DISPLACEMENT AT MOTION WITH ACCELERATION

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Theory recap

The main formula to use when finding how far will an object travel during time t while moving with acceleration $\vec{a}$ and starting with initial velocity $\vec{v}_0$ is

$$\vec{d} = \vec{v}_0 t + \frac{\vec{a}t^2}{2}$$

As always, pay attention to signs when applying this formula. Assign some direction as positive, then if displacement, velocity or acceleration look in the opposite direction, you should take them with a minus sign.

Alternatively, you could find displacement from average velocity. Then you need to remember that for motion with constant acceleration average velocity is the average between initial and final velocity.

Today we also discussed how to find the free fall acceleration experimentally. The goal was to determine free fall acceleration by measuring the time t it takes a ball to fall from some height h. If the ball is initially at rest, then from our general formula h in terms of g and t is

$$h = \frac{gt^2}{2}$$

For our experiment we need to reverse this formula and express g in terms of h and t. Then by measuring h and t we could calculate free fall acceleration:

$$g = \frac{2h}{t^2}.$$

Homework

1. Several weeks ago we calculated acceleration of Tesla model S Performance based on the fact that it reaches speed $v = 60$ mph in just $t = 2.4$ s. You could use your corresponding homework as a reference if you do not want to calculate everything from scratch.
   (a) Now find how far does the car travel during this acceleration. *If you want an extra challenge*, try to express the answer via the letters (v and t) and only then plug in the numbers.
   (b) We have also found previously how long it would take to brake from 60 mph with acceleration 4 m/s^2. Now find the braking distance (how far does the car travel during braking before it stops).

2. You have a bet with your friend that you could throw a ball higher than the roof of your school. Your school is 6 m high. You throw the ball vertically up with initial speed 15 m/s.
   (a) In what time will it reach the highest point? (hint: at highest point the ball has to stop - if it has not stopped yet it would go even higher)
   (b) What height will the ball reach? Did you win the bet?

(c) In what time after you threw the ball will it return to the ground?

The following problem is a bonus problem.

***3.** You stay next to the front door of the first carriage of a train on a train station. The train starts to move with a constant acceleration. You notice that exactly in 3 seconds after the train started moving the front door of the second carriage passes you. How many carriages will move past you in the following 3 seconds? And then in the next 3 seconds after that? Assume that it's a very long train and all the carriages have the same length.