Physics 7C Second Midterm: Lecture 2

Tuesday November 8, 2005

Answer all questions. They carry equal weighting. Write neatly and show all work. Cross out any work you do not want graded. Setting up the problem correctly is more important than completing the algebra, so if you are running out of time make sure to have the setup correctly, then write in words the next steps of the calculation for partial credit.

1) A double slit, with slits of width 0.06mm and separation 0.6mm is illuminated by light of wavelength 600nm, and the resulting interference/diffraction pattern is observed on a screen 6m away.

   What is the number of interference maxima within the central diffraction lobe? Sketch the shape of the patten.

2) Two spaceships, each 100m long when measured at rest, travel toward each other with speeds .85c relative to the Earth.

   a) Draw the space time diagram in the frame of the earth, indicating the worldlines of the beginning and the end of each ship.

   b) How long is each ship, measured in the frame of the Earth? Draw on the space time diagram the ships at one instant in Earth's frame.

   c) How fast is each ship traveling as measured from the rest frame of the other?

   d) What is the length of each ship as measured from the rest frame of the other?

   e) At time t=0 on Earth, the fronts of the two ship reach the same position. At what time (on Earth) do their ends pass?

   f) How much time in the rest frame of either ship, does it take for the ships to pass one another?

3) A space ship of mass M travels at speed V_0 relative to the earth. At one instant, it propels itself by ejecting mass m of fuel at speed $c/2$ relative to the ship.

   a) Use energy-momentum conservation to compute the speed of the ship in the original rest frame (frame moving with speed V_0 relative to earth) after it has ejected fuel.

   b) Use lorentz transformation of velocities to find the speed of the ship relative to earth after ejecting mass m.

4) A student in a lab is studying photo-electric effect for Cesium. He measures 2 data points: At wavelength 430 nm the stopping potential is 1 V, and at wavelength 550 nm, the stopping potential is 0.4 V. What values of the threshold frequency, work function for cesium and value for Plank's constant h should the student estimate from this?