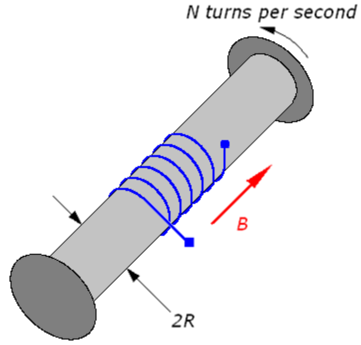
# Electromagnetism

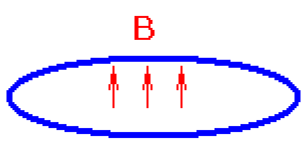
## Faraday law

**Problem 1.-** A solenoid is being wound around a plastic cylinder of radius $R$. There is a magnetic field of magnitude $B$ parallel to the axis of the cylinder. Calculate the emf induced between the open ends of the wire knowing that the rate of winding is $N$ turns per second.



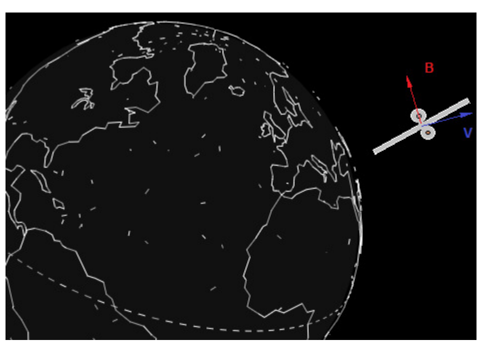

**Solution:** Faraday's law: $emf = -\frac{d\phi}{dt} = -\frac{dNBA\sin\angle_A^B}{dt} = -NB\pi R^2$

**Problem 2.-** A copper ring has a resistance R=0.15Ω, a radius r=0.25m and is in a constant magnetic field B=0.9 tesla perpendicular to the plane of the ring. Then, the magnetic field is reduced to zero, which induces a current in the ring. Calculate the total charge that passes through a given point in the ring.



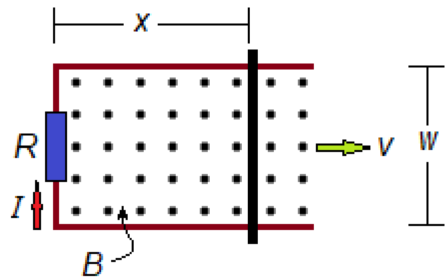

**Solution**: $emf = IR = \frac{dQ}{dt}R = \frac{d\phi}{dt} \rightarrow Q = \frac{\Delta\phi}{R} = \frac{NBA}{R} = \frac{0.9\times\pi\times0.25^2}{0.15} =$ **1.18 C**

**Problem 3.-** Consider a solar panel that has a length of 40m in orbit moving at a speed of 7,900 m/s. Calculate the voltage difference between the ends of the panel if the magnetic field of the earth at a certain instant is 30μT and makes 90 degrees with the panel and its velocity.



**Solution:** $emf = BvL = (30\times10^{-6}T)(7900m/s)(40m) = 9.48$ volts

**Problem 4.-** A circuit is built by connecting a resistance R=2Ω to a conducting wire in the shape of a U with width w = 0.5 m, and a sliding conducting bar that closes the circuit. Consider that this circuit is in a region where the magnetic field is B = 1 T perpendicular to the plane of the circuit and the resistances of the wire and bar are negligible.




a) Calculate the *emf* if the bar moves to the right at a speed v = 10m/s

b) Calculate the induced current in case (a). Is the direction indicated in the drawing correct?

c) Calculate the speed v necessary to induce a current of 0.5 A

d) Is it reasonable to ignore the magnetic field created by the induced current in each case?