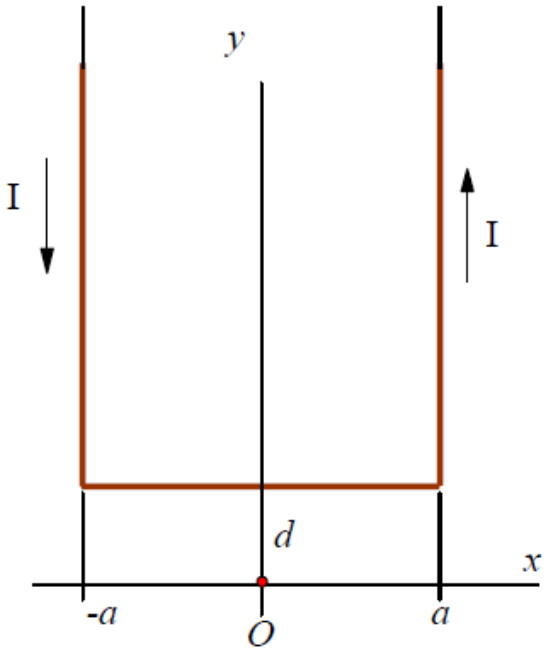
Dr. Sasha

Please, solve this problem and also show the steps to solve it.

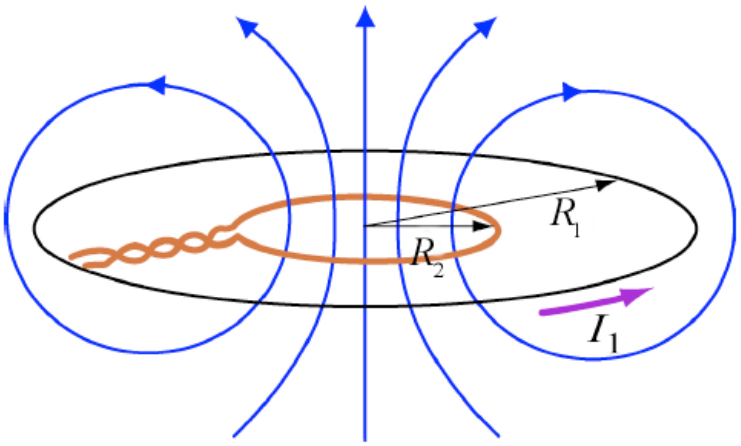
27.05.2015 – N9

1) Determine the magnetic field (in terms of I, a, and d) at the origin (O) due to the current loop in figure below?

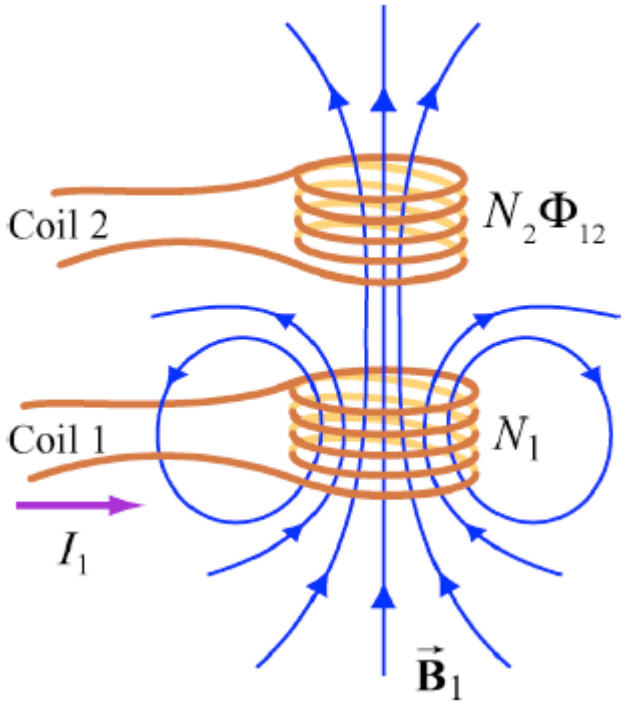


Hint: the Biot-Savart law: $B(r)=\frac{\mu_0}{4\pi}\int_C \frac{I\cdot\left[d\vec{l}\times\vec{r}'\right]}{\left|\vec{r}'\right|^3}$, where $\vec{r}'=\vec{r}-\vec{l}$.

2) Consider two single-turn co-planar, concentric coils of radii R_1 and R_2 , with $R_1 >> R_2$, as shown in figure below. What is the mutual inductance between the two loops?



Hint 1: Suppose two coils are placed near each other, as shown in figure below.



The first coil has N_1 turns and carries a current I_1 which gives rise to a magnetic field $\vec{B}_1$. The second coil has N_2 turns. Because the two coils are close to each other, some of the magnetic field lines through coil 1 will also pass through coil 2. Let Φ_{12} denote the magnetic flux through one turn of coil 2 due to I_1. Now, by varying I_1 with time, there will be an induced emf associated with the changing magnetic flux in the second coil:

$$\varepsilon_{12} = -N_2 \frac{d\Phi_{12}}{dt} = -\frac{d}{dt} \iint_{coil\,2} \vec{B}_1 \cdot d\vec{A}_2$$

The time rate of change of magnetic flux Φ_{12} in coil 2 is proportional to the time rate of change of the current in coil 1:

$$N_2 \frac{d\Phi_{12}}{dt} = M_{12} \cdot \frac{dI_2}{dt},$$

where the proportionality constant M_{12} is called the **mutual inductance**.

3) Find the velocity of a 6 GeV electron.

Hint: $\vec{p} = \dfrac{m_0 \cdot \vec{V}}{\sqrt{1-\left(\dfrac{V}{c}\right)^2}}$.

4) Two rockets of rest length L_0 are approaching the Earth from opposite directions at velocities $\mp c/2$. How long does one of them appear to the other?

5) A body of rest mass m_0 moving at speed v collides with and sticks to an identical body at rest. What is the mass and momentum of the final clump?

6) Show that a photon cannot break up into an electron and a positron.

Hint: the electron and positron are identical particles with four-momenta $\vec{P} = \left(E/c, \vec{p} = \gamma m_0 \cdot \vec{V} \right)$