Induced EMF

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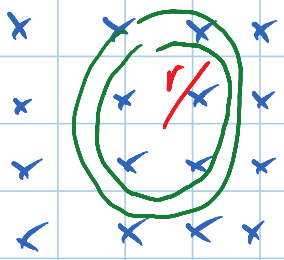
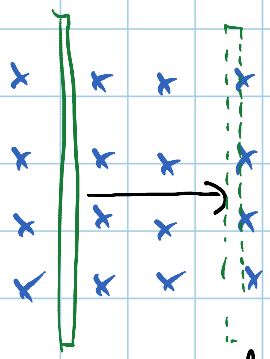
9:14 AM

Magnetic Flux is the amount of magnetic field passing thru a given area

- $\Phi = \phi = B \cdot A$, units are $T \cdot m^2 = Weber = Wb$



area $= \pi r^2$



area $= l \cdot w$

Faraday's Law: If a magnetic field near a wire is changed, a current & voltage is induced. This is called induced emf

$$Emf = -\frac{N \Delta \phi}{\Delta t}$$

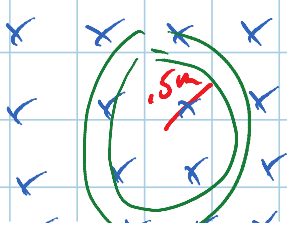
- determines the direction of current flow

N - # of loops

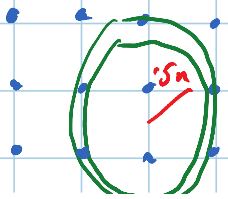
$\Delta \phi = \Delta B \cdot A$, $B \cdot \Delta A$

Δt = time for change

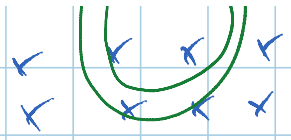
ex



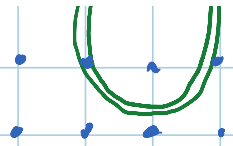
in $t = 2.0 s$



What is the induced emf



B = 3.0 T

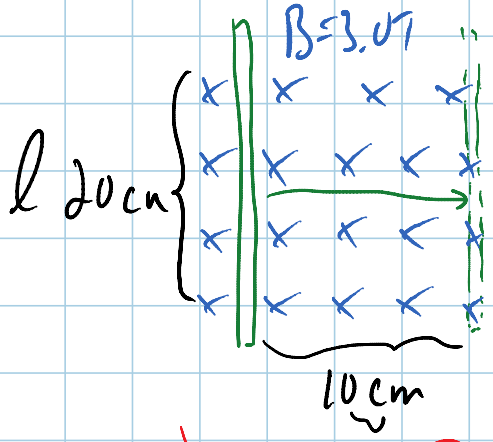


B = 2.0 T

Induced emf

$$\mathcal{E} = -\frac{N\Delta\Phi}{\Delta t} = -\frac{N\Delta B A}{\Delta t} = -\frac{(1)(5.0\,T)(\pi(.5)^2)}{2.0\,s}$$

$$= -1.96\,V$$



$t = 2.0$,

$$\mathcal{E} = -\frac{(1)(3.0\,T)(.2\times.1)}{2.0\,s} = -0.03\,V$$

$$\mathcal{E} = \frac{N B A}{t} = \frac{B l w}{t} = B l v$$

← velocity of moving wire

$N = 1$

$$\boxed{\mathcal{E} = B l v}$$

Induced EMF

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NAME: _____

Induced EMF

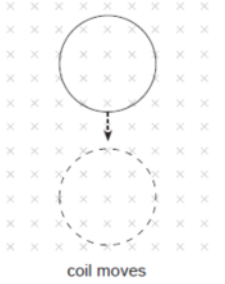
1. The flux through a circular coil with a radius of 0.075 m is 0.013 Wb when placed perpendicular to a magnetic field. What is the strength of the magnetic field?

$\Phi = B \cdot A$

$.013\,Wb = B(\pi(.075)^2)$ $\quad B = 0.74\,T$

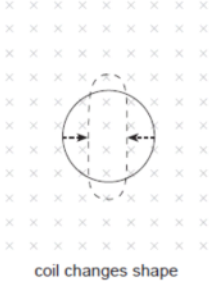
2. In which of the following situations would the greatest emf be induced in the coil? All changes occur in the same time interval.

A. $\vec{B}$



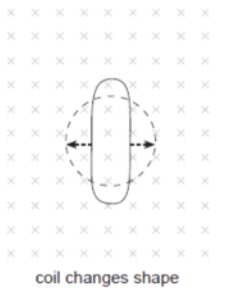
coil moves

B. $\vec{B}$



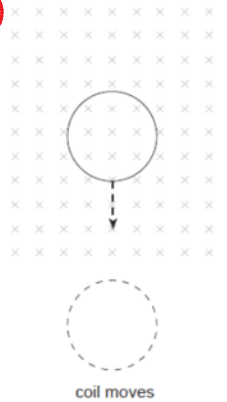
coil changes shape

C. $\vec{B}$



coil changes shape

D. $\vec{B}$



coil moves

3. A coil having 150 turns and a cross-sectional area of 0.042 m^2 is oriented with its plane perpendicular to a 0.12 T magnetic field. If the field increases to 0.66 T in 0.25 s, what emf is induced in the coil?

$\mathcal{E} = -\frac{N \Delta B A}{\Delta t} = -\frac{150(.66-.12)(0.042)}{.25s} = -14\,V$

4. An aircraft with a wingspan of 24 m flies at 85 m/s perpendicular to a magnetic field. An emf of 0.19 V is induced across the wings of the aircraft. What is the magnitude of the magnetic field?

A. 9.3×10^{-5} T
B. 5.4×10^{-2} T
C. 6.7×10^{-1} T
D. 3.9×10^{2} T

$\mathcal{E} = Blv$

$0.19V = B(24)(85 m/s)$ $\quad B = 9.3 \times 10^{-5}$

5. A rectangular coil of wire is situated in a constant magnetic field whose magnitude is 0.50 T. The coil has an area of 2.0 m^2 which is perpendicular to the magnetic field Determine the magnetic flux.

6. Determine the induced EMF in the loop from #1 if the loop is rotated 90° in 0.2 s

7. A coil of wire consists of 20 turns, each with area of 1.5×10^{-3} m^2. A magnetic field is perpendicular to the surface of each loop at all times, so that the initial orientation is at 0°. At time t = 0, the magnitude of B at the location of the coil is 0.050 T. At a later time t = 0.10 s, the magnitude of the field at the coil has increased to 0.060 T.
   a) Find the average emf induced in the coil during this time.

   b) What would be the value of the average induced emf if the magnitude of B decreased from 0.060 T to 0.050 T in 0.10 s?

8. A flat coil of wire has an area of 0.020 m^2 and consists of 50 turns. At t = 0 the coil is oriented so the normal to its surface is parallel to a constant magnetic field of 0.18 T. The coil is then rotated through an angle of 90° in a time of 0.10 s.
   a) Determine the average induced emf.

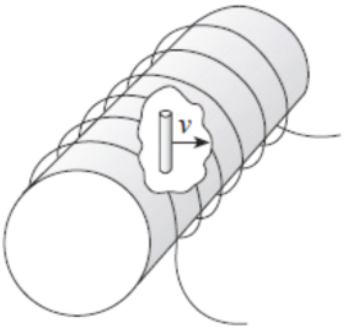
   b) What would be the induced emf if the coil were returned to its initial orientation in the same time of 0.10 s?

9. A circular coil of radius 2.50 cm and containing 725 turns is in a field of 0.850 T. Initially the plane of the coil is perpendicular to the field but the coil is rotated through 90° in 0.130 seconds. The coil has a resistance of 1.80 Ohms.
   a) Determine the change in flux and the induced EMF.

   b) Determine the energy required to rotate the coil through 90°.

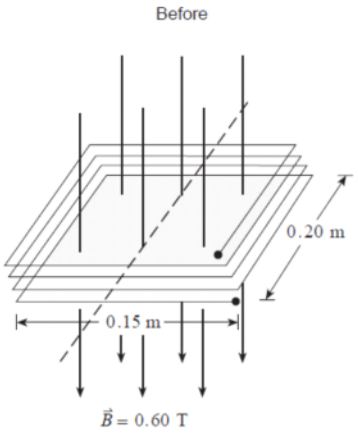
10. A solenoid of length 0.75 m has a radius 0.092 m. A current of 25 A flows through its 4 700 turns. Within this solenoid a 0.10 m long conductor moves at 4.3 m s perpendicular to the field in the solenoid.

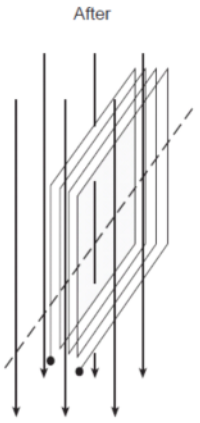
    What emf is induced between the ends of the conductor?
    A. 0.085 V
    B. 0.197 V
    C. 0. 430 V
    D. 4.80 V



11. A rectangular coil of wire containing 250 loops is placed in a magnetic field. Each loop measures 0.075 m by 0.28 m. The magnetic field changes over a time interval of 0.36 s producing an average emf of 1.3 V. What is the change in the magnetic field strength?

12. The diagram shows a coil with 25 windings and dimensions 0.15 m by 0.20 m. Its plane is perpendicular to a magnetic field of magnitude 0.60 T.





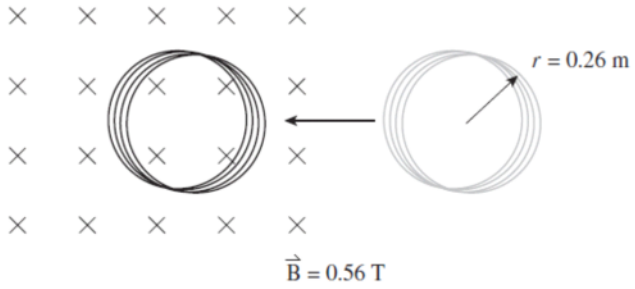
$\mathcal{E} = -N\frac{\Delta B \cdot A}{\Delta t}$

$= -25\frac{(0-.6T)(.15 \cdot .20)}{.0417}$

$= 10.8\,V$

If the coil rotates 90° in 4.17 x10^{-2} s so that its plane is now parallel to the magnetic field, what average emf is induced during this time?

13. A 520-turn circular coil of radius 0.26 m is initially outside a 0.56 T magnetic field. The coil is moved into the magnetic field, inducing an average emf of 47 V. How much time does it take to move the coil to its new position?



14. A coil consisting of 50 loops of radius 4.0 x10^{-2} m is placed with its plane perpendicular to a magnetic field that is increasing at a rate of 0.20 T/s. What is the magnitude of the emf induced in the coil?
    A. 0.0010 V
    B. 0.050 V
    C. 0.40 V
    D. 1.3 V

Answers:

1. 0.74 T
2. D
3. 14 V
4. A
5. 1.0 Wb
6. 0.065 V
7. -3.0 x 10^{-3} V, +3.0 x 10^{-3} V
8. +1.8 V, -1.8 V
9. 9.29 V, 6.23 J
10. A
11. -0.089 T
12. 10.8V
13. 1.3 s
14. B