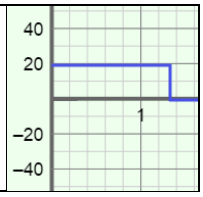
Name: _____ Date: _____

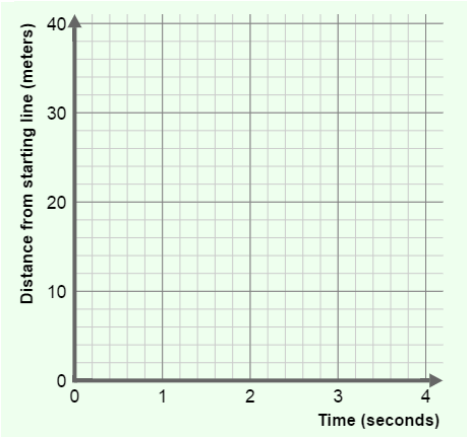
Student Exploration: Distance-Time and Velocity-Time Graphs

Activity A: **Velocity-time graphs**	Get the Gizmo ready: • Change the **Number of Points** to 5. • Turn off **Show graph** and **Show animation** for **Runner 2**.	

1. In the Gizmo, make a position-time graph for **Runner 1** with the following features:
   - There is at least one major change in speed.
   - There is at least one major change in direction.

   Click the green **Start** button and watch the runner run. Adjust your graph if needed to meet the requirements.

   Sketch your graph to the right.



2. Where was the runner each second? Based on your graph, fill in all except the final column in the table below. (Leave the velocity column blank for now.) Label any numbers with units.

Time	Position at end of time interval (m)	Distance moved this time interval (m)	To the left or right?	Velocity this time interval (m/s)
0 – 1 sec				
1 – 2 sec				
2 – 3 sec				
3 – 4 sec				

3. To calculate the velocity for each time interval, first calculate the speed of the runner in that interval (speed = distance ÷ time). If the direction is left to right, velocity is positive. If the direction is right to left, velocity is negative.

   Fill in the velocity column of the table above. Use units (m/s).

(Activity A continued on next page)

Activity A (continued from previous page)

4. **Slope** is the steepness of a graph. To find the slope of a line, divide the change in *y*-value (rise) by the change in *x*-value (run). Like velocity, slope can be positive, zero, or negative.

   Fill in the slope of each segment of your position-time graph, along with the runner's velocity during each time interval, in the table below.

Time interval	Slope	Velocity (m/s)
0 sec – 1 sec		
1 sec – 2 sec		
2 sec – 3 sec		
3 sec – 4 sec		

5. Examine your velocities and the position-time graph you made. How is the slope of a position-time graph related to the velocity of the runner? _____

6. On the left side of the Gizmo, select the VELOCITY-TIME GRAPH tab. Use the green probes to compare the velocity-time graph to the position-time graph.

   A. The slope of a position-time graph should always be equal to a velocity-time graph's _____.

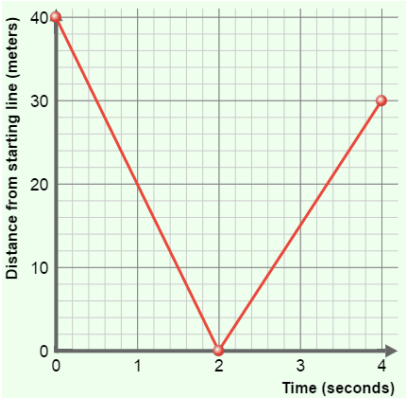
   B. If a velocity-time graph is above the x-axis, the object is moving _____

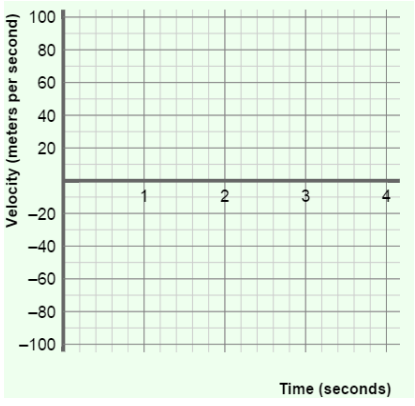
      If a velocity-time graph is below the x-axis, the object is moving _____

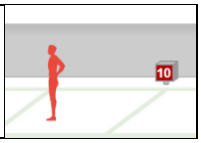
7. To the right is a position-time graph of a runner.

   First, sketch what you think his velocity-time graph will look like on the blank axes at the far right.

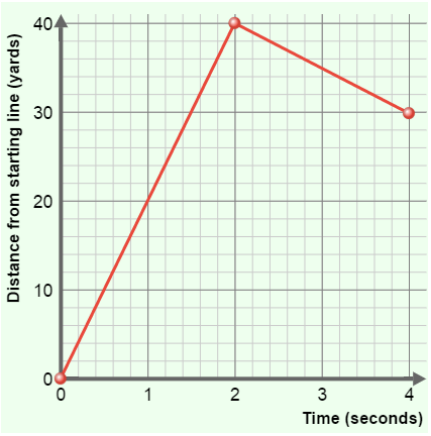
   Then check your answer in the Gizmo.





Activity C: **Distance and displacement**	Get the Gizmo ready: • Click on the **CONTROLS** Tab. • Change the **Number of Points** to 3.	

1. Create the position-time graph for **Runner 1** shown at right. Then fill in the blanks below to describe what you think the runner will do, based on that graph.



The runner will run _____ meters in the first 2 seconds, with a velocity of _____ m/s. His direction will be from _____ to _____.

Then he will run _____ meters in the next 2 seconds, with a velocity of _____ m/s. His direction will be from _____ to _____.

Click the green **Start** button and watch the runner go. Were you correct? _____

2. Two students, Gina and Walter, are discussing the runner whose graph is shown above.
   - Gina says the runner moved more than 40 meters.
   - Walter says the runner moved less than 40 meters.

   A. Who do you think is right? _____

   B. Explain your answer. _____

   _____

3. On top of the left half of the Gizmo, select the DISTANCE TRAVELED tab.

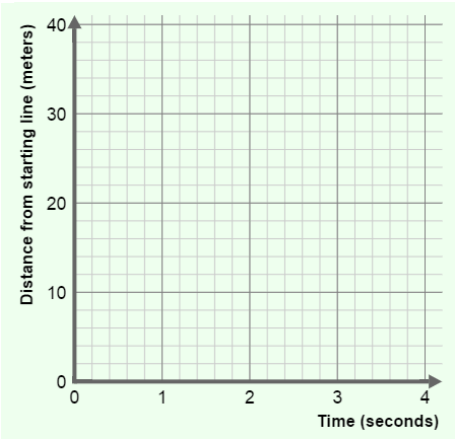
   A. What was the total **distance traveled** by the runner after 4 seconds? _____

   B. **Displacement** is equal to the difference between the starting and ending positions. Displacement to the right is positive while displacement to the left is negative.

   What is the displacement shown by the graph at the top of the page? _____

(Activity C continued on next page)

Activity C (continued from previous page)



4. In the Gizmo, create a position-time graph of a runner with these characteristics:
   - travels a distance of 60 meters in 4 seconds
   - has a displacement of +10 meters

   Sketch your graph on the blank axes to the right.

5. Select the VELOCITY-TIME GRAPH tab.
   A. What is the area under the curve of the first 2 seconds? _____
   B. What is the area under the curve for the last 2 seconds? _____
6. Select the DISTANCE TRAVELED tab.
   A. How does the area under the curve of the first 2 seconds compare to the distance traveled in the first 2 seconds? _____
   B. How does the area under the curve of the last 2 seconds compare to the distance traveled between seconds 2 and 4? _____
7. Suppose you knew the time, displacement, and total distance traveled for a runner.
   A. How would you calculate the runner's average speed? _____

      _____
   B. How would you calculate the runner's average velocity? _____

      _____
8. To the right is a graph of a runner. Calculate the values below for this runner. Include appropriate units.
   A. Distance traveled: _____
   B. Displacement: _____
   C. Average speed: _____
   D. Average velocity: _____