**Starter:**

What do you know about motion? How do we measure motion? What types of motion do we measure?

Where do you think students traditionally get stuck on these ideas?

In today’s activity we will create various types of human motion, track them, develop and analyze graphs based on the motion, and answer questions based on our understandings. As we move through the activity, think about the purpose of the questions, how you think students might respond, and where you think they might struggle.

**Roles**

|  |  |
| --- | --- |
| **Walker**  Follow the directions on the *Walking Function Card.* Must listen carefully to the *Time Keeper* and stop quickly when instructed to do so. | **Time Keeper**  Runs the stopwatch and announces the time. Must speak clearly so the *Walker* knows when to stop. |
| **Marker**  Moves with the *Walker* and identifies where the *Walker* was at important moments. Must listen to the *Timekeeper* and identify distances for the *Data Recorder* to write. | **Data Recorder**  Moves with the *Walker* and *Marker* and records where the *Walker* was at times 0 seconds, 5 seconds, 10 seconds, 15 seconds, and 20 seconds. Must make quick decisions on distance in order to write and move on. |

1. Position your team so that you and another team are on opposite sides of the measuring tape.

Their Team Your Team

1. Using the *Walking Function Card*, determine your starting point and position your team there (your starting point can be found in the top right hand corner of the card).
2. When you are ready, follow the instructions of your *Walking Function Card*, timing for five seconds. As a class, we will record the data together in the chart that follows.
3. What do you notice?
4. Now, continue to follow the instructions on the card, stopping every five seconds to record data and make observations.
5. When you are finished, have a seat and we will begin graphing the data as a class.
6. When you have completed the first graph, obtain a second *Walking Function Card* and repeat the steps above including the graph.

**Data**

Walking Function # \_\_\_\_\_\_\_\_\_ Walking Function # \_\_\_\_\_\_\_\_\_

|  |  |  |  |
| --- | --- | --- | --- |
| Time | Distance  (Location) | Time | Distance  (Location) |
| 0 seconds |  | 0 seconds |  |
| 5 seconds |  | 5 seconds |  |
| 10 seconds |  | 10 seconds |  |
| 15 seconds |  | 15 seconds |  |
| 20 seconds |  | 20 seconds |  |

**Big Questions for YOUR Graphs**

Answer the following questions about BOTH of the small graphs you created.

1. For each of your graphs, indicate the Walker’s position at 7 seconds.

1. **On each graph, place a circle around any *uphill lines****.* What does an uphill line tell you about the motion of the *Walker*? How do you know?
2. **Place a box around any *downhill lines***. What does a downhill line tell you about the motion of the *Walker*? How do you know?
3. **Place a squiggly circle around any *flat lines****.* What does a flat line tell you about the motion of the *Walker*? How do you know?
4. Is there a place on either graph where the *Walker changes direction*? If so, **mark it with a star and write “changes direction”**. How can you tell from the graph that there is a change in direction?
5. Is there a place on either graph where the *person changes speed*? If so, **mark it with an “x” and write “changes speed**”. How can you tell from the graph that there is a change in speed?

Now, create a large version of your SECOND graph on the poster paper. Consider what you might need to change about the scale before you begin.

**Big Questions for OTHER PEOPLE’S Graphs**

1. Look at each of the poster-sized graphs around the room. Try to match each Walking Function Card to the appropriate graph. Be prepared to briefly explain how you know. You can take notes on the back of the cards.
2. For which *Walking Function* did the walker travel the farthest distance? Explain how you know.
3. For each of the graphs, indicate the **time and position** at which the Walker **changed speed and/or direction**. If they change speed, indicate whether they were speeding up or slowing down.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Change in **direction**  (when and where?) | Change in **speed?**  (when and where?) | Speeding up or slowing down |
| *Graph A* |  |  |  |
| *Graph B* |  |  |  |
| *Graph C* |  |  |  |
| *Graph D* |  |  |  |
| *Graph E* |  |  |  |
| *Graph F* |  |  |  |

**What questions do you think your students might still have about motion or speed?**

**How might you extend this activity for your students OR connect to other part of the curriculum?**

**Extensions:**

***Calculating Speed***

An easy extension from this activity is calculation the *average speed* (change in distance/time). For older students, you can also calculate *velocity*, which will take direction into account as well as speed.

There are two ways to have students determine speed within a given time interval in this activity. One is using the data table. Because the data table indicates position along a line rather than a *change* in position, students will need to calculate the distance traveled using both the most recent *previous* position as well as the current position. For example, if the last position was 500 cm and the new position is 1500 cm, the change in position(or distance traveled) would be 1000cm. Students will then need to divide this distance by the interval time, which, in this activity, is always 5 seconds.

The second way to determine the speed is by using the graph. As students get older, they will be familiar with the concept of using rise over run to determine the slope of the line. Prior to this, students can find the difference between the starting and ending position of the *Walker* within an interval to determine the change in distance (drawing a vertical line to indicate this change may help clarify the idea), then divide that change in distance by the time interval, which is 5 seconds.

***The Fuzzy Speed Tracker***

Understanding position, motion, speed and how they relate to each other graphically can be difficult for students to wrap their heads around. The more visual and kinesthetic experiences they have with these ideas, the better.

In the previous activities, the students were able to compare speeds on the graphs, but not necessarily look at how fast and slow look different. Tracking two speeds at the same time can clear up how position vs. time compare in cases of fast and slow motion.

1. Have two walkers stand on either side of the tape. One will move quickly and one slowly. A regular walk and a heel-toe walk tend to work well.
2. Have other students line up on the outside of the walkers giving them room to move.
3. Have the students in the outer rows begin clapping (about once every 2 seconds or so).
4. Have the walkers begin moving at their assigned paces, bending down to place a cotton ball on the floor for each clap that they hear.

Then, analyze the data. A good way to start is simply, “What do you notice?” Students will probably offer some interesting insight into the distance between the markers, how the faster walker seemed to get further ahead the more time passed, that there are many more cotton balls on the slower walker’s side. If the students need a bit more prodding, you may ask some of the following questions:

What was the position of each *Walker* a given time (20 seconds, for example)?

How long did it take each Walker to reach the end of the tape?

What does the size of the space between the marker indicate?

If we made a graph similar to the one we made earlier, what would each graph look like?

***Walking Toys (*From *Teaching Physics with Toys)***

Older students (middle through early high school), can begin to make the connection between **speed** and **acceleration**. An extension of this activity is to change speeds during the walk. This is easier to control by using slow-moving wind up toys than by walking. They move more slowly and more consistently. Toothpicks can be used to mark time intervals, and students can clearly see the distance between the markers become smaller as the toy slows down. By graphing the **change in position vs. time**, students will obtain a graph similar to the ones in the *Walking Function* activity that will look something like this with a positive slope that flattens out as it slows down to a point that it is horizontal when stopped:

Time (sec)

Position (cm)

Additionally, students can graph **speed vs. time**. By laying painter’s tape OR register tape along side the markers, students can label each time increment (0-2 seconds, 2-4 seconds, 4-6 seconds, etc.), and make a cut at each marker. By placing these on a graph with time on the x-axis and speed on the y-axis, students can examine the **change in speed over time** or the **acceleration**. The graph would show the first few bars as the same size (indicating a constant speed), a couple of smaller bars (indicating a slow down) and then a flat line at zero (indicating a stop) and would look something like this:

Speed (cm/sec)

Time (sec)