<u>Tasks Workshop 1 (lecture 1 & 2)</u>

A/

Consider a charged ring with radius R. Where in the symmetry axis through the ring is the field largest?

B/

How does the field depend on the distance from two wires of opposite charge that are parallel and placed on (small) distance, *a*, from each other. Consider at least two different directions.

C/

Calculate the field between two oppositely charged rods paced end to end with an airspace length *d* between them.

D/

Consider the line connecting two oppositely charged spheres with charges q_1 and q_2=-2q_1 at distance d. Where in this line is the field weakest? Is the field zero somewhere else?

D'/

Consider the line connecting two charged spheres with charges q_1 and q_2=2q_1 at distance d. Where in this line is the field weakest?

Tasks Workshop 2 (lecture 3 & 4)

A/

Approximate the electric field from a CRT (the old bulky type computer screen) at a distance of 400mm from the screen. Use the approximation that the screen is circular with diameter = 17”. The potential at the screen is 12000 V.

B/

Calculate the E-field from a circular surface charge of radius R along the symmetry axis. Show that you reach the same result from first finding the potential and then taking the gradient.

C/

Find ways (preferably several) of approximating the order of magnitude of the energy in one lightning in a thunderstorm.

How much does the result from the different methods differ? Discuss.

D/

Calculate the energy in a cylindrical capacitor at a given voltage from CU^2 and from integrating E^2.

E/

What is the capacitance per meter for a double conductor? The radiuses of the wires are 1mm, and they are placed 3mm apart. Assume that isolator material between them has an ε_r of 2,7.

Tasks Workshop 3 (lecture 5 & 6)

A/

Find the field from a quadropole by direct calculation of E from each charge. Work in the simplest non-vanishing field direction.

B/

In a lab coupling we have a coaxial cable with capacitance C_{cable}, connected with a BNC contact in each end. The BNC connections have imperfect contact (most do actually), meaning that we have a resistive layer between the cores and between the shield conductors. How would you model the capacitance of the entire coupling?

C/

Metal detectors often work with electrical fields formed by dipoles (dipole antennas). Assume a dipole with p = 0,025 Cm just above the ground. This detects a nail, 2mm in cross section and 10 mm in length that is placed 1 m down into the soil. What E-field does this nail cause on the ground due the charge distribution the dipole causes in it? Neglect effects caused by the soil.

D/

In an *xyz* coordinate system we have a grounded, conducting plane *z=0* (i.e., the *xy* plane) and a rod along the *z* axis starting at *z=a* and ending at *z=2a* having a charge per length = λ. Find the electric potential.

E/

Calculate a numerical approximation (order of magnitude) on the maximum mechanical torque on a material of 1 cm^3 in volume with ε_r = 5 placed in a homogeneous field E=1MV/m. Hint: Consider geometry and type of material.

Tasks Workshop 4 (lecture 7 & 8)

A/

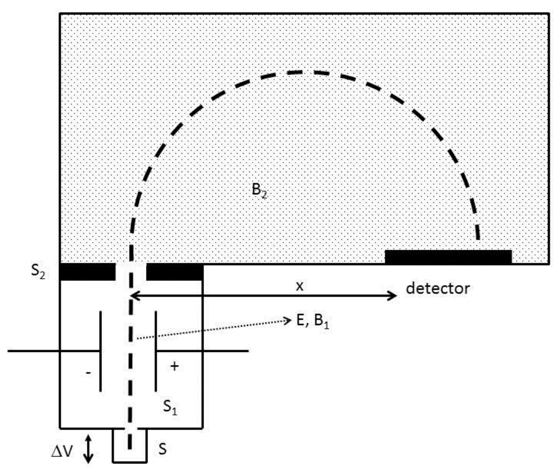
A double conductor is at 10 m height from ground and the two conductors are 0,5 m distance from each other, and the current is 2,5 A in each direction. Where at the ground is the horizontal component of the B-field from the double conductor strongest? What is the horizontal B-field strength there?

B/

A sketch of a commercial mass spectrometer is shown below. It is used to determine the mass of an ion and the composition of gas samples, since it can quantify the amount of species of different masses. In the source S, gas discharge takes place producing an ion of mass *m* and charge *q=+e*. The initially stationary ion is accelerated by a potential difference ΔV, and enters the selector chamber S_1, where there is an electric field and an adjustable magnetic field B_1 pointing out of the paper. Only the particles that have uniform velocity *v* leave the selector, and enter the separator S_2, where there is a second magnetic field B_2, also pointing out of page. These particles then move in a semicircle and strike the detector at a distance *x* form the entry slit.

(a) What magnetic field B_1 is needed to insure that the particles travel straight through?

(b) Find an expression for the mass of the particles after it has hit the detector at a distance x from the entry slit.



C/

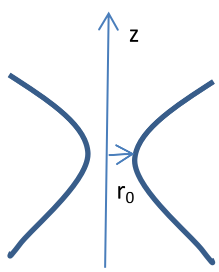
We want to make a copper wire of diameter *d* levitate using the earth magnetic field. How large current density must the wire carry and in which direction must it flow? When the wire is floating how much power will be dissipated per cubic centimeter? (Assume that you are at the Earth's equator, the magnetic field is horizontal and points north and has a magnitude of 0.5×10^{-4} T. The wire lies in a plane parallel to the surface of the Earth and is oriented in the East-West direction. The density of copper is 8.9×10^{-3} kg m^{-3} and its resistivity is $1.68 \times 10^{-8}\,\Omega$m.

D/

A lamp filament with known resistivity, ρ, has a length L and radius given by

$$r = r_0\sqrt{1+\left(\frac{z}{L}\right)^2} \quad \text{for} \quad -L < z < L$$

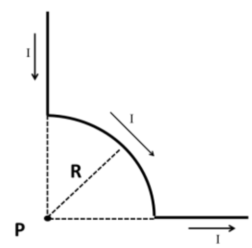
Find the power per length and the total power dissipated in the filament when the voltage U is put over it.



Tasks Workshop 5 (lecture 9 & 10)

A/
Find the magnetic field from a circular current loop at a point in the plane of the loop and one diameter to the side of the center of the loop. Compare with the electric dipole at the corresponding place.

B/
Find the magnetic field at the point P due to the following current distribution.



C/
Moving a square current loop into a magnetic field (as the book does in section 7.1.3) is a very common way to derive

$$EMF = -\frac{d\Phi}{dt}$$

Do the same for a square loop rotating in an homogeneous field, using the fact that mechanical power can be expressed as momentum times angular velocity (instead of force times velocity as the book does)

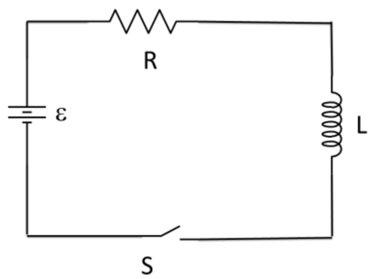
D/
On the old type of electrical stove hotplate heating is done by leading the current in spirals from the center and out. Find the typical value the magnetic field just above a 1000 W hotplate where the spiral covers the area from radius 15 mm to radius 85 mm and has 200 turns (equally distributed). The hotplate is not ferromagnetic (some are and some are not) and you can disregard the fact that alternating current is normally used.

E/
Suggest the geometry of a coil that can produce 100 V just by rotating in the earth magnetic field. Number of turns per minute is maximized to 3000.

Tasks Workshop 6 (lecture 11 & 12)

A/

In a circuit with a large induction (see drawing) a switch controls the current. Is a spark more likely to be produced when the switch is being closed or when it is being opened or it does not matter? Motivate your answer.



B/

Card readers are, in principle, made from a small coil reading the field of the cards permanent magnetization. The coil is connected to a device that can measure either voltage or energy (see it as voltage *x* current *x* time). One is often directed to pull the card fast through the reader. How does doubling the speed affect the voltage and the energy?

C/

Buying a permanent magnet often means that you have to read something like: “This magnet can give a magnetic field of 120 mT”. What can that mean? (It can mean two different things)

D/

A light bulb puts out 100 W of electromagnetic radiation. What is the time-average intensity of radiation from this bulb at 1m from the bulb? What are the maximum values of the electric and magnetic field at the same distance from the bulb?

E/

Find the wavelength and propagation speed in copper for radio waves at 1 MHz. Compare the corresponding values in air (or vacuum). Does it make sense to talk about the propagation speed in a metal? (Copper resistivity: $1.68 \times 10^{-8}\ \Omega$m)