PH354 - HW1 - Special Relativity: kinematics

SHOW all your works. Put the answers in a BOX.   NAME:_____

1 Calculate the Lorentz factor γ for objects traveling at 76% of the speed of light.

2 Consider a rod of length 31 m. The the same rod is placed on a "train" moving away at speed of 2.87801×10^8 m/s.
2.1 What will be its length observed by you if you stay on the train station?
2.2 What will be its length if you jump on the that train?

3 If you were in train moving a constant speed with no windows, could you sense the difference between uniform motion and rest *or* between accelerated motion and rest?
A. Only accelerated motion can be sensed.
B. Only uniform motion can be sensed.
C. Both accelerated and uniform motion can be sensed.
D. No motion can be sensed.

4 If you were on Earth monitoring a Bob in a rocket ship traveling away from the Earth at a speed close to the speed of light, what changes would you note in his pulse? And on his volume?
A. No changes.
B. Faster pulse and larger volume.
C. Slower pulse and smaller volume.
D. Faster pulse and smaller volume.

5 A spaceship is measured to be 166 m long while at rest relative to the observer. If this spaceship now flies by the observer with a speed $0.96c$, what length does the observer measure?

6 At what speed would you have to move past a 9.36 cm ruler so that you would observe its length to be 4.68 cm? Answer in unit of c.

7 The proper mean lifetime of subnuclear particles called pions is 2.6×10^{-8} s when at rest. A beam of pions has a speed of $0.74c$ respect to a laboratory.
7.1 In the reference frame of the pion, how far does it travel during its lifetime?
7.2 Which distance does it travel according to a person in the laboratory?

8 Anna is watching the stars late at night when she sees a spaceship pass at $0.856c$. 14 seconds pass on Earth while she observes a clock on the spaceship. How much time passes on the spaceship clock?

9 Find the speed relative to Earth of a uniformly moving spaceship whose clock runs 5 s slow per hour compared with an Earth based clock.

10 A star-ship somehow travels at c with respect to the Earth, and it fires a drone which has speed c with respect to the star-ship. What is the speed of the drone with respect to the Earth? Show your work!

11 A space vehicle is moving at a speed of $0.665c$ with respect to an external observer. An atomic particle is projected at $0.624c$ in the same direction as the spaceship's velocity with respect to an observer inside the vehicle. What is the speed of the projectile as seen by the external observer?

12 Two galactic jets of material from the center of a radio galaxy fly away in opposite directions. Both jets move at $0.83c$ relative to the galaxy. Determine the magnitude of the velocity of one jet relative to the other.

13 Time machine 101. You have built a merry-go-around with radius $R = 15$ m and you sit at the rim. If you want to ride for 10 minutes (on your clock) and expect the people outside to age 10 years, what would it be the necessary acceleration to act on your body?