total 100

PHY2054.002, Fall 2010

Name: Key Exam #2 PID:_____

Version A

5 each

Part I (50%)

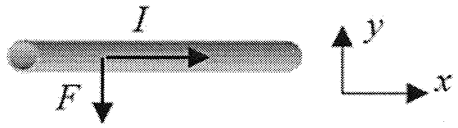
1. Which one of the following statements concerning the magnetic force on a charged particle in a magnetic field is true?

A) The magnetic force is a maximum if the particle is stationary.
B) The magnetic force is zero if the particle moves perpendicular to the field.
C) The magnetic force is a maximum if the particle moves parallel to the field.
D) The magnetic force acts in the direction of motion for a positively charged particle.
E) The magnetic force depends on the component of the particle's velocity that is perpendicular to the field.

2. A proton is traveling south as it enters a region that contains a magnetic field. The proton is deflected downward toward the earth. What is the direction of the magnetic field?

A) downward, toward the earth, B) west, C) north, D) east, E) south.

3. A long, straight wire carries a 6.0-A current that is directed in the positive x direction. When a uniform magnetic field is applied perpendicular to a 3.0-m segment of the wire, the magnetic force on the segment is 0.36 N, directed in the negative y direction, as shown. What are the magnitude and direction of the magnetic field?

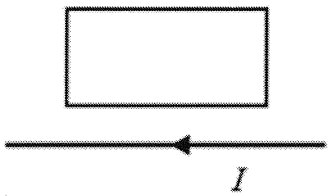


A) 0.020 T, out of the paper, B) 0.020 T, into the paper, C) 0.060 T, out of the paper, D) 0.060 T, into the paper, E) 0.65 T, out of the paper

4. A magnetic field is directed perpendicular to the plane of a 0.15-m × 0.30-m rectangular coil consisting of 240 loops of wire. To induce an average emf of –2.5 V in the coil, the magnetic field is increased from 0.1 T to 1.8 T during a time interval Δt. Determine Δt.

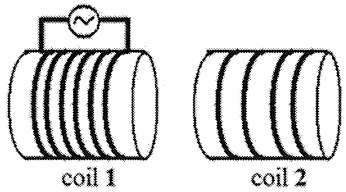
A) 0.053 s, B) 0.13 s, C) 12 s, D) 6.4 s, E) 7.3 s.

5. A long, straight wire is in the same plane as a rectangular, *conducting* loop. The wire carries a current I as shown in the figure. Which one of the following statements is true if the current is suddenly increased?



A) There will be no induced emf and no induced current. B) There will be an induced emf, but no induced current. C) There will be an induced current that is clockwise around the loop. D) There will be an induced current that is counterclockwise around the loop. E) There will be an induced electric field that is clockwise around the loop.

6. Two coils share a common axis as shown in the figure. The mutual inductance of this pair of coils is 1.0 mH. If the current in coil **1** is changing from 1 A to 2.75A in 0.5 s, what is the magnitude of the emf generated in coil **2**?

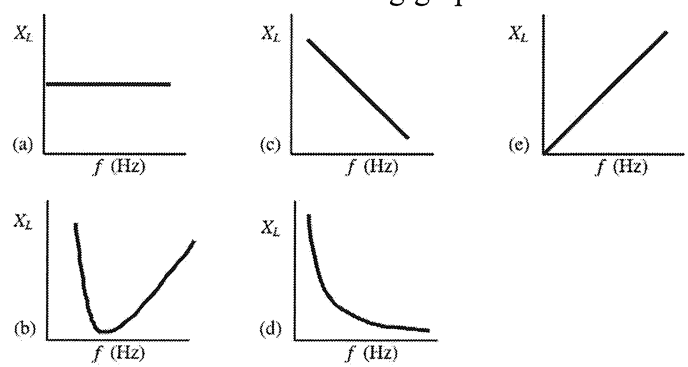


A) 5.8×10^{-4} V, B) 1.7×10^{-3} V, C) 3.5×10^{-3} V, D) 1.5×10^{-2} V, E) 2.1×10^{-2} V

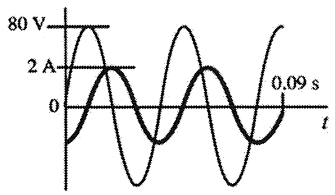
7. Three 83.0-μF capacitors are connected in parallel across the terminals of a 60.0-Hz generator. What is the capacitive reactance of the circuit?

A) 32 Ω, B) 110 Ω, C) 330 Ω, D) 660 Ω, E) 1.0×10^3 Ω

8. Which one of the following graphs shows how the inductive reactance varies with frequency?



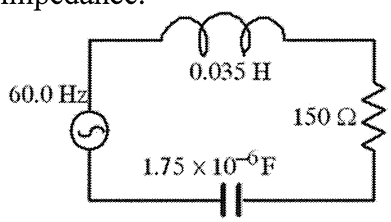
A) a, B) b, C) c, D) d, E) e



9. The voltage across and the current through a single circuit element connected to an ac generator are shown above. Which one of the following statements concerning this circuit element is true?

A) The element is a resistor. B) The element is a capacitor. (C) The element is an inductor. D) The element could be a resistor or an inductor. E) The element could be an inductor or a capacitor.

10. Use the information given in the figure for the series RCL circuit to determine its total impedance.



A) 300 Ω, B) 500 Ω, (C) 1500 Ω, D) 1700 Ω, E) 1900 Ω

Part II (50%)

B = 2.3 T

1. A Nickel ion Ni^+ has a mass of 9.8×10^{-26} kg, a charge of 1.60×10^{-19} C and a velocity of 5.0×10^{5} m/s entering a region that has a magnetic field that is perpendicular to Nickel's velocity. (a) Find the Lorentz force experienced by the Ni ion due to the magnetic field? (5%) (b) This force will bend the trajectory of the Ni ion into a circular orbit, find the radius of the orbit? (5%). (c) Find the acceleration experienced by the Ni ion? (5%)

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(a) $m = 9.8\times10^{-26}\,kg$, $q = 1.6\times10^{-19}\,C$ $V = 5\times10^{5}\,m/s$

$F = qVB = (1.6\times10^{-19})(5\times10^{5})(2.3) = 1.84\times10^{-13}\,N$

(b) $r = \frac{mv}{qB} = \frac{(9.8\times10^{-26})(5\times10^{5})}{(1.6\times10^{-19})(2.3)} = 1.33\times10^{-1}\,m$

(c) $F = ma$, $a = \frac{F}{m} = 1.9\times10^{12}\,m/s^2$

2. A coil of wire consists of 20 loops, each with an area of 2.0×10^{-2} m^2. A magnetic field is making a 30° with the normal of the surface of the loop. If the magnetic field changed from 0.1 T to 0.3 T in 0.20 s. (a) Find the magnetic flux change in 0.20 s. (5%), (b) Find the emf produced in the coil? (5%). (c) If the coil has a total resistance of 50 ohm, what is the current in the coil? (5%)

$N = 20$, $A = 2.0\times10^{-2}\,m$, $\phi = 30^0$.

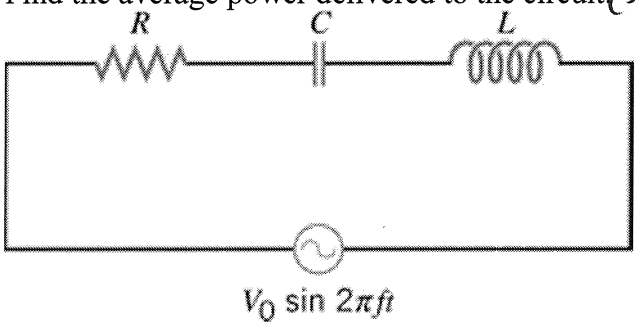
(a) $\Delta\Phi = (\Delta B)\cdot A = (0.3-0.1)(2.0\times10^{-2}\,m^2)$

$\Delta\Phi = 4.0\times10^{-3}\,TM^2$

(b) $\mathcal{E} = -N\dfrac{\Delta\Phi}{\Delta t} = -(20)\dfrac{4.0\times10^{-3}}{0.2} = -0.4$ Volt

(c) $|\mathcal{E}| = I\cdot R$ $\quad I = \dfrac{0.4}{50} = 0.008$ A

3. A series RLC circuit consists of a resistor, a capacitor and an inductor is connected to an ac source with a frequency of 120 Hz. The ac source is given by V=170sin(754t). The resistor has an resistance of 1000 Ω, the capacitor has a capacitance of 60 μF while the inductor has an inductance of 40 mH. (a) Find the inductive reactance of the inductor. (5%) (b) Find the impedance of the RCL circuit. (5%), (c) Find the phase angle ϕ(5%). (d) Find the average power delivered to the circuit(5%)



$V = 170 \sin 754t$

$R = 1000\,\Omega$, $C = 60\times10^{-6}\,F$. $L = 40\times10^{-3}\,H$.

$X_C = \frac{1}{2\pi fC}$ $\quad X_L = 2\pi fL$

$X_L = 30.2\,\Omega$.

$X_C = 22.1\,\Omega$.

(a) $X_L = 2\pi fL = 30.2\,\Omega$.

(b) $Z = \sqrt{R^2 + (X_C - X_L)^2} = 1000\,\Omega$.

(c) $\phi = \tan^{-1}\left[\frac{X_L - X_C}{R}\right] = \tan^{-1}\left[\frac{8.1}{1000}\right] = 0.5^\circ$

(d) $V_{rms} = I_{rms} Z$. $\quad V_{rms} = 120\,V \Rightarrow I_{rms} = 0.12\,A$

$\overline{P} = I_{rms}^2 Z \cdot \cos\phi = 14.4$ Watt.