PHYS 202 Equations Sheet You may tear this page

1. Force on a moving electric charge in a magnetic field. $F = q \times v \times B \times Sin\theta$

2. Force on a moving electric charge in an electric field. $F = q \times E$

3. Centripetal force: $F_c = m\frac{v^2}{r}$

4. Force on a current in a magnetic field. $F = I \times L \times B \times Sin\theta$

5. Magnetic field produced by electric current: $B = \frac{\mu_0 I}{2\pi r}$

6. Faraday's law of induction and Magnetic flux: $\xi = -N\frac{\Delta\Phi}{\Delta t}; \Phi = B_\perp A.$

7. Equations for transformers and power loss during transmission are shown below:

$\frac{V_s}{V_P} = \frac{N_s}{N_P}$ $I_S V_S = I_P V_P$ P = IV $P_{loss} = I^2 R$ $V_{rms} = \frac{V_p}{\sqrt{2}}$

8. Reactance (X_C) of a capacitor and Reactance (X_L) of an inductor:

$\chi_C = \frac{1}{2\pi fC}.$ $\chi_L = 2\pi fL.$ $f = \frac{1}{T}.$

9. Impedance (Z) of a series RCL circuit:

$$Z = \sqrt{(R^2 + (\chi_L - \chi_C)^2}.$$

10. Resonant frequency (f_0) of a series RCL circuit: $f_0 = \frac{1}{2\pi\sqrt{LC}}.$

11. Electromagnetic waves: $c = \frac{E}{B}$ $c = \lambda f$

12. Circumference, C and Area, A of a circle (radius r): $C = 2\pi r$ $A = \pi r^2$

13. Proton charge = 1.6×10^{-19}C. Proton mass = 1.673×10^{-27} kg

PHYS 202 Spring 2018 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 in the space provided with them.

a 1. The angular difference between the magnetic north and the geographical north is called the

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

d 2. 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?

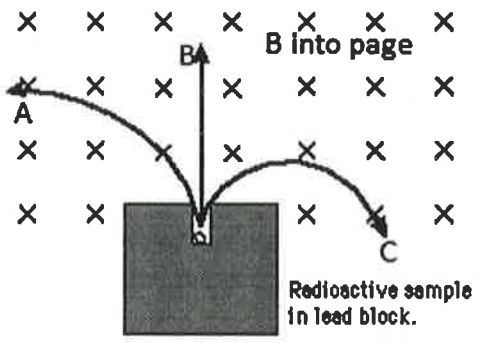
a. North b. South c. East d. West

d 3. 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. What is the direction of the magnetic force on the current, in between the poles?

a. Up b. Down
c. To the Left d. To the Right
e. in f. out

d 4. Three particles (A, B, and C) released from a radioactive sample are moving perpendicular to a uniform magnetic field (see the drawing). What are the signs of the charges in the particles?

a. All three are positive.
b. All three are negative.
c. All three are neutral.
d. A is positive, B is neutral, and C is negative.
e. C is positive, B is neutral, and A is negative.
f. A is positive, C is neutral, and B is negative.



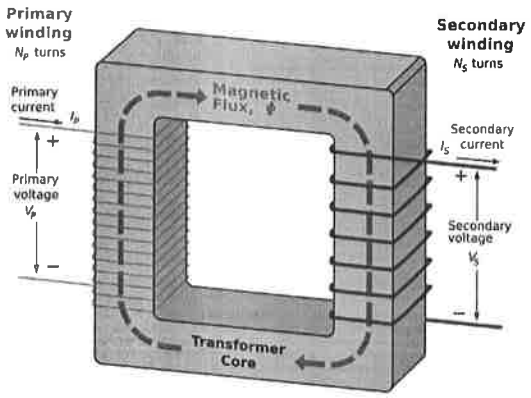
A 5. Among the electromagnetic waves, which one is used for communications?

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

C 6. This physicist is credited with the development of alternating current electrical system:

a. Maxwell b. Henry c. Tesla d. Hertz e. Faraday

b 7. The transformer shown below is:
a. step-up b. step-down

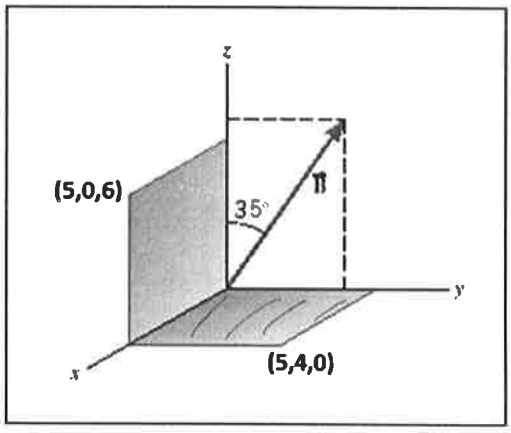


f 8. Identify two quantities (among 1-6) that are the same between the primary and secondary windings of an ideal transformer?
a. 1 and 2 b. 2 and 3 c. 3 and 4 d. 4 and 5 e. 5 and 6 f. 3 and 6

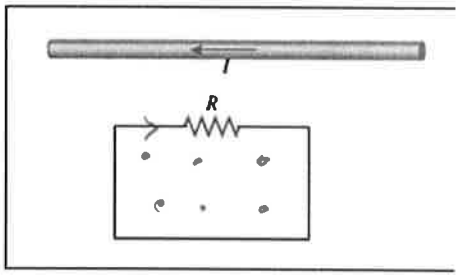
1. voltage 2. current 3. power
4. # of turns 5. magnetic flux 6. magnetic field

Magnetic flux is given below; $\Phi = B_{\perp} A$.

b 9. Two surfaces and a magnetic field (B = 0.5T), uniform throughout the surfaces, 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 xy plane?
a. 5.74 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. 8.6 T.cm^2



10-12) The drawing shows a straight wire carrying a current *I*. Below the wire is a rectangular loop that contains a resistor *R*.



a 10. What is the direction of the magnetic field inside the loop?
a. coming out (·) b. going in (X)

c 11. If the current *I* is constant, what is the direction of the induced current through the resistor *R*?
a 12. If the current *I* is increasing in time, what is the direction of the induced current through the resistor *R*?
Answers to 11 and 12
a. left to right b. right to left c. no current

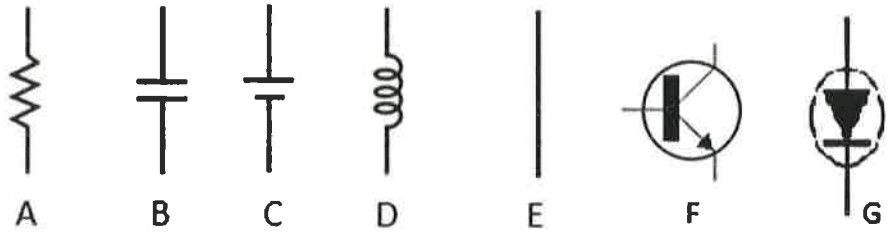
b 13. Radio waves travel at the speed of light, 3.0 x 10^8 m/s. What is the wavelength of the 88.1 MHz radio wave? (M = 10^6) Speed of light = $C = \lambda f$

a. 3.0 m b. 3.4 m c. 34 m d. 340 m e. 3.4 x 10^6 m

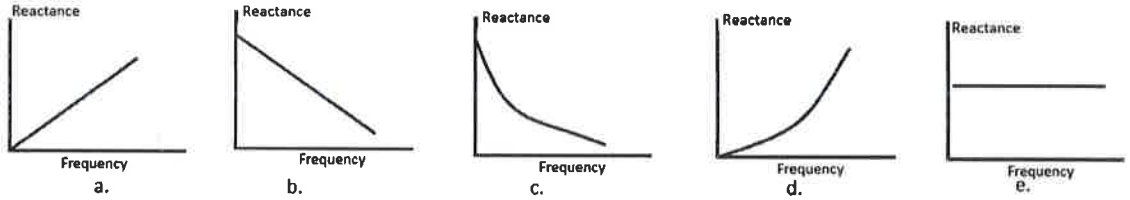
14-15) Various circuit elements are shown below.

D 14. Which one represents an inductor?

F 15. Which one represents a transistor?



C 16. Which one of the following shows the reactance of a capacitor as a function of frequency?



C 17. What is the angle between the electric and magnetic fields in an electromagnetic wave?

C 18. What is the angle between the electric field and velocity in an electromagnetic wave?

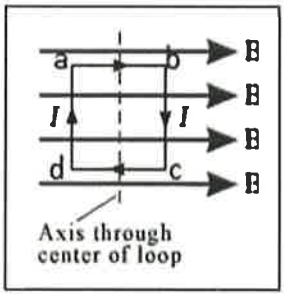
Answers for 17 and 18

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

f 19. 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. What is the direction of the force on the side bc of the loop?

a. up b. down c. left

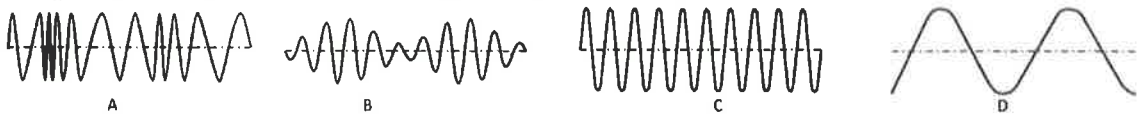
d. right e. in f. out



d 20. An alternating sine wave signal has a peak-to-peak voltage of 34 volt. What is its RMS voltage?

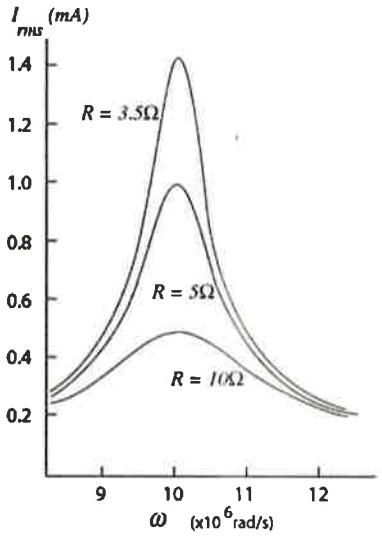
a. 34 volt b. 24 volt c. 17 volt d. 12 volt e. 6.0 volt

B 21. Which one of the following is an AM wave?



d 22. The resonance curves for an RLC circuit are shown for various resistances. Using the plot, determine the rms current for the 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



----------end of MC questions----------

$$\frac{V_s}{V_P} = \frac{N_s}{N_P} \qquad I_S V_S = I_P V_P \qquad P = IV$$

B. A generating station is producing 1.8 x 10^6 W of power at 1500 V. A transformer with 50 turns in the primary and 19,000 turns in the secondary is used to change the voltage before the power is transmitted. What is the current in the transmission lines?

$$\frac{V_S}{V_P} = \frac{N_S}{N_P}$$

$$\frac{V_S}{1500} = \frac{19{,}000}{50} \rightarrow V_S = \frac{19{,}000}{50} \times 1500$$

$V_S = 57{,}0000$ volt

$$P = IV \rightarrow I = \frac{P}{V} = \frac{1.8 \times 10^6}{57{,}0000} = 3.16\ A$$

$I = 3.16\ A$

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

C1. Using the above two equations, Derive an expression for the velocity of a charge particle in circular motion in terms of radius, charge, magnetic field, and mass.

$$\frac{mv^2}{r} = qvBSin\theta \quad (\theta = 90)$$

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

$$v = \frac{qBr}{m}$$

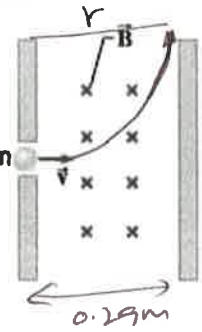
C2. A proton with a speed of 2.8×10^6 m/s is shot into a region between two plates that are separated by a distance of 0.29 m. As the drawing shows, a magnetic field exists between the plates, and it is perpendicular to the velocity of the proton. What must be the magnitude of the magnetic field so the proton just misses colliding with the opposite plate?

$r = 0.29\text{m}$

$$V = \frac{qBr}{m}$$

$$B = \frac{mv}{qr} = \frac{1.673\times10^{-27} \times 2.8\times10^{6}}{1.6\times10^{-19} \times 0.29}$$

$$B = 0.10\,T$$



D. Show that the following equation is dimensionally correct, ie, the units match on both sides.

$$c = \frac{E}{B}$$

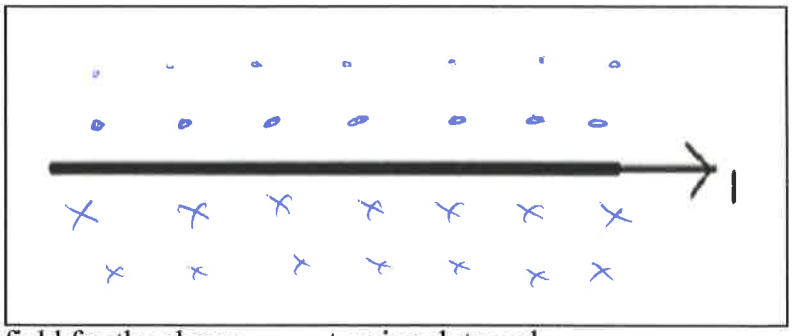
$F_E = qE \rightarrow E = \frac{F}{q} \rightarrow N/C$

$F_B = qvBSin\theta \rightarrow B = \frac{F}{qv} \rightarrow \frac{N}{C \cdot m/s}$

$$\frac{E}{B} = \frac{N/C}{(N/C)(m/s)} = m/s = C$$

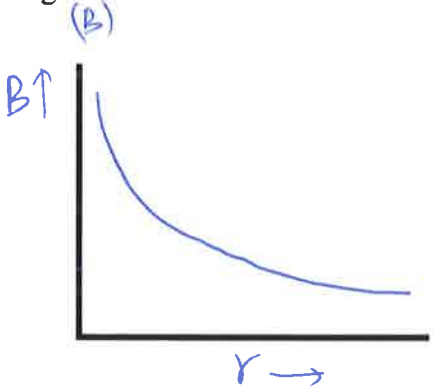
E. The magnetic field due to a long straight wire, carrying a current I, at a distance r is given by; ($\mu_0 = 4\pi x10^{-7}$ T.m/A)

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

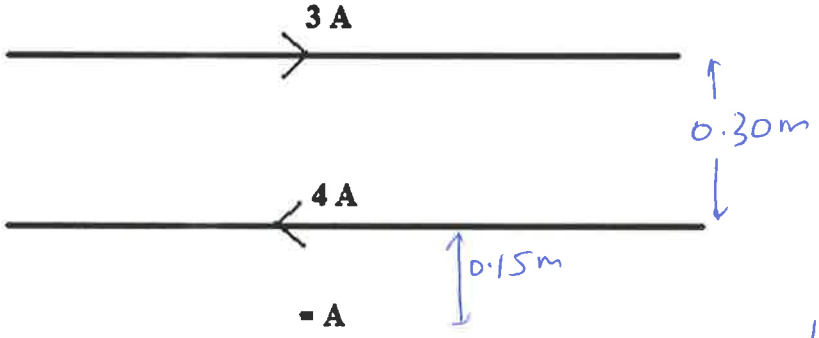


1. Show the cross-section of the magnetic field for the above current, using dots and crosses in the diagram above.

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



3. Two long straight wires, carrying currents 3.0 A and 4.0 A are separated by a distance of 0.30 m, lie as shown below. Determine the net magnetic field (magnitude and direction) from both currents at point A which is located 0.15 m from the bottom wire, as shown below.



$B_{3A} = \frac{\mu_0 I}{2\pi r} = \frac{4\pi x10^{-7} x\ 3}{2\pi x\ 0.45} = 1.33 x10^{-6}$ T ⊗

$B_{4A} = \frac{\mu_0 I}{2\pi r} = \frac{4\pi x10^{-7} x 4}{2\pi x\ 0.15} = 5.33 x10^{-6}$ T ⊙

$B_{net} = 5.33 x10^{-6} - 1.33 x10^{-6}$

$B_{net} = 4.0 x10^{-6}$ T ⊙

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

A loop of wire has the shape shown in the drawing.
The top part of the wire is bent into a semi-circle of diameter 0.30 m.
A constant magnetic field of magnitude 0.35 T is directed out of the paper.

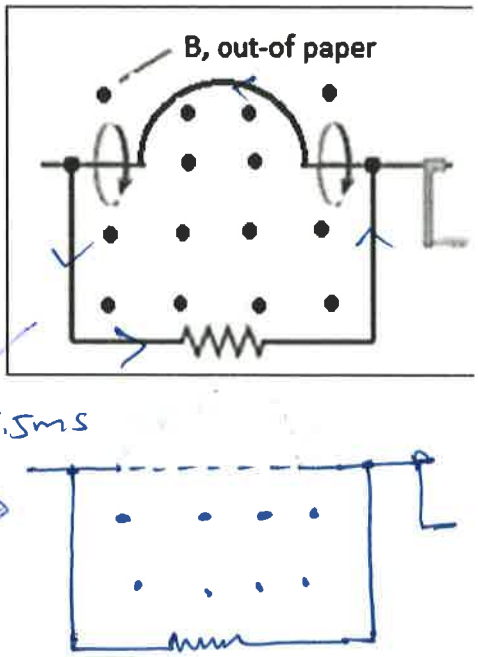
a. What is the change in magnetic flux when the semi-circular side is rotated through quarter of a revolution, starting from the position shown?

b. If the above quarter of a revolution takes 5.5 ms, what is the induced emf in the loop?

c. If the resistance shown in the loop is 1.8 ohm, what is the induced current?

d. Show the direction of the induced current in the loop?

f. What is the frequency of the above rotation?



a. diameter = 0.30m → r = 0.15m

$\frac{1}{4}$ of a revolution → $\frac{1}{2}\pi r^2$

$\Delta\phi = -B_{\perp}A = -0.35 \times \frac{1}{2}\pi \times 0.15^2$

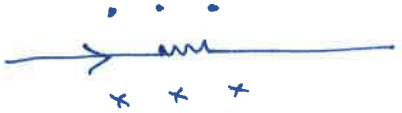
$\Delta\phi = -0.0124\ T.m^2$

b. $\xi = -N\frac{\Delta\phi}{\Delta t} = -1 \times \frac{(-0.0124)}{5.5\times10^{-3}} = 2.25\ Volt$

c. $V = IR \rightarrow I = \frac{V}{R} = \frac{\xi}{R} = \frac{2.25}{1.8} = 1.25A$

$I = 1.25A$

d. Losing dots. Need to create dots. Induced current flows →



f. $\frac{1}{4}$ of a revolution takes 5.5ms

Full " " $4\times5.5 = 22ms$

$T = 22\ ms = 0.022\ s$

$f = \frac{1}{T} = \frac{1}{0.022} = 45.5\ Hz$