PRACTICE MCQs

CLASS 12 PHYSICS (TERM - I)

ELECTROMAGNETIC INDUCTION

BY

learn-o-hub
learning simplified

Question 1:
Two coils are placed close to each other. The mutual inductance of the pair of coils depends upon the
(a) rate at which current change in the two coils
(b) relative position and orientation of the coils
(c) rate at which voltage induced across two coils
(d) currents in the two coils

Answer: (b) relative position and orientation of the coils
Mutual inductance of a pair of two coils depends on the relative position and orientation of twocoils, other statements are incorrect.

Question 2:
The magnetic flux linked with the coil (in Weber) is given by Theequation $\Phi= 5t^2 + 3t + 16$
The induced EMF in the coil at time, t=4 will be
(a -27 V
(b) -43 V
(c) -108 V
(d) 210 V

Answer: (b) -43 V
$\Phi= 5t^2 + 3t + 16$
$|e| = (d\Phi/dt)$
$=d/dt[5t^2+3t+16]$
$=10t +3$
$|e|_{(t=4)} = 10(4) +3$
$=43$ V
$e=-43$ V

Question 3:
"The magnitude of the induced emf in a circuit is equal to the time rate of change of magnetic flux through the circuit" – this statement is termed as ______.
(a) Coulomb's law
(b) Faraday's law of electromagnetic induction
(c) Gauss's law of electromagnetic induction
(d) Joule's law of induction

Answer: (b) Faraday's law of electromagnetic induction

Faraday's law of electromagnetic induction states that the magnitude of the induced emf in a circuit is equal to the time rate of change of magnetic flux through the circuit. Mathematically, the induced emf is given by $\varepsilon = -(d\varphi/dt)$. Negative sign shows that the current induced in a circuit always flows in such a direction that it opposes the change or the cause that it opposes the change or the cause produces it.

Question 4:

Which of the following is the statement of Lenz's law?

(a) The polarity of induced emf is such that it tends to produce a current which opposes the change in magnetic flux that produced it

(b) The polarity of induced emf is such that it tends to produce a current which opposes the change in magnetic field that produced it

(c) The polarity of the conductor is such that it tends to produce a current which opposes the change in magnetic flux that produced it

(d) The polarity of induced emf is such that it tends to produce a magnetic field which opposes the change in magnetic flux that produced it

Answer: (a) The polarity of induced emf is such that it tends to produce a current which opposes the change in magnetic flux that produced it

The polarity of induced emf is such that it tends to produce a current which opposes the change in magnetic flux that produced it.

$\varepsilon = -N(d\varphi/dt)$

The negative sign shown in this equation represents this effect.

Question 5:

The magnetic flux (ϕ) linked with a coil due to its own magnetic field is related to the number of turns of coil as

(a) $\Phi \propto N^2$

(b) $\Phi \propto N^{-1}$

(c) $\Phi \propto N$

(d) $\Phi \propto N^{-2}$

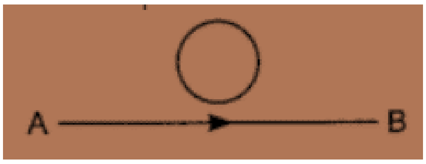
Answer: (c) $\Phi \propto N$

We know that $\Phi = NBA\cos\theta$

Question 6:
What does the potential difference induced in a conductor of length l moving with velocity v, in a direction perpendicular to the magnetic field B is called?
(a) Motional emf
(b) Motional potential difference
(c) Magnetic Flux
(d) Dipole moment

Answer: (a) Motional emf
When a conducting loop or rod of length l moves in the in a uniform magnetic field, so that flux through the loop changes, due to the change in the flux through the loop, an emf is induced it the loop, this is called as motional emf.

Question 7:
The current flows from A to B as shown in the figure. The direction of the induced current in the loop is



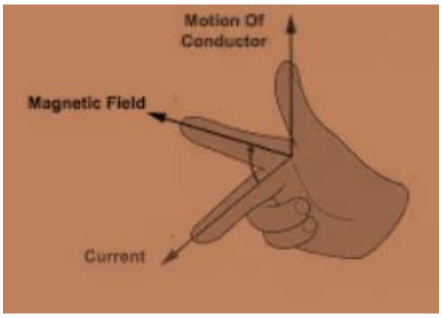
(a) clockwise
(b) anticlockwise
(c) straight line
(d) no induced e.m.f. produced

Answer: (a) clockwise
By Lenz's law, the induced current must produce inward flux to counter magnetic flux of AB. So induced current is clockwise in the loop.

Question 8:
Direction of current induced in a wire moving in a magnetic field is found using
(a) Fleming's left-hand rule
(b) Fleming's right-hand rule
(c) Ampere's rule
(d) Right hand clasp rule

Answer: (b) Fleming's right-hand rule
Direction of current induced in a wire moving in a magnetic field is using Fleming's right-hand rule. According to the rule, if we extend the fore finger, middle finger and the thumb of our right hand perpendicular to each other as shown in the figure with the thumb pointing towards the motion of the conductor and the fore finger pointing towards the magnetic field direction,

the middle finger gives us the direction of induced current flowing in the circuit.



Question 9:
When current changes from 13A to 7A in 0.5s through a coil the EMF induced is 3 x 10^{-4}. The coefficient of self-induction is
(a) 25 x 10^{-6} H
(b) 25 x 10^{-5} H
(c) 25 x 10^{-4} H
(d) 25 x 10^{-3} H

Answer: (a) 25 x 10^{-6} H
Given: - Time taken for change in current =0.5 sec
Induced emf e=3 x 10^{-4} V
Change in current (di/dt) = (13-7)A = 6A
Self-induced emf e=-L (di/dt)
Where L = coefficient of self-induction
(di/dt) = rate of change of current
e=-L(di/dt)
3 x 10^{-4} = -L (di/dt)
L= (3 x 10-4 x 0.5)/ (6)
=2.5 x 10^{-5} H
Or 25 x 10^{-6} H

Question 10:
Eddy currents may be reduced by using:
(a) Thick piece of cobalt
(b) Thick piece of nickel
(c) Laminated core of steel
(d) Laminated core of soft iron

Answer: (d) Laminated core of soft iron

Eddy currents are minimized in these devices by selecting magnetic core materials that have low electrical conductivity (e.g., ferrites) or by using thin sheets of magnetic material, known as laminations.

Question 11:
A small coil of N_1 turns, l_1 length is tightly wound over the centre of long solenoid of length l_2, area of cross section A and number of turns N_2. If a current I flow in the small coil, then the flux through the long solenoid is
(a) Zero
(b) $\mu_o N_1 N_2 A/L$
(c) $\mu_o N_{12} A/L$
(d) Infinite

Answer: (b) $\mu_o N_1 N_2 A/L$
$\Phi_2 = N_2 B_1 A$
$= N_2 \times (\mu_o N_1 I_1) (A)/(L)$
$\Phi_2 = (\mu_o N_1 N_2 A) (I_1)/(L)$
Comparing with $\Phi_2 = (MI_1)$
$M_2 = \mu_o N_1 N_2 A/L$

Question 12:
A solenoid is connected to a battery so that a steady current flows through it. If an iron core is inserted into the solenoid. What will happen to the current?
(a) Increase
(b) Decrease
(c) Remains same
(d) 0

Answer: (b) Decrease
The current will decrease. This is because on inserting an iron core in the solenoid, the magnetic field increases and hence magnetic flux linked with the solenoid increases. As per Lenzs law, the emf induced in the solenoid will oppose this increase, which can be achieved by a decrease in Current.

Question 13:
In electromagnetic induction, the induced e.m.f is independent of:
(a) Change of Flux
(b) Resistance of the circuit
(c) Number of turns in the coil
(d) None of the Above

Answer: (b) Resistance of the circuit

In electromagnetic induction, the induced emf is independent of resistance. It depends on change in flux, time and the magnetic field strength.

$\varepsilon=(d\varphi/dt)$, where $\varphi=nBA$.Thus, ε is independent of resistance of the coil.

Question 14:

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

Answer: (a) larger in case (i)

From Faraday's Law:$\varepsilon =(d\varphi/dt)$,If the magnet moves quickly, the rate of change of flux is also higher, hence the EMF induced is larger in case (i).

Question 15:

The mutual inductance between two coils depends upon

(a) medium between the coils
(b) separation between coils
(c) neither 1 nor 2
(d) both 1 and 2

Answer: (d) both 1 and 2

The mutual inductance between two coils depends upon both the medium and separation between the coils.

Question 16:

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 loop increases
(b) each loop decreases
(c) each loop remains the same
(d) one loop increases whereas that in the other loop decreases

Answer: (b) each decrease

As the two identical coaxial circular loops carry a current i each circulating in the same direction, their flux addswith each other. When the two are brought closer, the total flux linkage increase. By Lenz's a law a current will be induced in both the loops such that it opposes this change in flux. As the flux increases, the current in each loop will decreases so as to decrease the increasing flux.

Question 17:
Two solenoids of equal number of turns having their length and the radii in the same ratio 1 : 2. The ratio of their self-inductance will be
(a) 1 : 2
(b) 2 : 1
(c) 1 : 1
(d) 1 : 4

Answer: (a) 1 : 2
For solenoids, self-inductance is given by,
$L = (\mu_0 N^2 A)/(l)$
$L \alpha (N^2)/(l)$
$(L_1/L_2) = (\pi r_1^2/l_1)/(\pi r^2{}_2/l_2{}^2)$
$= (r_1^2/l_1)/(r^2{}_2/l_2)$
$= (r_1/r_2)^2(l_2/l_1)$
$(L_1/L_2) = (1/2)$ [Because $(r_1/r_2) = (l_1/l_2) = (1/2)$]

Question 18:
For perfect coupling of two coils of inductance L_1 and L_2 their mutual inductance M should be given by:
(a) $M = \sqrt{(L_1L_2)}$
(b) $M = L_1 / L_2$
(c) $M = (L_1L_2)^{3/2}$
(d) $M = L_1L_2$

Answer: (a) $M = \sqrt{(L_1L_2)}$
$M = -(e_2/di_1/dt) = -(e_2)/(di_2/dt)$
Also, $e_1 = -L_1(di_1/dt)$ and $e_2 = -L_2(di_2/dt)$
$M^2 = (e_1e_2)/(di_1/dt)\ (di_2/dt)$
$M = \sqrt{(L_1L_2)}$

Assertion Reason Based Questions

In the following questions from 19 to 23 a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

(a) Both assertion and reason are true and the reason is the correct explanation of assertion.
(b) Both assertion and reason are true but the reason is not the correct explanation of assertion.
(c) Assertion is true but reason is false.
(d) Assertion is false but reason is true.

Question 19:

Assertion: Strong electromagnets are situated above the rails in some electrically powered trains
Reason: 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.

Answer: (a) Both assertion and reason are true and the reason is the correct explanation of assertion.

Question 20:
Assertion: Certain galvanometers have a fixed core made of nonmagnetic metallic material.
Reason: When the coil oscillates, the eddy currents generated in the core helps the coil oscillate.

Answer: (c) Assertion is true but reason is false.
When the coil oscillates, the eddy currents generated in the core oppose the motion and bring the coil to rest quickly

Question 21:
Assertion: Induction furnace can be used to produce high temperatures and can be utilised to prepare alloys, by melting the constituent metals

Reason: A high frequency alternating current is passed through a coil which surrounds the metals to be melted. The eddy currents generated in the metals produce high temperatures sufficient to melt it

Answer: (a) Both assertion and reason are true and the reason is the correct explanation of assertion.

Question 22:
Assertion: The shiny metal disc in the electric power meter rotates due to the eddy currents
Reason: The shiny disc rotates due to repulsion from the magnetic field

Answer: (c) Assertion is true but reason is false.

Question 23:

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.

Answer: (a) Both assertion and reason are true and the reason is the correct explanation of assertion.
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.

Case Study Based Questions

Question 24:
When a current I flow through a coil, flux linked with $\varphi=LI$, where L is a constant known as self-inductance of the coil. Any change in current sets up an induced emf in the coil. Thus, self-inductance of a coil is the induced emf set up in it when the current passing through it changes at the unit rate. It is a measure of the opposition to the growth or the decay of current flowing through the coil. Also, value of self-inductance depends on the number of turns in the solenoid, its area of cross-section and the relative permeability of its core material.

1) The inductance in a coil plays the same role as
(a) Inertia in mechanics
(b) Energy in mechanics
(c) Momentum in mechanics
(d) Force in mechanics

2) A current 2.5A flows through a coil of inductance of 5H. The magnetic flux linked with the coil is
(a) 0.5 Wb
(b) 12.5 Wb
(c) zero
(d) 2 Wb

3) The inductance L of a solenoid depends upon its radius R as
(a) $L \propto R$
(b) $L \propto (1/R)$
(c) $L \propto R^2$
(d) $L \propto R^3$

4) The unit of self-inductance is
(a) weber-ampere
(b) $weber^{-1}$ ampere
(c) ohm second
(d) farad

5) The induced emf in a coil of 10 henry inductance in which current varies from 9A to 4A in 0.2 second is
(a) 200 V
(b) 250 V
(c) 300 V
(d) 350 V

Answer:

1) (a) Inertia in mechanics
The inductance in a coil plays the same role as inertia in mechanics

2) (b) 12.5 Wb
Given, I=2.5 A, L=5H
Magnetic flux linked in the coil is

φ = LI
=(5H) (2.5 A)
=12.5 Wb

3) (c) L ∝R^2
The inductance of a solenoid
L= $\mu_0 n^2 Al$
Where A= cross section of the solenoid
l= Length and n=number of turns per unit length.
A= πR^2
Where R=radius of the solenoid
Therefore, L= $\mu_0 \pi n^2 R^2 l$
Or L∝ R^2

4) (c) ohm second
The magnitude of induced emf is
|e| = L(dI/dt)
L=|e| (dI/dt)
Or L= (volt second)/(ampere)
=ohm second.

5) (b) 250 V
Given, L = 10 H, I_1=9A, I_2=4A and Δt=0.2 seconds
Then induced emf, e_1=-L(dI/dt)
=-L(I_2-I_1)/(Δt)
=-10 x (4-9)/ (0.1)
= (50/0.2)
=250 V

Question 25:
Electromagnetic damping: Take two hollow thin cylindrical pipes of equal internal diameters made of aluminium and PVC, respectively. Fix them vertically with clamps on retort stands. Take a small cylindrical magnet having diameter slightly smaller than the inner diameter of the pipes and drop it through each pipe in such a way that the magnet does not touch the sides of the pipes during its fall. You will observe that the magnet dropped through the PVC pipe takes the same time to come out of the pipe as it would take when dropped through the same height without the pipe. Now instead of PVC pipe use an aluminium pipe. Note the time it takes to come out of the pipe in each case. You will see that the magnet takes much longer time in the case of

aluminium pipe. Why is it so? It is due to the eddy currents that are generated in the aluminium pipe which oppose the change in magnetic flux, i.e., the motion of the magnet. The retarding force due to the eddy currents inhibits the motion of the magnet. Such phenomena are referred to as electromagnetic damping. Note that eddy currents are not generated in PVC pipe as its material is an insulator whereas aluminium is a conductor. This effect was discovered by physicist Foucault (1819-1868).

1) Eddy currents are generated in a:
(a) Metallic pipe
(b) PVC pipe
(c) Glass pipe
(d) Wooden pipe

2) Eddy current was first observed by:
(a) Helmhotlz
(b) Foucault
(c) D'Arsonval
(d) Shockley

3) What is electromagnetic damping?
(a) Generation of electromagnetic wave during the passage of a magnet through a metal pipe.
(b) Change of the direction of propagation of electromagnetic wave due to a variable magnetic flux.
(c) Change of the frequency of the frequency of electromagnetic wave due to variable magnetic flux.
(d) To slow down the motion of magnet moving through a metal pipe due to electromagnetically induced current.

4) To observe electromagnetic damping a magnet should be dropped through a metal pipe and:
(a) The magnet should not touch inner wall of the pipe.
(b) The magnet should touch the inner wall of the pipe.
(c) It does not matter whether the magnet touches the inner walls of the pipe or not.
(d) The magnet should be larger in size than the diameter of the pipe.

5) A piece of wood and a bar magnet of same dimension is dropped through an aluminium pipe. Which of the following statements is true?

a) The piece of wood will take more time to come out from the pipe.
b) The bar magnet will take more time to come out from the pipe.
c) Both will take same time to come out from the pipe.
d) The time required will depend on the mass of the wooden piece and the mass of the bar magnet.

Answer:

1) (a) Metallic pipe
Eddy currents are not generated in non-conductor/insulator. Eddy currents are generated in conductor/metal.

2) (b) Foucault
The generation of eddy currents was discovered by physicist Foucault.

3) (d) To slow down the motion of magnet moving through a metal pipe due to electromagnetically induced current.
The retarding force due to the eddy currents inhibits the motion of the magnet in a metal pipe. This phenomenon is known as electromagnetic damping.

4) (a) The magnet should not touch inner wall of the pipe.
To observe electromagnetic damping, a magnet should be dropped through a metal pipe and the magnet should not touch the inner wall of the pipe.

5) b) The bar magnet will take more time to come out from the pipe.
When a piece of wood and a bar magnet of same dimension is dropped through an aluminium pipe, the bar magnet will take more time to come out from the pipe due to electromagnetic damping.

****