**NAME:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Time Dilation and Length Contraction Worksheet**

**Physics 205**

**Prof. Singal**

Anna is on a train and Bob is on the ground. Suppose that the train is traveling with a speed *v* such that γ=1.5.

1. Anna measures the time period for one oscillation of a quartz crystal in a digital timepiece to be 6 nanoseconds (call it ΔtA). What time period ΔtB does Bob measure for this?

2. Now Anna stops the train, gives Bob the crystal to hold and then Anna gets back on the train traveling with a speed *v* such that γ=1.5. Now what time period do each of them measure for one oscillation?

Anna rides the train again at the same speed, and Bob stands on the side, holding a long rod

along the direction of the train tracks. Bob measures the rod to have length L0. Bob sees Anna

traveling past at speed *v*. Events “C” and “D” are Anna’s nose being even with the left and right

ends of the rod, respectively. Bob measures the time between event C and event D as ΔtB.

.

1. In Anna’s frame, what is the time between events C and D, in terms of γ and Bob’s ΔtB?

(Think about which of the two observers now measures the *proper time* between the two events?

2. What does Anna infer is the length L of the rod?

3. Bob’s measurement, L0, is the “proper length” of the rod. Write a definition of “proper

length” that highlights why Bob’s measurement is different from that made in any other

reference frame.

4. What does Anna say her speed *v* is? (Same as what Bob measures, bigger, or smaller?) Her measured speed is *u*=L/ΔtA and Bob’s measured speed is *u*=L0/ΔtB.