

Worksheet: Length Contraction



Q1: A spaceship that has a proper length of 2.00×10^2 m, moves at $0.970c$ relative to the Earth. What is the spaceship's length as measured by an observer on the Earth?



Question Video

A 101 m

B 76.7 m

C 48.6 m

D 85.5 m

E 133 m

Q2: An observer located at the origin of an inertial frame S sees the flash of a flashbulb occur at the position $x = 150$ km and at the time $t = 4.50 \times 10^{-4}$ s. The system S' is moving along the x -direction of S at a velocity of $0.600c$.

► At what time in the S' system did the flash occur?

A 2.13×10^{-4} s

B 1.88×10^{-4} s

C 2.64×10^{-4} s

D 3.37×10^{-4} s

E 3.91×10^{-4} s

► At what x -position did the flash occur as measured in the S' system?

A 178 km

B -101 km

C 119 km

D -48.9 km

E -82.6 km

Q3: A spaceship (A) is moving at speed $c/2$ with respect to another spaceship (B). Observers in A and B set their clocks so that the event at (x, y, z, t) of turning on a laser in spaceship B has coordinates $(0, 0, 0, 0)$ in A and also $(0, 0, 0, 0)$ in B. A photon from the laser in spaceship B arrives at $(x = 1.00 \text{ m}, 0, 0)$ at $t = 0$ in the frame of ship A.

► What will be the time value t' at which the observer in spaceship B measures the photon's arrival?

A $2.40 \times 10^{-9} \text{ s}$

B $1.93 \times 10^{-9} \text{ s}$

C $2.15 \times 10^{-9} \text{ s}$

D $2.29 \times 10^{-9} \text{ s}$

E $2.08 \times 10^{-9} \text{ s}$

► What displacement value x' will the observer in spaceship B measure for the position of the arriving photon?

A 1.30 m

B 1.15 m

C 1.08 m

D 1.22 m

E 1.00 m

Q4: An astronaut measures the length of his spaceship to be 100 m, while an observer on Earth measures it to be 25.0 m.

► Find the Lorentz factor γ that relates the values of measurements by the astronaut and the observer on Earth.

A 3.00

B 3.55

C 4.00

D 2.88

E 4.22

► What is the velocity of the spaceship relative to earth?

A $0.900c$

B $0.922c$

C $0.968c$

D $0.867c$

E $0.984c$

Q5: How fast should an athlete run for them to perceive a 200 m race as a 200 yd race given that $1 \text{ yd} = 0.9144 \text{ m}$?

A $0.395c$

B $0.405c$

C $0.287c$

D $0.293c$

E $0.164c$

Q6: Spaceship A is moving at speed $\frac{c}{3}$ with respect to another spaceship B. A rod of length 2 m is laid out on the x -axis in the reference frame of B from the origin to (2.00, 0.00, 0.00). What is the length of the rod as measured by an observer in the reference frame of spaceship A? Give your answer to 3 significant figures.

- A 1.78 m
- B 1.89 m
- C 2.45 m
- D 1.63 m
- E 2.12 m

Q7: How fast would a 5.000 m long sports car have to be going past an observer for the observer to measure its length as 4.500 m?

- A 0.3160c
- B 0.1898c
- C 0.2537c
- D 0.5217c
- E 0.4359c