DAY 3: Velocity and Slope

Materials

Worksheets:	3.2.1 Questions about the Velocities 3.3.1 Drawing Velocities / Definition of Slope
Transparencies:	none necessary
Manipulatives:	Stopwatches - three is sufficient 3 marked courses in the classroom, 8ft, 12ft and 20 ft Posters from Day 2 Calculators Graph paper - 1/4 inch

Major Concepts

- Velocity is neither a measure of distance, nor a measure of time, but is measured in units of distance divided by time.
- Velocity can be calculated from a distance vs. time graph.
- Velocity determines the "tilt" of a line graph, and this measurement is called the "slope" of the line.
- The slope of a line can be either positive or negative.

Activity One: Walking Activity (30 minutes)

Materials: Stopwatches, marked course of 8ft, 12ft and 20 ft.

Overview: Students develop a concrete understanding of velocity, how it is calculated, and what units are used to measure it by finding the velocities of students who have raced over different length courses.

To begin, have three separate courses marked out in the classroom. Each should have a clear beginning and ending line. The courses should be 8ft, 12 ft and 20 ft long. Identify three students to be time keepers. Give them each a stopwatch and assign them a course. Also identify three judges. These will watch the other students completing the course making sure that they touch heel to toe with every step. Assign them each to a course.

All other students will walk heel to toe as fast as they can on one of the courses and then write their name and time on the board. You should assign each of the students to go to one of the courses. This should appear to be random, although in reality it would be better if you send some of the students that you think will be fastest to the longer courses. When everyone has done a course the time keepers and judges can also walk the course if they choose.

With all of the names and times on the board you should find the shortest time and declare that person the fastest. (This, of course, may not be true and should elicit some howls of protest, especially from those that did the 20ft course.) A discussion should follow about a fair way to compare these times. Lead this discussion into finding the amount of feet per second each student covered. Leaving the times on the board, calculate the velocity of each person by dividing the distance they traveled by the time it took them.

Example: Sandra 7.22 seconds >> 12 ft / 7.22 seconds >>> 1.66 ft/sec

Point out that since everyone was moving forward, everyone has a positive velocity and that the units of velocity are neither a measure of distance, nor of time but a ratio of distance and time. Now it would be reasonable to look at everyone's velocity and decide who was fastest.

Activity Two : Calculating Velocity (60 minutes)

Materials: Posters from Day 2, calculators, Worksheet 3.2.1

Overview: Students calculate the velocities of the Walkers in each part of each of the posters from Day 2.

Together look at the poster from Walking Function 2. Ask the class if there is enough information on the graph to calculate the Walker's velocity. Was the velocity of the Walker constant (or steady) throughout the 20 seconds? Find from the graph how much distance the Walker covered in the first 5 seconds. Calculate the velocity. Do the same for the interval 5-10 seconds. **Be careful to find just the distance traveled during those 5 seconds. This would be the location at t=10 minus location at t = 5.** Repeat again for 10-15 seconds and 15-20 seconds. Keep this information organized on the board or overhead:

Example:

Interval 0-5	Directed Distance: +9 ft	Velocity: 1.8 ft/sec
Interval 5-10	Directed Distance: +26 ft	Velocity: 5.2 ft/sec
Interval 10-15	Directed Distance: 0 ft	Velocity: 0 ft/sec
Interval 15-20	Directed Distance: -22 ft	Velocity: -4.4 ft/sec

(Note that during the time 15-20 seconds the Walker was moving backward. This should be recorded as moving a negative amount of feet. Velocity is a directed distance over time, as opposed to speed which is distance (always positive over time.)

When you have finished with the poster from Walking Function 2 have the students calculate the velocities for each of the other intervals on each of the other posters. Then answer the questions on Worksheet 3.2.1. You can have students read some of their answers to the questions to the class if you feel you have time. It would be good to discuss some of them.

3.2.1 Questions about the Velocities

1. Which part of which graph has the highest velocity?

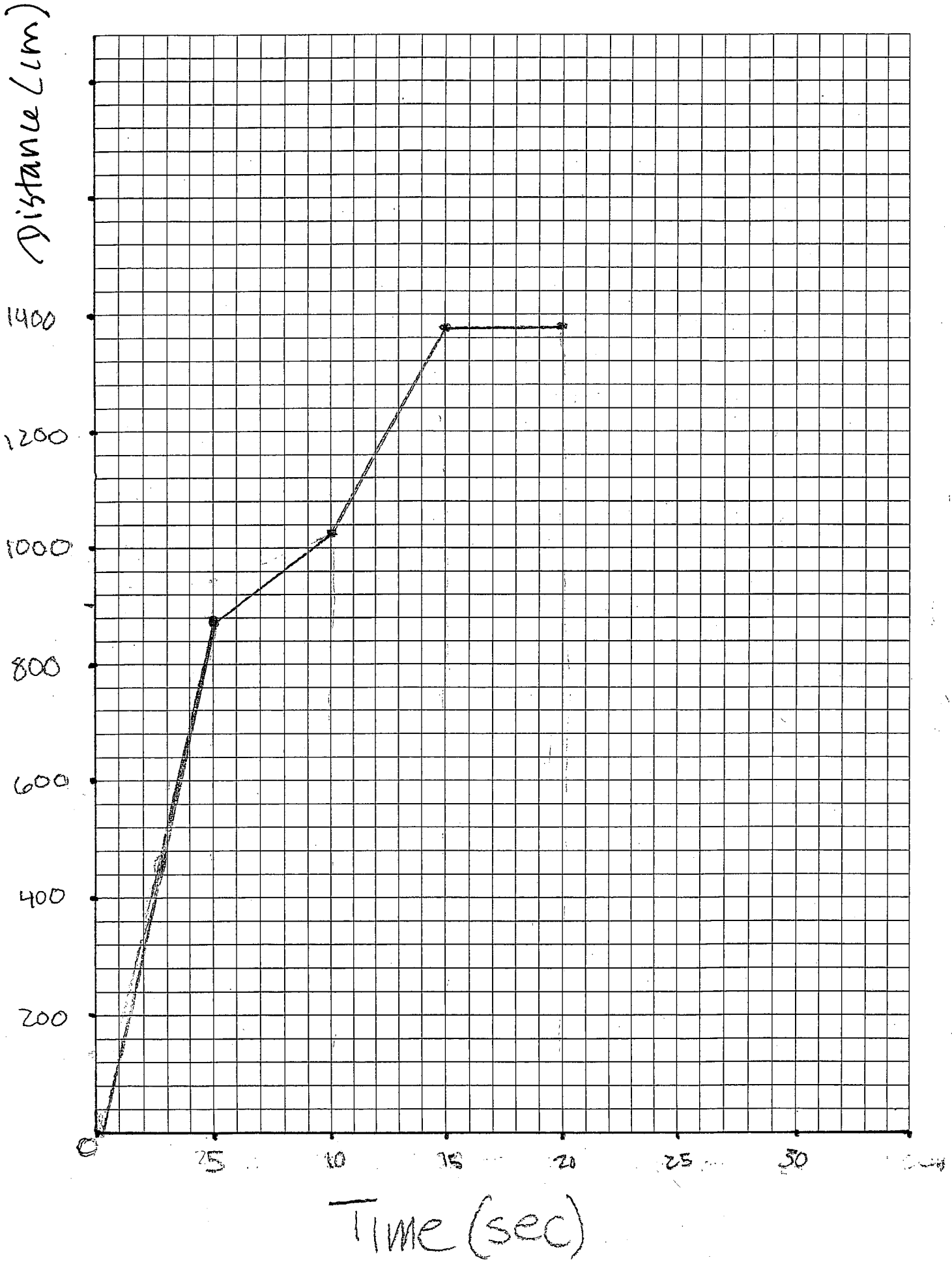
2. Which part of which graph has the lowest velocity that is still positive?

3. Which part of which graph has the lowest velocity?

4. Explain with a sentence and pictures how you can tell if a piece of a graph represents positive or negative velocity.

5. In real-life terms, what does a positive velocity mean a Walker is doing? What does a negative velocity mean?

6. Explain with a sentence and pictures how you can tell by looking at two parts of a graph which had the higher velocity.


Distance (m)
1400
1200
1000
800
600
400
200
0
5
10
15
20
25
30
Time (sec)


900
800
700
600
500
400
300
200
100
DISTANCE (CM)
0
5
10
15
20
25
30
35
TIME (SECONDS)

Activity Three: Velocity Graphs (30 minutes)

Materials: Graph paper, Worksheet 3.3.1

Overview: Students now draw graphs with given velocities. The word "slope" is introduced.

Make up a situation similar to those on Worksheet 3.3.1. Ask students to listen to the description and draw a graph based upon the description.
Be aware: This will probably need to be done in small steps with frequent checks, for understanding and suggestions of methods. When each student has made a graph individually have them compare their graphs and check for any differences. You can tell them that another word used to describe the "tilt" of the lines is slope. A formal definition of slope is:

$$\text{slope} = \frac{\text{change in y values}}{\text{change in x values}}$$

However, if they continue to think of slope as velocity it will help them to understand it. (Note: it is not important at this point to dwell too long here on the formal definition of slope.)

Have students answer the questions on Worksheet 3.3.1. If there is time have some present their solutions.

3.3.1 Drawing Velocities / Definition of Slope

For each, draw a graph and answer the questions.

1. A Walker begins at time 0 at 10 ft, then walks with a velocity of 2 ft/sec for 5 seconds, then walks at a velocity of 3 ft/sec for another 5 seconds. Where is she? How far has she traveled?

2. A Walker begins at time 0 at 0 ft, then walks with a velocity of 1 ft/sec for 1 second, then walks at a velocity of 2 ft/sec for 2 seconds, then walks at a velocity of 3 ft/sec for 3 seconds and finally walks at a velocity of 4 ft/sec for 4 seconds. Where is she? How far has she traveled?

3. A Walker begins at time 0 at 20 ft, then walks with a velocity of -5 ft/sec for 3 seconds, then walks at a velocity of 2 ft/sec for 4 seconds, then walks at a velocity of 1 ft/sec for 3 seconds and finally walks at a velocity of 4 ft/sec for 1 second. Where is she? How far is she from where she started? How far has she traveled?

Recall that the definition of slope is: $\text{slope} = \dfrac{\text{change in y values}}{\text{change in x values}}$

Use this idea, and your understanding of velocity, and a graph to find the slopes between these points:

4. Find the slope between (2, 10) and (4, 20)

5. Find the slope between (0, 6) and (10, 16)

6. Find the slope between (4, 10) and (8, 2)

7. Find the slope between (3, 4) and (7, 4)

8. Find the slope between (1, 6) and (7, 9)