PHYS 202 Spring 2015 Test #3 Name: Key

3 pts each
Total 45

A. Select the correct answer for the multiple choices questions and write your answer in the line next to the question number. Write down your answers for other questions/problems.

C 1. The angle that the magnetic field of the earth makes with respect to the surface at any point is:

a. angle of declination b. angle of rotation
c. angle of dip d. angle of latitude

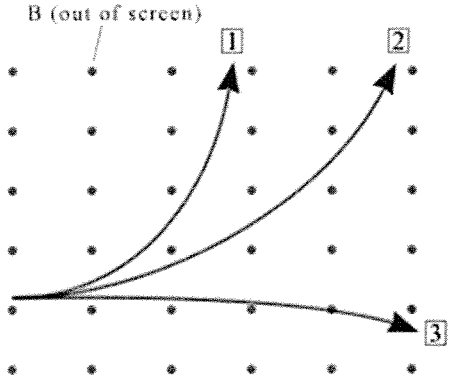
b 2. The SI unit for magnetic field, T is equivalent to: (F = qVB Sin θ)

a. $\frac{N.m}{C.s}$ b. $\frac{N.s}{C.m}$ c. $\frac{N}{C.s}$ d. $\frac{N.m}{C}$ e. $\frac{N}{C.m}$

d 3. At a location near the equator, the earth's magnetic field is horizontal and points north. An electron is moving vertically down to the ground. What is the direction of the magnetic force that acts on the electron?

a. North b. South c. East d. West

e 4. Three particles are moving perpendicular to a uniform magnetic field and travel on circular paths (see the drawing). They have the same mass and speed. List the particles in order of their charge magnitude, largest to smallest.



a. 3, 2, 1
b. 3, 1, 2
c. 2, 3, 1
d. 1, 3, 2
e. 1, 2, 3

e 5. What are the signs for the above charges?

a. All are positive b. All are negative c. All are neutral
d. 1 and 2 are positive, 3 is negative
e. 1 and 2 are negative, 3 is positive

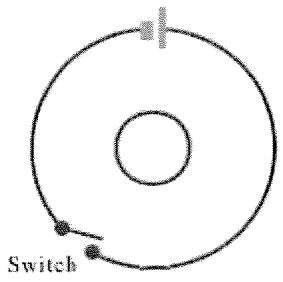
e 6. Which one of the following is not a ferromagnetic material?

a. iron b. nickel c. cobalt d. alnico e. copper

C 7. Which one of the following is always the same between the primary and secondary coils of an ideal transformer?

a. voltage b. current c. magnetic field d. resistance e. magnetic flux

C 8. The drawing shows a top view of two circular coils of conducting wire lying on a flat surface. The centers of the coils coincide. In the larger coil there is a switch and a battery. The smaller coil contains no switch and no battery. Describe the induced current that appears in the smaller coil when the switch in the larger coil is closed.



a. It flows counterclockwise forever after the switch is closed.

b. It flows clockwise forever after the switch is closed.

c. It flows counterclockwise, but only for a short period just after the switch is closed.

d. It flows clockwise, but only for a short period just after the switch is closed.

$$\chi_C = \frac{1}{2\pi fC}. \quad \chi_L = 2\pi fL. \quad Z = \sqrt{(R^2 + (\chi_L - \chi_C)^2}. \quad I = \frac{V}{Z}. \quad f_0 = \frac{1}{2\pi\sqrt{LC}}.$$

b 9. The reactance/resistance of which of the following increases linearly as a function of frequency?

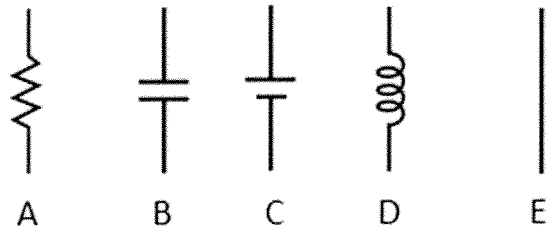
C 10. The reactance/resistance of which of the following is independent of the frequency?

a 11. The reactance/resistance of which of the following decreases non-linearly as a function of frequency?

Answers for 9-11

a. Capacitor b. Inductor c. Resistor

D 12. Identify the inductor among the circuit elements shown below:



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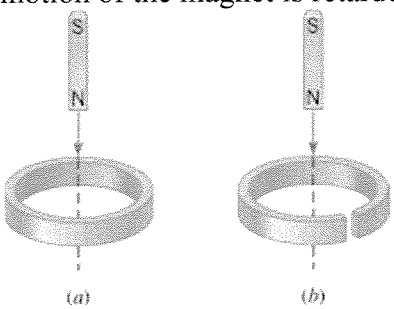
a 13. The drawing shows a bar magnet falling through a metal ring. In part *(a)* the ring is solid all the way around, but in part *(b)* it has been cut through. In which case the motion of the magnet is retarded?



b 14. Radio waves travel at the speed of light, 3.0×10^8 m/s. What is the wavelength of the 100 MHz radio wave? (M = 10^6) Speed of light = $C = \lambda f$

$3 \times 10^8 = \lambda \times 100 \times 10^6$

a. 0.3 m b. 3 m c. 30 m d. 300 m e. 3.0×10^6 m

a 15. In a velocity selector the charged particles experience a magnetic force that is,

a. equal in magnitude but opposite in direction to that of the electric force
b. equal to that of the electric force
c. different in magnitude and direction to that of the electric force

End of MC questions----------Show your work explicitly for the rest.....

Force (F) on a moving charge in a magnetic field is given by:	Centripetal force is given by:
$F = qvBSin\theta.$	$F_c = m\frac{v^2}{r}.$

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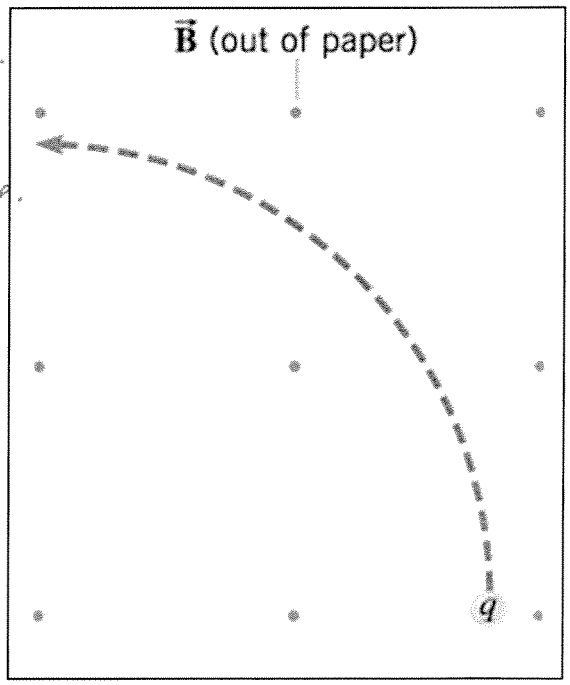
B. A charged particle enters a uniform magnetic field and follows the circular path shown in the drawing.

(a) Is the particle positively or negatively charged? Why?

(b) The particle's speed is 120 m/s, the magnitude of the magnetic field is 0.68 T, and the radius of the path is 760 m. Determine the mass of the particle, given that its charge has a magnitude of 8.2×10^{-4}C.



(a) The particle is negatively charged.

The deflection of the particle is given by the left-hand Rule.

or The deflection is in the opposite direction due to the right-hand Rule.

(b) $qvBSin\theta = \frac{mv^2}{r}$

$qBSin\theta = \frac{mv}{r}$

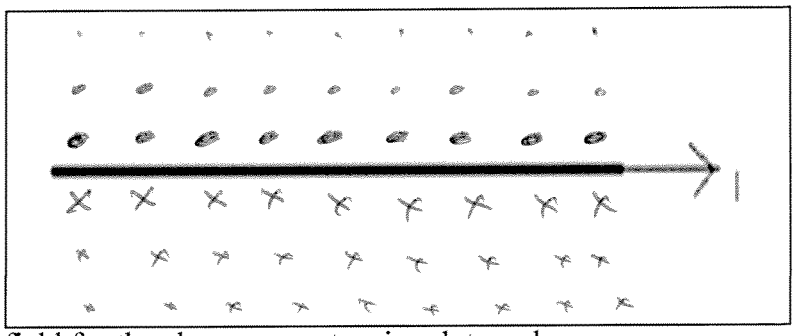
$\theta = 90$, $Sin\theta = 1$ $qB = \frac{mv}{r}$

$m = \frac{qBr}{v} = \frac{8.2 \times 10^{-4} \times 0.68 \times 760}{120}$

$m = 0.0035$ kg

C. The magnetic field due to a long straight wire, carrying a current I, at a distance r is given by; ($\mu_0 = 4\pi x10^{-7}$ T.m/A)

$$B = \frac{\mu_0 I}{2\pi r}$$



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1. Show the cross-section of the magnetic field for the above current, using dots and crosses in the diagram above.

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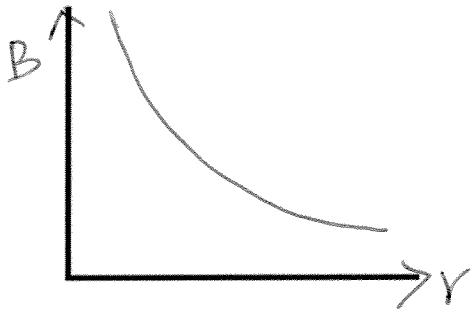
2. Sketch the above magnetic field as a function of the radial distance, below, also name the axes.



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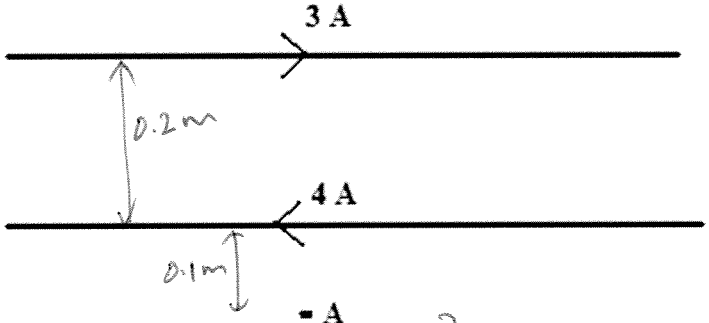
3. Two long straight wires, carrying currents 3.0 A and 4.0 A are separated by a distance of 0.20 m, lie as shown below. Determine the net magnetic field (magnitude and direction) from both currents at point A which is located 0.10 m from the bottom wire.



$B_{3A} = \frac{\mu_0 I}{2\pi r} = \frac{4\pi \times 10^{-7} \times 3}{2\pi \times 0.3} = 2 \times 10^{-6}$ T ⊗ in

$B_{4A} = \frac{\mu_0 I}{2\pi r} = \frac{4\pi \times 10^{-7} \times 4}{2\pi \times 0.1} = 8 \times 10^{-6}$ T ⊙ out

$B_{net} = B_{4A\,(out)} - B_{3A\,(out)} = 6 \times 10^{-6}$ T ⊙ out

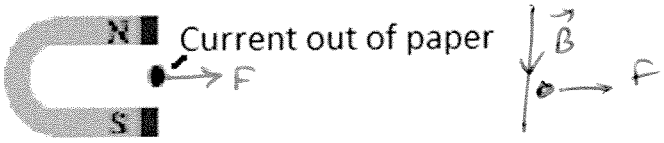
$B_{net} = 6 \times 10^{-6}$ T out ≈ ⊙

Transformer equations: $\frac{V_s}{V_P} = \frac{N_s}{N_P}$ $I_S V_S = I_P V_P$ $P_{loss} = I^2 R$

The following equations are used in RCL circuits:

$\chi_C = \frac{1}{2\pi f C}$. $\chi_L = 2\pi f L$. $Z = \sqrt{(R^2 + (\chi_L - \chi_C)^2}$. $I = \frac{V}{Z}$. $f_0 = \frac{1}{2\pi\sqrt{LC}}$.

[3] D. A horseshoe magnet and a current-carrying wire are shown in the drawing. The wire is perpendicular to the paper, and the current is directed out of the paper toward you. Show the direction of the magnetic force on the current, in the drawing below.



[6] E. A generating station is producing 1.6 x 10^6 W of power at 1100 V. A transformer with 30 turns in the primary and 18,000 turns in the secondary is used to change the voltage before the power is transmitted. What is the current in the transmission lines?

$\frac{V_s}{V_p} = \frac{N_s}{N_p} \Rightarrow \frac{V_s}{1100} = \frac{18{,}000}{30} \Rightarrow V_s = 660{,}000$ Volt

$P = I_s V_s \rightarrow 1.6 \times 10^6 = I_s \times 660{,}000$

$\frac{1.6 \times 10^6}{660{,}000} = I_s = 2.42$ A

[6] F. In a RCL circuit, a 16.0-Ω resistor, a 4.10-μF capacitor, and a 5.30-mH inductor are connected in series. Calculate the resonance frequency of this circuit.

$f_0 = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi\sqrt{5.3 \times 10^{-3} \times 4.1 \times 10^{-6}}}$

$f_0 = 1080$ Hz

G. Faraday's law of induction: $\xi = -N\frac{\Delta\Phi}{\Delta t}; \Phi = B_{\perp}A.$ Ohm's law: V = IR

[3] 1. Explain the significance of the negative sign in the above Faraday's law.

It is due to Lenz's law. The induced emf is such that it will always oppose the change in the original magnetic flux.

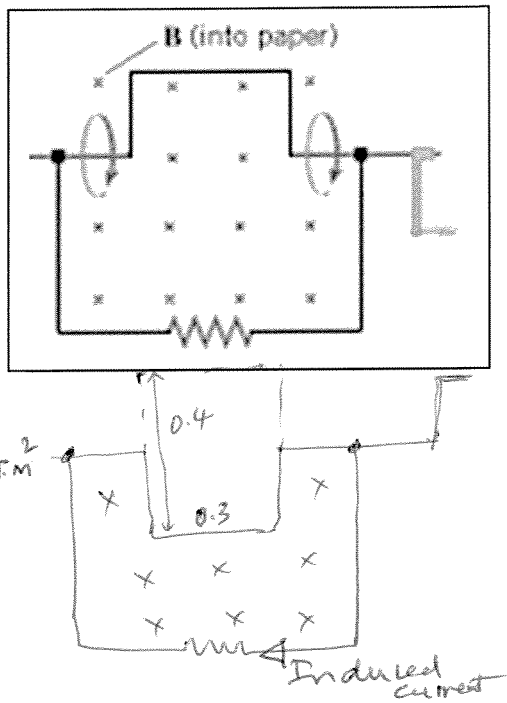
[12] 2. A loop of wire has the shape shown in the drawing. The top part of the wire is bent into a rectangle of length 0.30 m and width 0.20 m. A constant magnetic field of magnitude 0.80 T is directed into the paper.

a. What is the change in magnetic flux when the rectangular side is rotated through half a revolution, starting from the position shown?

b. If the above rotation of half a revolution takes 8 ms, what is the induced emf in the loop?

c. If the resistance shown in the loop is 0.15 ohm, what is the induced current?

d. What is the direction of the induced current?



a. $\Delta\phi = B \cdot \Delta A = 0.80 \times (0.4 \times 0.3) = 0.096\ T\,m^2$

b. $|\xi| = N\frac{\Delta\phi}{\Delta t} = \frac{1 \times 0.096}{8 \times 10^{-3}} = 12$ volt

c. $i = V/R = \frac{12}{0.15} = 80\ A$

d. During the rotation the magnetic flux (x) decreases. Induced current will produce magnetic flux with (x) to maintain the original flux inside the loop. Induced current must flow clockwise, as shown in the diagram.