Name FULLER Period ______ Date ______

REVIEW — Chapter 26

1. A loop of wire is turning in a magnetic field of magnetic induction 4.0×10^{-3} T. Each side of the coil is 5.0 cm long and carries 2.0 A of current. What is the EMF induced in one side of the loop if it is moving at 2.5 m/s?

$V = v l B_{\perp}$

$V = (2.5\,m/s)(0.050\,m)(4.0 \times 10^{-3}\,T)$

$V = 5.0 \times 10^{-4}\,V$

2. A copper wire with a resistance of 0.50 Ω is connected to a galvanometer. The wire is then moved through a field of magnetic induction 4.0×10^{-5} T at a speed of 4.0 m/s. The length of wire between the poles of the magnet is 7.0 cm. What is the current in the wire?

$V = v l B_{\perp}$

$V = (4.0\,m/s)(0.070\,m)(4.0 \times 10^{-5}\,T)$

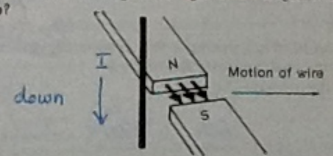
$V = 1.12 \times 10^{-5}\,V$

$V = IR$

$I = \frac{V}{R}$

$I = \frac{1.12 \times 10^{-5}\,V}{0.50\,\Omega} = 2.2 \times 10^{-5}\,A$

3. In the drawing below, the wire is moving to the right in the magnetic field. What is the direction of the current in the wire?

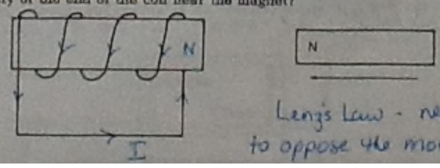


Conventional current will be down. (Right hand rule - generator effect)

4. A circuit breaker is a magnetic switch that opens the circuit when the current reaches a certain value. What is the effective current in a circuit if the circuit breaker opens when the AC current reaches 20.0 amps?

5. The effective voltage across a 300-ohm lamp in a household AC circuit is 115 V. What is the maximum current through the lamp?

6. A magnet is moving toward a coil as shown in the diagram. A magnetic field is induced in the coil. What is the polarity of the end of the coil near the magnet?



Lenz's Law - need a polarity to oppose the moving magnet.

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7. To operate a neon sign, the voltage must be stepped up from 120 V to 15 000 V. What is the ratio of secondary turns to primary turns?

$\frac{N_s}{N_p} = \frac{V_s}{V_p}$ $\frac{N_s}{N_p} = \frac{15\,000\ V}{120\ V} = 1.2 \times 10^2$

8. A power line can carry a maximum current of 175 A. The power company needs to deliver 1500 watts to each of 35 000 people in a city.

$P = IV$

a. What is the voltage at which this power would be delivered?

$(1500 W)(35000) = 5.25 \times 10^7 W$

$V = \frac{P}{I} = \frac{5.25 \times 10^7 W}{175 A}$

$V = 3.00 \times 10^5 V$

b. What is the ratio of secondary to primary turns needed to step down the voltage to 120 V?

$\frac{N_s}{N_p} = \frac{120 V}{3.00 \times 10^5 V} = 4 \times 10^{-4}$ or $\frac{1}{2500}$

9. A step-up transformer is connected to a generator that is delivering 120 V at 150 A. The ratio of turns on the secondary to the turns on the primary is 2500 to 1.

a. What is the voltage in the secondary?

$\frac{N_s}{N_p} = \frac{V_s}{V_p}$ $\frac{2500}{1} = \frac{V_s}{120 V}$ $V_s = 3.0 \times 10^5 V$

b. What is the current in the secondary?

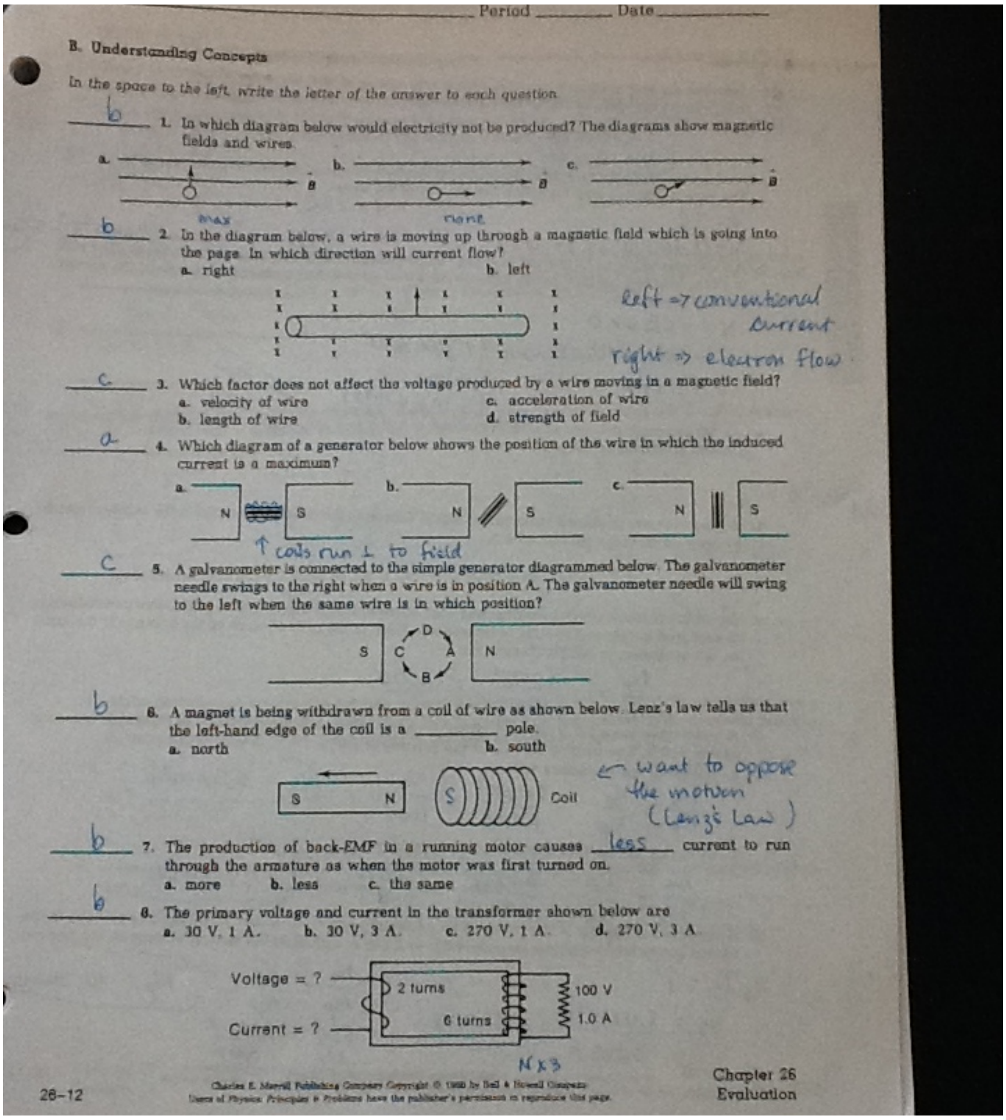
$\frac{V_s}{V_p} = \frac{I_p}{I_s}$ $\frac{3.0 \times 10^5 V}{120 V} = \frac{150 A}{I_s}$ $I_s = 0.060 A$

c. What is the power output?

$P = IV$

$P = (150 A)(120 V)$

$P = 1.8 \times 10^4 W$



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B. Understanding Concepts

In the space to the left, write the letter of the answer to each question.

__b__ 1. In which diagram below would electricity not be produced? The diagrams show magnetic fields and wires.

a. (max) b. (none) c.

__b__ 2. In the diagram below, a wire is moving up through a magnetic field which is going into the page. In which direction will current flow?
a. right b. left

left => conventional current
right => electron flow

__c__ 3. Which factor does not affect the voltage produced by a wire moving in a magnetic field?
a. velocity of wire
b. length of wire
c. acceleration of wire
d. strength of field

__a__ 4. Which diagram of a generator below shows the position of the wire in which the induced current is a maximum?

a. N S b. N S c. N S

↑ coils run ⊥ to field

__c__ 5. A galvanometer is connected to the simple generator diagrammed below. The galvanometer needle swings to the right when a wire is in position A. The galvanometer needle will swing to the left when the same wire is in which position?

S C D A B N

__b__ 6. A magnet is being withdrawn from a coil of wire as shown below. Lenz's law tells us that the left-hand edge of the coil is a ________ pole.
a. north b. south

S N (S) Coil

← want to oppose the motion (Lenz's Law)

__b__ 7. The production of back-EMF in a running motor causes __less__ current to run through the armature as when the motor was first turned on.
a. more b. less c. the same

__b__ 8. The primary voltage and current in the transformer shown below are
a. 30 V, 1 A. b. 30 V, 3 A. c. 270 V, 1 A. d. 270 V, 3 A.

Voltage = ?
Current = ?
2 turns
6 turns
100 V
1.0 A

N x 3

26–12

Chapter 26
Evaluation

C. Using Concepts

1. Calculate the EMF produced in a wire 50.0 m long moving at 40.0 m/s perpendicularly to a magnetic field with an induction of 1.6×10^{-1} T (N/A·m).

$V = vlB$ $\quad V = (40.0 m/s)(50.0 m)(1.6 \times 10^{-1} T)$

$V = 320 V$

2. A 32-Ω wire ~~produces 2.0 A~~ when moved perpendicularly to a magnetic field of induction 4.0×10^{-2} T. The wire is 100.0 m long. Calculate the velocity of the wire.

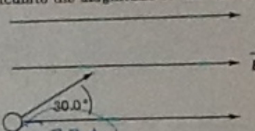
$V = IR$

$V = (2.0 A)(32 \Omega) = 64 V$

$V = vlB$

$v = V/lB = 64 V / (100 m)(4.0 \times 10^{-2} T) = 16 m/s$

3. A 2.0-Ω wire moves at 12 m/s and at a 30.0° angle through a magnetic field as shown below. The wire is 120 m long and the field has an induction of 2.0×10^{-3} T. Calculate the magnitude of the current induced in the wire.



$V = vlB \sin\theta$

$V = (12 m/s)(120 m)(2.0 \times 10^{-3} T) \sin 30.0°$

$V = 1.44 V$

$V = IR$

$I = V/R = 1.44 V / 2.0 \Omega = 0.72 A$

~~4.~~ An AC generator delivers an effective voltage of 115 V to a 350-W ~~light bulb~~. Calculate the maximum current produced by the generator.

~~5.~~ A generator can produce a maximum of 500 V. Calculate the resistance needed in the external circuit to draw an effective current of 4 A.

6. Electricity is transmitted through power lines at potentials of 240 000 volts (V_p). A step-down transformer is employed to deliver 120 volts (V_s) to households. What is the ratio of turns on the primary to the turns on the secondary in such a transformer?

$$\frac{N_p}{N_s} = \frac{240000}{120} = \frac{2000}{1}$$

7. A transformer has a 5.0×10^3-turn secondary and a 1.0×10^2-turn primary. The primary is connected across 110 V. The current flowing in the primary is 2.0 A.
   a. Calculate the secondary voltage.

$$\frac{N_s}{N_p} = \frac{V_s}{V_p} \qquad \frac{5.0 \times 10^3}{1.0 \times 10^2} = \frac{V_s}{110 V} \qquad V_s = 5.5 \times 10^3 V$$

   b. Calculate the current flowing in the secondary.

$$\frac{N_s}{N_p} = \frac{I_p}{I_s} \qquad \frac{5.0 \times 10^3}{1.0 \times 10^2} = \frac{2.0 A}{I_s} \qquad I_s = 0.040 A$$

8. A transformer has 8.0×10^2 turns on its secondary and a 1.0×10^4 W rating. The primary is connected across 40.0 V and the secondary draws 3.125 A. Calculate the number of turns on the primary.

$V_s I_s = P$

$$V_s = \frac{1.0 \times 10^4 W}{3.125 A} = 3200 V$$

$$\frac{N_s}{N_p} = \frac{V_s}{V_p} \qquad \frac{800}{N_p} = \frac{3200 V}{40 V} \qquad N_p = 10 \text{ turns}$$

REVIEW — Chapter 27

Assume the direction of all moving charged particles is perpendicular to any fields.

1. An electron moving at 2.0×10^{6} m/s moves through a magnetic field that has a magnetic induction of 8.0×10^{-2} T. What is the radius of the electron's path in this field?

$F_{mag} = F_c$

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

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

$r = \frac{(9.1 \times 10^{-31} kg)(2.0 \times 10^{6} m/s)}{(1.6 \times 10^{-19} C)(8.0 \times 10^{-2} T)}$

$r = 1.4 \times 10^{-4} m$

2. A magnetic field and an electric field are perpendicular to each other. A stream of charged particles moves in a straight line perpendicular to both fields. The electric field intensity is 5.0×10^{4} N/C and the magnetic induction is 3.0×10^{-2} T. What is the speed of the particles?

$F_e = F_{mag}$

$qE = qvB$

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

$v = \frac{5.0 \times 10^{4} N/C}{3.0 \times 10^{-2} T} = 1.7 \times 10^{6} m/s$

3. A charged particle is accelerated from rest through a potential difference of 8.0×10^{2} V. It enters a magnetic field of magnetic induction 5.0×10^{-2} T.

a. Calculate the m/q ratio.

$qV = \frac{1}{2}mv^2$

$\frac{m}{q} = \frac{2V}{v^2}$

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

$\frac{m}{q} = \frac{rB}{v}$

$\therefore \frac{2V}{v^2} = \frac{rB}{v}$

$\frac{2V}{v} = rB$

$v = \frac{2V}{rB} = 5.3 \times 10^{5} m/s$

so $\frac{m}{q} = \frac{2V}{v^2}$

$\frac{m}{q} = 5.7 \times 10^{-9} kg/C$

b. If the particle has a charge of 1.6×10^{-19} C, what is its mass?

$\frac{m}{q} = 5.7 \times 10^{-9} \frac{kg}{C}$

$m = (1.6 \times 10^{-19} C)(5.7 \times 10^{-9} \frac{kg}{C})$

$m = 9.1 \times 10^{-28} kg$

4. Alpha particles are accelerated through a potential difference of 8.0×10^{2} V. The particles have a mass of 6.68×10^{-27} kg and a charge twice that of an electron, but positive. If the magnetic field has an induction of 0.30 T, what is the radius of the path of the particles?

$qV = \frac{mv^2}{2}$

$v^2 = 2qV/m$

$v^2 = 2(2)(1.6 \times 10^{-19} C)(8.0 \times 10^{2} V)/(6.68 \times 10^{-27} kg) \Rightarrow v = 2.8 \times 10^{5} m/s$

$r = \frac{mv}{qB} = 0.019 m$

5. A beam of electrons is bent in a circle of radius 3.0 cm by a magnetic field that has a magnetic induction of 5.0×10^{-4} T. What is the speed of the electrons?

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

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

$v = \frac{(1.6 \times 10^{-19} C)(0.030 m)(5.0 \times 10^{-4} T)}{(9.1 \times 10^{-31} kg)}$

$v = 2.6 \times 10^{6} m/s$

Chapter 27 Review

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$m = 1.67 \times 10^{-27}$ kg

6. A proton moves across a field of magnetic induction 3.0×10^{-2} T. The radius of the path is 1.5×10^{-2} m.

a. What is the speed of the proton?

$qvB = \frac{mv^2}{r}$ $v = \frac{qrB}{m}$

$qB = \frac{mv}{r}$ $v = \frac{(1.6 \times 10^{-19}\,C)(1.5 \times 10^{-2}\,m)(3.0 \times 10^{-2}\,T)}{1.67 \times 10^{-27}\,kg} = 4.3 \times 10^{4}\,m/s$

b. The proton follows a straight line path when an electric field is applied at right angles to the magnetic field. What is the strength of the electric field?

$F_{mag} = F_E \Rightarrow qvB = qE$ $E = (4.3 \times 10^{4}\,m/s)(3.0 \times 10^{-2}\,T)$

$E = 1.3 \times 10^{3}\,\frac{N}{C}$

7. A lithium ion with a speed of 7.0×10^5 m/s and a charge of 1.6×10^{-19} C enters the magnetic field of a mass spectrometer. The magnetic induction is 0.28 T and the radius of the ion path is 0.30 m. Find the mass of the lithium ion.

$qvB = \frac{mv^2}{r}$ $m = \frac{qrB}{v}$

$m = \frac{qvBr}{v^2}$ $m = \frac{(1.6 \times 10^{-19}\,C)(0.30\,m)(0.28\,T)}{7.0 \times 10^{5}\,m/s} = 1.9 \times 10^{-26}\,kg$

8. An electron and a proton move at the same speed as they enter a 0.030 T magnetic field. The electron moves in a circular path of radius 8.0 mm. Calculate the radius of the path of the proton.

electron: $qvB = \frac{mv^2}{r}$ $v = \frac{(1.6 \times 10^{-19}\,C)(0.0080\,m)(0.030\,T)}{9.1 \times 10^{-31}\,kg}$

$v = \frac{qrB}{m}$ $v = 4.2 \times 10^{7}\,m/s$

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

$r = \frac{(1.67 \times 10^{-27}\,kg)(4.2 \times 10^{7}\,m/s)}{(1.6 \times 10^{-19}\,C)(0.030\,T)}$

$r = 15\,m$

9. A radio wave has a wavelength of 2500 km. Find its frequency.

universal wave equation: $v = \lambda f$ $f = \frac{v}{\lambda} = \frac{3.00 \times 10^{8}\,m/s}{2500 \times 10^{3}\,m}$

$f = 120\,Hz$

10. Gamma rays have a frequency of 6.0×10^{17} Hz. What is their wavelength?

$\lambda = \frac{v}{f}$

$\lambda = \frac{3.00 \times 10^{8}\,m/s}{6.0 \times 10^{17}\,Hz}$

$\lambda = 5.0 \times 10^{-10}\,m$

C. Using Concepts

$2(1.6\times10^{-19}C)$

1. An alpha particle (2 protons, 2 neutrons) with a mass of 6.6×10^{-27} kg is accelerated by a potential of 1.0×10^{3} V. Calculate the speed acquired by the alpha particles.

$qV = \frac{mv^2}{2}$

$v^2 = \frac{2qV}{m}$

$v^2 = \frac{2(2)(1.6\times10^{-19}C)(1.0\times10^{5}V)}{6.6\times10^{-27}kg}$

$v = 3.1\times10^{6}$ m/s

$1.6\times10^{-19}C$

2. A beam of singly charged particles is not deflected when subjected to both a 2.0×10^{-2} T magnetic field and an 8.0×10^{3} N/C electric field. Calculate the speed of the particles.

$F_{mag} = F_{Q}$

$qvB = qE$

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

$v = (8.0\times10^{3}N/C)/(2.0\times10^{-2}T) = 4.0\times10^{5}$ m/s

3. A beam of singly charged particles passes through electric and magnetic fields. The fields are adjusted so that there is no deflection, and the speed of the particles is calculated to be 6.00×10^{6} m/s. The beam then passes through another magnetic field which forces it into a circular path with a radius of 1.56 m. This magnetic field has an induction of 4.00×10^{-2} T. Calculate the mass of these particles.

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

$m = \frac{qvBr}{v^2}$

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

$m = \frac{(1.6\times10^{-19}C)(4.00\times10^{-2}T)(1.56m)}{(6.00\times10^{6}m/s)}$

$m = 1.7\times10^{-27}$ kg

4. With an accelerating voltage of 73.5 V, a mass spectrograph produces ions with masses of 6.8×10^{-26} kg that move in a semicircle (radius = 8.6×10^{-2} m) in a 6.5×10^{-2} T magnetic field.

a. What is the charge on one ion?

[illegible]

$v = \frac{2V}{rB} = \frac{2(73.5V)}{(8.6\times10^{-2}m)(6.5\times10^{-2}T)}$ (from 27-3)

$v = 2.6\times10^{4}$ m/s

b. How many electrons have been removed from one atom by the spectrograph to produce the ion?

$\frac{3.2\times10^{-19}C}{1.6\times10^{-19}C} = 2$

2 electrons have been removed

$qV = \frac{mv^2}{2}$

$q = \frac{mv^2}{2V}$

$q = (6.8\times10^{-26}kg)(2.6\times10^{4})^2$