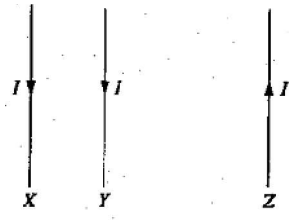
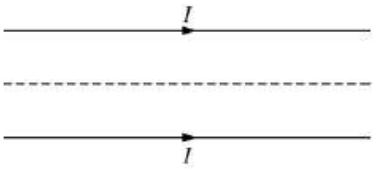
53. The currents in three parallel wires, X, Y, and Z, each have magnitude I and are in the directions shown. Wire y is closer to wire X than to wire z. The magnetic force on wire y is
(A) zero
(B) into the page
(C) out of the page
(D) toward the left



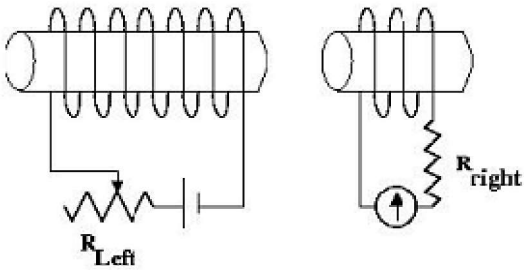
54. Two long, straight, parallel wires in the plane of the page carry equal currents *I* in the same direction, as shown above. Which of the following correctly describes the forces acting on the wires and the resultant magnetic field at points along the dotted line midway between the wires?



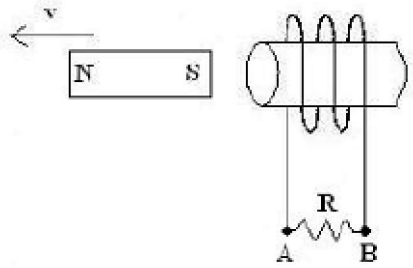
	Forces	Field
(A)	Attractive	Not zero
(B)	Attractive	Zero
(C)	Repulsive	Not zero
(D)	Repulsive	Zero

SECTION B – Electromagnetic Induction

1. For the solenoids shown in the diagram (which are assumed to be close to each other), the resistance of the left-hand circuit is slowly increased. In which direction does the ammeter needle (indicating the direction of conventional current) in the right-hand circuit deflect in response to this change?
A) The needle deflects to the left.
B) The needle deflects to the right.
C) The needle oscillates back and forth.
D) The needle never moves.



2. A strong bar magnet is held very close to the opening of a solenoid as shown in the diagram. As the magnet is moved away from the solenoid at constant speed, what is the direction of conventional current through the resistor shown and what is the direction of the force on the magnet because of the induced current?



	Current through resistor	Force on Magnet
A)	From A to B	To the left
B)	From B to A	To the left
C)	From A to B	To the right
D)	From B to A	To the right

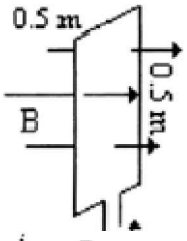
3. A magnet is dropped through a vertical copper pipe slightly larger than the magnet. Relative to the speed it would fall in air, the magnet in the pipe falls.
A) more slowly because it is attracted by the innate magnetic field of the pipe
B) more slowly because the currents induced in the pipe produce an opposing magnetic field
C) at the same rate
D) more quickly because the currents induced in the pipe produce an opposing magnetic field

4. A 0.20 m long copper rod has constant velocity 0.30 m/s traveling through a uniform magnetic field of 0.060 T. The rod, velocity, and magnetic field are all mutually perpendicular. What is the potential difference induced across the rod's length?
A) 0.0036 V B) 0.040 V C) 0.090 V D) 1.0 V ~~E) 25 V~~

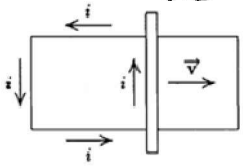
5. When a wire moving through a magnetic field has a voltage induced between the wire's ends, that voltage is
I. directly proportional to the strength of the magnetic field
II. directly proportional to the velocity of the wire
III. directly proportional to the diameter of the wire
A) I only B) II only C) III only D) I and II only

6. Lenz's law concerning the direction of an induced current in a conductor by a magnetic field could be considered a result of
A) Ampere's law B) Ohm's Law C) Tesla's Law
D) The Law of Conservation of Energy

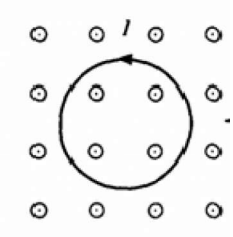
7. A square loop is placed in a uniform magnetic field perpendicular to the plane of the loop as shown. The loop is 0.50 meters on a side and the magnetic field B has a strength of 2 T. If the loop is rotated through an angle of 90° in 0.1 second what would be the average induced EMF in the loop?
A) 0.025 C B) 0.40 V C) 5 V D) 10 V



8. The figure shows a bar moving to the right on two conducting rails. To make an induced current i in the direction indicated, in what direction would the magnetic field be in the area contained within the conducting rails?
A) out of the page B) into the page
C) to the right D) to the left

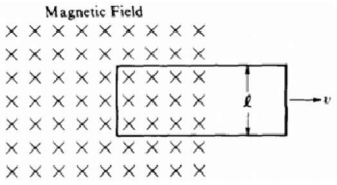


9. There is a counterclockwise current I in a circular loop of wire situated in an external magnetic field directed out of the page as shown. The effect of the forces that act on this current is to make the loop
(A) expand in size
(B) contract in size
(C) rotate about an axis perpendicular to the page
(D) accelerate into the page

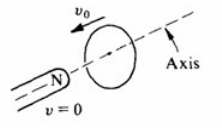


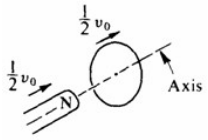
10. The figure shows a rectangular loop of wire of width *l* and resistance R. One end of the loop is in a uniform magnetic field of strength B at right angles to the plane of the loop. The loop is pulled to the right at a constant speed v. What are the magnitude and direction of the induced current in the loop?

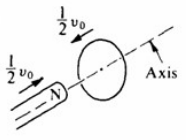
Magnitude	Direction
(A) BlvR	Clockwise
(B) BlvR	Counterclockwise
(C) Blv/R	Clockwise
(D) Blv/R	Counterclockwise

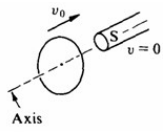


11. In each of the following situations, a bar magnet is aligned along the axis of a conducting loop. The magnet and the loop move with the indicated velocities. In which situation will the bar magnet NOT induce a current in the conducting loop?

(A) 

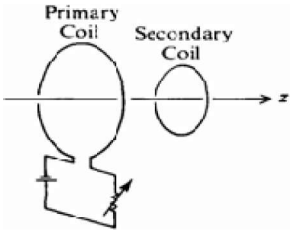
(B) 

(C) 

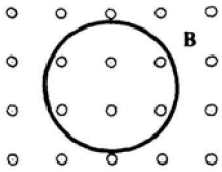
(D) 

12. A square loop of copper wire is initially placed perpendicular to the lines of a constant, uniform magnetic field of 5 x 10-3 tesla. The area enclosed by the loop is 0.2 square meter. The loop is then turned through an angle of 90° so that the plane of the loop is parallel to the field lines. The turn takes 0.1 second. The average emf induced in the loop during the turn is
(A) 1.0 x 10-4 V (B) 2.5 x 10-3 V (C) 0.01 V (D) 100

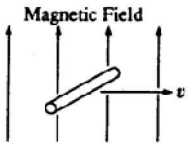
13. Two circular coils are situated perpendicular to the z-axis as shown. There is a current in the primary coil. All of the following procedures will induce a current in the secondary coil EXCEPT
(A) rotating the secondary coil about the z-axis
(B) rotating the secondary coil about a diameter
(C) moving the secondary coil closer to the primary coil
(D) varying the current in the primary coil

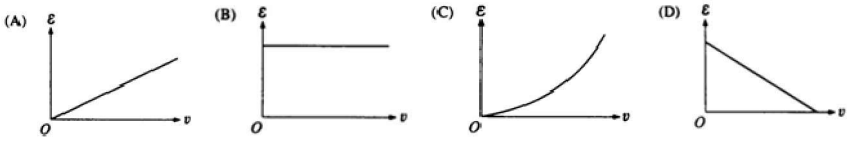


14. A magnetic field B that is decreasing with time is directed out of the page and passes through a loop of wire in the plane of the page, as shown. Which of the following is true of the induced current in the wire loop?
(A) It is counterclockwise in direction.
(B) It is clockwise in direction.
(C) It is directed out of the page.
(D) It is zero in magnitude.

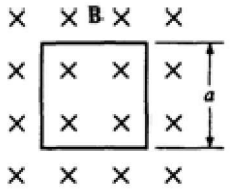


15. A wire of constant length is moving in a constant, uniform magnetic field, as shown. The wire and the velocity vector are perpendicular to each other and are both perpendicular to the field. Which of the following graphs best represents the potential difference E between the ends of the wire as a function of velocity?

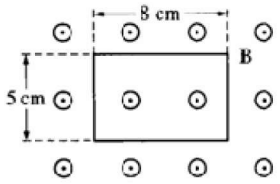




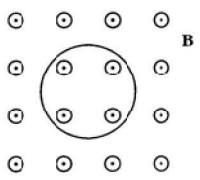
16. A square loop of wire of resistance *R* and side *a* is oriented with its plane perpendicular to a magnetic field **B**, as shown. What must be the rate of change of the magnetic field in order to produce a current *I* in the loop?
(A) IR/a^2 (B) Ia^2/R (C) Ia/R (D) IRa



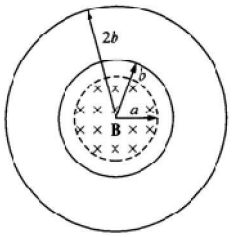
17. A rectangular wire loop is at rest in a uniform magnetic field **B** of magnitude 2 T that is directed out of the page. The loop measures 5 cm by 8 cm, and the plane of the loop is perpendicular to the field, as shown. The total magnetic flux through the loop is
(A) zero (B) 2 x 10^{-3} T-m^2 (C) 8 x 10^{-3} T-m^2
(D) 8 x 10^{-1} T-m



18. A single circular loop of wire in the plane of the page is perpendicular to a uniform magnetic field **B** directed out of the page, as shown. If the magnitude of the magnetic field is decreasing, then the induced current in the wire is
(A) directed out of the paper
(B) directed into the paper
(C) clockwise around the loop
(D) counterclockwise around the loop

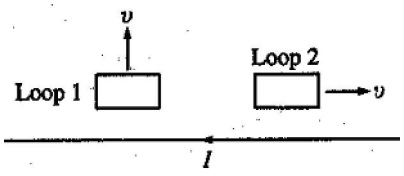


19. A uniform magnetic field **B** that is perpendicular to the plane of the page now passes through the loops, as shown. The field is confined to a region of radius *a*, where $a < b$, and is changing at a constant rate. The induced emf in the wire loop of radius *b* is $\mathcal{E}$. What is the induced emf in the wire loop of radius *2b* ?



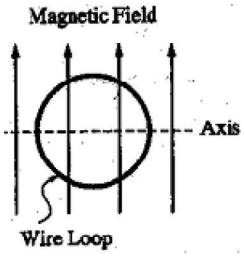
(A) Zero (B) $\mathcal{E}/2$ (C) $\mathcal{E}$ (D) $4\mathcal{E}$

20. Two conducting wire loops move near a very long, straight conducting wire that carries a current I. When the loops are in the positions shown, they are moving in the direction shown with the same constant speed v. Assume that the loops are far enough apart that they do not affect each other. Which of the following is true about the induced electric currents, if any, in the loops?



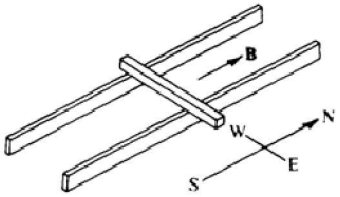
Loop 1	**Loop 2**
(A) No current	No current
(B) No current	Counterclockwise direction
(C) Clockwise direction	No current
(D) Counterclockwise direction	Clockwise direction

21. A wire loop is rotated in a uniform magnetic field about an axis perpendicular to the field, as shown. How many times is the induced current in the loop reversed if the loop makes 3 complete revolutions from the position shown?



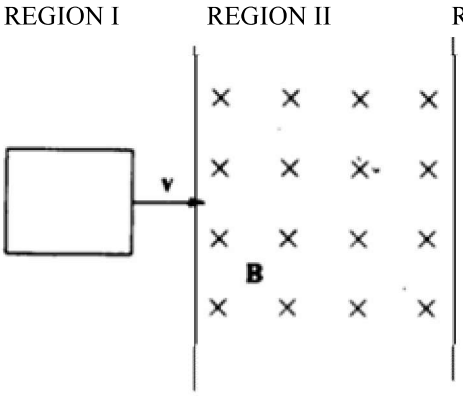
(A) One (B) Two C) Three (D) Six

22. The ends of a metal bar rest on two horizontal north-south rails as shown. The bar may slide without friction freely with its length horizontal and lying east and west as shown. There is a magnetic field parallel to the rails and directed north.If the bar is pushed northward on the rails, the electromotive force induced in the bar as a result of the magnetic field will



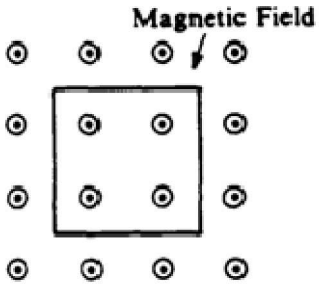
(A) be directed upward
(B) be zero
(C) produce a westward current
(D) stop the motion of the bar

23. A loop of wire is pulled with constant velocity v to the right through a region of space where there is a uniform magnetic field B directed into the page, as shown. The induced current is as follows

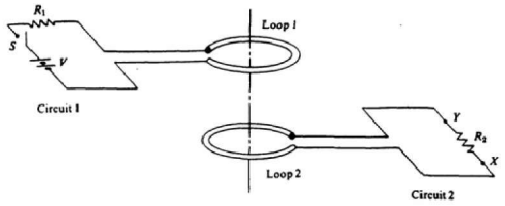


A) Directed CW both entering and leaving REGION II.
B) Directed CCW both entering and leaving REGION II.
C) Directed CW entering REGION II and CCW leaving REGION II
D) Directed CCW entering REGION II and CW leaving REGION II.

24. A square loop of wire of side 0.5 meter and resistance 10^{-2} ohm is located in a uniform magnetic field of intensity 0.4 tesla directed out of the page as shown. The magnitude of the field is decreased to zero at a constant rate in 2 seconds. As the field is decreased, what are the magnitude and direction of the current in the loop?
(A) Zero
(B) 5 A, counterclockwise
(C) 5 A, clockwise
(D) 20 A, counterclockwise



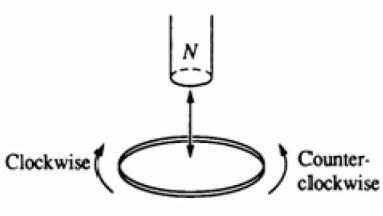
Questions 25-26



25. After the switch S is closed, the initial current through resistor R_2 is
(A) from point X to point Y (B) from point Y to point X
(C) zero at all times (D) impossible to determine its direction

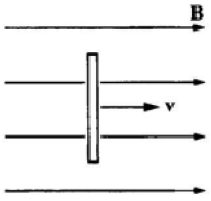
26. After the switch S has been closed for a very long time, the currents in the two circuits are
(A) zero in both circuits (B) zero in circuit 1 and V/R_2 in circuit 2
(C) V/R_1 in circuit 1 and zero in circuit 2 (D) V/R_1 in circuit I and V/R_2 in circuit 2

27. In the figure, the north pole of the magnet is first moved down toward the loop of wire, then withdrawn upward. As viewed from above, the induced current in the loop is
A) always clockwise with increasing magnitude
B) always counterclockwise with increasing magnitude
C) always counterclockwise with decreasing magnitude
D) first counterclockwise, then clockwise

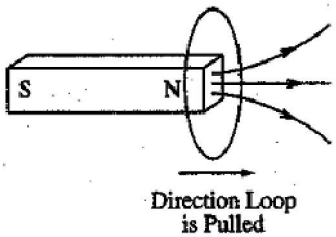


28. A vertical length of copper wire moves to the right with a steady velocity v in the direction of a constant horizontal magnetic field B as shown. Which of the following describes the induced charges on the ends of the wire?

Top End	Bottom End
(A) Positive	Negative
(B) Negative	Positive
(C) Zero	Negative
(D) Zero	Zero



29. A conducting loop of wire that is initially around a magnet is pulled away from the magnet to the right, as indicated in the figure, inducing a current in the loop. What is the direction of the force on the magnet and the direction of the magnetic field at the center of the loop due to the induced current?



Direction of Force on the Magnet	**Direction of Magnetic Field at Center of Loop due To Induced Current**
(A) To the right	To the right
(B) To the right	To the left
(C) To the left	To the right
(D) No direction; the force is zero.	To the left

30. A uniform magnetic field **B** is directed out of the page, as shown to the right. A loop of wire of area 0.40 m^2 is in the plane of the page. At a certain instant the field has a magnitude of 3.0 T and is decreasing at the rate of 0.50 T/s. The magnitude of the induced emf in the wire loop at this instant is most nearly
(A) 0.20 V (B) 0.60 V (C) 1.2 V (D) 1.5 V