Name: ________________________ Class: ___________________ Date: __________ ID: A

Phys.G12-Q4W3-Electromagnetism- Qs. bank

Multiple Choice
Identify the choice that best completes the statement or answers the question.

____ 1. A current can be induced in a closed circuit without the use of a battery or an electrical power supply by moving the circuit through a
a. high temperature field.
b. gravitational field.
c. magnetic field.
d. nuclear field.

____ 2. All of the following are ways to induce an emf in a loop of wire *except* which one?
a. Move the loop into or out of a magnetic field.
b. Rotate the loop in a magnetic field.
c. Move the loop parallel to a magnetic field.
d. Insert the loop into a changing magnetic field.

____ 3. A loop of wire is held in a vertical position at the equator with the face of the loop facing in the east-west direction. What change will induce the greatest current in the loop?
a. raising the loop to a higher elevation
b. moving the loop north
c. rotating the loop so its face is vertical
d. rotating the loop so its face is north-south

____ 4. A bar magnet falls through a loop of wire with constant velocity, and the north pole enters the loop first. The induced current will be greatest when the magnet is located so that the loop is
a. near either the north or the south pole.
b. near the north pole only.
c. near the middle of the magnet.
d. With no acceleration, the induced current is zero.

____ 5. Electricity may be generated by rotating a loop of wire between the poles of a magnet. The induced current is greatest when
a. the plane of the loop is parallel to the magnetic field.
b. the plane of the loop is perpendicular to the magnetic field.
c. the magnetic flux through the loop is a minimum.
d. the plane of the loop makes an angle of 45° with the magnetic field.

____ 6. A loop of wire is rotated 360° across an external magnetic field. During one period of revolution, the induced current changes in
a. magnitude only.
b. direction only.
c. both magnitude and direction.
d. amplitude.

____ 7. According to Lenz’s law, the magnetic field of an induced current in a conductor will
a. enhance the applied field.
b. heat the conductor.
c. increase the potential difference.
d. oppose a change in the applied magnetic field.

____ 8. Which statement is correct?
a. The magnetic field of an induced current increases the approaching magnetic field.
b. According to the principle of energy conservation, an induced field attempts to keep the total field strength constant.
c. An induced electric field opposes an applied magnetic field.
d. Lenz’s law is used to find the average induced emf.

____ 9. According to Lenz's law, if the applied magnetic field changes,
a. the induced field attempts to keep the total field strength constant.
b. the induced field attempts to increase the total field strength.
c. the induced field attempts to decrease the total field strength.
d. the induced field attempts to oscillate about an equilibrium value.

____ 10. A coil with 150 turns and a cross-sectional area of 1.00 m^2 experiences a magnetic field whose strength increases by +0.65T in 1.80 s. The plane of the coil is perpendicular to the plane of the applied magnetic field. What is the induced emf in the coil?
a. 54 V
b. 0.36 V
c. –27 V
d. –54 V

____ 11. A circular coil with an area of 5.0×10^{-2} m^2 and with 500 turns of wire is placed in a uniform magnetic field perpendicular to the plane of the coil. If the field changes in value from –0.100 T to +0.150 T in an interval of 0.500 s, what is the induced emf in the coil?
a. –12.5 V
b. 125 V
c. 188 V
d. 252 V

____ 12. A coil with a wire that is wound around a 2.0 m^2 hollow tube 35 times. A uniform magnetic field is applied perpendicular to the plane of the coil. If the field changes uniformly from 0.00 T to 0.55 T in 0.85 s, what is the induced emf in the coil?
a. –45 V
b. –33 V
c. 33 V
d. 45 V

____ 13. Which of the following options can be used to generate electricity?
a. Move the circuit loop into and out of a magnetic field.
b. Change the magnetic field strength around the circuit loop.
c. Change the orientation of the circuit loop with respect to the magnetic field.
d. all of the above

____ 14. A generator with a single loop produces the greatest magnetic force on the charges and the greatest induced emf when
a. the plane of the loop is parallel to the magnetic field.
b. half of the loop segments are moving perpendicular to the magnetic field.
c. the plane of the loop is perpendicular to the magnetic field.
d. none of the above

____ 15. The operation of an electric motor depends on
a. the Doppler effect.
b. the photoelectric effect.
c. the magnetic force acting on a current-carrying wire in a magnetic field.
d. induced commutators from the rotation of a wire in a magnetic field.

____ 16. How is a motor's mechanical energy able to perform mechanical work?
a. Mechanical energy is converted into electrical energy.
b. A current is generated by a rotating loop in a magnetic field.
c. Electrical energy is converted into a magnetic force.
d. A shaft connected to the rotating coil is attached to some external device.

____ 17. Under which condition is the back emf in an electric motor at its maximum value?
a. Motor speed is zero.
b. Current is at maximum.
c. Voltage is at maximum.
d. Motor speed is at maximum.

____ 18. Which of the following determines the maximum generated emf in an ac generator?
a. the coil rotation rate or angular frequency
b. the magnetic field strength, *B*
c. the loop area, *A*
d. all of the above

Use the following equations to find maximum emf.
maximum emf = $NAB\omega$
$\omega = 2\pi f$, where f = frequency in Hz.

____ 19. A generator consists of eight turns of wire, and each turn has an area of $0.15\ \text{m}^2$. The loop rotates in a magnetic field of 0.55 T at constant frequency of 9.0 Hz. What is the maximum induced emf in the loop?
a. 37 V
b. 19 V
c. 5.9 V
d. 4.1 V

____ 20. A generator consists of 10.0 turns of wire, and each turn has an area of $0.095\ \text{m}^2$. If a maximum emf of 1.2×10^2 V is induced when the coil rotates with a frequency of 60.0 Hz, what is the strength of the magnetic field?
a. 0.15 T
b. 0.34 T
c. 0.85 T
d. 1.5 T

____ 21. Which conversion process is the basic function of the electric motor?
a. mechanical energy to electrical energy
b. electrical energy to mechanical energy
c. low emf to high emf, or vice versa
d. alternating current to direct current

____ 22. In a two-coil system, the mutual inductance depends on
a. only the geometrical properties of the coils.
b. only the orientation of the coils to each other.
c. both the geometrical properties of the coils and their orientation to each other.
d. neither the geometrical properties of the coils nor their orientation to each other.

____ 23. In a two-coil system, the induced potential difference in the secondary coil depends on
a. the orientation of the coils being kept constant.
b. the number of turns of wire.
c. the switch being kept open.
d. the iron ring around which the coils are wrapped.

____ 24. In a primary-secondary coil combination, which of the following conditions is met in the primary coil when the current in the secondary coil is at its maximum?
a. The current is maximum in a positive direction.
b. The current is maximum in a negative direction.
c. The rate of current change is maximum.
d. The voltage is maximum in a positive direction.

____ 25. Two loops of wire are arranged so that a changing current in the primary will induce a current in the secondary. The secondary loop has twice as many turns as the primary loop. As long as the current in the primary is steady at 3.0 A, the current in the secondary will be
a. 6.0 A.
b. 3.0 A.
c. 1.5 A.
d. zero.

____ 26. All of the following statements about ac rms values and maximum values are true *except* which one?
a. Rms values may equal maximum values.
b. Rms values are always less than maximum values.
c. Rms values are approximately 70 percent of the maximum values.
d. Rms values are different from maximum values because the alternating current is at its maximum only for an instant.

____ 27. What is rms (root-mean-square) current?
a. the value of alternating current that gives the same heating effect that the corresponding value of direct current does
b. an important measure of the current in an ac circuit
c. the amount of direct current that would dissipate the same energy in a resistor as is dissipated by the instantaneous alternating current over a complete cycle
d. all of the above

____ 28. A generator's maximum output is 220 V. What is the rms potential difference?
a. 110 V
b. 150 V
c. 160 V
d. 310 V

____ 29. The rms current in an ac current is 3.6 A. Find the maximum current.
a. 5.1 A
b. 4.7 A
c. 2.8 A
d. 1.8 A

____ 30. An ac generator has a maximum output emf of 215 V. What is the rms potential difference?
a. 145 V
b. 152 V
c. 216 V
d. 304 V

____ 31. The maximum current supplied by a generator to a 25 Ω circuit is 6.2 A. What is the rms potential difference?
a. 150 V
b. 120 V
c. 110 V
d. 62 V

____ 32. A generator supplies an rms current of 1.66 A. If the resistance of the circuit is 66.0 Ω, what is the maximum emf?
a. 38.7 V
b. 77.5 V
c. 125 V
d. 156 V

____ 33. An ac generator has a maximum output emf of 120 V. The generator is connected to a 125 Ω resistor. What is the rms current through the resistor?
a. 0.68 A
b. 1.47 A
c. 1.73 A
d. 2.43 A

____ 34. An ac generator has a maximum emf output of 150 V. What is the rms current in the circuit when the generator is connected to a 35 Ω resistor?
a. 3.1 A
b. 2.6 A
c. 1.5 A
d. 1.2 A

____ 35. A step-up transformer used on a 120 V line has 95 turns on the primary and 2850 turns on the secondary. What is the emf across the secondary?
a. 30 V
b. 1800 V
c. 2400 V
d. 3600 V

____ 36. A step-down transformer has 2500 turns on its primary and 5.0×10^1 turns on its secondary. If the potential difference across the primary is 4850 V, what is the potential difference across the secondary?
a. 1.0 V
b. 97 V
c. 110 V
d. 240 V

____ 37. A potential difference of 115 V across the primary of a step-down transformer provides a potential difference of 2.3 V across the secondary. What is the ratio of the number of turns of wire on the primary to the number of turns on the secondary?

a. 1:50 c. 7:1
b. 50:1 d. 1:7

____ 38. A transformer has 15 turns in its primary and 6750 turns in its secondary. If the potential difference across the primary is 1.2 V, what is the potential difference across the secondary?

a. 540 V c. 270 V
b. 380 V d. 125 V

____ 39. Electromagnetic waves are ____ electric and magnetic fields.

a. transverse c. oscillating
b. constant d. parallel

____ 40. How does an electromagnetic wave propagate itself?

a. A changing magnetic field induces an electric field perpendicular to the magnetic field.
b. A changing electric field induces a magnetic field perpendicular to the electric field.
c. Changing electric and magnetic fields produce a transverse wave that is perpendicular to both of the oscillating fields.
d. all of the above

____ 41. All of the following statements about the electromagnetic force are true *except* which one?

a. It is one of the four fundamental forces in the universe.
b. It exerts a force on either charged or uncharged particles.
c. It obeys the inverse-square law.
d. It is produced by—and produces—electric and magnetic fields.

____ 42. How many electromagnetic forces exist?

a. one c. three
b. two d. four

____ 43. Where is energy stored in electromagnetic waves?

a. in the wave's moving atoms
b. in the oscillating electric and magnetic fields
c. in the electromagnetic force
d. in the wave's directional vector

____ 44. Which of the following statements about electromagnetic radiation is true?

a. It transfers energy to objects in the path of the electromagnetic waves.
b. It can be converted to other energy forms.
c. It transports the energy of electromagnetic waves.
d. all of the above

____ 45. What do radio waves, microwaves, X rays, and gamma rays all have in common?

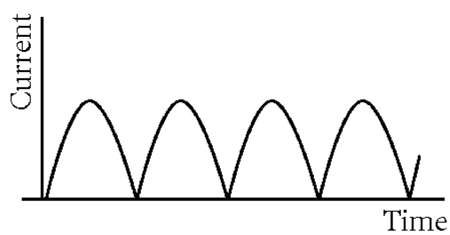
a. They are produced in the same way.
b. They are electromagnetic waves.
c. They are detected in the same way.
d. They store the same amount of energy.

Short Answer

1. Explain how the polarity of an induced emf in a wire is related to the right-hand rule.

2. Name four factors that affect the magnitude of the induced emf in a closed loop of wire.

3. List three ways to induce a current in a circuit loop, using only a magnet.
4. Thoroughly describe the magnetic field characteristics as an induced current is produced in a coil of wire by an approaching and receding magnet.
5. Lenz's law states that the magnetic field of the induced ____________________ is in a direction to produce a field that ____________________ the change causing it.
6. What does the minus sign in front of Faraday's law of magnetic induction indicate? How does it relate to Lenz's law?
7. Using Faraday's law of magnetic induction, predict what happens to the induced emf as Δt, the time rate of change of the magnetic flux, increases and decreases. Explain. What happens to the induced emf as θ, the angle of a circuit loop's orientation with respect to the magnetic field, is increased from 0.0° to 90.0°? Why?
8. What is a turbine's rotational motion used for in commercial power plants?
9. Explain why there is no induced current in a closed loop of wire when the area of the loop is perpendicular to the magnetic field.
10. Why does a generator produce a continuously changing emf?
11. List three essential components of an ac generator.



12. Identify the component that must be added to an ac generator in order to convert it to a dc generator. Interpret and relate the figure above to this component.
13. What kind of energy conversion occurs in a motor?
14. What induces a current in the secondary coil of a two-coil system?
15. Mutual inductance, M, is dependent on what two factors?
16. What extremely useful device is based on the principle of mutual inductance?
17. Given $P = \left(I_{rms}\right)^2 R$ and $P = \frac{1}{2}\left(I_{max}\right)^2 R$, find I_{rms}.
18. The rms emf across a resistor is equal to what?
19. What does an ac transformer consist of in its simplest form?
20. What kind of transformer has more turns in the primary coil than in the secondary coil?
21. If the secondary emf is less than the primary emf, what kind of transformer is used?
22. Why is power lost in real transformers?

23. Why does a car's ignition system need a transformer to work? What kind of transformer is in a car's ignition system?
24. Describe electromagnetic waves.
25. What determines the frequency of an electromagnetic wave?
26. How does an electromagnetic wave propagate itself?
27. What property does the electromagnetic force share with gravity, light, and sound?
28. What are the three quantities that can express the electromagnetic spectrum?
29. Identify one type of electromagnetic wave with a long wavelength. Describe at least two of its applications, and explain why the selected wave's long wavelength is important for both applications.
30. Identify one type of electromagnetic wave with a short wavelength. Describe at least two of its applications, and explain why the selected wave's short wavelength is important for both applications.

Problem

1. A coil with 279 turns and a cross-sectional area of $0.966\ \text{m}^2$ experiences a magnetic field whose strength increases by 0.786 T in 1.88 s. The plane of the coil is perpendicular to the plane of the magnetic field. What is the induced emf in the coil?
2. A coil with 6.98×10^2 turns and a cross-sectional area of $1.42\ \text{m}^2$ experiences a magnetic field for 3.26 s. The plane of the coil is perpendicular to the plane of the magnetic field. The magnetic field changes from 0.364 T to –0.351 T. What is the induced emf in the coil?
3. A coil with 37 turns of wire moves out of a uniform magnetic field of 1.7 T. The plane of the magnetic field is perpendicular to the plane of the coil. The coil has a cross-sectional area of $0.95\ \text{m}^2$. The coil exits the field in 1.8 s. If the coil's resistance is $1.7\ \Omega$, what is the induced current?
4. A coil of wire has 49 turns around a $0.51\ \text{m}^2$ hollow tube. A magnetic field is applied perpendicularly to the plane of the coil. The field changes uniformly from 1.8 T to 0.0 T in 2.7 s. If the resistance in the coil is $1.5\ \Omega$, what is the magnitude of the induced current?
5. A hollow tube whose cross-sectional area is $0.839\ \text{m}^2$ is wrapped with 5.46×10^2 turns of wire. A magnetic field that changes uniformly from –0.367 T to –0.786 T is applied perpendicularly to the plane of the coil for 0.966 s. If the current in the coil is 16.76 A, what is the coil's resistance?
6. The rms emf of an ac generator is 5.3×10^2 V. What is the maximum output emf?
7. A generator supplies an rms current of 7.99 A. If the resistance of the circuit is 35.7 Ω, what is the maximum emf?
8. An ac generator has a maximum output emf of 299 V. The generator is connected to a 99 Ω resistor. What is the rms current through the resistor?
9. A generator with a maximum output emf of 153 V is connected to a $19.3\ \Omega$ resistor. Find the maximum ac current in the circuit.

10. A generator with a maximum output emf of 9.65×10^3 V is connected to a 3.85×10^2 Ω resistor. Find the maximum ac current in the circuit.

11. The maximum allowed rms current in a circuit before its circuit breaker trips is 12.5 A. If a maximum emf of 180 V is connected to a device whose resistance is 8.4 Ω, will the circuit breaker trip and interrupt the flow of electricity?

12. A step-up transformer used on a 120 V line has 38 turns on the primary and 5815 turns on the secondary. What is the emf across the secondary?

13. A step-up transformer has a 120 V rms emf in its primary coil. The primary coil has 150 turns and the secondary coil has 6100 turns. What is the maximum emf across the secondary coil?

14. A primary coil with 88 turns and a cross-sectional area of 0.268 m^2 experiences a magnetic field whose strength increases uniformly from 0.00 T to 0.52 T in 0.65 s. The plane of the coil is perpendicular to the magnetic field. If the secondary coil has 4741 turns, what is the induced rms potential difference in the secondary coil?

15. A primary coil with 111 turns and a cross-sectional area of 0.132 m^2 experiences a magnetic field whose strength increases uniformly from 0.000 T to 0.869 T in 0.687 s. The plane of the coil lies perpendicular to the plane of the magnetic field. If the secondary coil has 7851 turns, what is the maximum induced emf in the secondary coil?

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Answer Section

MULTIPLE CHOICE

1.	ANS: C	PTS: 1	DIF: I	OBJ: 20-1.1
2.	ANS: C	PTS: 1	DIF: II	OBJ: 20-1.1
3.	ANS: D	PTS: 1	DIF: II	OBJ: 20-1.2
4.	ANS: A	PTS: 1	DIF: II	OBJ: 20-1.2
5.	ANS: A	PTS: 1	DIF: I	OBJ: 20-1.2
6.	ANS: C	PTS: 1	DIF: II	OBJ: 20-1.2
7.	ANS: D	PTS: 1	DIF: I	OBJ: 20-1.3
8.	ANS: B	PTS: 1	DIF: II	OBJ: 20-1.3
9.	ANS: A	PTS: 1	DIF: I	OBJ: 20-1.3

10. ANS: D

Given

$N = 150$ turns

$A = 1.00\ \text{m}^2$

$\Delta B = +0.65\ \text{T}$

$\Delta t = 1.80\ \text{s}$

$\theta = 0.0°$

Solution

Substitute values into Faraday's law of magnetic induction.

$$\text{emf} = -N\frac{\Delta\Phi_M}{\Delta t} = -N\frac{\Delta AB\cos\theta}{\Delta t} = -NA\cos\theta\frac{\Delta B}{\Delta t}$$

$$= -(150\ \text{turns})\left(1.00\ \text{m}^2\right)(\cos 0.0°)\,\frac{(0.65\ \text{T})}{(1.80\ \text{s})} = -54\ \text{V}$$

PTS: 1 DIF: IIIB OBJ: 20-1.3

11. ANS: A
Given

$N = 500$ turns

$A = 5.00 \times 10^2\ \text{m}^2$

$B_i = -0.100\ \text{T}$

$B_f = +0.150\ \text{T}$

$\Delta t = 0.500\ \text{s}$

$\theta = 0.00°$

Solution
Substitute values into Faraday's law of magnetic induction.

$$\text{emf} = -N\frac{\Delta\Phi_M}{\Delta t} = -N\frac{\Delta AB\cos\theta}{\Delta t} = -NA\cos\theta\frac{\Delta B}{\Delta t} = -NA\cos\theta\frac{\left(B_f - B_i\right)}{\Delta t}$$

$$= -(500\ \text{turns})\left(5.00 \times 10^2\ \text{m}^2\right)(\cos 0.00°)\ \frac{\left(0.150\ \text{T} - [-0.100\ \text{T}]\right)}{(0.500\ \text{s})}$$

$$= -12.5\ \text{V}$$

PTS: 1 DIF: IIIB OBJ: 20-1.3

12. ANS: A
Given

$N = 35$ turns

$A = 2.0\ \text{m}^2$

$B_i = 0.00\ \text{T}$

$B_f = 0.55\ \text{T}$

$\Delta t = 0.85\ \text{s}$

$\theta = 0.00°$

Solution
Substitute values into Faraday's law of magnetic induction.

$$\text{emf} = -N\frac{\Delta\Phi_M}{\Delta t} = -N\frac{\Delta AB\cos\theta}{\Delta t} = -NA\cos\theta\frac{\Delta B}{\Delta t} = -NA\cos\theta\frac{\left(B_f - B_i\right)}{\Delta t}$$

$$= -(35\ \text{turns})\left(2.0\ \text{m}^2\right)(\cos 0.00°)\ \frac{(0.55\ \text{T} - 0.00\ \text{T})}{(0.85\ \text{s})}$$

$$= -45\ \text{V}$$

PTS: 1 DIF: IIIB OBJ: 20-1.3

13. ANS: D PTS: 1 DIF: I OBJ: 20-2.1

14. ANS: A	PTS: 1	DIF: II	OBJ: 20-2.1
15. ANS: C	PTS: 1	DIF: I	OBJ: 20-2.1
16. ANS: D	PTS: 1	DIF: I	OBJ: 20-2.1
17. ANS: D	PTS: 1	DIF: I	OBJ: 20-2.1
18. ANS: D	PTS: 1	DIF: I	OBJ: 20-2.1

19. ANS: A

Given

$N = 8 \text{ turns}$

$A = 0.15 \text{ m}^2$

$B = 0.55 \text{ T}$

$f = 9.0 \text{ Hz}$

Solution

$\text{maximum emf} = NAB\omega = NAB2\pi f$

$= (8 \text{ turns})\left(0.15 \text{ m}^2\right)(0.55 \text{ T})(2\pi)(9.0 \text{ Hz}) = 37 \text{ V}$

PTS: 1 DIF: IIIB OBJ: 20-2.1

20. ANS: B

Given

$N = 10.0 \text{ turns}$

$A = 0.095 \text{ m}^2$

$f = 60.0 \text{ Hz}$

$\text{maximum emf} = 1.2 \times 10^2 \text{ V}$

Solution

Rearrange the equation, maximum emf = $NAB\omega$, to solve for B.

$$B = \frac{\text{maximum emf}}{NA\omega} = \frac{\text{maximum emf}}{NA2\pi f}$$

$$= \frac{1.2 \times 10^2 \text{ V}}{(10.0 \text{ turns})\left(0.095 \text{ m}^2\right)(2\pi)(60.0 \text{ Hz})} = 0.34 \text{ T}$$

PTS: 1 DIF: IIIB OBJ: 20-2.1

21. ANS: B	PTS: 1	DIF: I	OBJ: 20-2.2
22. ANS: C	PTS: 1	DIF: I	OBJ: 20-2.3
23. ANS: B	PTS: 1	DIF: I	OBJ: 20-2.3
24. ANS: C	PTS: 1	DIF: I	OBJ: 20-2.3
25. ANS: D	PTS: 1	DIF: II	OBJ: 20-2.3
26. ANS: A	PTS: 1	DIF: II	OBJ: 20-3.1

27. ANS: D PTS: 1 DIF: I OBJ: 20-3.1
28. ANS: C

Given

$\Delta V_{max} = 220 \text{ V}$

Solution

$\Delta V_{rms} = 0.707\Delta V_{max} = (0.707)(220 \text{ V}) = 160 \text{ V}$

PTS: 1 DIF: IIIA OBJ: 20-3.2

29. ANS: A

Given

$I_{rms} = 3.6 \text{ A}$

Solution

Rearrange the equation, $I_{rms} = 0.707 I_{max} =$, to solve for I_{max}.

$$I_{max} = \frac{I_{rms}}{0.707} = \frac{(3.6 \text{ A})}{(0.707)} = 5.1 \text{ A}$$

PTS: 1 DIF: IIIA OBJ: 20-3.2

30. ANS: B

Given

$\Delta V_{max} = 215 \text{ V}$

Solution

$\Delta V_{rms} = 0.707\Delta V_{max} = (0.707)(215 \text{ V}) = 152 \text{ V}$

PTS: 1 DIF: IIIA OBJ: 20-3.2

31. ANS: C

Given

$I_{max} = 6.2 \text{ A}$

$R = 25\ \Omega$

Solution

$I_{rms} = 0.707 I_{max} = (0.707)(6.2 \text{ A}) = 4.4 \text{ A}$

$\Delta V_{rms} = I_{rms} R = (4.4 \text{ A})(25\ \Omega) = 110 \text{ V}$

PTS: 1 DIF: IIIA OBJ: 20-3.2

32. ANS: D

Given

$I_{rms} = 1.66 \text{ A}$

$R = 66.0\ \Omega$

Solution

$\Delta V_{rms} = I_{rms} R = (1.66 \text{ A})(66.0\ \Omega) = 110 \text{ V}$

Rearrange the equation, $\Delta V_{rms} = 0.707 \Delta V_{max}$, to solve for ΔV_{max}.

$$\Delta V_{max} = \frac{\Delta V_{rms}}{0.707} = \frac{(110 \text{ V})}{(0.707)} = 156 \text{ V}$$

PTS: 1 DIF: IIIB OBJ: 20-3.2

33. ANS: A

Given

$\Delta V_{max} = 120 \text{ V}$

$R = 125\ \Omega$

Solution

$\Delta V_{rms} = 0.707 \Delta V_{max} = (0.707)(120 \text{ V}) = 85 \text{ V}$

Rearrange the equation, $\Delta V_{rms} = I_{rms} R$, to solve for I_{rms}.

$$I_{rms} = \frac{\Delta V_{rms}}{R} = \frac{(85 \text{ V})}{(125\ \Omega)} = 0.68 \text{ A}$$

PTS: 1 DIF: IIIB OBJ: 20-3.2

34. ANS: A

Given

$\Delta V_{max} = 150 \text{ V}$

$R = 35\ \Omega$

Solution

$\Delta V_{rms} = 0.707 \Delta V_{max} = (0.707)(150 \text{ V}) = 110 \text{ V}$

Rearrange the equation, $\Delta V_{rms} = I_{rms} R$, to solve for I_{rms}.

$$I_{rms} = \frac{\Delta V_{rms}}{R} = \frac{(110 \text{ V})}{(35\ \Omega)} = 3.1 \text{ A}$$

PTS: 1 DIF: IIIB OBJ: 20-3.2

35. ANS: D
Given

$\Delta V_1 = 120\ \text{V}$

$N_1 = 95\ \text{turns}$

$N_2 = 2850\ \text{turns}$

Solution

$$\Delta V_2 = \Delta V_1 \frac{N_2}{N_1} = (120\ \text{V})\left(\frac{2850\ \text{turns}}{95\ \text{turns}}\right) = 3600\ \text{V}$$

PTS: 1 DIF: IIIA OBJ: 20-3.3

36. ANS: B
Given

$\Delta V_1 = 4850\ \text{V}$

$N_1 = 2500\ \text{turns}$

$N_2 = 5.0 \times 10^1\ \text{turns}$

Solution

$$\Delta V_2 = \Delta V_1 \frac{N_2}{N_1} = (4850\ \text{V})\left(\frac{5.0 \times 10^1\ \text{turns}}{2500\ \text{turns}}\right) = 97\ \text{V}$$

PTS: 1 DIF: IIIA OBJ: 20-3.3

37. ANS: B
Given

$\Delta V_1 = 115\ \text{V}$

$\Delta V_2 = 2.3\ \text{V}$

Solution

$$N_1{:}N_2 = \frac{\Delta V_1}{\Delta V_2} = \frac{(115\ \text{V})}{(2.3\ \text{V})} = 50{:}1$$

PTS: 1 DIF: IIIA OBJ: 20-3.3

38. ANS: A

Given

$\Delta V_1 = 1.2\ \text{V}$

$N_1 = 15\ \text{turns}$

$N_2 = 6750\ \text{turns}$

Solution

$$\Delta V_2 = \Delta V_1 \frac{N_2}{N_1} = (1.2\ \text{V})\left(\frac{6750\ \text{turns}}{15\ \text{turns}}\right) = 540\ \text{V}$$

PTS: 1	DIF: IIIA	OBJ: 20-3.3	
39. ANS: C	PTS: 1	DIF: I	OBJ: 20-4.1
40. ANS: D	PTS: 1	DIF: I	OBJ: 20-4.1
41. ANS: B	PTS: 1	DIF: I	OBJ: 20-4.2
42. ANS: A	PTS: 1	DIF: I	OBJ: 20-4.2
43. ANS: B	PTS: 1	DIF: I	OBJ: 20-4.3
44. ANS: D	PTS: 1	DIF: I	OBJ: 20-4.4
45. ANS: B	PTS: 1	DIF: I	OBJ: 20-4.4

SHORT ANSWER

1. ANS:

The right-hand rule shows the relationship between the magnetic field, magnetic force, and the velocity of charged particle(s). The polarity of the induced emf depends on the direction in which the wire is moved through the magnetic field. As the right-hand rule indicates, reversing the wire’s velocity (motion or direction) will reverse the direction of the magnetic force and thus the polarity of the induced emf.

PTS: 1 DIF: II OBJ: 20-1.2

2. ANS:

the velocity of the wire through the magnetic field, the length of wire, the magnetic field strength, the angle between the magnetic field and the wire

PTS: 1 DIF: I OBJ: 20-1.2

3. ANS:

Move the circuit loop into or out of the magnetic field. Rotate the circuit loop in the magnetic field so that the angle between the plane of the circuit loop and magnetic field changes. Vary the intensity of the magnetic field by rotating the magnet.

PTS: 1 DIF: I OBJ: 20-1.2

4. ANS:
When an applied magnetic field approaches the coil of wire, the direction of the induced current produces an induced magnetic field that is in a direction opposite the approaching (or strengthening) magnetic field. As a result, these magnetic fields repel each other. When the applied magnetic field moves away from the coil of wire, the direction of the induced current once again produces a magnetic field that is in a direction opposite the receding (or weakening) magnetic field. This time, however, the induced magnetic field is in the same direction as the receding magnetic field. As a result, these magnetic fields attract each other.

PTS: 1 DIF: II OBJ: 20-1.2

5. ANS:
current, opposes

PTS: 1 DIF: I OBJ: 20-1.3

6. ANS:
the polarity of the induced emf; The induced magnetic field opposes the change in the applied magnetic field as stated by Lenz's law.

PTS: 1 DIF: I OBJ: 20-1.3

7. ANS:
As Δt increases, the induced emf decreases. As Δt decreases, the induced emf increases. These effects are observed because emf and Δt are indirectly related according to Faraday's law of magnetic induction. As θ is increased from 0.0° to 90.0°, the induced emf decreases. This occurs because only the magnetic field component perpendicular to the plane of the loop can induce a current. As θ increases, the magnetic field component perpendicular to the plane of the loop decreases and thus the emf is reduced.

PTS: 1 DIF: II OBJ: 20-1.3

8. ANS:
to turn wire loops (or a coil of wire) in a magnetic field

PTS: 1 DIF: I OBJ: 20-2.1

9. ANS:
When the area of the loop is perpendicular to the magnetic field, every segment of the wire in the loop is moving parallel to the magnetic field. At this point, no magnetic field lines are being crossed. Consequently, there is no magnetic force on any of the charges in the wire segments.

PTS: 1 DIF: II OBJ: 20-2.1

10. ANS:
As the loop rotates, the direction and number of wire segments that cross the magnetic field lines are constantly changing.

PTS: 1 DIF: II OBJ: 20-2.1

11. ANS:
field magnet, slip rings, and brushes

PTS: 1 DIF: I OBJ: 20-2.1

12. ANS:
commutator (or single split slip ring); The pulsating graph shows that the induced current changes from zero to a maximum value and back to zero. When the current approaches zero, each half of the commutator comes into contact with the brush that was previously in contact with the other half of the commutator. Even though the current reverses directions, the output current has the same direction as before, which the graph indicates by its plot of only positive current values.

PTS: 1 DIF: II OBJ: 20-2.1

13. ANS:
electrical energy to mechanical energy

PTS: 1 DIF: I OBJ: 20-2.2

14. ANS:
a changing current in the primary coil

PTS: 1 DIF: I OBJ: 20-2.3

15. ANS:
the geometrical properties of the coils and their orientation to each other

PTS: 1 DIF: I OBJ: 20-2.3

16. ANS:
transformer

PTS: 1 DIF: I OBJ: 20-2.3

17. ANS:
Since both equations = P, set them equal to each other and solve for I_{rms}.

$$\left(I_{rms}\right)^2 R = \frac{1}{2}\left(I_{max}\right)^2 R$$

$$\left(I_{rms}\right)^2 = \frac{\left(I_{max}\right)^2}{2}$$

$$I_{rms} = \frac{I_{max}}{\sqrt{2}} = 0.707\, I_{max}$$

PTS: 1 DIF: IIIA OBJ: 20-3.2

18. ANS:
the rms current multiplied by the resistance (or $I_{rms} \cdot R$)

PTS: 1 DIF: I OBJ: 20-3.2

19. ANS:
two coils of wire wound around a core of soft iron

PTS: 1 DIF: I OBJ: 20-3.3

20. ANS:
step-down transformer

PTS: 1 DIF: I OBJ: 20-3.3

21. ANS:
step-down transformer

PTS: 1 DIF: I OBJ: 20-3.3

22. ANS:
because of small currents induced by changing magnetic fields in the transformer’s iron core and because of resistance in the wires

PTS: 1 DIF: I OBJ: 20-3.3

23. ANS:
A transformer is needed to convert a car battery’s 12 dc volts to a larger potential difference so sparking will occur in the spark plug gaps and ignite the fuel. It is a step-up transformer.

PTS: 1 DIF: II OBJ: 20-3.3

24. ANS:
Electromagnetic waves are made of electric and magnetic fields that are oscillating at right angles to each other and to the direction of wave motion.

PTS: 1 DIF: I OBJ: 20-4.1

25. ANS:
the frequency of oscillation or the wavelength

PTS: 1 DIF: I OBJ: 20-4.1

26. ANS:
The changing electric field induces a magnetic field perpendicular to the electric field. The induced magnetic field then induces another electric field, and so forth.

PTS: 1 DIF: II OBJ: 20-4.1

27. ANS:
their magnitudes obey the inverse-square law

PTS: 1 DIF: I OBJ: 20-4.2

28. ANS:
wavelength, frequency, and energy

PTS: 1 DIF: I OBJ: 20-4.4

29. ANS:
Answers may vary. Sample answer: Radio waves work well for transmitting information across long distances because the long wavelengths can easily travel around objects. Radio waves help scientists understand deep space objects because the long wavelengths of radio waves pass through Earth’s atmosphere.

PTS: 1 DIF: II OBJ: 20-4.4

30. ANS:
Ultraviolet light is used as a disinfectant to kill bacteria because the UV wave's short wavelength (and high frequency) have enough energy to destroy these organisms. UV light is also used to study the chemical makeup of atoms and molecules because the short wavelengths increase resolution and permit scientists to study atomic structures.

PTS: 1 DIF: II OBJ: 20-4.4

PROBLEM

1. ANS:
$-113\ \text{V}$

Given

$N = 279\ \text{turns}$

$A = 0.966\ \text{m}^2$

$\Delta B = 0.786\ \text{T}$

$\Delta t = 1.88\ \text{s}$

$\cos\theta = 1.00$

Solution

$$\text{emf} = -N\frac{\Delta\Phi_M}{\Delta t} = -N\frac{\Delta AB\cos\theta}{\Delta t} = -NA\cos\theta\frac{\Delta B}{\Delta t} = -NA\frac{\Delta B}{\Delta t}$$

$$\text{emf} = -(279\ \text{turns})\left(0.966\ \text{m}^2\right)\frac{(0.786\ \text{T})}{(1.88\ \text{s})} = -113\ \text{V}$$

PTS: 1 DIF: IIIB OBJ: 20-1.3

2. ANS:
2.17×10^{2} V

Given

$N = 6.98 \times 10^{2}$ turns

$A = 1.42\ \text{m}^2$

$B_i = 0.364\ \text{T}$

$B_f = -0.351\ \text{T}$

$\Delta t = 3.26\ \text{s}$

$\cos\theta = 1.00$

Solution

$$\text{emf} = -N\frac{\Delta\Phi_M}{\Delta t} = -N\frac{\Delta AB\cos\theta}{\Delta t} = -NA\cos\theta\frac{\Delta B}{\Delta t} = -NA\frac{\Delta B}{\Delta t} = -NA\frac{\left(B_f - B_i\right)}{\Delta t}$$

$$\text{emf} = -\left(6.98 \times 10^{2}\ \text{turns}\right)\left(1.42\ \text{m}^2\right)\frac{(-0.351\ \text{T} - 0.364\ \text{T})}{(3.26\ \text{s})} = -\left(6.98 \times 10^{2}\ \text{turns}\right)\left(1.42\ \text{m}^2\right)\frac{(-0.715\ \text{T})}{(3.26\ \text{s})}$$

$$\text{emf} = 2.17 \times 10^{2}\ \text{V}$$

PTS: 1 DIF: IIIB OBJ: 20-1.3

3. ANS:
   19 A

   Given

   $N = 37$ turns

   $\Delta B = -1.7\ \text{T}$

   $A = 0.95\ \text{m}^2$

   $\Delta t = 1.8\ \text{s}$

   $\cos\theta = 1.0$

   $R = 1.7\ \Omega$

   Solution

   $$\text{emf} = -N\frac{\Delta\Phi_M}{\Delta t} = -N\frac{\Delta AB\cos\theta}{\Delta t} = -NA\cos\theta\frac{\Delta B}{\Delta t} = -NA\frac{\Delta B}{\Delta t}$$

   $$\text{emf} = -(37\ \text{turns})\left(0.95\ \text{m}^2\right)\frac{(-1.7\ \text{T})}{(1.8\ \text{s})} = 33\ \text{V}$$

   Substitute the induced emf into the definition of resistance to determine the induced current in the coil.

   $$I = \frac{\text{emf}}{R} = \frac{(33\ \text{V})}{(1.7\ \Omega)} = 19\ \text{A}$$

   PTS: 1 DIF: IIIC OBJ: 20-1.3

4. ANS:
11 A

Given

$N = 49$ turns

$A = 0.51\ \text{m}^2$

$B_i = 1.8\ \text{T}$

$B_f = 0.0\ \text{T}$

$\Delta t = 2.7\ \text{s}$

$\cos\theta = 1.0$

$R = 1.5\ \Omega$

Solution

$$\text{emf} = -N\frac{\Delta\Phi_M}{\Delta t} = -N\frac{\Delta AB\cos\theta}{\Delta t} = -NA\cos\theta\frac{\Delta B}{\Delta t} = -NA\frac{\Delta B}{\Delta t} = -NA\frac{\left(B_f - B_i\right)}{\Delta t}$$

$$\text{emf} = -(49\ \text{turns})(0.51\ \text{m}^2)\frac{(0.0\ \text{T} - 1.8\ \text{T})}{(2.7\ \text{s})} = -(49\ \text{turns})(0.51\ \text{m}^2)\frac{(-1.8\ \text{T})}{(2.7\ \text{s})} = 17\ \text{V}$$

Sustitute the induced emf into the definition of resistance to determine the induced current in the coil.

$$I = \frac{\text{emf}}{R} = \frac{(17\ \text{V})}{(1.5\ \Omega)} = 11\ \text{A}$$

PTS: 1 DIF: IIIC OBJ: 20-1.3

5. ANS:
$11.9\ \Omega$

Given

$N = 5.46 \times 10^2$ turns

$A = 0.839\ \text{m}^2$

$B_i = -0.367\ \text{T}$

$B_f = -0.786\ \text{T}$

$\Delta t = 0.966\ \text{s}$

$\cos\theta = 1.00$

$I = 16.76\ \text{A}$

Solution

$$\text{emf} = -N\frac{\Delta\Phi_M}{\Delta t} = -N\frac{\Delta AB\cos\theta}{\Delta t} = -NA\cos\theta\frac{\Delta B}{\Delta t} = -NA\frac{\Delta B}{\Delta t} = -NA\frac{\left(B_f - B_i\right)}{\Delta t}$$

$$\text{emf} = -\left(5.46 \times 10^2\ \text{turns}\right)\left(0.839\ \text{m}^2\right)\frac{\left(-0.786\ \text{T} - (-0.367\ \text{T})\right)}{(0.966\ \text{s})} = -\left(5.46 \times 10^2\ \text{turns}\right)\left(0.839\ \text{m}^2\right)\frac{(-0.419\ \text{T})}{(0.966\ \text{s})}$$

$\text{emf} = 199\ \text{V}$

Rearrange the definition of resistance equation, $I = \frac{\text{emf}}{R}$, to find R.

$$R = \frac{\text{emf}}{I} = \frac{199\ \text{V}}{16.76\ \text{A}} = 11.9\ \Omega$$

PTS: 1 DIF: IIIC OBJ: 20-1.3

6. ANS:
7.5×10^2 V

Given
$\Delta V_{rms} = 5.3 \times 10^2$ V

Solution
$\Delta V_{rms} = 0.707 \Delta V_{max}$

$$\Delta V_{max} = \frac{\Delta V_{rms}}{0.707} = \frac{\left(5.3 \times 10^2\ \text{V}\right)}{(0.707)} = 7.5 \times 10^2\ \text{V}$$

PTS: 1 DIF: IIIA OBJ: 20-3.2

7. ANS:
   403 V

   Given

   $I_{rms} = 7.99\text{ A}$

   $R = 35.7\ \Omega$

   Solution

   $R = \dfrac{\Delta V}{I}$

   $\Delta V_{rms} = I_{rms}R = (7.99\text{ A})(35.7\ \Omega) = 285\text{ V}$
   $\Delta V_{rms} = 0.707\Delta V_{max}$
   $\Delta V_{max} = \dfrac{\Delta V_{rms}}{0.707} = \dfrac{(285\text{ V})}{(0.707)} = 403\text{ V}$

   PTS: 1 DIF: IIIB OBJ: 20-3.2

8. ANS:
   2.1 A

   Given

   $\Delta V_{max} = 299\text{ V}$

   $R = 99\ \Omega$

   Solution

   $\Delta V_{rms} = 0.707\Delta V_{max} = (0.707)(299\text{ V}) = 211\text{ V}$

   $R = \dfrac{\Delta V}{I}$

   $I_{rms} = \dfrac{\Delta V_{rms}}{R} = \dfrac{(211\text{ V})}{(99\ \Omega)} = 2.1\text{ A}$

   PTS: 1 DIF: IIIB OBJ: 20-3.2

9. ANS:
7.93 A

Given

$\Delta V_{max} = 153 \text{ V}$

$R = 19.3\ \Omega$

Solution

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

$$I_{max} = \frac{\Delta V_{max}}{R} = \frac{153 \text{ V}}{19.3\ \Omega} = 7.93 \text{ A}$$

PTS: 1 DIF: IIIC OBJ: 20-3.2

10. ANS:
25.1 A

Given

$\Delta V_{max} = 9.65 \times 10^3 \text{ V}$

$R = 3.85 \times 10^2\ \Omega$

Solution

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

$$I_{max} = \frac{\Delta V_{max}}{R} = \frac{9.65 \times 10^3 \text{ V}}{3.85 \times 10^2\ \Omega} = 25.1 \text{ A}$$

PTS: 1 DIF: IIIC OBJ: 20-3.2

11. ANS:
15 A > 12.5 A; The actual I_{rms} exceeds the maximum allowable I_{rms}, so the circuit breaker will trip and interrupt the flow of electricity.

Given

$\Delta V_{max} = 180\text{ V}$

$R = 8.4\ \Omega$

$I_{max} = 12.5\text{ A}$

Solution

$\Delta V_{rms} = 0.707\Delta V_{max} = (0.707)(180\text{ V}) = 130\text{ V}$

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

$$I_{rms} = \frac{\Delta V_{rms}}{R} = \frac{(130\text{ V})}{(8.4\ \Omega)} = 15\text{ A} > 12.5\text{ A} = I_{max}$$

The actual I_{rms} exceeds the maximum allowable I_{rms}, so the circuit breaker will trip and interrupt the flow of electricity.

PTS: 1 DIF: IIIC OBJ: 20-3.2

12. ANS:
1.8×10^4 V

Given

$\Delta V_1 = 120\text{ V}$

$N_1 = 38\text{ turns}$

$N_2 = 5815\text{ turns}$

Solution

$$\Delta V_2 = \frac{N_2}{N_1}\Delta V_1 = \left(\frac{5815\text{ turns}}{38\text{ turns}}\right)(120\text{ V}) = 1.8 \times 10^4\text{ V}$$

PTS: 1 DIF: IIIA OBJ: 20-3.3

13. ANS:
6.9×10^3 V

Given

$\Delta V_{1,rms} = 120$ V

$N_1 = 150$ turns

$N_2 = 6100$ turns

Solution

$$\Delta V_{2,rms} = \frac{N_2}{N_1}\Delta V_{1,rms} = \left(\frac{6100 \text{ turns}}{150 \text{ turns}}\right)(120 \text{ V}) = 4.9 \times 10^3 \text{ V}$$

$$\Delta V_{rms} = 0.707\Delta V_{max}$$

$$\Delta V_{2,max} = \frac{\Delta V_{2,rms}}{0.707} = \frac{\left(4.9 \times 10^3 \text{ V}\right)}{(0.707)} = 6.9 \times 10^3 \text{ V}$$

PTS: 1 DIF: IIIB OBJ: 20-3.3

14. ANS:
-7.0×10^2 V

Given

$N_1 = 88$ turns

$N_2 = 4741$ turns

$A = 0.268 \text{ m}^2$

$B_i = 0.00$ T

$B_f = 0.52$ T

$\Delta t = 0.65$ s

$\cos\theta = 1.0$

Solution
Use Faraday's law of magnetic induction to calculate the emf in the primary coil.

$$\text{emf} = -N\frac{\Delta\Phi_M}{\Delta t} = -N\frac{\Delta AB\cos\theta}{\Delta t} = -NA\cos\theta\frac{\Delta B}{\Delta t} = -NA\frac{\Delta B}{\Delta t} = -NA\frac{\left(B_f - B_i\right)}{\Delta t}$$

$$\text{emf} = -(88\text{ turns})\left(0.268\text{ m}^2\right)\frac{(0.52\text{ T} - 0.00\text{ T})}{(0.65\text{ s})} == -(88\text{ turns})\left(0.268\text{ m}^2\right)\frac{(0.52\text{ T})}{(0.65\text{ s})}$$

$$\text{emf} = -19\text{ V}$$

Use the equation relating rms and maximum potential differences to find the rms potential difference in the primary coil.

$\Delta V_{rms} = 0.707\Delta V_{max}$
$\Delta V_{1,rms} = (0.707)(\text{emf}) = (0.707)(-19\text{ V}) = -13\text{ V}$

Use the transformer equation to find the induced emf in the secondary coil.

$$\Delta V_{2,rms} = \frac{N_1}{N_2}\Delta V_{1,rms} = \left(\frac{4741\text{ turns}}{88\text{ turns}}\right)(-13\text{ V}) = -7.0 \times 10^2\text{ V}$$

PTS: 1 DIF: IIIB OBJ: 20-3.2

15. ANS:
-1.31×10^3 V

Given

$N_1 = 111$ turns

$N_2 = 7851$ turns

$A = 0.132\ \text{m}^2$

$B_i = 0.000$ T

$B_f = 0.869$ T

$\Delta t = 0.687$ s

$\cos\theta = 1.00°$

Solution
Use Faraday's law of magnetic induction to calculate the emf in the primary coil.

$$\text{emf} = -N\frac{\Delta\Phi_M}{\Delta t} = -N\frac{\Delta AB\cos\theta}{\Delta t} = -NA\cos\theta\frac{\Delta B}{\Delta t} == -NA\frac{\Delta B}{\Delta t} - NA\frac{\left(B_f - B_i\right)}{\Delta t}$$

$$\text{emf} = -(111\text{ turns})\left(0.132\text{ m}^2\right)\frac{(0.869\text{ T} - 0.000\text{ T})}{(0.687\text{ s})} = -(111\text{ turns})\left(0.132\text{ m}^2\right)\frac{(0.869\text{ T})}{(0.687\text{ s})}$$

$$\text{emf} = -18.5\text{ V}$$

Use the transformer equation to find the induced emf in the secondary coil.

$$\Delta V_{2,max} = \frac{N_2}{N_1}\Delta V_{1,max} = \frac{N_2}{N_1}\text{emf} = \left(\frac{7851\text{ turns}}{111\text{ turns}}\right)(-18.5\text{ V}) = -1.31\times 10^3\text{ V}$$

PTS: 1 DIF: IIIC OBJ: 20-3.3