Test Bank

Conceptual Questions

C1. A double loop of wire (making 2 turns) is in the x-y plane centered at the origin. A uniform magnetic field is increasing at a constant rate in the positive z-direction. Viewed from the positive z-axis, in which direction is the induced magnetic field in the loop?

a. in the positive z-direction
b. in the negative z-direction
c. There is no induced field because of the double loop.
d. There is no induced field because the rate of change of the magnetic field is constant.

C2. A circular loop of wire has its radius reduced in half in time Δt. A uniform magnetic field is at an angle of 60° to the plane of the coil, and the magnetic field doubles its intensity in the same time interval Δt. During this interval, what happens to the flux through the coil?

$\mathcal{E} = \frac{\Delta \Phi_B}{\Delta t} = \frac{B \Delta A \cos\theta}{\Delta t}$ B & Δt ↑ at same rate, A ↓

a. It increases.
b. It decreases.
c. It remains the same.
d. More information is needed to make this conclusion.

C3. Two solenoids, wound from wire from the same spool, have the same length and cross-sectional area, but solenoid #1 has half the turns of solenoid #2. If these solenoids are each connected to a circuit, and the only non-negligible resistance is that of the solenoids, which solenoid gives the greater time constant and by what factor?

$\mathcal{E} = -N \frac{\Delta \Phi_B}{\Delta t}$ → constant; N ↑ 2

a. #1 by a factor of 2
b. #2 by a factor of 2
c. #2 by a factor of 4
d. No answer above is completely correct.

C4. One time constant after an RL circuit has its switch closed, how does the current I in it compare to the maximum current I_{max} that occurs for this circuit?

a. $I > I_{max}/2$
b. $I = I_{max}/2$
c. $I < I_{max}/2$
d. Without knowing R and L, this cannot be determined.

C5. Three loops of wire, one circular, one rectangular, and one square, are made from identical lengths of wire. If the loops are in the same increasing magnetic field perpendicular to the plane of the coils, which loop has the greatest induced emf?

a. the circular one
b. the rectangular one
c. the square one
d. All three would have the same emf induced.

20.1 Induced emf and Magnetic Flux

1. A uniform 4.5-T magnetic field passes perpendicularly through the plane of a wire loop 0.10 m^2 in area. What flux passes through the loop?

a. 5.0 T·m^2
b. 0.45 T·m^2
c. 0.25 T·m^2
d. 0.135 T·m^2

$\Phi_B = BA\cos\theta$
$= (4.5\,T)(0.10\,m^2)\cos 0$
$= 0.45\ T\cdot m^2$

2. A uniform 4.5-T magnetic field passes through the plane of a wire loop 0.10 m^2 in area. What flux passes through the loop when the direction of the 4.5-T field is at a 30° angle to the normal of the loop plane?

a. 5.0 T·m^2
b. 0.52 T·m^2
c. 0.39 T·m^2
d. 0.225 T·m^2

$\Phi_B = BA\cos\theta$
$= (4.5\,T)(0.10\,m^2)\cos 30$
$= 0.39\ T\cdot m^2$

3. A loop of area 0.250 m^2 is in a uniform 0.020 0-T magnetic field. If the flux through the loop is 3.83×10^{-3} T·m^2, what angle does the normal to the plane of the loop make with the direction of the magnetic field?

a. 40.0°
b. 50.0°
c. 37.5°
d. This is not possible.

$\Phi_B = BA\cos\theta$
$0.0200\,T = (3.83\times10^{-3}\,T\cdot m^2)(0.250\,m^2)\cos\theta$
$\theta = \cos^{-1}\dfrac{0.0200\,T}{(3.83\times10^{-3}\,T\cdot m^2)(0.250\,m^2)} = 40°$

4. A coil in a magnetic field encloses a flux of 0.256 T·m^2 when the angle between the normal to the coil and the direction of the magnetic field is 70.0°. What flux would go through the coil if the angle were changed to 40.0°?

a. 0.332 T·m^2
b. 0.198 T·m^2
c. 0.114 T·m^2
d. 0.573 T·m^2

$0.256\ T\cdot m^2$ at 70°
$0.256\,T\cdot m^2 = BA\cos 70$
$BA = \dfrac{0.256\,T\cdot m^2}{\cos 70}$
$BA = 0.7485$

$\Phi_B = (0.7485\,m^2)\cos 40$
$I_B = 0.573\ T\cdot m^2$

5. A coil is placed in a magnetic field and has a flux Φ_B through it. The coil is stressed so that its area reduces to 75% of its original value. If the plane of the coil stays the same and the flux through it remains the same, how must the magnetic field change?

a. It must increase by 25%.
b. It must increase by 33%.
c. It must increase by 125%.
d. It must decrease by 25%.

$\Phi_B = BA$
Φ_B $\left(\dfrac{4}{3}\right)\dfrac{3}{4}$
+33%

20.2 Faraday's Law of Induction

6. The units $T \cdot m^2/s$ are equivalent to:

   a. W.
   b. V.
   c. N/m.
   d. webers.

7. A sensitive ammeter is connected to a wire loop and placed within the magnetic field of a strong horseshoe magnet. The ammeter shows a deflection when:

   a. the wire is moved parallel to the field.
   b. the wire is moved perpendicularly to the field.
   c. neither wire nor magnet is moving.
   d. the wire's axis is parallel to the field.

8. According to Lenz's law the direction of an induced current in a conductor will be that which tends to produce which of the following effects?

   a. enhance the effect which produces it
   b. produce a greater heating effect
   c. produce the greatest voltage
   d. oppose the effect which produces it

9. "GFI" stands for:

   a. grand flux indicator.
   b. ground forcing indicator.
   c. ground fault interrupter.
   d. gauss-free invention.

10. The principle or law that says "an induced emf in a circuit loop produces a current whose magnetic field opposes further change of magnetic flux" is credited to:

    a. Faraday.
    b. Lenz.
    c. Ampere.
    d. Volta.

11. A square coil, enclosing an area with sides 2.0 cm long, is wrapped with 2 500 turns of wire. A uniform magnetic field perpendicular to its plane is turned on and increases to 0.25 T during an interval of 1.0 s. What average voltage is induced in the coil?

    a. 0.25 V
    b. 0.12 V
    c. 2.0 V
    d. 2.5 V

12. A 10-turn square coil of area 0.036 m^2 and a 20-turn circular coil are both placed perpendicular to the same changing magnetic field. The voltage induced in each of the coils is the same. What is the area of the circular coil?

a. 0.072 m^2
b. 0.60 m^2
c. 0.018 m^2
d. 0.036 m^2

13. A bar magnet is falling through a loop of wire with constant velocity. The south pole enters first. As the magnet leaves the wire, the induced current (as viewed from above):

a. is clockwise.
b. is counterclockwise.
c. is zero.
d. is along the length of the magnet.

14. A flat coil of wire consisting of 20 turns, each with an area of 50 cm^2, is positioned perpendicularly to a uniform magnetic field that increases its magnitude at a constant rate from 2.0 T to 6.0 T in 2.0 s. If the coil has a total resistance of 0.40 Ω, what is the magnitude of the induced current?

a. 70 mA
b. 140 mA
c. 500 mA
d. 800 mA

15. A planar loop consisting of four turns of wire, each of which encloses 200 cm^2, is oriented perpendicularly to a magnetic field that increases uniformly in magnitude from 10 mT to 25 mT in a time of 5.0 ms. What is the resulting induced current in the coil if the resistance of the coil is 5.0 Ω?

a. 60 mA
b. 12 mA
c. 0.24 mA
d. 48 mA

16. A coil is placed in a changing magnetic field and an emf is induced. What happens to the induced emf if the rate of change of magnetic field quadruples?

a. There is no change.
b. The emf doubles.
c. The emf quadruples.
d. The emf increases by a factor of 16.

20.3. Motional emf

17. A 0.200-m wire is moved parallel to a 0.500-T magnetic field at a speed of 1.50 m/s. What emf is induced across the ends of the wire?

a. 2.25 V
b. 1.00 V
c. 0.600 V
d. zero

18. An airplane with a wingspan of 60.0 m flies parallel to the Earth's surface at a point where the downward component of the Earth's magnetic field is 0.400×10^{-4} T. If the induced potential between wingtips is 0.900 V, what is the plane's speed?

a. 250 m/s
b. 338 m/s
c. 375 m/s
d. 417 m/s

19. A metal rod is falling toward the surface of the Earth near the equator. As it falls, one end of the rod becomes positively charged due to the motional emf of the rod through the Earth's magnetic field. The rod is oriented so that:

a. the rod is vertical with the positive end higher.
b. the rod is horizontal with the positive end toward the north.
c. the rod is horizontal with the positive end toward the east.
d. the rod is horizontal with the positive end toward the west.

20. The magnet moving past an object will produce eddy currents in the object if the object:

a. is magnetic material only.
b. is a conductor.
c. is an insulator.
d. is a liquid.

21. A large jetliner with a wingspan of 40 m flies horizontally and due north at a speed of 300 m/s in a region where the magnetic field of the earth is 60 μT directed 50° below the horizontal. What is the magnitude of the induced emf between the ends of the wing?

a. 250 mV
b. 350 mV
c. 550 mV
d. 750 mV

22. A straight wire of length ℓ is oriented east-west and is in a magnetic field B pointing north. The wire is moving downward at a constant speed v. Which end of the rod is positively charged?

a. neither
b. the east end
c. the west end
d. both ends

23. A straight wire of length ℓ is oriented east-west and is in a magnetic field B pointing north. The wire is moving downward at a constant speed v. If the resistance of the rod is R, what is the current through the rod?

a. $R/B\ell v$
b. $B\ell v/R$
c. $B^2\ell^2v^2/R^2$
d. not given

20.4 Lenz's Law Revisited (The Minus Sign in Faraday's Law)

24. The operation of a tape player to play music depends on which of the following?

a. the Doppler effect
b. the photoelectric effect
c. the force acting on a current-carrying wire in a magnetic field
d. induced current from the motion of a magnet past a wire

25. A bar magnet is falling through a loop of wire with constant velocity. The north pole enters first. The induced current will be greatest in magnitude when the magnet is located so that:

a. the loop is near either the north or the south pole.
b. the loop is near the north pole only.
c. the loop is near the middle of the magnet.
d. with no acceleration, the induced current is zero.

26. A bar magnet is falling through a loop of wire with constant velocity. The north pole enters first. As the south pole leaves the loop of wire, the induced current (as viewed from above) will be:

a. clockwise.
b. counterclockwise.
c. zero.
d. along the length of the magnet.