Ph 504 pset 1: relativistic effects

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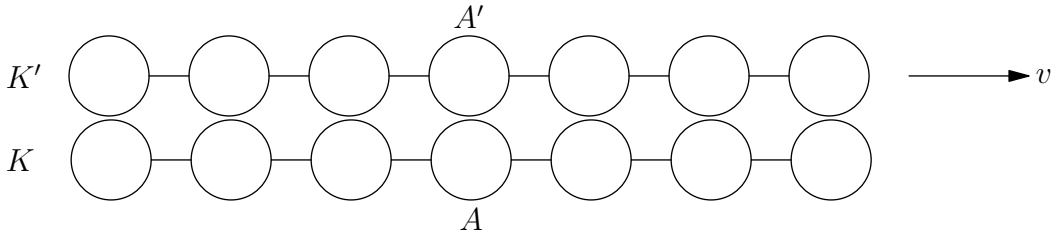
1. A system of clocks K' moves with velocity v with respect to another system of clocks K. As clock A' moves past A, the two are synchronized. Draw the hands of all the clocks with respect to K.



2. A thin rod of length L' rests at an angle θ' with the $x'-$axis of the K' frame. The K' frame is moving at velocity v with respect to K. What is the length L of the rod in the K frame and what angle θ does it make with the $x-$axis?

3. An equilateral triangle moves past you at a speed v. Determine the perimeter of the triangle when the motion is along a(n)

   (a) angle bisector

   (b) side

   and analyze the results for $v << c$ and $v \approx c$.

4. A rod moves along a ruler with a constant velocity. When the positions of both ends of the rod are marked simultaneously in the reference frame fixed to the ruler, the difference of readings on the ruler is equal to Δx_1. But when the positions of the rod's ends are marked simultaneously in the reference frame of the rod, the difference of readings on the same ruler is equal to Δx_2. Find the proper length of the rod and its velocity relative to the ruler in terms of Δx_1 and Δx_2.

5. Cookie dough lies on a conveyor belt which moves along at speed v. A circular stamp stamps out cookies as the dough rushed by beneath it. When the belt stops moving, what shape are the cookies?

6. Two planets, A and B, are at rest with respect to each other, a distance L apart, with synchronized clocks. A spaceship flies at speed v past planet A toward planet B and synchronizes its clock with A's right when it passes A. The spaceship eventually flies past planet B and compares its clock with B's. We know, from working in the planets' frame, that when the spaceship reaches B, B's clock reads L/v. And the spaceship's clock reads $L/\gamma v$, because it runs slow by a factor of γ when viewed in the planets' frame. How would someone on the spaceship quantitatively explain to you why B's clock reads L/v (which is more than its own $L/\gamma v$), considering that the spaceship sees B's clock running slow?

7. A square with side L flies past you at speed v, in a direction parallel to two of its sides. You stand in the plane of the square. When you see the square at its nearest point to you, show that it *looks* (you need to consider the time it takes the light to reach your eye) to you like it is simply rotated, instead of contracted. Assume that L is small compared to the distance between you and the square.

8. A train and a tunnel both have proper lengths l. The train speeds toward the tunnel, with speed v. A bomb is located at the front of the train. The bomb is designed to explode when the front of the train passes the far end of the tunnel. A deactivation sensor is located at the back of the train. When the back of the train passes the near end of the tunnel, this sensor tells the bomb to disarm itself. Does the bomb explode?