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PHYS-309(3) (Kaldon-48499)
 WMU - Spring 2004
 Exam 1 - 100,000 points

309

Name _____

Book Title _____

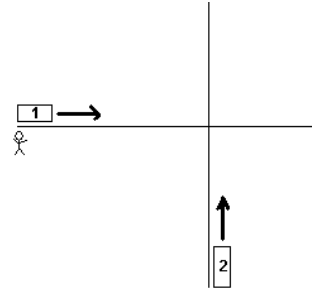
1/28/2004

State Any Assumptions You Need To Make – Show All Work – Circle Any Final Answers
Use Your Time Wisely – Work on What You Can – Be Sure to Write Down Equations
Feel Free to Ask Any Questions

For all problems, use $c = 3.00 \times 10^8$ m/s.

“Oh no! The trains are going to crash!” (50,000 points)

1.) At time $t = t' = 0$, an observer O on Earth sees a relativistic train go by at $0.910c$. 25,000 meters down the tracks to the east, there is a crossing with another relativistic railroad at $x=y=0$, and 25,000 meters south of that crossing is a second relativistic train traveling north at $0.910c$, as shown. In classical physics, the two trains will crash. Now let's change to the P.O.V. of the engineer O' on the first train, who is at $x'=y'=0$ at the beginning of the problem. Find the coordinates (x', y', t') of the crossing at (a) the beginning of the problem and (b) when the engineer sees the crossing go by.



Find the velocity vector \vec{u}' at (c) the beginning of the problem and (d) when the engineer sees train 2 reach the crossing.

Find the coordinates (x', y', t') of train 2 when it reaches the crossing. (Is train 1 there at the same time, according to the engineer?)

“I can't see the train, the headlight is too bright!” (50,000 points)

2.) At time $t = t' = 0$, an observer O on Earth sees a relativistic train go by at $0.910c$. The engineer on the train measures the wavelength of the filtered sodium vapor headlight to be $\lambda = 555 \text{ nm} = 555 \times 10^{-9} \text{ m}$. (a) What frequency f does the engineer say that this light has?

(b) When the train is approaching, the observer O sees what frequency and what wavelength of light?

(c) When the train is going away, what frequency and wavelength would the observer O observe? Assume some light from the headlight is shining towards the back of the train...

(d) Find the relativistic momentum, kinetic energy and rest mass energy that the observer O would say the train has. Use $m_0 = 1,000,000 \text{ kg}$ for the train.

(e) What total energy E would the engineer say his train has?