Part F

The famous equation $E = mc^2$ is _____.

ANSWER:

- used to describe the time it takes light to travel from the Sun to Earth
- unrelated to the special theory of relativity
- part of the special theory of relativity
- used to calculate time dilation

Correct

As discussed in the video and your textbook, this is why the fact that the Sun shines (by converting mass to energy in accord with $E = mc^2$) is in essence evidence in support of the special theory of relativity.

Problem S2.50

A clever student, after learning about the theory of relativity, decides to apply his knowledge in order to prolong his life. He decides to spend the rest of his life in a car, traveling around the freeways at 55 miles per hour (89 $\mathrm{km/hr}$).

Part A

Suppose he drives for a period of time during which 70 years pass in his house. How much time will pass in the car? (***Hint***: If you are unable to find a difference, be sure to explain why.)

Express your answer is seconds to two significant figures.

ANSWER:

$t' = 70\ \mathrm{yr} - 7.5\times10^{-6}\ \mathrm{s}$

Correct

Part B

An even more clever student decides to prolong her life by cruising around the local solar neighborhood at a speed of 0.89 c (89% of the speed of light). How much time will pass on her spacecraft during a period in which 70 years pass on Earth?

Express your answer in years to three significant figures.

ANSWER:

$t' = 31.9 \text{ yr}$

Correct

Part C

Will *she* feel as if her life span has been extended?

ANSWER:

- (•) no
- ( ) yes

Correct

Part D

Explain.

ANSWER:

Essay answers are limited to about 500 words (3800 characters maximum, including spaces).

3785 Character(s) remaining

(none provided)

Part E

Suppose you stay home on Earth while your twin sister takes a trip to a distant star and back in a spaceship that travels at 99% of the speed of light. If both of you are 25 years old when she leaves and you are 45 years old when she returns, how old is your sister when she gets back?

ANSWER:

- 30 years
- 26 years
- 28 years
- 24 years

Correct

Problem S2.54

Part A

The International Space Station orbits Earth at a speed of about 30,000 $\mathrm{km/hr}$. While 1 hour passes on Earth, how much less time passes on the Station? Assume that both the Station and Earth are in free-float frames, although in reality they are not. (***Hint***: Start by converting the Station's speed to $\mathrm{km/s}$.)

Express your answer to three significant figures and include the appropriate units.

ANSWER:

$t - t' =$ 1.39 μs

Correct

Problem S2.52

Part A

A spaceship has a rest mass of 700,000 tons. If you could measure its mass when it was traveling at half the speed of light, what would the value be?

Express your answer in tons to three significant figures.

ANSWER:

$M' =$ 8.08×10^5 tons

Correct

Part B

A fly has a mass of 1 gram at rest. How fast would it have to be traveling to have a mass of 3000 kilograms (about that of a large SUV)?

ANSWER:

- (●) very close to the speed of light
- ( ) at three fourths of the speed of light
- ( ) at half the speed of light
- ( ) at one quarter of the speed of light

Correct

Problem S2.55

For the game of interstellar baseball, teams have used robotic enhancements to allow superhuman feats. Consider a pitcher who can throw a baseball at 80% of the speed of light and is practicing in a spaceship traveling away from Earth at 95% of the speed of light (on the way to the team's next game).

Part A

Assuming that he throws the baseball in the same direction the spacecraft is traveling, how fast will those of us on Earth measure the baseball to be going?

Express your answer in units of the speed of light to four significant figures.

ANSWER:

$v' = 0.9943\ c$

Correct

Time Dilation and Length Contraction with Three Observers

Learning Goal:
To understand how relative motion affects time and length in situations involving three observers, each in a different reference frame.

Part A

Each item below shows three spaceships that are all moving relative to one another; the speeds are shown as they appear in Jackie's reference frame. Rank the items according to how much time *you* would say passes (on your own ship) while *Bob*'s clock ticks off one second, from the shortest to the longest amount of time. To rank items as equivalent, overlap them.