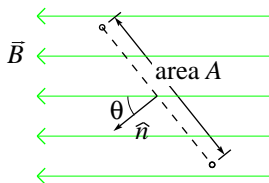


AC Generator

end view



(a.) Because \vec{B} is uniform, the flux through one loop of area A is

$$\Phi_B^{(1)} = A \vec{B} \cdot \hat{n} = A |\vec{B}| \cos \theta,$$

where θ is the tilt angle of the loop, as shown in the figure.

Now θ increases linearly with time in such a way that after one period, that is, after a time of $1/f$, the angle θ is 2π . Thus $\theta = 2\pi ft$.

Therefore the flux through one loop is

$$\Phi_B^{(1)} = AB \cos(2\pi ft)$$

and the flux through N loops is

$$\Phi_B = NAB \cos(2\pi ft). \quad (1)$$

The emf induced is

$$\mathcal{E} = -\frac{d\Phi_B}{dt} = 2\pi f NAB \sin(2\pi ft). \quad (2)$$

So to get a larger amplitude you could increase the number of loops N , the area A , the magnetic field B , or the speed of turning f .

(b.) In particular, if you want an amplitude of 170 V with 30 loops, field 0.100 T, and frequency 60.0 Hz, you'll need an area of

$$A = \frac{\mathcal{E}_0}{2\pi f NB}, \quad (3)$$

and hence (for a square loop) an edge length of

$$\sqrt{A} = \sqrt{\frac{\mathcal{E}_0}{2\pi f NB}} = 0.388 \text{ m} \quad (4)$$

Grading: 2 points for any sort of starting up

2 points for reaching equation (1)

2 points for reaching equation (2)

2 points for number in equation (4)

1 point for units in equation (4)

1 point for three significant figures in equation (4)