

Proper Time and the Binomial Approximation

Physics II: Modern Physics

College of the Atlantic

1. Anastajia and Beowulf are hanging out. Ana decides to go for a quick trip. She gets in her rocket ship and goes once around the earth at an essentially constant speed of 0.9.
 - (a) How far does Ana travel according to Beowulf? Answer in SR units.
 - (b) How long does the trip take according to Beowulf?
 - (c) How long does the trip take according to Ana?
2. Anastajia takes a very fast space train to the moon. The moon is 1.3 light seconds from the earth. In our reference frame on earth, we observe that the train arrives on the moon 260 seconds after departing. Assume the space train travels at a constant speed.
 - (a) In the earth reference frame, what is the speed of the train? (Answer in SR units and km/s.)
 - (b) According to a clock on the train, how long does the trip from the earth to the moon take? (You'll need to keep more digits in your calculation than you're used to.)
3. Ana and Beowulf decide to visit their friends in San Francisco for spring break. They bribe someone to take them to the Concord Trailways bus station and take the bus to the Boston airport. They then take a flight from Boston to San Francisco. Suppose the flight takes exactly six hours (21,600 seconds) as measured by someone on the ground. The distance from Boston to San Francisco is 2700 miles. Assume that the plane travels at a constant speed.
 - (a) What is the distance from Boston to San Francisco in light seconds?
 - (b) What is the speed of the plane as observed by someone on the ground. Answer in SR units.
 - (c) How much less time does the flight take as measured by Ana and Beowulf? I.e., Ana and Beowulf will measure the duration of the flight to be slightly less than six hours. How much less? Answer in nanoseconds.
4. Anastajia and Beowulf are hanging out, and Ana decides to go for a quick trip. She gets in her rocket ship and travels exactly once around the earth at a speed of 0.9. (The circumference of the earth is approximately 40,000 km.)
 - (a) How long does the trip take according to Beowulf?
 - (b) How long does the trip take for Ana?

5. Anastajia and Beowulf synchronize their watches on earth. Call this event P. Anastajia then hops in her spaceship and flies to Neptune and back. Upon Anastajia's return, she and Beowulf compare the time on their watches. Call this moment of comparison event Q.
- (a) Whose watch(es) measure the spacetime interval between events P and Q?
 - (b) Whose watch(es) measure a coordinate time interval between events P and Q?
 - (c) Whose watch(es) measure a proper time between events P and Q?
 - (d) Whose watch measures a shorter time interval between P and Q?
6. Anastajia and Beowulf operate synchronized clocks at two points on the earth's surface. Charlotte rides a train that travels at a constant speed in a straight line between these two points. Let the event of her departure from Ana's clock be event A and her arrival at Beowulf's clock be event B. Deon, on the other hand, pilots a plane that takes a complicated three-dimensional path between these two points, but leaves Ana's clock at the same time as Charlotte and arrives at Beowulf's clock just as Charlotte does.
- (a) Which clock registers the largest time interval between the events?
 - (b) Which clock registers the largest time interval between the events?