Homework #7 (due Oct. 21)

Each problem is 10 points

Textbook problems: 9.1, 9.6, 9.10

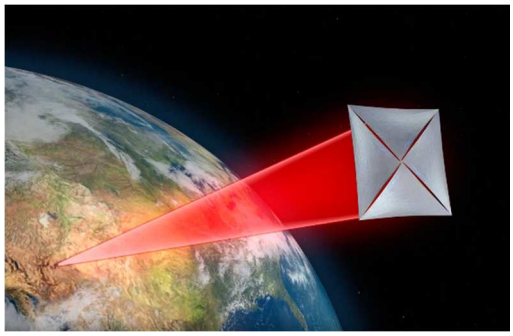
Problem 9.1: Titanium oxide has refractive index 2.35. Calculate the velocity of light in this material and its characteristic impedance. What does the wavelength of light from a laser of wavelength 633nm change to when it enters the oxide?

Problem 9.6: Calculate the amplitude reflection and transmission coefficients using Fresnel's equations for light incident at 30^o on an air/glass surface.

Problem 9.10: Suppose the refractive index of the XMM-Newton Mirror gold surface is 0.999 at X-ray wavelength. At what angles of incidence will the X-rays be totally internally reflected in air?

A1. A linearly polarized microwave of wavelength 1.50cm is directed along positive z axis. The electric field vector has a maximum value E_0=175V/m . Assuming the magnetic field component of the wave can be written in the form $B=B_0 sin(kz-\omega t)$, give values for B_0, k and ω. If the wave were directed at normal incidence onto a perfectly reflecting sheet what radiation pressure would it exert?

A2. An astronaut, stranded in space 10m from her spacecraft and at rest relative to it, has a mass of 70kg. Because she has a 100W flashlight that forms a directed beam, she considers using the beam as a photon rocket to propel herself continuously toward the spacecraft. Calculate the time required for her to reach the spacecraft by this method.



Bonus question (extra credit, do after A2): Stephen Hawkins, Yuri Milner and Mark Zuckerberg are considering sending a nanocraft with a laser sail to Alpha Centauri. Google the details of "Breakthrough Starshot" projects for details. Imagine that you are an optical engineer who is hired to design the laser system for this project. Give your best estimate of how much laser power it will require. In your opinion, is this project realistic?