AREA OF STUDY 1: HOW FAST CAN THINGS GO?

REVISION QUESTIONS: EINSTEIN'S THEORY OF SPECIAL RELATIVITY

SOLUTIONS

QUESTION 1 Answer is D

QUESTION 2 Answer is B

QUESTION 3 Answer is B

QUESTION 4

a. They are both correct. At rest or constant velocity are both inertial frames of reference.

b. $L = \frac{L_o}{\gamma}$

$L = 1 \times \sqrt{(1 - 0.92^2)}$
$L = 0.39\ m$

QUESTION 5

Time dilation will occur as we are nearing the speed of light.

$\gamma = (1 - v^2/c^2)^{-1/2}$ and $= T_0\,\gamma$

$= (1 - .75^2)^{-1/2}$

$= 1.52$ $= 20 \times 1.52 = 30.4$ years

QUESTION 6

$\gamma = (1 - v^2/c^2)^{-1/2}$ and $T = T_0\,\gamma$

$= (1 - .999^2)^{-1/2}$

$= 22.37$ **$= 22.37 \times .22 \times 10^{-5} = 4.92 \times 10^{-5}$ s**

As this time is very close to the half-life, the muons with a slightly longer half-life would survive the trip.

QUESTION 7

a. $E_k = 1/2mv^2 = ½ \times 9.1 \times 10^{-31} \times (.8 \times 3 \times 10^8)^2 = 2.6 \times 10^{-14}$ J (1 mark)

b. $E_k = (\gamma - 1)mc^2$ with $\gamma = 1.67$, $E_k = 5.5 \times 10^{-14}$ J (1 mark)

QUESTION 8

a. $Ek = \frac{1}{2}mv^2$

$Ek = 0.5 \times 562 \times (0.94 \times 3 \times 10^8)^2$

$Ek = 2.23 \times 10^{19}\ J$

b. $Ek = (\gamma - 1)mc^2 = \left(\frac{1}{\sqrt{(1-0.92^2)}} - 1\right) \times 562 \times (3 \times 10^8)^2 = 7.85 \times 10^{19}\ J$

c. $Ek = (\gamma - 1)mc^2 = \frac{1}{\sqrt{\left(1 - \frac{v^2}{c^2}\right)}} mc^2$

If $v = c$ the bottom line is zero. This results in infinite energy.
Therefore, it is impossible to travel at the speed of light.