

hhh.32.14_32.20

Read pages 314 and 315

“Flux” is a more or less construction from the imagination of Michael Faraday to describe magnetic and electric fields. There is no such thing as a “flux capacitor” at least in terms of time travel. Think of magnetic flux as arrows that represent a field between the north and south poles of a magnet. They point from north to south. The stronger the magnet is, the more densely pack the “arrows” are.

The flux (in webers) is like the number of arrows

The B field (in teslas) is the density of the arrows or “flux density”

The most important thing in electricity and magnetism

- **A changing electric field (or changing electric flux) creates a magnetic field**
- **A changing magnetic field (or changing magnetic flux) creates an electric field**

32.14 Just divide the two numbers. Notice that there are no units since the answer is a ratio.

32.15 Flux is a vector and its direction is pretty obvious. **Area is also a vector and its area is a vector that points “normal” or perpendicular to its surface.**

The flux through a surface is equal to $AB\cos\theta$ where A is the area in m^2 and B is the magnetic flux intensity or “ B ” field in teslas.

(through the left side the answer is really 0.18 weber but they rounded it up to 0.2 weber so that it would be the correct number of sig figs) Notice that the total flux that enters the box must also exit it. **This is known as Gauss’s law**

32.16. Use the formulas and figures from page 308 to find the B field inside the solenoid. Then using the radius determine the area. The B field inside a solenoid is parallel to the vector of the

area (the cross-sectional area) that you need to find the flux.

32.17 No assigned

32.18 Look at Faraday's Law. Actually, memorize it. *Emf* is called electro-motive force and means "no-load" voltage.

$$Emf (voltage) = -N \frac{\Delta \Phi_m}{\Delta t}$$

Φ (magnetic _ flux)

In other words, the voltage induced is equal to the number of turns of the coil (N) times the **change in magnetic flux (in webers) divided by the change in time (in seconds)**

The negative sign is so important it represents a law of physics known as **Lenz's Law**. This states that the induced voltage will cause a current to flow that **will fight the change in magnetic flux through the loop**.

32.20 This problem in some form is on 99% of all general standardized physics tests. It is very representational of Lenz's law and actually an introduction to how induction brakes work on high speed trains.

As the loop enters the magnetic field that is pointing into the page, the magnetic flux is increasing inside the loop. This causes a voltage (emf) that causes a current to flow that **will fight the increase in magnetic flux**. Thus this induced current must flow in a direction that creates a **magnetic field that points out of the page**.

Once again, use your right hand. Your thumb points in the direction of the induced magnetic field which in this case is out of the page or towards you. Notice that the fingers of your right hand curl in a counterclockwise direction. This is the direction of the induced current.

When the coil is inside the magnetic field, there is no change in the magnetic flux through even though it is moving. Thus there is no induced emf

As the coil leaves the magnetic field the magnetic flux is decreasing through it. Therefore there is an emf induced that causes the current to **increase the flux into the page**. Thus the

current will reverse direction and run clockwise through the coil

Coils of wire are often called inductors.

Inductors fight a change in current while capacitors fight a change in voltage

Finding the magnitude of the induced emf

From

$$Emf (voltage) = -N \frac{\Delta\Phi_m}{\Delta t}$$

Φ (magnetic flux)

magnetic flux = $AB\cos\theta$

But theta equals zero so

Flux = AB (Area in m^2 times B field in teslas)

Now, the B field is not changing but the area of the coil that is entering the field is changing

Area = Width times height

Height = 20 cm = 0.20 m

But the width that affected by the B field is changing at 3.0 m/s so

$$Emf = \frac{\Delta\Phi_m}{\Delta t} = \frac{\Delta A \cdot B}{\Delta t}$$

$$\frac{\Delta\Phi_m}{\Delta t} = \frac{\Delta W \cdot l \cdot B}{\Delta t}$$

$$\frac{\Delta\Phi_m}{\Delta t} = \left(\frac{\Delta W}{\Delta T} \right) \cdot lB$$

But $\left(\frac{\Delta W}{\Delta T} \right)$ is just the speed