CH 25 SPECIAL RELATIVITY 1996-97

$c := 3.0 \cdot 10^8 \cdot \frac{m}{sec}$ $m_o := 88000kg$ $L_{rocket\_o} := 72.0m$ $D_o := 12.5m$ $L_o := 110c \cdot yr$

$v_1 := 0.998c$ $age_o := 22.0yr$ $HR_o := \frac{64}{min}$ $t_{research} := 1.20yr$ $v_2 := 0.98c$ $cyr := c \cdot yr$ $cyr = 9.467 \times 10^{15} m$

1. $D := D_o$ $D = 12.5m$ **1. the relativistic diameter of the rocket. [3 pts]**

2. $D = 12.5m$ **2. Diameter doesn't change! [3 pts]**

3. $L := L_{rocket\_o}$ $L = 72m$ **3. Length as measured by observer on board the rocket. [3 pts]**

4. $\beta_1 := \frac{1}{\sqrt{1 - \frac{v_1^2}{c^2}}}$ $\beta_1 = 15.819$ $L := \frac{L_{rocket\_o}}{\beta_1}$ $L = 4.551m$ **4. Length of the rocket as measured by an observer on the Earth. [3 pts]**

5. $m_1 := m_o$ $m_1 = 8.8 \times 10^4 kg$ **5. Mass of the rocket as measured by the astronaut on board the rocket. [3 pts]**

6. $L := \frac{L_o}{\beta_1}$ $L = 6.954cyr$ **6. Distance to Gamma Draconis as measure by the astronaut on board the first rocket. [3 pts]**

7. $t_{1o} := \frac{L_o}{v_1}$ $t_{1o} = 110.22yr$ **7. Time for the first rocket to reach Gamma Draconis as measured from the Earth frame of reference. [3 pts]**

8. $t_{1r} := \frac{t_{1o}}{\beta_1}$ $t_{1r} = 6.967yr$ **8. Time to reach Gamma Draconis according to the astronaut on board the first rocket. [3 pts]**

9. $m_{1\_earth} := m_o \cdot \beta_1$ $m_{1\_earth} = 1.392 \times 10^6 kg$ **9. Mass of the first rocket as measured by an observer on the earth. [3 pts]**

10. $KE := \left(m_o \cdot c^2\right)\left(\beta_1 - 1\right)$ $KE = 1.174 \times 10^{23} joule$ **10. Kinetic energy of rocket A as measured by an observer on the earth. [3 pts]**

11. $HR := HR_o$ $HR = 64min^{-1}$ **11. Heart rate as monitored by an observer within the first rocket. [3 pts]**

12. $HR_{earth} := \frac{HR_o}{\beta_1}$ $HR_{earth} = 4.046min^{-1}$ **12. Heart rate of the astronaut as monitored from the earth. [3 pts]**

13. $RE := m_o \cdot c^2$ $RE = 7.92 \times 10^{21} joule$ **13. The rest energy of the rocket. [3 pts]**

14. $v_{relative} := \frac{v_1 - v_2}{1 - \frac{v_1 \cdot v_2}{c^2}}$ $v_{relative} = 0.82c$ **14. Relative velocity between the two rockets on their way to Gamma Draconis. [3 pts]**

15. $v_{projectile} := 0.985c$ $v_{pe} := \frac{v_2 + v_{projectile}}{1 + \frac{v_2 \cdot v_{projectile}}{c^2}}$ $v_{pe} = 0.99985c$ **15. Velocity of the projectile as measured by an observer on the earth. [3 pts]**

16. $v_{laser} := \frac{v_2 + c}{1 + \frac{v_2 \cdot c}{c^2}}$ $v_{laser} = 1c$ **16. Velocity of the laser as measured by any observer. [3 pts]**

17. $v_{p2} := -0.95c$ $v_{p2\_R2} := \frac{v_{relative} + v_{p2}}{1 + \frac{v_{relative} \cdot v_{p2}}{c^2}}$ $v_{p2\_R2} = -0.589c$ **17. Velocity of the second projectile as measured fron rocket B. [3 pts]**

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18. $v_{p2\_earth} := \dfrac{v_1 + v_{p2}}{1 + \dfrac{v_1 \cdot v_{p2}}{c^2}}$ $v_{p2\_earth} = 0.925c$

18. Velocity of the second projectile as measured by an observer on the earth. [3 pts]

19. $\beta_r := \dfrac{1}{\sqrt{1 - \dfrac{v_{relative}^2}{c^2}}}$ $\beta_r = 1.746$ $KE := m_o \cdot c^2 \cdot (\beta_r - 1)$ $KE = 5.906 \times 10^{21}\ joule$

19. The kinetic energy of one rocket as measured by the other. [3 pts]

20. $v_{relative} := \dfrac{v_1 + v_2}{1 + \dfrac{v_1 \cdot v_2}{c^2}}$ $v_{relative} = 0.99998c$

20. The relative velocity between the two rockets as they approach one another. [3 pts]

21. $D_o := 15 \cdot cyr$ $t_o := \dfrac{D_o}{v_{relative}}$ $t_o = 15.000303yr$

21. Time for the rockets to meet according to an observer on the earth. [3 pts]

22. $\beta_2 := \dfrac{1}{\sqrt{1 - \dfrac{v_2^2}{c^2}}}$ $\beta_2 = 5.025$ $t_2 := \dfrac{t_o}{\beta_2}$ $t_2 = 2.985yr$

22. Time for the rockets to meet according to an observer in rocket 2. [3 pts]

23. $\beta_1 := \dfrac{1}{\sqrt{1 - \dfrac{v_1^2}{c^2}}}$ $\beta_1 = 15.819$ $t_1 := \dfrac{t_o}{\beta_1}$ $t_1 = 0.948yr$

23. Time for the rockets to meet according to an observer in rocket 1. [3 pts]

24.

$\beta_{relative} := \dfrac{1}{\sqrt{1 - \dfrac{v_{relative}^2}{c^2}}}$ $\beta_{relative} = 157.244$

$m_{relative} := m_o \cdot \beta_{relative}$ $m_{relative} = 1.384 \times 10^7\ kg$

24. Mass of either rocket as measured by the other as they approach one another. [3 pts]

25. $L_{relative} := \dfrac{L_{rocket\_o}}{\beta_{relative}}$ $L_{relative} = 0.458m$

25. Length of either rocket as measured from the other as they approach one another. [3 pts]

26. $age := t_{1r} + t_{1r} + 1.2 \cdot yr + 22 \cdot yr$ $age = 37.135yr$

26. Age of the astronaut when she returns to the earth. [3 pts]

27. $year\_of\_return := \dfrac{1996yr + t_{1o} + t_{1o} + 1.2 \cdot yr}{yr}$ $year\_of\_return = 2217.641$

27. Year in which the astronaut returns to the earth. [3 pts]

28. $T := 1 \cdot yr$ $T_o := 110yr$ $c = 3 \times 10^8 \dfrac{m}{sec}$ $v := 10^6 \cdot \dfrac{m}{sec}$

Given $T = T_o \cdot \sqrt{1 - \dfrac{v^2}{c^2}}$ $v := Find(v)$ $v = 0.99996c$

28. Velocity required if the rocket is to reach Gamma Draconis in 1 year. [3 pts]

28. Two postulates & evidence. [10 pts]
29. Effects real? Evidence. [10 pts
30. Maximum speed? Evidence. [10 pts]
31. Simultaneous? [10 pts]