Name: ____________________ Teacher: _______________ Pd. ___ Date: ________

STAAR Science Tutorial 22
TEK 8.6B: Speed & Acceleration

TEK 8.6B: Differentiate between speed, velocity, and acceleration.

- **Speed** is one measurement of the rate of motion. Speed is defined as the distance travelled divided by the time it took to travel that distance. The formula for speed is:

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

- **Distance** is the length of the path travelled, following all of the turns or curves of the path. Distance is what a car odometer measures, the actual path of travel that the car took, without any notation of direction. For example, if you walk 100 meters north, and 35 meters south back towards your starting point, the distance you have traveled will be 135 meters, even though you end up at a point 65 meters north from the starting point.

- Another measurement of the rate of motion is velocity. **Velocity** is defined as displacement divided by time. The formula for velocity is:

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

- **Displacement** is the straight-line length and direction from the start point to the end point that the object moved. Displacement does not measure the path travelled, through any turns or curves. It is always a straight-line length, even if the object did not actually travel along that straight line. A displacement measurement must also include a direction, such as compass direction (north) or bearing (north 20° east). A car odometer does not measure velocity, unless it happens to be a straight-line trip. To use the same example as for speed above, if you walk 100 meters north, and 35 meters south back towards your starting point, your displacement is 65 meters north, even though you travelled a total distance of 135 meters.

- In day-to-day life, speed is the usual measurement of motion. Displacement and velocity are primarily used in physics and engineering problems.

- Another measurement of the rate of motion is acceleration. **Acceleration** 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:

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

- Because acceleration uses velocity as part of its formula, direction must be stated in both velocity and acceleration. In simple acceleration problems, the direction of the start and end velocities will be the same.

- Any change in velocity, either because the direction of movement has changed, or the rate of motion has changed, means that acceleration has occurred. For this reason, a car moving at a constant speed around a curve in the road is accelerating.

- In the common use of English, we use acceleration as a synonym for "speeding up," and deceleration for "slowing down." In science, "speeding up" is called a positive acceleration, and "slowing down" is called negative acceleration. If the end velocity is greater than the start velocity (speeding up), the acceleration will be positive. If the end velocity is less than the starting velocity (slowing down), the acceleration will be negative.

- One common use of acceleration is to calculate the end velocity of a falling object over a certain period of time, using the known acceleration due to the force of gravity on Earth: 9.8 m/s^2. What this means is that a dropped object will accelerate from a downward velocity of 0 m/s to 9.8 m/s by the end of the first second, and from 9.8 m/s to 19.6 m/s by the end of the 2^{nd} second. Stated another way, for every second that an object falls, its velocity will increase by another 9.8 m/s. The formula for this calculation would be:

Velocity (m/s) = Gravitational Acceleration (9.8m/s^2) • time (s)

- The units of acceleration have two different time components: the time that is part of the velocity, and the time over which the change in velocity occurred. These two time units may be the same, as in the example of gravitational acceleration above, or they may be different. For example, the measured acceleration of a car may be stated as 20 kilometers per hour per second, meaning that the car can increase its velocity by 20 km/h every second.

Practice Questions

1. A car travels a distance of 60 kilometers in 2 hours. What is its speed in kilometers per hour? ___________________ km/h

2. A car travels a distance of 120 kilometers in 4 hours. What is its speed in kilometers per hour? ___________________ km/h

3. A car travels a distance of 320 kilometers in 8 hours. What is its speed in kilometers per hour? ___________________ km/h

4. A car has a displacement of 160 kilometers to the north in 2 hours. What is its velocity in kilometers per hour? __________________ km/h ______________

5. A car has a displacement of 125 kilometers to the south in 5 hours. What is its velocity in kilometers per hour? _________________ km/h _____________

6. A car has a displacement of 480 kilometers to the east in 8 hours. What is its velocity in kilometers per hour? _________________ km/h _____________

7. A car follows a curved highway from point A to point B, covering a distance of 50 kilometers and displacement to the east of 40 kilometers in 0.5 hours. What is speed and velocity of the car in kilometers per hour? Speed: __________ km/h Velocity: __________ km/h ______________

8. A car follows a curved highway from point C to point D, covering a distance of 100 kilometers and displacement of 80 kilometers to the south in 2 hours. What is speed and velocity of the car in kilometers per hour?
Speed: ___________km/h Velocity: ___________km/h _____________

9. If a car is traveling at a constant speed of 100 kilometers per hour (km/h), how many hours will it take for the car to travel a distance of 500 kilometers?
______________ h

10. If a car is traveling at a constant speed of 70 kilometers per hour (km/h), how many hours will it take for the car to travel a distance of 280 kilometers?
______________ h

11. If a car moves at a speed of 80 km/h for 5 hours, what distance will it travel?
_________ km

12. If a car moves at a speed of 75 km/h for 4 hours, what distance will it travel?
_________ km

13. If the velocity of a car changes from 0 meters per second (m/s) to 100 m/s in 10 seconds, what is the acceleration over that 10 second period?
________________ m/s^2

14. If the velocity of a car changes from 20 meters per second (m/s) to 60 m/s in 4 seconds, what is the acceleration over that 4 second period?
________________ m/s^2

15. If the velocity of a car changes from 100 km/h to 0 km/h in 10 seconds, what is the acceleration over that 10 second period? _______________________ km/h/s