LECTURE 05: Physical representation (picture)

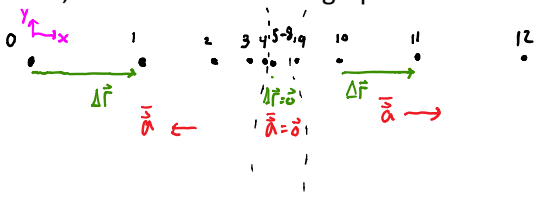
Select LEARNING OBJECTIVES:

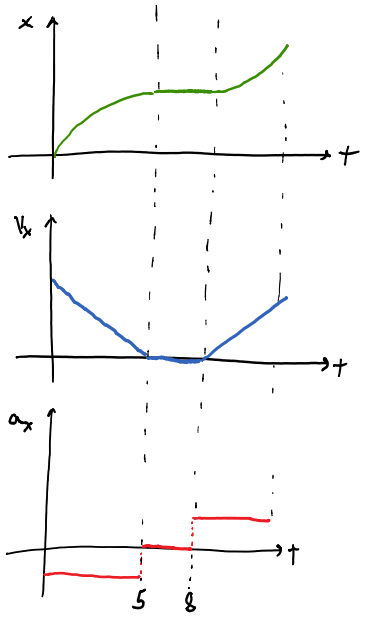
i. Demonstrate the ability to construct a physical representation properly identifying initial and final locations and the corresponding physical quantities.

TEXTBOOK CHAPTERS:

- Giancoli (Physics Principles with Applications 7th) :: Part of problem solving strategy in 2-6 and 3-6
- Knight (College Physics : A strategic approach 3rd) :: Part of problem solving strategy in 2.6 ; tactics box 2.2 ; part of problem solving strategy in 3.7
- BoxSand :: Kinematics (1D Kinematics - Multiple Representations)

WARM UP: Draw a motion diagram for a car driving on a straight horizontal road braking for a stop light, waiting at the red light for a little bit, then driving away. Also sketch position vs time, velocity vs time, acceleration vs time graphs.





Physics is too often thought of as a collection of facts and equations that one must memorize and regurgitate during an exam or quiz. Quite the contrary, getting to the end result by memorizing specific equations will not get you far in this course or in life. In fact, you can pass this course with high marks without ever getting the correct final answer. We are more interested in helping you think like a physicist, which means that we care more about how you get to a result, rather than the result itself. Some underlying principles which will help you think and approach all sorts of problems (even problems not related to physics) are: making simplifying assumptions, translating a problem into another representation to help visualize, collecting your thoughts (e.g. listing knowns and unknowns), using basic physical models to work towards a solution, and finally reflecting upon the solution (whether right or wrong) which involves reasonableness checks and some sort of personalization thought process. We will work on all of these principles throughout this course, but this lecture will focus on translating a problem into a different representation, specifically the physical representation.

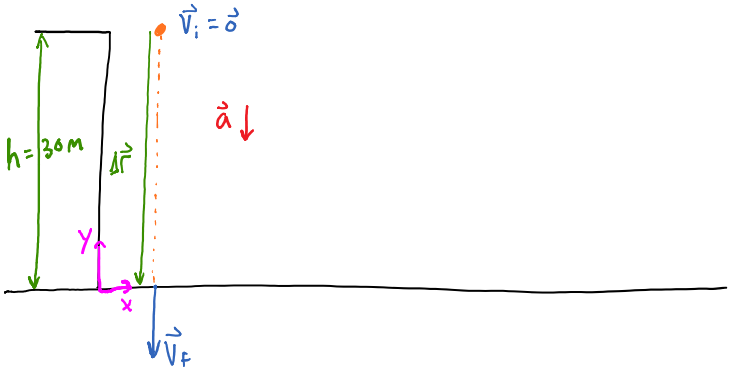
The ability to take a word problem, or even a photograph and translate it into a physical representation is often overlooked. This physical representation will serve as your tool to help solve problems. This tool will provide you will all the relevant information you need to continue on your path to solving a problem, while freeing up some brain space so that you don't have to struggle to hold onto a mental picture of the problem. Almost all problems we do this term have some physical significance to the real world, a physical representation is your visual link to this real phenomena. And at a more fundamental level, the ability to sift through information to create a physical representation which is an abstract way to view a problem, demands a high level of creativity.

So let's get to it. Almost all topics we cover will have their own version of a physical representation. Here, we are working under the umbrella of kinematics, which deals with the description of an objects motion through space and time without regards to why it is moving in the first place. A physical representation relating to kinematics should include the following pieces of information:

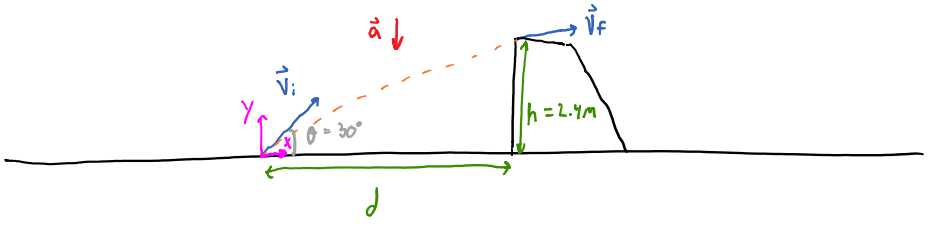
1) Basic sketch of the physical scenario. Perhaps the outline of a building, a horizontal road, etc…
2) A trajectory of the object.
3) Velocity vectors located at at-least 2 specific locations.
4) Acceleration vector(s) for the object.
5) Displacement vector(s), or labeled dimensions.
6) COORDINATE SYSTEM at a specific location.

Let's start with an example. We will only be drawing a picture for each problem, and not attempting to solve it. Drawing pictures like these are the first step when actually attempting to solve a kinematics type problem.

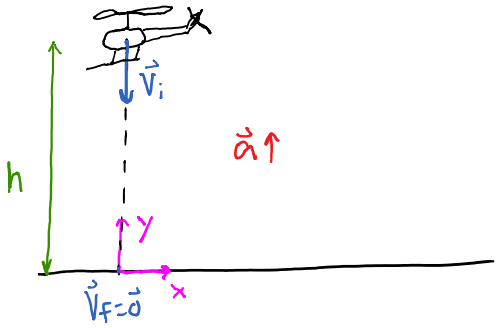
EXAMPLE (1-D): A penny is dropped from the top of a 30 m tall building.



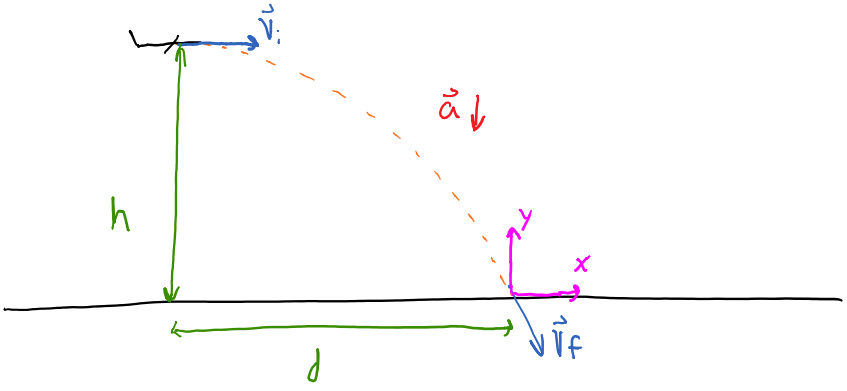
EXAMPLE (2-D): A soccer ball is kicked from the level ground at an angle of 30 degrees with respect to the horizontal. The ball then hits the top of the goal post at a height of 2.44 m above the level ground.



PRACTICE: A helicopter descends vertically downwards, decreasing its speed with a constant acceleration until it touches down.



PRACTICE: An airplane is accelerating from 80 mph to 100mph in a straight line at an altitude of 3,000 ft above ground level. A ball is dropped from the airplane when the airplane hits a speed of 90 mph.



Conceptual problems for practice

1) Can you think of a scenario in your life where drawing a physical representation might be of benefit? (This does not have to be a formal kinematics picture like the ones we practiced in this lecture.)