HW2

Reading assignment: Einstein chapters 7-9.
Reading assignment: Feynman sections 3.1 and 3.2.

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0. If you have not already done so, finish problem 4 from HW1. Optionally, try problem 5 from HW1.

1. A man throws a ball vertically upward on Earth where acceleration due to gravity is $-10m/s^2$ (minus because objects accelerate downwards). (a) What are the ball's velocity and acceleration at its maximum height? (b) What is the acceleration of the ball just before it hits the ground? (c) With words or a diagram describe the motion of the ball. (d) Suppose a woman on a train traveling at a speed w (not zero) passes by the man throwing this ball (who is standing on the train-station platform). With words or a diagram describe the ball's motion as seen by the woman. (e) Who is able to use Newton's equations (i.e., $F = ma$ and the law of gravity) to describe the ball's trajectory? The man? The woman? Both? If both, explain the why the ball's motion looks different.

2. (a) Draw a position versus time graph for a moving car given the information that the car is initially at $x_{\texttt{initial}} = -3m$, with an initial speed of $v_{\texttt{initial}} = 0$, and accelerates at a rate of $a = 2m/s^2$. Suppose you are the driver. (b) Describe the forces you feel and where they come from. (c) Are you an inertial observer? Why or why not?

3. (We will discuss this problems importance to special relativity on Wednesday) An airplane travels in the horizontal (x-axis) direction from the origin O of a reference frame to a point B at a speed c. The length between these points is $L = B - O$. (a) How long will it take the plane to make a round trip from O to B and back? (b) How long will it take the plane to make the round trip if wind is blowing in the positive x direction such that the plane's speed is now $c+v$ for the trip to point B and $c-v$ for the return trip from point B? (c) What happens with $v = c$? (Hint: this problem uses nothing but distance = (rate)*time and some careful thought. Drawing pictures would be very helpful too.)

4. Recall a Galilean coordinate transformation relates a reference frame K' moving with a constant velocity v (along the x direction) relative to another reference frame K. Suppose we have a third reference frame K'' moving with a velocity w (along the x direction) relative to the frame K'. Find the condition such that all velocity measurements in K and K'' agree. (This problem is easier than it sounds. First, try to guess an intuitive answer by carrying out a thought experiment. Next, think about and draw the situation. Use formulas given in class to write K' coordinates in terms of K coordinates, and K'' coordinates in terms of K' coordinates. Solve these algebraic equations to find K'' coordinates in K. A condition relating v and w should reveal itself.).

6. (**OPTIONAL**) Using calculus (integration) derive the formula $x_f = x_i + v_i T_f + 1/2a(T_f)^2$ from $\frac{\partial^2 x}{\partial t^2} = a$ when acceleration a is a constant. What happens to your derivation if a is not a constant (e.g. suppose $a = (3m/s^3)t$)?