Student 8
Average 49.8/100
Best 84/100

12thG Physics (2018– 19)

4thQ Final Exam

(May 29, 2019)

Class	No.	Name Solutions

In calculation problems, describe equations clearly and systematically enough to show how to solve the problems. <u>If not enough, you won't get any point.</u>

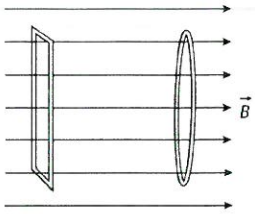
5point/question x 21questions=105points
Max 100 points

Exam ／[Total 100 points]

Lab Reports	Homework
/	/

Average 93.0 31.7

(1) An emf is induced in a conducting loop of wire 1.22 m long as it changed from square to circular. Find the average magnitude of the induced emf if the change in shape occurs in 4.25 s and the local 0.125-T magnetic field is perpendicular to the plane of the loop.



(Equations)

$A = \left(\frac{1.22}{4}\right)^2 = 0.09303$

$2\pi r = 1.22 \rightarrow r = \frac{1.22}{2\pi}$

$A = \pi r^2 = \pi \frac{1.22^2}{4\pi^2} = \frac{1.22^2}{4\pi} = 0.1184$

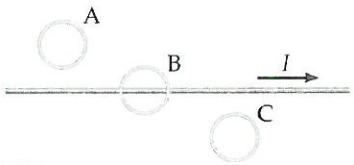
$$V = \left|\frac{\Delta\Phi}{\Delta t}\right| = B\frac{\Delta A}{\Delta t} = 0.125 \times (0.1184 - 0.09303)$$

$$= \frac{0.125 \times 0.0254}{4.25} = 7.47 \times 10^{-4}\,(V) \rightarrow 7.5 \times 10^{-4}\,(V)$$

(1) Answer
7.5×10^{-4} V

(38%)

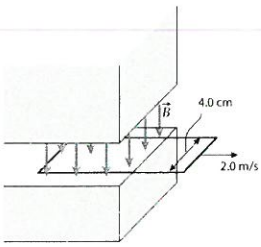
(2) A long, straight wire carries a current *I*, as indicated in the figure. Three small metal rings are placed near the wire (A and C) or directly on top of it (B). If the current in the wire is ~~decreasing~~ increasing with time, indicate whether the induced current in each of the rings is clockwise (CW), counterclockwise (CCW), or zero (N).



(2) Answer		
A CW	B N	C CCW

(93%)

(3, 4) The wire loop in the figure is being pulled out of the magnetic field at a constant rate. If the field is uniform (1.50 mT) in the region shown and zero elsewhere,
(3) what is the induced emf in the loop?
(4) what is its direction, CW or CCW?
(Equations)



$V = vBl$

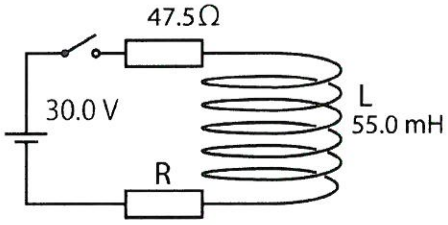
$= 2 \times 1.50 \times 10^{-3} \times 4.0 \times 10^{-2}$

$= 12.0 \times 10^{-5} \longrightarrow 1.2 \times 10^{-4}$ V

(3) Answer
1.2×10^{-4} V (61%)

(4) Answer
CW (50%)

(5) After the switch in the circuit shown has been closed a long time, the energy stored in the inductor is 3.11×10^{-3} J. What is the value of the resistance R?
(Equations)



$U = \frac{1}{2} L I^2$

$\rightarrow I = \sqrt{\frac{2U}{L}} = \sqrt{\frac{2 \times 3.11 \times 10^{-3}}{55 \times 10^{-3}}}$

$= 0.3363$

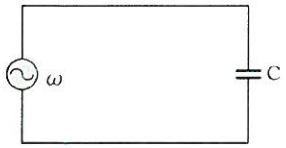
$I = \frac{30}{R + 47.5} = 0.3363$

$R = \frac{30}{0.3363} - 47.5$

$= 41.71 \longrightarrow 41.7$

(5) Answer
41.7 Ω (26%)

(6) An AC generator with a frequency of 30.0 Hz and an rms voltage of 12.0 V is connected to a 45.5-μ F capacitor.



(6-a) What is the maximum current in this circuit?

(6-b) What is the current in circuit when the voltage across the capacitor is 5.05 V and increasing?
(Equations)

(a) $X_C = \dfrac{1}{2\pi f C}$, $I_{max} = \sqrt{2}\, I_{rms} = \sqrt{2}\, \dfrac{V_{rms}}{X_C}$

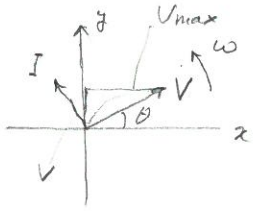
$= \sqrt{2} \times 12.0 \times 2\pi \times 80.0 \times 45.5 \times 10^{-6}$

$= 0.1456 \longrightarrow 0.146\ (A)$

(b) $V = V_{max} \sin\theta$, $V_{max} = \sqrt{2} \times 12.0 = 16.97$

$\theta = \sin^{-1}\left(\dfrac{V}{V_{max}}\right) = \sin^{-1}\left(\dfrac{5.05}{16.97}\right)$

$= 17.31^\circ$



$I = I_{max} \sin(\theta + 90^\circ)$

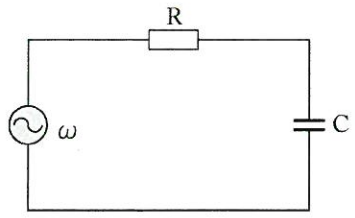
$= 0.1456 \sin 107.31^\circ$

$= 0.1390$

(6-a) Answer	0.146 A
(6-b) Answer	0.139 A

(50%)

(7, 8) A 65.0 Hz generator with nan rms voltage 135 V is connected in series to a 3.35kΩ resistor and 1.50-μ F capacitor.



(7) Find the rms current in the circuit.

(8) Find the phase angle, ϕ, between the current and the voltage. (Equations)

(7) $X_c = \frac{1}{2\pi fC} = \frac{1}{2\pi \times 65.0 \times 1.50 \times 10^{-6}}$

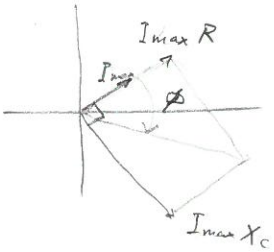
$= 1632$

$Z = \sqrt{R^2 + X_c^2} = \sqrt{3350^2 + 1632^2} = 3726$

$I = \frac{V}{Z} = \frac{135}{3726} = 0.036223$

(8) $\tan\Phi = \frac{X_c}{R} = \frac{1632}{3350} = 0.4872$

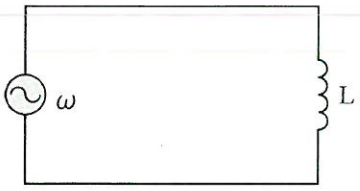
$\Phi = \tan^{-1}(0.4872) = 25.97^\circ \rightarrow 26.0^\circ$



(7) Answer	
36.2 mA	(55%)

(8) Answer	
-26.0°	(30%)

(9) What rms voltage is required to produce an rms current of 2.1 A in a 66 mH-inductor at a frequency of 25 Hz?
(Equations)



$V = I X_L$

$= I \cdot 2\pi f L$

$= 2.1 \times 2\pi \times 25 \times 66 \times 10^{-3}$

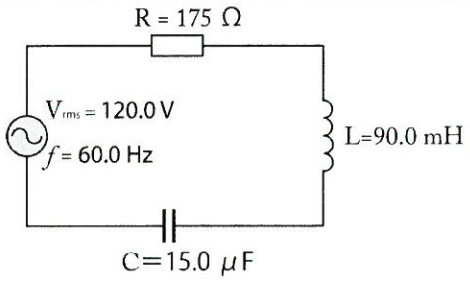
$= 21.8 \longrightarrow 22$

(9) Answer

22 V

(85%)

(10) Aan AC generator with a frequency of 60.0 Hz and an rms voltage of 120.0 V is connected in seriew with a 175-Ω resistor, a 90.0-mH inductor, and a 15.0-μ F capacitor.



(10-a) Find the current in the circuit.
(10-b) Find the voltage across the inductor.

(11-c) Find the voltage across the capacitor.
(11-d) Find the phase angle from the current to the total maximum voltage.
(Equations)

(10) $X_C = \frac{1}{2\pi f C} = \frac{1}{2\pi \times 60.0 \times 15.0 \times 10^{-6}} = 176.82$

$X_L = 2\pi f L = 2\pi \times 60.0 \times 90.0 \times 10^{-3} = 33.93$

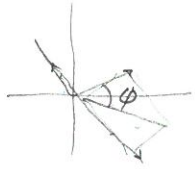
$Z = \sqrt{R^2 + (X_L - X_C)^2} = \sqrt{175^2 + 142.9^2} = 225.9$

$I = \frac{V}{Z} = \frac{120.0}{225.9} = 0.5312 \longrightarrow 0.531\ (A)$

(10b) $V = I X_L = 0.5312 \times 33.93 = 18.02 \longrightarrow 18.0\ (V)$

(11-c) $V = I X_C = 0.5312 \times 176.82 = 93.92 \longrightarrow 93.9\ (V)$

(11-d) $\tan\Phi = \frac{X_L - X_C}{R} = \frac{33.93 - 176.82}{175} = -0.81651$



$\Phi = \tan(-0.81651)$

$= -39.23° \longrightarrow -39.2°$

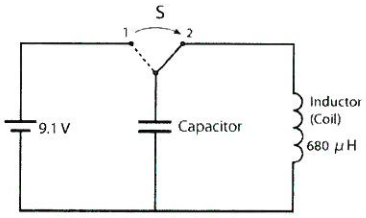
(10-a) Answer	
0.531 A	
(10-b) Answer	(38%)
18.0 V	

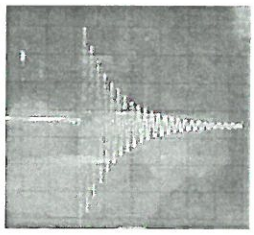
$V_{max.L} = 25.5\ V$ $V_{rms.L}$

$V_{max.C} = 133\ V$ $V_{rms.C}$

(11-c) Answer	
93.9 V	
(11-d) Answer	(25%)
−39.2°	

(12) A circuit as shown is made using a 9.1 V battery, a capacitor and a 680 μ H inductor. After charging the capacitor, the switch is replaced to connect the capacitor and the inductor. Oscilloscope observation of the voltage between both the ends of the inductor shows an attenuating sinusoidal pattern with 18 times vibration in 100 microseconds.





(12-a) Find the capacitance of the capacitor.
(12-b) Find the maximum value of the current.
(Equations)

(a) $f = \frac{18}{100\times10^{-6}} = 18\times10^{4}\ Hz$

$f = \frac{1}{2\pi\sqrt{LC}} \rightarrow \sqrt{C} = \frac{1}{2\pi f\sqrt{L}}$

$C = \frac{1}{4\pi^2 f^2 L} = \frac{1}{4\pi^2\times18^2\times10^8\times680\times10^{-6}} = 1.149\times10^{-9}$

$\rightarrow 1.1\times10^{-9}\ F = 1100\ pF$

(b) $\frac{1}{2}CV^2 = \frac{1}{2}LI^2$

$\rightarrow I = V\sqrt{\frac{C}{L}}$

$= 9.1\times\sqrt{\frac{1.149\times10^{-9}}{680\times10^{-6}}}$

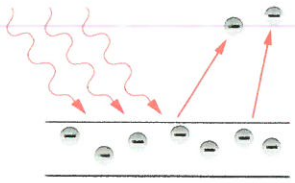
$= 9.1\times\sqrt{1.69\times10^{-6}}$

$= 11.8\times10^{-3} \longrightarrow 12\ mA$

(12-a) Answer	1100 pF
(12-b) Answer	12 mA

(9%)

(13) Find the work function of a material that has a threshold (minimum) wavelength of 430 nm. Express your answer in electronvolts.
(Equations)



$$K_{max} = hf - W = 0$$

$$W = h f_0 = h \frac{c}{\lambda_0} = \frac{6.63\times10^{-34}\times3.00\times10^{8}}{1.60\times10^{-19}\times430\times10^{-9}}$$

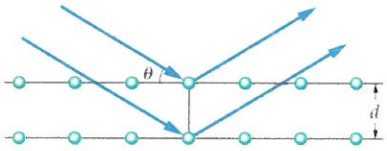
$$= 0.02886\times10^{2} \longrightarrow 2.89\ eV$$

(13) Answer
2.89 eV

(26%)

(14) A beam of neutrons with a de Broglie wavelength of 0.250 nm diffracts from a crystal of table salt, which has an interionic spacing of 0.282 nm.

(14-a) What is the speed of the neutron?
(14-b) What is the angle of the second interference maximum?



(a) $p = \frac{h}{\lambda} = mv$

$$v = \frac{h}{m\lambda} = \frac{6.63\times10^{-34}}{1.67\times10^{-27}\times0.250\times10^{-9}} = 1582 \longrightarrow 1580$$

(b) $2d\sin\theta = 2\lambda$

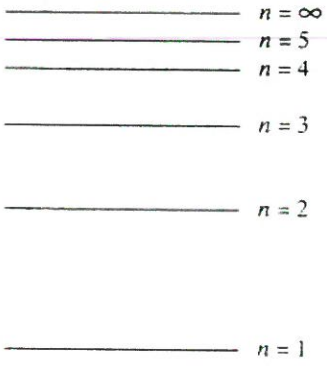
$$\sin\theta = \frac{\lambda}{d} = \frac{0.250\times10^{-9}}{0.282\times10^{-9}} = 0.8805$$

$$\theta = \sin^{-1} 0.8805 = 62.4^\circ$$

(14-a) Answer
1580 m/s
(14-b) Answer
62.4°

(38%)

(15) How much energy is required to ionize hydrogen when it is in the n= 4 state?
(Equations)



$$E_n = (-13.6)\frac{1}{n^2}$$

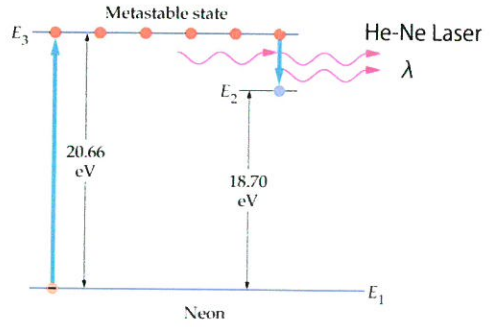
$$= (-13.6)\times\frac{1}{4^2} = 0.8500$$

$$\rightarrow 0.850\,(eV)$$

(15) Answer

0.850 eV (34%)

(16) The figure shows the relevant energy levels in He-Ne Laser. Find the wavelength λ.
(Equations)



$$\Delta E = 20.66 - 18.70 = 1.96\ eV$$

$$hf = \Delta E\,(J) \rightarrow f = \frac{\Delta E\,(J)}{h}$$

$$\lambda = \frac{c}{f} = \frac{6.63\times10^{-34}\times3.00\times10^{8}}{1.96\times1.60\times10^{-19}}$$

$$= 6.342\times10^{-7} \rightarrow 634\times10^{-9}\,(m)$$

(16) Answer

634 nm (23%)

(17) Complete the following nuclear-decay equations:

(17-a) ${}^{1}_{0}\mathrm{n} + {}^{40}_{18}Ar \rightarrow {}^{37}_{16}S + {}^{4}_{2}\mathrm{He}$

(17-b) ${}^{40}_{19}\mathrm{K} \rightarrow {}^{40}_{20}\mathrm{Ca} + e^{-}$.

(17-c) ${}^{236}_{92}\mathrm{U} \rightarrow {}^{131}_{53}\mathrm{I} + 3({}^{1}_{0}\mathrm{n}) + {}^{102}_{39}\mathrm{Y}$

(17-d) ${}^{47}_{21}\mathrm{Sc}^{*} \rightarrow {}^{47}_{21}\mathrm{Sc} + \gamma$

(17-e) ${}^{13}_{6}C + {}^{1}_{1}H \rightarrow {}^{14}_{7}N$

(17-a) Answer Complete the equation
(17-b) Answer Complete the equation
(17-c) Answer Complete the equation
(17-d) Answer Complete the equation
(17-e) Answer Complete the equation

(40%)

(47%)

(Equations)

(a) $A = 40 + 1 - 4 = 37$

$Z = 18 - 2 = 16$

(c) $A = 236 - (131 + 102) = 3$

$Z = 92 - (53 + 39) = 0$

(18 19) An archeologist on a dig finds a fragment of an ancient basket woven from grass. Later, it is determined that the carbon-14 content of the grass in the basket is9.05 % that of an equal carbon sample from present-day grass. What is the age of the basket?
(Equations)

$$N = N_0 e^{-\lambda t} = N_0 e^{-\frac{\ln 2}{T} t}$$

$$\frac{N_0}{N} = 0.0905$$

$$\ln 0.0905 = -\frac{\ln 2}{T} t$$

$$t = -2.402 \times \left(-\frac{5730}{0.6931}\right)$$

$$= 19861 \longrightarrow 19900$$

(18 19) Answer

19,900 years

(26%)

20
(~~19~~) Complete the following fission reaction and determine the amount of energy it reases:

$$^{1}_{0}\mathrm{n} + {}^{235}_{92}U \rightarrow {}^{133}_{51}Sb + \underline{{}^{98}_{41}Nb} + 5\,{}^{1}_{0}n$$

(Equations)

$A = 236 - (133 + 5) = 98$

$Z = 92 - 51 = 41$

$m_f =$ 132.915237 + 97.910331 +) 5.043325 = 235.868893

$5 \times 1.008665 = 5.043325$

$m_i =$ 235.043925 + 1.008665 = 236.052590

$\Delta m = m_f - m_i = -0.183697\ (u)$

$E = |\Delta m| C^2$

$= 0.183697(u) \times 931.5\ (MeV/c^2)$

$= 171.11\ (MeV) \rightarrow 171.1\ MeV$

20
(~~19~~) Answer

Complete the reaction.

Energy: 171.1 MeV

(59%)

You have one more question next.

(21) Did you study 12th grade physics seriously and enjoy it?

(21) Answer

Circle your answer.

Yes No Neutral

(100%)

Opinions

Your name:

I am very happy to meet you!

難しい勉強に１年間付き合ってくれてありがとう。君の人生に幸あれといつも祈っています。進路が決まったら教えてください。 Tohei