RH = /77; CH1 = CH2 = /70

PHYS 252 TEST #4 Dr. Holmes 4/3/19 NAME **Key**

ANSWER ALL 8 QUESTIONS. THE WORTH OF EACH QUESTION IS AS MARKED. SHOW YOUR WORK FOR PARTIAL CREDIT. Do not round any calculated values to less than 3 significant digits, for example, .992 should not be rounded to 1 or even .99.

1) a) What was the purpose of the Michelson-Morley experiment? [4]

b) Describe the experimental setup for the Michelson-Morley experiment and explain the basic idea on which the experiment is based. [4]

c) What was the result of the experiment? [4]

2) a) Distinguish a proper time interval from a non-proper time interval: [3]

b) Give one example (in a real or in a "thought" experiment) of a non-proper time interval measurement; be sure to say what is being measured and by whom: [3]

c) Is the proper time interval: always smaller than, always larger than, sometimes larger than, or always the same as the non-proper time interval?

[2] **always smaller than**

3) a) Why is c the upper limit for the speed of material objects? [4]

b) If c is the upper speed limit, explain why it is possible for a person who lives less than 100 years to travel distances greater than the 100 light years (assuming the person has a space ship that can go fast enough). [4]

4) Describe TWO REAL (not just thought) experiments (other than the Michelson-Morley experiment) that:
(a) can be explained by special relativity but cannot be explained by the classical theory;
(b) tell how classical theory fails in each case; and
(c) how relativity succeeds in each case:

1. a) [2]

b) [2]

c) [2]

2. a) [2]

b) [2]

c) [2]

5) Two explosions (call them # and $) are seen by observer A: the $ explosion happens 4,000 meters to the right of the #, and the $ explosion happens 7 microseconds before the # explosion. Observer B is moving with a speed of .850c to the right with respect to the A observer.
a) What does observer B measure for the distance between the two explosions?

[4] **10,982 m**. b) Did the $ explosion happen to the right or left of explosion # according to observer B?

[2] **right**. c) What does observer B measure for the time difference between the two explosions?

[4] **34.8×10^{-6} sec**. d) Which explosion happened first (# or $) as determined by observer B?

[2] **$**.

6) a) How fast would a spaceship have to travel for the personnel on the spaceship to age 1 year on the spaceship while the earth observers say the ship has been in flight for 7 years as determined by the earth?

[3] **.990 c**. b) Which of these two times (the 1 year or the 7 years) is the proper time for the aging of the spaceship personnel?

[2] **1 year**.
c) According to the earth observer, how far will the spaceship have traveled during the 7 years?

[3] **6.93 lt yrs**. d) According to the spaceship observer, how far will the spaceship have receded from the earth during the 1 year?

[2] **.990 lt yrs**. e) Which of these two distances (answer to c or answer to d) is the proper length of that section of the galaxy?

[2] **6.93 lt yrs**.

7) A space ship moving at a speed of .850c towards the earth (as measured by both the earth and the spaceship) fires a missile going toward the earth at a speed of .920c relative to the space ship. a) What speed would an earth observer measure for the missile?

[4] **.993 c**.

b) Is the missile going toward the earth or away from the earth?

[2] **toward**.

c) If the missile were fired at a speed of .920c away from the earth (as measured by the spaceship) instead of toward it (with the spaceship still going .850c towards the earth), what speed would the earth observer measure for the missile?

[4] **.321 c**. d) Is the missile now going toward the earth or away from the earth?

[2] **away**. e) If the missile were replaced by a light pulse directed away from the earth, what speed would the earth measure for the speed of the light pulse?

[2] **c**.

8) A photon has energy 3.30 MeV. a) What is the wavelength of light that has photons of this energy?

[3] **3.77×10^{-13} m**. b) What type of light is this (IR, UV, radio, etc.; if visible, what color is it)?

[2] **gamma ray**. c) What is the mass of this photon?

[3] **5.87×10^{-30} kg**.

d) What is the rest mass of this photon?

[2] **0**. e) What is the momentum of this photon?

[3] **1.76×10^{-21} kg*m/s**. f) If an electron had a kinetic energy of 3.30 MeV, what speed would it have?

[3] **.991 c**. g) What would the momentum be for an electron that has a kinetic energy of 3.30 MeV?

[3] **2.02×10^{-21} kg*m/s**. h) What would the wavelength of an electron with this kinetic energy and momentum be?

[3] **3.29×10^{-13} m**.