VISUAL PHYSICS ONLINE

Special Relativity

Question 1

Astronaut Chris travels to Vega, the fifth brightest star in the night sky, leaving his 35 year old twin Pat behind on Earth. Chris travels at a speed of 0.990*c* and Vega is 25.3 light-years from Earth. (a) How long does the trip take from the point of view of Pat. How old is Pat when Chris arrives at Vega? (b) How old is Chris when he arrives at Vega (use the time dilation effect)? (c) What distance did Chris travel from his point of view and how old is he at the end of his journey.

Question 2

The radius of our galaxy is 3×10^{20} m, or about 3×10^{4} light years.

Assume the speed of a spacecraft is 0.99*c.*

a) From the point of view of an observer on Earth, calculate the time to travel to the edge of our galaxy?
b) Use the length contraction formula to calculate the time for a person to travel from the centre to the edge of our galaxy.
c) Use the time dilation effect to calculate the time for a person to travel from the centre to the edge of our galaxy.
d) How fast would a spaceship have to travel to go from the centre to the edge of our galaxy in 30 yrs as measured from within the spaceship? How much time would elapse on Earth during this journey?
e) What does this tell us about the future of traveling to edge of our galaxy?

Question 3

A spacecraft in the shape of a square box with sides 300 mm long moves away from the Earth at a velocity of 0.5*c*. Find the volume of the box as measured from Earth.

Question 4

A missile travelling at 90% of the speed of light has a rest length of 10 m. Calculate the length of the moving missile as measured by a stationary observer directly under the flight path of the missile.

Question 5

A rectangular painting is hanging on the wall of a spaceship. The dimensions of the painting are 1.50 m (width) x 1.00 (height) m. An Earth based observer measures the spaceship to be travelling at speed of 0.90c.

What are the dimensions of the painting according to an observer on the spaceship?

What are the dimensions of the painting according to the observer on Earth?

What are the true dimensions of the painting?

Answer 1

(a) Δt = 25.6 yrs Pat 60.6 yrs old

(b) t_0 = 3.6 yr Chris 38.6 yrs old

(c) distance = 3.57 ly t_0 = 3.6 yr Chris 38.6 yrs

Answer 2

a) $t = 3.2 \times 10^4$ y

b) $t_0 = 4.5 \times 10^3$ y

c) $t_0 = 4.5 \times 10^3$ y

d) $v = 0.9999995c$

e) With our present technologies, space travel outside our solar system is not possible.

Answer 3

$v = 0.023\ m^3$

Answer 4

4.36 m

Answer 5

The painting as well as everything on the spaceship appears to be normal and the dimensions of the paining are 1.50 m x 1.00 m.

For the Earth based observer, only the dimension in the direction of motion is shorten, so the height is unchanged at 1.00 m.

The width however is contracted

$$L = L_0\sqrt{1-\frac{v^2}{c^2}} \quad L0 = 1.50\ \text{m} \quad v = 0.90c$$

$$L = 0.65\ \text{m}$$

The painting has dimensions 0.65 m x 1.00 m

There are NO true dimensions of the painting. Difference observers can disagree on the dimensions of the painting as length is a relative concept and depends upon the relative motion between the object and the observer.