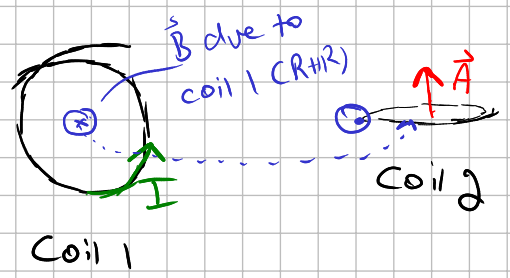
Exercises on Faraday's law

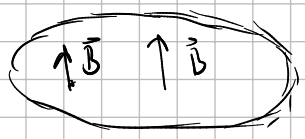
1) Consider the two coils show

What is the magnetic flux at coil 2 due to coil 1, which has a current I passing through it?



$\vec{B}$ from coil 1 and $\vec{A}$ for coil 2 are $\perp$, so $\vec{B} \cdot \vec{A}$ is 0, so magnetic flux is 0.

2) A loop of wire with radius r = 0.15m is placed in a region of uniform magnetic field (B). The magnetic field is perpendicular to the plane of the loop. If the magnitude of the magnetic field goes from 6.7T to 0.3T in 3.1s, and the resistance of the wire is 3 Ohms, what is the current induced in the loop?



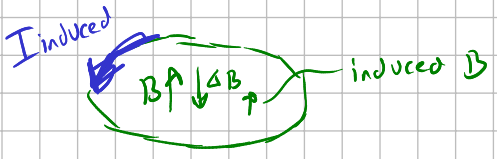
$$\mathcal{E} = -\frac{d\Phi_B}{dt} \approx -\frac{\Delta\Phi_B}{\Delta t} = -\frac{\Delta(BA)}{\Delta t}$$

$$= -\frac{(B_f - B_i)(\pi r^2)}{\Delta t}$$

$$= -\frac{(6.7\,T - 0.3\,T)(\pi \times (0.15\,m)^2)}{3.1\,s} \approx -0.15\,V$$

Units: $\frac{\frac{V \cdot s}{m^2} \cdot m^2}{s} = V$ ✓

$$I = \frac{V}{R} = \frac{0.15\,V}{3\,\Omega} = \boxed{0.05\,A}$$



3) A conducting rod of length L is moving along a pair of rails of resistance R at velocity v with a magnetic field perpendicular to the plane of the rails.

a) Derive an expression for the induced current in the rails.

$$\mathcal{E} = -\frac{d\Phi_B}{dt} = -\frac{\Delta(BA)}{\Delta t} = -\frac{B\,\Delta(L\cdot w)}{\Delta t} = -\frac{BL\,\Delta w}{\Delta t} = -BLv$$

$$I = \frac{V}{R} = \boxed{-\frac{BLv}{R}}$$