# Notes – Distance and Velocity

## Review

- Where an object is can be discerned by two different methods. The first is displacement and the second is distance. Displacement is denoted with a $\vec{d}$ and distance is just a $d$ .

- These are different!! Displacement is a measurement of how far the object is from the starting spot. Distance is how far you have travelled, not how far you are from the origin (start).

- Distance is a scalar quantity. This means that distance just has a magnitude (value). Displacement is a vector quantity, so it has a magnitude and a direction. Objects to the right have a positive value and objects to the left of start have a negative value.

- To find displacement you subtract the starting position ($\vec{d}_i$) from the final position ($\vec{d}_f$). $\Delta\vec{d} = \vec{d}_f - \vec{d}_i$

- A time interval (time) is found in the same manner as displacement. $\Delta t = t_f - t_i$.

- Average velocity is speed with a direction (vector). This can be discovered by dividing $\Delta\vec{d}$ by $\Delta t$ . That is how far you have moved in what space of time. $\vec{v}_{avg} = \frac{\Delta\vec{d}}{\Delta t}$ or $\vec{v}_{avg} = \frac{\vec{d}_f - \vec{d}_i}{t_f - t_i}$

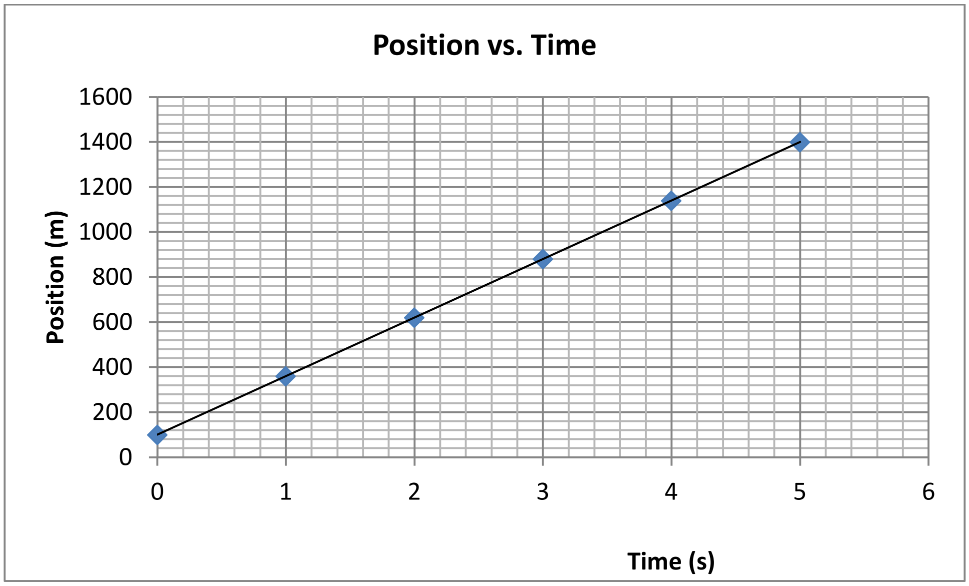
- Ex. – In the 1988 Olympics Ben Johnson ran the $100\ m$ race in $9.88\ s$. Find his average velocity in $\frac{m}{s}$ and $\frac{km}{h}$ .

Answer - $\vec{v}_{avg} = \frac{\Delta\vec{d}}{\Delta t}$ $\vec{v}_{avg} = \frac{+100}{9.88}$ $\vec{v}_{avg} = +10.12\ \frac{m}{s}$ + is needed for direction!!!!!

$$+10.12\ \frac{m}{s} \times \frac{3600s}{1hr} \times \frac{1km}{1000m} = +36.44\ \frac{km}{h}$$

- Velocity is often shown in the form of a graph. A graph that shows position in regards to time is called a position-time graph. The slope of the line is velocity.

- Ex. – Use the following graph to calculate the velocity of the object.

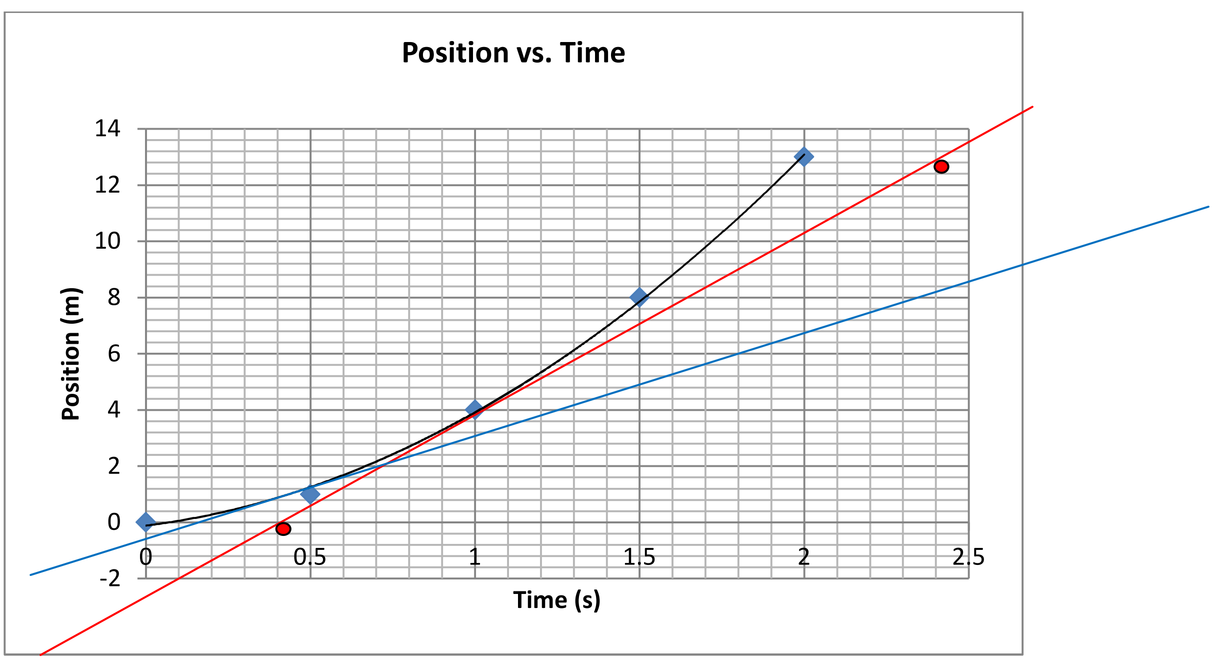



Answer - $\vec{v}_{avg} = \frac{\Delta\vec{d}}{\Delta t}$ $\vec{v}_{avg} = \frac{1400-100}{5-0}$ $\vec{v}_{avg} = +260\ \frac{m}{s}$

- Notice how the equation is the same as $\frac{rise}{run}$ $or$ $\frac{y_2 - y_1}{x_2 - x_1}$.

- Often when velocity is changing it becomes difficult to find the velocity at one moment in time or instantaneous velocity. To discover the velocity at a given moment we need to find the slope of a position time graph for the instant velocity is needed. We do this by drawing a tangent.

- Ex. –



- The red line is a tangent to the curve at time $1.0\ s$. The slope of the tangent will allow me to calculate instantaneous velocity at $1.0\ s$. $\vec{v} = \frac{13-0}{2.4-0.4}$ $\vec{v} = +6.5\ \frac{m}{s}$

- The blue line is tangent to the curve at $0.50\ s$. The slope of the tangent will allow me to calculate instantaneous velocity at $0.50\ s$.

- Now that we understand velocity we can use it to learn about acceleration. Acceleration is a measure of the change in velocity over time. In other words it's how fast you are speeding up. That is just as velocity was position in regards to time, acceleration is velocity in regards to time.

- So average acceleration is $\vec{a}_{avg} = \frac{\Delta\vec{v}}{\Delta t}$ or $\vec{a}_{avg} = \frac{\vec{v}_f - \vec{v}_i}{t_f - t_i}$

- Ex. – The velocity of a car increases from $+2.0\frac{m}{s}$ at $1.0\ s$ to $+16\frac{m}{s}$ at $4.5\ s$. What is the car's average acceleration?

Answer -

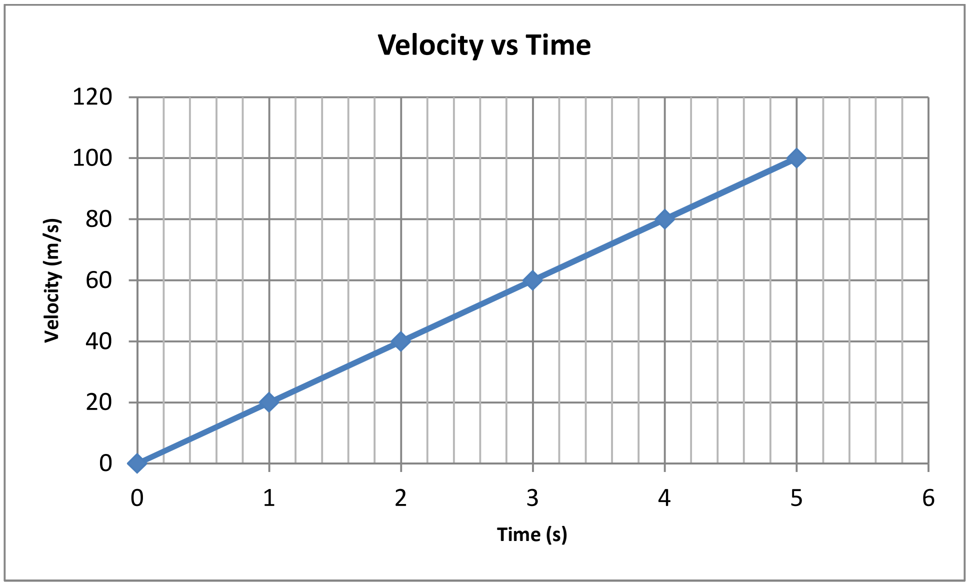
- Ex. – A car speeds up backwards down a long driveway. We define forward velocity as positive, so backwards is negative. The car's velocity changes from $-2.0\frac{m}{s}$ to $-9.0\frac{m}{s}$ in $2.0\ s$. Find the acceleration.

Answer -

- Velocity can also be graphed with time. A velocity-time graph allows us to discover acceleration.

- Acceleration is the slope of the line for a velocity-time graph.

- Ex. – Airplane rolling down a runway.




- Note how the slope is constant so the acceleration is constant. It is speeding up but at the same amount each second.

- <u>Ex.</u> – Solve for the acceleration of the jet.

<u>Answer</u> –

- Instantaneous acceleration is solved the same way as instantaneous velocity was. That is you need to draw a tangent and solve for the slope of the tangent.

- <u>Please note – The area under a velocity-time graph is equal to the displacement!!!!!!</u>