Homework 02
Physics II
"Due" Friday, April 12, 2024
College of the Atlantic. Spring 2024

There are two parts to this assignment.

Part 1: WeBWorK. Do Homework 02 which you will find on your WeBWorK page. I recommend doing the WeBWorK part of the homework first. This will enable you to benefit from WeBWorK's instant, if not necessarily friendly, feedback before you do part two.

Part 2: Not WeBWorK. Below are some non-WeBWorK problems.

- If you want, you can do these problems in pairs and hand in only one write-up.

- "Hand in" the problem on google classroom. You can take a picture of your work, or type up your work, or scan your work.
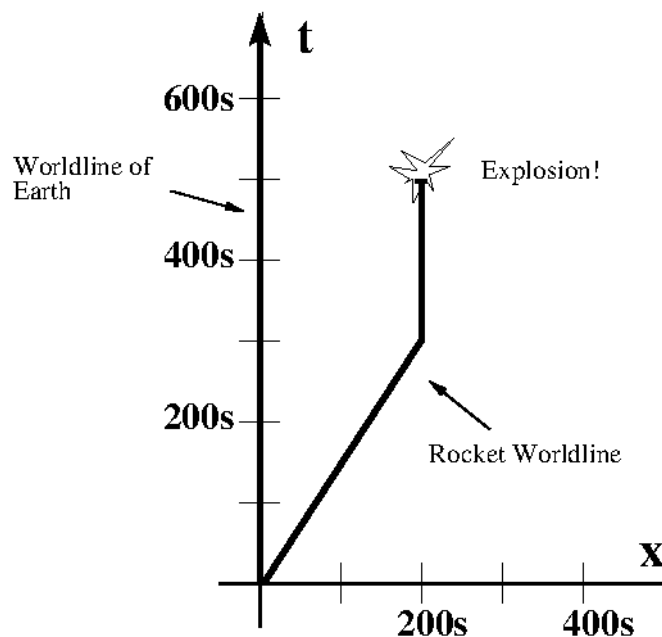

Figure 1: A spacetime diagram.

1. The spacetime diagram in Fig. 1 shows a rocket ship that leaves earth, travels at a constant speed for a while, comes to rest, and then explodes.

   (a) What are the spacetime coordinates of the following events: A, the rocket launches from earth; B, the rocket comes to rest, C, the rocket explodes.

   (b) What is the speed of the rocket before it comes to rest?

   (c) A light signal from earth happens to have reached the rocket at the moment it explodes. Draw the worldline of this light signal on the spacetime diagram. When did the light signal leave earth?

2. Beowulf is in a spaceship traveling toward a space station at a constant speed of $v = 3/4$. Anastajia is on the space station, which we will take to be at $x = 0$ in the space station reference frame. At time $t = 0$ the spaceship is 16 light-hours from the space station. At this time and place, Beowulf sends a pulse of light to Anastajia to signal his intention to land on the space station. Call the launching of this signal event A. The station receives the signal (event B). Anastajia waits half an hour and then sends a laser pulse back to Beowulf, who has continued traveling at $v = 3/4$ all the while. Call Anajstajia's launch of her signal event C. Sometime later the signal reaches Beowulf in his spaceship (event D).

   (a) Draw this situation on a reasonably carefully drawn spacetime diagram. Include the worldlines for the Anastajia and Beowulf. Also include events A, B, C, and D. Use units of light-hours for you axes.

   (b) Exactly where and when does event D occur? Don't just estimate it from your diagram—use math to figure out an exact value.

3. Imagine that an advanced alien race, bent on keeping humans from escaping the solar system, places an opaque spherical force field around the solar system. The force field is 6 light-hours in diameter, is centered on the sun, and is formed in a signal instant of time as measured by synchronized clocks in an inertial frame attached to the sun. This instant corresponds to 9PM on Saturday night in whatever time zone you happen to be in. When does the opaque sphere appear to start blocking light from the stars from your vantage point on earth, 8 light-minutes from the sun? Does the opaque sphere appear all at once? If not, how long does it take for the sphere to appear, and what does it look like as it appears? Describe what you would see as completely as you can. (This is a lightly-edited version of problem R2R.1 from Thomas A. Moore, *Six Ideas that Shaped Physics: Unit R (2nd ed.)*, McGraw Hill, 2003. Moore notes that the inspiration for this problem comes from the novel *Quarantine* by Greg Egan.)