HW2 Solutions

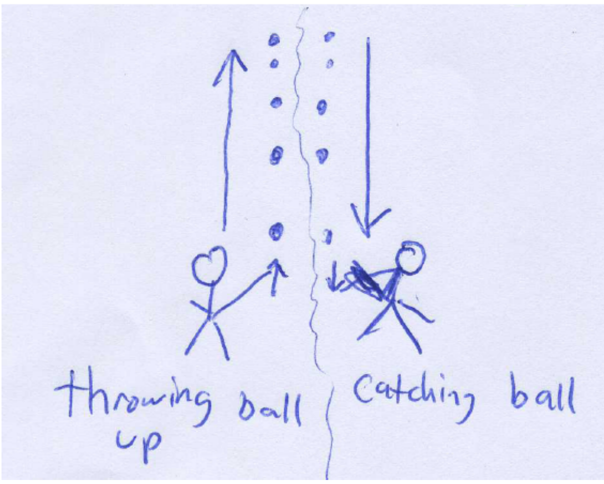
1. a) Gravity is always pulling the ball towards the ground at $10.0m/s^2$. At the maximum height the ball begins to fall back towards the ground, thus at this instant its velocity is zero.

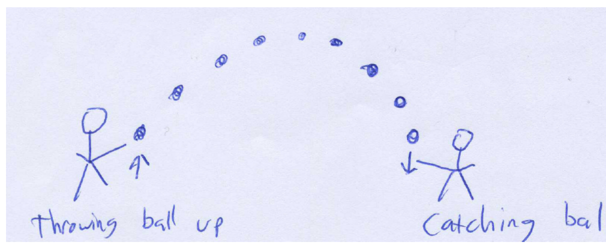
b) still $10.0m/s^2$.

c) In a straight line up and down (see figure)

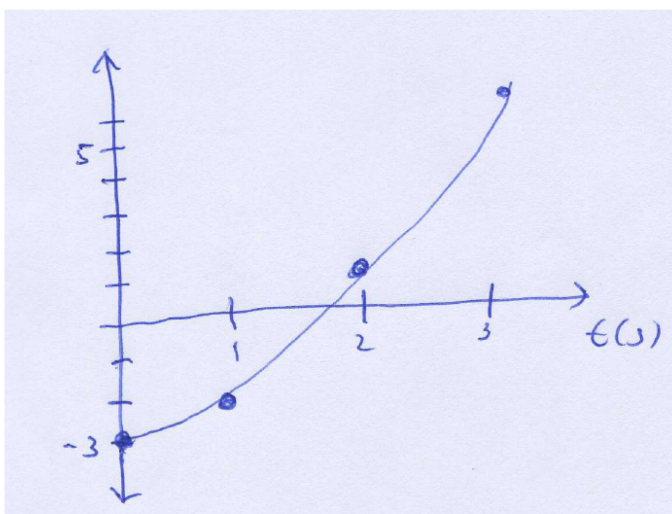
d) In addition to the motion in part c, the ball moves with a constant horizontal velocity w (see figure)

e) Newton's laws of motion are the same for both inertial observers, the difference is that the women on the train uses an initial velocity w in the horizontal direction. (NOTE: technically speaking the Earth is not an inertial reference frame. If you stated that neither can use $F = ma$ for this reason, thats OK too. Unless the ball is thrown absurdly high, however, its unlikely that the Earth's acceleration will be noticeable.).





2. The equation for position is $x = x_i + \frac{1}{2}at^2 = -3m + t^2$

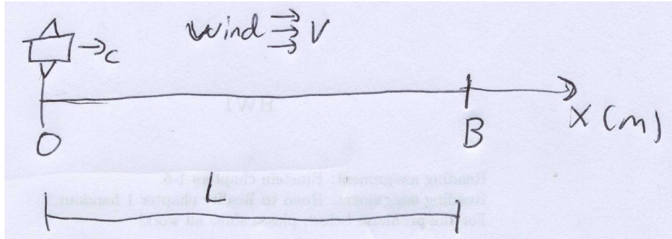


b) While accelerating the seat pushes you forward (The seat accelerates due to the engine, which transmits its force to the seat by way of the car's frame).

c) You are not inertial. You are accelerating.

4. *Distance* = (*rate*) × (*time*)

Going from O to B we find $L = (c+v)T_1 \rightarrow T_1 = L/(c+v)$. Going from B to O we find $L = (c-v)T_2 \rightarrow T_2 = L/(c-v)$. And so $T_{\text{total}} = T_1 + T_2 = L/(c+v) + L/(c-v) = \frac{L(c-v)+L(c+v)}{(c+v)(c-v)} = \frac{2LC}{c^2-v^2} = \frac{2L}{c(1-v^2/c^2)}$



5. Lets enumerate the different coordinate relationships. K' coordinates in K

$$y' = y \qquad t' = t \qquad x' = x - vt \tag{1}$$

and K" coordinates in K'

$$y'' = y' \qquad t'' = t' \qquad x'' = x' - wt' \rightarrow y' = y'' \qquad t' = t'' \qquad x' = x'' + wt' \tag{2}$$

Now substitute Equations (2) into (1) and solve for K" coordinates in K

$$y'' = y \qquad t'' = t \qquad x'' = x - vt - wt = x - (v + w)t \tag{3}$$

So we must have $v = -w$. For some intuition, imagine a train moving at $10m/s$ to the right as measured by a person standing at the train station. Then a person riding a bike on the top of that train moving at a speed of $10m/s$ to the left, measured by someone on the train, will appear to be stationary when viewed from the train station.

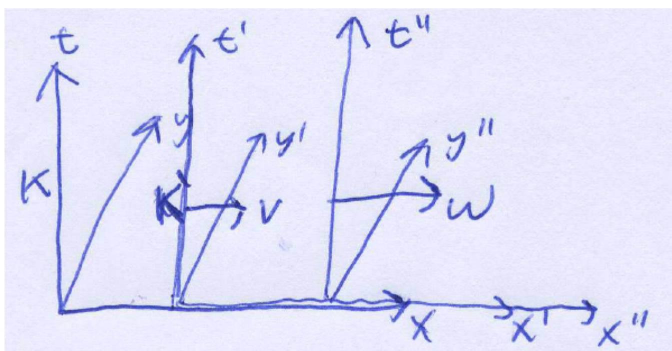


FIG. 1. NOTE: the axis t should be z