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FYS-1400 Optics   **Final Examination 21.05.2015**
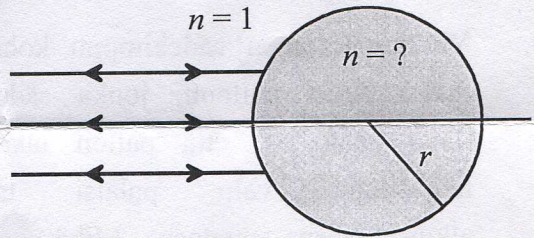
Martti Kauranen

Allowed in the examination: A3-size (or 2 x A4) hand-written notes (to be returned with the exam), calculator (can be also programmable), mathematical tables.

1. Define the meaning of the following concepts as briefly as possible: a) Brewster angle, b) Poynting vector, c) Far point, d) Birefringence, e) Group velocity, f) Etalon.

2. Explain briefly but accurately:

   a) An object is placed in space so that it experiences a force due to radiation pressure. The goal is to maximize the force. Is it better to coat the object to be fully reflecting, fully absorbing, or something in between in order to achieve this? Justify your answer.

   b) The magnification of a Keplerian telescope is 5x. What happens when the telescope is used in the wrong orientation, i.e., with the objective close to the eye?

   c) Which two important issues are affected by the f-number (f#) regarding the performance of optical devices?

3. A parallel beam of rays is applied on a dielectric ball with radius r. The goal is that the light reflected from the back surface returns exactly in the opposite direction. What must the index of refraction of the ball be for this to happen when the index of refraction of the surrounding material is 1? Estimate also, which fraction of the light energy is reflected back if the back surface is coated with a fully reflecting material. Paraxial treatment is sufficient.

4. Consider scattering of light by atoms with a single strong resonance at the wavelength of 800 nm. The atoms can be described by the simples Lorentz model. The atoms are illuminated with light with constant polarization and the irradiance of the scattered light is measured at a certain constant direction. Calculate the ratio of the intensities of scattered light for the wavelengths of 850 nm and 500 nm.

5. The wavelength of a helium-neon laser is 632,8 nm. The beam diameter is 2 mm and the intensity distribution even (top-hat profile). The laser is used to draw a marking grid on a wall. The required precision is 5 mm. How large can the room be?

Remember to give feedback through the Kaiku system, so that your grade is recorded.

Suomenkieliset kysymykset kääntöpuolella