Modern Physics (PHY 3305) Lecture Notes

HomeworkAssignment003

SteveSekula, 4 February 2010 (created 3 February 2010)

Expectations for the quality of your handed-in homework are available at http://www.physics.smu.edu/sekula/phy3305 /homework.pdf. Failure to meet these guidelines will result in loss of points as detailed in that document. This assignment covers material from Harris Ch. 3.1-3.6 and 4.1-4.2. It is worth 100 points.

no tags

- HARRIS, *CH3-2* (10 Points)
- HARRIS, *CH3-25* (20 Points)
    - if you write a computer program to solve this, or devise a computational method to solve this, you must turn in the code/files used to obtain the answer
- HARRIS, *CH3-36* (20 Points)
- *SS-6* (see below)
- HARRIS, *CH4-4* (10 Points)
- *SS-7* (see below)

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PROBLEM *SS-6* (20 Points)

A "solar sail" is a large, lightweight, highly reflective device which has been proposed as a means for cheap transport in space (one is featured in Star Wars: Attack of the Clones - it is
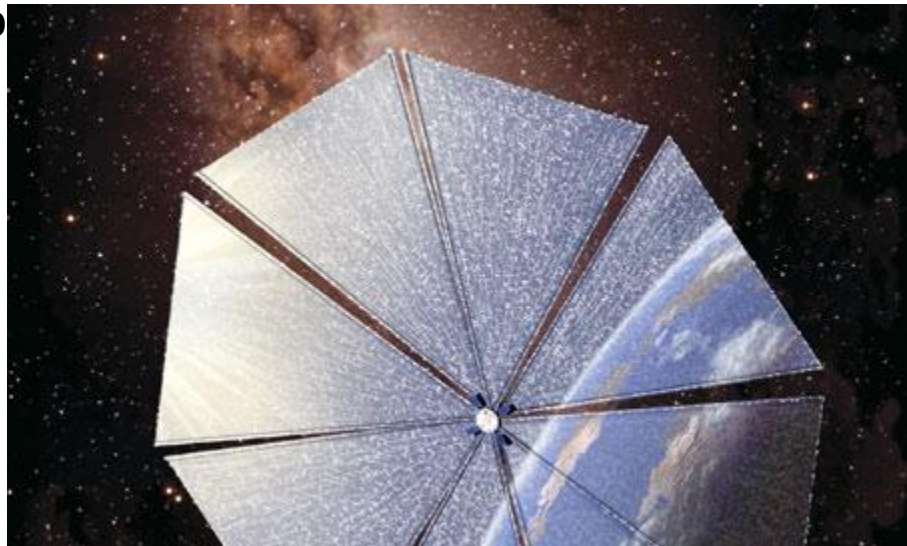
Count Dooku's escape ship). The sail is unfurled and reflects starlight. The theory is that since light carries momentum, its reflection off the sail exerts force on the sail and pushes the ship.

1. The light emitted by our sun is "white light" - that is, it contains all visible light wavelengths. Make the simplifying assumption that the wavelength is 550nm - the middle of the visible spectrum. If the power of sunlight reaching the Earth is 1.5kW/m^2, how many photons per second hit a solar sail that has an area of 0.25km^2?
2. If the solar sail reflects all incident light completely, what force would sunlight exert on the sail?
3. Assume that the mass of such a solar sailing ship is 9000.0 kg. If you could sustain the power on the sail at the level of 1.5kW/m^2, how long would it take to accelerate the ship to 0.5c?

PROBLEM *SS-7* (20 Points)

This problem is a variation of Harris, *CH4-25*.

The question of whether or not we can treat a single atom using classical physics, or whether we should apply quantum physics, is important to making progress on understanding and manipulating atomic structure. We will try to address this question here.

1. Consider a Hydrogen atom. This is composed of a proton at the center (the nucleus), orbited by an electron. Let us think about the atom classically for a moment. If we are to treat the atom classically, we must think of the electron in orbit around the proton, attracted to it by the Coulomb force. How fast must the electron be moving in order to maintain the measured distance between the electron and the proton, 0.1nm?
2. What is the wavelength of this electron?
3. In order to treat the atom as a classical object, its wavelength must be smaller than the dimensions of its orbit; if the wavelength is comparable, or larger, then we cannot think of the electron as a particle orbiting another particle. Compare the wavelength of the

electron to the radius of its orbit. Can we treat the Hydrogen atom
classically?