PHYS 202 Equations Sheet You may tear this page T#3 S2022

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 = IR $V_{rms} = \frac{V_p}{\sqrt{2}}$

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

$\chi_C = \frac{1}{2\pi f C}.$ $\chi_L = 2\pi f L.$ $f = \frac{1}{T}$

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): $C = 2\pi r$ $A = \pi r^2$

Area of a rectangle = length x width. Area of a triangle = $\frac{1}{2} \times base \times height$

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

PHYS 202 Spring 2022 Test #3 Name: Key

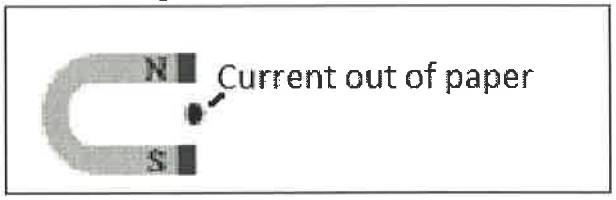
A. Select the correct answer for the multiple choices questions and write your answer in the line next to the question number.

__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

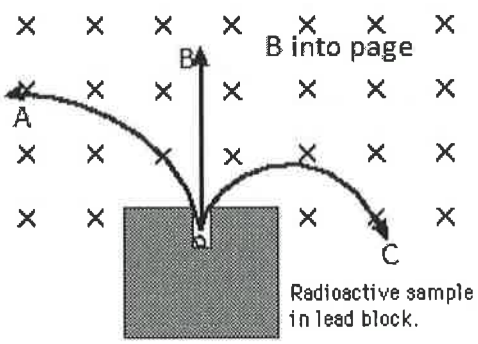
__d__ 2. A horseshoe magnet and a current-carrying wire are shown in the drawing. The wire is perpendicular to the paper, and the current is directed out of the paper. What is the direction of the magnetic force on the current, in between the poles?

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



__d__ 3. 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.

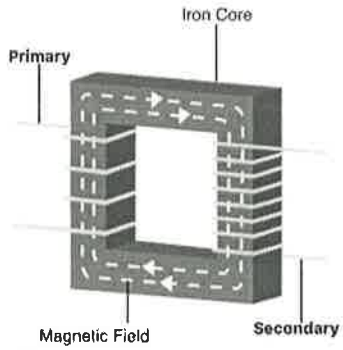


__A__ 4. Among the electromagnetic waves, which one is used for communications?
A. radio wave B. ultraviolet C. Gamma D. X-ray E. Infrared

__c__ 5. Who is credited with the development of alternating current electrical system:
__e__ 6. Who is credited with the development of electromagnetic induction:
Answers for 5 & 6
a. Maxwell b. Henry c. Tesla d. Hertz e. Faraday

__d__ 7. Which one of the following is a unit for magnetic field?
__e__ 8. Which one of the following is a unit for magnetic flux?
__c__ 9. Which one of the following is a unit for magnetic energy?
Answers for 7,8,9
a. C b. W c. J d. T e. Wb f. A

a 10. The transformer shown below is:
a. step-up b. step-down



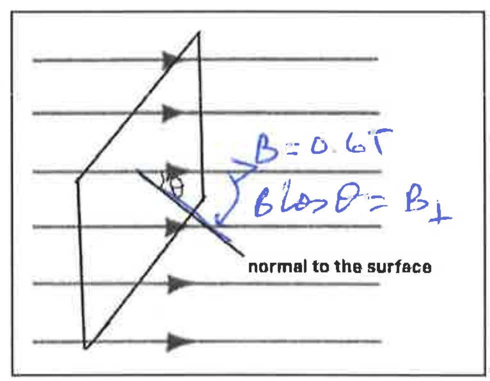
ꝭ 11. Identify two quantities (among 1-6) that are the same between the primary and secondary windings of an ideal transformer?
a. 1 and 2 b. 2 and 3 c. 3 and 4 d. 4 and 5 e. 5 and 6 f. 3 and 6
1. voltage 2. current 3. power
4. # of turns 5. magnetic flux 6. magnetic field

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

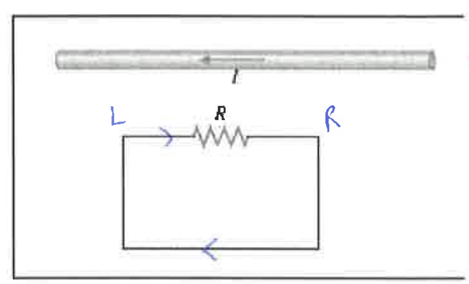
d 12. Magnetic field lines (B = 0.6 T) are passing through a rectangular loop of length 12 cm and width 8.0 cm as shown. The angle between the magnetic field and the normal to the loop-surface, $\theta = 25^0$. What is the magnetic flux through the loop?

a. 57.6 $T.cm^2$ b. 24.3 $T.cm^2$
c. 96.6 $T.cm^2$ d. 52.2 $T.cm^2$
e. 96.0 $T.cm^2$ f. 12.0 $T.cm^2$

(B cos θ) x 12x8



13-15) The drawing shows a straight wire carrying a current *I*. Below the wire is a rectangular loop that contains a resistor *R*.



a 13. What is the direction of the magnetic field inside the loop?
a. coming out (·) b. going in (X)

c 14. If the current *I* is constant, what is the direction of the induced current through the resistor *R*?

a 15. If the current *I* is increasing in time, what is the direction of the induced current through the resistor *R*?

Answers to 14 and 15
a. left to right b. right to left c. no current

b 16. Radio waves travel at the speed of light, 3.0×10^8 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. 3.4×10^6 m

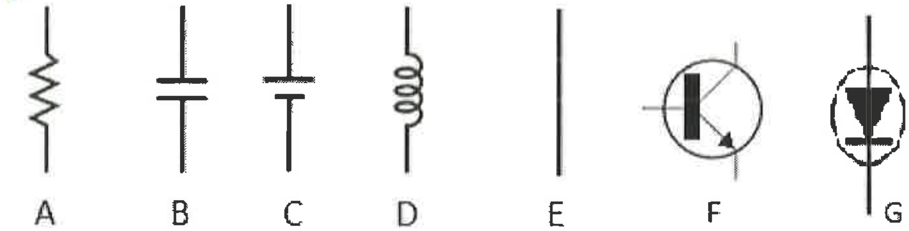
$3 \times 10^8 = 88.1 \times 10^6 \times \lambda$

$\frac{3 \times 10^8}{88.1 \times 10^6} = \lambda$

17-18) Various circuit elements are shown below.

__D__ 17. Which one represents an inductor?

__F__ 18. Which one represents a transistor?



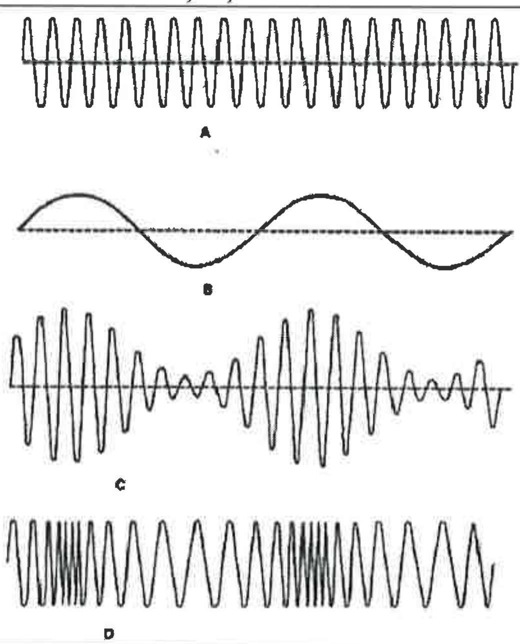
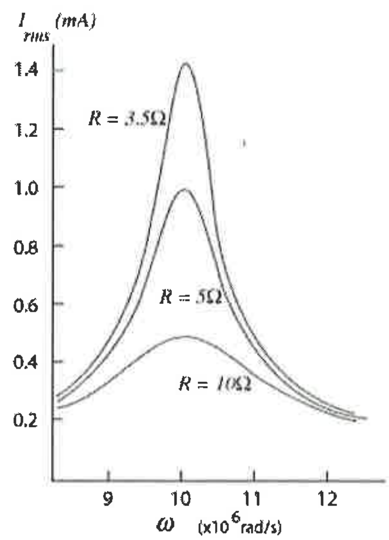
__C__ 19. What is the angle between the electric and magnetic fields in an electromagnetic wave?

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

__A__ 20. Which one of the following is an unmodulated career wave?

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

__D__ 22. Which one of the following is a FM wave?

Answers for 20,21,22	Figure for Q23
	

__f__ 23. The resonance curves for an RLC circuit are shown for various resistances above. Using the plot, determine the V_{rms} for the 5 ohm resistor at the resonance?

a. 0.4 mV b. 0.45 mV c. 0.8 mV d. 1.0 mV e. 1.4 mV f. 5.0 mV

__d__ 24. In a RCL circuit, a 16.0-Ω resistor, a 4.10-μF capacitor, and a 5.30-mH inductor are connected in series. What is the resonance frequency of this circuit?

a. 108 Hz b. 546 Hz c. 732 Hz d. 1080 Hz e. 6780 Hz

--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

6

B. A generating station is producing 1.8 x 10^6 W of power at 2500 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?

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

$\frac{V_S}{2500} = \frac{19000}{50} \rightarrow V_S = \frac{2500 \times 19000}{50} = 95,0000$ volt

$P = IV \rightarrow 1.8 \times 10^6 = 950000 \times I$

$\frac{1.8 \times 10^6}{950000} = I = 1.9A$

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

5

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.

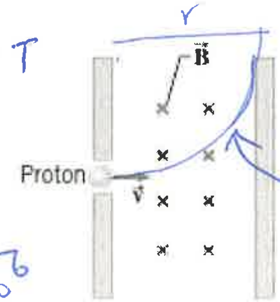
$\frac{mv^2}{r} = qvB\sin\theta \quad (\rightarrow 90°)$

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

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

6

C2. A proton with a speed of 2.8 x 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 (a) magnitude of the magnetic field so the proton just misses colliding with the opposite plate and leaves parallel to the second plate?
(b) how long the proton takes to clear the magnetic field?



$B = \frac{mV}{qr} = \frac{1.673 \times 10^{-27} \times 2.8 \times 10^6}{1.6 \times 10^{-19} \times 0.29} = 0.1T$

$B = 0.1 T$

$d = \frac{2\pi r}{4}$

$t = \frac{d}{v} = \frac{2\pi r/4}{2.8 \times 10^6} = \frac{2\pi r}{4 \times 2.8 \times 10^6} = \frac{2\pi \times 0.29}{4 \times 2.8 \times 10^6}$

$t = 0.163 \mu s$

4

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

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

$\vec{F} = q\vec{E}$

$E = F/q = N/C$

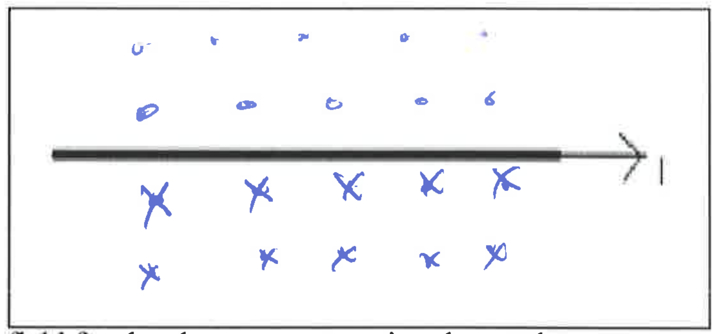
$F_B = qvB\sin\theta$

$B = F/qv = \frac{N \cdot s}{C \cdot m} = \frac{kg \cdot m \cdot s / s^2}{C \cdot m} = \frac{kg}{C \cdot s}$

$c \stackrel{?}{=} \frac{N/C}{N \cdot s / C \cdot m} = m/s$

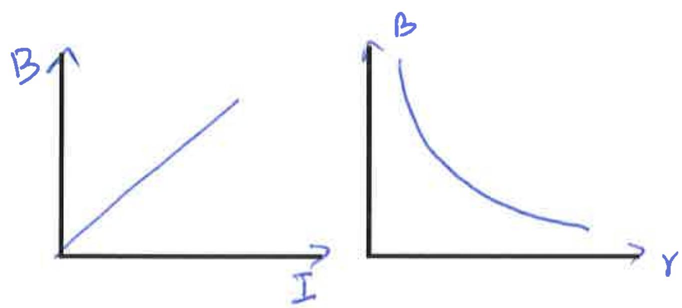
E. The magnetic field due to a long straight wire, carrying a current I, at a distance r is given by; ($\mu_0 = 4\pi x 10^{-7}$ T.m/A)

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

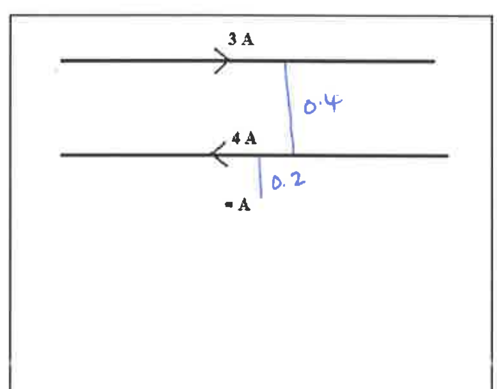


4 1. Show the cross-section of the magnetic field for the above current, using dots and crosses in the diagram above.

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



6 3. Two long straight wires, carrying currents 3.0 A and 4.0 A are separated by a distance of 0.40 m, lie as shown below. Determine the net magnetic field (magnitude and direction) from both currents at point A which is located 0.20 m from the bottom wire, as shown below.



$B_{3A} = \frac{\mu_0 I}{2\pi r} = \frac{4\pi \times 10^{-7} \times 3}{2\pi \times 0.6} = 1\,\mu T \otimes$

$B_{4A} = \frac{\mu_0 I}{2\pi r} = \frac{4\pi \times 10^{-7} \times 4}{2\pi \times 0.2} = 4\,\mu T \odot$

$B_{net} = 4\,\mu T \odot + 1\,\mu T \otimes$

$B_{net} = 3\,\mu T \odot$

15

F. Faraday's law of induction: $\xi = -N\dfrac{\Delta\Phi}{\Delta t}; \Phi = B_{\perp}A.$ 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 triangle of base 0.16 m and height 0.08 m. A constant magnetic field of magnitude 0.35 T is directed into the paper.

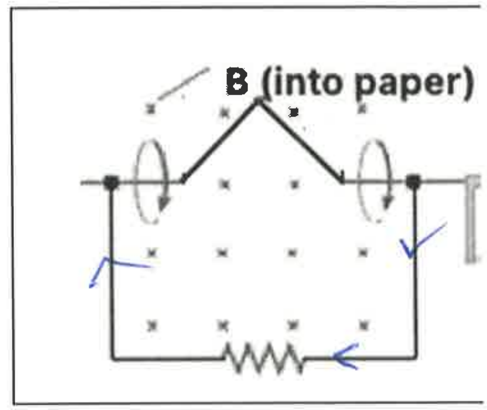
a. What is the change in magnetic flux when the triangular side is rotated through quarter of a revolution, starting from the position shown?

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

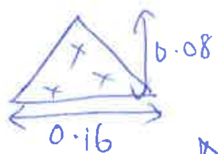
c. If the resistance shown in the loop is 1.8 ohm, what is the induced current?

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

f. What is the frequency of the above rotation?



a.



Area = $\frac{1}{2}bh = \frac{1}{2} \times 0.16 \times 0.08 = 0.0064\,m^2$

$\Delta\phi = -0.0064 \times 0.35 = -0.00224\,T.m^2$

(b) $\xi = -N.\dfrac{\Delta\phi}{\Delta t} = -\dfrac{1 \times (-0.0024)}{0.0055} = 0.407$ Volt

(c) $V = IR \rightarrow I = \dfrac{V}{R} = \dfrac{0.407}{1.8} = 0.226\,A$

(d) During quarter of a revolution loosing (X).
So, Induced current will produce (X)
So, the induced current will flow as shown.

(f) $f = \dfrac{1}{T}$, $T = 4 \times 5.5\,ms = 22\,ms = 0.022\,s$
↳ for 1/4 of a revolution.

$f = \dfrac{1}{0.022} = 45.5\,Hz$