# 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 $-10m/s^2$. (a) What are its velocity and acceleration when it reaches 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 $w$ passes by the man throwing this ball (who is standing on the train-station platform), with words or a diagram describe the motion as seen by the woman. (e) Who is able to use Newton's equations (ie laws) of motion to describe the ball's trajectory? The man? The woman? Both? If both, explain the why the ball's motion looks different. (HINT: who is in an inertial reference frame).

**2.** Draw a position versus time graph for a car in motion given the information that $x_i = -3m$, $v_i = 0$, $a = 2m/s^2$.

**3.** A truck accelerates from rest at $2m/s^2$ until it reaches a speed of $20m/s$. 1) How long and how far has the truck traveled? 2) To stop the truck in $10s$ what constant acceleration needs to be applied? 3) Suppose you are driver, describe the forces you feel and where they come from. 4) Are you an inertial observer? Why or why not?

**4.** (This is difficult but please try – we will discuss its importance to special relativity on Wednesday) An airplane travels in the horizontal (x-axis) direction from the origin $O$ of a reference frame $K$ to point $B$, and the length between these points is $L = B - O$. Suppose the plane travels with a speed $c$, (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 $c + v$ and $c - v$ for the trip to and 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.)

**5.** (**OPTIONAL**) Recall a Galilean coordinate transformation relates a reference from $K'$ 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. Hint: 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 $K''$ coordinate in $K$, from which the condition is obvious).

**6.** (**OPTIONAL**) Using calculus (integration) derive the formula $x_f = x_i + v_i T_f + 1/2 a (T_f)^2$ from $\frac{\partial^2 x}{\partial t^2} = a$ where a is a constant. What does the formula look like if $a = (3m/s^3)t$?