CHAPTER 21

ELECTROMAGNETIC INDUCTION

FACT/DEFINITION TYPE QUESTIONS

1. Whenever the magnetic flux linked with an electric circuit changes, an emf is induced in the circuit. This is called
(a) electromagnetic induction
(b) lenz's law
(c) hysteresis loss
(d) kirchhoff's laws

2. An induced e.m.f. is produced when a magnet is plunged into a coil. The strength of the induced e.m.f. is independent of
(a) the strength of the magnet
(b) number of turns of coil
(c) the resistivity of the wire of the coil
(d) speed with which the magnet is moved

3. According to Faraday's law of electromagnetic induction
(a) electric field is produced by time varying magnetic flux.
(b) magnetic field is produced by time varying electric flux.
(c) magnetic field is associated with a moving charge.
(d) None of these

4. A moving conductor coil produces an induced e.m.f. This is in accordance with
(a) Lenz's law (b) Faraday's law
(c) Coulomb's law (d) Ampere's law

5. A coil of insulated wire is connected to a battery. If it is taken to galvanometer, its pointer is deflected, because
(a) the induced current is produced
(b) the coil acts like a magnet
(c) the number of turns in the coil of the galvanometer are changed
(d) None of these

6. Lenz's law is a consequence of the law of conservation of
(a) charge (b) mass
(c) energy (d) momentum

7. A magnet is moved towards a coil (i) quickly (ii) slowly, then the induced e.m.f. is
(a) larger in case (i)
(b) smaller in case (i)
(c) equal to both the cases
(d) larger or smaller depending upon the radius of the coil

8. The laws of electromagnetic induction have been used in the construction of a
(a) galvanometer (b) voltmeter
(c) electric motor (d) generator

9. Two identical coaxial circular loops carry a current i each circulating in the same direction. If the loops approach each other, you will observe that the current in
(a) each increases
(b) each decreases
(c) each remains the same
(d) one increases whereas that in the other decreases

10. Which of the following represents correct formula for magnetic flux?
(a) $d\phi = \vec{ds} . \vec{B}$ (b) $d\phi = \vec{v} . \vec{B}$
(c) $d\phi = \vec{B} . \vec{ds}$ (d) $d\phi = \vec{B} . \vec{dl}$

11. Magnetic flux is
(a) total charge per unit area.
(b) total current through a surface.
(c) total number of magnetic field lines passing normally through given area.
(d) total e.m.f. in closed circuit.

12. In electromagnetic induction, the induced charge is independent of
(a) change of flux
(b) time.
(c) resistance of the coil
(d) None of these

13. The induced e.m.f. in a rod of length l translating at a speed v making an angle θ with length l and perpendicular to magnetic field B is
(a) Blv (b) $Blv \cos\theta$
(c) $Blv \sin\theta$ (d) $Blv \tan\theta$

14. Len'z law provides a relation between
(a) current and magnetic field.
(b) induced e.m.f. and the magnetic flux.
(c) force on a conductor in magnetic field.
(d) current and induced e.m.f.

15. A conducting loop is placed in a uniform magnetic field with its plane perpendicular to the field. An e.m.f. is induced in the loop, if

(a) it is translated.
(b) it is rotated about its axis.
(c) both (a) and (b).
(d) it is rotated about its diameter.

16. The expression for the induced e.m.f. contains a negative sign $\left[e = -\frac{d\phi}{dt}\right]$. What is the significance of the negative sign?
(a) The induced e.m.f. is produced only when the magnetic flux decreases.
(b) The induced e.m.f. opposes the change in the magnetic flux.
(c) The induced e.m.f. is opposite to the direction of the flux.
(d) None of the above.

17. A coil of insulated wire is connected to a battery. If it is connected to galvanometer, its pointer is deflected, because
(a) induced current is set up
(b) no induced current is set up
(c) the coil behaves as a magnet
(d) the number of turns is changed

18. A cylindrical bar magnet is kept along the axis of a circular coil. On rotating the magnet about its axis, the coil will have induced in it
(a) a current (b) no current
(c) only an e.m.f. (d) both an e.m.f. and a current

19. Direction of current induced in a wire moving in a magnetic field is found using
(a) Fleming's left found rule
(b) Fleming's right hand rule
(c) Ampere's rule
(d) Right hand clasp rule

20. A circular coil expands radially in a region of magnetic field and no electromotive force is produced in the coil This is because
(a) the magnetic field is constant
(b) the magnetic field is in the same plane as the circular coil and it may or may not vary.
(c) the magnetic field has a perpendicular (to the plane of the coil) component whose magnitude is decreasing suitably.
(d) both (b) and (c).

21. Whenever, current is changed in a coil, an induced e.m.f. is produced in the same coil. This property of the coil is due to
(a) mutual induction (b) self induction
(c) eddy currents (d) hysteresis

22. When current i passes through an inductor of self inductance L, energy stored in it is 1/2. L i^2. This is stored in the
(a) current (b) voltage
(c) magnetic field (d) electric field

23. An inductor may store energy in
(a) its electric field
(b) its coils
(c) its magnetic field
(d) both in electric and magnetic fields

24. If N is the number of turns in a coil, the value of self inductance varies as
(a) N^0 (b) N
(c) N^2 (d) N^{-2}

25. Two coils of inductances L_1 and L_2 are linked such that their mutual inducatance is M. Then
(a) $M = L_1 + L_2$
(b) $M = \frac{1}{2}(L_1 + L_2)$
(c) the maximum value of M is $(L_1 + L_2)$
(d) the minimum value of M is $\sqrt{L_1 L_2}$

26. The SI unit of inductance, the henry can be written as
(a) weber/ampere (b) volt second/ampere
(c) joule/ampere^2 (d) all of the above

27. The mutual inductance between two coils depends on
(a) medium between the coils
(b) separation between the two coils
(c) orientation of the two coils
(d) All of the above

28. Which of the following units denotes the dimension $\frac{ML^2}{Q^2}$, where Q denotes the electric charge?
(a) Wb/m^2 (b) henry (H)
(c) H/m^2 (d) weber (Wb)

29. The emf is induced in a single, isolated coil due to ...A... of flux through the coil by means of varying the current through the same coil. This phenomenon is called ...B... Here, A and B refer to
(a) constancy, mutual induction
(b) change, self induction
(c) constancy, self induction
(d) changes, mutual induction

30. Two coils, A and B, are lined such that emf ε is induced in B when the current in A is changing at the rate I. If current i is now made to flow in B, the flux linked with A will be
(a) $(\varepsilon/I)i$ (b) $\varepsilon\, i\, I$
(c) $(\varepsilon I)i$ (d) $i\, I/\varepsilon$

31. The polarity of induced emf is given by
(a) Ampere's circuital law (b) Biot-Savart law
(c) Lenz's law (d) Fleming's right hand rule

32. The self inductance of a coil is a measure of
(a) electrical inertia (b) electrical friction
(c) induced e.m.f. (d) induced current

33. The coils in resistance boxes are made from doubled insulated wire to nullify the effect of
(a) heating (b) magnetism
(c) pressure (d) self induced e.m.f.

34. Two pure inductors each of self inductance L are connected in series, the net inductance is
(a) L (b) 2 L
(c) L/2 (d) L/4

35. The self inductance associated with a coil is independent of
(a) current (b) induced voltage
(c) time (d) resistance of a coil

36. Induction coil is an instrument based on the principle of
(a) electromagnetic induction
(b) mutual induction
(c) self induction
(d) induction furnace.

37. If the magnetic flux linked with a coil through which a current of x A is set up is y Wb, then the coefficient of self inductance of the coil is
(a) $(x - y)$ henry (b) $\frac{x}{y}$ henry
(c) $\frac{y}{x}$ henry (d) x y henry

38. Production of induced e.m.f. in a coil due to the changes of current in the same coil is
(a) self induction (b) mutual induction
(c) dynamo (d) none of these

39. Henry is the S.I. unit of
(a) resistance (b) capacity
(c) inductance (d) current

40. Mutual induction is the production of induced e.m.f. in a coil due to the changes of current in the
(a) same coil (b) neighbouring coil
(c) both (a) and (b) (d) neither (a) nor (b)

41. The self inductance associated with a coil is independent of
(a) current (b) time
(c) induced voltage (d) resistance of coil

42. Eddy currents are produced when
(a) A metal is kept in varying magnetic field
(b) A metal is kept in the steady magnetic field
(c) A circular coil is placed in a magnetic field
(d) Through a circular coil, current is passed

43. Which of the following does not use the application of eddy current ?
(a) Electric power meters (b) Induction furnace
(c) LED lights (d) Magnetic brakes in trains

44. Induction furnace make use of
(a) self induction (b) mutual induction
(c) eddy current (d) None of these

45. When strength of eddy currents is reduced, as dissipation of electrical energy into heat depends on the ...A... of the strength of electrical energy into heat depends on the ...*A*... of the strength of electric current heat loss is substantially ...*B* ... .
Here, *A* and *B* refer to
(a) cube, increase (b) inverse, increased
(c) inverse, decreased (d) square, reduced

46. The plane in which eddy currents are produced in a conductor is inclined to the plane of the magnetic field at an angle equal to
(a) 45° (b) 0°
(c) 180° (d) 90°

47. Which of the following is not the application of eddy currents?
(a) Induction furnace (b) Dead beat galvanometer
(c) speedometer (d) X-ray crystallography

48. Eddy currents do not cause
(a) damping (b) heating
(c) sparking (d) loss of energy

49. For magnetic breaking in trains, strong electromagnets are situated above the rails in some electrically powered trains. When the electromagnets are activated, the ...*A*... induced in the rails oppose the motion of the train. As there are no ... *B*... linkages, the ...*C*... effects is smooth.
Here, *A*, *B* and *C* refer to
(a) eddy currents, mechanical, breaking
(b) induced currents, thermal, accelerating
(c) induced emf, mechanical, accelerating
(d) eddy currents, thermal, flying

50. The pointer of a dead-beat galvanometer gives a steady deflection because
(a) eddy currents are produced in the conducting frame over which the coil is wound.
(b) its magnet is very strong.
(c) its pointer is very light.
(d) its frame is made of ebonite.

51. Eddy currents do not produce
(a) heat (b) a loss of energy
(c) spark (d) damping of motion

52. If in a galvanometer the coil is wound on a bad conductor, the eddy current will be
(a) zero (b) maximum
(c) minimum (d) 50% of the actual value

53. Certain galvanometers have a fixed core made of non-magnetic metallic material, when the coil oscillates, ...*A*... generated in the core ...*B*... the motion and bring the coil to rest ...*C*...
Here, *A*, *B* and *C* refer to
(a) induced emf, support, long time
(b) induced current, support, long time
(c) mechanical energy, oppose, long time
(d) eddy currents, oppose, quickly

54. When the plane of the armature of an a.c. generator is parallel to the field. in which it is rotating
(a) both the flux linked and induced emf in the coil are zero.
(b) the flux linked with it is zero, while induced emf is maximum.
(c) flux linked is maximum while induced emf is zero.
(d) both the flux and emf have their respective maximum values.

55. A dynamo converts
(a) mechanical energy into thermal energy
(b) electrical energy into thermal energy
(c) thermal energy into electrical energy
(d) mechanical energy into electrical energy
(e) electrical energy into mechanical energy

56. Choke coil works on the principle of
(a) transient current (b) self induction
(c) mutual induction (d) wattless current

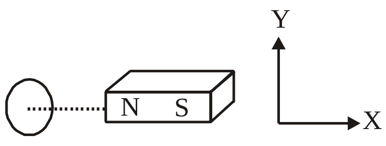
57. If a coil made of conducting wires is rotated between poles pieces of the permanent magnet. The motion will generate a current and this device is called
(a) An electric motor (b) An electric generator
(c) An electromagnet (d) All of the above

STATEMENT TYPE QUESTIONS

58. A current carrying infinitely long wire is kept along the diameter of a circular wire loop, without touching it, the correct statement(s) is(are)
I. The emf induced in the loop is zero if the current is constant.
II. The emf induced in the loop is finite if the current is constant.
III. The emf induced in the loop is zero if the current decreases at a steady rate.
(a) I only (b) II only
(c) I and II (d) I, II and III

59. Whenever the magnetic flux linked with a coil changes, an induced e.m.f.is produced in the circuit. The e.m.f. lasts
I. for a short time
II. for a long time
III. so long as the change in flux takes place
The correct statement(s) is/are
(a) I and II (b) II and III
(c) I and III (d) III only

60. Consider coil and magnet



Current is induced in coil when
I. coil and magnet both are at rest.
II. coil is at rest and magnet moves along x.
III. magnet is at rest and coil moves along x.
IV. both coil and magnet move along y with same speed.
The correct statements are
(a) I and IV (b) I and II
(c) III and IV (d) II and III

61. Two coils are placed close to each other. The mutual inductance of the pair of coils depends upon
I. relative position and orientation of the two coils
II. the materials of the wires of the coils
III. the rates at which currents are changing in the two coils
Which of the above statements is/are correct?
(a) I only (b) II only
(c) I and III (d) II and III

62. A coil of self-inductance L is connected in series with a bulb B and an AC source. Brightness of the bulb decreases when
I. number of turns in the coil is reduced
II. a capacitance of reactance $X_C = X_L$ is included in the same circuit
III. an iron rod is inserted in the coil
Which of the above statements is/are correct?
(a) I only (b) II and III
(c) III only (d) I and II

MATCHING TYPE QUESTIONS

63. Match the column-I and column-II

	Column I		Column II
(A)	AC generator	(1)	Eddy current
(B)	DC motor	(2)	Slip rings
(C)	Dead beat galvanometer	(3)	Split ring
(D)	Solenoid	(4)	Insulated copper wire wound in the form of a cylindrical coil

(a) $A \rightarrow 2 ; B \rightarrow 3 ; C \rightarrow 2 ; D \rightarrow 1$
(b) $A \rightarrow 4 ; B \rightarrow 2 ; C \rightarrow 1 ; D \rightarrow 3$
(c) $A \rightarrow 2 ; B \rightarrow 3 ; C \rightarrow 1 ; D \rightarrow 4$
(d) $A \rightarrow 2 ; B \rightarrow 1 ; C \rightarrow 3 ; D \rightarrow 4$

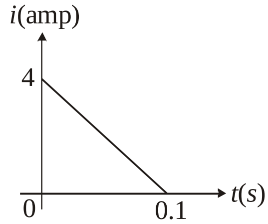
64. Match the column-I and column-II

	Column I		Column II
(A)	Ring uniformly charged	(1)	Constant electrostatic field out of system
(B)	Rotating ring uniformly charged	(2)	Magnetic field strength rotating with angular velocity ω
(C)	Constant current in ring i	(3)	Electric field (induced)
(D)	$i = i_0 \cos\omega t$	(4)	Magnetic dipole moment

(a) $A \rightarrow 2 ; B \rightarrow 2, 3 ; C \rightarrow 1, 4, 3 ; D \rightarrow 3$
(b) $A \rightarrow 3, 4 ; B \rightarrow 1 ; C \rightarrow 2, 3 ; D \rightarrow 2$
(c) $A \rightarrow 1 ; B \rightarrow 1, 2, 4 ; C \rightarrow 2, 4 ; D \rightarrow 3$
(d) $A \rightarrow 2 ; B \rightarrow 4, 2, 1 ; C \rightarrow 2, 1 ; D \rightarrow 4, 2$

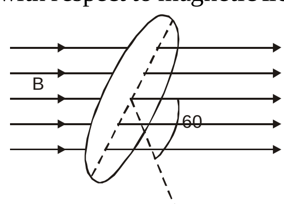
DIAGRAM TYPE QUESTIONS

65. In a coil of resistance 10 Ω, the induced current developed by changing magnetic flux through it, is shown in figure as a function of time. The magnitude of change in flux through the coil in weber is



(a) 8 (b) 2
(c) 6 (d) 4

66. Fig shown below represents an area $A = 0.5\ m^2$ situated in a uniform magnetic field $B = 2.0$ weber/m^2 and making an angle of 60° with respect to magnetic field.

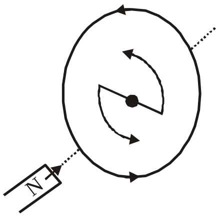


The value of the magnetic flux through the area would be equal to

(a) 2.0 weber (b) $\sqrt{3}$ weber

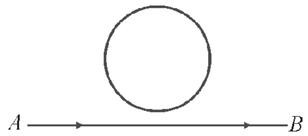
(c) $\sqrt{3}/2$ weber (d) 0.5 weber

67. In the given situation, the bar magnet experinces a ...A... force due to the ... B ... in coil.



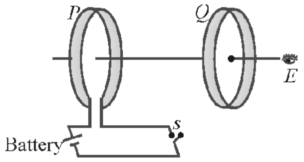
Here, A and B refer to
(a) an attractive, air
(b) an attractive, induced current
(c) repulsive, induced current
(d) attractive, vacuum

68. An electron moves along the line *AB*, which lies in the same plane as a circular loop of conducting wires as shown in the diagram. What will be the direction of current induced if any, in the loop



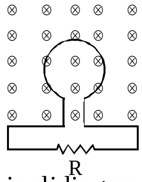
(a) no current will be induced
(b) the current will be clockwise
(c) the current will be anticlockwise
(d) the current will change direction as the electron passes by

69. As shown in the figure, *P* and *Q* are two coaxial conducting loops separated by some distance. When the switch *S* is closed, a clockwise current I_P flows in *P* (as seen by *E*) and an induced current I_{Q_1} flows in *Q*. The switch remains closed for a long time. When *S* is opened, a current I_{Q_2} flows in *Q*. Then the directions of I_{Q_1} and I_{Q_2} (as seen by *E*) are



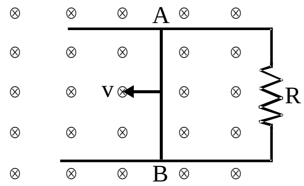
(a) respectively clockwise and anticlockwise
(b) both clockwise
(c) both anticlockwise
(d) respectively anticlockwise and clockwise

70. In the figure the flux through the loop perpendicular to the plane of the coil and directed into the paper is varying according to the relation $\phi = 6t^2 + 7t + 1$ where ϕ is in milliweber and t is in second. The magnitude of the emf induced in the loop at t = 2 s and the direction of induce current through R are



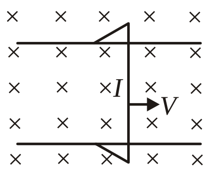
(a) 39 mV; right to left
(b) 39 mV; left to right
(c) 31 mV; right to left
(d) 31 mV; left to right

71. Consider the situation shown. The wire AB is sliding on fixed rails with a constant velocity. If the wire AB is replaced by semi-circular wire, the magnitude of induced e.m.f. will



(a) increase
(b) decrease
(c) remain the same
(d) increase or decrease depending on whether the semi-circle buldges towards the resistance or away from it.

72. The figure shows a wire sliding on two parallel conducting rails placed at a separation *I*. A magnetic field *B* exists in a direction perpendicular to the plane of the rails. The force required to keep the wire moving at a constant velocity *v* will be



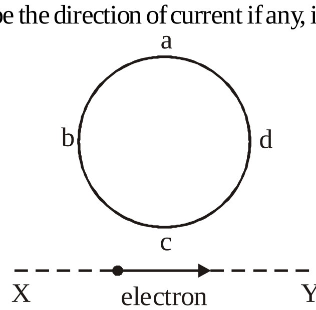
(a) evB

(b) $\dfrac{\mu_0 Bv}{4\pi I}$

(c) BIv

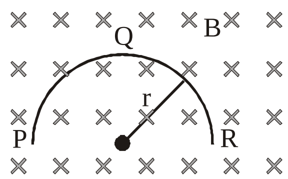
(d) zero

73. An electron moves on a straight line path XY as shown. The abcd is a coil adjacent to the path of electron. What will be the direction of current if any, induced in the coil?



(a) adcb
(b) The current will reverse its direction as the electron goes past the coil
(c) No current induced
(d) abcd

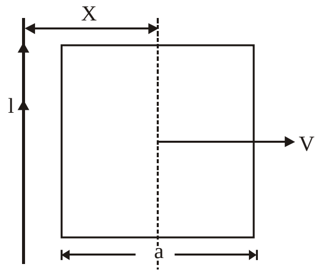
74. A thin semicircular conducting ring (PQR) of radius 'r' is falling with its plane vertical in a horizontal magnetic field B, as shown in figure. The potential difference developed across the ring when its speed is v, is :



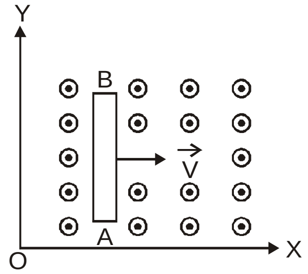
(a) Zero
(b) $Bv\pi r^2/2$ and P is at higher potnetial
(c) πrBv and R is at higher potnetial
(d) 2rBv and R is at higher potential

75. A conducting square frame of side 'a' and a long staight wire carrying current I are located in the same plane as shown in the figure. The frame moves to the right with a constant velocity 'V'. The emf induced in the frame will be proportional to

(a) $\dfrac{1}{(2x-a)^2}$
(b) $\dfrac{1}{(2x+a)^2}$
(c) $\dfrac{1}{(2x-a)(2x+a)}$
(d) $\dfrac{1}{x^2}$

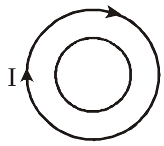


76. A conducting rod AB moves parallel to X-axis in a uniform magnetic field, pointing in the positive X-direction. The end A of the rod gets

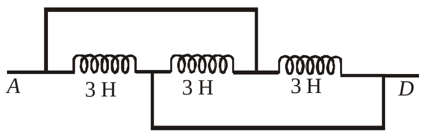


(a) positively charged
(b) negatively charged
(c) neutral
(d) first positively charged and then negatively charged

77. Two different wire loops are concentric and lie in the same plane. The current in the outer loop (I) is clockwise and increases with time. The induced current in the inner loop
(a) is clockwise
(b) is zero
(c) is counter clockwise
(d) has a direction that depends on the ratio of the loop radii.



78. The inductance between A and D is
(a) 3.66 H
(b) 9 H
(c) 0.66 H
(d) 1 H



ASSERTION- REASON TYPE QUESTIONS

Directions : Each of these questions contain two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.
(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

79. **Assertion :** Induced emf will always occur whenever there is change in magnetic flux.
Reason : Current always induces whenever there is change in magnetic flux.

80. **Assertion :** Faraday's laws are consequence of conservation of energy.
Reason : In a purely resistive ac circuit, the current legs behind the emf in phase.

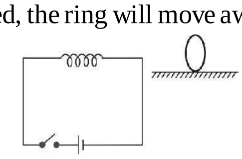
81. **Assertion :** Only a change in magnetic flux will maintain an induced current in the coil.
Reason : The presence of large magnetic flux through a coil maintain a current in the coil of the circuit is continuous.

82. **Assertion :** Lenz's law violates the principle of conservation of energy.
Reason : Induced emf always opposes the change in magnetic flux responsible for its production.

83. **Assertion :** An induced current has a direction such that the magnetic field due to the current opposes the change in the magnetic flux that induces the current.
Reason : Above statement is in accordance with conservation of energy.

84. **Assertion :** Acceleration of a magnet falling through a long solenoid decreases.
Reason : The induced current produced in a circuit always flow in such direction that it opposes the change to the cause that produced it.

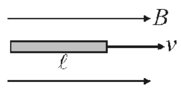
85. **Assertion :** Figure shows a horizontal solenoid connected to a battery and a switch. A copper ring is placed on a smooth surface, the axis of the ring being horizontal. As the switch is closed, the ring will move away from the solenoid.



Reason : Induced emf in the ring, $e = -\dfrac{d\phi}{dt}$.

86. **Assertion :** An emf can be induced by moving a conductor in a magnetic field.
Reason : An emf can be induced by changing the magnetic field.

87. **Assertion :** Figure shows a metallic conductor moving in magnetic field. The induced emf across its ends is zero.



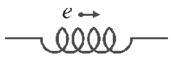
Reason : The induced emf across the ends of a conductor is given by $e = Bv\ell\sin\theta$.

88. **Assertion :** Eddy currents are produced in any metallic conductor when magnetic flux is changed around it.
Reason : Electric potential determines the flow of charge.

89. **Assertion :** An induced emf appears in any coil in which the current is changing.
Reason : Self induction phenomenon obeys Faraday's law of induction.

90. **Assertion :** When number of turns in a coil is doubled, coefficient of self-inductance of the coil becomes 4 times.
Reason : This is because $L \propto N^2$.

91. **Assertion :** Figure shows an emf e induced in a coil. It happens due to rightward decreasing current.



Reason : In the coil self induced emf $e = -L\frac{di}{dt}$.

92. **Assertion :** In the phenomenon of mutual induction, self induction of each of the coil persists.

Reason : Self induction arises due to change in current in the coil itself. In mutual induction current changes in both the individual coil.

CRITICALTHINKING TYPE QUESTIONS

93. A coil having an area A_0 is placed in a magnetic field which changes from B_0 to 4 B_0 in time interval t. The e.m.f. induced in the coil will be

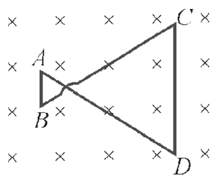
(a) $3A_0 B_0 / t$ (b) $4A_0 B_0 / t$

(c) $3B_0 / A_0 t$ (d) $4A_0 / B_0 t$

94. An infinitely long cylinder is kept parallel to an uniform magnetic field B directed along positive z axis. The direction of induced current as seen from the z axis will be

(a) zero
(b) anticlockwise of the +ve z axis
(c) clockwise of the +ve z axis
(d) along the magnetic field

95. A conducting wire frame is placed in a magnetic field which is directed into the paper. The magnetic field is increasing at a constant rate. The directions of induced current in wires *AB* and *CD* are



(a) *B* to *A* and *D* to *C* (b) *A* to *B* and *C* to *D*

(c) *A* to *B* and *D* to *C* (d) *B* to *A* and *C* to *D*

96. The magnetic flux through a circuit of resistance R changes by an amount $\Delta\phi$ in a time Δt. Then the total quantity of electric charge Q that passes any point in the circuit during the time Δt is represented by

(a) $Q = R.\frac{\Delta\phi}{\Delta t}$ (b) $Q = \frac{1}{R}.\frac{\Delta\phi}{\Delta t}$

(c) $Q = \frac{\Delta\phi}{R}$ (d) $Q = \frac{\Delta\phi}{\Delta t}$

97. The north pole of a bar magnet is moved towards a coil along the axis passing through the centre of the coil and perpendicular to the plane of the coil. The direction of the induced current in the coil when viewed in the direction of the motion of the magnet is

(a) clockwise
(b) anti-clockwise
(c) no current in the coil
(d) either clockwise or anti-clockwise

98. If a current increases from zero to one ampere in 0.1 second in a coil of 5 mH, then the magnitude of the induced e.m.f. will be

(a) 0.005 volt (b) 0.5 volt

(c) 0.05 volt (d) 5 volt

99. A coil has 200 turns and area of 70 cm^2. The magnetic field perpendicular to the plane of the coil is 0.3 Wb/m^2 and take 0.1 sec to rotate through 180º.The value of the induced e.m.f. will be

(a) 8.4 V (b) 84 V

(c) 42 V (d) 4.2 V

100. A coil of resistance 400Ω is placed in a magnetic field. If the magnetic flux ϕ (wb) linked with the coil varies with time t (sec) as $\phi = 50t^2 + 4$. The current in the coil at $t = 2$ sec is

(a) 0.5 A (b) 0.1 A

(c) 2 A (d) 1 A

101. A coil having n turns and resistance R Ω is connected with a galvanometer of resistance 4R Ω. This combination is moved in time t seconds from a magnetic field W_1 weber to W_2 weber. The induced current in the circuit is

(a) $-\frac{(W_1 - W_2)}{Rnt}$ (b) $-\frac{n(W_2 - W_1)}{5\ Rt}$

(c) $-\frac{(W_2 - W_1)}{5\ Rnt}$ (d) $-\frac{n(W_2 - W_1)}{Rt}$

102. Magnetic flux ϕ in weber in a closed circuit of resistance 10Ω varies with time ϕ (sec) as $f = 6t^2 - 5t + 1$. The magnitude of induced current at t = 0.25s is

(a) 0.2 A (b) 0.6 A

(c) 1.2 A (d) 0.8 A

103. The flux linked with a coil at any instant 't' is given by $\phi = 10t^2 - 50t + 250$. The induced emf at t = 3s is

(a) –190 V (b) –10 V

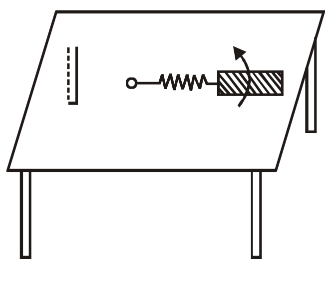
(c) 10 V (d) 190 V

104. A copper rod of length I rotates about its end with angular velocity ω in uniform magnetic field B. The emf developed between the ends of the rod if the field is normal to the plane of rotation is

(a) $B\omega I^2$ (b) $\frac{1}{2}B\omega I^2$

(c) $2B\omega I^2$ (d) $\frac{1}{4}B\omega I^2$

105. A metallic rod of length 'ℓ' is tied to a string of length 2ℓ and made to rotate with angular speed ω on a horizontal table with one end of the string fixed. If there is a vertical magnetic field 'B' in the region, the e.m.f. induced across the ends of the rod is



(a) $\frac{2B\omega\ell^2}{2}$

(b) $\frac{3B\omega\ell^2}{2}$

(c) $\frac{4B\omega\ell^2}{2}$

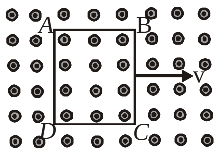
(d) $\frac{5B\omega\ell^2}{2}$

106. In a uniform magnetic field of induction B, a wire in the form of a semicircle of radius r rotates about the diameter of the circle with an angular frequency ω. The axis of rotation is perpendicular to the field. If the total resistance of the circuit is R, the mean power generated per period of rotation is

(a) $\frac{(B\pi r\omega)^2}{2R}$ (b) $\frac{(B\pi r^2\omega)^2}{2R}$

(c) $\frac{B\pi r^2\omega}{2R}$ (d) $\frac{(B\pi r\omega^2)^2}{8R}$

107. A metallic square loop *ABCD* is moving in its own plane with velocity *v* in a unifrom magnetic field perpendicular to its plane as shown in figure. An electric field is induced



(a) in *AD*, but not in *BC*
(b) in *BC*, but not in *AD*
(c) neither in *AD* nor in *BC*
(d) in both *AD* and *BC*

108. A conductor of length 0.4 m is moving with a speed of 7 m/s perpendicular to a magnetic field of intensity 0.9 Wb/m^2. The induced e.m.f. across the conductor is

(a) 1.26 V (b) 2.52 V
(c) 5.04 V (d) 25.2 V

109. A circular coil and a bar magnet placed nearby are made to move in the same direction. If the coil covers a distance of 1 m in 0.5. sec and the magnet a distance of 2 m in 1 sec, the induced e.m.f. produced in the coil is

(a) zero (b) 0.5 V
(c) 1 V (d) 2 V.

110. A circular coil of radius 6 cm and 20 turns rotates about its vertical diameter with an angular speed of 40 rad s^{-1} in a uniform horizontal magnetic field of magnitude 2×10^{-2} T. If the coil form a closed loop of resistance 8Ω, then the average power loss due to joule heating is

(a) 2.07×10^{-3} W (b) 1.23×10^{-3} W
(c) 3.14×10^{-3} W (d) 1.80×10^{-3} W

111. A boy peddles a stationary bicycle the pedals of bicycle. are attached to a 200 turn coil of area 0.10 m^2, The coil ratotes at half a revolution per second and it is placed in a uniform magnetic field of 0.02 T perpendicular to the axis of rotation of the coil. The maximum voltage generated in the coil is

(a) 1.26 V (b) 2.16 V
(c) 3.24 V (d) 4.12 V

112. A conducting circular loop is placed in a uniform magnetic field, *B* = 0.025 *T* with its plane perpendicular to the loop. The radius of the loop is made to shrink at a constant rate of 1 mm s^{-1}. The induced e.m.f. when the radius is 2 cm, iss

(a) $2\pi\mu V$ (b) $\pi\mu V$

(c) $\frac{\pi}{2}\mu V$ (d) $2\mu V$

113. Two pure inductors, each of self inductance L are connected in parallel but are well separated from each other, then the total inductance is

(a) L (b) 2L
(c) L/2 (d) L/4

114. Two coils of self inductances L_1 and L_2 are placed so close together that effective flux in one coil is completely linked with the other. If M is the mutual inductance between them, then

(a) $M = L_1L_2$ (b) $M = L_1/L_2$
(c) $M = (L_1L_2)^2$ (d) $M = \sqrt{(L_1 L_2)}$

115. The mutual inductance of a pair of coils, each of N turns, is M henry. If a current of I ampere in one of the coils is brought to zero in t second, the emf induced per turn in the other coil, in volt, will be

(a) $\frac{MI}{t}$ (b) $\frac{NMI}{t}$

(c) $\frac{MN}{It}$ (d) $\frac{MI}{Nt}$

116. In an inductor of self-inductance L = 2 mH, current changes with time according to relation $i = t^2e^{-t}$. At what time emf is zero?

(a) 4s (b) 3s
(c) 2s (d) 1s

117. When the current in a coil changes from 2 amp. to 4 amp. in 0.05 sec., an e.m.f. of 8 volt is induced in the coil. The coefficient of self inductance of the coil is

(a) 0.1 henry (b) 0.2 henry
(c) 0.4 henry (d) 0.8 henry

118. The north pole of a long horizontal bar magnet is being brought closer to a vertical conducting plane along the perpendicular direction. The direction of the induced current in the conducting plane will be

(a) horizontal (b) vertical
(c) clockwise (d) anticlockwise

119. Two coils of self inductances 2 mH and 8 mH are placed so close together that the effective flux in one coil is completely linked with the other. The mutual inductance between these coils is

(a) 6 mH (b) 4 mH
(c) 16 mH (d) 10 mH

120. The mutual inductance of a pair of coils is 0.75 H. If current in the primary coil changes from 0.5 A to zero in 0.01 s, find average induced e.m.f. in secondary coil.

(a) 25.5 V (b) 12.5 V
(c) 22.5 V (d) 37.5 V

121. A coil of 50 turns is pulled in 0.02 s between the poles of a magnet, where its area includes 31×10^{-6} Wb to 1×10^{-6}Wb. The average e.m.f. is

(a) 7.5×10^{-2} V (b) 7.5×10^{-3} V
(c) zero (d) 7.5×10^{-4} V

122. A wire of length 50 cm moves with a velocity of 300 m/min, perpendicular to a magnetic field. If the e.m.f. induced in the wire is 2 V, the magnitude of the field in tesla is

(a) 2 (b) 5
(c) 0.8 (d) 2.5

123. A circular wire of radius r rotates about its own axis with angular speed ω in a magnetic field B perpendicular to its plane, then the induced e.m.f. is

(a) $\frac{1}{2}Br\omega^2$ (b) $Br\omega^2$
(c) $2Br\omega^2$ (d) zero

124. The coefficient of self inductance of a solenoid is 0.18 mH. If a core of soft iron of relative permeability 900 is inserted, then the coefficient of self inductance will become nearly.

(a) 5.4 mH (b) 162 mH
(c) 0.006 mH (d) 0.0002 mH

125. The inductance of a closed-packed coil of 400 turns is 8 mH. A current of 5 mA is passed through it. The magnetic flux through each turn of the coil is

(a) $\frac{1}{4\pi}\mu_0$ Wb (b) $\frac{1}{2\pi}\mu_0$ Wb
(c) $\frac{1}{3\pi}\mu_0$ Wb (d) $0.4\ \mu_0$ Wb

126. A 100 millihenry coil carries a current of 1 ampere. Energy stored in its magnetic field is

(a) 0.5 J (b) 1 J
(c) 0.05 J (d) 0.1 J

127. Two solenoids of same cross-sectional area have their lengths and number of turns in ratio of 1 : 2. The ratio of self-inductance of two solenoids is

(a) 1 : 1 (b) 1 : 2
(c) 2 : 1 (d) 1 : 4

128. The self inductance of the motor of an electric fan is 10 H. In order to impart maximum power at 50 Hz, it should be connected to a capacitance of

(a) 8 μF (b) 4 μF
(c) 2 μF (d) 1 μF

129. A long solenoid having 200 turns per cm carries a current of 1.5 amp. At the centre of it is placed a coil of 100 turns of cross-sectional area 3.14×10^{-4} m^2 having its axis parallel to the field produced by the solenoid. When the direction of current in the solenoid is reversed within 0.05 sec, the induced e.m.f. in the coil is

(a) 0.48 V (b) 0.048 V
(c) 0.0048 V (d) 48 V

130. Two coils have a mutual inductance 0.005H. The current changes in first coil according to equation $I = I_0 \sin \omega t$ where $I_0 = 10$A and $\omega = 100\pi$ radian/sec. The max. value of e.m.f. in second coil is

(a) 2π (b) 5π
(c) π (d) 4π

131. A coil is wound on a frame of rectangular cross-section. If all the linear dimensions of the frame are increased by a factor 2 and the number of turns per unit length of the coil remains the same, self-inductance of the coil increases by a factor of

(a) 4 (b) 8
(c) 12 (d) 16

132. A small square loop of wire of side ℓ is placed inside a large square loop of side L ($L >> \ell$). The loop are coplanar and their centres coincide. The mutual inductance of the system is proportional is

(a) $\frac{\ell}{L}$ (b) $\frac{\ell^2}{L}$
(c) $\frac{L}{\ell}$ (d) $\frac{L^2}{\ell}$

133. A solenoid has 2000 turns wound over a length of 0.3 m. Its cross-sectional area is 1.2×10^{-3} m^2. Around its central section a coil of 300 turns is wound. If an initial current of 2 A flowing in the solenoid is reversed in 0.25 s, the emf induced in the coil will be

(a) 2.4×10^{-4} V (b) 2.4×10^{-2} V
(c) 4.8×10^{-4} V (d) 4.8×10^{-2} V

134. Two coaxial solenoids are made by winding thin insulated wire over a pipe of cross-sectional area A = 10 cm^2 and length = 20 cm. If one of the solenoid has 300 turns and the other 400 turns, their mutual inductance is
($\mu_0 = 4\pi \times 10^{-7}$ Tm A^{-1})

(a) $2.4\pi \times 10^{-5}$ H (b) $4.8\pi \times 10^{-4}$ H
(c) $4.8\pi \times 10^{-5}$ H (d) $2.4\pi \times 10^{-4}$ H

135. In an AC generator, a coil with N turns, all of the same area A and total resistance R, rotates with frequency ω in a magnetic field B. The maximum value of emf generated in the coil is

(a) N.A.B.R.ω (b) N.A.B.
(c) N.A.B.R. (d) N.A.B.ω

136. A copper disc of radius 0.1 m rotated about its centre with 10 revolutions per second in a uniform magnetic field of 0.1 tesla with its plane perpendicular to the field. The e.m.f. induced across the radius of disc is

(a) $\frac{\pi}{10}$ volt (b) $\frac{2\pi}{10}$ volt
(c) $\pi \times 10^{-2}$ volt (d) $2\pi \times 10^{-2}$ volt

137. A generator has an e.m.f. of 440 Volt and internal resistance of 4000 hm. Its terminals are connected to a load of 4000 ohm. The voltage across the load is

(a) 220 volt (b) 440 volt
(c) 200 volt (d) 400 volt

138. An AC generator of 220 V having internal resistance $r = 10\Omega$ and external resistance $R = 100\Omega$. What is the power developed in the external circuit?

(a) 484 W (b) 400 W
(c) 441 W (d) 369 W

139. A conducting ring of radius 1 *m* kept in a uniform magnetic field *B* of 0.01 *T*, rotates uniformly with an angular velocity 100 rad s^{-1} with its axis of rotation perpendicular to *B*. The maximum induced emf in it is

(a) 1.5πV (b) πV
(c) 2πV (d) 0.5πV

140. A six pole generator with fixed field excitation develops an e.m.f. of 100 V when operating at 1500 r.p.m. At what speed must it rotate to develop 120V?

(a) 1200 r.p.m (b) 1800 r.p.m
(c) 1500 r.p.m (d) 400 r.p.m

HINTS AND SOLUTIONS

FACT/DEFINITION TYPE QUESTIONS

1. **(a)** **2.** **(c)**

3. **(a)** Farady's law states that time varying magnetic flux can induce an e.m.f.

4. **(b)** **5.** **(a)** **6.** **(c)** **7.** **(a)**

8. **(d)** **9.** **(b)** **10.** **(c)** **11.** **(c)** **12.** **(b)** **13.** **(c)**

14. **(b)** **15.** **(d)** **16.** **(b)** **17.** **(a)** **18.** **(b)**

19. **(b)** **:** Direction of current induced in a wire moving in a magnetic field is found by using Fleming's right hand rule.

20. **(d)** When a circular coil expands radially in a region of magnetic field, induced emf developed is

$\varepsilon = BIv = B \times$ rate of change of area

Here, magnetic field B is in a plane perpendicular to the plane of the circular coil.

As $\varepsilon = 0$, magnetic field must be in the plane of circular coil so that its component perpendicular to the plane of the coil, whose magnitude is decreasing suitably so that magnitic flux linked with the coil stays constant then $\varepsilon = \frac{d\phi}{dt} = 0$

So both option (b) and (c) are correct.

21. **(b)** **22.** **(c)** **23.** **(c)** **24.** **(c)** **25.** **(d)** **26.** **(d)**

27. **(d)** Mutual inductance between two coils depends on all the three factors given here.

28. **(b)** Mutual inductance $= \frac{\phi}{I} = \frac{BA}{I}$

$$[\text{Henry}] = \frac{[MT^{-1}Q^{-1}L^2]}{[QT^{-1}]} = ML^2Q^{-2}$$

29. **(b)** Inductance it is also possible the emf is induced in a single isolated coil due to change of flux through the coil by means of varying the current through the same coil. This phenomenon is called self-induction. In this case, flux linkage through a coil of N turns is proportional to the currente through the coil and is expressed as $N\phi_B \propto I \Rightarrow N\phi_B \propto LI$ ...(i)

where, constant of proportionality L is called self-inductance of the coil. It is also called the coefficient of self-induction of the coil. When the current is varied, the flux linked with the coil also changes and an emf is induced in the coil. Using Eq. (i) the induced emf is given by

$$\varepsilon = -\frac{d(N\phi_B)}{dt} \Rightarrow \varepsilon = -L\frac{dI}{dt}$$

Thus, the self-induced emf always opposes any change (increase or decrease) of current in the coil.

30. **(a)**

31. **(c)** Lenz's law gives the polarity of induced emf.

32. **(a)** **33.** **(d)** **34.** **(b)** **35.** **(d)** **36.** **(b)**

37. **(c)** $\phi = LI \Rightarrow L = \frac{\phi}{I} = \frac{y}{x}$ henry

38. **(a)** **39.** **(c)** **40.** **(b)** **41.** **(d)**

42. **(a)** **43.** **(c)** **44.** **(c)**

45. **(d)** $P = I^2R$ when I becomes half, then P becomes one-fourth, heat per unit time depends on square of I. When I is reduced P is substancially reduced.

46. **(d)** **47.** **(d)** **48.** **(c)**

49. **(a)** Magnetic braking in trans, Strong electromagnets are situated above the rails in some electrically powered trains. When the electromagnets are activated, the eddy currents induced in the rails oppose the motion of the train. As there are no mechanical linkages, the braking effect is smooth.

50. **(a)** **51.** **(c)** **52.** **(a)**

53. **(d)** Electromagnetic damping certain galvanometers have a fixed core made of non-magnetic metallic material. When the coil oscillates, the eddy currents generated in the core oppose the motion and bring the coil to rest quickly.

54. **(b)** As $\phi = NAB \cos 90° = 0$

$\varepsilon = \varepsilon_0 \sin 90° = \varepsilon_0 =$ maximum

θ is the angle between the field and normal to the plane of the coil.

55. **(d)** A dynamo is a device which converts mechanical energy into electrical energy

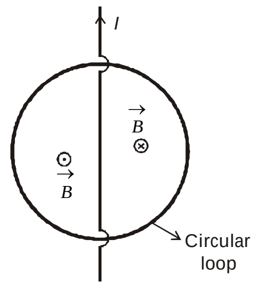
56. **(b)** **57.** **(b)**

STATEMENT TYPE QUESTIONS

58. **(a)** Emf will be induced in the circular wire loop when flux through it changes with time.

$$e = -\frac{\Delta\phi}{\Delta t}$$

when the current is constant, the flux changing through it will be zero.



When the current is decreasing at a steady rate then the change in the flux (decreasing inwards) on the right half of the wire is equal to the change in flux (decreasing outwards) on the left half of the wire such that $\Delta\phi$ through the circular loop is zero.

59. **(d)**

60. **(d)** Relative motion between the magnet and the coil that is responsible for induction in the coil.

61. **(a)**

62. **(c)** By inserting iron rod in the coil,
$L\uparrow z\uparrow I\downarrow$ so brightness $\downarrow$

MATCHING TYPE QUESTIONS

63. **(c)** (A) $\rightarrow$ (2); (B) $\rightarrow$ (3); (C) $\rightarrow$ (1); (D) $\rightarrow$ (4)

64. **(c)** A - 1 ; A charged ring can produced electric field out of the centre.
B - 1, 2, 4 ; A charged rotating ring can produce electric field out of centre, magnetic and dipole moment.
C- 2, 4 ; Current carrying produces magnetic field at the centre.
D- 3 ; Alternating current can produce induced electric field .

DIAGRAM TYPE QUESTIONS

65. **(b)** The charge through the coil = area of current-time ($i-t$) graph

$$q=\frac{1}{2}\times 0.1\times 4=0.2\,C$$

$$q=\frac{\Delta\phi}{R}\quad \because \text{Change in flux } (\Delta\phi)=q\times R$$

$$q=0.2=\frac{\Delta\phi}{10}$$

$\Delta\phi = 2$ weber

66. **(d)** $\phi = BA\cos\theta = 2.0\times 0.5\times\cos 60^{o}$

$$=\frac{2.0\times 0.5}{2}=0.5 \text{ weber.}$$

67. **(c)** In this situation, the bar magent experiences a repulsive force due to the induced current. Therefore, a person has to do work in moving the magnet.

68. **(d)** When electron approaches nearby the loop flux inside loop will increase and when electron recedes from the loop the flux inside loop decreases and so current change in direction.

69. **(d)**

70. **(d)** $\phi = 6t^2+7t+1 \Rightarrow \frac{d\phi}{dt}=12t+7$

At time, t = 2 sec.

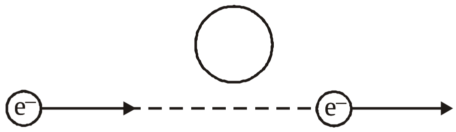
$$\frac{d\phi}{dt}=24+7=31 \text{ volt}$$

Direction of current is from left to right according to Flemmings right hand rule.

71. **(c)** E.m.f. will remain same because change in area per unit time will be same in both cases.

72. **(d)** No change in flux, hence no force required

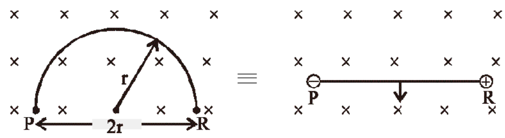
73. **(b)** Current will be induced,
when e^- comes closer the induced current will be anticlockwise
when e^- comes farther induced current will be clockwise



74. **(d)** Rate of decreasing of area of semicircular ring = $\frac{dA}{dt}=(2r)V$

From Faraday's law of electromagnetic induction

$$e=-\frac{d\theta}{dt}=-B\frac{dA}{dt}=-B(2rV)$$



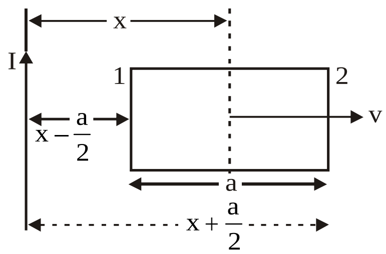
As induced current in ring produces magnetic field in upward direction hence R is at higher potential.

75. **(c)** Emf induced in side 1 of frame $e_1 = B_1 V\ell$

$$B_1=\frac{\mu_o I}{2\pi\,(x-a/2)}$$

Emf induced in side 2 of frame $e_2 = B_2 V\ell$

$$B_2=\frac{\mu_o I}{2\pi\,(x+a/2)}$$



Emf induced in square frame
$e = B_1V\ell - B_2V\ell$

$$=\frac{\mu_0 I}{2\pi\,(x-a/2)}\ell v-\frac{\mu_0 I}{2\pi\,(x+a/2)}\ell v$$

or, $e \propto \frac{1}{(2x-a)(2x+a)}$

76. **(a)** According to right hand palm rule, the Lorentz force on free electrons in the conductor will be directed towards end B. Hence, the end A gets positively charged.

77. **(c)** As I increases, ϕ increases
$\therefore$ I_i is such that it opposes the increases in ϕ.
Hence, ϕ decreases (By Right Hand Rule). The induced current will be counterclockwise.

78. **(d)** The given circuit clearly shows that the inductors are in parallel we have, $\frac{1}{L}=\frac{1}{3}+\frac{1}{3}+\frac{1}{3}$ or L= 1H

ASSERTION- REASON TYPE QUESTIONS

79. **(c)** Emf will always induces whenever, there is change in magnetic flux. The current will induced only in closed loop.

80. (c) In purely resistive circuit, the current and emf are in the same phase.

81. (c)

82. (a) Lenz's law (that the direction of induced emf is always such as to oppose the change that cause it) is direct consequence of the law of conservation of energy.

83. (b) **84. (a)**

85. (a) When switch is closed , the magnetic flux through the ring will increase and so ring will move away form the solenoil so as to compensate this flux. This is according to Lenz's law.

86. (b) In both the cases, the magnetic flux will change, and so there is an induced current.

87. (a) In the given case, there is no component of velocity, perpendicular to the magnetic field and so $e = Bv\ell \sin 0°$.

88. (b) Both the statements are independently correct.

89. (b) **90. (b)** **91. (a)** **92. (a)**

CRITICALTHINKING TYPE QUESTIONS

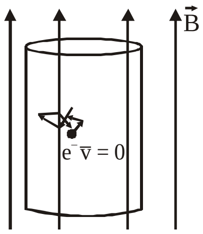
93. (a) Induced e.m.f. $\varepsilon = \dfrac{d\phi}{dt} = \dfrac{dBA}{dt} = A_0\dfrac{dB}{dt}$

$$= A_0\left(\frac{4B_0 - B_0}{t}\right) = 3A_0 B_0 / t$$

94. (a) For a current to induce in the cylindrical conducting rod.

(a) The cylindrical rod should cut magnetic lines of force which will happen only when the cylindrical conducting rod is moving.

Since conducting rod is at rest, no current will be induced.



(b) The magnitude / direction of the magnetic field changes. A changing magnetic field will create an electric field which can apply force on the free electrons of the conducting rod and a current will get induced.

But since the magnetic field is constant, no current will be induced.

95. (a) As the magnetic field increases, its flux also increases into the page and so induced current in bigger loop will be anticlockwise. i.e., from D to C in bigger loop and then from B to A in smaller loop.

96. (c) $\dfrac{\Delta\phi}{\Delta t} = \varepsilon = iR \Rightarrow \Delta\phi = (i\Delta t)R = QR \Rightarrow Q = \dfrac{\Delta\phi}{R}$

97. (b)

98. (c) $\varepsilon = (5\times10^{-3})(1/0.1) = 0.05\,V$.

99. (a) Change in flux = 2 B A N

$$\therefore \text{Induced e.m.f.} = \frac{2\times0.3\times200\times70\times10^{-4}}{0.1}$$

100. (a) According, to Faraday's law of induction

Induced e.m.f. $\varepsilon = -\dfrac{d\phi}{dt} = -(100t)$

Induced current i at t = 2 sec.

$$= \left|\frac{\varepsilon}{R}\right| = +\frac{100\times2}{400} = +0.5\,\text{Amp}$$

101. (b) $\dfrac{d\phi}{dt} = \dfrac{(W_2 - W_1)}{t}$ $\quad R_{tot} = (R + 4R)\Omega = 5R\ \Omega$

$$i = \frac{nd\varphi}{R_{tot}dt} = \frac{-n(W_2 - W_1)}{5Rt}.$$

($\because W_2$ & W_1 are magnetic flux)

102. (a) $e = \dfrac{-d\phi}{dt} = \dfrac{-d}{dt}\left(6t^2 - 5t + 1\right) = -12t + 5$

e = – 12 (0.25) + 5 = 2 volt

$$i = \frac{e}{R} = \frac{2}{10} = 0.2A.$$

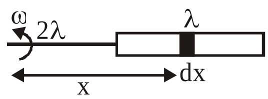
103. (b) $\phi = 10t^2 - 50t + 250$

$$e = -\frac{d\phi}{dt} = -(20t - 50)$$

$$e_{t=3} = -10\ V$$

104. (b)

105. (d) Here, induced e.m.f.



$$e = \int_{2\ell}^{3\ell} (\omega x)B dx$$

$$= B\omega\frac{[(3\ell)^2 - (2\ell)^2]}{2} = \frac{5B\ell^2\omega}{2}$$

106. (b) $\varphi = \vec{B}.\vec{A}$ $\qquad \phi = BA\cos\omega t$

$$\varepsilon = -\frac{d\phi}{dt} = \omega BA\sin\omega t\ ;\ i = \frac{\omega BA}{R}\sin\omega t$$

$$P_{inst} = i^2R = \left(\frac{\omega BA}{R}\right)^2 \times R\sin^2\omega t$$

$$P_{avg} = \frac{\int_0^T P_{inst}\times dt}{\int_0^T dt} = \frac{(\omega BA)^2}{R}\frac{\int_0^T \sin^2\omega t dt}{\int_0^T dt}$$

$$= \frac{(\omega BA)^2}{R}\left(\frac{T}{2.T}\right).$$

$$\therefore P_{avg} = \frac{(\omega B\pi r^2)^2}{2R}$$

107. (c) The electric field/emf is induced neither in sides *AD* and nor in *BC*. Unless the metallic square loop is entering or leaving the magnetic field and the flux linked with it is changing.

108. (b) Length of conductor (l) = 0.4 m; Speed (v) = 7 m/s and magnetic field (B) = 0.9 Wb/ m^2. Induced e.m.f. (ε) = Blv cos q = 0.9 × 0.4 × 7 × cos 0° = 2.52 V.

109. (a) Vel. of coil $= \frac{1}{0.5} = 2\text{m/s}$

velocity of magnet $= \frac{2}{1} = 2\text{m/s}$.

As they are made to move in the same direction, their relative velocity is zero. Therefore, induced e.m.f. = 0.

110. (a) Here, $r = 6$ cm $= 6 \times 10^{-2}\ m$, $N = 20$, $\omega = 40$ rads^{-1}
$B = 2 \times 10^{-2}\ T$, $R = 8\Omega$
Maximum emf induced, $\varepsilon = NAB\omega$
$= N(\pi r^2)B\omega$
$= 20 \times \pi \times (6 \times 10^{-2})\ 2 \times 10^{-2} \times 40 = 0.18$ V
Average value of emf induced over a full cycle
$\varepsilon_{av} = 0$
Maximum value of current in the coil.

$$I = \frac{\varepsilon I}{R} = \frac{0.18}{8} = 0.023 \text{ A}$$

Average power dissipated,

$$P = \frac{\varepsilon I}{2} = \frac{0.18 \times 0.023}{2} = 2.07 \times 10^{-3} \text{ W}$$

111. (a) Here $\upsilon = 0.5$ Hz, $N = 200$, $A = 0.1\ m^2$
and $B = 0.02\ T$
Maximum voltage generated is
$\varepsilon_0 = NBA\ (2\pi\upsilon)$
$= 200 \times 0.02 \times 0.1 \times (2\pi \times 0.5) = 1.26\ V$

112. (b) Magnetic flux linked with the loop is $\phi = B\pi r^2$

$$|e| = \frac{d\phi}{dt} = B\pi \cdot 2r\frac{dr}{dt}$$

When $r = 2$ cm, $\frac{dr}{dt} = 1$ mm s^{-1}

$e = 0.025 \times \pi \times 2 \times 2 \times 10^{-2} \times 10^{-3}$
$= 0.100 \times \pi \times 10^{-5} = \pi \times 10^{-6}$ V $= \pi\mu$V

113. (c) When the coils are connected in parallel, let the currents in the two coils be i_1 and i_2 respectively. Total induced current

$$i = i_1 + i_2 \text{ or } \frac{di}{dt} = \frac{di_1}{dt} + \frac{di_2}{dt} \quad ......(1)$$

Now $e = -L_1\left(\frac{di_1}{dt}\right) = -L_2\left(\frac{di_2}{dt}\right)$

($\because$ In parallel, induced e.m.f. across each coil will be same)

Hence $\frac{di_1}{dt} = -\frac{e}{L_1}$ and $\frac{di_2}{dt} = -\frac{e}{L_2}$ ......(2)

Let L' be the equivalent inductance.

Then $e = -L'\frac{di}{dt}$ or $\frac{di}{dt} = -\frac{e}{L'}$ ......(3)

From eqs. (1), (2) and (3), we get

$$-\frac{e}{L'} = -\frac{e}{L_1} - \frac{e}{L_2} \text{ or } \frac{1}{L'} = \frac{1}{L_1} + \frac{1}{L_2}$$

$$\therefore L' = \frac{L_1 L_2}{L_1 + L_2}$$

Here $L_1 = L_2 = L$

$$\therefore L' = \frac{L \times L}{L + L} = \frac{L}{2}$$

114. (d)

115. (a) $E = \frac{d}{dt}(NMI) \Rightarrow E = NM\frac{dI}{dt} \Rightarrow E = \frac{NMI}{t}$

emf induced per unit turn $= \frac{E}{N} = \frac{MI}{t}$

116. (c) $L = 2$mH, $i = t^2e^{-t}$

$$E = -L\frac{di}{dt} = -L[-t^2e^{-t} + 2te^{-t}]$$

when E = 0
$-e^{-t}t^2 + 2te^{-t} = 0$
$2t\ e^{-t} = e^{-t}\ t^2$
t = 2 sec.

117. (b) $\varepsilon = M\frac{di}{dt}$ or $8 = M\left[\frac{(4-2)}{0.05}\right]$

$$\therefore M = \frac{8 \times 0.05}{2} = 0.2 \text{ henry}$$

118. (d) According to Lenz's law

119. (b) Mutual Inductance of two coils

$$M = \sqrt{M_1 M_2} = \sqrt{2\text{mH} \times 8\text{mH}} = 4\text{mH}$$

120. (d) Given : $M = 0.75$ H and $\frac{dI}{dt} = \frac{0.5 - 0}{0.01} = 50$ A/s

$\therefore$ Average induced e.m.f. in secondary coil

$$e = M\frac{dI}{dt} = 0.75 \times 50 = 37.5 \text{ V}$$

121. (a) $e = \frac{-n(\phi_2 - \phi_1)}{t}$

$$= \frac{-50(1 \times 10^{-6} - 31 \times 10^{-6})}{0.02}$$

$= 7.5 \times 10^{-2}$ V

122. (c) The magnitude of induced e.m.f. is given by
$|e| = Blv$
v = 300 m/min = 5m/s

$$\therefore B = \frac{|e|}{lv} = \frac{2}{0.5 \times 5} = 0.8 \text{ tesla}$$

123 (d) The e.m.f. is induced when there is change of flux. As in this case there is no change of flux, hence no e.m.f. will be induced in the wire.

124. (b) $L = \mu_0 nI$

$\therefore \frac{L_2}{L_1} = \frac{\mu}{\mu_0}$ ----($\because$ n and I are same)

$\therefore L_2 = \mu_r L_1 = 900 \times 0.18 = 162$ mH

125. (a) $N\phi = LI$

$\therefore \phi = \frac{LI}{N} = \frac{8\times10^{-3}\times5\times10^{-3}}{400}$

$= 10^{-7} = \frac{\mu_0}{4\pi}$ Wb

126. (c) Energy stored U is given by

$U = \frac{1}{2}Li^2 = \frac{1}{2}\times(100\times10^{-3})\ (1)^2 = 0.05$ J.

127. (b) From $L = \frac{\mu_0 N^2 A}{l} \alpha \frac{N^2}{l}$

we get, $\frac{L_1}{L_2} = \frac{(1/2)^2}{1/2} = \frac{1}{2}$

128. (d) For maximum power, $X_L = X_C$, which yields

$C = \frac{1}{(2\pi n)^2 L} = \frac{1}{4\pi^2\times50\times50\times10}$

$\therefore C = 0.1\times10^{-5}\,F = 1\mu F$

129. (b) $B = \mu_0 ni = (4\pi\times10^{-7})\ (200\times10^{-2})\times1.5$

$= 3.8\times10^{-2}$ Wb / m^2

Magnetic flux through each turn of the coil

$\phi = BA = (3.8\times10^{-2})(3.14\times10^{-4}) = 1.2\times10^{-5}$ weber

When the current in the solenoid is reversed, the change in magnetic flux

$= 2\times(1.2\times10^{-5}) = 2.4\times10^{-5}$ weber

Induced e.m.f. $= N\frac{d\phi}{dt} = 100\times\frac{2.4\times10^{-5}}{0.05} = 0.048$ V.

130. (b) $\varepsilon = \frac{M}{dt} dI = 0.005\times I_0 \cos\omega t\times\omega$

and $\varepsilon_{max} = 0.005\times I_0\times\omega = 5\pi$

131. (b) Self inductance $= \mu_0 n^2 AL = \mu_0 n^2(\ell\times b)\times L$

n = Total number of turns/length

L = Length of inductor

l = Length of rectangular cross section

b = breadth of rectangular cross-section

So, when all linear dimensions are increased by a factor of 2. The new self inductance becomes L' = 8L.

132. (b)

133. (b) $n = \frac{N}{\ell} = \frac{2000}{0.3} = \frac{20000}{3}$

$\xi = \frac{d}{dt}(NBA) = NA\frac{dB}{dt}$

Since $B = \mu_0 nI$

$\Rightarrow \xi = (\mu NAn)\frac{dt}{dt} \Rightarrow \xi = 0.024$ V

134. (d) $M = \frac{\mu_0 N_1 N_2 A}{\ell} = \frac{4\pi\times10^{-7}\times300\times400\times100\times10^{-4}}{0.2}$

$= 2.4\pi\times10^{-4}$ H

135. (d) $e = -\frac{d\phi}{dt} = -\frac{d(N\vec{B}.\vec{A})}{dt}$

$= -N\frac{d}{dt}(BA\cos\omega t) = NBA\omega\sin\omega t$

$\Rightarrow e_{max} = NBA\omega$

136. (c) e.m.f. induced $= \frac{1}{2}BR^2\omega = \frac{1}{2}BR^2(2\pi n)$

$= \frac{1}{2}\times(0.1)\times(0.1)^2\times2\pi\times10 = (0.1)^2\ \pi$ volts

137. (d) Total resistance of the circuit = 4000 + 400 = 4400 W

Current flowing $i = \frac{V}{R} = \frac{440}{4400} = 0.1$ amp.

Voltage across load = R i = 4000 × 0.1 = 400 volt.

138. (b) $V = 200V;\ r = 10\Omega$

$R' = 10 + 100\Omega = 110\Omega$

$I = \frac{V}{R'} = \frac{220}{100} = 2A$

$P = I^2R = 4\times100 = 400\ W$

139. (b) Given, $B = 0.01\ T, A = \pi R^2 = \pi\times(1\ m)^2 = \pi m^2$

$\omega = 100$ rads^{-1}

$\therefore$ The maximum induced emf $\varepsilon_{max} = BA\omega$

$= 0.01\times\pi\times100\ V = \pi V$

140. (b) The e.m.f. induced is directly proportional to rate at which flux is intercepted which in turn varies directly as the speed of rotation of the generator.