Name: _____

Lesson 1.6. Displacement

Date: _____   Period: _____

Get to the point, please.

1) An object's *position* is the distance and direction *from* a reference point *to* the object.
2) An object's *displacement* is the distance and direction it traveled from one position to another position.
3) You determine the value of displacement by *calculating* the difference between two position measurements.

Displacement

In order to determine whether something *moved*, you must observe its position *twice*: once earlier in time, and again later in time. If the object's position changes from one observation to the next, then the object moved. And, in order to study something that moves continuously, you must observe its position over and over again, spread out over an extended period of time. Thus, one of the fundamental measurements in the study of motion is the measurement of *position*. (The other fundamental measurement is the measurement of *time point*.) A *position* value answers the question, "Where is it located?"

Now that we know how to tell whether something moved at all, the next question is, "*How far* and in what direction did it move?" Remember, we only measure the *positions* of markers placed next to the moving object at evenly-spaced *time points*; that is all the data we have. So, how can we use *position* measurements to figure out *how far* something moved?
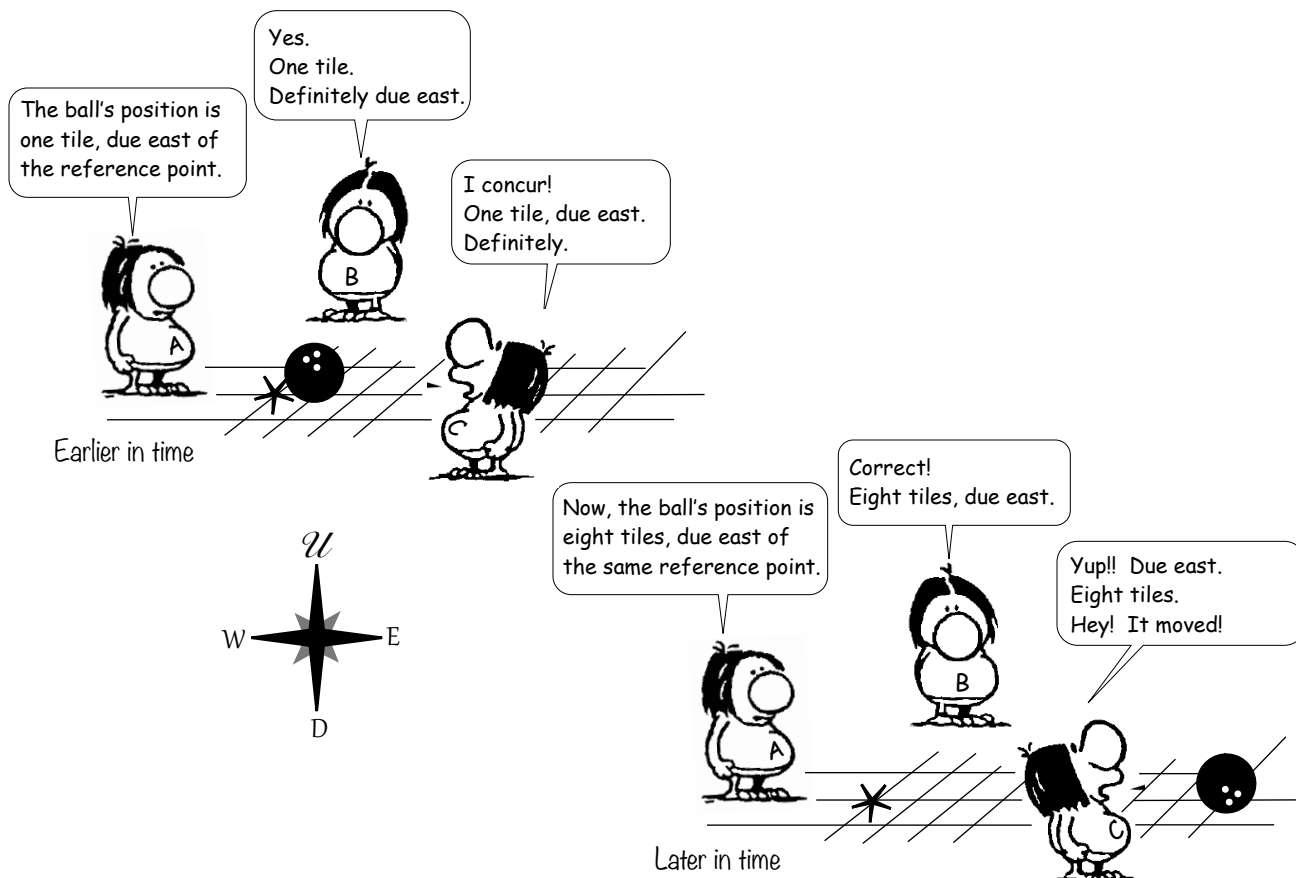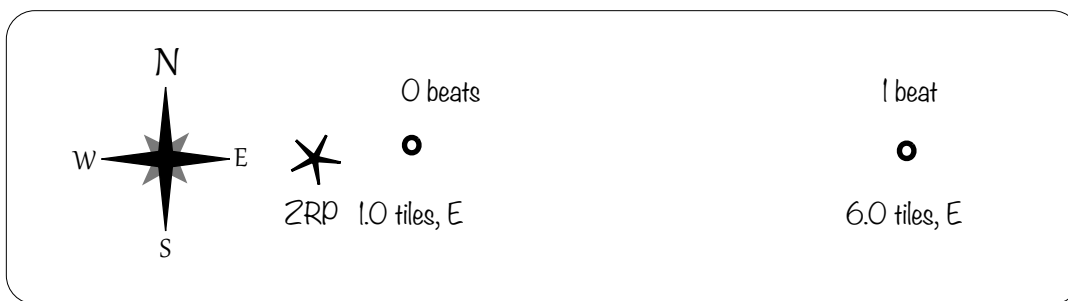
Q: How can you use *position* measurements to determine the distance *between* the washers?

I'll bet you already know how to do this! For example, consider the diagram above showing the positions of two washers placed beside a groovy dune buggy as it traveled along the floor. Can you figure out how far it traveled during the interval from 0 beats to 1 beat? Please carefully explain *exactly* what you did! If you do not know how to figure this out, then read on. However, it would be much better if you tried to answer by yourself, first.

_____

_____

_____

A: You subtract the earlier position value *from* the later position value!

We must pause here in order to define an important physics quantity: *displacement*. *Displacement* is defined as a *change of position*. Change in *anything* is always equal to the later value minus the earlier value; thus change in *position* is equal to the later position minus the earlier position. *Displacement* tells you the distance and the direction between one position and another.

> **displacement ≡ change of position**
>
> displacement = final position − initial position
>
> $\text{displacement}_{i \to f} = \text{position}_f = \text{position}_i$

Just subtract the *earlier position* from the *later position*. In this case, the later position is 6.0 tiles, E , and the earlier position is 1.0 tile, E.
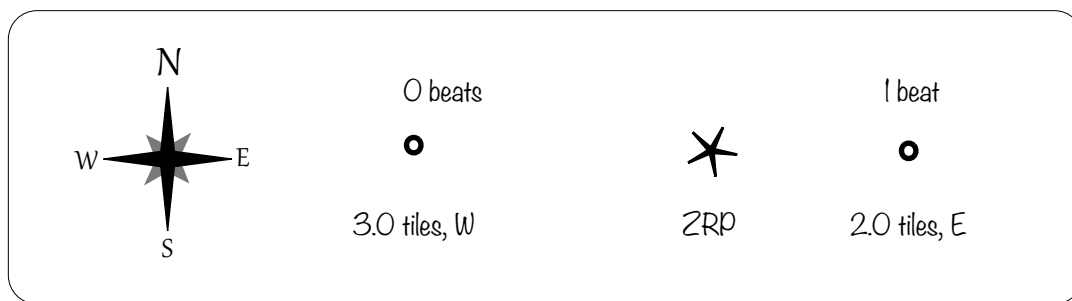
$\text{displacement}_{0 \to 1} = \text{position}_1 - \text{position}_0$

$\text{displacement}_{0 \to 1} = 6.0 \text{ tiles} - 1.0 \text{ tile}$

*Both position values are **positive** because the buggy was **east** of the reference point.*

$\text{displacement}_{0 \to 1} = 5.0 \text{ tiles, eastward}$

During the interval from 0 beats to 1 beat, the buggy traveled 5.0 tiles, eastward

N

0 beats   1 beat

W ——— E

O   ✕   O

S

3.0 tiles, W   ZRP   2.0 tiles, E

This time, the earlier washer is *west* of the reference point, so its value will be ***negative*** for the arithmetic.

$$\text{displacement}_{0\to 1} = \text{position}_1 - \text{position}_0$$

$$\text{displacement}_{0\to 1} = 2.0 \text{ tiles} - (-3.0 \text{ tiles})$$

$$\text{displacement}_{0\to 1} = 5.0 \text{ tiles, eastward}$$

During the interval from 0 beats to 1 beat, the buggy traveled 5.0 tiles, eastward

*The earlier position is **negative** here because the buggy was **west** of the reference point.*

Some Rules

In mathematical statements (only):

✳ **East**, **north**, and **up** are indicated by a **positive** sign (this is usually not written; it is the "default" sign).
For example, **1.7 tiles, east** is written, **1.7 tiles**

✳ **West**, **south**, and **down** are indicated by a **negative** sign.
For example, **3.6 tiles, west** is written, **−3.6 tiles**

✳ Direction of **position** is stated just plain: **east**, **west**, **north**, **south**, **up**, or **down**.
The position of the buggy at time point 2 beats was **1.7 tiles, east**.

✳ Direction of **displacement** has "-ward" after the direction: **eastward**, **southward**, **upward**.
During the time interval from 3 beats to 4 beats, the buggy traveled **3.6 tiles, westward**.

Please note: the positive or negative sign is used only in mathematical statements! In your answers, the direction is indicated by a capital letter for the cardinal direction: **N, S, E, W, U, D**.

Practice
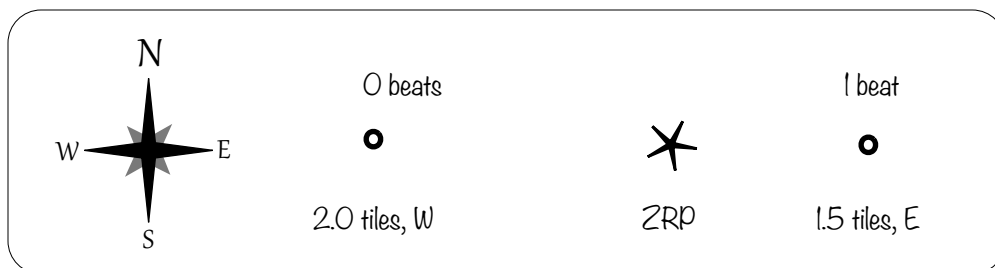
	0 beats		1 beat
	2.0 tiles, W	ZRP	1.5 tiles, E

1) In the space below, neatly write out the displacement calculation for the diagram above.

	1 beat		0 beats
	6.0 tiles, S	ZRP	4.0 tiles, N
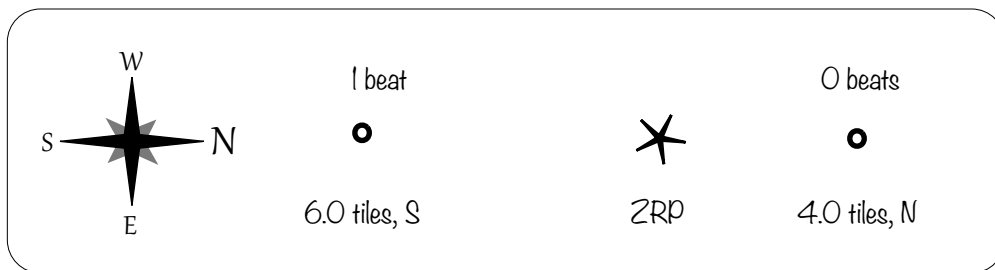
2) In the space below, neatly write out the displacement calculation for the diagram above.
    (*Be careful! Which is the later position here?*)

Answers:
1) During the interval from 0 beats to 1 beat, the buggy traveled 3.5 tiles, eastward
2) During the interval from 0 beats to 1 beat, the buggy traveled 10.0 tiles, southward
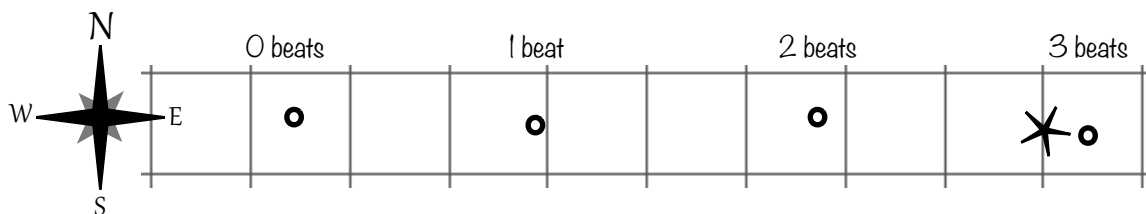
Homework 1.6. Displacement

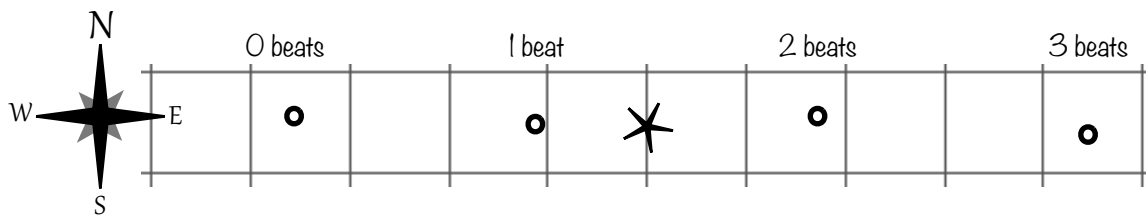*Please answer the following questions neatly, in pencil, on a nice, clean sheet of lined notebook paper.*

Examples of the correct format of calculations are in the lesson.

For questions requiring a written answer, please carefully and fully express your ideas as complete thoughts written in clear, declarative English sentences. Make every pronoun refer unmistakably to a definite antecedent. Whenever possible, justify your reasoning by stating the physics principle.
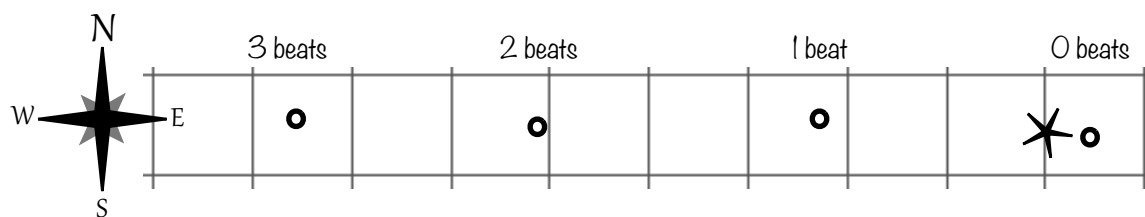
When I read your answers, I should be able to tell that you studied and understood the lesson and that you learned something from it!
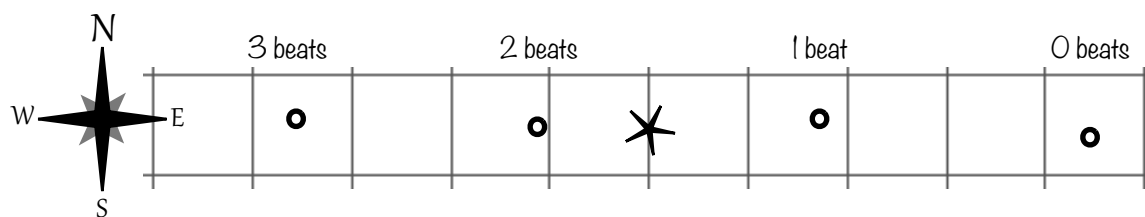
1) Consider the diagram above showing washers placed as a dune buggy traveled along the floor of the physics classroom.

    a) Label the position value of each washer **right on the printed sheet**.

    b) On your notebook paper, determine the *displacement* of the buggy during the intervals from 0 beats to 1 beat, and from 2 beats to 3 beats. (*Hint, you will perform two calculations. You may write the formula just once, but the other steps must be written out for each calculation.*)

2) Here is the same pattern of washers as shown in question 1 above, but the reference point is in a different place.

    a) Do you predict that the *position* values will change? Carefully explain your thinking.

    b) Do you predict that the *displacement* values will change? Carefully explain your thinking.

    c) Label the position value of each washer **right on the printed sheet.**

    d) On your notebook paper, determine the *displacement* of the buggy during the intervals from 0 beats to 1 beat, and from 2 beats to 3 beats. (*Hint, you will perform two calculations. You may write the formula just once, but the other steps must be written out for each calculation.*)

N
W —✴— E
S

3 beats	2 beats	1 beat	0 beats
○	○	○	✳○

3) Consider the diagram above showing washers placed as a dune buggy traveled along the floor of the physics classroom.

   a) Label the position value of each washer **right on the printed sheet**.

   b) On your notebook paper, determine the *displacement* of the buggy during the intervals from 0 beats to 1 beat, and from 2 beats to 3 beats. (*Hint, you will perform two calculations. You may write the formula just once, but the other steps must be written out for each calculation.*)

N
W —✴— E
S

3 beats	2 beats	1 beat	0 beats
○	○ ✕	○	○

4) Here is the same pattern of washers as shown in question 3 above, but the reference point is in a different place.

   a) Do you predict that the *position* values will change? Carefully explain your thinking.

   b) Do you predict that the *displacement* values will change? Carefully explain your thinking.

   c) Label the position value of each washer **right on the printed sheet.**

   d) On your notebook paper, determine the *displacement* of the buggy during the intervals from 0 beats to 1 beat, and from 2 beats to 3 beats. (*Hint, you will perform two calculations. You may write the formula just once, but the other steps must be written out for each calculation.*)
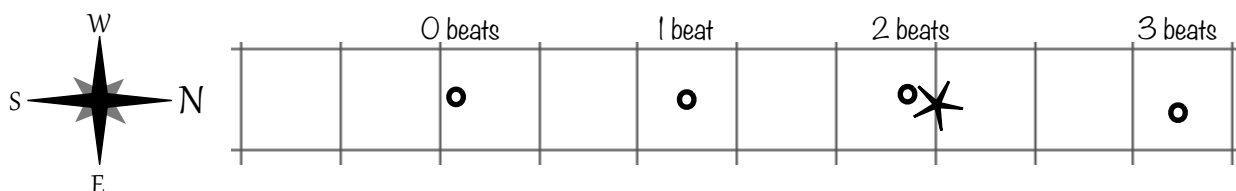
Homework 1.6. Displacement

Name: _____

Date: _____   Period: _____

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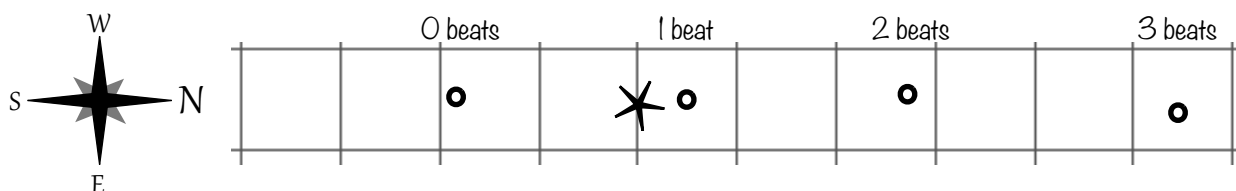
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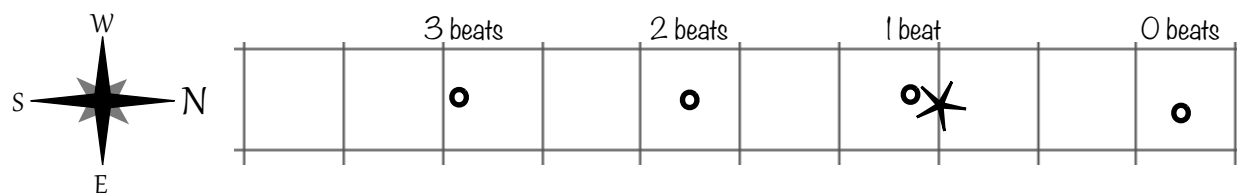
When I read your answers, I should be able to tell that you studied and understood the lesson and that you learned something from it!

W
S ——✦—— N
E

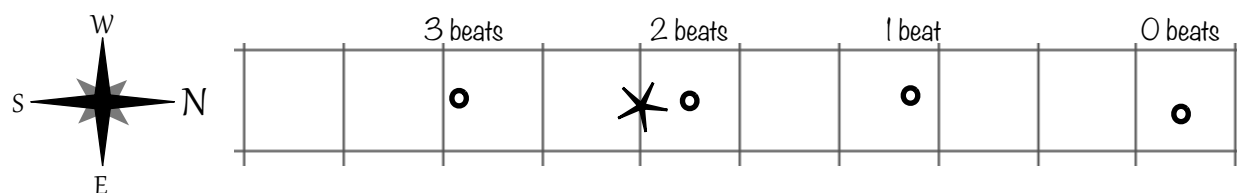| | | 0 beats | | 1 beat | | 2 beats | | 3 beats | |
| | | ○ | | ○ | | ○✶ | | ○ | |

1) Consider the diagram above showing washers placed as a dune buggy traveled along the floor of the physics classroom.

   a) Label the position value of each washer **right on the printed sheet**.

   b) On your notebook paper, determine the *displacement* of the buggy during the intervals from 0 beats to 1 beat, and from 2 beats to 3 beats. (*Hint, you will perform two calculations. You may write the formula just once, but the other steps must be written out for each calculation.*)

W
S ——✦—— N
E

| | | 0 beats | | 1 beat | | 2 beats | | 3 beats | |
| | | ○ | | ✶○ | | ○ | | ○ | |

2) Above is the same pattern of washers as shown in question 1 above, but the reference point is in a different place.

   a) Do you predict that the *position* values will be different than they were in question1? Carefully explain your thinking.

   b) Do you predict that the *displacement* values will be different than they were in question 1? Carefully explain your thinking.

   c) Label the position value of each washer **right on the printed sheet.**

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W
S —✴— N
E

3 beats   2 beats   1 beat   0 beats

3) Consider the diagram above showing washers placed as a dune buggy traveled along the floor of the physics classroom.

    a) Label the position value of each washer ***right on the printed sheet***.

    b) On your notebook paper, determine the *displacement* of the buggy during the intervals from 0 beats to 1 beat, and from 2 beats to 3 beats. (*Hint, you will perform two calculations. You may write the formula just once, but the other steps must be written out for each calculation.*)

W
S —✴— N
E

3 beats   2 beats   1 beat   0 beats

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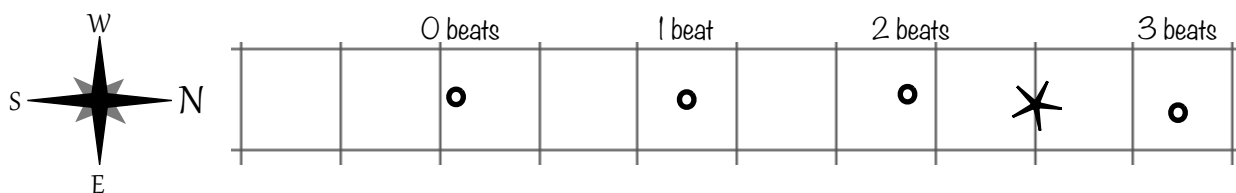
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Date: _____ Period: _____

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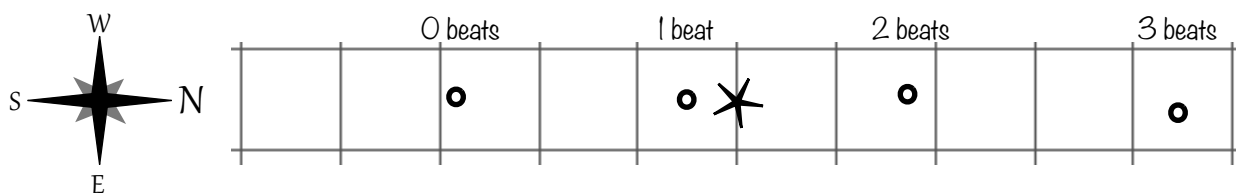
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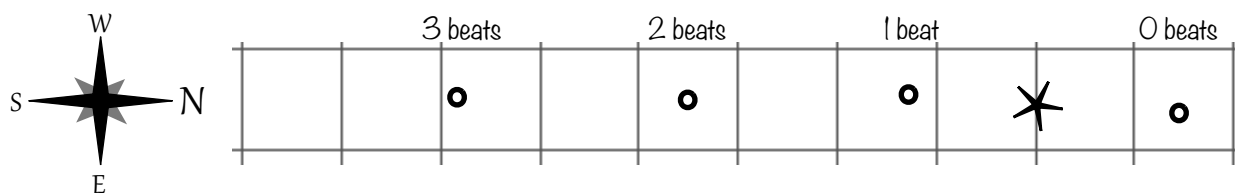
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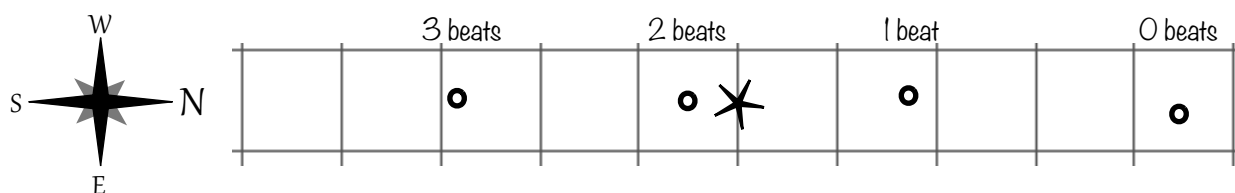
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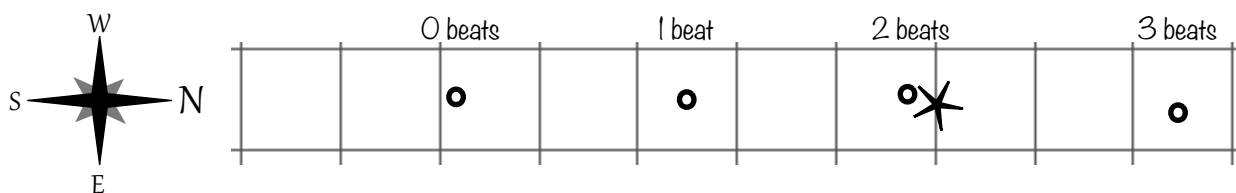
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Homework 1.6. Displacement

Date: _____   Period: _____

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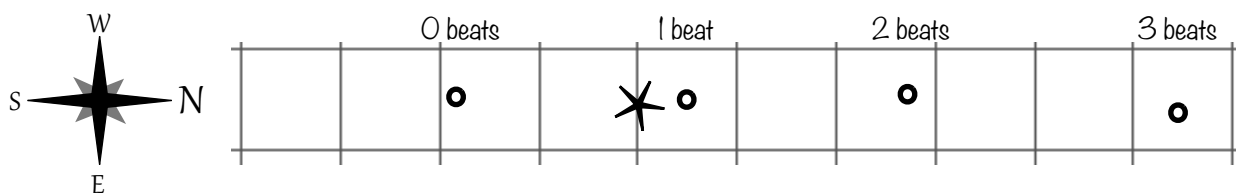
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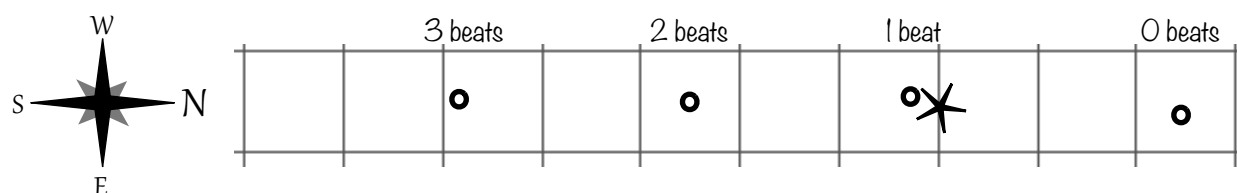
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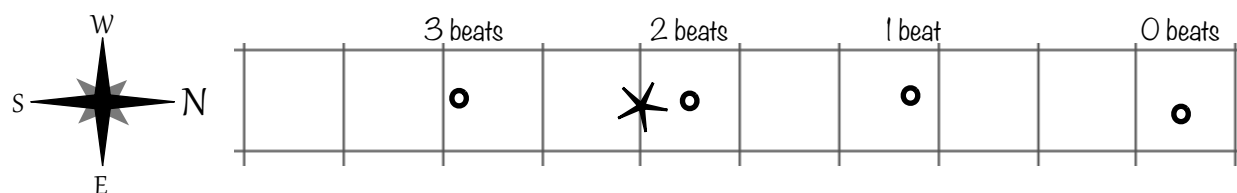
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   c) Label the position value of each washer ***right on the printed sheet.***

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W
S ✦ N
E

3 beats   2 beats   1 beat   0 beats

3) Consider the diagram above showing washers placed as a dune buggy traveled along the floor of the physics classroom.

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Name: _____

Lab Activity 1.1. An Interesting Question!

Date: _____   Period: _____

Science is performed *in community*; and it is important that everybody who performs a given measurement obtains the same, or equivalent, result. The students of Lab Group I have discovered that it is necessary to first agree upon four things before they can all assign the same numbers to the position of a stationary object. Please list the four things.

1) _____

2) _____

3) _____

4) _____

Now, the students of Lab Group A approach Lab Group 1 to propose an experiment.
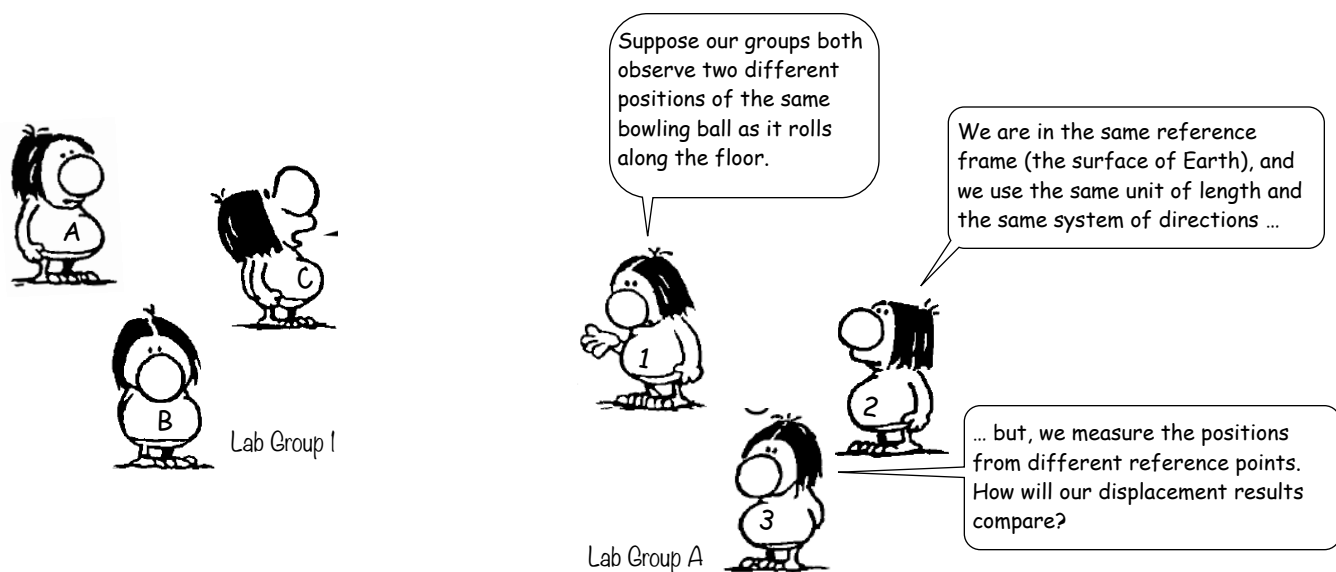
Everybody agrees. That *is* an interesting question! What do you predict is the answer? Carefully explain your thinking.

_____

_____

_____

_____

In your own group, please write out the steps you must follow in order to perform this experiment; then make sure your partner group agrees with your steps! If not, then reconcile the differences together. You may write out your thoughts and notes on a piece of scratch paper if you like, however the final draft should be neatly organized on lined notebook paper.

Then, do the experiment!