

NAME: Solution	Quiz #7a: Phys270 Section 0102
--------------------------	-----------------------------------

[10 pts] A 2m long cow is running at relativistic velocity towards a 1m long shed.

[5 pts] From the cow's reference frame, is it possible for the cow to fit inside the barn? If so, what minimum speed must the cow be moving? [leave your answer in terms of the speed of light c]

The actual length of the barn is = 1m (in its own frame where it is at rest)

In the Cow's reference frame the barn seems to move towards itself.

Therefore the cow sees the length of the barn contracted \Rightarrow less than 1m
Hence it is NOT possible for the cow to fit in the barn in its own reference frame.

[5 pts] From the barn's reference frame, is it possible for the cow to fit inside the barn? If so, what minimum speed must the cow be moving? [leave your answer in terms of the speed of light c]

From the barn's reference frame the cow is running and hence its length seems contracted $L < 2\text{m}$. Therefore if the cow is moving with sufficient velocity such that its length appears to be $L \leq 1.0\text{m}$ then it might seem possible for the cow to fit in the barn.

For this we use,

$$L = l/\gamma \quad \text{where } l=2.0\text{m} \text{ is the actual length of the cow.}$$

hence ,

$$\gamma \geq 2 \quad \text{or more for } L \leq 1.0\text{m}$$

Hence the minimum velocity of the cow which is determined by the lowest value of $\gamma=2$ is $v=0.867c$ (Answer)

Solution

NAME:	Quiz #7c: Phys270 section 0104
-------	-----------------------------------

[10 pts] A muon has a decay time of $(3/2) \mu\text{s}$ as measured inside of a rocket

moving at $(1/2)c$ with respect to the earth. [$1 \mu\text{s} = 10^{-6} \text{ sec}$]

[5 pts] What is the muon's decay time as measured on earth?

The rest frame of the muon is the rocket frame. Therefore the decay time is the proper time,

$$t = (3/2) \mu\text{s}$$

Since, in the earth frame the muon (i.e., the rocket frame) is moving with $v = (1/2)c$ therefore the decay time seems to have dilated.

we have,

$$\gamma = \frac{1}{\sqrt{1 - v^2/c^2}} = \frac{1}{\sqrt{1 - (1/2)^2}} = \frac{2}{\sqrt{3}}$$

Therefore, the decay time as seen from earth is,

$$t' = \gamma t = \frac{2}{\sqrt{3}} \cdot (3/2) \mu\text{s} = 1.73 \mu\text{s}$$

[5 pts] What is the muon's decay time as measured by the muon?

With respect to itself the muon is at rest. therefore, the decay time is the proper time of decay $t = (3/2) \mu\text{s}$