Physics 262 Exam 4 Fall2010

1] A ruler on earth makes an angle of 45° with respect to horizontal. To the nearest 10°, what angle does it make in the frame of a spaceship traveling at 0.9 c horizontally?

Two lightning strikes occur on South Sandia and North Sandia Peak, which are separated by 30 km on the Earth. According to an observer on the Earth, the lightning on the North Peak struck 0.2 microseconds before the lightning on the South Peak (after accounting for light travel time.)

2] Is there any inertial reference frame in which the strikes are simultaneous?
A] yes, a northward-moving frame
B] yes, a southward-moving frame
C] yes, an eastward-moving frame
D] yes, a westward-moving frame
E] no

3&4] What is the speed of a frame (in m/s) in which the strikes are simultaneous? (OR enter 0,0 for no simultaneous frame.)

5]A spaceship moves at 0.7 c from A to B, a distance of 5 light years. How much time, to the nearest year, elapses on the spaceship clock during this trip?

6]The spaceship launches a small probe toward B as the ship passes A. The speed of the probe relative to the spaceship is 0.7 c. How long, to the nearest year, does the probe take to make the trip to B *on its own clock?*

7&8] A relativistic train has a rest length of 1 km. It moves into a tunnel with length 0.98 km. With what minimum speed must it move if (in the Earth's frame), doors at both ends of the tunnel can be closed simultaneously while the train is inside? Answer in m/s.

9] How does an observer *on the train* "explain" the closing of the tunnel doors *in her frame*?
A] The tunnel is not in absolute motion, so there is no length contraction of the tunnel
B] The entrance door of tunnel closes, and then opens before the exit door closes.
C] The exit door of the tunnel closes, and then opens before the entrance door closes.

10] An astronaut travels from Earth to a distant planet Zeta (which is stationary in the Earth's frame.) The Earth and the distant planet have synchronized their calendars. When the astronaut arrives, he has aged 5 years, but the planetary calendars have advanced 10 years. But while he was in motion, he noticed that the clocks on all planets he passed (all stationary wrt Earth) were moving at *half speed,* not at twice normal speed. How is this possible?

A] Since only the astronaut is in motion, only *his* clock really changes from true time.
B] While in inertial motion, the astronaut notices that clocks in the Earth frame are not synchronized: the clocks closer to Zeta are ahead of clocks closer to Earth.
C] While in inertial motion, the astronaut notices that clocks in the Earth frame are not synchronized: the clocks closer to Zeta are behind clocks closer to the Earth.

11] Two events are separated by a spacetime interval of 578*i*. (in light seconds)
This interval is
A] spacelike
B] lightlike
C] timelike

12&13] If, in one reference frame, these events occur 10 s apart, what is their spatial separation, in light seconds?

14&15] What is the largest possible spatial separation, for any observer? (Enter 0,0 for 0 and 0,1 for infinity.)

16&17] A light signal of frequency 33 MHz is reflected off a (radio)mirror that is moving toward you at half the speed of light. What is the reflected frequency in Hz?