<table>
<tr><td>What is velocity?</td><td>Speed and direction. Therefore, 6mph east and 6mph west are different velocities.</td></tr>
<tr><td>What is uniform motion?</td><td>Also known as uniform or constant velocity, this is motion with an unchanging velocity. This does include objects at rest (even though their direction is undefined).</td></tr>
<tr><td>What is Newton's first law?</td><td>An object moves in a straight line and at constant speed to the extend that it interacts with other objects.</td></tr>
<tr><td>What indicates an interaction?</td><td>Change is an indicator of interaction:
• change of velocity
• change of identity (chemical change)
• change of shape or configuration (physical change, phase shift)
• change of temperature</td></tr>
<tr><td>What is a vector?</td><td>A quantity with magnitude and direction. Vectors are denoted by letters with arrows drawn over them ($\vec{p}$) and consist of several components. For example, if $\vec{p}$ was a vector that denoted a position in three dimensions, it would have three components, corresponding to the x, y, and z axes. $\vec{p}=(p_x, p_y, p_z)$
Vectors are not positive, negative, or zero, although their components are.
The magnitude of a vector, $|\vec{p}|$ is the square root of the sum of the squares of its components.
<table>
<tr><th colspan="2">Algebra for vectors</th></tr>
<tr><th>Allowed</th><th>Not allowed</th></tr>
<tr><td>Addition or subtraction of vectors (by adding or subtracting the respective components)
• addition is commutative
• associative property holds for both addition and subtraction</td><td>Setting a vector equal to a scalar</td></tr>
<tr><td>Finding magnitude (square root of sum of squares of components)</td><td>Adding or subtracting a vector from a scalar</td></tr>
<tr><td>Multiplying or dividing a vector by a scalar (each component is multiplied or divided by the scalar. This changes magnitude. Multiplying by a negative scalar reverses direction)</td><td>Dividing by a vector</td></tr>
<tr><td>Finding the rate of change of a vector $\frac{(d\vec{r})}{dt}$</td><td></td></tr>
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</td></tr>
<tr><td>What is a scalar?</td><td>A quantity that can be represented by a single quantity. Scalars can be positive or negative. Scalars denote quantities like speed, temperature, and mass. Unlike vectors, the value of a scalar does not change if the arrangement of the coordinate axes is altered. The magnitude of a vector is a scalar.</td></tr>
<tr><td>What is a unit vector?</td><td>A vector of magnitude 1 (with any direction). A unit vector has no units.
It is written as $\hat{r}$, with a hat/caret instead of an arrow. There are three important to know unit vectors in the 3D Cartesian coordinate system:
$\hat{i}=\langle 1,0,0\rangle$
$\hat{j}=\langle 0,1,0\rangle$
$\hat{k}=\langle 0,0,1\rangle$
Other vectors can be expressed in terms of these specific unit vectors, which point across the x, y,</td></tr>
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	and z axes, respectively. Other unit vectors exist (all have components less than or equal to one). A unit vector may be calculated by dividing a vector by its magnitude. Conversely, it is possible to factor a vector into a product: a unit vector in the direction of the vector, multiplied by a scalar (equal to the magnitude of the original vector).
How are unit vectors and angles related?	A unit vector whose direction is at a known angle from the x axis can be calculated using trigonometry. The unit vector, points away from the x axis at angle Θ_x, creating a triangle with base A_x and hypotenuse $\lvert\vec{A}\rvert$, which is 1. Since $cos\Theta = \frac{adjacent}{hypotenuse} = \frac{A_x}{1}$, $A_x = cos\Theta$. This is true for y and z as well. A unit vector can therefore be calculated from an angle using the cosine function: $\hat{t}=\langle cos\Theta_x, cos\Theta_y, cos\Theta_z\rangle$. One special case of this is a unit vector in the x-y plane (where z is equal to 0). In this case, $cos\Theta_y$ is the same as $sin\Theta_x$.
What is the zero vector?	A vector whose components are all zero. $\vec{0}=\langle 0,0,0\rangle$
How is velocity represented with vectors?	Dividing displacement by time interval. $\vec{v}_{avg}=\frac{(\vec{r}_f-\vec{r}_i)}{(t_f-t_i)}=(\frac{\Delta x}{\Delta t},\frac{\Delta y}{\Delta t},\frac{\Delta z}{\Delta t})$
What is the position update formula?	$\vec{r}_f=\vec{r}_i+\vec{v}_{avg}(t_f-t_i)$ $\vec{r}_f=\vec{r}_i+\vec{v}_{avg}\Delta t$ This formula allows a final position to be predicted using the starting position, time interval, and average velocity.
What is instantaneous velocity?	$\vec{v}=\lim_{(\Delta t\to 0)}\frac{\Delta\vec{r}}{\Delta t}=\frac{d\vec{r}}{dt}=\frac{d}{dt}(x,y,z)=(\frac{dx}{dt},\frac{dy}{dt},\frac{dz}{dt})=(v_x,v_y,v_t)$ The derivative of the position vector $\vec{r}$. When graphed, it is tangent to the path of the object's motion.
What is acceleration?	The rate of change of velocity. Instantaneous acceleration is the derivative of velocity: $\vec{a}=\frac{d\vec{v}}{dt}$ Average acceleration can be calculated from the change in velocity over time: $\vec{a}_{avg}=\frac{\Delta\vec{v}}{\Delta t}$ Acceleration is measured in m/s^2.
What is momentum?	The product of mass and velocity, represented by $\vec{p}=\vec{v}\cdot m$. When determining momentum at high speeds, it is necessary to introduce another factor, γ. Usually, greater interactions produce greater changes in momentum. Nearing the speed of light, however, this is not quite correct. Therefore, let $\gamma=\frac{1}{\sqrt{1-(\frac{\lvert\vec{v}\rvert}{c})^2}}$. This proportionality factor depends on the ratio of the object's speed to the speed of light. At slow speeds ($\lvert\vec{v}\rvert\ll c$), γ is about equal to 1, and can be left out of the expression. The direction of momentum is the same direction as velocity.