Name: ______________________ Teacher: ________________ Pd. ___ Date: _________

STAAR Science Tutorial 21
TEK 6.8D: Graphing Motion

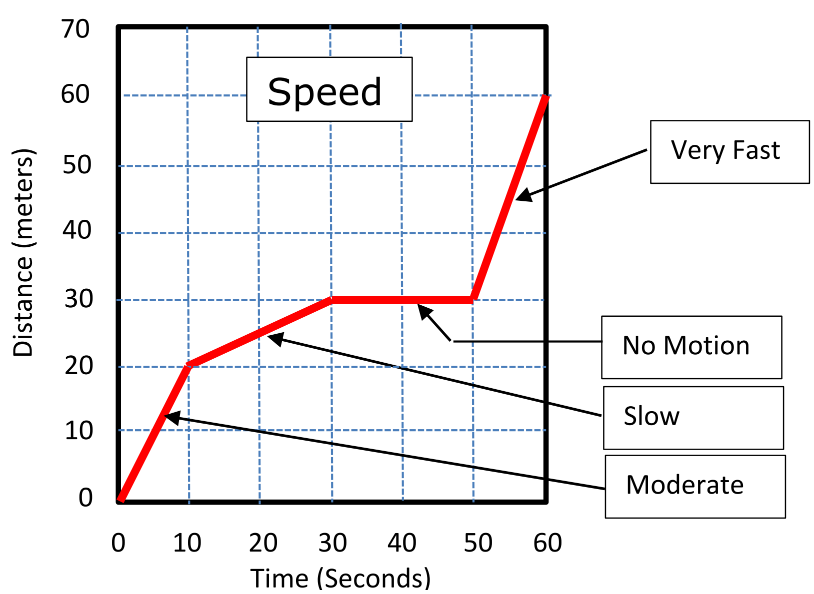
TEK 6.8D: Measure and graph changes in motion.

Graphing Speed on a Distance – Time Graph

- **Speed** is defined as the distance travelled divided by the time it took to travel that distance. **Distance** is the length of the path travelled, following all of the turns or curves of the path. The formula for speed is:

$$\textbf{Speed} = \frac{\textbf{Distance}}{\textbf{Time}}$$

- To graph speed, the total distance traveled at each point of time is graphed on the y-axis, and the elapsed time since the start of measurement is graphed on the x-axis. Because speed does not include direction, any motion is considered forward motion, even if it is back towards the starting point. Lines on a speed graph can either be flat, for no motion, or upward sloping, for motion. The steeper (more vertical) the slope, the faster the speed.
- The graph below shows a trip in which the speed was moderate during the first time interval, slower in the second time interval, had no speed in the third interval, and very fast speed in the fourth and last interval.



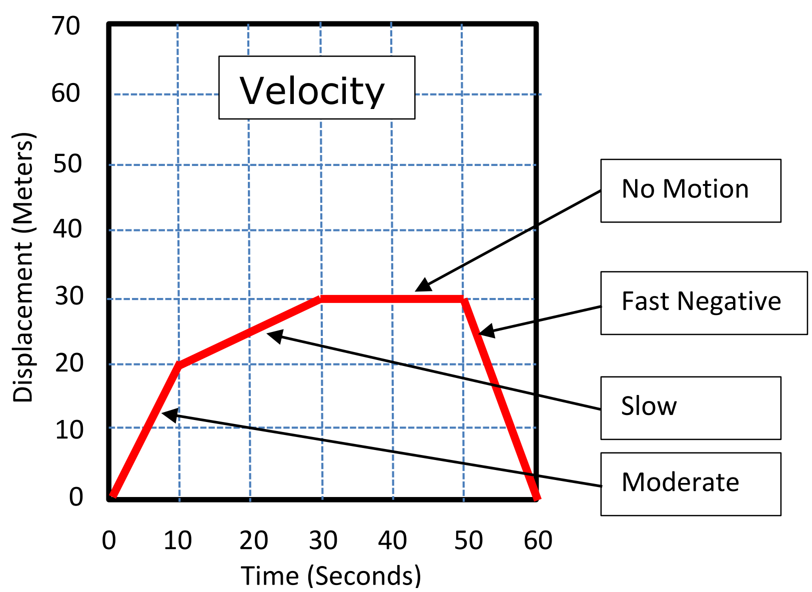
- During the first 10 seconds, the object moved 20 meters. During the next 20 seconds, the object moved an additional 10 meters, for a total of 30 meters in 30 seconds. During the next 20 seconds, the object did not move at all. Total motion is still 30 meters after 50 seconds. During the last 10 seconds, the object moved 30 meters. The total motion was 60 meters in 60 seconds.

Graphing Velocity on a Displacement – Time Graph

- **Velocity** is defined as displacement divided by time. **Displacement** is the straight-line length and direction from the start point to the end point that the object moved. The formula for velocity is:

$$\textbf{Velocity} = \frac{\textbf{Displacement}}{\textbf{Time}}$$

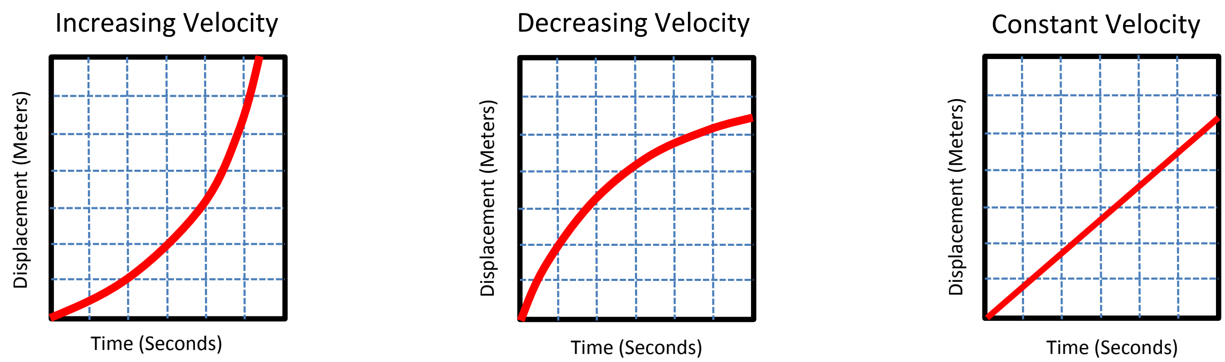
- To graph velocity, the displacement from the starting point at each point of time is graphed on the y-axis, and the elapsed time since the start of measurement is graphed on the x-axis. Because velocity does include direction, any motion is measured from the starting point. Lines on a velocity graph can be flat, for no motion, upward sloping, for forward motion, or downward sloping, for backward motion (negative velocity). The steeper (more vertical) the slope, the faster the velocity.
- The graph below shows a trip in which the velocity was moderate during the first time interval, slower in the second time interval, had no velocity in the third interval, and fast negative velocity (motion back to the starting point) in the fourth and last interval.



- During the first 10 seconds, the object moved 20 meters away from the starting point. During the next 20 seconds, the object moved an additional 10 meters away from the starting point, for a total of 30 meters in 30 seconds. During the next 20 seconds, the object did not move at all. Total displacement is still 30 meters away from the starting point after 50 seconds. During the last 10 seconds, the object moved 30 meters back to the starting point. The total displacement was 0 meters in 60 seconds. The velocity during each segment was constant. The only acceleration occurred at the instant of time between segments.
- Compare the speed graph in the first section with the velocity graph above. The amount of motion was exactly the same in both graphs, but the graphs are

different because in velocity the displacement is always measured from a starting point.

- In the following three displacement – time graphs of velocity, the first upwardly curving graph shows increasing velocity (positive acceleration), the second downwardly curving graph shows decreasing velocity (negative acceleration), and third straight-line graph shows a constant velocity (no acceleration).

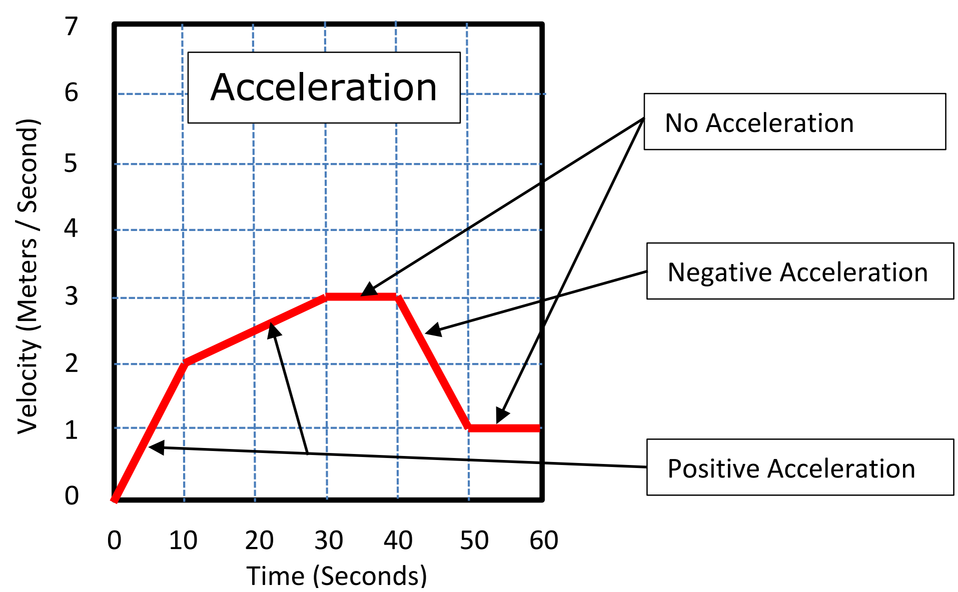


<u>Graphing Acceleration on a Velocity – Time Graph</u>

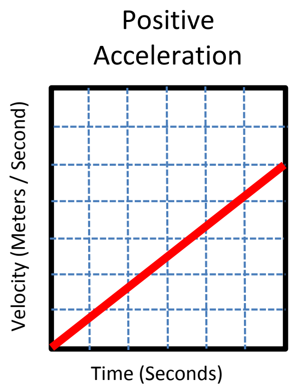
- <u>**Acceleration**</u> is defined as the change in velocity (end velocity minus start velocity) divided by the period of time that the change occurred. The formula for acceleration is:

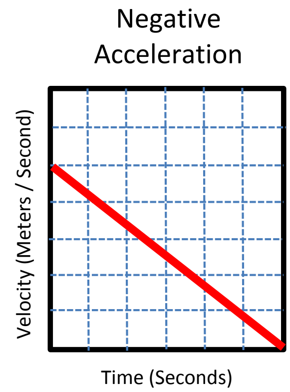
$$\textbf{Acceleration} = \frac{\textbf{(End Velocity – Start Velocity)}}{\textbf{Time}}$$

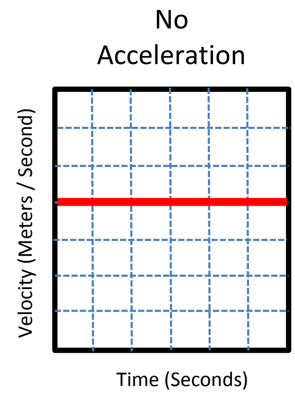
- To graph acceleration, the velocity at each point of time is graphed on the y-axis, and the elapsed time since the start of measurement is graphed on the x-axis. Because velocity does include direction, motion is measured from the starting point, and motion back towards the starting point is negative velocity. Lines on an acceleration graph can be flat, for no acceleration, upward sloping, for positive acceleration, or downward sloping, for negative acceleration. The steeper (more vertical) the slope, the greater the acceleration.



- In the following three velocity – time graphs of acceleration, the first upwardly sloped graph shows positive acceleration, the second downwardly sloped graph shows negative acceleration, and third flat graph shows no acceleration.





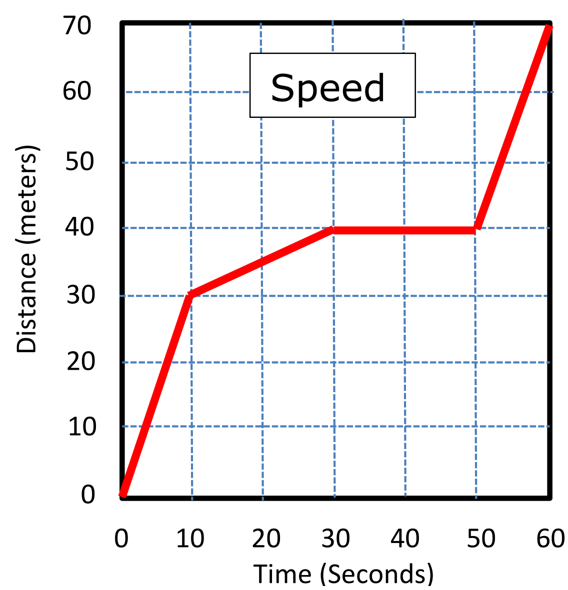


Practice Questions

1. In the speed graph to the right, how many meters has the object moved after 10 seconds? ________________

2. In the speed graph to the right, how many meters has the object moved after 30 seconds? ________________

3. In the speed graph to the right, how many seconds did it take for the object to move 70 meters? _______________



4. In the velocity graph to the right, how far from the starting point had the object moved after 40 seconds?

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5. In the velocity graph to the right, during what time period did the object have negative velocity?

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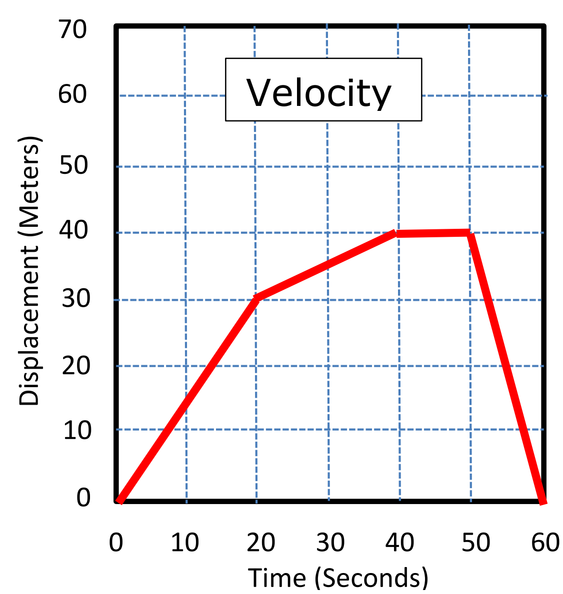

6. In the velocity graph on the previous page, what was the velocity during the time period from 0 seconds to 20 seconds? ______________________________

7. In the velocity graph on the previous page, what was the velocity during the time period from 20 seconds to 40 seconds? ______________________________

8. In the velocity graph on the previous page, what was the velocity during the time period from 40 seconds to 50 seconds? ______________________________

9. In the velocity graph on the previous page, what was the velocity during the time period from 50 seconds to 60 seconds? ______________________________

10. In the acceleration graph to the right, in what time period were there no acceleration? _____________________

11. In the acceleration graph to the right, in what time period were there the greatest positive acceleration?

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12. In the acceleration graph to the right, in what time period were there the greatest negative acceleration?

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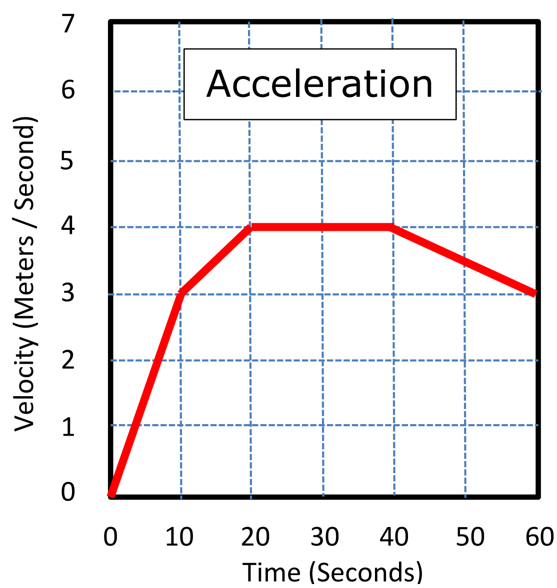

13. In the acceleration graph above, what is the acceleration during the time period from 0 seconds to 10 seconds? _________________________________

14. In the acceleration graph above, what is the acceleration during the time period from 10 seconds to 20 seconds? _________________________________

15. In the acceleration graph above, what is the acceleration during the time period from 20 seconds to 40 seconds? _________________________________

16. In the acceleration graph above, what is the acceleration during the time period from 40 seconds to 60 seconds? _________________________________

17. In the acceleration graph above, what is the average acceleration during the time period from 0 seconds to 60 seconds?

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