force per unit charge,

$$\vec{f}_{mag} = \vec{v} \times \vec{B}$$
$$= \omega r \hat{\phi} \times B \hat{z}$$
$$= \omega r B (\hat{\phi} \times \hat{z})$$
$$\boxed{\vec{f}_{mag} = \omega r B \hat{r}}$$

B'coz of this force, charges move towards outer edge so outer edge become +ve terminal of battery & centre " " -ve "

$$\varepsilon = \int_0^a \omega B r \, dr$$
$$\boxed{\varepsilon = \frac{\omega B a^2}{2}}$$

The Current flow, $I = \frac{\varepsilon}{R}$

$$I = \frac{\omega B a^2}{2R}$$

Dir^n of the current will be $A \longrightarrow B$

- If disc rotate oppositely then dir^n of v will be opposite & dir^n of force opposite & then +ve charge on centre & -ve on surface. So terminal changes.
- The Current flow on external Circuit is from +ve to -ve terminal.

Ques 1- A metal bar of mass m slides frictionlessly on two parallel conducting rails. A distance l apart a resistor R is conected across the rails & a uniform mag. field $\vec{B}$ is pointing into the page.
(A) find dir^n & magnitude of the current in the resistor.
(B) Magnetic force on the metal bar with dir^n.
(C) If V_0 is the speed at $t=0$ time. find the speed at later time t of the conducting bar.

(A)

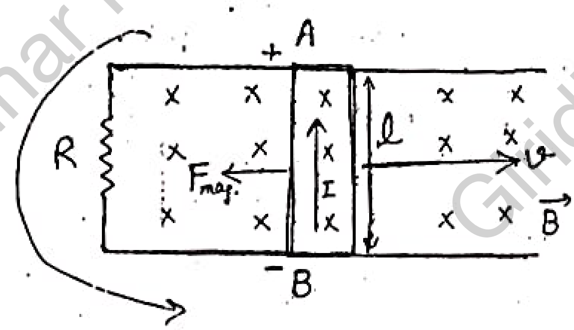
For +ve charges push upward

-ve " " down

So A → +ve

B → -ve

Current will flow towards resistance as this is open circuit from one side.



emf, $\varepsilon = \int \vec{F}_{mag} \cdot d\vec{l}$

$$\boxed{\varepsilon = vBl}$$

Current $I = \frac{\varepsilon}{R} \Rightarrow \boxed{I = \frac{vBl}{R}}$

dir^n → downwards

Inside the rod, current from B → A

Metal Bar does not have any resistance. So total resistance is R on whole circuit.

(B) If a wire of length l & current flowing in it is I then magnetic force will be

$$\vec{F}_{mag} = I \int d\vec{l} \times \vec{B}$$

$$= \frac{vBl}{R} \cdot lB$$

$$\boxed{\vec{F}_{mag} = \frac{vB^2l^2}{R}}$$

dir^n → to the left

(C) Bar is moving in dir $\longrightarrow$

& $\vec{F}_{mag}$ is in dir^n $\longleftarrow$

Both will try to stop the bar.

If m be the mass of bar & v be the vel. then mechanical force

$$m\frac{dv}{dt} = -\frac{vB^2l^2}{R} \Rightarrow \frac{dv}{dt} = -\frac{vB^2l^2}{mR}$$

$$\frac{dv}{v} = -\frac{B^2l^2}{mR}\,dt$$

$$\ln v = -\frac{B^2 l^2}{Rm} t + C$$

At $t = 0,\ v = v_0$

$$\ln\left(\frac{v}{v_0}\right) = -\frac{B^2 l^2}{Rm} t$$

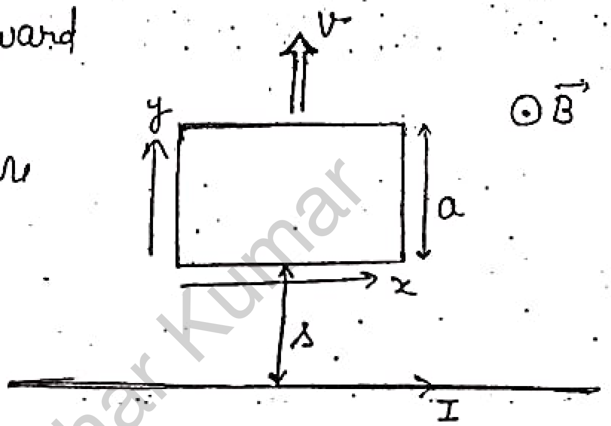
$$\boxed{v = v_0\, e^{-\frac{B^2 l^2 t}{Rm}}}$$

velocity is exponentially ↓ with time.

As B ↑, the decrease in v will be more.

Qu:- A square loop of wire of side 'a' lies on a table at a distance s from a very long straight wire which carries a current I. If someone pulls the loop away from the wire at speed v. What is the induced emf in the loop. Also find the dirn of induced current.

Square loop is pulled upward dirn.



Flux passes through the square loop

$$\phi_m = \int B \cdot ds$$

B → mag. field of wire

ds → area of loop

Mag. field of a wire is

$$B = \frac{\mu_0 I}{2\pi s}\hat{\phi}$$

dirn of Mag. field → It is coming out.

Area, $ds = dx\,dy$

$$\phi_m = \int_0^a \int_s^{s+a} \frac{\mu_0 I}{2\pi y}\, dx\, dy$$ {limits of $y \to s$ to $s+a$

Here variation of mag field is along y dirn

$$\boxed{\phi_m = \frac{\mu_0 I}{2\pi} a \ln\left(\frac{s+a}{s}\right)}$$

If flux → const then No emf.

s is variable. If loop is away from wire then $s \uparrow$ & then flux $\downarrow$. (area of loop & angle $\rightarrow$ constant & mag. field changes) depending on s

So Here flux is not Constant.

Now, Emf,
$$\mathcal{E} = \frac{-d\phi_m}{dt}$$
$$= -\frac{\mu_0 I a}{2\pi}\left(\frac{s}{s+a}\right)\left(\frac{-a}{s^2}\right)\frac{ds}{dt}$$

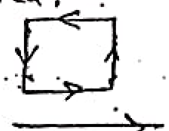
$\frac{ds}{dt} \rightarrow$ Rate of change of distance i.e. velocity v.

$$\boxed{\mathcal{E} = \frac{\mu_0 I a^2}{2\pi s(s+a)} v}$$

This much emf will enduce in the loop.

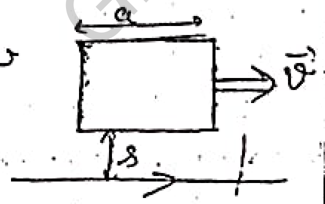
Dir^n of the induce current :- As loop is moving away from wire $\rightarrow s\uparrow$ - Here flux is decreasing. So induce current will try to increase it, & flux is decreasing due to dec. in mag. field so Induce current will try to inc. the mag. field. To do so, it will develop a mag. field opposite to original.

So, Dir^n of current - Anticlockwise



- If we are pulling the loop towards the wire, then flex $\uparrow$, $\vec{B}\uparrow$, so current try to dec. the $\vec{B}$. Dir^n of current - Clockwise

- If we pull the loop parallel to wire then there will be No change in flex. Now flex will pass through the loop but change in flex $= 0$ so emf $= 0$



* If wire is finite then on the ends of wire, mag. field will be complicated.

* If loop pulling away from wire, dir^n of $I \rightarrow$ Anti
" " " towards " " " $\rightarrow$ clockwise

* Induced emf try to dec. the flex