An unstable particle (e.g. a radioactive nucleus) has a half-life of 10^{-8}s when it is at rest. If we produce a beam of these particles travelling at 4/5 times the speed of light, how far on average will the particles travel before decaying?

A) About 1.4m
B) About 2.4m
C) Abour 4m
D) They won't decay once they are moving

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Here $\gamma = \frac{1}{\sqrt{1-\left(\frac{v}{c}\right)^2}} = \frac{1}{\sqrt{1-\left(\frac{4}{5}\right)^2}} = \frac{5}{3}$

Particles decay in their own frame in 10^{-8}s, so will be observed to take $\frac{5}{3} \times 10^{-8}$s. They travel

$$\underbrace{\left(\frac{4}{5} \times 3\times10^{8}\,\text{m/s}\right)}_{\text{speed}} \times \underbrace{\left(\frac{5}{3} \times 10^{-8}\,\text{s}\right)}_{\text{time}} = 4\,\text{m}$$

in this time.

Wonder Woman and Batman set their alarm clocks to ring at 8:00 and 8:01 respectively. Superman is flying at v=3/5c relative to the clocks. What is the time interval between the alarms in Superman's frame of reference?

A) 1 minute
B) 1.25 minutes
C) 0.8 minutes
D) Not enough information to answer
E) The principle of relativity does not apply to superheroes as they have the power to be in several different reference frames at once. The time interval that superman observes can be anything he wants it to be.

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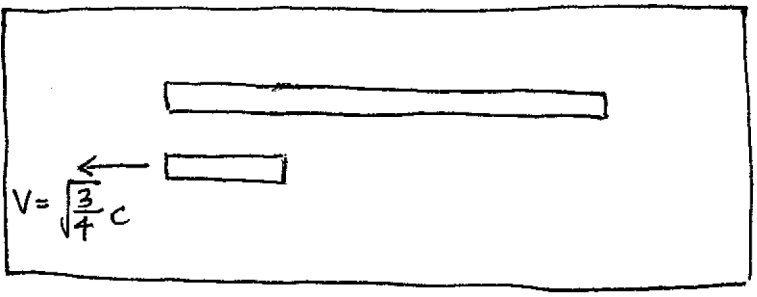
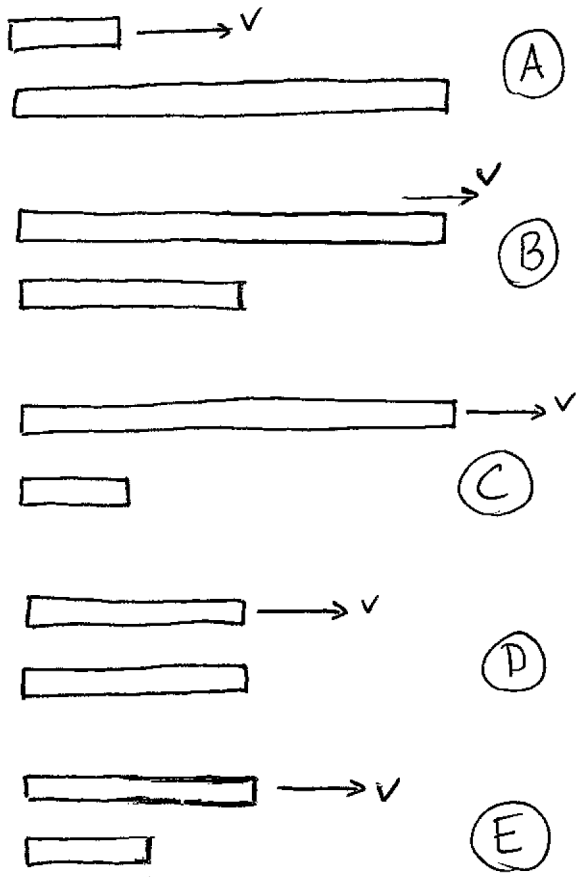
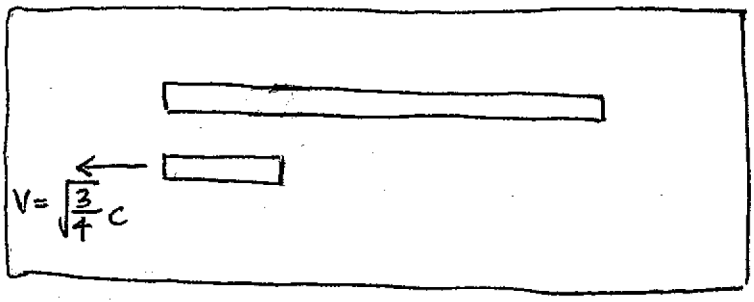
To use time dilation, the two events must be at the same place in one frame. Then we can say that these events will appear to be further apart in time to an observer moving relative to that frame.



The picture shows two rods, as observed in the frame of the upper rod. Which of the pictures below it represents an observation of the same rods in the frame of the upper rod?





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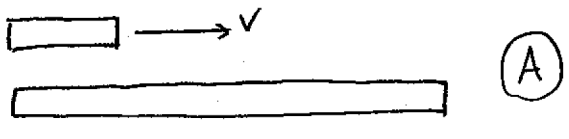

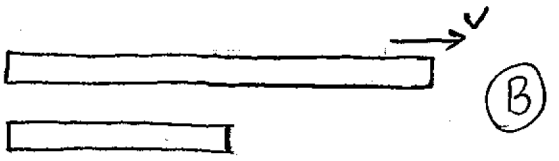

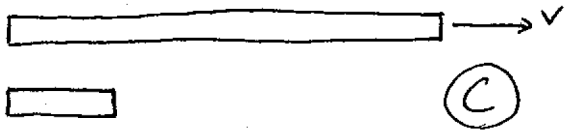

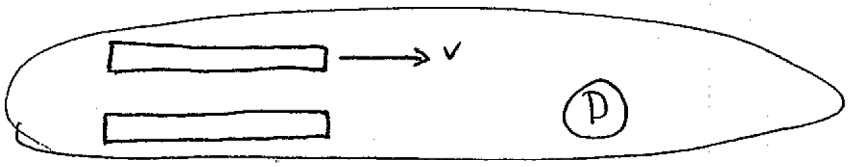

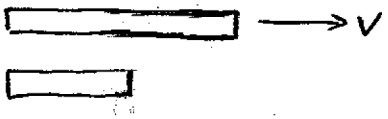

$v = \sqrt{\frac{3}{4}}c \Rightarrow \gamma = 2$

* lower ruler's proper length is twice as long as it appears in 1st picture
* upper ruler will appear half as long in the frame of lower ruler.