# Electromagnetic induction

Brief recall the electromagnetic induction background and related definitions.

**Faraday's law:** Faraday's law states that the induced emf in a closed loop equals the negative of the time rate of change of magnetic flux through the loop. This relationship is valid whether the flux change is caused by a changing magnetic field, motion of the loop, or both.

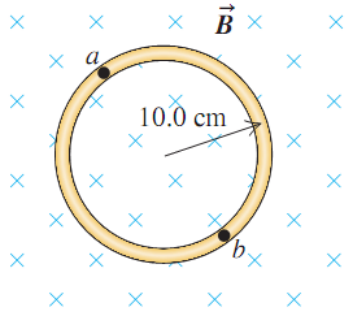
$$\mathcal{E} = -\frac{d\Phi_B}{dt}$$

**Lenz's law:** Lenz's law states that an induced current or emf always tends to oppose or cancel out the change that caused it. Lenz's law can be derived from Faraday's law and is often easier to use.

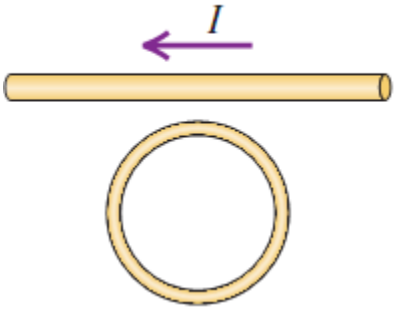
Discuss some main applications of electromagnetic induction in technics and real life.

**APPLICATIONS**

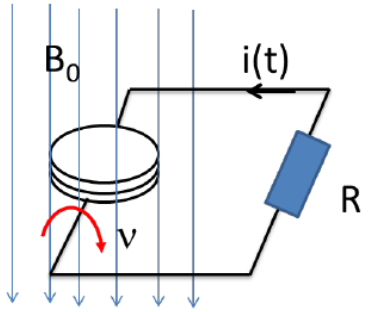
**1/** A circular loop of wire is in a region of spatially uniform magnetic field, as shown in Fig. below. The magnetic field is directed into the plane of the figure. Determine the direction (clockwise or counterclockwise) of the induced current in the loop when (a) B is increasing; (b) B is decreasing; (c) B is constant with value Explain your reasoning.



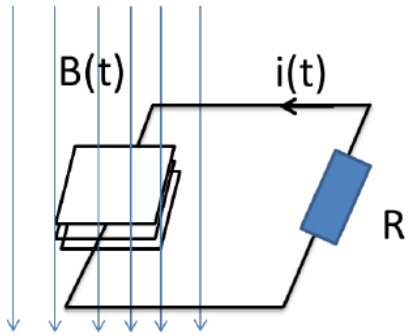

**2/** The current in fig below obeys the equation: $I(t) = I_0 e^{-bt}$ where b>0. Find the direction (clockwise or counterclockwise) of the current induced in the rebound coil for t>0.



**3/** A circular coil composed by N turns of radius r=1cm rotates in a constant magnetic field B=0.1T (see fig) with the frequency f=10Hz. Explain the origin of the induced electromotive voltage and calculate the current intensity in a resistor R=1kOhm connected in the circuit.




**4/** A square coil having the lateral side of 3cm composed by N turns is placed in a perpendicular to the surface time varying magnetic field $B = 0.1\sin(200\pi t + \pi/3)$. Calculate the intensity of the induced current in the circuit if the resistor is R=1kOhm.




**5/** The conducting rod *ab* shown in Fig. below makes contact with metal rails *ca* and *db* . The apparatus is in a uniform magnetic field of 0.800 T, perpendicular to the plane of the figure (a) Find the magnitude of the emf induced in the rod when it is moving toward the right with a speed v=7.5m/s. (b) In what direction does the current flow in the rod? (c) If the resistance of the circuit *abdc* is 1.5Ohm (assumed to be constant), find the force (magnitude and direction) required to keep the rod moving to the right with a constant speed of 7.5m/s. You can ignore friction. (d) Compare the rate at which mechanical work is done by the force ($Fv$) with the rate at which thermal energy is developed in the circuit ($I^2R$).