	INDIAN SCHOOL AL WADI AL KABIR	
Class: XII	**DEPARTMENT OF SCIENCE -2023-24** **SUBJECT: PHYSICS**	DATE OF COMPLETION: **10.09.2023**
WORKSHEET NO. 6 WITH ANSWERS	**TOPIC: ELECTRO MAGNETIC INDUCTION**	**A4 FILE FORMAT**
CLASS & SEC:	**NAME OF THE STUDENT:**	**ROLL NO.**

MULTIPLE CHOICE QUESTIONS,

1. In the expression e = –dØ /dt, the negative sign signifies:
(a) The induced emf is produced only when magnetic flux decreases
(b) The induced emf opposes the change in the magnetic flux
(c) The induced emf is opposite to the direction of the flux
(d) None of these

Answer: (b) The induced emf opposes the change in the magnetic flux

2. 1 henry is equal to:
(a) weber/ampere
(b) weber/Volt
(c) weber ampere
(d) None of these

Answer: (a) weber/ampere

3. The role of inductance is equivalent to:
(a) inertia
(b) force
(c) energy
(d) momentum

Answer-a-inertia

4. A choke is used as a resistance in:
(a) dc circuits
(b) ac circuits
(c) both ac and dc circuits
(d) neither (a) nor (b)

Answer- b – in ac circuits

5. In the relation $\phi = B A \cos\theta$, θ is angle

(a) which normal to the surface area makes with the direction of magnetic field.

(b) which magnetic field makes with the surface.

(c) is always a constant.

(d) None of the above.

Answer-a

6. SI unit of magnetic flux is

(a) Henry (b) weber (c) coulomb (d) volt

7. **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

Answer:
(c)

8. 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

Answer-a

9. 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

Answer-b

Answer

10. 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

Answer- c

11. The self-inductance of a coil is a measure of

(a) electrical inertia
(b) electrical friction
(c) induced e.m.f.
(d) induced current

Answer -a

12. 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.

Answer -d
13. 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
Answer-b
14. Lenz's law is a consequence of the law of conservation of
(a) charge
(b) mass
(c) energy
(d) momentum

Answer-c
Q.15. Two coils are placed closed to each other. The mutual inductance of the pair of coils depends upon
(a) the rate at which currents are changing in the two coils.
(b) relative position and orientation of two coils.
(c) the material of the wires of the coils.
(d) the currents in the two coils.

Answer-b
Answer
16. The current flows from A to B is 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) 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.
Q.22. In a coil of self-induction 5 H, the rate of change of current is 2 As-1. Then emf induced in the coil is
(a) 10 V
(b) -10 V
(c) 5 V
(d) -5 V

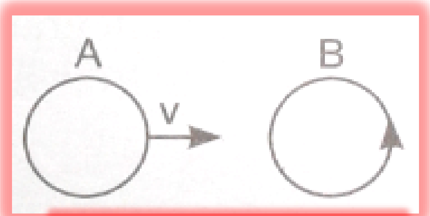
Answer-(b) Induced e.m.f. ε = -LdIdt = – 5 × 2 = -10 V

Q.23. The magnetic flux linked with a coil of N turns of area of cross section A held with its plane parallel to the field B is

(a) $\frac{NAB}{2}$ (b) NAB (c) $\frac{NAB}{4}$ (d) zero

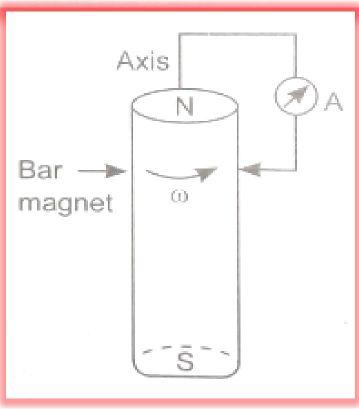
Answer-d

24. There are two coils A and B as shown in figure. A current start flowing in B as shown, when A is moved towards B and stops. B is kept stationary when A moves. we can infer that



(a) there is a constant current in the clockwise direction in A.
(b) there is a varying current in A.
(c) there is no current in A.
(d) there is a constant current in the counter clockwise direction in A.
Answer-d

25. A cylindrical bar magnet is rotated about its axis. A wire is connected from the axis and is made to touch the cylindrical surface through a contact. Then



(a) a direct current flow in the ammeter A.
(b) no current flows through ammeter A.
(c) an alternating sinusoidal current flow through the ammeter A with a time period $T = 2\pi/\omega$.
(d) a time varying non-sinusoidal current flows through the ammeter A.
Answer-b

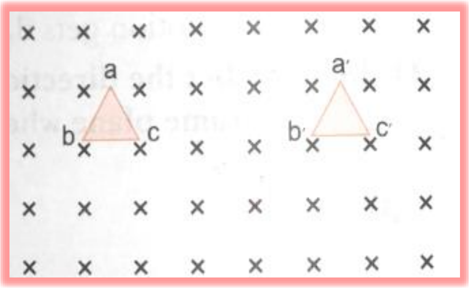
26. An emf is produced in a coil, which is not connected to an external voltage source. This is not due to
(a) the coil being in a time varying magnetic field.
(b) the coil moving in a time varying magnetic field.
(c) the coil moving in a constant magnetic field.
(d) the coil stationary in external spatially varying magnetic field, which does not change with time.
Answer-d
27. The self-inductance L of a solenoid of length l and of cross-section A, with a fixed number of turns N increases as,
(a) l and A increases.
(b) l decreases and A increases.
(c) l increases and A decreases.
(d) both l and A increases.
Answer-b

SHORT ANSWER TYPE QUESTIONS;

1. state the law that gives the polarity of induced emf.
Ans: - Lenz’s law

2.On what factors does the magnitude of the emf induced in the circuit due to magnetic flux depend?
Ans: - flux density, length of the coil, velocity with which the coil is moved and the angle between the velocity and flux.

3. Triangular loop of wire placed at *abc* is moved completely inside a magnetic field which is directed normal to the plane of the loop away from the reader to a new position *a'b'c'*. What is the direction of the current induced in the loop? Give reason.



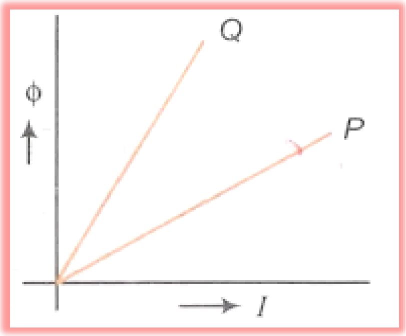
Ans: - change in magnetic flux through wire loop is zero, hence no current.

5. Current in a circuit falls from 3.0 to 0.0 A in 300 ms. If an average emf of 200 V is induced. Calculate the self-inductance of the circuit.

Ans: - $L = \frac{-e}{dI/dt} = 20$ H.

6.(i)If the rate of change of current 2 As^{-1} Induces an emf of 40 mV in the solenoid, what is the self-inductance of the solenoid?

(ii) The given graph shows a plot of magnetic flux(φ) and the electric current(I) following through two inductors P and Q. Which of the two inductors has smaller value of self-inductance.



Ans: -(i) L = 20mH.

(ii) L = slope, p is having smaller resistance,

LONG ANSWER TYPE QUESTION;

1. A circular coil of radius 10 cm, 500 turns and resistance 200 Ω is placed with its plane perpendicular to the horizontal component of the Earth's magnetic field. It is rotated about its vertical diameter through 180° in 0.25 second. Estimate the magnitudes of the emf and current induced in the coil. (horizontal component of the earth magnetic field at the place is 3×10^{-5} T)

Hints; - Initial magnetic flux through the coil,

$\phi_i = B_H A \cos\theta = 3.0\times10^{-5}\times(\pi\times10^{-2})\times\cos 0^\circ$

$= 3\pi\times10^{-7}$Wb

Final magnetic flux after the rotation

$\phi_f = 3.0\times10^{-5}\times(\pi\times10^{-2})\times\cos 180^\circ$

$= -3\pi\times10^{-7}$Wb.

Induced emf,

$\epsilon = -N\frac{d\phi}{dt} = -\frac{N(\phi f - \phi i)}{t}$.

$= -\frac{500(-3\pi\times10-7-3\pi\times10-7)}{0.25}$

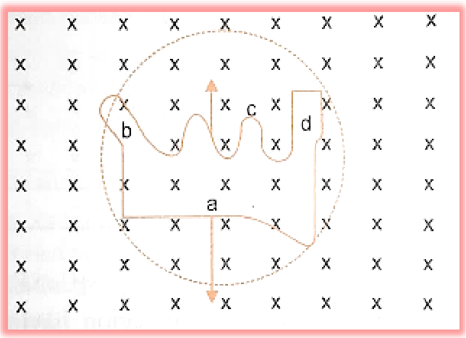
$= \frac{500\times(6\pi\times10-7)}{0.25} = 3.8\times10^{-3}$V

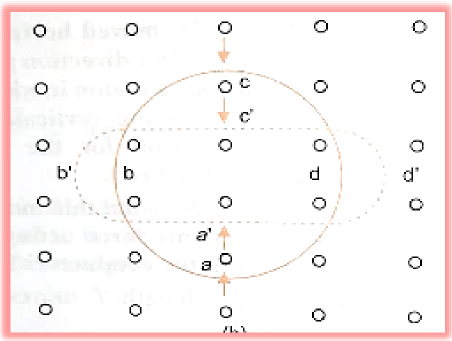
$I = \epsilon/R = 3.8\times10^{-3}V/2\Omega = 1.9\times10^{-3}$A.

2.Use Lenz's law to determine the direction of induced current in the situation described by following figures.

(i) A wire of irregular shape turning into a circular shape.

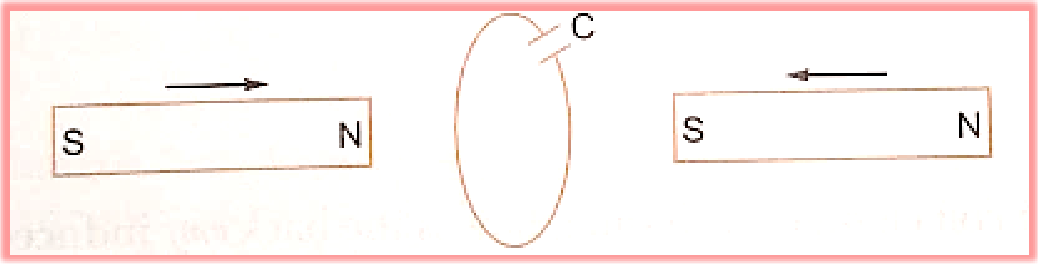
(ii) A circular loop being deformed into a narrow straight wire.





Hints: - (a)The wire is expanding to form a circle, which means that force is acting outwards on each part of wire because of magnetic field (acting in the downwards direction). The direction of induced current should be such that it will produce magnetic field in upward direction (towards

the reader). Hence force on wire will be towards inward direction, i.e. induced current is flowing in anticlockwise direction in the loop from cbad.
(b)When the shape of a circular loop is deformed into a narrow straight wire, the flux piercing the surface decreases. Hence, the induced current flows along abcd.
3. (i)State Lenz's law. Illustrate, by giving an example, how this law helps in predicting the direction of the current in a loop in the presence of a changing magnetic flux.
(ii)In a given coil of self-inductance of 5.0 mH, current changes from 4 A to 1 A in 30 ms. Calculate the emf induced in the coil.
Ans: -(i) refer note book.
(ii) e = 500 V.
4. (i) Show that Lenz's law is in accordance with the law of conservation of energy.
(ii) Two bar magnets are quickly moved towards a metallic loop connected across a capacitor 'C' as shown in the figure. Predict the polarity of the capacitor.



Ans: - (i) refer note book.
(ii) apply Lenz's law.
5. A jet plane is travelling west at 450 ms^{-1}. If the horizontal component of earth's magnetic field at that place is 4 x 10^{-4} T and the angle of dip is 30°, find the emf induced between the ends of wings having a span of 30 m.
Hints: - apply e = Blvsinθ.

6. (i) State Faraday's law of electromagnetic induction.
(ii) Explain, with the help of a suitable example, how we can show that Lenz's law is consequences of the principle of conservation of energy.
(iii) Use the expression for Lorentz force acting on the charge carriers of a conductor to obtain the expression for the induced EMF across the conductor of length '*l*' moving with velocity '*v*' through a magnetic field 'B' acting perpendicular to its length.
Hints: - refer note book.

ASSERTION REASONING QUESTIONS
1. Assertion: Induced emf will always occur whenever there is change in magnetic flux.
Reason: Current always induces whenever there is change in magnetic flux.

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

2. **Assertion:** Lenz's law does not violate the principle of conservation of energy.
Reason: Induced emf always opposes the change in magnetic flux responsible for its production.

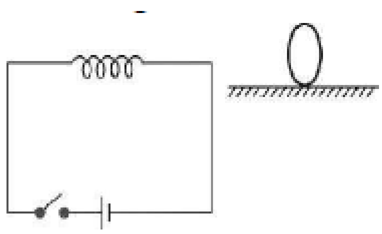
Answer(a) Lenz's law (that the direction of induced emf is always such as to oppose the change that cause it) is direct consequence of the law of conservation of energy.

3. 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.

Answer-(b)
Q.6. 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.

Answer – (a)

Q.7. 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, $e=-d\Phi/dt$

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

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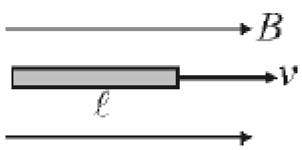
8. Assertion: Figure shows a metallic conductor moving in magnetic field. The induced emf across its ends is zero.



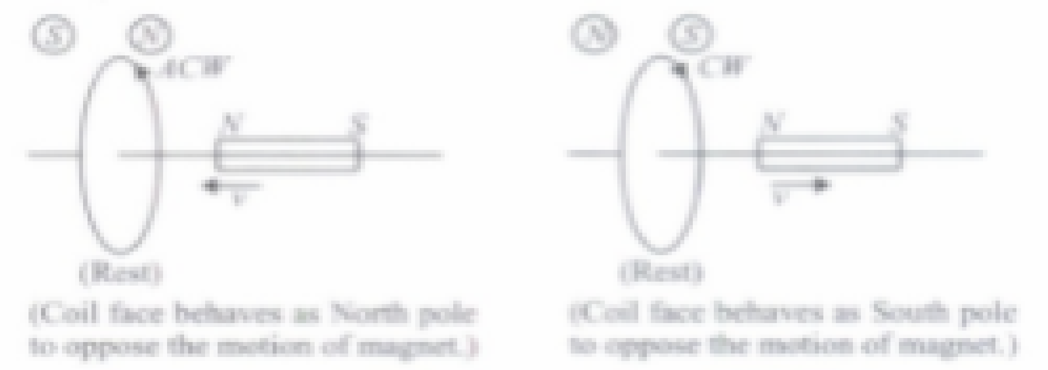
Reason: The induced emf across the ends of a conductor is given by $e = Bv\ell \sin\theta$.

Answer-a

CASE STUDY BASED QUESTIONS: -

1. Lenz's law states that the direction of induced current in a circuit is such that it opposes the change which produces it. Thus, if the magnetic flux linked with a closed-circuit increase, the induced current flows in such a direction that magnetic flux is created in the opposite direction of the original magnetic flux. If the magnetic flux linked with the closed-circuit decreases, the induced current flows in such a direction so as to

create magnetic flux in the direction of the original flux.



(i) Which of the following statements is correct?

(a) The induced e.m.f is not in the direction opposing the change in magnetic flux so as to oppose the cause which produces it.

b) The relative motion between the coil and magnet produces change in magnetic flux.

(c) Emf is induced only if the magnet is moved towards coil.
d) Emf is induced only if the coil is moved towards magnet.

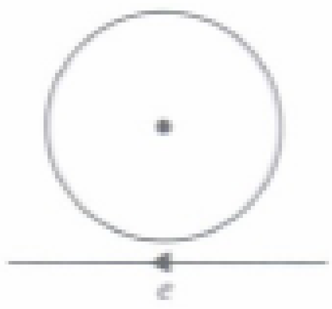
(ii) The polarity of induced emf is given by

(a) Ampere's circuital law **(b) Biot-Savart law**
(c) Lenz's law **(d) Fleming's right hand rule**

(iii) Lenz's law is a consequence of the law of conservation of

(a) charge **(b) mass** **(c) momentum** **(d) energy**

(iv) Near a circular loop of conducting wire as shown in the figure, an electron moves along a straight line.



The direction of the induced current if any in the loop is

(a) variable (b) clockwise (c) anticlockwise (d) zero

Answer-a- variable

(v) Two identical circular coils A and B are kept in a horizontal tube side by side without touching each other. If the current in coil A increases with time, in response, the coil B

a) is attracted b) neither repelled nor attracted
c) repelled d) rotates

Answer- c

is repelled
Two identical circular coils A and B are kept on a horizontal tube side by side without touching each other. If the current in the coil A increases with time, in response, the coil B is repelled. It is so because when the current in coil A is changed, the magnetic field associated with it also changes. As a result, the magnetic field around coil B also changes. This change in magnetic field lines around coil B induces an electric current in it. Now as the same current is flowing in both the coils and in same direction, hence they both will repel each other.

CBSE BOARD QUESTIONS- 2021-22

1) A coil of wire of radius r has 600 turns and a self inductance of 108 mH. The self inductance of a coil with same radius and 500 turns is:

a) 80 mH b) 75 mH c) 108 mH d) 90 mH

Ans.

Correct option is B)

Given : $N = 600$ $L = 108\ \text{mH}$ $N' = 500$

Self inductance of the coil $L = \frac{\mu_0 N^2 A}{l}$ where $A = \pi r^2$

$\Rightarrow \quad L \propto N^2 \qquad (\because A = \text{constant})$

$$\Rightarrow \quad \frac{L'}{L} = \frac{N'^2}{N^2}$$

$$\therefore \quad \frac{L'}{108} = \frac{(500)^2}{(600)^2}$$

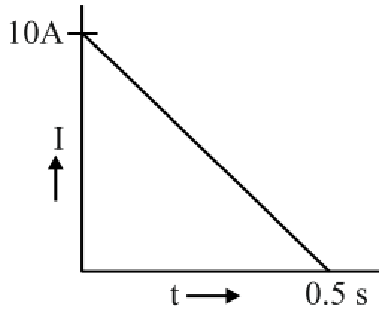
OR $L' = 108 \times \frac{25}{36} \qquad \Rightarrow L' = 75\ \text{mH}$

2. The current in the primary coil of a pair of coils changes from 7A to 3A in 0.04s. The mutual inductance between the two coils is 0.5 H. The induced emf in the secondary coil is

a) 50 V b) 75 V c) 100 V d) 220 V

Ans. a – 50 V

BOARD QUESTIONS
1) In a coil of resistance 100 Ω a current is induced by changing the magnetic **(1 MARK)** flux through it. The variation of current with time is as shown in the figure. The magnitude of change in flux through coil is



(a) 200 Wb (b) 275 Wb (c) 225 Wb (d) 250 Wb

ANS.

A11: d $e = \frac{\Delta\Phi}{\Delta t}, I = \frac{1}{R}\frac{\Delta\Phi}{\Delta t}$ **1M**

$I\,\Delta t = \frac{\Delta\Phi}{R}$ = Area under $I - t$ graph, R = 100 ohm

$\therefore \quad \Delta\Phi = 100 \times \frac{1}{2} \times 10 \times 0.5 = 250$ Wb.

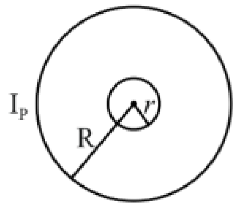
2.a) Define mutual inductance and write its SI unit. **(3 MARKS)**

b. Two circular loops, one of small radius r and other of larger radius R, such that R >> r, are placed co-axially with centres coinciding. Obtain the mutual inductance of the arrangement.

ANS.

(a) : Definition and S.I. Unit. **½ + ½ M**

(b)



Let a current I_P flow through the circular loop of radius R. The magnetic induction at the centre of the loop is

$$B_P = \frac{\mu_0 I_P}{2R}$$ **½ M**

As, r << R, the magnetic induction B_P may be considered to be constant over the entire cross sectional area of inner loop of radius r. Hence magnetic flux linked with the smaller loop will be

$$\phi_S = B_P A_S = \frac{\mu_0 I_P}{2R}\pi r^2$$ **½ M**

Also, $\phi_S = M I_P$ **½ M**

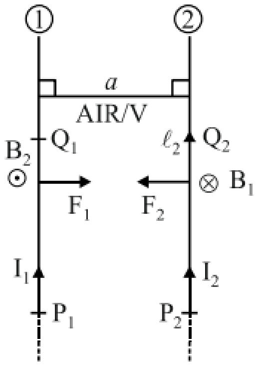
$$\therefore \qquad M = \frac{\Phi_S}{I_p} = \frac{\mu_0 \pi r^2}{2R}$$ **½ M**

2)Two long straight parallel current carrying conductors are kept 'a' distant apart in air. The direction of current in both the conductors is same. Find the magnitude of force per unit length and direction of the force between them. Hence define one ampere. **(3 MARKS)**

ANS.

The magnetic induction B_1 set up by the current I_1 flowing in first conductor at a point somewhere in the middle of second conductor is

$$B_1 = \frac{\mu_0 I_1}{2\pi a} \qquad ...(1)$$ **½ M**



The magnetic force acting on the portion P_2Q_2 of length ℓ_2 of second conductor is

$$F_2 = I_2 \ell_2 B_1 \sin 90° \qquad ...(2)$$

From equation (1) and (2),

$$F_2 = \frac{\mu_0 I_1 I_2 \ell_2}{2\pi a}$$, towards first conductor **½ M**

$$\frac{F_2}{\ell_2} = \frac{\mu_0 I_1 I_2}{2\pi a} \qquad ...(3)$$

The magnetic induction B_2 set up by the current I_2 flowing in second conductor at a point somewhere in the middle of first conductor is

$$B_2 = \frac{\mu_0 I_2}{2\pi a} \qquad ...(4)$$ **½ M**

The magnetic force acting on the portion P_1Q_1 of length ℓ_1 of first conductor is

$$F_1 = I_1 \ell_1 B_2 \sin 90° \qquad ...(5)$$

From equation (3) and (5)

$$F_1 = \frac{\mu_0 I_1 I_2 \ell_1}{2\pi a}$$, towards second conductor **½ M**

$$\frac{F_1}{\ell_1} = \frac{\mu_0 I_1 I_2}{2\pi a} \qquad ...(6)$$

The standard definition of 1A

If $I_1 = I_2 = 1A$

$\ell_1 = \ell_2 = 1m$

$a = 1m$ in V/A then $$\frac{F_1}{\ell_1} = \frac{F_2}{\ell_2} = \frac{\mu_0 \times 1 \times 1}{2\pi \times 1} = 2 \times 10^{-7}\ N/m$$

∴ One ampere is that electric current which when flows in each one of the two infinitely long straight parallel conductors placed 1m apart in vacuum causes each one of them to experience a force of 2×10^{-7} N/m. **1**M

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