Dr. Sasha

Result for task N9

2) (mutual inductance**) – rightly**

Result for task N10

6) (Collision an electron with a positron**) – rightly**

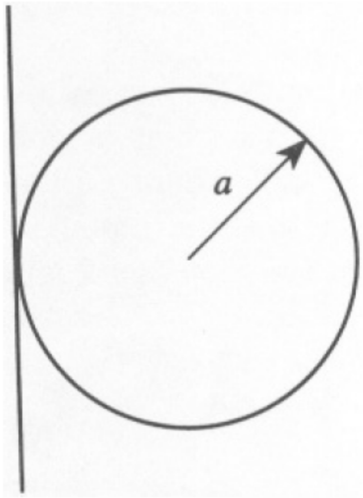
Result for task N11 and N12

All rightly

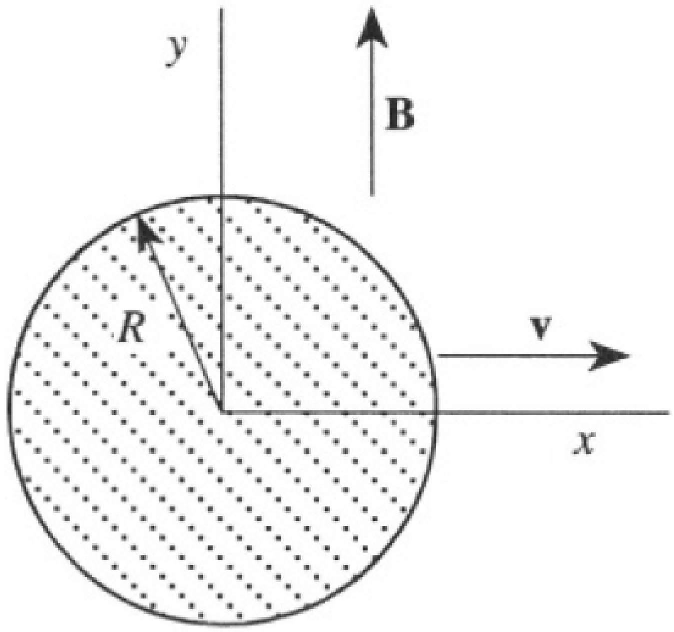
Please, solve this problem and also show the steps to solve it.

3.06.2015 – N14

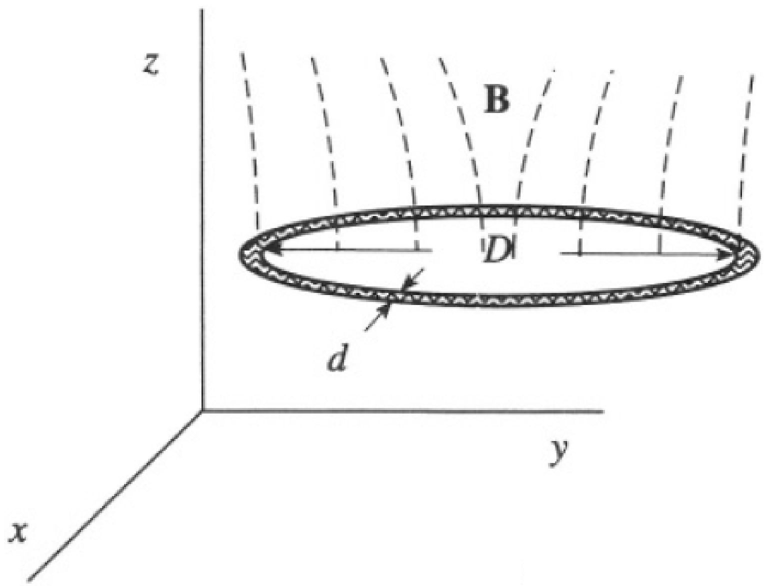
1) A circular wire of radius is insulated from an infinitely long straight wire in a tangential direction (see figure below). Find the mutual inductance..



2) A perfectly conducting sphere of radius R moves with constant velocity $\vec{v} = v\vec{x}$ ($v << c$) through a uniform magnetic field $\vec{B} = B_0\vec{y}$ (see figure below). Find the surface charge density induced on the sphere.



3) A conducting circular loop made of wire of diameter d, resistivity ρ, and mass density ρ_m is falling from a great height h in a magnetic field with a component $B_z = B_0 \cdot (1 + \kappa \cdot z)$, where κ is some constant. The loop of diameter D is always parallel to the $x-y$ plane. Disregarding air resistance, find the terminal velocity of the loop.



4) The wave function

$$\psi(x) = A \cdot x \cdot e^{-\alpha \cdot x^2}$$

Describes a state of a harmonic oscillator $U(x) = \frac{m\omega^2}{2} \cdot x^2$.

a) Using the Schrodinger equation $-\frac{\hbar^2}{2m}\frac{d^2}{dx^2}\psi(x) + U(x)\cdot\psi(x) = \varepsilon \cdot \psi(x)$, determine an expression for α .

b) Determine the energy ε of this state and normalize the wave function.

c) Calculate $\overline{x},\ \overline{x^2}$ and the uncertainty in the position of a particle in this state $\Delta x = \sqrt{\overline{x^2} - (\overline{x})^2}$, where $\overline{x^2} = \int_{-\infty}^{+\infty} x^2 \cdot \psi(x)^2\, dx$

d) Calculate $\overline{p},\ \overline{p^2}$ and the uncertainty in the momentum of a particle in this state $\Delta p = \sqrt{\overline{p^2} - (\overline{p})^2}$, where $\overline{p} = -i\hbar\int_{-\infty}^{+\infty} \psi(x) \cdot \frac{d}{dx}\psi(x)\, dx$.

f) Show that the following Heisenberg's uncertainty relation $\Delta p \cdot \Delta x \geq \frac{\hbar}{2}$ holds. Heisenberg's uncertainty principle tells us that it is impossible to simultaneously measure the position and momentum of a particle with infinite precision for any state.