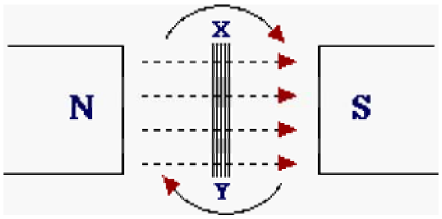
Name: ________________________ Class: ___________________ Date: __________ ID: A

Day 3 flux worksheet

Multiple Choice
Identify the choice that best completes the statement or answers the question.

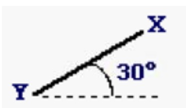
1. A straight wire is held perpendicular to the direction of a magnetic field. What must the angle be between the direction of the wire's motion and the direction of the magnetic field in order for the EMF generated in the conductor to be greatest?
   a. 0°
   b. 30°
   c. 45°
   d. 90°

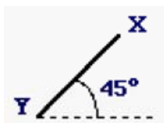
2. If a magnet is pushed into a coil, voltage is induced across the coil. If the same magnet is pushed into a coil with twice the number of loops
   a. one half as much voltage is induced
   b. the same voltage is induced
   c. twice as much voltage is induced
   d. four times much voltage is induced
   e. none of these

3. 

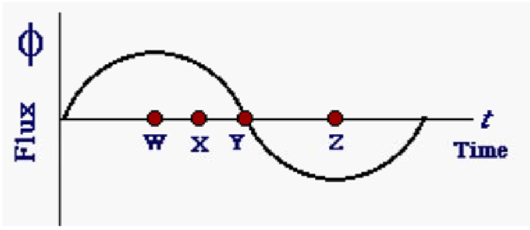
   The above diagram shows the top of a rectangular coil which is rotated clockwise at a constant rate between two magnetic poles. In which of the following positions in the near future will cause the **greatest** flux change?
   a. 

   c. 

   b. 

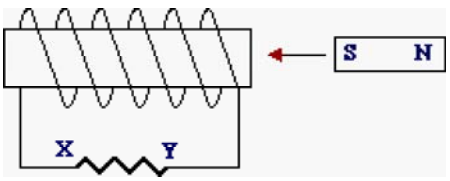
   d. 

4. The graph below shows the magnetic flux through a loop with respect to time.



At which time is the magnitude of the induced emf in the loop greatest?
a. W
b. X
c. Y
d. Z

5. When the magnet is moved to the left towards the inside center of the coil the current through the resistor is

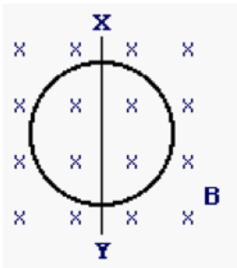


a. from X to Y
b. from Y to X
c. zero
d. alternating

6. Which of the following is a correct unit for magnetic flux?
a. Newtons/Coulomb
b. Tesla meter^2
c. Volts
d. Tesla

7. The voltage induced when a coil moves across a magnetic field is determined by?
a. the number of turns in the coil.
b. the change in the magnetic flux.
c. the number of coils of wire and the rate of change of magnetic flux.
d. the current in the coil.

8. The diagram at right shows a singular circular coil of wire in a constant, uniform magnetic field B. In the position shown, the magnetic flux through the coil is 4.5 x 10^{-4} Wb.



If the coil now rotates 90° about axis XY in a time of 0.125 s, what average EMF is generated between the ends of the coil during that time?

a. zero
b. 5.6 x 10^{-5} V
c. 9.0 x 10^{-4} V
d. 3.6 x 10^{-3} V

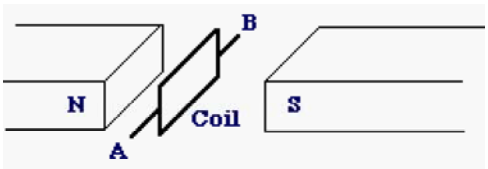
9. Consider the following factors for a magnet moving inside a coil:

I. the strength of the magnet
II. the number of turns in the coil
III. the speed at which the magnet moves

Which of the factors can affect the size of the voltage induced in the coil ?
a. I only
b. II only
c. III only
d. I and II only
e. I, II and III

10. What is the average EMF induced in a transformer with 600 turns of wire in the secondary windings if the flux through it changes by 1.0 Wb in 0.50 s?
a. 2.0 V
b. 12 V
c. 3.0 x 10^{2} V
d. 1.2 x 10^{3} V

11. The coil shown below is rotating in a clockwise direction on the axis AB in the magnetic field caused by the two magnets. At which of the following angles, considering 0° at the vertical would the maximum EMF be induced?



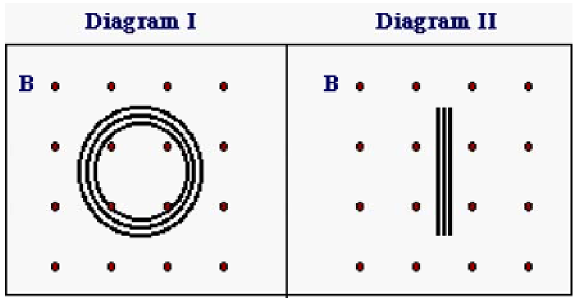
a. 0°
b. 45°
c. 90°
d. 180°

12. A 2.5 cm radius single circular wire coil is removed from a 4.5×10^{-4} T magnetic field in 0.25 s. What is the EMF induced in the coil?
a. 1.1×10^{-5} V
b. 3.5×10^{-6} V
c. 2.8×10^{-4} V
d. 2.2×10^{-7} V

13. Which of the following must a collapsing magnetic field produce?
a. an electric field
b. a concentrated electric charge
c. a change in flux
d. accelerated charges

14. A square loop 15 cm by 15 cm consisting of 12 turns of wire is in a magnetic field of strength 3.3×10^{-3} T with its plane PARALLEL to the direction of the field. Then it is rotated in a time interval of 0.12 s so that its plane is PERPINDICULAR to the direction of the field. What is the average EMF induced in the loop during this interval?
a. 0
b. 1.1×10^{-4} V
c. 6.2×10^{-4} V
d. 7.4×10^{-3} V

15.



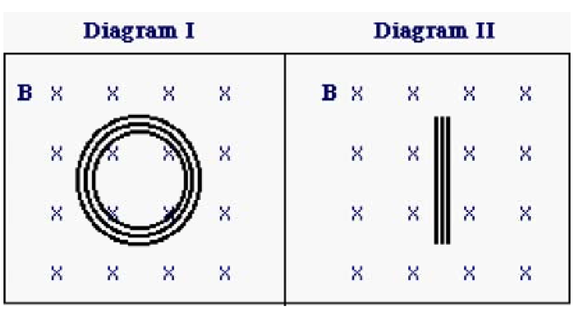
A coil in a magnetic field consists of 55 circular loops of wire with an area of 0.18 m^2 as shown in the above diagram. The coil takes 0.13 s to turn from the position shown in Diagram I to the position shown in Diagram II. If the strength of the magnetic field B is 0.58 T, what is the average emf induced in the wire while it is turning?

a. 69 V
b. 44 V
c. zero
d. 0.80 V

16. A stationary square coil 2.0 cm x 2.0 cm consists of 50 turns. Its plane is perpendicular to an external magnetic field of 0.40 T. This field is changed at a constant rate until it has a strength of 0.40 T in the opposite direction. If the change takes 0.10 s, what is the emf induced in the coil during this time?

a. zero
b. 1.6×10^{-1} V
c. 8.0×10^{-2} V
d. 3.2×10^{-3} V

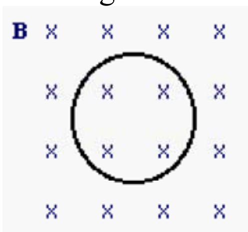
17. A coil of wire consisting of 32 circular loops of wire with an area of 0.15 m^2 is placed so its plane is perpendicular to a magnetic field of 0.48 T as shown in Diagram I. The coil is then rotated 90° in a time of 0.12 s until its plane is parallel to the magnetic field as shown in Diagram II.



What is the average emf induced in the coil?

a. 0.0 V
b. 0.60 V
c. 9.5 V
d. 19 V

18. The diagram shows a coil in a constant uniform magnetic field.



An EMF will be generated in the coil if

a. the coil is moved parallel to the field without being turned
b. the coil is moved perpendicular to the field without being turned
c. the coil is rotated about an axis perpendicular to its plane
d. the coil is cut

Day 3 flux worksheet
Answer Section

MULTIPLE CHOICE

1. ANS: D
Maximum force on a charge (and therfore voltage) occurs when the wire travels perpendicular to the magnetic field

PTS: 1 DIF: K TOP: Induction

2. ANS: C
Using the equation: $\varepsilon = -\frac{N\Delta\Phi}{t}$

Notice the induced voltage is directly proportional to the number of coils/loops (N). Therefore, if there are twice as many loops, there will be twice as much voltage.

PTS: 1 DIF: K TOP: Induction

3. ANS: A
rotation must be at right angles to the magnetic field to create the maximum change in flux

PTS: 1 DIF: K TOP: Induction

4. ANS: C
emf = change in flux time for change
so emf = slope of tangent line on graph
greatest slope will be at position Y

PTS: 1 TOP: Induction

5. ANS: A
Moving the magnet towards the solenoid will increase the flux thereby induce a magnetic field in the solenoid that is opposite in direction of the bar magnet (ie. to the left).

Using the right hand rule, current in the solenoid will be upward on the front side, therefore, current will flow from X to Y through the resistor.

PTS: 1 DIF: K TOP: Induction

6. ANS: B
$\phi = BA$
$\phi = Tm^2$

B = magnetic field strength measured in Tesla (T)
A = area measured in m^2

PTS: 1 DIF: K TOP: Induction

7. ANS: C

ε = Induced voltage, N = number of coils of wire, and $\frac{\Delta\Phi}{t}$ is rate of change of magnetic flux. Also known as the equation below:

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

PTS: 1 DIF: K TOP: Induction

8. ANS: D

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

There will be a maximum flux when the full area of the circular coil is exposed to the magnetic field, so Φ_i is 4.5×10^{-4} Wb. When the coil rotates 90°, there will be no area of the coil exposed to the magnetic field, so Φ_f will drop to zero. To calculate the change in flux, we use the expression $\Phi_f - \Phi_i$

$$\varepsilon = -\frac{N(\Phi_f - \Phi_i)}{t}$$

$$\varepsilon = -\frac{1(0 - 4.5 \times 10^{-4})}{0.125} = 3.6 \times 10^{-3} V$$

PTS: 1 DIF: U TOP: Induction

9. ANS: E

Using the equations $\varepsilon = -\frac{N\Delta\Phi}{t}$

We see the size of the induced voltage (ε) varies directly with the number of coils (N). In other words, more coils means more induced voltage (satisfies II).

We also see the stronger magnet means a stronger magnetic field, which results in a larger change in flux (since Φ = BA) (satisfies I). The faster the magnet moves, the smaller the time and the larger the induced voltage(satisfies III).

PTS: 1 TOP: Induction

10. ANS: D

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

$$\varepsilon = -\frac{600(1.0)}{0.50} = 1200V$$

PTS: 1 TOP: Induction

11. ANS: C
maximum emf induced will occur when there is a maximum flux change. That occurs when the maximum area of the loop exposed to the field rotates 90° so that no area is exposed to the magnetic field. This causes the largest change in flux, and therefore, the larges induced voltage.

PTS: 1 DIF: K TOP: Induction

12. ANS: B
$\varepsilon = -\dfrac{N\Delta\Phi}{t}$

Now, we see the magnetic field stays constant, but the area of the circle exposed the magnetic field changes to zero. So we only need to consider the change in area for the flux change.

$\varepsilon = -\dfrac{NB(A_f - A_i)}{t}$ now, we need to put in the area of a circle

$\varepsilon = -\dfrac{NB(\pi r_f^2 - \pi r_i^2)}{t}$ now factor our pi

$\varepsilon = -\dfrac{NB\pi(r_f^2 - r_i^2)}{t}$ now substitute variables

$\varepsilon = -\dfrac{(1)(4.5\times 10^{-4})\pi(0 - 0.025^2)}{0.25} = 3.53\times 10^{-6}\,V$

PTS: 1 DIF: U TOP: Induction

13. ANS: C
changing magnetic field will produce a change in flux

PTS: 1 DIF: K TOP: Induction

14. ANS: D
$\varepsilon = -\dfrac{N\Delta\Phi}{t}$, the magnetic field strength stays the same, but the loop rotates so the exposed area to the magnetic field changes from a maximum to zero (ie. final area will be measured as zero).

The initial area of the square loop exposed to the magnetic field is:
$A_i = lw = (0.15m)(0.15m) = 0.225m^2$

$\varepsilon = -\dfrac{NB\Delta A}{t} = -\dfrac{NB(A_f - A_i)}{t} = -\dfrac{(12)(3.3\times 10^{-3})(0 - 0.225)}{0.12} = 7.4\times 10^{-3}\,V$

PTS: 1 DIF: U TOP: Induction

15. ANS: B

$\varepsilon = -\frac{N\Delta\Phi}{t}$, the magnetic field strength stays the same, but the loop rotates so the exposed area to the magnetic field changes from a maximum to zero (ie. final area will be measured as zero).

$A_i = 0.18m^2$

$$\varepsilon = -\frac{NB\Delta A}{t} = -\frac{NB(A_f - A_i)}{t} = -\frac{(55)(0.58)(0-0.18)}{0.13} = 44.2V$$

PTS: 1 DIF: U TOP: Induction

16. ANS: B

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

When the magnetic field changes from 0.40T in one direction to 0.40T in the opposite direction, the total change in the the magnetic field is 0.80T. In this case, the area remains unchanged.

$A = lw = (0.02m)(0.02m) = 0.0004m^2$

$$\varepsilon = -\frac{NA\Delta B}{t} = -\frac{(50)(0.0004)(0.80)}{0.10} = 0.16V$$

PTS: 1 DIF: U TOP: Induction

17. ANS: D

$\varepsilon = -\frac{N\Delta\Phi}{t}$, the magnetic field strength stays the same, but the loop rotates so the exposed area to the magnetic field changes from a maximum to zero (ie. final area will be measured as zero).

$A_i = 0.15m^2$

$$\varepsilon = -\frac{NB\Delta A}{t} = -\frac{NB(A_f - A_i)}{t} = -\frac{(32)(0.48)(0-0.15)}{0.12} = 19.2V$$

PTS: 1 DIF: U TOP: Induction

18. ANS: C

In this case, the change in magnetic flux is due to a change in the area of the loop exposed to the magnetic field ($\Delta\Phi = B\Delta A$) as it rotates. This will cause an induce a voltage (EMF). This occurs as the area of the loop that is exposed to the magnetic field goes from a maximum to zero.

PTS: 1 TOP: Induction