Distance, Displacement, and Position

The goal of this problem set is to consider the precise definitions of distance, displacement, and position in a 1-dimension.

In particular, consider the precise definition of *position*.
Position is probably the most fundamental kinematic quantity, but very often physics students overlook precisely what *position* is.

Distance: (d)
Distance is the sum total of motion for a person.
Distance is typically considered for an entire journey.
Distance is a scalar, it has magnitude only and no direction.

In physics, the *sign* of a vector describes its direction. Because scalars have no direction, they are always positive (with a few exceptions).

Displacement (Δx)
Displacement is the *change in position*.

Displacement is typically considered for an entire journey.

Displacement is a vector, meaning it has both magnitude and direction.
In one-dimension, we typically represent the direction of a vector with the sign.

Displacement can be calculated mathematically as final position – initial position.

Position (x)
The position is described as "distance from an arbitrary reference point, called the *origin*.

Unlike distance and displacement, position is always considered at one moment and can never be considered for an entire journey.

Position is a vector, meaning it has both magnitude and direction. In one-dimension, we typically represent the direction of a vector with the sign.

Whenever using position as a variable in a problem, it is always good to **explicitly** describe the point you select as the origin.

Distance, Displacement, and Position Name ______________________

Setting up a 1-dimensional Kinematics Problem:

In order to properly set up a kinematics problem, you need to
a) determine a single point to be the origin.
b) determine one direction which will be the positive direction, and another direction to be the negative direction.

This can be called setting up a "coordinate system."

It is a very good practice to always **explicitly** describe the coordinate system you are setting up. This is one of the small nuances that is often overlooked but can lead to confusion down the road.

Therefore, I would recommend in any problem that is more complicated than simply forward motion, to **explicitly** identify the origin and to identify the positive and negative direction in a problem.

Conventions
A convention is a method that many different people use

Frequently,
when a problem is horizontal,
the positive direction is to the right and the negative direction is to the left**.

When a problem is vertical:
the origin is the ground, the positive direction is up and the negative direction is down.

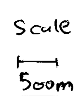
You do not have to follow typical conventions of motion. However, *even when you do*, please **explicitly** describe the location of the origin and the positive and negative directions.

Also,
**Note that the convention for horizontal problems can be somewhat problematic because *left* and *right* are not universally defined directions. Simply turning around reverses left and right. So, when possible, it is better to describe directions such as "towards the door" or "away from the window," because these directions do not reverse.

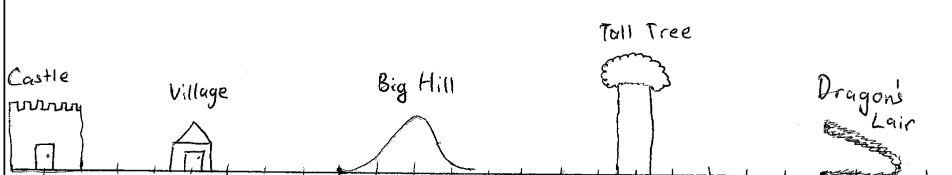
We are going to practice using these quantities by taking a silly story and analyzing it using distance, displacement, and position.

The Legend of Nick the Knight

(Pronounced Nick the ki-nicked,
which was the proper pronunciation
in Chaucer's day.)



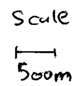
Once upon a time in a one-dimensional world there lived a brave stick figure knight named Nick.

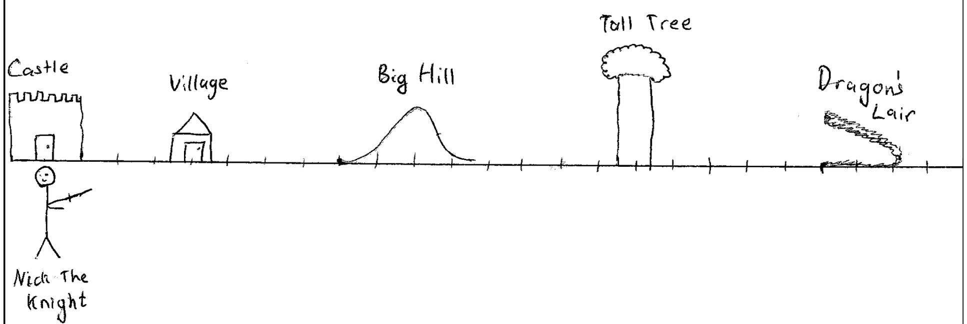


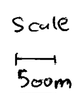
His world consisted only of a castle, a village that had merely one house, a big hill, a tree much taller than the hill, and a lair in which lived a terrible dragon.

One day, Nick went out to slay the dragon. This is his story.

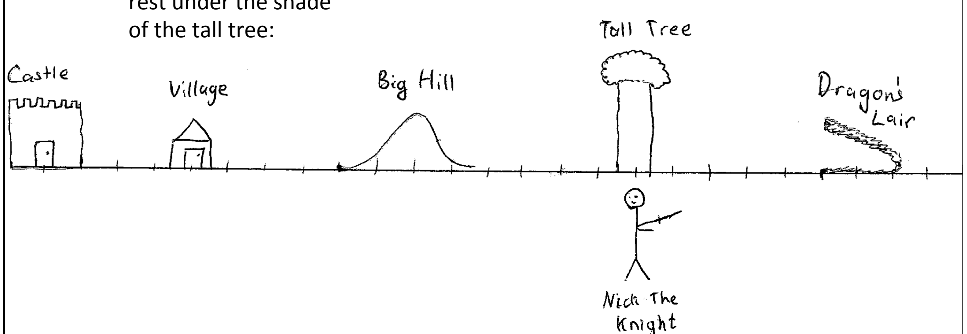
Chapter 1: Nick sets out from the castle to travel to the dragon's lair. Here begins Nick's Journey.



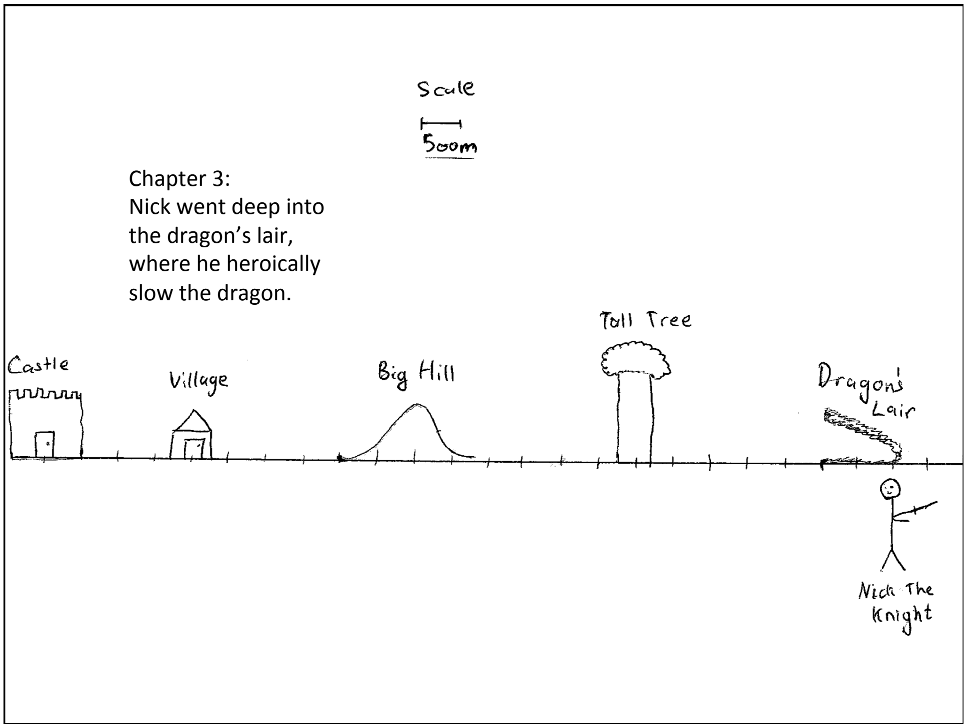




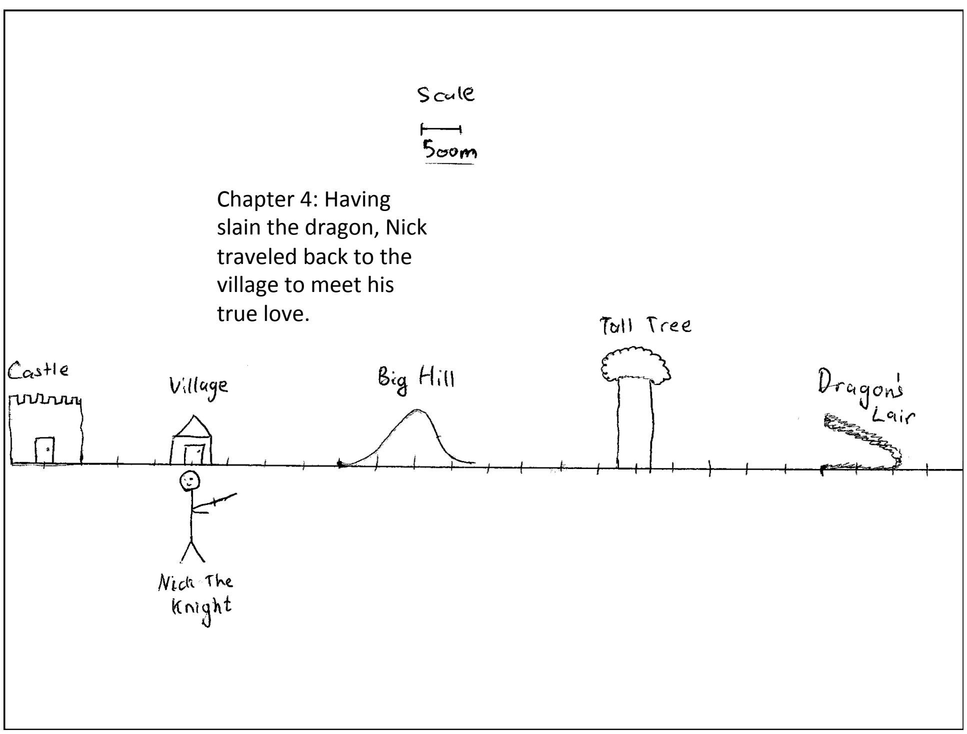
Chapter 2
He traveled past the village and over the big hill, but stopped to rest under the shade of the tall tree:



Chapter 3:
Nick went deep into the dragon's lair, where he heroically slow the dragon.



Chapter 4: Having slain the dragon, Nick traveled back to the village to meet his true love.



Distance, Displacement, and Position Name ______________________

The Legend of Nick the Knight
(pronounced Nick the Ki-Nicked, which is the proper Middle English pronunciation of the word "Knight")

One day Nick the Knight decided to go on a quest to slay the dragon.
Chapter 1: Nick sets out from the castle to travel to the dragon's lair. Here begins Nick's Journey.
Chapter 2:- He then traveled past the village and the over big hill, but stopped to rest under the shade of the tall tree.
Chapter 3- Then he traveled to the dragon's lair, where he heroically slew the dragon.
Chapter 4: Having slain the dragon, Nick traveled back to the village to meet his true love. here ends Nick's journey.

Goal: To determine Nick's position at each step of his journey, as well as his displacement and distance. However, you will view the journey from three different points of view, in which the origin and the direction of the axes will be different.

Point of view 1:
The *origin* is the door to the castle. The positive direction is defined as towards the dragon's lair, and the negative direction is the opposite.

Point of view 2:
The *origin* is defined as the entrance of the dragon's lair. The positive direction is defined as towards the castle, and the negative direction is the opposite.

Point of view 3:
The *origin* is defined as the top of the big hill. The positive direction is defined as towards the dragon's lair, and the negative direction is towards the castle.

Distance, Displacement, and Position Name ______________________

Point of View the First:
The *origin* is the door to the castle. The positive direction is defined as towards the dragon's lair, and the negative direction is the opposite.

Chapter	**Position:**	**Displacement:**	**Distance of this step:**	**Cumulative Distance**
Chapter 1:				
Chapter 2:				
Chapter 3:				
Chapter 4:				

What is Nick's Total Displacement? (Total Displacement = Initial Position – Final Position)
Displacement is a VECTOR.

What is Nick's total distance? (Distance is a scalar)

Point of View the Second:
The *origin* is defined as the entrance of the dragon's lair. The positive direction is defined as towards the castle, and the negative direction is the opposite.

Chapter	**Position:**	**Displacement:**	**Distance of this step:**	**Cumulative Distance**
Chapter 1:				
Chapter 2:				
Chapter 3:				
Chapter 4:				

What is Nick's Total Displacement? (Total Displacement = Initial Position – Final Position)
Displacement is a VECTOR.

What is Nick's total distance? (Distance is a scalar)

Distance, Displacement, and Position Name ______________________

Point of View the Third:
The *origin* is defined as the top of the big hill. The positive direction is defined as towards the dragon's lair, and the negative direction is towards the castle.
The *origin* is defined as the entrance of the dragon's lair. The positive direction is defined as towards the castle, and the negative direction is the opposite.

Chapter	**Position:**	**Displacement:**	**Distance of this step:**	**Cumulative Distance**
Chapter 1:				
Chapter 2:				
Chapter 3:				
Chapter 4:				

What is Nick's Total Displacement? (Total Displacement = Initial Position – Final Position)
Displacement is a VECTOR.

What is Nick's total distance? (Distance is a scalar)

Distance, Displacement, and Position Name ________________________

Overall Questions:

Does the magnitude of Nick's Displacement depend upon the origin you selected? Explain how you know:

The *sign* of Nick's displacement should be different for the different points of view. Why?

Represent Nick's displacement as an arrow. (Any vector can be represented as an arrow.) Does this depend in any way on the point of view?

Does Nick's Distance depend upon the location of the origin?

Can distance ever be negative? Explain why or why not: