Physics 12 Electromagnetic Induction Worksheet

Name: ______________________

Magnetic Field Strength of a solenoid B = $\mu_0 \frac{NI}{L}$

[Tesla]

$\mu_0 = 4\pi \times 10^{-7}$, N - number of wraps, I - current, L - length

Induced EMF in a wire = $\mathcal{E} = Bv\ell$

v - velocity

B + v must be ⊥

Faraday's Law = $\mathcal{E} = -N\frac{\Delta\phi}{\Delta t} = -N\frac{(B_f A_f - B_i A_i)}{\Delta t}$

B - mag field strength, A - area

Magnetic Field Strength of a solenoid

1. A solenoid has 40 wraps over a length of 10 cm and carries a current of 3 A. What is the magnetic field strength inside the solenoid?

$$B = \mu_0 \frac{nI}{L} = \frac{(4\pi \times 10^{-7})(40)(3)}{.1} = 0.0015\ T$$

2. You want to create a solenoid (electromagnet) with a magnetic field strength of 2 T.

The solenoid is 20 cm long and has 50 wraps. How much current will you need?

$$B = \mu_0 \frac{nI}{L} \Rightarrow 2 = \frac{(4\pi \times 10^{-7})(50)\, I}{.2}$$

$$I = \frac{2(.2)}{(4\pi \times 10^{-7})(50)} = \frac{0.4}{6.2831 \times 10^{-5}} = 6366\ A.$$

NOTE μ for Iron $\approx 2.3 \times 10^{-2}$, which means if you have an iron core, about 10,000x less current required.

Induced EMF in a wire

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?

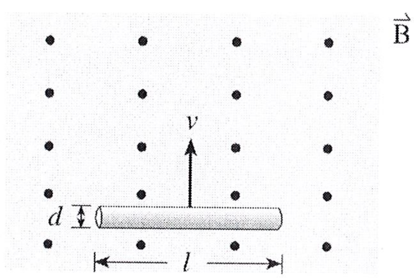
A. 9.3×10^{-5} T
B. 5.4×10^{-2} T
C. 6.7×10^{-1} T
D. 3.9×10^{2} T

$\mathcal{E} = Bvl$

$0.19 = B(85)(24)$

$B = \frac{.19}{(85)(24)} = 9.3 \times 10^{-5}$

A length of conducting wire is moving perpendicular to a magnetic field as shown below.



Which of the following does not affect the size of the emf produced between the ends of the wire?

A. speed of wire ✓
B. length of wire ✓
(C.) thickness of wire ✗
D. magnetic field strength ✓

$\mathcal{E} = Bvl$

Thickness is not a factor.

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?

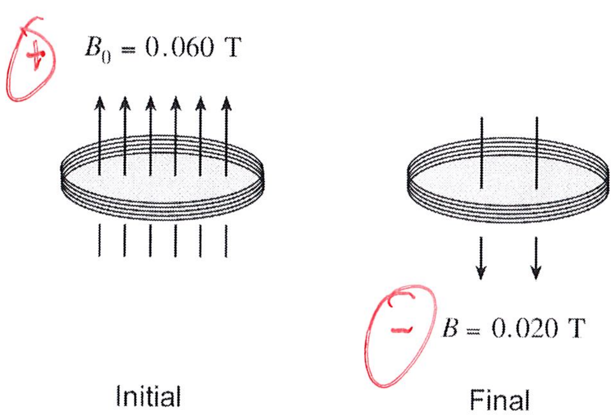
A. 9.8 V
B. 14 V
C. 20 V
D. 320 V

$$\mathcal{E} = -N\frac{(B_f A_f - B_i A_i)}{\Delta t}$$

$$= 150\,\frac{((.66)(.042) - (.12)(.042))}{.25}$$

$$= 150\,\frac{0.02268}{.25} = 13.6\ V = 14 V$$

A 500-turn circular coil with an area of $1.54 \times 10^{-2}\ m^2$ is perpendicular to a 0.060 T field. The magnetic field changes to 0.020 T in the opposite direction in 0.12 s.



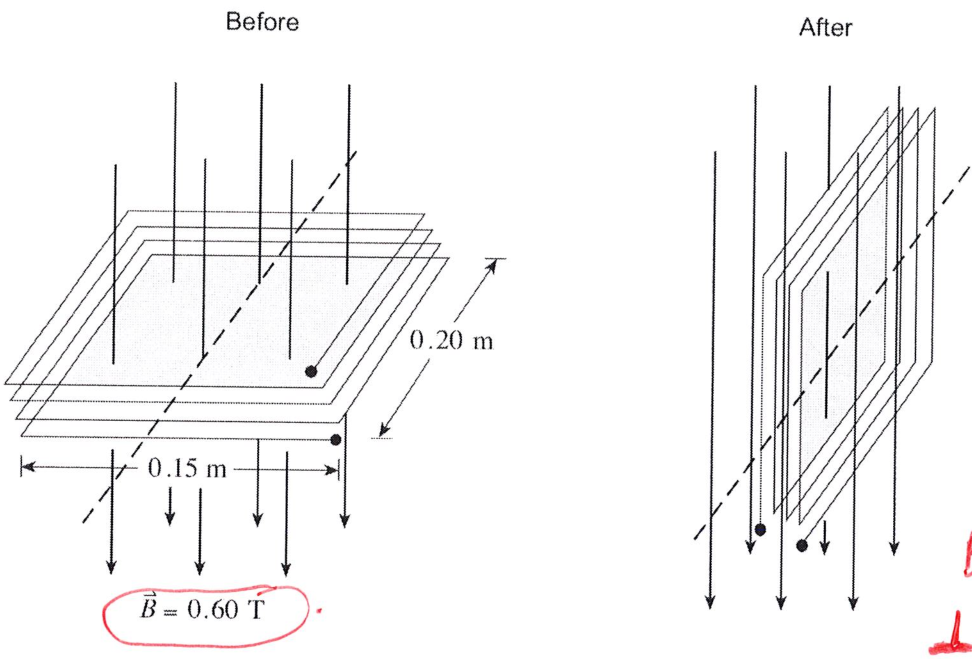
What is the average emf induced in the coil?

A. 5.1×10^{-3} V
B. 1.0×10^{-2} V
C. 2.6 V
D. 5.1 V

$$\mathcal{E} = \frac{-N\Delta\phi}{\Delta t} = \frac{(500)((.02)(1.54\times10^{-2}) - (-.06)(1.54\times10^{-2}))}{.12}$$

$$= \frac{500\,(0.001232)}{.12} = 5.13\ V$$

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.



B = 0, B must be ⊥ to plane of coil.

If the coil rotates 90° in 4.17×10^{-2} s so that its plane is now parallel to the magnetic field, what average emf is induced during this time? **(7 marks)**

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

area = (.15)(.20) = 0.03 m²

$\Delta B = B_f - B_i = 0.6$

$$= \frac{N (B_f - B_i) A}{\Delta t}$$

$$= \frac{25 (.6)(.03)}{4.17 \times 10^{-2}} = 10.8 \text{ V}$$