\Phi}{\Delta t} = -(700)\frac{(-6.33\times10^{-4})}{9.30\times10^{-4}s} = \boxed{477V}$ ANS

---

④ Field from one strand of bone: $B = \frac{\mu_0 I}{2\pi r}$

Total from all fifteen: $B = (15)\frac{\mu_0 I}{2\pi r} = (15)\frac{(4\pi\times10^{-7})(4.5A)}{2\pi(.013m)}$

$B = .001038\,T$

Force on one strand on balance: $F = I\ell B \underbrace{\sin\theta}_{1}$

Total on all nine: $F = (9)I\ell B = 9(4.5A)(.17m)(.001038) = \boxed{.00715N}$ ANS

5. a. In iron, the atoms can get lined up with each other. (If your answer says something about "domains," that's even better.)

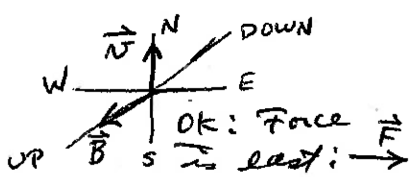
b. <u>About 3.7 V</u>. In one time constant, you get about 63% of the way to the final value, 37 % of the way still to go. So, V has gone down by 6.3 V, and 3.7 V is left.

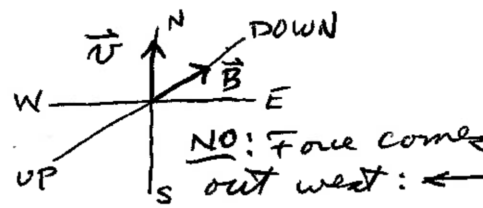
c. i. <u>No</u>. DC won't go through a capacitor.

ii. <u>Yes</u>. $X_L = (2\pi f)L$. Steady DC has a frequency of 0, so $X_L = 0\ \Omega$. All that would oppose the current is the coil's small resistance; I would be even larger than the AC case.

d. <u>–Z direction</u>. By the right hand rule, the coil's B field points in the +x direction. Use the right hand rule again to see that a current in the +y direction flowing through a field in the +x direction is pushed in the –z direction.

e. Up. Since $\vec{F}$ and $\vec{v}$ are horizontal, $\vec{B}$ must be vertical. Choose between up and down with the right hand rule:

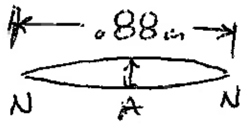




F

PHY 122 — Review of 9-12:

(1)

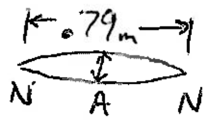


220 Hz

(a) $\lambda = 2(N \text{ to } N) = 2(.88) = 1.76\,m$

$v = f\lambda = (220)(1.76) = \boxed{387\,m/s}$

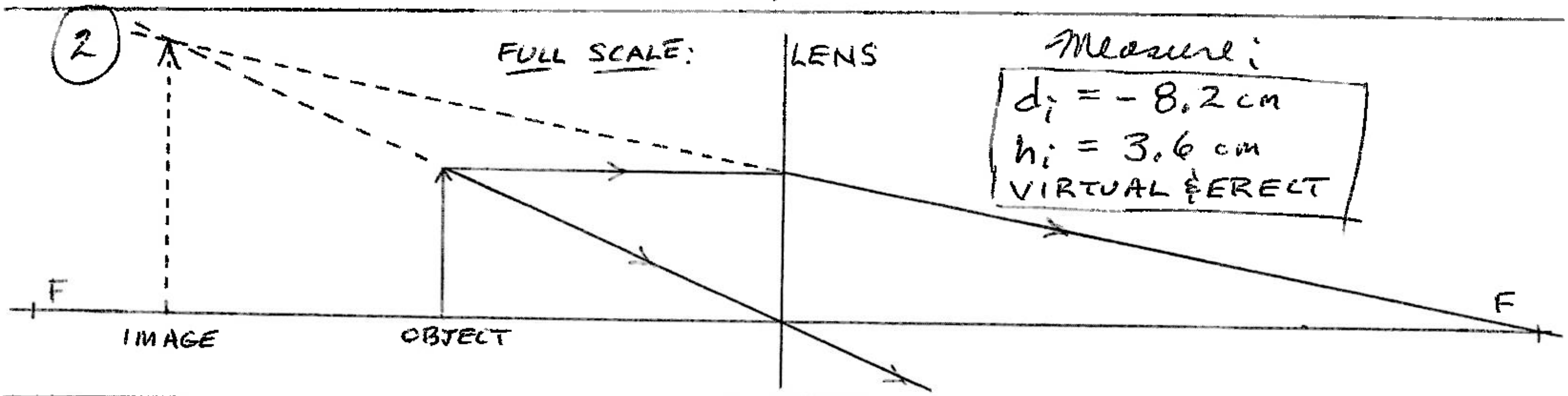
(b)



$f = \frac{v}{\lambda} = \frac{387\,m/s}{2(.79\,m)} = \boxed{245\,Hz}$

---

(2)



Measure:

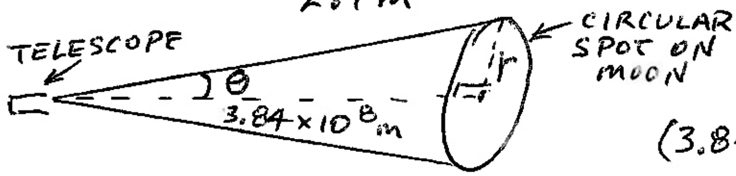
$d_i = -8.2\,cm$
$h_i = 3.6\,cm$
VIRTUAL & ERECT

---

(3) WITH DIFFRACTION THROUGH A CIRCULAR OPENING, THE EDGE OF THE CENTRAL MAX. IS AT $\theta = 1.22\frac{\lambda}{D}$.

$\lambda = \frac{v}{f} = \frac{2.998\times10^{8}\,m/s}{4.32\times10^{14}\,Hz} = 6.94\times10^{-7}\,m$

$\theta = 1.22\,\frac{6.94\times10^{-7}\,m}{2.7\,m} = 3.136\times10^{-7}\,RAD$



OPP / ADJ

$\tan(3.136\times10^{-7}) = \frac{r}{3.84\times10^{8}}$

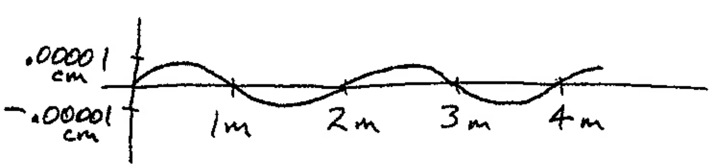
$(3.84\times10^{8}\,m)\tan(3.136\times10^{-7}\,RAD) = r$

$\boxed{120\,m = r}$

---

(4) $A = .00001\,cm$ (given)

$\lambda = \frac{v}{f} = \frac{343\,m/s}{171.5\,Hz} = 2.0\,m$



5. a. Violet. From $m\lambda = d \sin\theta$, the smallest θ goes with the smallest λ. Violet has the shortest visible wavelength.

b. Greater than. From $n = \frac{c}{v}$, glass's smaller n means a larger v. (See table of refractive indices in formula sheet.)

c. Constructive. 20.5 μm – 20.0 μm = .5 μm, which equals the wavelength. When the path difference is a whole number of wavelengths, you get constructive interference.

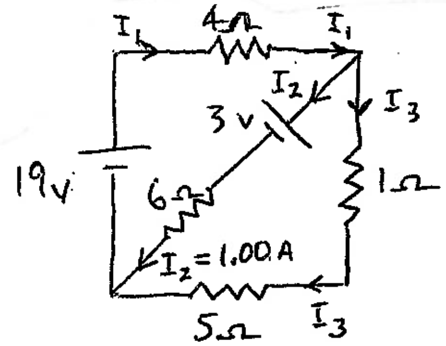
d. $\frac{1}{9}$ of the intensity, from $\frac{I_1}{I_2} = \frac{r_2^2}{r_1^2}$.

e. i. Frequency. I'll accept wavelength, but that isn't actually correct, technically.
ii. Amplitude. Intensity would be correct also.

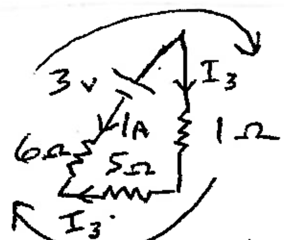
PHY 122: REVIEW OF SEC. 1-14:

e

① ASSUME I_1, I_2 & I_3 FLOW FROM + ON THE 19 V TOWARD ITS −. (3 V PUSHING THE OTHER WAY DOESN'T SEEM LIKELY TO OVERCOME 19 V. IF IT DOES, WE'LL GET AN IMPOSSIBLE ANSWER.)

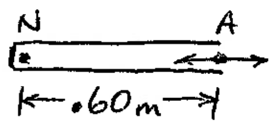


Loop rule:



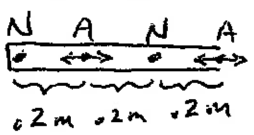
$$3\,V - I_3(1\Omega) - I_3(5\Omega) + (1A)(6\Omega) = 0$$
$$3 - 6I_3 + 6 = 0$$
$$9 = 6I_3 \Rightarrow I_3 = \boxed{1.5\,A}$$

② a)



$$\lambda = 4(N \text{ to } A) = 4(.6) = \boxed{2.40\,m}$$
$$f = \frac{v}{\lambda} = \frac{343\,m/s}{2.4\,m} = \boxed{143\,Hz}$$

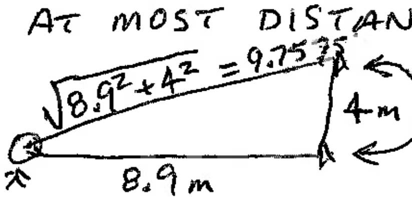
b) next longest λ where you have a node at the closed end and antinode at the open end:



$$\lambda = 4(N \text{ to } A) = 4(.2) = \boxed{.800\,m}$$
$$f = \frac{v}{\lambda} = \frac{343}{.8} = \boxed{429\,Hz}$$

③ DESTRUCTIVE INTERFERENCE IF PATH DIFFERENCE = $(m+\frac{1}{2})\lambda$

AT MOST DISTANT MINIMUM, m = 0



PATH DIFFERENCE = 9.7575 − 8.9 = .8575 m

$$.8575\,m = (0+\tfrac{1}{2})\lambda$$
$$\lambda = 2(.8575) = 1.715\,m$$
$$f = \frac{v}{\lambda} = \frac{343\,m/s}{1.715\,m} = \boxed{200\,Hz}$$

④ $Q = (m \text{ before} - m \text{ after})(931.5\,\frac{MeV}{u})$

$= [2.014102 + 6.015122 - 2(4.002603)](931.5)$

$= (.024018)(931.5)$

$= 22.37\,MeV = 2.237 \times 10^7\,eV$

times $\left(\frac{1.6\times10^{-19}\,J}{1\,eV}\right) = \boxed{3.58\times10^{-12}\,J}$

(5)

$$E = \frac{\Delta V}{d} = \frac{120\,V}{.008\,m} = 15000\ \frac{N}{C}$$

$$E = \frac{F}{q} \Rightarrow F = qE = (3.68\times10^{-18}\,C)(15000\ \tfrac{N}{C}) = \boxed{5.52\times10^{-14}\,N}$$

---

(6) $B_i = 0 \qquad B_f = \frac{\mu_0 I N}{L} = \frac{(4\pi\times10^{-7})(10\,A)(700)}{1\,m} = .008796\,T$

$\Phi_i = 0 \qquad \Phi_f = B\cos\theta A = (.008796)(1)(.028\,m^2) = 2.463\times10^{-4}\,wb$

$$\mathcal{E} = -N\frac{\Delta\Phi}{\Delta t} = -(130)\frac{2.463\times10^{-4} - 0}{.002\,s} = \boxed{-16.0\,V}$$ (positive ok.)

---

(7) $V = IZ \Rightarrow Z = \frac{V}{I} = \frac{50\,V}{1.6\,A} = 31.25\,\Omega$

$$Z = \sqrt{R^2 + (X_L - \underbrace{X_C}_{0:\ \text{NO CAPACITOR}})^2} \Rightarrow X_L = \sqrt{Z^2 - R^2} = \sqrt{31.25^2 - 20^2} = 24.0\,\Omega$$

$$X_L = (2\pi f)L \Rightarrow L = \frac{X_L}{2\pi f} = \frac{24\,\Omega}{2\pi(60)} = \boxed{.0637\,H}\ (63.7\,mH)$$

---

8. a. The LC circuit is AC. Alternating current is when charge goes back and forth. Direct current means it always flows in the same direction, which is what happens is an RC or LR circuit.

b. Constructively. Over and back makes $\lambda/2$ of extra distance travelled by the ray that reflects off the right side of the bubble. The ray reflected off the left side reflects off a higher index of refraction, which causes half a cycle of difference in its phase. So, both rays leave the bubble shifted half a cycle compared to when they got there, and are still in phase.

c. 10.2 eV. More precisely, 13.606 – 3.401 = 10.205 eV. The smallest energy would be if the electron jumps to the closest level above where it started.

d. No. By $v = \sqrt{\frac{F}{\mu}}$, the speed is faster in the lighter rope, since the tension is the same. By $\lambda = \frac{v}{f}$, the wavelength is longer where v is greater, since the frequency is the same. (Same period means same frequency.)

e. An ampere. (Look at the units in $I = \frac{q}{t}$.)