**Instructional Design**

**9th Grade Science: Motion**

By: Kathrine Miller

**Rationale**

When teaching science one element that allows students to understand the concepts are the ability to apply it to their life and experience it firsthand. According to the Center for Science, Mathematics, and Engineering Education, **“The program of study must emphasize student understanding through inquiry” because “**Inquiry is a critical component of a science program at all grade levels and in every domain of science, and designers of curricula and programs must be sure that the approach to content, as well as the teaching and assessment strategies, reflect the acquisition of scientific understanding through inquiry. Students then will learn science in a way that reflects how science actually works.” This is not new to science teachers but the State of Ohio is adding it to the new core standards to all levels of high school science. So for my unit on motion it is important to have both inquiry and contextual teaching in my lesson plans.

When deciding what type of lesson plan structure to use I had to keep both the inquiry and contextual teaching in mind. Both are not very different from one another inquiry allows them to learn how science really works and contextual teaching is “a conception of teaching and learning that helps teachers relate subject matter content to real world situations and motivates students to make connections between knowledge and its applications to their lives as family members, citizens, and workers” (Berns and Erickson, 2001). Since both are important I chose to use the basic model because it allows for modification and differentiation. This instructional design can also be altered if the amount of time allotted for the lesson changes or the content involved in the lesson needs to be reviewed. The topic I am covering in my unit is motion. This topic involves both math equations and science concepts. Using the basic design for this unit allows for both activities and instruction to be used to teach the concepts. Students will also take away valuable skills such as solving equations and problem solving from this unit. This design also will be easily changed depending on the outcome of the student’s abilities on the pre-assessment or if there are students in the class who require modifications.

The design of my project using the basic lesson model allows for the use of both inquiry and contextual learning strategies. In the always changing science curriculum it is important to use a design that can be easily modified or added to meet the needs of all students. This specific unit was created with the changing curriculum in mind and with the knowledge that the students need to form an ownership with their learning.

References

Berns, R.G., & Erickson, P. M. (2001). Contextual teaching and learning: Preparing students for the new economy. The highlight zone: research @ work no. 5. Retrieved September 17, 2002, from <http://nccte.com/publications/infosynthesis/highlightzone/highlight05/highlight05-CTL.html>

Center for Science, Mathematics, and Engineering Education. (1996). Chapter 7 Science Education

Program Standards . In NATIONAL ACADEMY PRESS (Ed.), *National Science Education Standards* (pp. 209-226)). Retrieved from http://www.nap.edu/openbook.php?record\_id=4962&page=R2

**Learning Outcomes**

**Unit One-Motion:**

Students will be able to explain the difference between speed and velocity. (Comprehension)

Students will be able to calculate the velocity of objects given the equation. (Application)

Students will distinguish the difference between distance and displacement. (Comprehension)

Students will create and interpret graphs depicting distance verse time. (Analysis, Synthesis)

Students will be able to utilize a reference frame to locate an objects position. (Application)

Unit Two-Acceleration:

Students will relate the ideas of acceleration, time, and velocity. (Analysis)

Students will be able to calculate the acceleration of an object given the equation. (Application)

Students will be able to explain how positive and negative acceleration affect motion.(Synthesis)

Unit Three-Force:

Students will compare and contrast static, sliding, and rolling friction. (Analysis)

Students will be able to explain the difference between balanced and unbalanced forces. (Comprehension)

Students will be able to describe the affects of air resistance on a falling object. (Knowledge)

Students will be able to explain and describe the concept of gravity and how it affects an objects motion. (Knowledge and Comprehension)

Unit Four-Newton’s 3 Laws:

Students will be able to define Newton’s three laws of motion. (Knowledge)

Students will be able to explain how mass and inertia are related. (Synthesis)

Students will be able to identify action and reaction forces. (Knowledge)

Students will be able to calculate an objects momentum given the equation. (Application)

**Pre-Assessment**

***Fill in the following blanks with the correct vocabulary word.***

1. Motion is a change in \_\_\_\_\_\_\_\_\_\_\_\_\_\_.

2. The position of an object depends on a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

3. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is the distance and direction of an objects final position from its initial position.

4. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is the distance an object travels per unit of time.

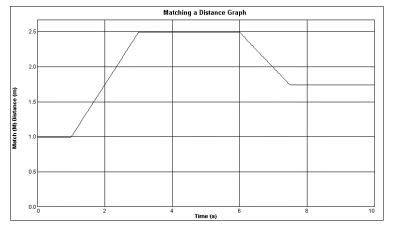
5.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_ is the speed of an object at a single instant of time.

6. \_\_\_\_\_\_\_\_\_\_\_\_\_\_ is the speed of an object and its direction of motion.

***Use the equation for velocity (v=d/t) to solve the following word problems. Show all work and label with correct units.***

7. What is the velocity of a car that travels 1050m in 50s?

***Use the following graph to answer the following questions.***



8. Describe the motion represented by a horizontal line on a distance-time graph.

9. The slope of a distance-time graph gives you what?

10. Calculate the speed of the graphed object at 2 seconds.

**Lesson Plans**

Lesson #1/ Day #1- Position and Reference Frame

Objective:

Students will be able to utilize a reference point to locate an objects position. (Application)

Procedure:

Introductory:

15min- Students will be given the pre-assessment and told to try their best.

5 min- Have a short discussion about what is needed for motion to occur and what you need to know that something has moved.

Development:

10min- Students will be given a handout of notes to fill in during the teacher’s lesson (handout follows lesson)

Conclusion:

10 min- The students will need to complete an exit ticket before leaving for the day. (exit ticket follows lesson)

Assessment:

At the beginning of the unit the students will be given a pre-assessment to see what they know and the following lessons will be adjusted to the results.

An exit ticket will be given and must be returned before the students leave.

Materials:

Computer

Projector

Smartboard

Notes handout

Exit slip

Teacher Copy- (Italicized font is what the teacher speaks. The underlined words are what the students need to write. All other typed words will be given to the students on their copy of the handout)

Motion and Reference Position Notes

Motion and Position

*When running a race in a track meet how do you know the runner is moving? Do you need to see the runner actually run the race to know they have moved?*

You don’t always need to see something move to know that motion has taken place.

A reference point is needed to determine the position of an object.

Motion occurs when an object changes its position relative to a reference point.

The motion of an object depends on the reference point that is chosen.

*Motion example: Need two volunteers. Have one stand next to their desk and the other leave the room. After the student leaves have the other student move to another location in the room. As soon as the other student chooses their new location have the hallway student re-enter the classroom. Ask them what they notice. They should say that the other student has moved. Ask them how they know this. Ask a non-volunteer student what the hallway students reference point was and if there could be other objects used as reference points.*

Relative Motion

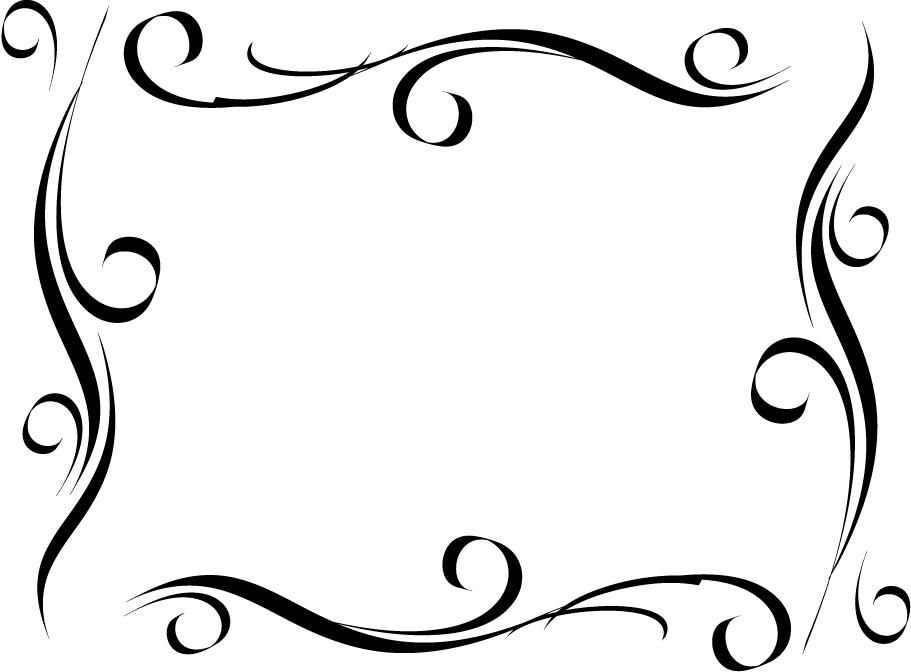
If you are sitting in a chair reading this sentence, you are moving. How?

You are not moving relative to your desk or your school building, but you are moving relative to the other planets in the solar system and the Sun.

Motion and Reference Position Exit Ticket

Exit Slip

Using the key terms we discussed today describe the motion of a child riding a ferris-wheel in an amusement park



Lesson #2/ Day #2- Distance vs. Displacement

Objective:

Students will distinguish the difference between distance and displacement. (Comprehension)

Procedure:

Introductory:

Students will be given back their exit slip from yesterday and asked to check their description of their motion for the word or concept of direction. If they did not use the word they are to re-write the description using the word or concept. After they are to write what they think the term displacement means.

Development:

15 min- Students will get a handout to take notes on the concept of distance and displacement. (Handout follows lesson)

Conclusion:

10 min- Students will create four questions with answers on a separate sheet. These questions will pertain to the day’s lesson about distance versus displacement. They can be problems or vocabulary there is to be no true/false, yes/no, or multiple choice.

10 min- After the creation of the questions they will pass the questions only to the person behind them. This person must answer the questions before leaving the class.

2 min- Students are to read their interpretation of what the term displacement means and turn the slip in before they leave.

Assessment:

Students will be verbally assessed throughout the notes

Students will be assessed on the creation and answering of the questions.

Materials:

Computer

Projector

Smartboard

Note handout

Teacher Copy

Distance vs. Displacement Notes

Distance

An important part of describing the motion of an object is to describe how far it has moved, which is distance.

The SI unit of length or distance is the meter (m). Longer distances are measured in kilometers (km).

Shorter distances are measured in centimeters (cm).

*Hold up different items and ask what unit they should be measured in (textbook, marker, smartboard, classroom…)*

Displacement

Sometimes you may want to know not only your distance but also your displacement from a reference point, such as from the starting point.

Displacement is the distance and direction of an object’s change in position from the starting point.

Suppose a runner jogs to the 50-m mark and then turns around and runs back to the 20-m mark.

The runner travels 50 m in the original direction (north) plus 30 m in the opposite direction (south), so the total distance she ran is 80 m.

The length of the runner’s displacement and the distance traveled would be the same if the runner’s motion was in a single direction.

*Ask the question: Since the runner ended up not on the starting line what is the runner’s displacement?*

Lesson #3/ Day #3- Speed and Velocity

Objective:

Students will be able to explain the difference between speed and velocity. (Comprehension)

Students will be able to calculate the velocity of objects given the equation. (Application)

Procedure:

Introductory:

10 min- As students enter the class they will read the bell ringer prompt on the Smartboard and complete it on a piece of paper within the first few minutes of class. The students will leave the prompt on the corner of their desk and it will be discussed during the notes. After the students complete the prompt we will review the past discussed concepts of motion, reference point, distance, and displacement.

Prompt: Briefly tell what is typically meant when we use the term speed when describing a car or a runner. Does the word velocity get used in everyday language? If so what does it mean?

Development:

10 min- Students will get a handout of notes over speed and velocity (handout follows lesson)

15 min- Students will conduct a mini-activity that will allow them to measure the speed of a toy car. If the students do not finish the questions or calculations they are to finish them for homework and turn it in the following day. (handout follows lesson)

Conclusion:

5 min- When most students have finished their activity there will be a short discussion about the activity. Includes the following questions:

1. Why do the speeds for each group differ?
2. What could everyone do to get similar results?
3. How accurate do you feel the activity is? How could it be made more accurate?

5 min- Pass out homework worksheet over speed and velocity. # 1 and 2 will be done on the board as examples of how the problems should be completed. Also take any questions about the homework.

Assessment:

Students will be assessed by the ability to calculate the toy cars speed thru the activity

They will be verbally assessed during the discussion about the activity

The homework will be another assessment

Materials:

Computer

Projector

Smartboard

Masking tape

Toy car

Stopwatch

Meter stick

Handouts (notes, activity, and homework)

Teacher Copy

Speed and Velocity Notes

**Speed**

You could describe movement by the distance traveled and by the displacement from the starting point.

You also might want to describe how fast it is moving.

Speed is the distance an object travels per unit of time.

**Calculating Speed**

Any change over time is called a rate.

If you think of distance as the change in position, then speed is the rate at which distance is traveled or the rate of change in position.

**Calculating Speed**

The following equation can be used to calculate the speed of an object.

Speed (meters/second) = Distance (meters) / time (second)

*The following problems will be done as a class but still need to be written in your notes:*

*What is the average speed of a car that travels a distance of 750m in 25 seconds?*

*An elevator travels a distance of 220m from the first floor to the 60th floor in 27.5 seconds. What is the elevators speed?*

*A motorcycle travels with an average speed of 20 km/h. If the motorcycle is going 5km, how long does it take the motorcycle to make the trip?*

**Changing Speed**

Usually speed is not constant.

**Average Speed**

Average speed describes speed of motion when speed is changing.

Average speed is the total distance traveled divided by the total time of travel.

**Instantaneous Speed**

A speedometer shows how fast a car is going at one point in time or at one instant.

The speed shown on a speedometer is the instantaneous speed. Instantaneous speed is the speed at a given point in time.

**Changing Instantaneous Speed**

When something is speeding up or slowing down, its instantaneous speed is changing.

If an object is moving with constant speed, the instantaneous speed doesn’t change.

**Velocity**

Speed describes only how fast something is moving.

To determine direction you need to know the velocity.

Velocity includes the speed of an object and the direction of its motion.

Because velocity depends on direction as well as speed, the velocity of an object can change even if the speed of the object remains constant.

*Give them the example of a race car being driven around a circular track at a constant speed*

*The speed of this car might be constant, but its velocity is not constant because the direction of motion is always changing.*

Speed of a toy car activity handout

**Measuring Average Speed**

Materials: Masking tape, toy car, stopwatch, meter stick

Before getting started make sure you create a data table in the space below to record your information in.

Procedure:

1. Mark a starting point on the floor with tape. Place a toy car at the starting point.
2. Give the toy car a gentle push forward. At the same time, start a stopwatch.
3. Record the time it takes for the car to come to a stop.
4. Use a meter stick to measure the distance the car traveled
5. Run steps 2-4 at least three times.

Analysis:

Calculate the average speed of the car in m/s. How does the average speed depend on the direction of motion?

Why did you repeat the activity?

Speed and Velocity Homework

Complete the following speed/velocity problems. Show all of your work and make sure to use correct labels. Some problems may require a conversion…..PAY ATTENTION!

1. If Steve throws the football 50 meters in 3 seconds, what is the average speed (velocity) of the football?
2. If it takes Ashley 3 seconds to run from the batters box to first base at an average speed (velocity) of 6.5 meters per second, what is the distance she covers in that time?
3. Bart ran 5000 meters from the cops and an average speed (velocity) of 6 meters/second before he got caught. How long did he run?
4. If Justin races his Chevy S-10 down Highway 37 for 2560 meters in 60 seconds, what is his average speed (velocity)?
5. Mike rides his motorcycle at an average speed (velocity) of 20 meters/second for 500 seconds, how far did he ride?
6. Sarah backstrokes at an average speed of 8 meters per second, how long will it take her to complete the race of 200 meters length?
7. Lauren’s SUV was detected exceeding the posted speed limit of 60 kilometers per hour, how many kilometers per hour would she have been traveling over the limit if she had covered the a distance of 10 kilometers in 5 minutes?
8. Tina’s calculations of the tarantula found that the spider was able to cover 20 centimeters in 5 seconds, what was the average speed of the spider?
9. The world speed record on water was set on October 8, 1978 by Ken Warby of Blowering Dam, Australia. If Ken drove his motorboat a distance of 1000.0 m in 7.045 s, how fast was his boat moving?
10. Hans stands at the rim of the Grand Canyon and yodels down to the bottom. He hears his yodel echo back from the canyon floor 5.20 s later. Assume that the speed of sound in air is 340.0 m/s. How deep is the canyon? (Hint: Note that the time is for the sound to travel to the bottom

and back.)

1. According to the World Flying Disk Federation, on April 8, 2000, Jennifer Griffin of Fredericksburg, Virginia threw a Frisbee for a distance of 138.56 m to capture the women’s record. If the Frisbee was thrown horizontally with a speed of 13.0 m/s, how long did the Frisbee remain aloft?

Lesson #4/ Day #4- Graphing Motion

Objective:

Students will create and interpret graphs depicting distance verse time. (Analysis, Synthesis)

Procedure:

Introductory:

5 min- Take any questions students may have about their homework before collecting it.

5-7min- Bell ringer handout about graphing (bell ringer follows)

Development:

10 min- Notes about graphing motion. Students will get a handout to fill out during lesson. (Handout follows)

Conclusion:

15- 20 min- Students will complete the graphing motion activity. (Handout follows)

5 min- Review all key points for the quiz the following day.

Assessment:

Students will be assessed on their ability to graph the data and answer the questions about the graph

The review will also serve as an assessment

Materials:

Computer

Projector

Smartboard

Handouts (bell-ringer, notes, and activity)

Bell- ringer prompt

**Graph It!**

One of the best ways to identify a pattern is to draw a graph. A graph turns random data into a pattern that gives specific information.

Mary tested how fast blocks of clay dry under a bright light. She recorded the time it took different-sized blocks to dry.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Volume of block (cm3) | 27 | 8 | 43 | 125 | 16 | 166 | 64 | 91 |
| Time to dry (s) | 5 | 3 | 7 | 21 | 4 | 37 | 9 | 14 |

Create a graph below that shows Mary’s Data.

Teacher Copy

Graphing Motion Notes

**Graphing Motion**

The motion of an object over a period of time can be shown on a distance-time graph.

Time is plotted along the horizontal axis of the graph and the distance traveled is plotted along the vertical axis of the graph.

Each axis must have a scale that covers the range of number to be plotted.

Once the scales for each axis are in place, the data points can be plotted.

After plotting the data points, draw a line connecting the points.

The slope on a distance- time graph tells you the speed of the object.

If the line of the graph is horizontal that means the object is no longer moving.

*Show the students the multiple examples of distance- time graphs some with steep slopes and some with horizontal lines. Point out the different scales depending on the data and the size of the graph. Talk about the importance of labeling each axis and giving the graph a title.*

Graphing Motion Activity

**Introduction:**

Jill walks forward while Bob records her distance from where she started at one second intervals. The data recorded are listed below. Using the recorded data, Jill’s average speed during any time interval can be determined using the definition:

average speed (m/s)  =  distance traveled (m) divided by time traveled (s).

Another way to examine the data is to construct a distance vs. time graph. The steepness of the graph gives you information about Jill’s speed. Using the following data create a distance vs. time graph on the graph paper provided.

**Data**

The following are Bob’s recorded data.

|  |  |  |  |
| --- | --- | --- | --- |
| **Total Time** | **Total Distance** | **Total Time** | **Total Distance** |
| **(s)** | **(m)** | **(s)** | **(m)** |
| 0.0 | 0.0 | 8.0 | 8.5 |
| 1.0 | 1.0 | 9.0 | 13.0 |
| 2.0 | 2.0 | 10.0 | 17.5 |
| 3.0 | 3.0 | 11.0 | 22.0 |
| 4.0 | 4.0 | 12.0 | 24.0 |
| 5.0 | 4.0 | 13.0 | 26.0 |
| 6.0 | 4.0 | 14.0 | 28.0 |
| 7.0 | 4.0 | 15.0 | 30.0 |

**Analysis:**

**1.** What quantity is plotted on the y-axis?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

On the x-axis?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**2.** Sometimes dividing a graph into regions make it easier to analyze. Look for patterns in the data. Examine your graph and draw vertical lines that divide it into regions. How many different patterns did you mark? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**3. W**hat was Jill doing during the time interval 4sec-7sec? What was Jill’s average speed during that time? Describe the shape of the graph for this time interval. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**4.** What was Jill’s average speed for:

(A) the first four seconds?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

(B) the time interval 7 seconds to 11 seconds?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

(C) the last four seconds?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

(D) the entire trip? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**5.** Suppose the distance for 16s was 29m. Describe the motion of Jill during that time.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Conclusions:**

**6.** Look at your answers in #3 and #4 above. What conclusion can you draw about the relationship between the shape of the distance time graph and Jill’s speed?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**7.** Why might you prefer to show the data on a graph instead of in a table?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Lesson #5/ Day #5- Post- Assessment Day

Objective:

Students will be able to explain the difference between speed and velocity. (Comprehension)

Students will be able to calculate the velocity of objects given the equation. (Application)

Students will distinguish the difference between distance and displacement. (Comprehension)

Students will create and interpret graphs depicting distance verse time. (Analysis, Synthesis)

Students will be able to utilize a reference frame to locate an objects position. (Application)

Procedure:

Introductory:

5-10min- Answer any questions students may have before the assessment

Development and Concluding:

25-35 min- Administer the post- assessment

Assessment:

Post-assessment

Materials:

Smartboard

Post-assessment

**Post- Assessment**

Motion Quiz

***Fill in the following blanks with the correct vocabulary word.***

1. Motion is a change in \_\_\_\_\_\_\_\_\_\_\_\_\_\_.

2. The position of an object depends on a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

3. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is the distance and direction of an objects final position from its initial position.

4. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is the distance an object travels per unit of time.

5.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_ is the speed of an object at a single instant of time.

6. \_\_\_\_\_\_\_\_\_\_\_\_\_\_ is the speed of an object and its direction of motion.

***Answer the following questions in complete sentences.***

7. Infer whether the size of an object’s displacement can be greater than its distance traveled.

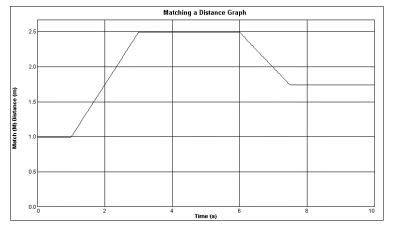
8. You are walking toward the back of a bus that is moving forward with a constant velocity. Describe your motion relative to the bus and relative to a point on the ground.

***Use the equation for velocity (v=d/t) to solve the following word problems. Show all work and label with correct units.***

9. What is the velocity of a car that travels 750m in 25s?

10. A woman on a motorcycle travels with a velocity of 20 km/h. If she is going to a friend’s house 5km away, how long does it take her to make the trip?

***Use the following graph to answer the following questions.***



11. Describe the motion represented by a horizontal line on a distance-time graph.

12. The slope of a distance-time graph gives you what?

13. Calculate the average speed of the graphed object at 2 seconds.