**Chapter 30**

1. Scientific work is currently under way to determine whether weak oscillating magnetic fields can affect human health. For example, one study found that drivers of trains had a higher incidence of blood cancer than other railway workers, possibly due to long exposure to mechanical devices in the train engine cab. Consider a magnetic field of magnitude 1.00 x 10-3 T, oscillating sinusoidally at 60.0 Hz.

**SOLUTION:**

2. A coil formed by wrapping 50 turns of wire in the shape of a square is positioned in a magnetic field so that the normal to the plane of the coil makes an angle of 30.08 with the direction of the field. When the magnetic field is increased uniformly from 200 *µ*T to 600 *µ*T in 0.400 s, an emf of magnitude 80.0 mV is induced in the coil. What is the total length of the wire in the coil?

**SOLUTION:**

3. A long solenoid with 1.00 x 103 turns per meter and radius 2.00 cm carries an oscillating current *I* = 5.00 sin 100*πt*, where *I* is in amperes and *t* is in seconds. (a) What is the electric field induced at a radius *r* = 1.00 cm from the axis of the solenoid? (b) What is the direction of this electric field when the current is increasing counterclockwise in the solenoid?

**SOLUTION:**

**Solution for Chapter 30**

1. Scientific work is currently under way to determine whether weak oscillating magnetic fields can affect human health. For example, one study found that drivers of trains had a higher incidence of blood cancer than other railway workers, possibly due to long exposure to mechanical devices in the train engine cab. Consider a magnetic field of magnitude 1.00 x 10-3 T, oscillating sinusoidally at 60.0 Hz.

**Ans:**

We have a stationary loop in an oscillating magnetic field that varies sinusoidally in time: 

where  

 and *f* = 60.0 Hz.

The loop consists of a single band (*N* = 1) around the perimeter of a red blood cell with diameter *d* = 8.00 × 10–6 m and area *A* = *π d*2/4.

The induced emf is then

 

Comparing this expression to 

we see that  Therefore,

 

From Equation 30.2,



2. A coil formed by wrapping 50 turns of wire in the shape of a square is positioned in a magnetic field so that the normal to the plane of the coil makes an angle of 30.08 with the direction of the field. When the magnetic field is increased uniformly from 200 *µ*T to 600 *µ*T in 0.400 s, an emf of magnitude 80.0 mV is induced in the coil. What is the total length of the wire in the coil?

**Ans:**

Faraday’s law, , becomes here

 

The magnitude of the emf is

 

The area is

 

 

Each side of the coil has length , so the total length of the wire is

 

3. A long solenoid with 1.00 x 103 turns per meter and radius 2.00 cm carries an oscillating current *I* = 5.00 sin 100*πt*, where *I* is in amperes and *t* is in seconds. (a) What is the electric field induced at a radius *r* = 1.00 cm from the axis of the solenoid? (b) What is the direction of this electric field when the current is increasing counterclockwise in the solenoid?

**Ans:**

(a)  where 

 

 Solving for the electric field gives

 

 Substituting numerical values and suppressing units,

 

 

(b) If a viewer looks at the solenoid along its axis, and if the current is increasing in the counterclockwise direction,

the magnetic flux is increasing toward the viewer; the electric field always opposes increasing magnetic flux;

therefore, by the right-hand rule, the electric field lines are .