Motion Graphs

Lesson Overview

In this series of lessons, students will complete hands-on experiments to explore nonlinear functions. They will extend their understanding to include how the graphs of such functions may represent an object's speed, direction, and position.

This series of lessons should be part of a larger unit that includes student practice problems, quizzes, tests, and materials for reteaching if needed.

Alignment

Science Standards

SC 2014 8.P.2A.6	Use mathematical and computational thinking to generate graphs that represent the motion of an object's position and speed as a function of time.
SC 2014 8.P.2A.7	Use mathematical and computational thinking to describe the relationship between the speed and velocity (including positive and negative expression of direction) of an object in determining average speed (v=d/t).

Science and Engineering Practices

SEP 4: Analyze and interpret data.
SEP 5: Use mathematical and computational thinking.
SEP 6: Construct explanations.

Crosscutting Concepts (from the SDE instructional unit resources document)

2. **Cause and effect**: The National Research Council states "events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts" (p. 84).

Math Standards

SCCCR Math 8.F.2 Compare multiple representations of two functions, including mappings, tables, graphs, equations, and verbal descriptions, in order to draw conclusions.

SCCCR Math 8.F.3 Investigate the differences between linear and nonlinear functions using multiple representations (i.e., tables, graphs, equations, and verbal descriptions).

a. Define an equation in slope-intercept form $(y=mx+b)$ as being a linear function.
b. Recognize that the graph of a linear function has a constant rate of change.
c. Provide examples of nonlinear functions.

Standards for Mathematical Practice

Standard 1: Make sense of problems and persevere in solving them.
Standard 3: Use critical thinking skills to justify mathematical reasoning and critique the reasoning of others.
Standard 5: Use a variety of mathematical tools effectively and strategically.
Standard 7: Identify and utilize structure and patterns.

ELA Inquiry Standards

Standard 3: Construct knowledge, applying disciplinary concepts and tools, to build deeper understanding of the world through exploration.

3.1 Develop a plan of action by using discipline-specific strategies.

3.4 Organize and categorize important information, revise ideas, and report relevant findings.

ELA Writing Standards

Standard 6: Write independently, legibly, and routinely for a variety of tasks, purposes, and audiences over short and extended time frames.

6.1 Write routinely and persevere in writing tasks over short and extended time frames, for a range of domain-specific tasks, and for a variety of purposes and audiences.

ELA Communication Standards

Standard 1 Interact with others to explore ideas and concepts, communicate meaning, and develop logical interpretation through collaborative conversations; build upon the ideas of others to clearly express one's own views while respecting diverse perspectives.

1.2 Initiate and participate effectively in a range of collaborative discussions with diverse partners; build on the ideas of others and express own ideas clearly and persuasively.

1.4 Engage in dialogue with peers and adults to explore meaning and interaction of ideas, concepts, and elements of text, reflecting, constructing, and articulating new understandings.

1.5 Synthesize areas of agreement and disagreement including justification for personal perspective; revise conclusions based on new evidence.

Connections

Content Area (2 or more) Connections

- Science
- Math

Content Connections

Graphing, understanding, and being able to interpret nonlinear functions includes foundational big ideas that are essential to success in eighth grade, as well as providing a bridge to high school mathematics. These concepts are also very easily applied to the distance-time graphs that are part of eighth grade Science. This lesson offers students opportunities to explore graphing non-linear functions and looking for patterns, as well as applying those ideas to distance-time graphs.

Active Learning Strategies (for Purposeful Reading, Meaningful Writing, and Productive Dialogue)

- Exit Ticket
- Story Boards
- Paper Slides
- Thinking Stems

Computational Thinking

This series of lessons addresses computational thinking by having students extend their understanding of functions to include those which are not linear. They will use a combination of hands-on experimentation and technology to graph motion, explore the shapes of those graphs, and consider how those concepts might help them interpret data in both Math and Science. Students must work together and persist in identifying and analyzing patterns that empower them to generalize those concepts.

Computational thinking (CT) is a problem-solving process that includes (but is not limited to) the following ***characteristics****:*

- Logically organizing and analyzing data
- Confidence in dealing with complexity
- Persistence in working with difficult problems
- The ability to communicate and work with others to achieve a common goal or solution
- Generalizing and transferring this problem-solving process to a wide variety of problems.

These skills are supported and enhanced by several dispositions or attitudes that are essential dimensions of CT. These ***dispositions or attitudes*** *include:*

- Confidence in dealing with complexity
- Persistence in working with difficult problems
- Tolerance for ambiguity
- The ability to deal with open ended problems
- The ability to communicate and work with others to achieve a common goal or solution

Lesson Plans

There are 3 complete lessons in this series.

- L.5.A. How Far? (one 60-minute period)
- L.5.B. Motion Detectives (two 60-minute periods)

- L.5.C. Velocity Stories (two 60-minute periods)

<u>Lesson 5, Part A</u>: How Far?

How Far? experiment adapted from:

Algebra Experiments II: Exploring Nonlinear Functions
Ronald J. Carlson and Mary Jean Winter (Dale Seymore Publications, 1993)

Time Required – 60 minutes

Disciplinary Vocabulary – linear, nonlinear, x-axis, y-axis, x- and y-coordinates, slope, steep, flat, time, distance, speed

Materials Needed:

Lesson 5, Part A: How Far?

Standard Materials:

- Student Math notebooks
- Colored pencils

How Far? hands-on experiment:

- Blocks to hold up ramps (15 cm in height)
    - A stack of textbooks or other materials would also work
- Ramps (set-up for each group of students)
    - One ramp that is at least 92 cm long with increments of 10 cm marked from 40 cm – 90 cm; or
    - If you choose to use multiple ramps, you will need 1 of each: 40 cm, 50 cm, 60 cm, 70 cm, 80 cm, and 90 cm
      Note: Each ramp should be about 2 cm longer than needed so that there's enough ramp to sit firmly on the blocks.
    - Experiment with materials until you find what works best. In the set-up used when writing this lesson, the blocks that hold the ends of the ramps are the supersized Duplo blocks for toddlers.
    - In the set-up used when writing this lesson, the ramp is a 92 cm piece of deck drain bracket from Lowe's. It comes in 4 ft lengths and will need to be cut. This works well because the plastic is very smooth and because the ramp is v-shaped,

the marble stays on the ramp once it's released. Regular tin-snips or garden shears easily cut the material.

- Marble that works well with ramp material – each group needs to use the same size marble

Handouts:

- ***How Far? handouts***
  - L.3. *How Far?* student HO – Each student needs a copy to write on; OR
  - L.3. *How Far?* Math NB GO – This front and back handout is put in a sheet protector. Students use the information to organize the notes they'll add to their individual Math notebooks. One or two sets of handouts per group would be sufficient.

Note: There are PowerPoint slides available.

Technology :

- Access to Desmos.com (app or website)

Formative Assessment Strategies: student dialogue, handouts, exit ticket

Misconceptions:

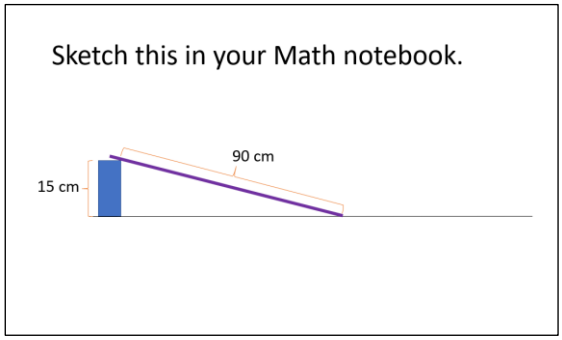
Students may:

- expect the results of the *How Far?* experiment to show a constant rate of change.
- incorrectly graph ordered pairs.
- incorrectly label the axes.

Safety Note(s): None noted

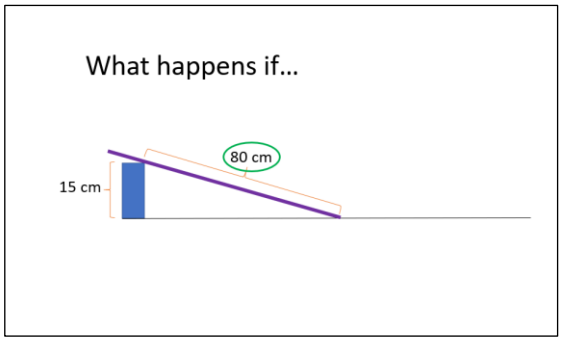
Engage

- Display these instructions as students enter the room:



- Ask: “What do you think will happen if we place a marble at the top of the ramp and let it roll?” Students make individual predictions in their Math notebooks.

- Display this information:



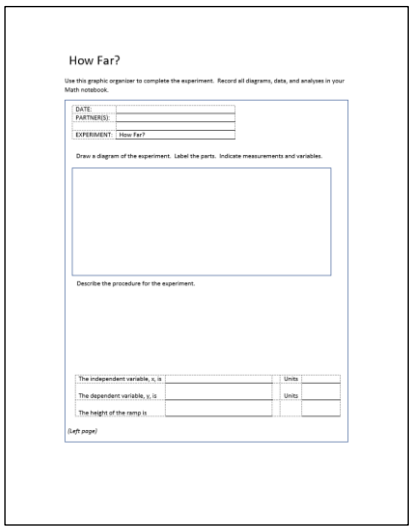
- Point out that the block was moved in so that the ramp is now 80 cm long. Ask: “How did this impact the slope of the ramp? What do you think will happen if we roll a marble from 80 cm rather than 90 cm?” Students make individual predictions in their Math notebooks.
- Tell students they will complete an experiment called *How Far?*

Explore

- Students work in groups of 3 or 4 to complete the *How Far?* experiment.
- There are detailed handouts for the students. See Materials list for handout options.
- Each group needs a ramp set-up.

- The height of each ramp should be fixed. In the set-up used when writing this lesson, that height is 15 cm. (In the picture above, the blocks are the supersized Duplo blocks for toddlers.)
- Ramps should range in length from 40 cm – 90 cm. You may have sets of ramps (one for each length). You may also have one ramp that's ~ 92 cm long with the increments marked on it. (In the picture above, the ramp is a piece of deck drain bracket from Lowe's.)
- Mark the increments as shown at right.
- While students are working in groups, each student needs to collect the data outlined in the *How Far?* handouts.
- When students have collected the data and recorded it in a t-chart in their Math notebooks, they use Desmos to graph the data.
- Provide grids for students to use to sketch the graphs. They can tape the grid into their Math notebooks.

How Far? Graphic organizer handouts (L.3. How Far Math NB G0)



How Far?

Use this graphic organizer to complete the experiment. Record all diagrams, data, and analyses in your Math notebook.

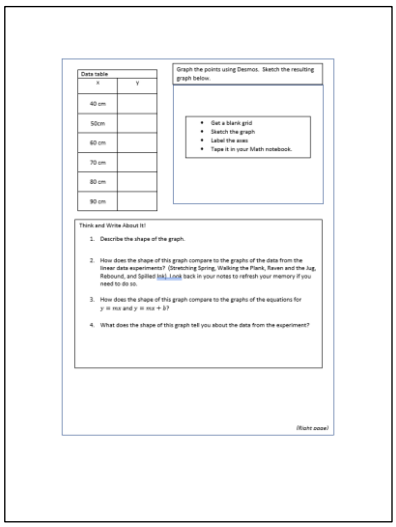
DATE:
PARTNER(S):
EXPERIMENT: How Far?

Draw a diagram of the experiment. Label the parts. Indicate measurements and variables.

Describe the procedure for the experiment.

The independent variable, x, is		Units
The dependent variable, y, is		Units
The height of the ramp is		

(Left page)



Data table	
x	y
40 cm	
50cm	
60 cm	
70 cm	
80 cm	
90 cm	

Graph the points using Desmos. Sketch the resulting graph below.

- Get a blank grid
- Sketch the graph
- Label the axes
- Tape it in your Math notebook.

Think and Write About It!

1. Describe the shape of the graph.
2. How does the shape of this graph compare to the graphs of the data from the linear data experiments? (Stretching Spring, Walking the Plank, Raven and the Jug, Rebound, and Spilled Ink). Look back in your notes to refresh your memory if you need to do so.
3. How does the shape of this graph compare to the graphs of the equations for $y = mx$ and $y = mx + b$?
4. What does the shape of this graph tell you about the data from the experiment?

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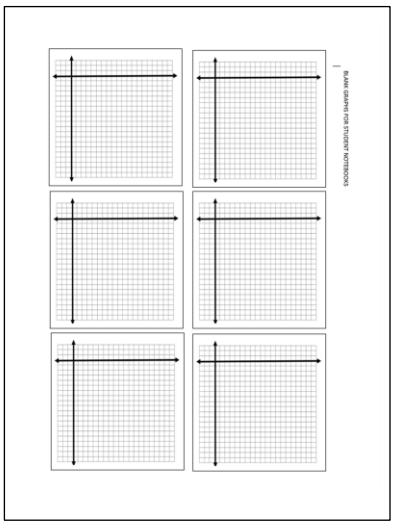
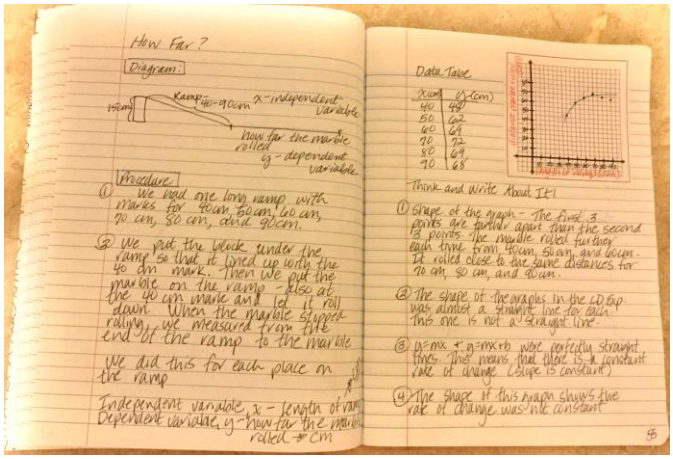


BLANK GRAPHS FOR STUDENT NOTEBOOKS

If students use the handouts as a graphic organizer to write information in their Math notebooks (rather than on the actual handouts), their work will look something like this:



How Far?

Diagram:

15cm Ramp 40-90cm x-independent variable

how far the marble rolled y-dependent variable

Procedure

① We had one long ramp with marks for 40cm, 50cm, 60cm, 70 cm, 80 cm, and 90cm.

② We put the block under the ramp so that it lined up with the 40 cm mark. Then we put the marble on the ramp - also at the 40 cm mark and let it roll down. When the marble stopped rolling, we measured from the end of the ramp to the marble. We did this for each place on the ramp

Independent variable, x - length of ramp
Dependent variable, y - how far the marble rolled - cm

Data Table

x (cm)	y (cm)
40	49
50	62
60	69
70	72
80	69
90	68

Think and Write About It!

① Shape of the graph - The first 3 points are further apart than the second 3 points. The marble rolled further each time from 40cm, 50cm, and 60cm. It rolled close to the same distances for 70 cm, 80 cm, and 90cm.

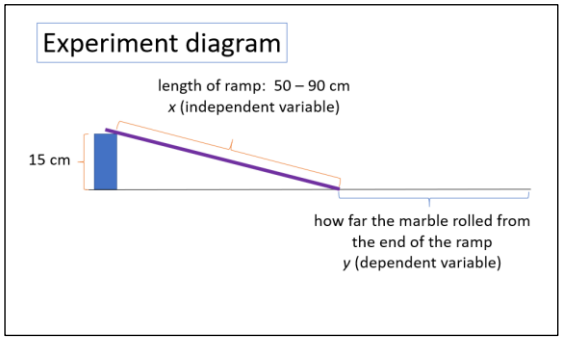
② The shape of the graphs in the LD Exp was almost a straight line for each. This one is not a straight line.

③ y=mx + y=mx+b were perfectly straight lines. That means that there is a constant rate of change (slope is constant)

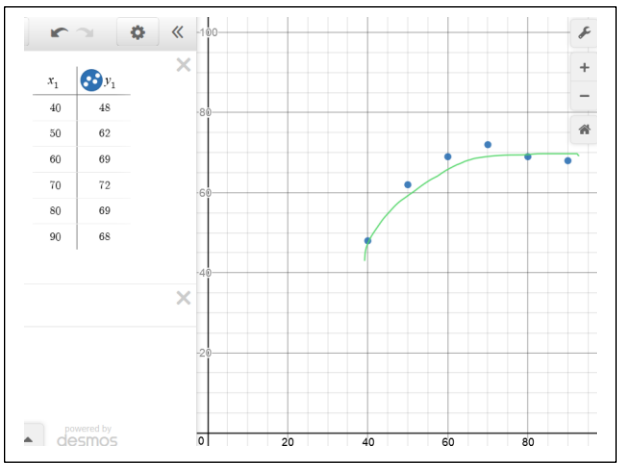
④ The shape of this graph shows the rate of change was not constant

Explain

- Bring the class back together and lead a debrief of the experiment.
- Display this information. Students' diagrams of the experiment should look something like this:



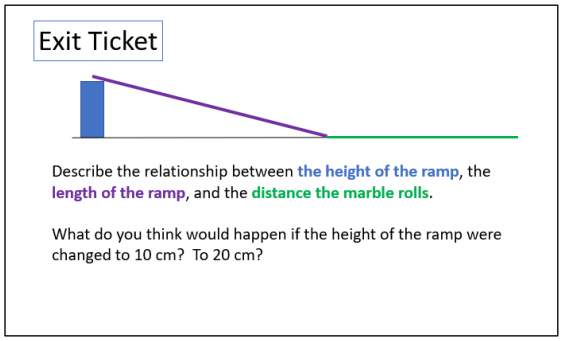
- These are the results I got when I did the experiment. Student results will vary, but their graphs should have a similar shape.



- Go over the Think & Write About It! The following are points that should result from the debrief of the experiment.
  - Labels on the axes
  - Any accurate description of the shape of the graph is okay. Students should use vocabulary such as x- and y-axis, positive direction, steep, flat, etc.
  - The shape of this graph is NOT linear. It has a curve to it.
  - The graphs for $y = mx$ and $y = mx + b$ were linear. The linear graphs showed a constant rate of change. The graphs of the Linear Data Experiments demonstrated a clear relationship between x and y. Even though the rate of change was not exactly constant, they had that line-like shape.

- Keeping the height of the ramp fixed and changing the lengths meant that the shorter the ramp, the steeper the slope. This contributed to the shape of the graph. As the ramps got longer with the slope becoming less steep because of the fixed height, the distance the marble rolled began to level out.
- Show students how to sketch the path of the points. Remind them of the best-fit lines they found for the Linear Data Experiments. For this experiment, it's acceptable to simply draw the path rather than finding the exact equation. Students draw the path on the graph in their Math notebooks.
- Expectations about what might happen if the ramp were longer than 90 cm or shorter than 40 cm while maintaining the height of 15 cm
- For example: What they think might happen to the shape of the graph if the marble were rolled from 100 cm or 110 cm OR 30 cm. Ask them to name approximate points based on their own graphs.
  NOTE: It would be good for students take their educated guesses and run the experiment to see how their predictions worked out.
- You could collect the class data, average the y-values and create a graph that represents the combination of all the groups' data. If you teach more than one class, a collection across classes would also be pretty cool and would provide solid, content – collected by the students - for further discussion.

Exit Ticket



<u>End of Lesson 5, Part A</u>

Lesson 5, Part B: Motion Detectives

Time Required – Two 60-minute periods

Disciplinary Vocabulary – linear, nonlinear, x-axis, y-axis, x- and y-coordinates, slope, steep, flat, time, distance, speed, velocity, v=d/t

Materials Needed:

This lesson requires the use of motion detectors to collect and graph data during the **Explore** portion. You will need to adjust the instructions to fit the parameters of the hardware/software/app/device(s) you have at your disposal. The goal is to have students "walk out" several set paths and study the shapes of the graphs created. You will need a large, clear space for groups of students to work and walk in.

Lesson 5, Part B: Motion Detectives

Standard Materials:

- Student Math notebooks
- Colored pencils
- 11 x 14 or 11 x 17 paper for mini-posters (one sheet per pair of students)
- Straight edges

Walk This Way! hands-on experiment:

For each group:

- Motion detectors
- Work space marked with blue tape
- Thinking Stems cards

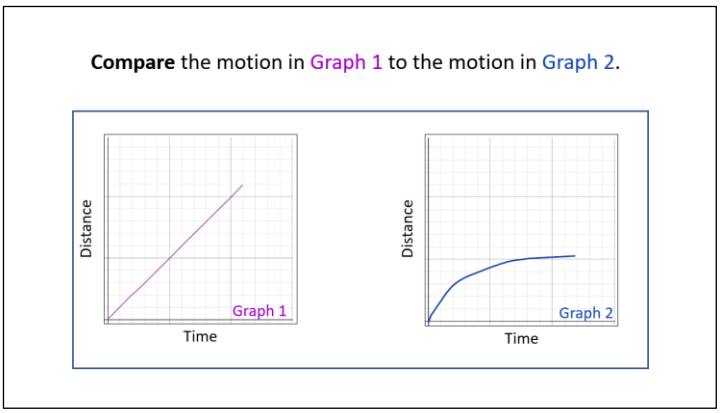
Handouts:

- *Walk This Way!* (one for each student)
- Card Sort (one for each pair of students)
- *What's My Story?* (one or two graphs for each pair of students)

NOTE: If the motion detector set up you use allows students to save their graphs after collecting the data, have them do so.

Engage

- Remind students about the Linear Data and How Far? experiments they completed in earlier lessons.
- Then display this prompt for students:



- Each student writes their response in their Math notebooks.
- Students turn to their Elbow Partners to discuss their responses.
- Lead a whole group discussion about the prompt using vocabulary from earlier lessons. Points to include:
    - Graph 1 shows a constant rate of speed. We know this because the object/person that's moving is going away from the starting point in a straight line.
    - Graph 2 does not show a constant rate of speed. We know this because the object/person that's moving is going away from the starting point quickly at first and then more steadily.
    - Both graphs show a relationship between time and distance (x and y).

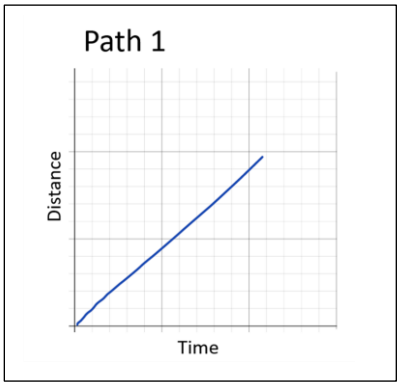
Explore

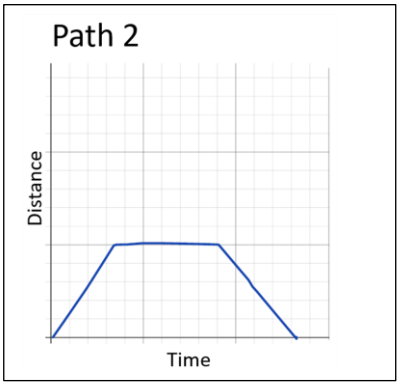
Prior to lesson:

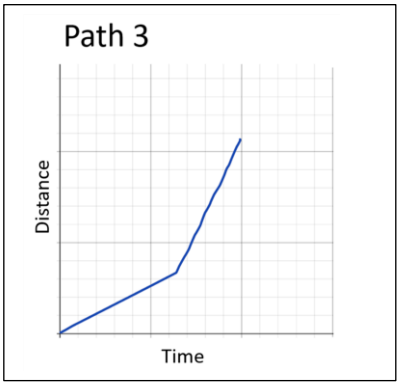
- Mark work areas for the groups.
- Each group needs a space as described here: Use short strips of blue tape to mark 0 m, 1 m, 2 m, 3 m, and 4 m as shown below.

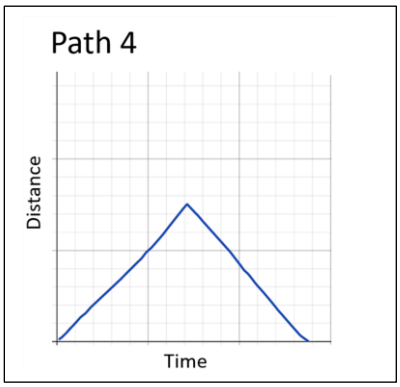
0 m Point A	1m	2m Point B	3m	4m Point C

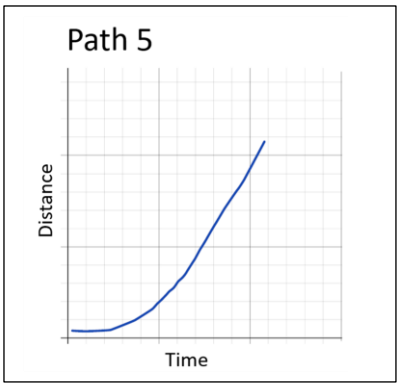
- Be sure to use the motion detectors to "walk out" the instructions yourself first. The graphs produced by walking the paths should be similar to the ones below.









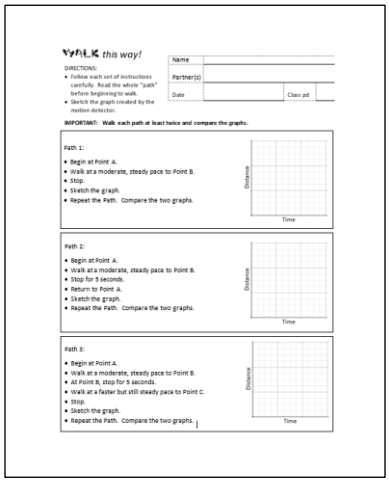


- Prepare some index cards with Thinking Stems (prompts). These may be used to jump start student thinking when they get to the part of the *Walk this Way!* handout that has them make statements about the paths and the shapes of the graphs. Some possible thinking stems:
    - The graph for Path ____ is shaped like _____(*a curve, a line, etc*.). It looks like this because _____ (*info from the description of the path: steady speed, walk quickly, stop, etc*.).
    - A straight line with a positive / negative slope shows _____.
    - A "flat" line shows _____.

During the lesson. Completing *Walk this Way!*

- Students work in small groups of 2 – 4 people.
- Each student needs a copy of the *Walk this Way!* handouts. For each of the five paths:
    - Members take turns walking out the path described by the instructions. Each path should be walked twice. This allows students to double check they followed the instructions for the walking path. The graphs of the two paths should be similarly shaped.
    - Each student sketches the graph created by the motion detector.
- Meet with groups as they work to check their progress. Be prepared to provide thinking stems as needed.

Walk this Way! handouts



WALK *this way!*

Name
Partner(s)
Date
Class pd

DIRECTIONS:
- Follow each set of instructions carefully. Read the whole "path" before beginning to walk.
- Sketch the graph created by the motion detector.

IMPORTANT: Walk each path at least twice and compare the graphs.

Path 1:
- Begin at Point A.
- Walk at a moderate, steady pace to Point B.
- Stop.
- Sketch the graph.
- Repeat the Path. Compare the two graphs.

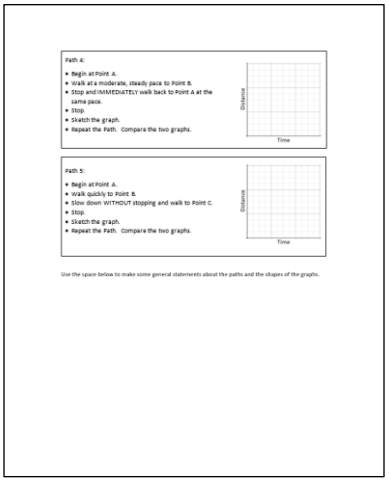
Distance
Time

Path 2:
- Begin at Point A.
- Walk at a moderate, steady pace to Point B.
- Stop for 5 seconds.
- Return to Point A.
- Sketch the graph.
- Repeat the Path. Compare the two graphs.

Distance
Time

Path 3:
- Begin at Point A.
- Walk at a moderate, steady pace to Point B.
- At Point B, stop for 5 seconds.
- Walk at a faster but still steady pace to Point C.
- Stop.
- Sketch the graph.
- Repeat the Path. Compare the two graphs.

Distance
Time



Path 4:
- Begin at Point A.
- Walk at a moderate, steady pace to Point B.
- Stop and IMMEDIATELY walk back to Point A at the same pace.
- Stop.
- Sketch the graph.
- Repeat the Path. Compare the two graphs.

Distance
Time

Path 5:
- Begin at Point A.
- Walk quickly to Point B.
- Slow down WITHOUT stopping and walk to Point C.
- Stop.
- Sketch the graph.
- Repeat the Path. Compare the two graphs.

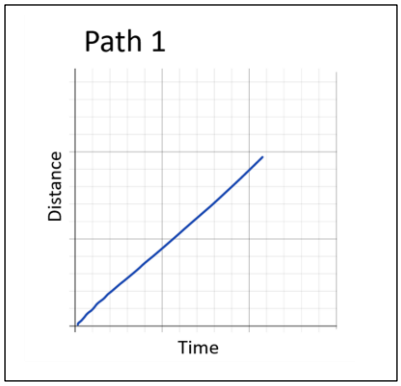
Distance
Time

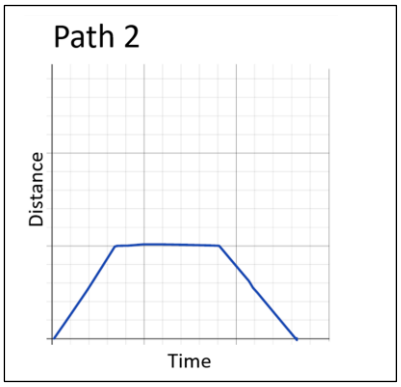
Use the space below to make some general statements about the paths and the shapes of the graphs.

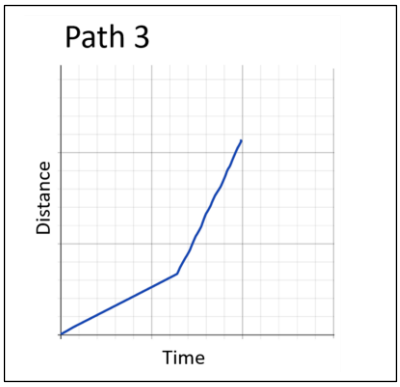
Explain

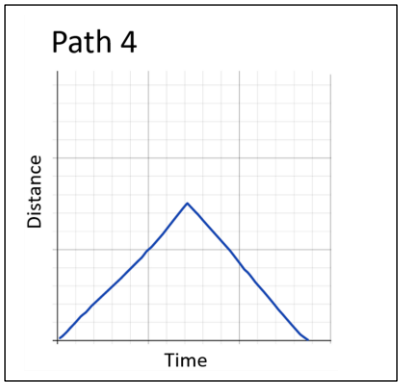
Part 1 – Reviewing Walk this way!

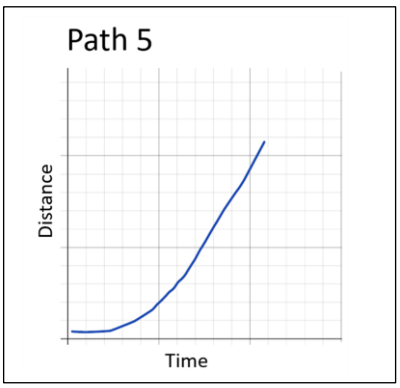
- Bring the class back together and go over the graphs. Ask guiding questions related to prior lessons (Linear Data experiments, $y = mx$, $y = mx + b$, and How Far?) to help students make sense of the shapes of the graphs. Student generated paths should be similar to the figures below.











- Points to bring out include:
  - Even though there are no numbers on the scales to represent units, we can tell what's happening motion-wise from how the graphs are shaped.
  - Where A, B, and C are positioned on these graphs (exact location for A; approximate locations for B and C).
  - Point A corresponds to the beginning of the path; Points B and C correspond to the changes in motion dictated by the Path instructions.
  - A line-like shape shows a constant rate of speed.
  - A positive line-like shape shows movement away from the starting point.
  - A negative line-like shape shows movement back towards the starting point.
  - Steeper lines show faster speeds regardless of direction.
  - A line that's horizontal to the x-axis shows no movement, i.e., the walker was standing still for a period of time (in this case, several seconds).
  - The graph that shows an upward curved shape shows acceleration away from the starting point.
- Students may have written some or all these points in the general statements section of the handout. If they did not, they should put them there now.

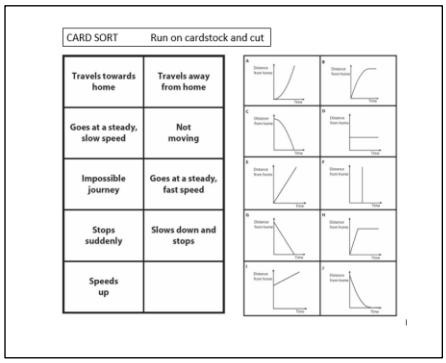
Part 2: Matching stories and graphs

- Students work in pairs to complete the Card Sort. Some of the stories match more than one graph.
- Pairs square (make groups of four) as they finish to compare their work.
- If possible, one student from each group should take a picture of their completed card sorts. Pictures may be printed or distributed electronically to provide students a record of the matches for their notes.
- In their Math notebooks, each student writes an explanation of how a story may be represented in multiple graphs. For example, the story "travels towards home" is represented in graphs C, G, and J. A possible explanation would be that in each of those graphs, the starting point is some distance from the origin, so I know that the person didn't begin at their house.
- Monitor students as they work, asking guiding questions and checking for understanding. You may choose to have students whose explanations (as in the point above) are particularly good, make a Story Board (mini poster) on 11 x 14 or 11 x 17 paper. The Story Board (mini poster) would include the story, the graphs that match it, and the explanation.
- Bring the class back together and go over the graphs. Ask guiding questions related to prior lessons (Linear Data experiments, $y = mx$, $y = mx + b$, and *How Far?)* as well as

the graphs from Walk this way! to help students understand why each graph matches the story or stories it represents.

- Points to bring out include:
  - Most everything from the earlier discussion about *Walk this Way!* Stress again the fact that even though there are no numbers on the scales to represent units, the shape of the graph tells the story.
  - Paths that begin anywhere on the y-axis (other than the origin) show a starting point other than "home."
  - Why graph F is impossible
  - Comparison of graphs B and H (slowing then stopping vs stopping suddenly)
  - Comparison of the different slopes and what they represent (steeper is faster; flatter is slower; horizontal is not moving at all; vertical is impossible)
  - Explanations for why a single graph may represent multiple scenarios

Card Sort handout


CARD SORT Run on cardstock and cut

Travels towards home	Travels away from home
Goes at a steady, slow speed	Not moving
Impossible journey	Goes at a steady, fast speed
Stops suddenly	Slows down and stops
Speeds up	

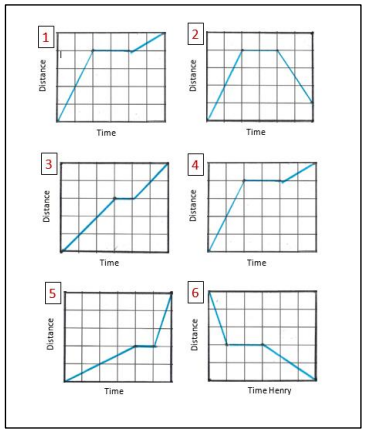
Extend

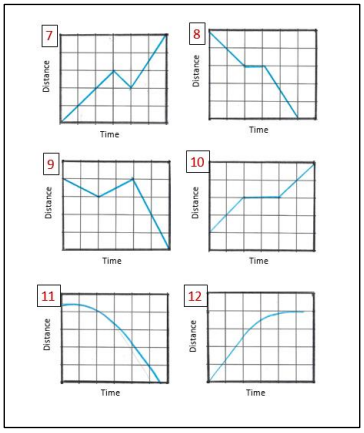
Writing stories to match graphs

- Students may work independently, in pairs, or in small groups.
- Provide a copy of the *What's My Story?* handouts. There are 10 graphs. Students don't have to complete all of them. You may choose to assign a student/pair/group one or two specific graphs.
- Students study the graph(s) and make up a story that matches the shape of each graph. The stories should include measures for distance and times AND should make sense. For example, a normal person can't run miles in minutes; they can run miles in hours (even if it's fractions of an hour) OR meters in seconds.

- Students should compare their stories, so they can see that a graph has more than one possible story to tell. They should look for the similarities in their stories and explain why those similarities exist. Options for recording work:
    - Students may record their thinking and explanations on regular paper or in their Math notebooks.
    - Students may make Story Boards (mini posters). These posters would include the graph and the different (yet similar) stories as described above.
    - Explanations of how the graph represents both stories, as well as why this is possible should be included.
- If you choose to have students make the mini-posters, do a Gallery Walk. Students study the posters and decide whether they think the graphs and stories match. They must defend their choice either way.

What's My Story? handouts





<u>End Lesson 5, Part B</u>

Lesson 5, Part C: Velocity

This lesson extends the concepts taught in Lessons 4A (How Far?) and 4B (Motion Detectives)

Engage

- Tell students they'll be continuing their roles as Motion Detectives.
- Show the video *Calculating Speed and Velocity with the Science Geeks*. Tell students they are looking for a way figure out the speed (velocity) of an object.
  Note: It's a goofy video.

  https://www.youtube.com/watch?v=84MwLscYyX0

- After the video, move directly into the **Explore** by presenting two graphs with a challenge.

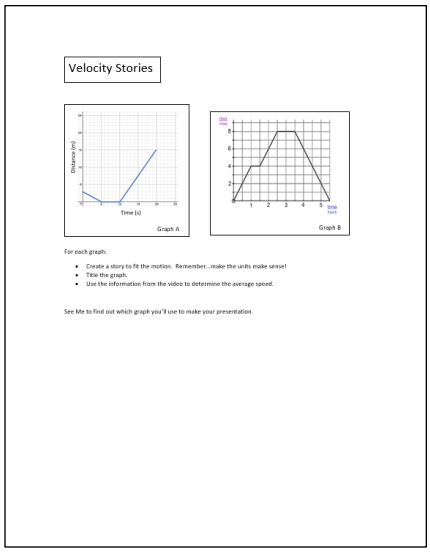
Explore

- Students may go back and watch the video again.
- Students work with a partner to tackle the challenge.
- Distribute the *Velocity Stories* handout.
- Students work together to solve the problems.
- Circulate as students work, asking guiding questions and checking for understanding.

Explain

- Assign *pairs* of students Graph A **or** Graph B from the *Velocity Stories* handout.
- Students create a Paper Slides presentation of their solution for the assigned graph.
- You may have pairs form quads (A's with A's and B's with B's). The quad determines which of the two solutions and/or a combination of to use in the Paper Slides presentation.
- Students may watch this video to see how to make a Paper Slides presentation.
  https://www.youtube.com/watch?v=E5RXynA_D3I
- Paper Slides videos will be shared with the whole class.

Handouts for Velocity Stories and Paper Slides



Velocity Stories

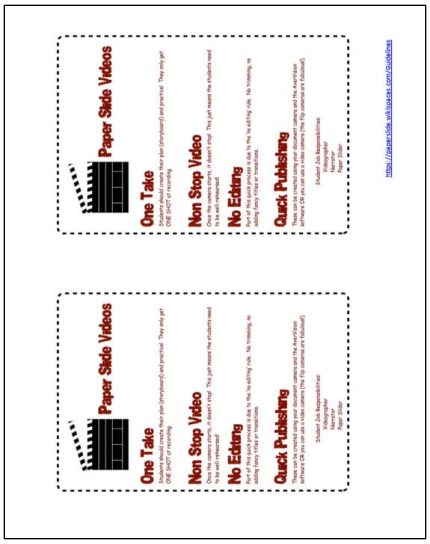
Graph A

Graph B

For each graph:

- Create a story to fit the motion. Remember…make the units make sense!
- Title the graph.
- Use the information from the video to determine the average speed.

See Me to find out which graph you'll use to make your presentation.



Paper Slide Videos

One Take

Non Stop Video

No Editing

Quick Publishing

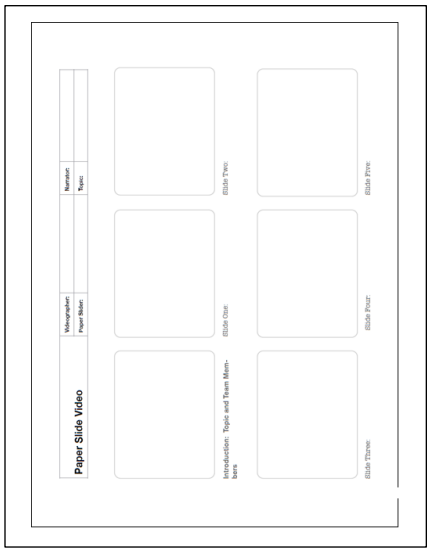
Paper Slide Videos

One Take

Non Stop Video

No Editing

Quick Publishing



Paper Slide Video

Videographer:

Paper Slider:

Narrator:

Topic:

Introduction: Topic and Team Members

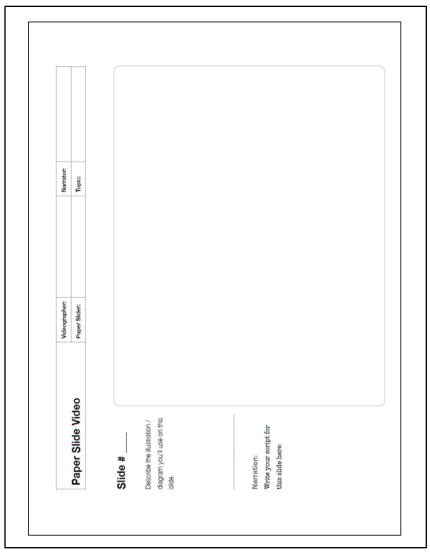
Slide One:

Slide Two:

Slide Three:

Slide Four:

Slide Five:



Paper Slide Video

Videographer:

Paper Slider:

Narrator:

Topic:

Slide # ____

Describe the illustration / clip art you'll use on this slide.

Narration:

Write your script for this slide here:

Here are suggestions for additional activities:

- Give them instructions for a path, have them make a prediction, then walk it out to see how close they were with their guess.
- [Reverse of *Walk this Way!*] Give students graphs with time and distance indicated on the axes. Their task is to create instructions for the path on the graph. Then they walk out their instructions to see if they match the graph. They tweak their instructions until they're close to the graph. If each pair or small group is given 2 graphs, with each pair/group having different graphs, they could swap graphs and paths with another

pair/group. The goal is for them to see if the instructions are written well enough for other groups to follow them to match the graph.

HANDOUTS FOR LESSONS BEGIN ON THE FOLLOWING PAGE

How Far?

Use this graphic organizer to complete the experiment. Record all diagrams, data, and analyses in your Math notebook.

DATE: _____

PARTNER(S): _____

_____

EXPERIMENT: How Far?

Draw a diagram of the experiment. Label the parts. Indicate measurements and variables.

Describe the procedure for the experiment.

The independent variable, x, is _____ Units _____

The dependent variable, y, is _____ Units _____

The height of the ramp is _____ _____

(Left page)

Data table	
x	y
40 cm	
50cm	
60 cm	
70 cm	
80 cm	
90 cm	

Graph the points using Desmos. Sketch the resulting graph below.

- Get a blank grid
- Sketch the graph
- Label the axes
- Tape it in your Math notebook.

Think and Write About It!

1. Describe the shape of the graph.

2. How does the shape of this graph compare to the graphs of the data from the linear data experiments? (Stretching Spring, Walking the Plank, Raven and the Jug, Rebound, and Spilled Ink) Look back in your notes to refresh your memory if you need to do so.

3. How does the shape of this graph compare to the graphs of the equations for $y = mx$ and $y = mx + b$?

4. What does the shape of this graph tell you about the data from the experiment?

(Right page)

How Far?

DATE: _____

PARTNER(S): _____

_____

Draw a diagram of the experiment. Label the parts. Indicate measurements and variables.

Describe the procedure for the experiment.

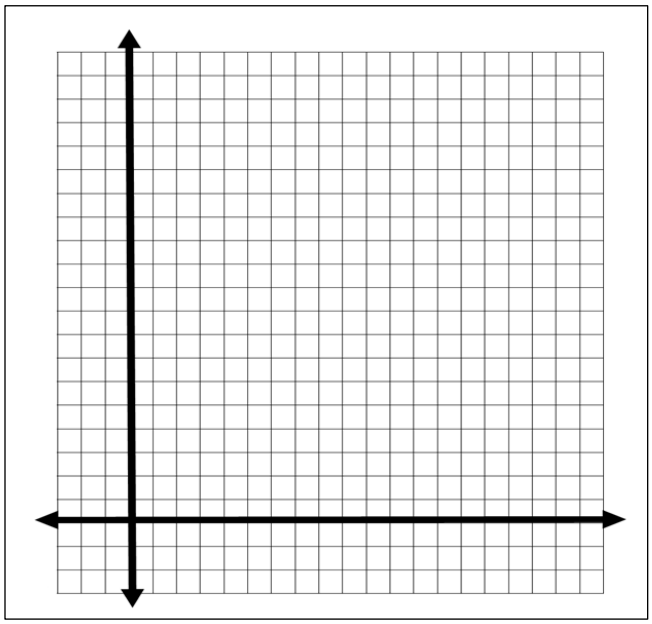
The independent variable, x, is _____ Units _____

The dependent variable, y, is _____ Units _____

The height of the ramp is _____ _____

Data table	
x	y
40 cm	
50 cm	
60 cm	
70 cm	
80 cm	
90 cm	

Graph the points using Desmos. Sketch the resulting graph below. Label the axes.



Think and Write About It!

1. Describe the shape of the graph.

2. How does the shape of this graph compare to the graphs of the data from the linear data experiments? (Stretching Spring, Walking the Plank, Raven and the Jug, Rebound, and Spilled Ink) Look back in your notes to refresh your memory if you need to do so.

3. How does the shape of this graph compare to the graphs of the equations for $y = mx$ and $y = mx + b$?

4. What does the shape of this graph tell you about the data from the experiment?

WALK *this way!*

Name _____

Partner(s) _____

Date _____ Class pd _____

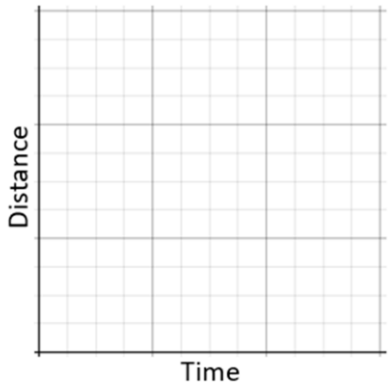
DIRECTIONS:

- Follow each set of instructions carefully. Read the whole "path" before beginning to walk.
- Sketch the graph created by the motion detector.

IMPORTANT: Walk each path at least twice and compare the graphs.

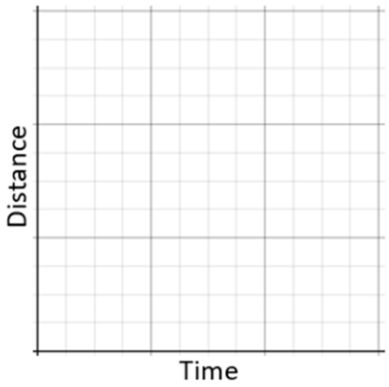
Path 1:

- Begin at Point A.
- Walk at a moderate, steady pace to Point B.
- Stop.
- Sketch the graph.
- Repeat the Path. Compare the two graphs.



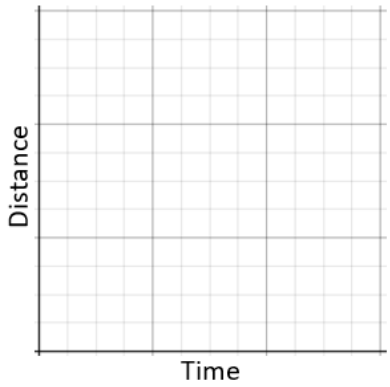
Path 2:

- Begin at Point A.
- Walk at a moderate, steady pace to Point B.
- Stop for 5 seconds.
- Return to Point A.
- Sketch the graph.
- Repeat the Path. Compare the two graphs.



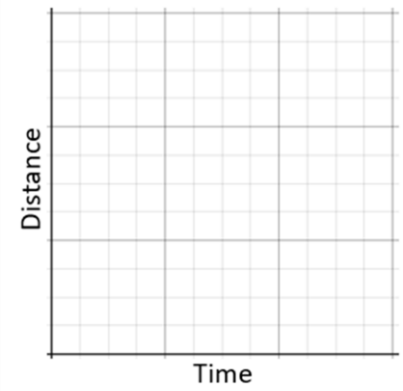
Path 3:

- Begin at Point A.
- Walk quickly to Point B.
- Slow down WITHOUT stopping and walk to Point C.
- Stop.
- Sketch the graph.
- Repeat the Path. Compare the two graphs.



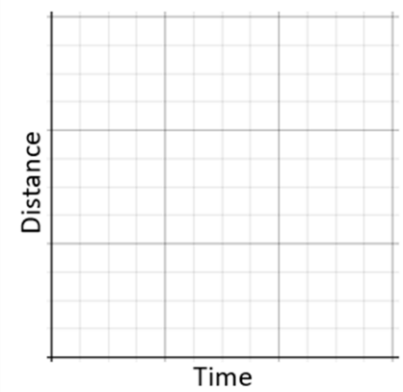
Path 4:

- Begin at Point A.
- Walk at a moderate, steady pace to Point B.
- Stop and IMMEDIATELY walk back to Point A at the same pace.
- Stop.
- Sketch the graph.
- Repeat the Path. Compare the two graphs.

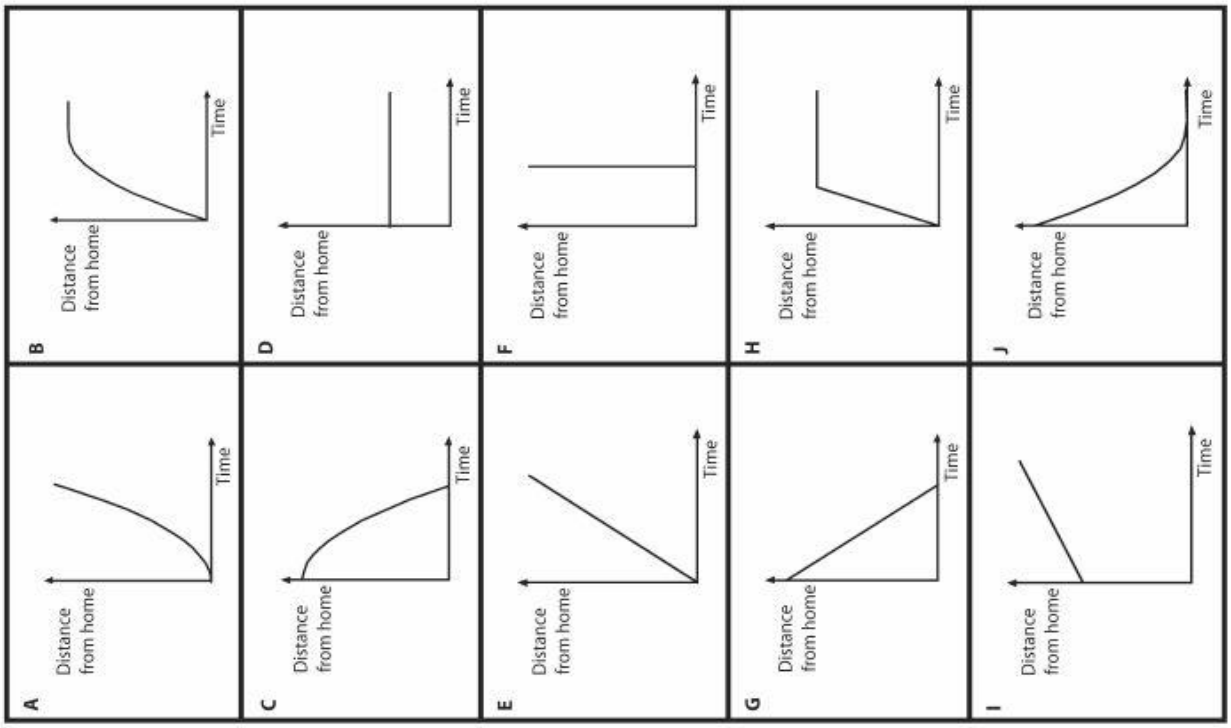


Path 5:

- Begin at Point A.
- Walk towards Point B, accelerating as you go.
- Begin to slow down as you reach Point B.
- Continue to decelerate as you walk towards Point C.
- Stop at Point C.
- Sketch the graph.
- Repeat the Path. Compare the two graphs.



Use the space below to make some general statements about the paths and the shapes of the graphs.

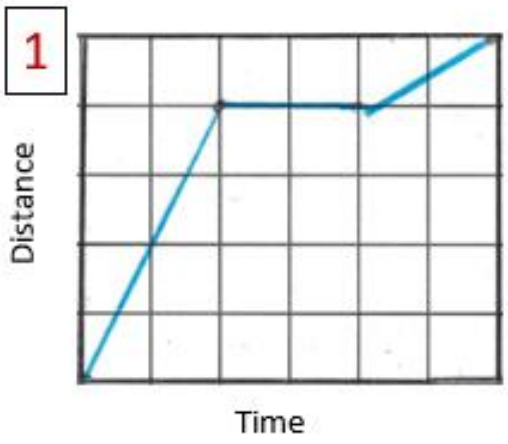


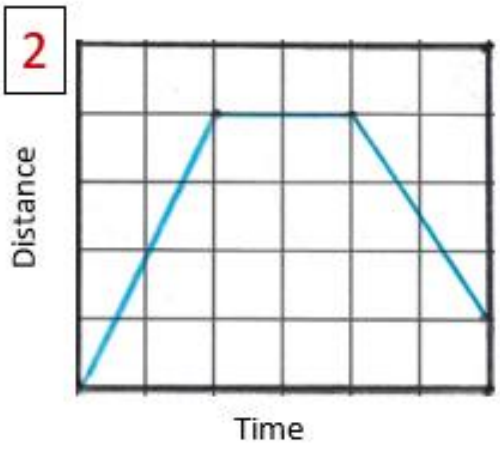
Travels towards home	**Travels away from home**
Goes at a steady, slow speed	**Not moving**
Impossible journey	**Goes at a steady, fast speed**
Stops suddenly	**Slows down and stops**
Speeds up	

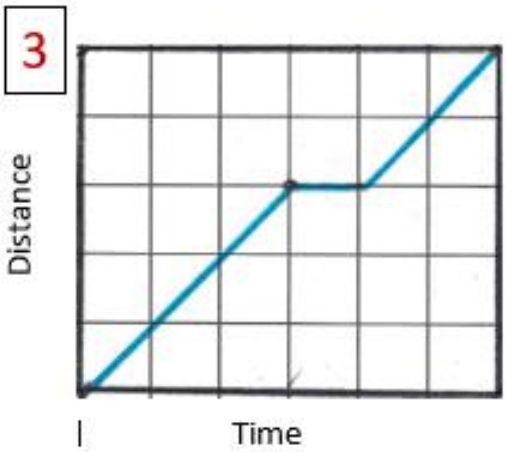
CARD SORT Run on cardstock and cut apart.

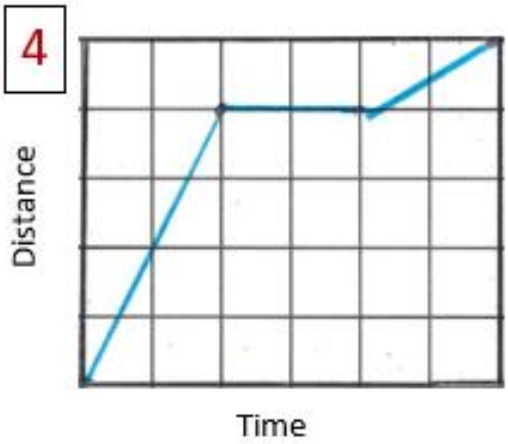
What's My Story?

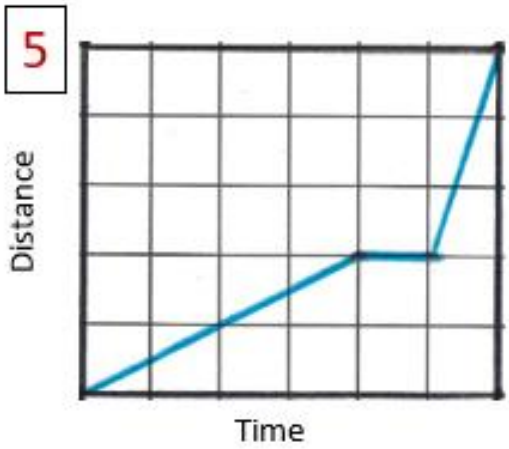
These can be run on card stock and cut apart in singles or pairs to assign to partners and/or small groups.

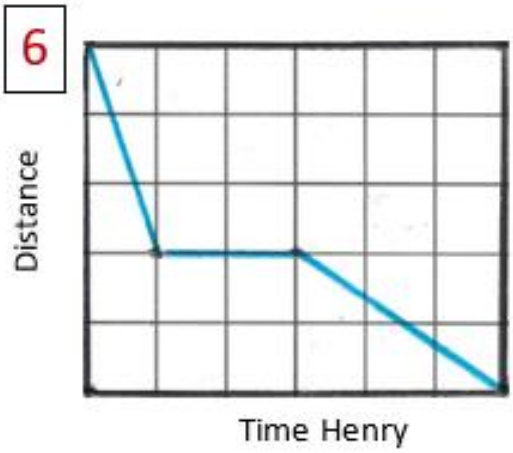


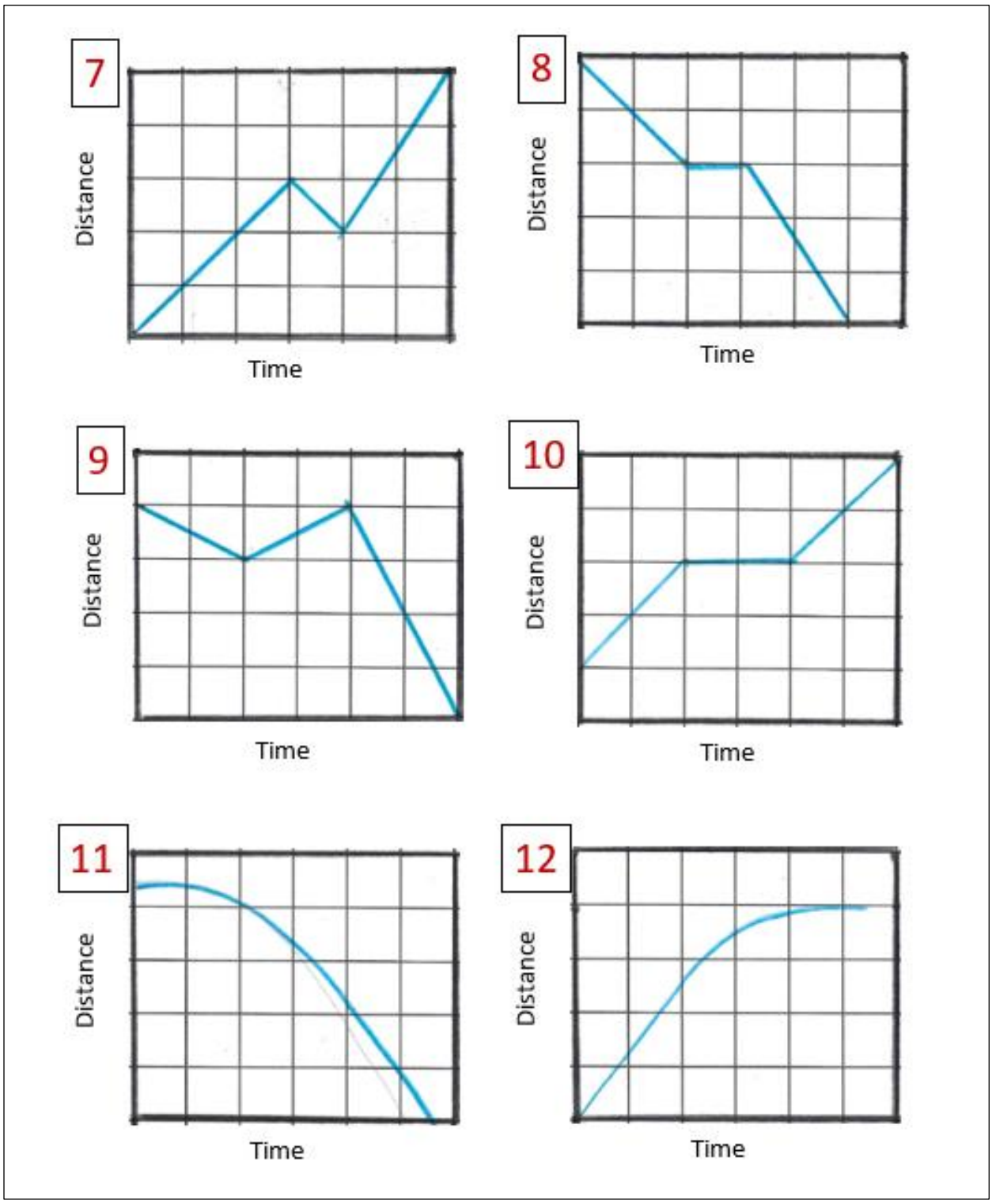




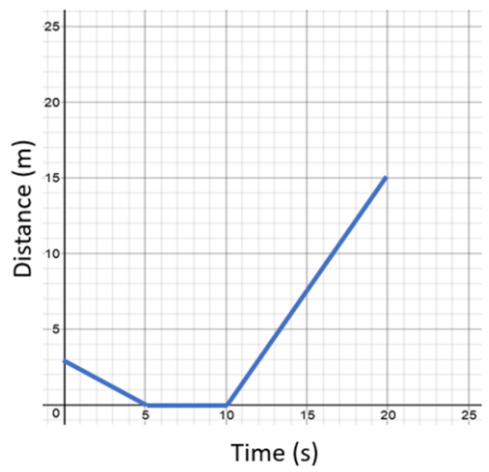




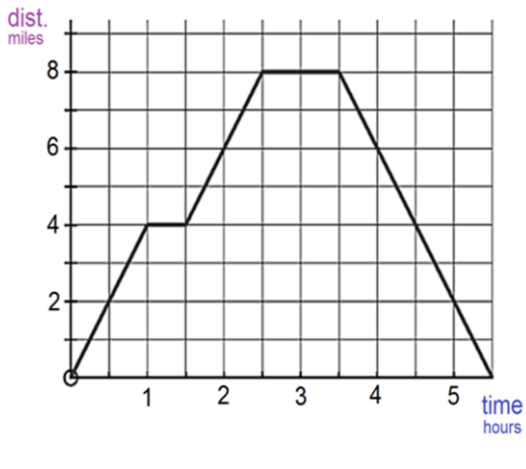




Velocity Stories



Graph



Graph

For each graph:

- Create a story to fit the motion. Remember…make the units make sense!
- Title the graph.
- Use the information from the video to determine the average speed.

SEE ME to find out which graph you'll use to make your presentation.

https://paperslide.wikispaces.com/Guidelines

Paper Slide Video

Videographer:	
Paper Slider:	
Narrator:	
Topic:	

Introduction: Topic and Team Members

Slide One:

Slide Two:

Slide Three:

Slide Four:

Slide Five:

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Paper Slide Video	Videographer:		Narrator:	
	Paper Slider:		Topic:	

Slide # ____

Describe the illustration / diagram you'll use on this slide.

Narration:

Write your script for this slide here:

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