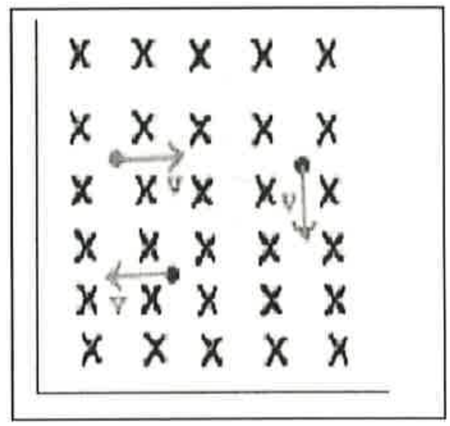
PHYS 202 Spring 2019 Test #3 Name: KEY

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

_c_ 2. Refer the figure to the right. The magnetic field is into the page. What is the direction of the magnetic force on the charge, on the right, which is negative and moving down?



a. UP b. DOWN c. LEFT
d. RIGHT e. OUT f. IN

_d_ 3. At a location near the equator, the earth's magnetic field is horizontal and points north. A proton is moving vertically upward from the ground. What is the direction of the magnetic force that acts on the proton?

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

_a_ 4. Magnetic force, F on a moving charge in a magnetic field is given by: $F = qVB \sin\theta$. The SI unit for magnetic field, T is equivalent to:

a. $\frac{Kg}{C.s}$ b. $\frac{Kg}{C.s^2}$ c. $\frac{Kg.m}{C.s}$ d. $\frac{Kg.m}{C.s^2}$

_d_ 5. Which one of the following is a unit for magnetic flux?

a. N b. W c. J d. Wb e. T f. A

_b_ 6. Which one of the following energy transformations takes place in a microphone?

a. Magnetic energy is converted into electrical energy.
b. Sound energy (mechanical energy) is converted into electrical energy.
c. Electrical energy is converted into magnetic energy.
d. Electrical energy is converted into sound energy (mechanical energy).

_E_ 7. A pyroelectric thermometer measures body temperature by determining the amount of __________ radiation emitted by the eardrum and surrounding tissue.

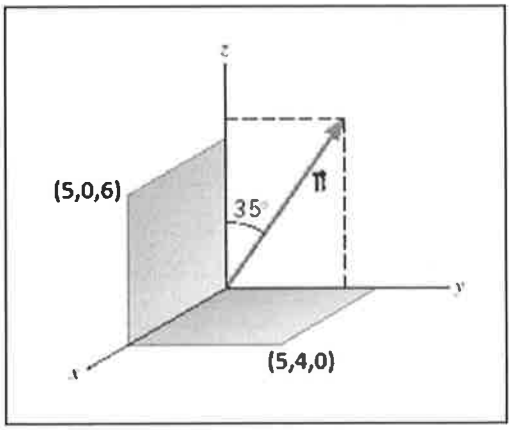
A. radio wave B. ultraviolet C. Gamma D. X-ray E. Infrared

_C_ 8. Which one of the following circuit elements has three leads?

a. Capacitor b. Diode c. Transistor d. Battery e. LED

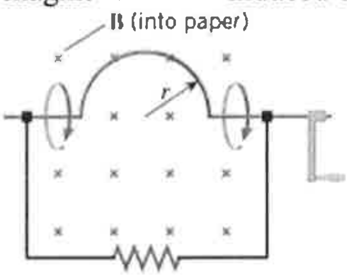
Faraday's law of induction is given below; $\xi = -N\dfrac{\Delta\Phi}{\Delta t};\Phi = B_{\perp}A.$

a 9 Two surfaces and a magnetic field (B = 0.5T), present everywhere are shown in the xyz coordinate system. The coordinates of the corners: (5,0,6) and (5,4,0) are in cm. What is the magnetic flux through the surface in the xz plane?



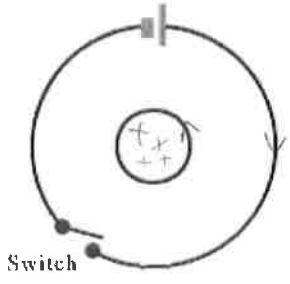
a. 8.60 $T.cm^2$
b. 8.19 $T.cm^2$
c. 10.0 $T.cm^2$
d. 11.5 $T.cm^2$
e. 15.0 $T.cm^2$
f. 16.4 $T.cm^2$
g. 17.2 $T.cm^2$
h. 24.6 $T.cm^2$

c 10. A loop of wire has the shape shown in the drawing. The top part of the wire is bent into a semicircle of radius $r = 0.25$ m. The normal to the plane of the loop is parallel to a constant magnetic field of magnitude 0.75 T. Starting with the position shown in the drawing, the semicircle side is rotated through ¼ of a revolution in 0.42 s. What is the magnitude of the induced emf? (Area of a circle = πr^2)



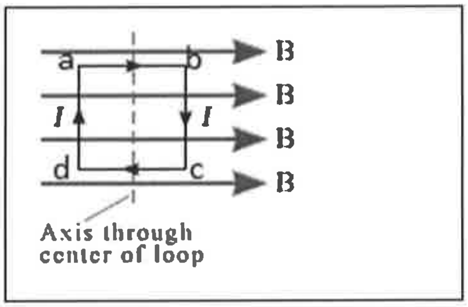
a. 0.075 volt
b. 0.15 volt
c. 0.18 volt
d. 0.35 volt
e. 0.75 volt

c 11. 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.

12-13) A square loop (abcd), carrying a current I, is placed in a uniform magnetic field B with the plane of the loop parallel to the magnetic field (see the drawing). The dashed line is the axis of rotation.



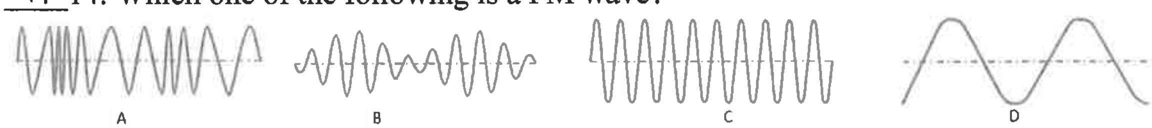
C 12. What is the angle between I and B for the side 'da'?

a. 0^0 b. 45^0 c. 90^0 d. 180^0

a 13. What is the direction of the force on the side da of the loop?

a. up b. down c. left
d. right e. in f. out

A 14. Which one of the following is a FM wave?



C 15. What is the angle between the electric and magnetic fields in an electromagnetic wave?

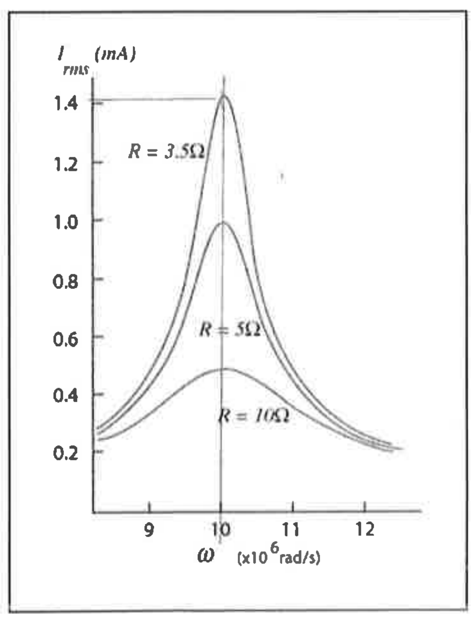
a. 0^0 b. 45^0 c. 90^0 d. 120^0 e. 180^0

d 16. Maxwell theorized electromagnetic theory using how many equations?

a. 1 b. 2 c. 3 d. 4 e. 5

e 17. The resonance curves for an RLC circuit are shown for various resistances. Using the plot, determine the angular frequency, ω of the resonance?

a. 10 rad/s b. 10^4 rad/s c. 10^5 rad/s
d. 10^6 rad/s e. 10^7 rad/s f. 10^8 rad/s



f 18. What is the rms current for the 3.5 ohm resistor at the resonance?

a. 0.4 mA b. 0.45 mA c. 0.8 mA
d. 1.0 mA e. 1.2 mA f. 1.4 mA

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

__b__ 19. This physicist first conclusively proved the existence of the **electromagnetic** waves by generating and detecting them___________.
a. Maxwell b. Hertz c. Tesla d. Henry

__C__ 20. What happens to the capacitive reactance X_C and the inductive reactance X_L if the frequency of the ac voltage is doubled?
a. X_C and X_L do not change
b. X_C increases by a factor of 2, and X_L decreases by a factor of 2
c. X_C decreases by a factor of 2, and X_L increases by a factor of 2
d. X_C and X_L both decrease by a factor of 2
e. X_C and X_L both increase by a factor of 2

____________________end of MC questions____________________

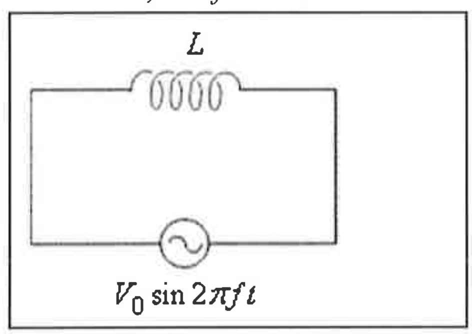
B. What is the rms current I_{rms} in the circuit when V_{rms} = 45 V, L = 5.3 mH, and f = 1.5 kHz?

$Z = X_L$, $R = 0$, $X_C = 0$

$X_L = 2\pi f L = 2\pi \times 1.5\times10^{3} \times 5.3\times10^{-3}$

$X_L = 49.95\,\Omega$

$I_{rms} = \frac{V_{rms}}{X_L} = \frac{45}{49.95} = 0.90\,A$

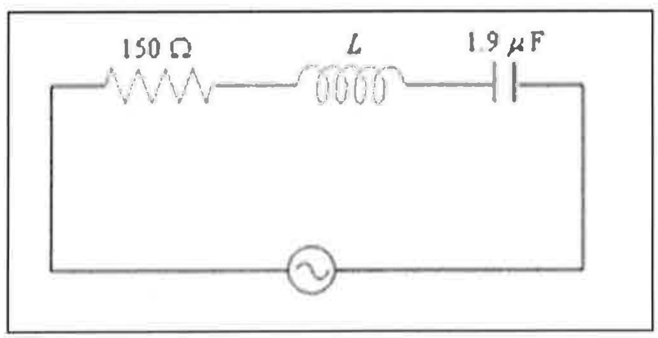


C. The inductance in the drawing has a value of L = 7.2 mH. What is the resonant frequency f_0 of this circuit?

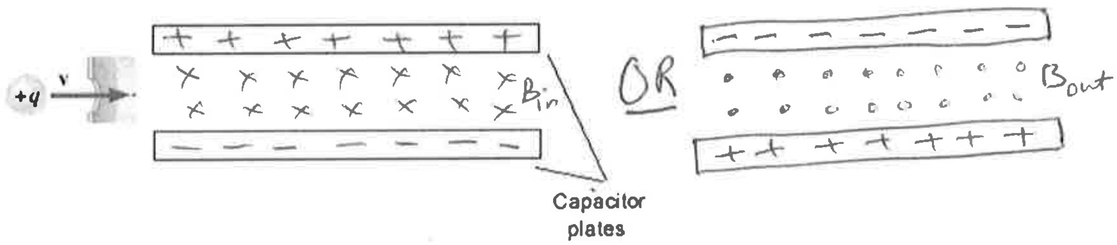
$f_0 = \frac{1}{2\pi\sqrt{LC}}$

$f_0 = \frac{1}{2\pi\sqrt{7.2\times10^{-3}\times1.9\times10^{-6}}}$

$f_0 = 1360$ Hz

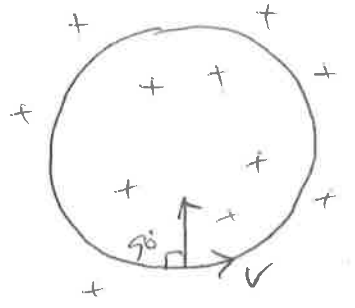


D. A velocity selector is shown below for positively charged particles. Show the charges in the capacitor plates and the magnetic field between the plates, for this to work.



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

E1. Using the above two equations, Derive an expression for the radius of a charge particle in circular motion in terms of velocity, charge, magnetic field, and mass.

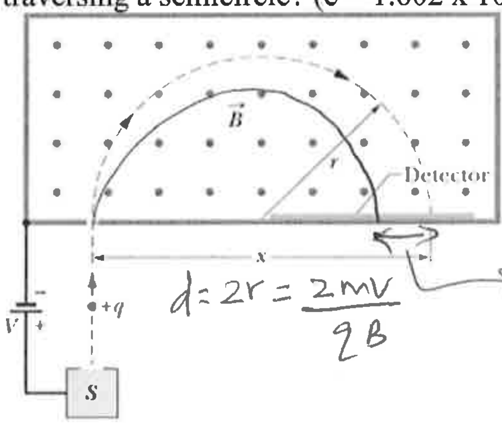


$$qvB\sin\theta = \frac{mv^2}{r}$$

$$qvB = \frac{mv^2}{r}$$

$$qB = \frac{mv}{r} \rightarrow \boxed{r = \frac{mv}{qB}}$$

E2. Doubly charged uranium-235 and uranium-238 ions are being separated in a mass spectrometer. (The much rarer uranium-235 is used as reactor fuel.) The masses of the ions are 3.90×10^{-25} kg and 3.95×10^{-25} kg, respectively, and they travel at 2.2×10^{5} m/s in a 0.21-T field. What is the separation between their paths when they hit a target after traversing a semicircle? ($e = 1.602 \times 10^{-19}$C)



$$d = 2r = \frac{2mv}{qB}$$

Separation $= d_2 - d_1$

$$d_2 = \frac{2m_2v}{qB}, \quad d_1 = \frac{2m_1v}{qB}$$

$$d_2 = \frac{2\times3.95\times10^{-25}\times2.2\times10^{5}}{2\times1.602\times10^{-19}\times0.21} = 2.583\text{ m}$$

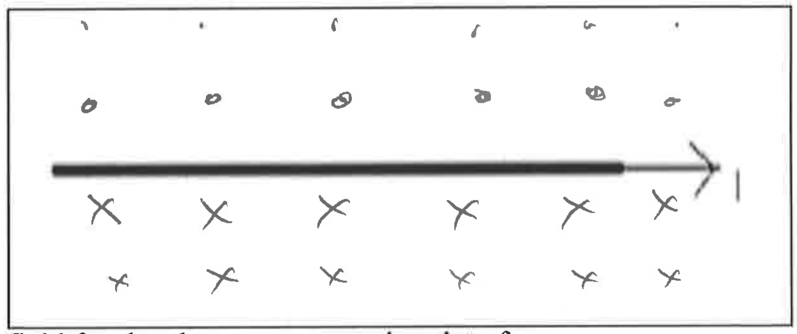
$$d_1 = \frac{2\times3.90\times10^{-25}\times2.2\times10^{5}}{2\times1.602\times10^{-19}\times0.21} = 2.550\text{ m}$$

$$d_2 - d_1 = 2.583 - 2.550 = 0.0326\text{ m}$$

$$\Delta d = 0.0326\text{ m} \text{ or } 3.26\text{ cm}$$

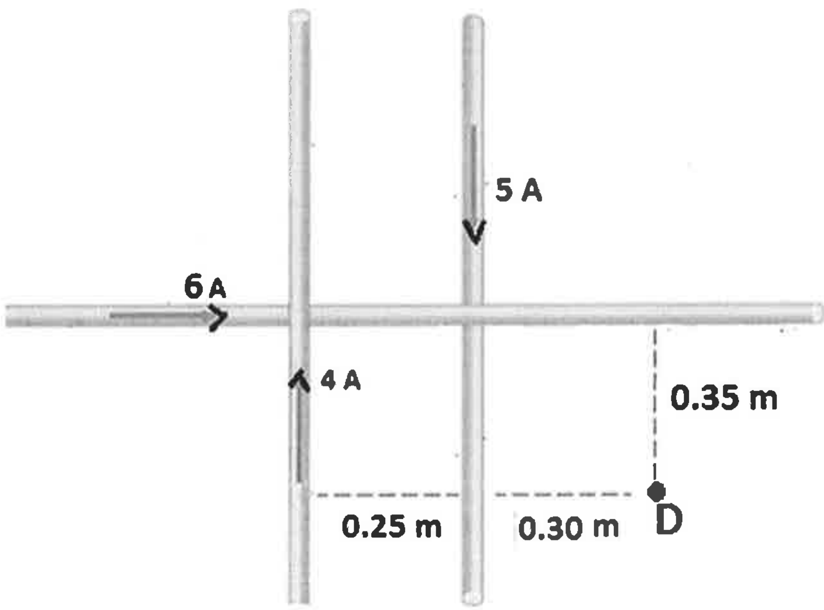
F. The magnetic field due to a long straight wire, carrying a current I, at a distance r is given by; ($\mu_0 = 4\pi \times 10^{-7}$ T.m/A)

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



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

2. The drawing below shows three long, straight wires, all of which lie in the plane of the paper. The current in each of the wires are shown in the diagram. Find the magnitude and direction of the net magnetic field at D, due to all three currents.



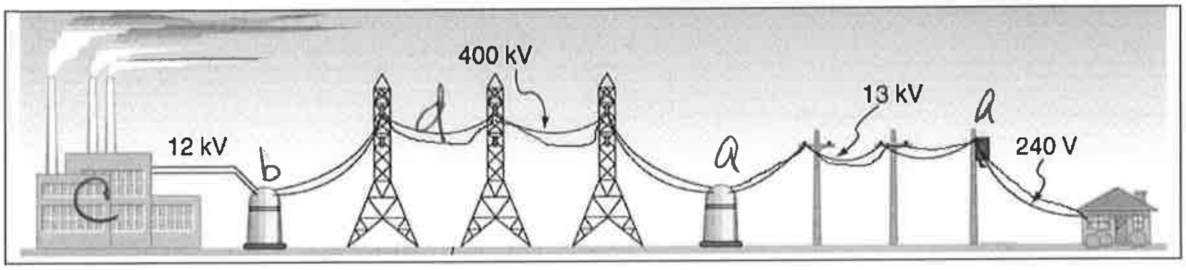
$$B_{6A} = \frac{\mu_0 I}{2\pi r} = \frac{4\pi \times 10^{-7} \times 6}{2\pi \times 0.35} = 3.43 \times 10^{-6} \text{ T } \otimes$$

$$B_{4A} = \frac{\mu_0 I}{2\pi r} = \frac{4\pi \times 10^{-7} \times 4}{2\pi \times 0.55} = 1.45 \times 10^{-6} \text{ T } \otimes$$

$$B_{5A} = \frac{\mu_0 I}{2\pi r} = \frac{4\pi \times 10^{-7} \times 5}{2\pi \times 0.3} = 3.33 \times 10^{-6} \text{ T } \odot$$

$$B_{net} = 3.43 \times 10^{-6} + 1.45 \times 10^{-6} - 3.33 \times 10^{-6}$$

$$B_{net} = 1.55 \times 10^{-6} \text{ T } \otimes = 1.55\ \mu\text{T } \otimes$$



G. Power transmission is illustrated above.
Equations for transformers and power transmission are shown below:

$$\frac{V_s}{V_p} = \frac{N_s}{N_p} \qquad P = IV \qquad I_S V_S = I_P V_P \qquad P_{loss} = I^2 R$$

1. Identify the following in the figure above:
a. step-down transformer b. step-up transformer c. Power plant
d. high-voltage transmission lines

2. At what voltage, power is transmitted through the high-voltage transmission lines? 400 kV

d 3. Which one of the following is the same between the primary (input) and secondary (output) coils of an ideal transformer?
a. voltage b. current c. magnetic flux d. magnetic field

4. A power plant is producing 1.8×10^6 W of power that is to be sent to a small town located 150 km away. Each of the two wires that comprise the transmission line has a resistance per kilometer of length of 4.0×10^{-2} Ω/km.
(a) Calculate the total resistance of the two wires.

$150\,km \times 2 \times 4.0 \times 10^{-2} \frac{\Omega}{km} = 12\,\Omega$

(b) Calculate the ratio $\frac{N_S}{N_P}$ for the step-up transformer shown in the figure.

$\frac{N_s}{N_p} = \frac{V_s}{V_p} = \frac{400\,kV}{12\,kV} = \frac{400}{12} = 33.33$

(c) Find the power lost in heating the wires if the power is transmitted at 12 kV.

$P = IV \rightarrow 1.8 \times 10^6 = 12 \times 10^3 I \rightarrow I = 150\,A$

$P_{loss} = I^2 R = 150^2 \times 12 = 270{,}000\,W = 270\,kW$

$P_{loss} = 270\,kW$

(d) Find the power lost in heating the wires if the power is transmitted at 400 kV.

$P = IV \rightarrow 1.8 \times 10^6 = I \times 400 \times 10^3$

$I = 4.5\,A$ $\quad P_{loss} = 4.5^2 \times 12$

$P_{loss} = 243\,W$