1) (20 pts) Find the frequency of revolution of a proton with an energy of 50 eV in a uniform magnetic field of magnitude 300 mT with its velocity perpendicular to the field. (The mass of a proton is $1.67 \times 10^{-27}$ kg. The charge of a proton is $1.6 \times 10^{-19}$ C.)

Calculate the radius of the path of this proton.
2) (25 pts) The wire shown in this figure lies in a uniform magnetic field. Each straight section is 1.5 m long and makes angles $\theta_1=45^\circ$ and $\theta_2=30^\circ$ with the x-axis. The current in the wire is 2 A. What is the net magnetic force on the wire if the magnetic field is $2.0 \hat{k}$ T?
3) (25 pts) In this figure, a 2-m long vertical pole extends from the bottom of a swimming pool to a point 50 cm above the water. Sunlight is incident at an angle $\theta = 40$ degrees. What is the length of the shadow of the pole on the level bottom of the pool? (the index of refraction for water is 1.3)
4) (15 pts) Sketch 2 rays for each of these mirrors or lenses. Identify whether the image is real or virtual and upright or inverted?
5) (15 pts) In this figure, a real inverted image I of an object O is formed by a certain lens (not shown); the object-image separation is 30.0 cm, measured along the central axis of the lens. The image is one-third the size of the object.

a) What kind of lens must be used to produce this image?

b) How far from the object must the lens be place?

c) What is the focal length of the lens?