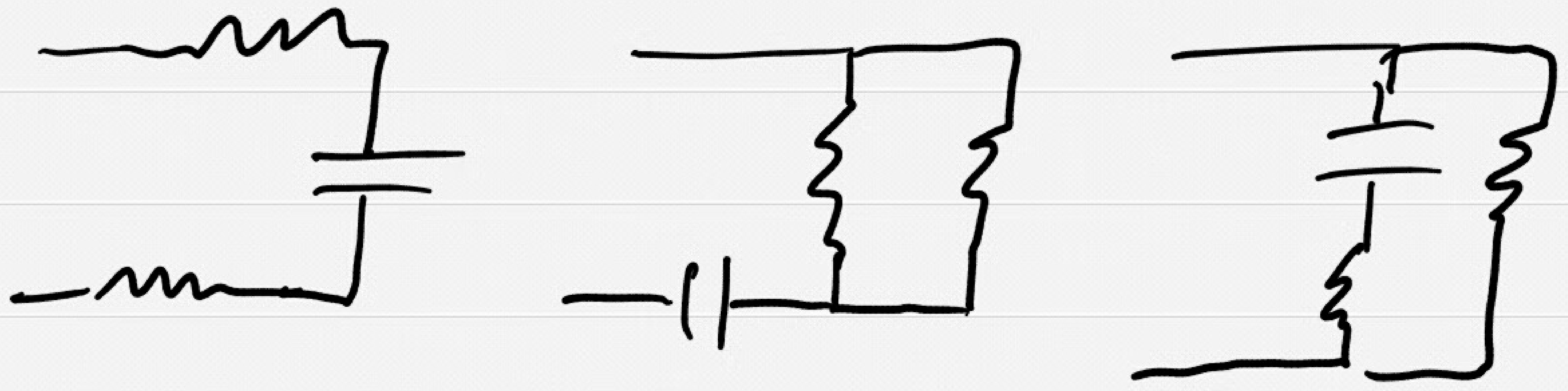
HWC1: $I_0 = V/R$

- so higher curves have lower R

$\tau = RC$

so curves w/ higher RC fall faster

HWC2: Final equilibrium w/ no current through C



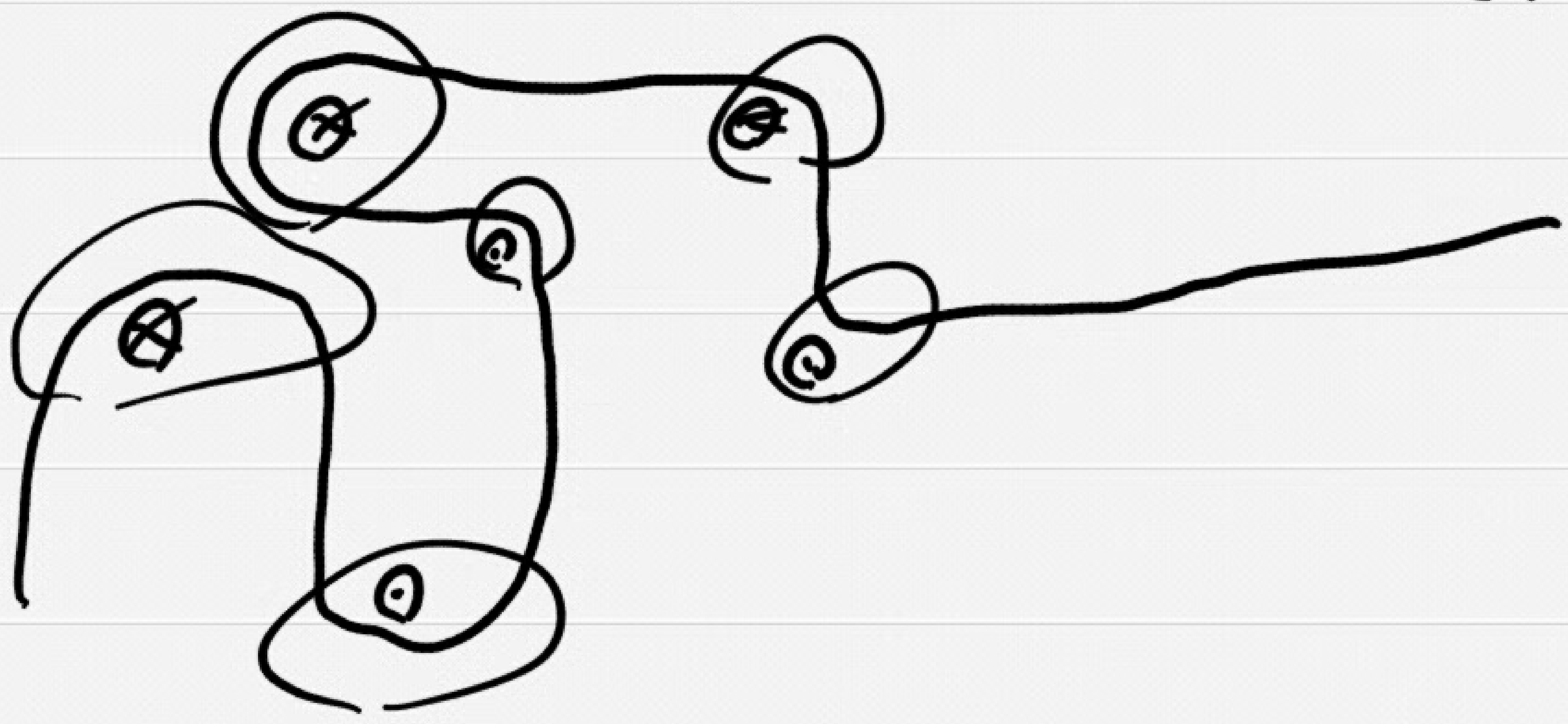
- In all 3, all V across capacitor once current stops
- For charging look @ R_{eq} in series w/ C.

$R_{1eq} = 2R$, $R_{2eq} = R/2$, $R_{eq} = R$

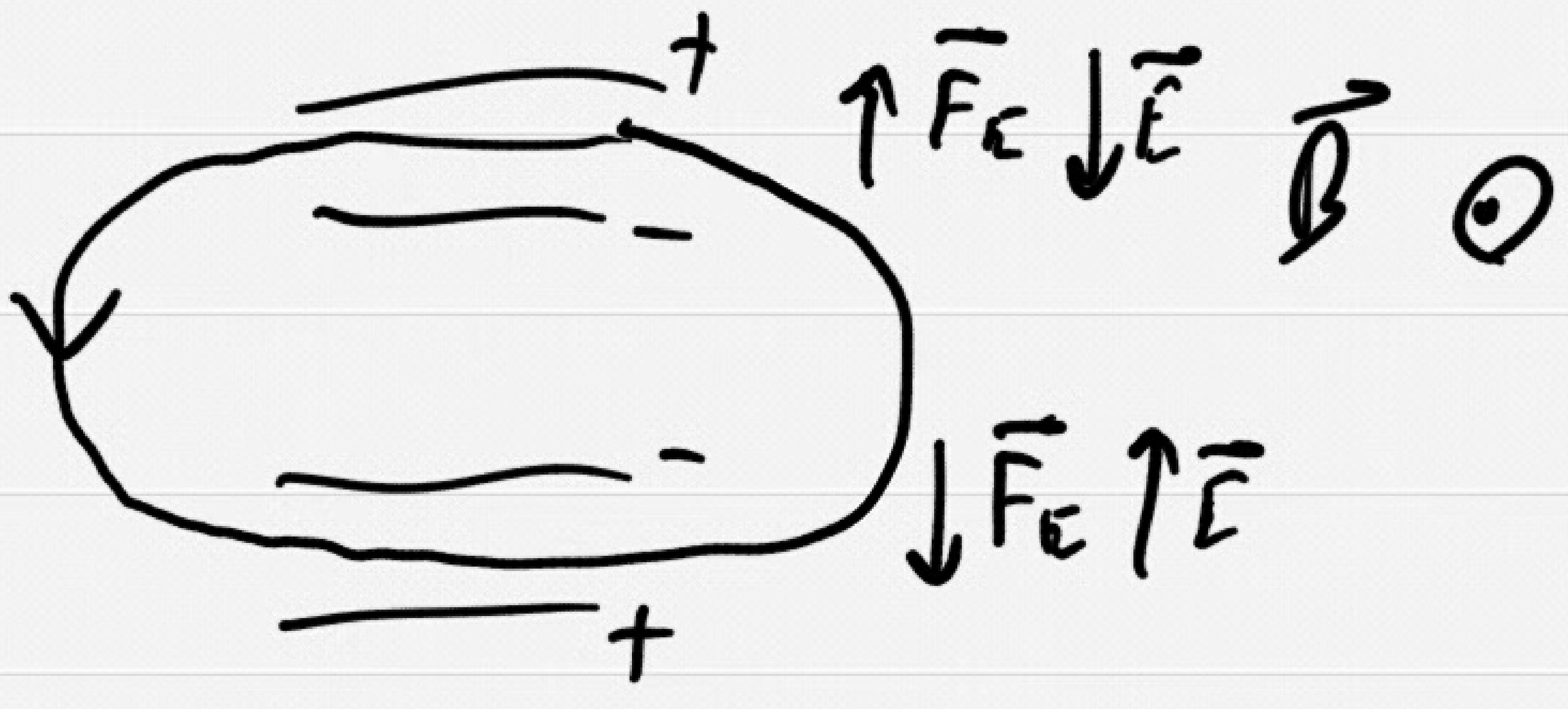
HWC3:

No Yes No

HWC4: - Def toward higher potential so $q = -$
- Means deflection in B is CCW (R-handed)



HWC5: Need $\vec{E}, \vec{B}$ to balance in straight sections



HWM1: $\tau = RC$

$Q_{max} = CV$

solve $Q = CV(1 - e^{-t/\tau})$

HWM2: Until lamp flashes this is just an RC circuit!

$$V_C = Q/C = \mathcal{E}\left(1-e^{-t/\tau}\right)$$

Discharge instantaneous since $R_{Lamp}=0$

Need $V_C = V_L$ @ $t=0.25\,s$

so $V_L = \mathcal{E}\left(1-e^{-0.25/\tau}\right)$

$$V_L/\mathcal{E} = 1-e^{-0.25/\tau}$$

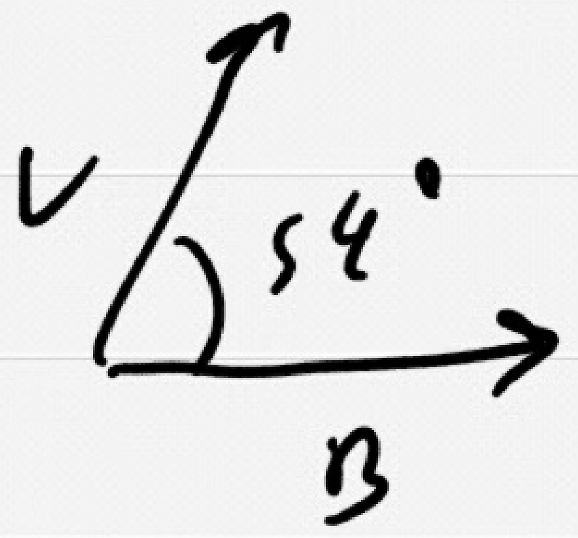
$$e^{-0.25/\tau} = \left(1-V_L/\mathcal{E}\right)$$

$$-0.25/\tau = \ln\left(1-V_L/\mathcal{E}\right)$$

$$\tau = -0.25/\ln\left(1-V_L/\mathcal{E}\right)$$

$$R = \tau/C$$

HWM3:



$$\vec{F} = q\vec{v} \times \vec{B}$$

$$|\vec{F}| = qvB\sin\theta$$

$$a = |\vec{F}|/m$$

since $\vec{F}$, $\vec{a}$ perpendicular, $|\vec{v}| = \text{const.}$

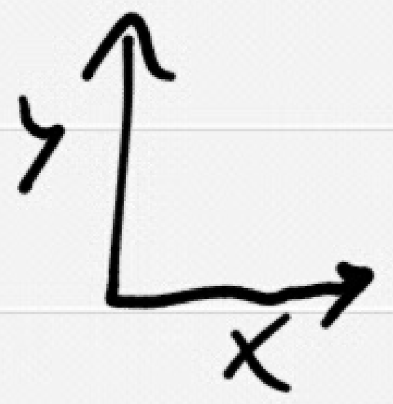
HWM4:

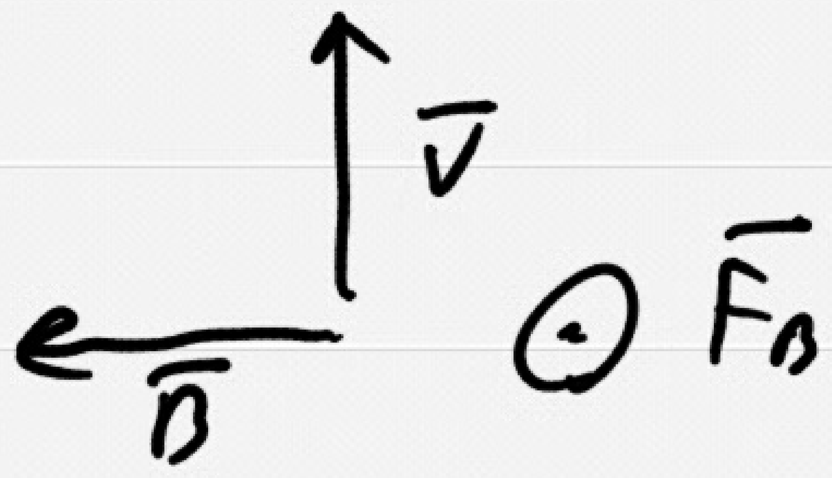
$$\vec{B} = B_x\hat{i} + \cancel{B_y\hat{j}} + B_z\hat{k}$$
$$\vec{v} = v_x\hat{i} + \cancel{v_y\hat{j}} + v_z\hat{k}$$

$$\vec{F} = q\vec{v} \times \vec{B}$$

$$F_x = q(v_y B_z - v_z B_y)$$
$$\cancel{F_y} = q(v_z B_x - v_x B_z)$$

HWM5:





$\vec{F}_1 \odot$ $\quad \vec{F}_2 \otimes$ $\quad \xrightarrow{\vec{F}_3}$

Solve $\vec{F} = q\vec{v} \times \vec{B}$

say $\vec{v}(t) = [v_x(t), v_y(t), 0]$

$\vec{B}(t) = [0, 0, B_z]$

$\vec{v} \times \vec{B} = v_y B_z \hat{i} - v_x B_z \hat{j}$

$\vec{F} = m\, d\vec{v}/dt$

$= m\, [dv_x/dt,\ dv_y/dt,\ 0]$

$= m\, dv_x/dt\, \hat{i} + m\, dv_y/dt\, \hat{j}$

$\Rightarrow \quad m\, dv_x/dt = q v_y B_z$
$\quad\quad m\, dv_y/dt = -q v_x B_z$

differentiate:

$$m\, d^2v_x/dt^2 = q\, dv_y/dt\, B_z$$

$$= -q^2/m\, B_z^2 v_x$$

or $d^2v_x/dt^2 = -\left(\frac{qB}{m}\right)^2 v_x$

similarly $d^2v_y/dt^2 = -\left(\frac{qB}{m}\right)^2 v_y$

solutions are

$$A \cos \omega t \,, \quad B \sin \omega t$$
$$\text{w/ } \omega = qB/m$$

Match initial conditions to solve

say $\vec{v}(0) = [v_0, 0, 0]$

$$v_x(t) = v_0 \cos \omega t$$
$$v_y(t) = -v_0 \sin \omega t$$

sign to satisfy
$dv_y/dt = -\omega v_x$

or $\vec{v} = v_0 [\cos \omega t, -\sin \omega t, 0]$

- This is a circle w/ $\theta = \omega t$
$= \frac{qB}{m} t$
- Agrees w/ $qvB = mv^2/r$

$\Rightarrow r = mv/qB$ = "gyro-radius"

$$\omega = v/r = qB/m$$

$$f = \omega/2\pi = qB/2\pi m$$
= "gyro-frequency"