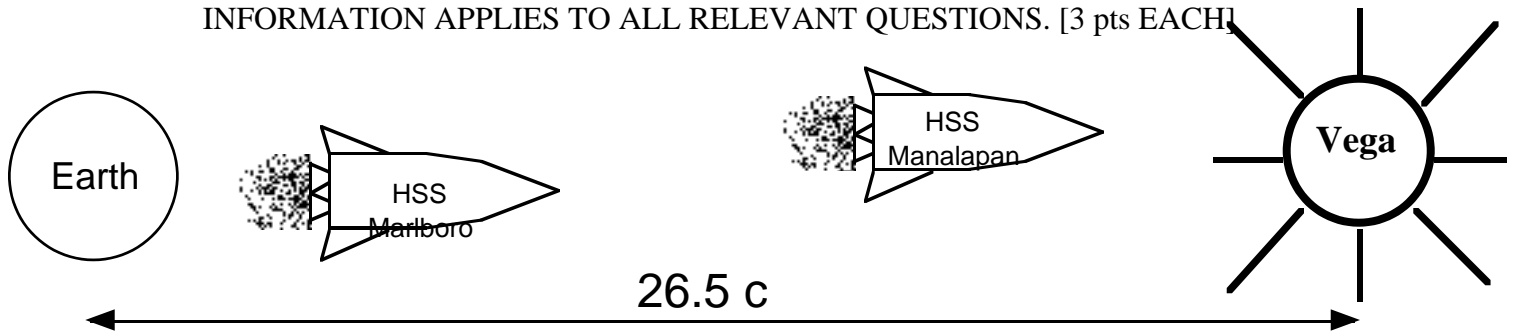


SE PHYSICS TEST - CHAPTER 25 2000-2001

EINSTEIN'S SPECIAL THEORY OF RELATIVITY

ANSWER EACH OF THE FOLLOWING QUESTIONS BEING SURE TO SHOW ALL WORK CAREFULLY!
EACH OF THE FOLLOWING QUESTIONS REFERS TO THE DIAGRAM ABOVE. THE FOLLOWING
INFORMATION APPLIES TO ALL RELEVANT QUESTIONS. [3 pts EACH]



- a. Each rocket has a mass of 196,000 kg, a length of 154.0 meters and a diameter of 18.5 meters while sitting at rest relative to the observer.
- b. The distance between the Earth and Vega is 26.5 light years, as measured by an observer at rest on the Earth. [Assume that there is no relative velocity between the Earth and Vega!]
- c. In October of 2000 Rocket **HSS Manalapan** leaves the Earth for Vega with a velocity of $0.99995c$, as measured by an observer on the Earth. On board Rocket **HSS Manalapan** is an astronaut exactly 24.0 years old at the time of liftoff. The normal, resting pulse rate of this astronaut is 62 beats per minute. After arriving at Vega the astronaut stops and does research for exactly 1.20 years and then returns to the Earth at the same velocity of $0.99995c$.
- d. Exactly 6.0 years later in October of 2006 Rocket **HSS Marlboro** leaves the Earth for Vega with a velocity of $0.988c$ as measured by an observer on the Earth. On board HSS Marlboro is an astronaut exactly 29.0 years old at the time of liftoff.

For each of the following questions assume that it is the year 2004!

1. What will be the diameter of **HSS Manalapan** as measured by an observer on the Earth?
2. What will be the diameter of **HSS Manalapan** as measured by the astronaut on board HSS Manalapan?
3. What will be the length of **HSS Manalapan** as measured by the astronaut on board HSS Manalapan?
4. What will be the length of **HSS Manalapan** as measured by an observer on the Earth?
5. What will be the mass of **HSS Manalapan** as measured by the astronaut on board HSS Manalapan?
6. What will be the distance between the Earth and Vega as measured by the astronaut on board **HSS Manalapan**?
7. How long will it take for **HSS Manalapan** to reach Vega according to an observer on the Earth?
8. How long will it take for **HSS Manalapan** to reach Vega according to the astronaut on board **HSS Manalapan**?
9. What will be the mass of **HSS Manalapan** as measured by an observer on the Earth?
10. What will be the kinetic energy of **HSS Manalapan** as measured by an observer on the Earth?
11. What will be the pulse rate of the astronaut on board **HSS Manalapan** as monitored by the instruments on **HSS Manalapan**?
12. What will be the pulse rate of the astronaut on board **HSS Manalapan** as monitored by instruments located on the Earth?
13. What is the Rest Energy of **HSS Manalapan**?

[Continued on opposite side!]

For each of the following questions assume that it is the year 2012 AD. At which point both rockets are

heading toward Vega!

14. What will be the velocity of **HSS Marlboro** as measured by an the astronaut on board **HSS Manalapan**?
 15. Suppose that **HSS Marlboro** fires a projectile at **HSS Manalapan** with a velocity of $0.965c$ relative to **HSS Marlboro**. What will be the velocity of this projectile as measured by an observer at rest on the Earth?
 16. Suppose that **HSS Marlboro** fires a LASER at **HSS Manalapan**. What will be the velocity of this LASER as measured by an observer on the Earth?
 17. Suppose that **HSS Manalapan** returns fire with a projectile that leaves **HSS Manalapan** with a velocity of $.93c$ [as measured by the astronaut on board **HSS Manalapan**!]. What will be the velocity of this projectile as measured by an observer on board **HSS Marlboro**?
 18. Suppose that **HSS Manalapan** returns fire with a projectile that leaves **HSS Manalapan** with a velocity of $0.985c$ [as measured by the astronaut on board **HSS Manalapan**!]. What will be the velocity of this projectile as measured by an observer on the Earth?
 19. What will be the kinetic energy of **HSS Marlboro** as measured from **HSS Manalapan**?
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Each of the following questions takes place after HSS Manalapan is returning from Vega but before it has encountered HSS Marlboro on the return trip. These two rockets are now heading in opposite directions and are a distance of 5.0 cyrs apart, as measured by an observer at rest on the Earth.

20. What will be relative velocity between **HSS Manalapan** and **HSS Marlboro** as they approach one another?
 21. According to an observer on the Earth, how long will it take for these two rockets to meet?
 22. According to an observer on **HSS Marlboro**, how long will it take for these two rockets to meet?
 23. According to an observer on **HSS Manalapan**, how long will it take for these two rockets to meet?
 24. What will be the mass of **HSS Manalapan** as measured by the astronaut on board **HSS Marlboro**?
 25. How much matter would have to be annihilated [100% efficiency] to give the **HSS Manalapan** its velocity of $0.99995c$?
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Each of the following questions takes place after HSS Manalapan has returned to the Earth.

26. How old will the astronaut on **HSS Manalapan** be when **HSS Manalapan** returns to the Earth?
 27. In what year does **HSS Manalapan** return to the Earth?
 28. With what speed should this rocket have traveled if the astronaut was to have aged only one year in each direction of the trip to Vega?
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SELECT AND ANSWER TWO [2] OF THE FOLLOWING ESSAY QUESTIONS. MAKE SURE THAT YOUR ESSAY IS THOROUGH AND COMPLETE! YOUR JOB IS TO SHOW ME WHAT YOU KNOW ABOUT THE TOPIC! [10 pts]

28. The Special Theory of Relativity is based upon two postulates or assumptions. What are these two assumptions and what evidence lead Einstein to make them?
29. Are the effects of relativity REAL? Present concrete, scientific evidence to support your response?
30. One of the significant conclusions of the Special Theory of Relativity is that nothing can go or exceed the speed of light in a vacuum. What arguments can be used to support this conclusion? Justify!
31. Two events that are simultaneous in one inertial frame of reference will not necessarily be simultaneous in any other inertial frame of reference. Explain!