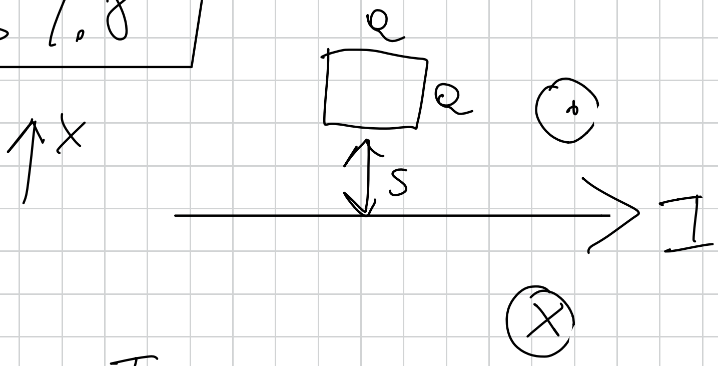
SESSION 1

Griffiths 7.8



(a) $$B(x) = \frac{\mu_0 I}{2\pi x}$$

$$\Phi = \frac{\mu_0 I}{2\pi} \int_s^{s+a} \frac{a}{x} dx$$

$$\boxed{\Phi = \frac{\mu_0 I}{2\pi} a \log\frac{s+a}{s}}$$

(b) $$\text{emf} = -\frac{d\Phi}{dt} = -\frac{\mu_0 I a}{2\pi} \frac{d}{dt} \log\frac{s+a}{s}$$

$$\text{emf} = -\frac{\mu_0 I a}{2\pi} \frac{ds}{dt} \frac{d}{ds} \log \frac{s+a}{s}$$

But $\frac{ds}{dt} = v$ $\quad \log \frac{s+a}{s} = \log s+a - \log s$

$$\text{emf} = -\frac{\mu_0 I a v}{2\pi} \left(\frac{1}{s+a} - \frac{1}{s} \right).$$

$$\boxed{\text{emf} = \frac{\mu_0 I a v}{2\pi s (s+a)}}$$

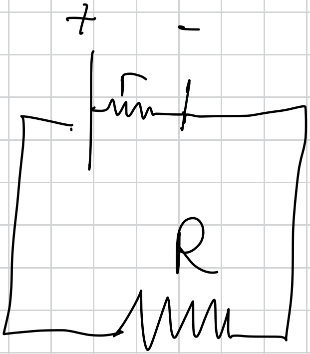
The original $\vec{B}$ was out of the paper

As the loop is pulled away, the magnitude of the flux decreases.

By Lenz's law, in order to keep the flux as constant as possible, the induced field must also be out of the paper. Then by the RH rule, the current is anticlockwise

(c) $\frac{d\Phi}{dt}=0 \Longrightarrow \boxed{\text{emf}=0}$

Griffiths 7.5



$$I = \frac{\text{emf}}{R+r} = \frac{\mathcal{E}}{R+r}$$

$$P = I^2 R = \frac{\mathcal{E}^2 R}{(R+r)^2}$$

Maximum power $\frac{dP}{dR} = 0$

$$\frac{dP}{dR} = \mathcal{E}^2 \frac{2(R+r)R - (R+r)^2}{(R+r)^4}$$

$$\frac{dP}{dR} = \frac{\varepsilon^2}{(R+r)^4}\left(2R^2 + 2rR - R^2 - r^2 - 2rR\right)$$

$$\frac{dP}{dR} = \frac{\varepsilon^2}{(R+r)^4}\left(R^2 - r^2\right)$$

Setting $\frac{dP}{dR} = 0 \implies \boxed{R = r}$