

Relativity-1: Time dilation, length contraction, velocity addition & simultaneity

-
1. A rocket ship is 100 m long on the ground. When in flight its length appears 99 m to an observer on the ground. What is the speed of the rocket in terms of c ? [0.14c]
 2. Calculate the percentage contraction in the length of a rod moving with a speed of $0.8c$ in a direction at angle of 60° with its own length. [8%]
 3. A meson has a proper lifetime of 2×10^{-6} s. What is its lifetime to a stationary observer who sees it travel at a speed of $0.998c$? How far does the observer see it travel? What distance would it travel without relativistic effects? [31.6 μ s, 9.5 km, 0.6 km]
 4. At what speed should a clock be moved so that it may appear to lose 1 min in an hour? [0.18c]
 5. A certain particle has a proper lifetime of 1×10^{-7} s. How far does a stationary observer see it to travel if its speed is $0.99c$? [211 m]
 6. How fast must a spacecraft travel relative to the earth for each day on the spacecraft to match 2 days on the earth? [0.87c]
 7. A plane is flying at 300 ms^{-1} . What time must elapse before a clock in the plane and one on the ground differ by 1 s? [63000 years]
 8. An astronaut is standing in a spacecraft parallel to its direction of motion. An observer on the earth finds that the speed of the spacecraft is $0.6c$ and the astronaut is 1.3 m tall. What is the astronaut's height as measured in the spacecraft? [1.63 m]
 9. A metre stick moving with respect to a stationary observer appears only 500 mm long. What is its relative speed? [0.87c]
 10. Two electrons are ejected in opposite directions from a radioactive atom at rest in the laboratory. Each electron has a speed of $0.67c$ with respect to the laboratory. What is the speed of one electron with respect to the other, according to classical velocity addition and relativity? [1.34c, 0.92c]
 11. Two particles travel towards each other with a speed of $0.8c$ with respect to the laboratory. Find the relative speed. [0.98c]
 12. Two β -particles A and B travel in opposite directions, each with a velocity $0.9c$ with respect to the laboratory. What is their relative velocity as observed by A , and as observed by a stationary observer? [0.99c, 0.9c]
 13. A particle moves with a speed of $0.8c$ at 30° to the x -axis, as seen by a static observer. What is its speed measured by a second observer, moving with a speed of $-0.6c$ along the x - x' axis? [0.94c]
 14. With respect to a static frame, a photon travels at 60° to the x -axis. A moving frame travels with a speed of $0.6c$ along the common x - x' axis. What angle does the photon make with the direction of the moving frame? [81.8°]
 15. A train, 800 m long (as measured by an observer in the train), travels at a speed of 160 km hr^{-1} . A ground observer sees two simultaneous lightning strikes at the two ends of the train. What is the time separation between the lightning strikes measured by the observer in the train? [0.4 ps]
-