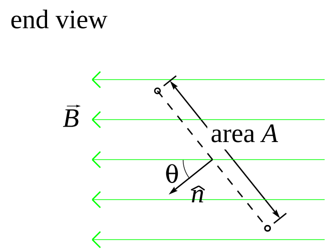
AC Generator



(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 $\theta = 2\pi f t$.

Therefore the flux through one loop is

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

and the flux through N loops is

$$\Phi_B = NAB\cos(2\pi f t). \tag{1}$$

The emf induced is

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

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 150 V with field 0.500 T and frequency 60.0 Hz (all typical for commercial AC power generation in the United States), you'll need a total area of

$$NA = \frac{\mathcal{E}_0}{2\pi f B} = 0.796\text{ m}^2. \tag{3}$$

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 (3)
1 point for units in equation (3)
1 point for three significant figures in equation (3)