Physics 262: Final Exam
100 points

1. (10 points) A ray of light passes through a glass (n=1.5) equilateral prism. The ray inside the prism is parallel to one side of the prism.

   (a) (5 points) Draw the prism and the ray and label the angles that correspond to the incident and refracted ray on both interfaces.

   (b) (5 points) Calculate the angles of incidence and refraction. Take the calculation as far as you can without a calculator.

2. (10 points) An extended object is located to the left of a plano-convex lens at a distance equal to 2 times the focal length. Use 3 principle rays to show the location of the image. Calculate the magnification in terms of the focal length f.

3. (20 points) Two particles have equal rest mass, m. In the first reference frame, one particle is at rest and the other moves at 0.5c.

   (a) (5 points) What is the total momentum of the system in the first reference frame?

   (b) (5 points) What is the total energy of the system in the first reference frame?

   (c) (10 points) Calculate the speed of a second reference frame relative to the first in which both masses move at the same speed.

4. (20 points) A photon with wavelength 400 nm liberates an electron from a metal that has a work function of 2 eV.

   (a) (10 points) What is the wavelength of the ejected electron?

   (b) (10 points) The ejected electron passes through two slits in an opaque screen that are separated by a distance of D. What is the angular width of the central diffraction peak? Write the expression in terms of λ, but don't put in numerical values.

5. (10 points) Muons have a lifetime of $\tau = 2\mu$s in their rest frame. If they are accelerated to 0.8 c in a particle accelerator, what is the observed lifetime?

6. (10 points) A free particle wavefunction is given by $\psi(x) = Ae^{ikx}$. Use the Schrödinger equation to find the energy as a function of the wave number, k.

7. (5 points) A sinusoidal electromagnetic wave has a magnetic field amplitude of 1 μT. What is the electric field amplitude? What is the intensity?

8. (5 points) A helium atom (Z=2) is ionized so that one electron remain. What is the wavelength of the photon emitted in a transition from the first excited state to the ground state?