RELATIVITY

1. Special Relativity
2. Time Dilation
3. Doppler Effect
4. Length Contraction
5. Twin Paradox
6. Electricity and Magnetism
7. Relativistic Momentum
8. Mass and Energy
9. Energy and Momentum
10. General Relativity

TIME DILATION

Measurements of time intervals are *affected by relative motion* between an observer and what is observed.

A clock that moves with respect to an observer ticks more slowly than it does without such motion.

All process (including those of life) occur more slowly to an observer when they take place in a different inertial frame.

TIME DILATION

In a moving space craft, the time between two events in the space craft is t_o.
We on the ground find the same interval has a longer duration t.

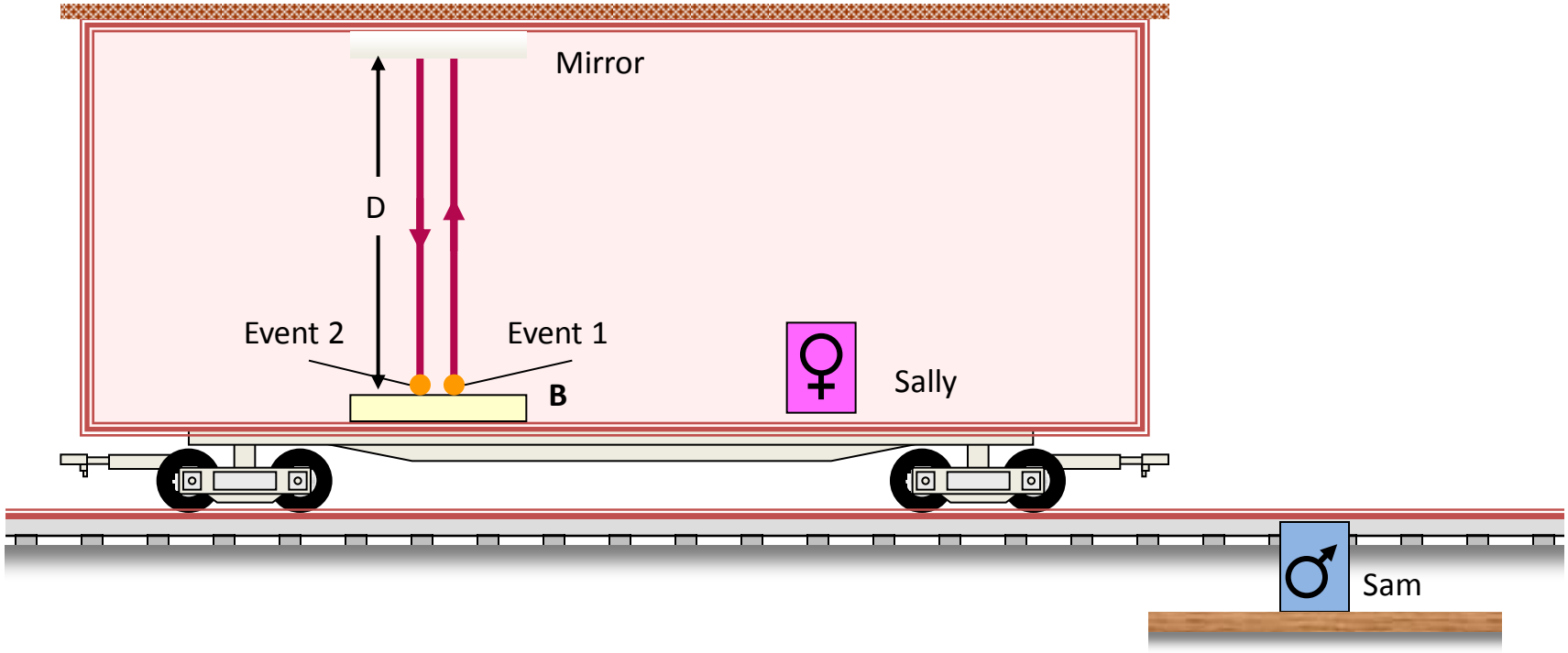
The quantity t_o is the proper time ← determined by events at the same place in an observer's frame of reference.

From the ground, the duration of the interval appears longer ← the events that mark the beginning and end of the time interval occur at different places.

This effect is called TIME DILATION

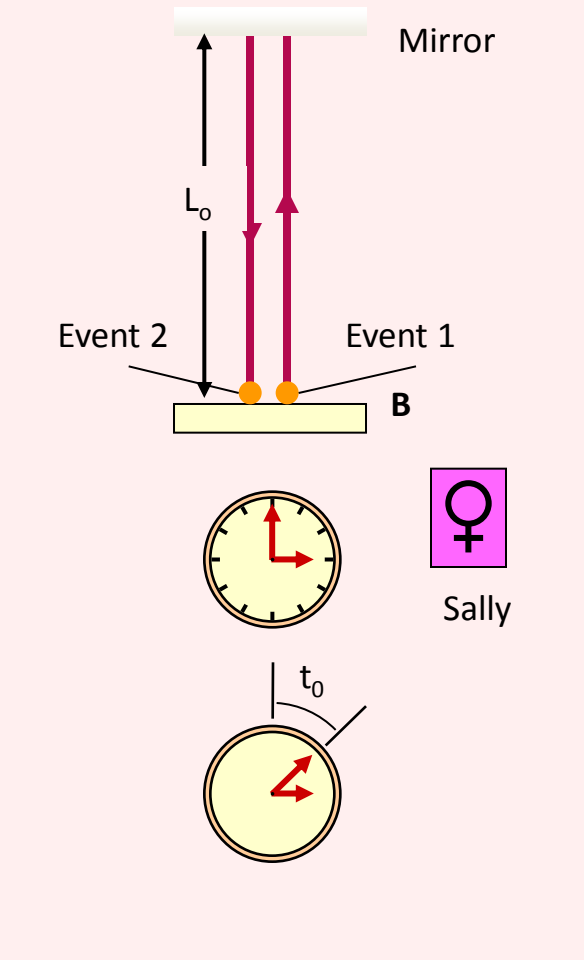
TIME DILATION

How does time dilation comes about?

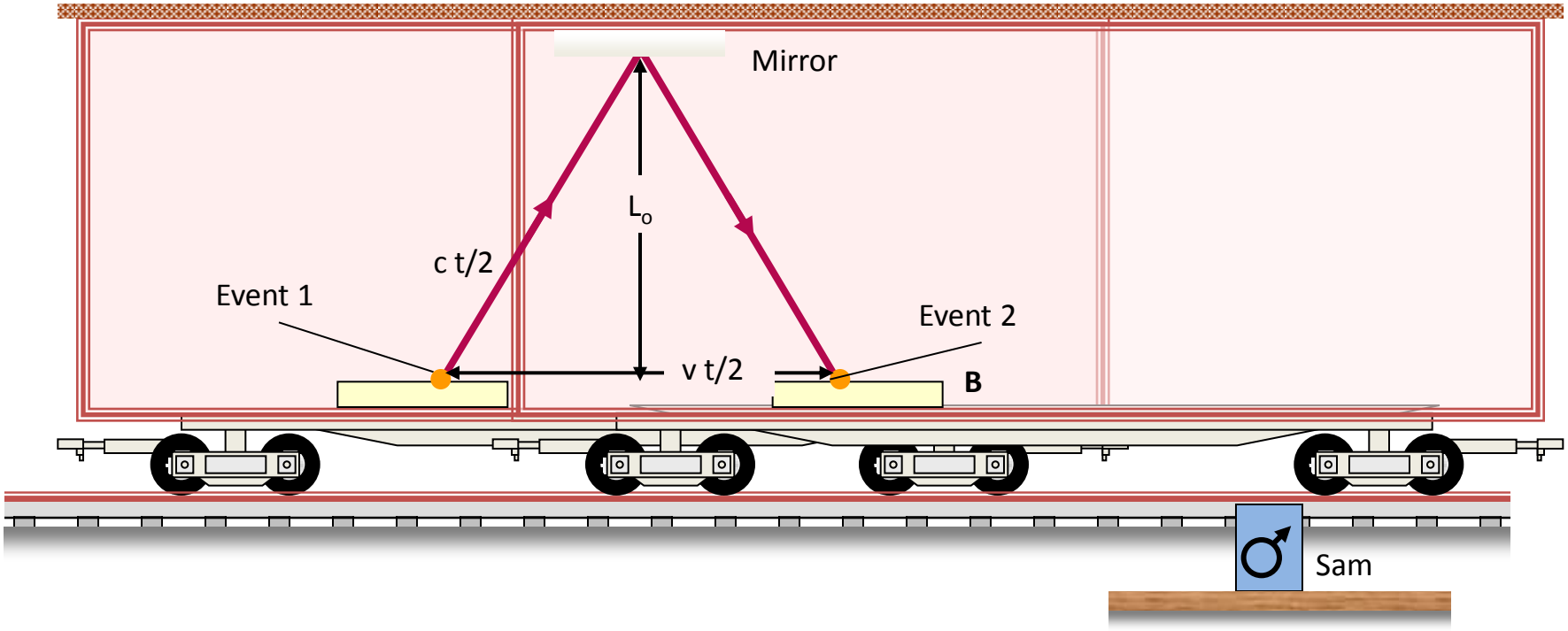


TIME DILATION

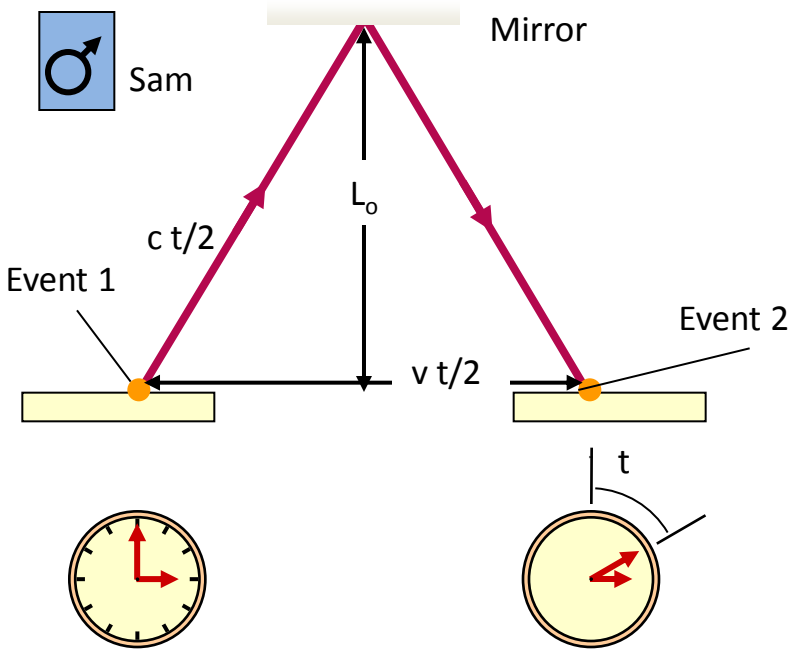
$$t_0 = \frac{2L_o}{c} \qquad \text{(Sally)}$$



TIME DILATION



TIME DILATION



$$\left(\frac{ct}{2}\right)^2 = L_o^2 + \left(\frac{\upsilon t}{2}\right)^2$$

$$\frac{t^2}{4}\left(c^2 - \upsilon^2\right) = L_o^2$$

$$t^2 = \frac{4L_o^2}{c^2 - \upsilon^2} = \frac{\left(2L_o\right)^2}{c^2\left(1 - \upsilon^2/c^2\right)}$$

$$t = \frac{2L_o/c}{\sqrt{1 - \upsilon^2/c^2}}$$

$$t_0 = \frac{2L_o}{c} \qquad \text{(Sally)}$$

$$t = \frac{t_o}{\sqrt{1 - \upsilon^2/c^2}}$$

TIME DILATION

$$t = \frac{t_o}{\sqrt{1 - \upsilon^2 / c^2}}$$

t_o = time interval on clock at rest relative to an observer = proper time
t = time interval on clock in motion relative to an observer
υ= speed of relative motion
c = speed of light

How would Sally see Sam's clock?

TIME DILATION

Although time is a relative quantity but…

- Time does not run backward to any observer.
- A sequence of event will appear in the same order to all observers everywhere, though not necessarily with the same time intervals between each pair of events.
- No observer can see an event before it happens (before a nearby observer sees it).
- There is no way to peer into the future, although past events may appear different to different observers.

TIME DILATION

REMEMBER….

A MOVING CLOCK TICKS MORE SLOWLY THAN A CLOCK AT REST

TIME DILATION

EXAMPLE 1.1:

A spacecraft is moving relative to the earth. An observer on the earth finds that, between 1 pm and 2 pm, according to her clock, 3601 s elapse on the spacecraft's clock. What is the spacecraft's speed relative to the earth?