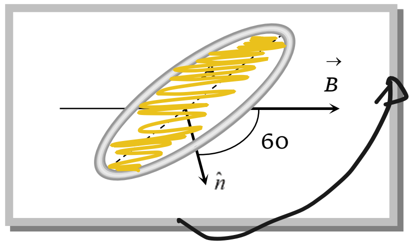
1. A coil of area $A = 0.5\ m^2$ is situated in a uniform magnetic field $B = 4.0\ wb/m^2$ and area vector makes an angle of 60° with respect to the magnetic field as shown in figure. The value of the magnetic flux through the area A would be equal to

(a) 2 *weber*

(b) 1 *weber*

(c) 3 *weber*

(d) $\frac{3}{2}$ *weber*



$3\ rad/sec = \omega$

$\phi = BA\cos 60^\circ = 4 \times 0.5 \times \frac{1}{2} = 1$ weber.

$(emf)_{max} = NBA\omega = 1 \times 3 = 3$ volts.

2. A coil of N turns and area A is rotated at the rate of n rotations per second in a magnetic field of intensity B, the magnitude of the maximum ~~magnetic flux~~ will be

emf induced

(a) NAB (b) nAB

(c) $NnAB$ (d) $2\pi nNAB$

freq $= n$

$\omega = 2\pi f = 2\pi n$

$E_{max} = NBA\omega(\cos \omega t)$

$= NBA2\pi n$

3 A coil of area 100 cm^2 has 500 turns. Magnetic field of 0.1 $weber/metre^2$ is perpendicular to the coil. The field is reduced to zero in 0.1 sec. The induced emf in the coil is

(a) 1 V (b) 5 V

(c) 50 V (d) Zero

$A = 100 \times 10^{-4}\ m^2$, $N = 500$, $B = 0.1\ \frac{wb}{m^2}$ / tesla.

after 0.1 sec

$-\left(\phi_2 - \phi_1 / t\right)$

$emf = -\left(\frac{NB_2A - NB_1A}{t}\right)$

$\theta = 0^\circ$ $B = 0$

For both the cases

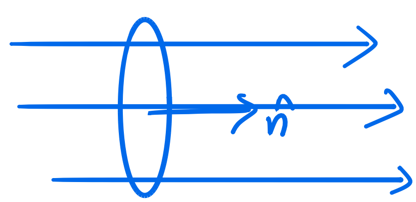
$emf = \left(\frac{0 - 500 \times \cancel{0.1} \times 10^{-2}}{\cancel{0.1}}\right)$

$emf = 5$ volts.

4. A coil has 1000 turns and 500 cm^2 as it's area. The plane of the coil is placed at right angles to a magnetic induction field of 2×10^{-5} wb/m^2. The coil is rotated through 180° in 0.2 sec. The average emf induced in the coil in mV is

(a) 5 (b) 10 (c) 15 (d) 20

$A = 500\ cm^2 = 500 \times 10^{-4}\ m^2$



$\theta_i = 0^\circ$ $\phi_1 = NBA$

$= 500 \times$

$\Delta\phi = -2NBA$

$\theta_f = 180^\circ$ $\phi_f = -NBA$

$(emf)_{av.} = \frac{-(\phi_f - \phi_i)}{t} = \frac{2 \times 500 \times 10^{-2} \times 1000 \times 2 \times 10^{-5}}{0.}$

5. A circular coil of 500 turns of a wire has an enclosed area of 0.1 m^2 per turn. It is kept perpendicular to a magnetic field of induction 0.2 T and rotated by 180° about a diameter perpendicular to the field in 0.1 *sec*. How much charge will pass when the coil is connected to a galvanometer with a combined resistance of 50 *ohms*

(a) 0.2 C (b) 0.4 C (c) 2 C (d) 4 C

$A = 0.1 m^2$, $B = 0.2 T$, $t = 0.1 sec$,

$$\frac{dQ}{dt} = i = \frac{emf}{R} = -\frac{N}{R}\frac{d\phi}{dt}$$

$BA\cos 0^\circ$

$-BA$

$$\Delta Q = \frac{N}{R}\Delta\phi = \frac{2NBA}{R}$$

$$= \frac{2 \times 5\cancel{00}^{10} \times 0.\cancel{1} \times 0.2}{\cancel{50}}$$

$$= 0.4 C$$

6. Flux ϕ (in *weber*) in a closed circuit of resistance 10 *ohm* varies with time t (in *sec*) according to the equation

$\phi = 6t^2 - 5t + 1$. What is the magnitude of the induced current at t = 0.25 s ?

(a) 1.2 A (b) 0.8 A

(c) 0.6 S (d) 0.2 A

$i = ?$

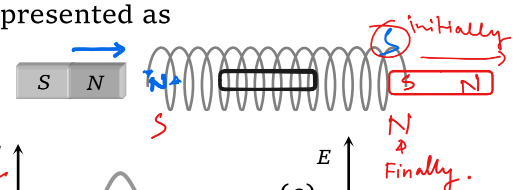
$$emf = -\frac{d\phi}{dt} = -(12t - 5)$$

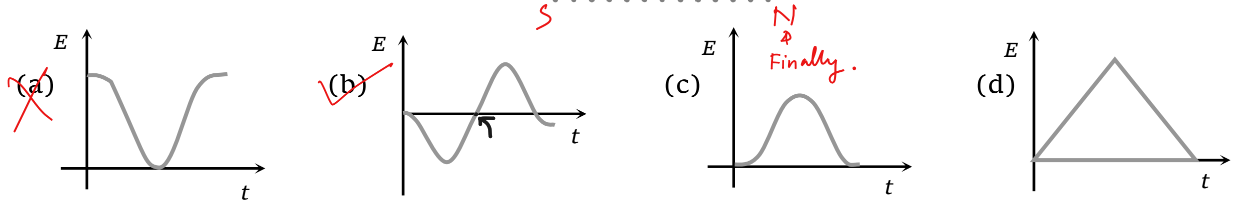
$$emf = -(\cancel{12}^{3} \times \frac{1}{\cancel{4}} - 5)$$

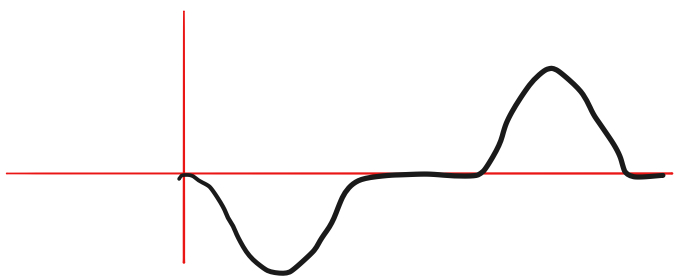
$$i = \frac{emf}{R} = \frac{2}{10} = 0.2 Amp.$$

$emf = 2 volts.$

7. The variation of induced emf (E) with time (t) in a coil if a short bar magnet is moved along its axis with a constant velocity is best represented as **[IIT-JEE (Screening 2004)]**





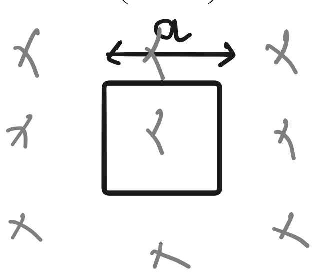


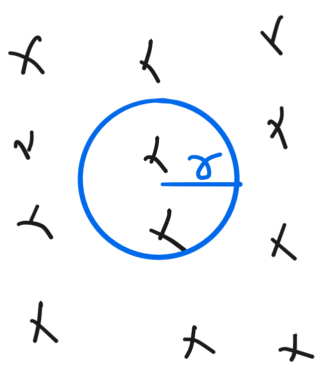
8. A square loop of side ‘a’ and resistance R is placed in a transverse uniform magnetic field B. If it suddenly changes into circular form in time t then magnitude of induced charge will be

(a) $\frac{Ba^2}{R}(4\pi - 1)$ (b) $\frac{Ba^2}{R}\left(1 - \frac{1}{4\pi}\right)$

(c) $\frac{Ba^2}{R}\left(\frac{1}{4\pi} - 1\right)$ (d) $\frac{Ba^2}{R}\left(\frac{4}{\pi} - 1\right)$

$4a = 2\pi r, \quad r = \frac{2a}{\pi}$





$\phi = BA = Ba^2$ — (A)

$\phi' = B\pi r^2$ — (B)

$$\Delta Q = \frac{\Delta\phi}{R} = \frac{B\pi r^2 - Ba^2}{R} = \frac{B\left(\frac{\cancel{\pi}\,4a^2}{\pi^{\cancel{2}}} - a^2\right)}{R}$$

9. A circular coil and a bar magnet placed near by are made to move in the same direction. 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 emf produced in the coil

(a) Zero ✓ (b) 1 *V*

(c) 0.5 *V*

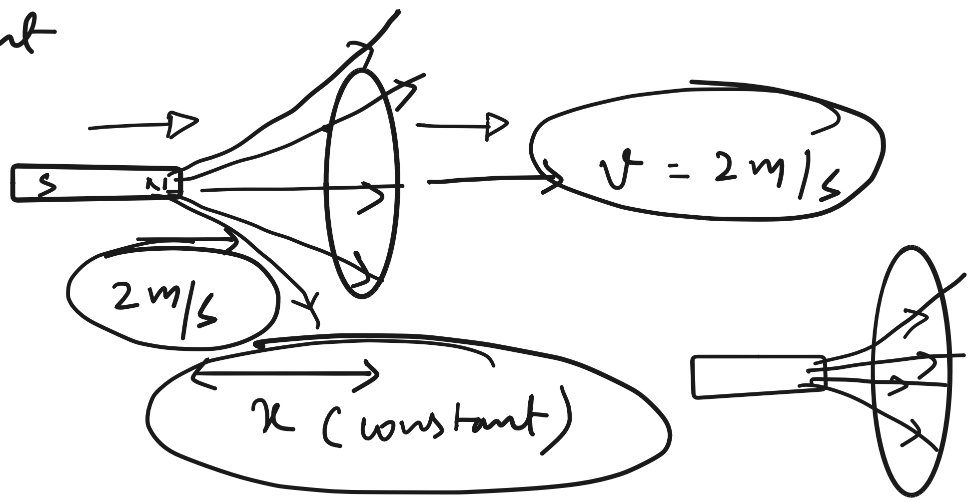
(d) Cannot be determined from the given information

$\frac{1}{0.5} = 2\, m/s$

$\phi = \text{constant}$

$emf = -\frac{d\phi}{dt}$

$emf = 0$



$V_{rel} = 0, \quad emf = 0$

10. A solenoid has 2000 turns wound over a length of 0.314 *m*. Around its central section a coil of 100 turns and area of cross-section $1 \times 10^{-3}\ m^2$ is wound. If an initial current of 2 *A* in the solenoid is reversed in 0.25 *sec*, the emf induced in the coil is equal to

(a) $6 \times 10^{-4}\ V$ (b) 12.8 *mV* ✓

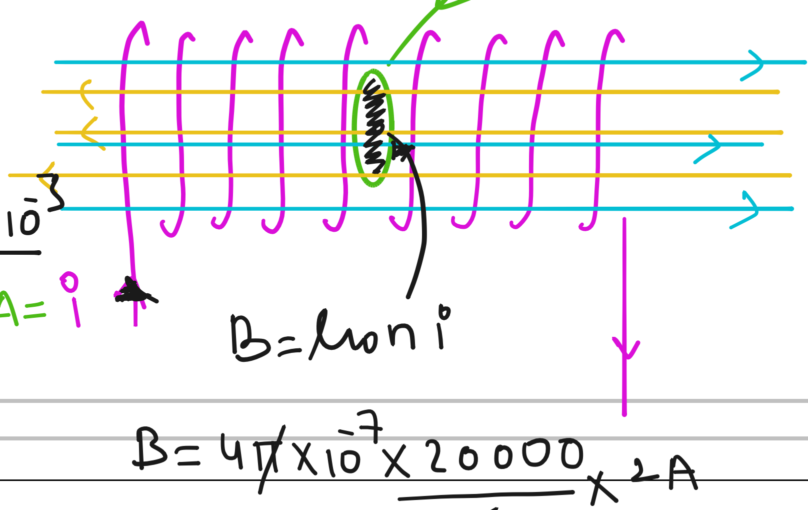
(c) $6 \times 10^{-2}\ V$ (d) 12.8 *V*

$\phi_f = -NBA$

$\phi_i = NBA$

$\Delta\phi = \phi_f - \phi_i = -2NBA$

$N = 100, \quad A = 10^{-3}\ m^2$



$emf = \frac{2NBA}{t}$

$= \frac{2 \times 100 \times 10^{-3} \times 16 \times 10^{-3}}{0.25}$

$2A = i$

$B = \mu_0 n i$

$B = \frac{4\pi \times 10^{-7} \times 20000}{0.314\, m} \times 2A$

$B = 16 \times 10^{-3}$ Tesla.

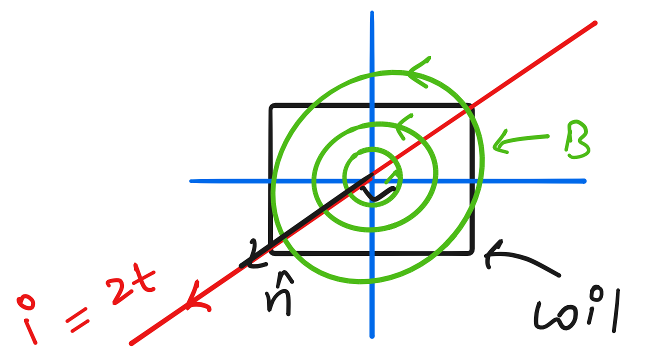
11. A square coil *ABCD* lying in *x*-*y* plane with it's centre at origin. A long straight wire passing through origin carries a current $i = 2t$ in ~~negative~~ +ve *z*-direction. The induced current in the coil is

(a) Clockwise

(b) Anticlockwise

(c) Alternating

(d) Zero



$\phi = BA\cos 90^\circ$

always $\longrightarrow$ $\phi = 0$

12.

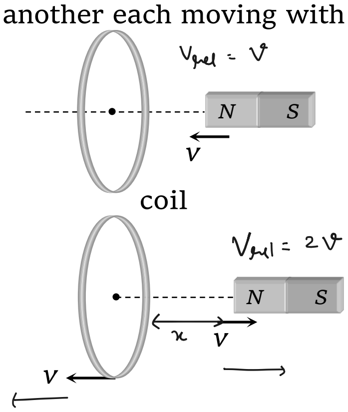
In the following figure, the magnet is moved towards the coil with a speed *v* and induced *emf* is *e*. If magnet and coil recede away from one another each moving with speed *v*, the induced *emf* in the coil will be

(a) *e*

(b) 2*e*

(c) *e*/2

(d) 4*e*



13. Consider a metal ring kept on a horizontal plane. A bar magnet is held above the ring with its length along the central axis of the ring. If the magnet is now dropped freely, the acceleration of the falling magnet is (g is acceleration due to gravity)

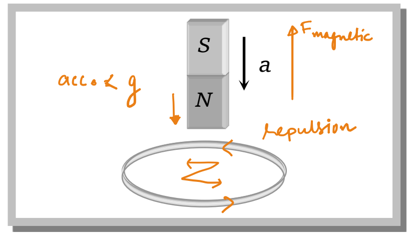
Kerala (Engg.) 2001; MP PET 1990, 99, 2001; MP PMT 2001]

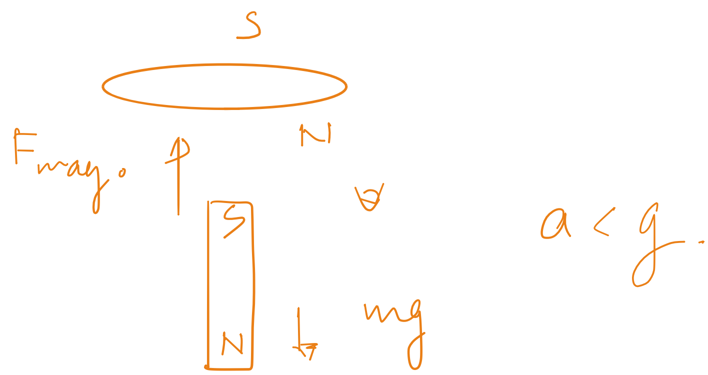
(a) More than g

(b) Equal to g

(c) Less than g

(d) Depends on mass of magnet





14. A bar magnet is falling freely inside a long copper tube and a solenoid as shown in figure (i) and (ii) respectively then acceleration of magnet inside the copper tube and solenoid are respectively (acceleration due to gravity = g)

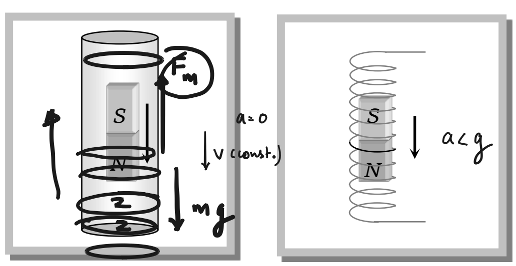
(a) g, g

(b) Greater than g, lesser than g

(c) Greater than g, g

(d) Zero, lesser than g

IIT



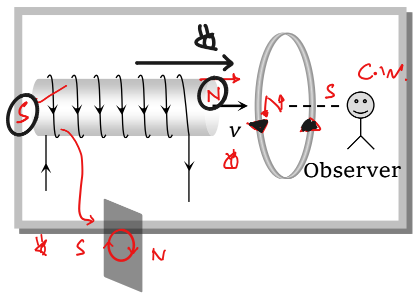
15. A current carrying solenoid is approaching a conducting loop as shown in the figure. The direction of induced current as observed by an observer on the other side of the loop will be

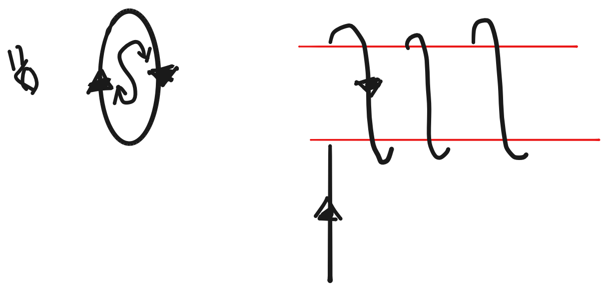
(a) Anticlockwise

(b) Clockwise

(c) East

(d) West





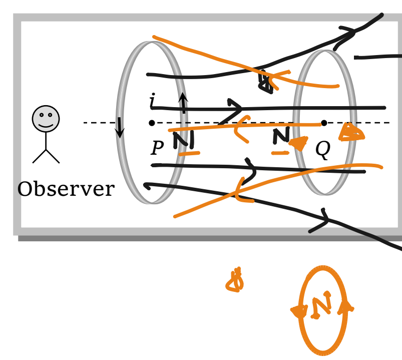
16. Two coils P and Q are lying a little distance apart coaxially. If an anticlockwise current i is suddenly set up in the coil P then the direction of current induced in coil Q will be

(a) Clockwise

(b) Towards north

(c) Towards south

(d) Anticlockwise



try to go away.

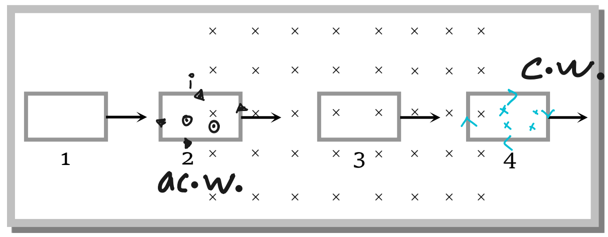
17. A rectangular loop is drawn from left to right across a uniform magnetic field perpendicular into the plane of the loop

(a) The direction of current in position 1 is clockwise

(b) The direction of current in position 2 is clockwise

(c) The direction of current in position 3 is anticlockwise

(d) The direction of current in position 4 is clockwise



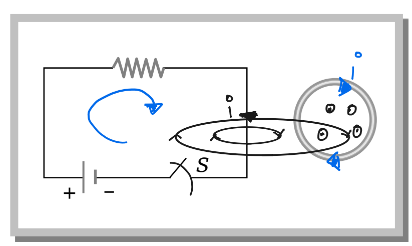
18. A small loop lies outside a circuit. The key of the circuit is closed and opened alternately. The closed loop will show

(a) Clockwise pulse followed by another clockwise pulse

(b) Anticlockwise pulse followed by another anticlockwise pulse

(c) Anticlockwise pulse followed by a clockwise pulse

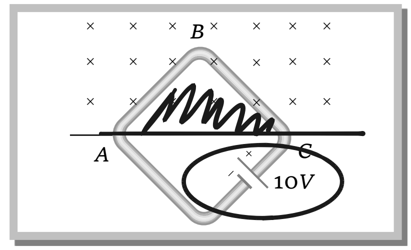
(d) Clockwise pulse followed by an anticlockwise pulse



C.W. when switch is on

A.C.W. when switch is off.

19. A square loop of side 1*m* is placed in a perpendicular magnetic field. Half of the area of the loop inside the magnetic field. A battery of emf 10 *V* and negligible internal resistance is connected in the loop. The magnetic field changes with time according to relation $B = 0.01 - 2t$ *Tesla*. The resultant emf in the loop will be



(a) 1 *V*

(b) 11 *V*

(c) 10 *V*

(d) 9 *V*

$B = 0.01 - 2t \uparrow$

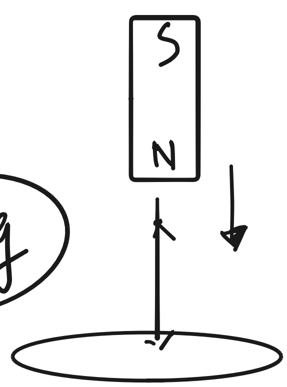
$emf = -\frac{d\phi}{dt} = -\frac{d}{dt}(0.01-2t)\,a^2/2$

$emf = +a^2 = 1$ volts.

20.

A short magnet is allowed to fall along the axis of a horizontal metallic ring. Starting from rest, the distance fallen by the magnet in one second may be

(a) 4 *m* (b) 5 *m* (c) 6 *m* (d) 7 *m*



$a < g$

Freely fall.

In 1sec less then 5m.

$a = g$

$S = ut + \frac{1}{2}at^2$

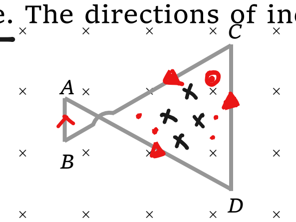
$S = \frac{1}{2}gt^2$

$S = \frac{1}{2} \times 10 \times 1$

$S = 5m.$

21.

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

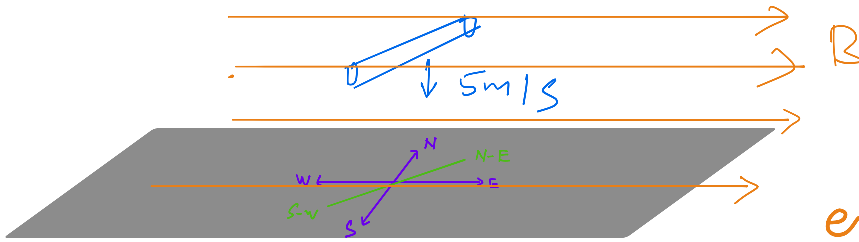
(c) A to B and D to C

(d) B to A and C to D

look at only bigger.

A 10 m long horizontal wire extends from North-East to South-West. It is falling with a speed of 5.0 ms^{-1} at right angles to the horizontal component of the earth's magnetic field of 0.3×10^{-4} Wb/m^2. The value of the induced emf in wire is **(Main 2019, 12 Jan II)**

(a) 1.5×10^{-3} V
(b) 1.1×10^{-3} V
(c) 0.3×10^{-3} V
(d) 2.5×10^{-3} V



emf = $Bl v$

emf = $0.3 \times 10^{-4} \times 10 \times 5$

$= 1.5 \times 10^{-3}$

The self-induced emf of a coil is 25 V. When the current in it is changed at uniform rate from 10 A to 25 A in 1s, the change in the energy of the inductance is

(Main 2019, 10 Jan II)

(a) 437.5 J (b) 740 J

(c) 637.5 J (d) 540 J

$U = \frac{Li^2}{2}$

$emf = -L\frac{di}{dt}$

$25 = L\left(\frac{25-10}{1}\right)$

$25 = L \times 15$

$L = \frac{25}{15} = \frac{5}{3}$ Henry.

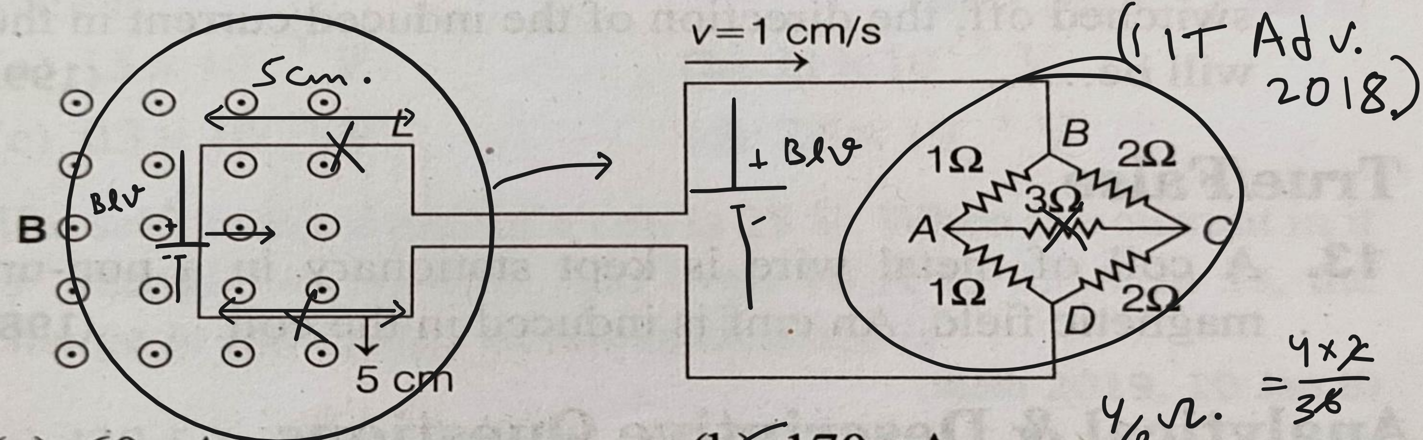
$\Delta U = \frac{Li_f^2}{2} - \frac{Li_i^2}{2}$

$\Delta U = \frac{L}{2}(25^2 - 10^2)$

$\Delta U = \frac{5}{6}[625-100]$

$\Delta U = \frac{525 \times 5}{6}$

The figure shows a square loop L of side 5 cm which is connected to a network of resistances. The whole setup is moving towards right with a constant speed of 1 cm s^{-1}. At some instant, a part of L is in a uniform magnetic field of 1 T, perpendicular to the plane of the loop. If the resistance of L is $1.7\ \Omega$, the current in the loop at that instant will be close to **(Main 2019, 12 April I)**



(a) $60\,\mu A$
~~(b)~~ $170\,\mu A$
(c) $150\,\mu A$
(d) $115\,\mu A$

$$emf = Blv = 1\times10^{-2}\times5\times10^{-2}\times1$$

$$emf. = 5\times10^{-4}\ volts.$$

$V = IR$

$\frac{4}{3} = 1.33$

1.7

3Ω

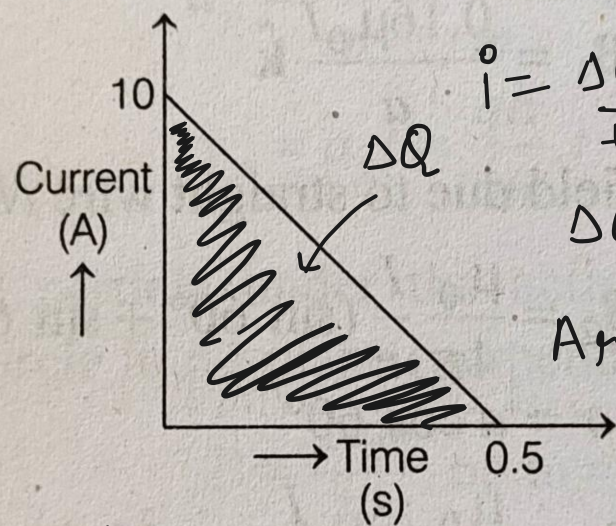
$5\times10^{-4} = I\times3$

$\frac{5}{3}\times10^{-4} = I$

$166\,\mu A = I$

$3\overline{)5}(1.66$
3
20

In a coil of resistance 100 Ω, a current is induced by changing the magnetic flux through it as shown in the figure. The magnitude of change in flux through the coil is **(2017 Main)**



$i = \frac{\Delta Q}{t}$

$\Delta Q = i \times t$ when i is constant

Area of i vs time graph gives Change flow

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

$$\Delta Q = \frac{\Delta \phi}{R}$$

$$\frac{1}{\cancel{2}} \times \cancel{10}^{5} \times 0.5 \times 100 = \Delta \phi$$

$$250\ \text{wb} = \Delta \phi$$

A transformer consisting of 300 turns in the primary and 150 turns in the secondary gives output power of 2.2 kW. If the current in the secondary coil is 10 A, then the input voltage and current in the primary coil are (Main 2019, 10 April I)

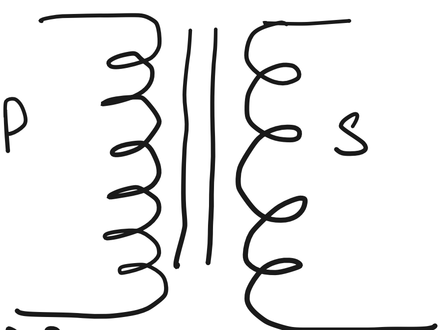
(a) 440 V and 5 A ✓ (b) ~~220 V and 20 A~~

(c) ~~220 V and 10 A~~ (d) 440 V and 20 A

ideal transformer $P_{input\ power} = P_{output\ power}$

$$i_p V_p = i_s V_s$$

i_p V_p P



S $i_s V_s$

$$\frac{N_p}{N_s} = \frac{V_p}{V_s} = \frac{i_2}{i_p} = K$$

$$\frac{V_p}{220} = \frac{\cancel{300}\ 2}{\cancel{150}}$$

$$\frac{N_1}{N_2} = \frac{V_1}{V_2} = \frac{i_2}{i_1} = K$$

transformer ratio.

$V_p = 440V$ $\quad V_p = -N_p \frac{d\phi}{dt}$

$$V_s = -N_s \frac{d\phi}{dt}$$

$$\frac{i_2}{i_1} = \frac{N_p}{N_2}$$

$$P_{output} = I_s V_s$$

$$2.2 \times 1000 = 10 V_s$$

$$V_s = 222 \text{ volts.}$$

$$\frac{10}{i_1} = \frac{3\cancel{00}\ 2}{1\cancel{50}}$$

$$i_1 = 5A.$$

There are two long coaxial solenoids of same length l. The inner and outer coils have radii r_1 and r_2 and number of turns per unit length n_1 and n_2, respectively. The ratio of mutual inductance to the self-inductance of the inner coil is

(Main 2019, 11 Jan I)

(a) $\frac{n_2}{n_1} \cdot \frac{r_1}{r_2}$ (b) $\frac{n_2}{n_1} \cdot \frac{r_2^2}{r_1^2}$ (c) $\frac{n_2}{n_1}$ (d) $\frac{n_1}{n_2}$

$$\phi = Li$$

For one coil

$$L_{inner} = \mu_0 \pi r_1^2 n_1^2 l$$

$$\phi_s = M i_p$$

For two coils.

$$M = \mu_0 n_1 n_2 \pi r_1^2 l.$$

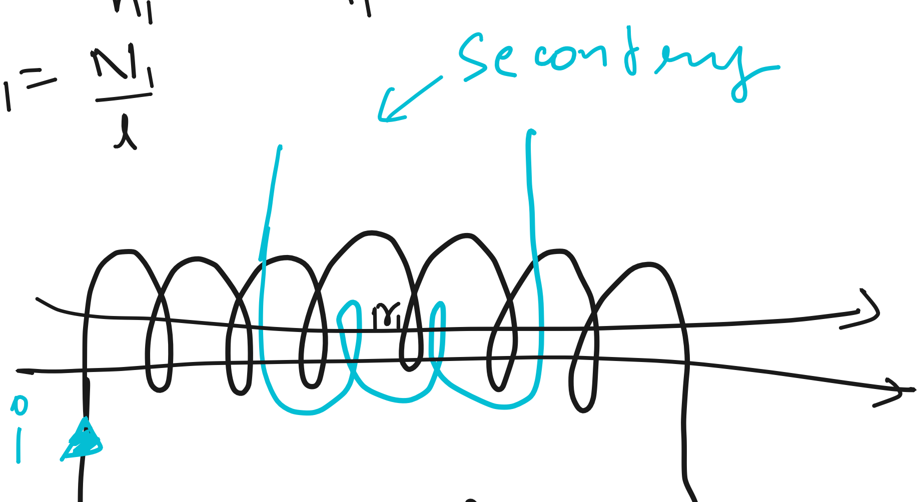
$$\frac{M}{L} = \frac{n_1 n_2}{n_1^2} = \frac{n_2}{n_1}$$

$$n_1 = \frac{N_1}{l}$$

$$\phi_s = M i_p$$

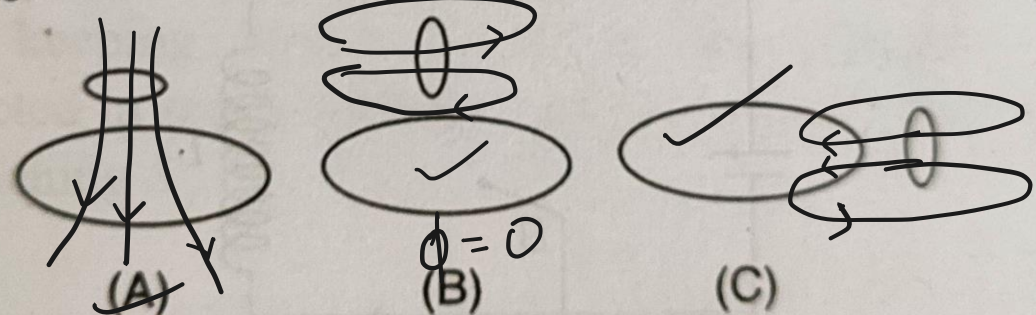
$$N_2 B_p A_s = M i_p$$

$$N_1 \times \mu_0 n_2 i \times \pi r_1^2$$



$$\phi_2 = n_1 l \times \mu_0 n_2 i \times \pi r_1^2$$

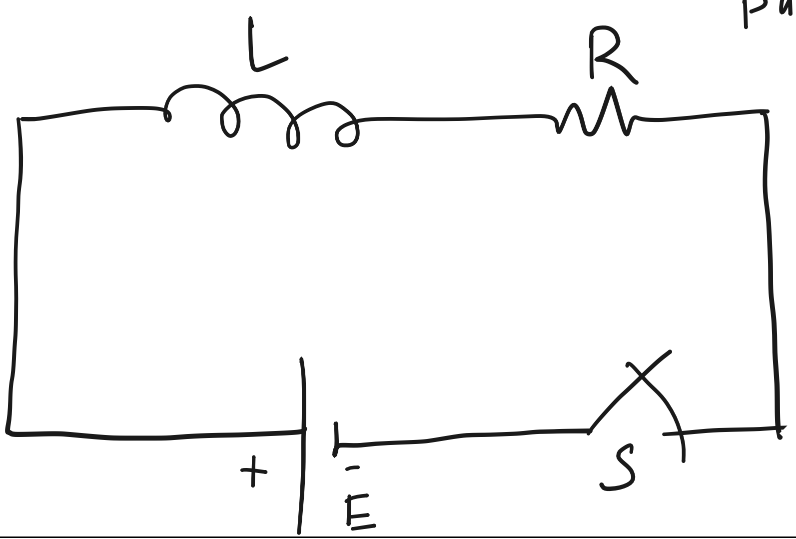
Two circular coils can be arranged in any of the three situations shown in the figure. Their mutual inductance will be (2001, S)



(a) maximum in situation (A).
(b) maximum in situation (B).
(c) maximum in situation (C).
(d) the same in all situations.

IIT mains 2019 12 April II

Amount of charge that passes through the battery $t=0$ to $t=\frac{L}{R}$



$$i = i_0\left(1 - e^{-t/L/R}\right)$$

$i_0 \leftarrow$ maximum current

$$i_0 = \frac{E}{R}$$

$$i = \frac{E}{R}\left(1 - e^{-t/L/R}\right)$$

$$\frac{dQ}{dt} = \frac{E}{R}\left(1 - e^{-t/L/R}\right)$$

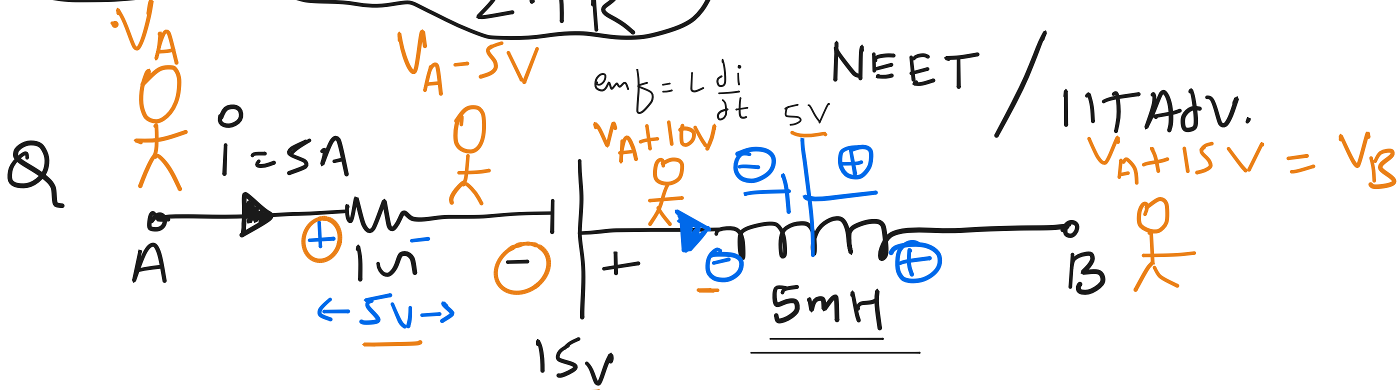
$$\int dQ = \int_0^{L/R} \frac{E}{R}\,dt - \int_0^{L/R} \frac{E}{R} e^{-t/L/R}\,dt$$

(b) $Q = \dfrac{EL}{2.7R^2}$

$V_A - V_B = -15V$

NEET / IIT Adv.

Q

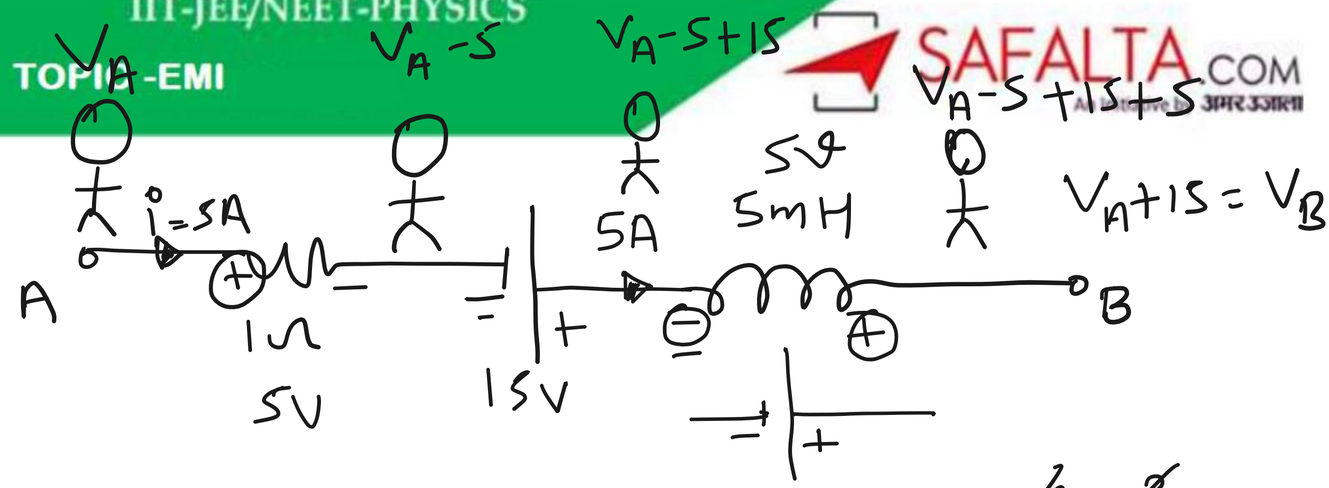


current is decreasing at rate of 10^3 A/s.

Find $V_A - V_B$

IIT-JEE/NEET-PHYSICS

TOPIC-EMI



$$emf = L\frac{di}{dt} = 5 \times \cancel{10^{-3}} \times \cancel{10^{3}}$$

$$V_A - V_B = -15V$$

~~Q9, Q17, Q20, Q10~~, last wall, Q ~~15~~.