PHY 201 (Concepts of Physics)

Problem Set 3 assigned 6.11.12

due in tutorial, 15.11.12 (3 pages, inc. figure)

1 I stand on Earth holding a metre-stick, while my twin brother travels on a spaceship moving at nearly the speed of light, holding an identical metre-stick. Which of the following statements, if any, is true?

a In my reference frame, my twin's metre-stick appears shorter than mine

b In my reference frame, my twin's metre-stick appears longer than mine

c In my twin's reference frame, my metre-stick appears shorter than his.

d In my twin's reference frame, my metre-stick appears longer than his.

2 Which of the following questions could have different (correct) answers in different reference frames?

a Flash 1 occurred before flash 2.

b The light from flash 1 reached Joe before the light from flash 2 did.

c Spaceship 1 is at rest.

d Spaceship 1 is at rest with respect to spaceship 2. (Assume neither spaceship is accelerating.)

e A signal travelling at twice the speed of light would have arrived in time for Joe to act upon the information.

f A signal travelling at the speed of light would have arrived in time for Joe to act upon the information.

3 The graph on slide 5 of lecture 12 is actually wrong. Both reference frames agree that an event occurring "here" (x=0) and"now" (t=0) is at the origin of the graph -- the x=0 and t=0 linescross at the same point as the x'=0 and t'=0 lines. At other times,they have different definitions of "here" (x'=0 no longer coincideswith x=0), and at other places they have different definitions of "now"(t'=0 no longer coincides with t=0).Following the x=0 and x'=0 lines up (remember that each one represents the path or "worldline" followed by one of the observers), determine which clock each observer thinks ticks more slowly, by seeing whether you cross the successive "t" lines or the successive "t'" lines first. Now, following the t=0 and t'=0 lines to the right (these represent all the events the observers consider to be "now"), determine which ruler each observer thinks is longer, by seeing whether you cross the successive"x" lines or the successive "x'" lines first. What is wrong with the graph?

5 The figure on the following page shows the "worldlines" of two ships which start a distance d apart, and accelerate (jerkily) in unison, from the point of view of an observer on earth (the reference frame as drawn). From the point of view of an Earth-bound observer, their distance remains constant. At some time later than t=0, draw the time and space axes ("here lines" and "now lines," as I've been referring to them in class) for both ships. Consider how far ship 2 has moved, at this "instant" from the perspective of ship 1; and how far ship 1 has moved at this "instant" from the perspective of ship 2. Are they the same or different? If different, which one is larger? Does ship 1 think the distance between the two ships is remaining constant, growing or shrinking? What does ship 2 think?

6 In Newtonian mechanics (which obeys Galilean relativity), forces may depend on which of the following? (Check all which apply.)

a. positions

b. velocities

c. accelerations

7 Magnetic forces depend on which of the following? (Check all which apply.)

a. positions

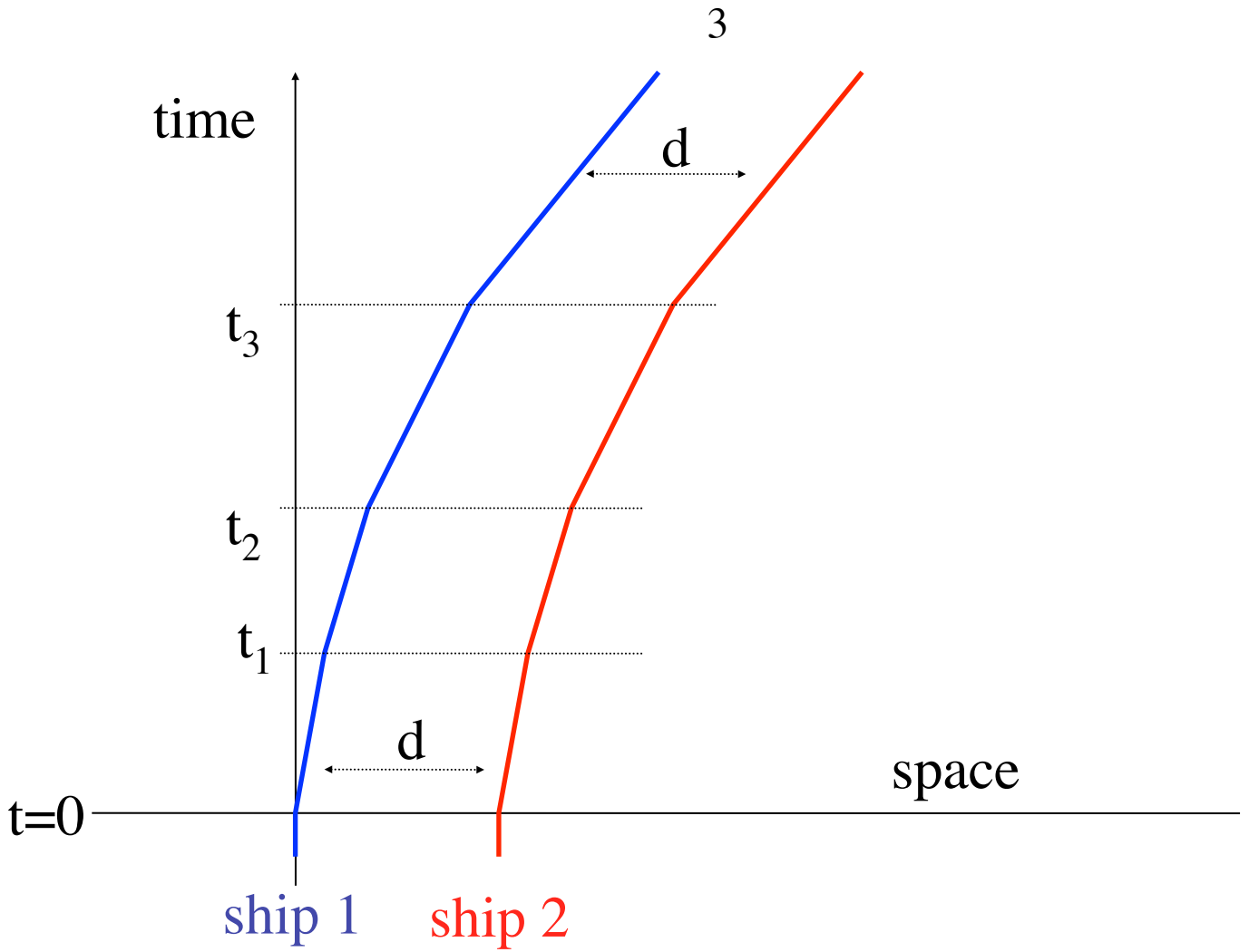
b. velocities

c. accelerations

8 Have gravity waves been directly observed? If so, how? Have they been indirectly observed? If so, how?

9 State in 2-3 sentences what the observational effects of the curvature of spacetime are, and what determines the curvature.

10 It takes energy to split a molecule of water into two Hydrogen atoms and one Oxygen atom. If I could weigh water, Hydrogen, and Oxygen extremely accuracy, would I find that the mass of the water molecule is (the same as / greater than / less than) the mass of two Hydrogen atoms plus the mass of one Oxygen atom?


time
d
t_3
t_2
t_1
d
space
t=0
ship 1
ship 2