Elektrodynamica

(22/06/2012 (9u30u-14u))

Om ambiguïteit in terminologie te vermijden zijn de vragen in het Engels opgesteld. Als je bepaalde woorden of vragen in het Nederlands wilt vertaald krijgen, kan je dit om het even wanneer komen vragen. Het examen is mondeling met schriftelijke voorbereiding.

1 Give a brief answer to the following questions and explain clearly and precisely why your answer is correct.

(a) The net force on an electric dipole in a background electrostatic field $\vec{E}$ can be written as $F_x = \vec{p} \cdot \vec{\nabla} E_x$, and similarly for F_y and F_z. Alternatively, it can be written as $\vec{F} = -\vec{\nabla} U$, where $U = -\vec{p} \cdot \vec{E}$ is the potential energy of the dipole. These two alternative expressions are not identical. Can you nevertheless reconcile them?

(b) A lightbulb is placed in series with an inductance and an AC voltage source. When the frequency of the AC voltage is increased, will the light get brighter or darker?

(c) I'm holding a jumping rope (*springtouw*) made entirely of copper in my hands and start jumping (I mean the thing people usually do with jumping ropes), somewhere on the surface of the earth. A current will flow through my body. Explain why.

(d) A glass of water is put in front of a bright white light. Some drops of milk are added to the water. What will happen to the color of the transmitted light?

(e) My sunglasses block horizontally polarized light. The sun is rising in the east and I am looking south. Does the sky look brighter or darker when I tilt my head to the right?

(f) The dipole moment of some object is constant over time. Can it emit any radiation?

2 An (ideal) electric diple is fixed at the origin and points in the z-direction. An electric point charge is released from the point $(x, y, z) = (R, 0, 0)$ with zero initial velocity. Show that the particle will swing back and forth along a trajectory of constant radius $r = R$.

Hint: First prove that in general $\frac{d^2}{dt^2}\left(\frac{r^2}{2}\right) = v^2 + \vec{r} \cdot \vec{a}$, *then use conservation of energy and Newton's law for the case at hand.*

3 Compute the total angular momentum stored in the electromagnetic field of a particle with magnetic moment $\vec{m}$ and electric charge e. You can put a cutoff at some small radius r_0.

4 (The following is a somewhat open question. The less time you take to prepare, the less I except here.) Describe, in as much quantitive detail as you want, the fate (*het lot*) of a classical electron circling around a proton.