PH 429/529 **HW #2** Spring 2006

Due Friday, 14 April 2006

0. PRACTICE *(You do not need to turn these in.)*

(a) Problem 12.7 on p. 488 of Griffiths.

(b) Problem 12.8 on p. 489 of Griffiths.

(c) Problem 12.9 on p. 493 of Griffiths.

(d) Problem 12.13 on p. 498 of Griffiths.

1. **THE GETAWAY**

The outlaws are escaping in their getaway car, which goes $\frac{3}{4}c$, chased by the police, moving at only $\frac{1}{2}c$. Realizing they can't catch up, the police attempt to shoot out the tires of the getaway car. Their guns have a muzzle velocity (speed of the bullets relative to the gun) of $\frac{1}{3}c$.

(a) Does the bullet reach its target according to Galileo?

(b) Does the bullet reach its target according to Einstein?

(c) Verify that your answer to part (b) is the same in all four (!) reference frames: ground, police, outlaws, and bullet.

This is a combination of Problems 12.4 and 12.15 on p. 483 and p. 498 of Griffiths, respectively. You may answer part (c) using the table on p. 498.

2. **ANGLES ARE NOT INVARIANT**

(a) The mast of a sailboat leans at an angle θ (measured from the deck) towards the rear of the boat. An observer on the dock sees the boat go by at speed $v \ll c$ (so that you do ***not*** need to use relativity to do this problem). What angle does the observer say the mast makes?

(b) A child on the boat throws a ball into the air at the same angle θ. What angle does the observer on the dock say the ball makes with the deck?

Ignore the subsequent influence of gravity on the ball — this question is only about the initial angle when the ball leaves the child's hand. You may wish to first consider the following special case: Suppose that the horizontal component of the ball's velocity exactly cancels the forward motion of the boat. What angle does the observer see?

(c) A spaceship goes past the dock at speed V. An antenna is mounted on the hull at an angle θ with the (horizontal) hull. What angle does the observer on the dock say the antenna makes?

(d) A spotlight is mounted on the spaceship so that its beam makes an angle θ with the hull. What angle does the observer on the dock say the beam makes with the hull?

(e) Briefly discuss the differences (if any) between your answers to these questions.

This problem is based on Problems 12.10 and 12.14 on p. 493 and p. 498 of Griffiths, respectively.

(CONTINUED ON BACK)

3. **THE TWIN PARADOX I**

Do Problem 12.16 on p. 499 of Griffiths.

Be especially careful to note that the origins of all three coordinate systems are at the point of departure, ***not*** *at the turnaround point.*

4. **THE TWIN PARADOX II**

Consider the same scenario as in the previous problem.

(a) Draw a single spacetime diagram showing the entire trip in the reference frame of the stay-at-home twin. Your diagram should show the world lines of both twins.

(b) The traveling twin's path consists of 2 segments: 1 outbound, and 1 inbound. Determine the "squared length" (interval) of each segment.

(c) Draw in the lines of constant t, t', and t'' which pass through the event of the traveling twin turning around. These lines divide the world line of the stay-at-home twin into 4 segments. Determine the "squared length" (interval) of each segment.

(d) Compare the intervals just computed with the clock readings computed for the previous problem. Can you deduce a statement analogous to:

The shortest distance between 2 points is a straight line

which applies here? hw3