Engineering Physics I

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Significant Figures

When multiplying or dividing, the result is as precise as the least precise input to the number of digits.
Example: $54.3 * 6.8991 = 374.62113$, truncated to 374 or rounded to 375.

When adding or subtracting, the result is as precise as the least precise input to the nuber of digits post decimal place.
Example: $10.65 + 3.0 = 13.65$, truncated to 13.6 or rounded to 13.7.

As a general rule (from the professor), round up down to the nearset even number, as always rounding up will accumulate more error.

Variables of Movement and Position

1. Position: Location in space with respect to another object or coordinate system.
   x, y, z
2. Displacement: Difference in position at two different times.
   $\Delta x, \Delta y, \Delta z, \Delta x = x_2 - X_1$
3. Average Velocity: Displacement divided by time.
   $v_{avg}, v_{avg} = \frac{\Delta x}{\Delta t}$
4. Speed: Total distance divided by time.
   $s, s \equiv \frac{d}{t}$
5. Instantanious Velocity: Velocity measured at a single time.
   $v, v = \lim_{t \to a} \frac{\Delta x}{\Delta t} = \lim_{t \to a} \frac{x_2 - x_1}{t_2 - t_1}$

Motion at Constant Velocity

$x = x_0 + vt$ The following computes a new position of x according to an object's initial position (x_0), velocity (v) and the given time passed (t). The equation is a slope-intercept formula.

Velocity at Constant Acceleration

$v = v_0 + at$ The following computes a new velocity of v according to an object's initial velocity (v_0), acceleration (a) and the given time passed (t). The equation is a slope-intercept formula.

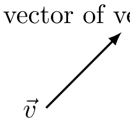
The following equations can be combined as a system to calculate constant acceleration with velocity, position and time. When given a final velocity v_f and an initial velocity v_0 one can deduce an average velocity (v or v_{avg})

$v_f = v_0 + at$ and $x = x_0 + vt \to x = x_0 + (\frac{v_0+v_f}{2})t \to x = x_0 + \frac{1}{2}(v_0 + v_0 + at)t \to x = x_0 + v_0t + \frac{1}{2}at^2$ after simplification.

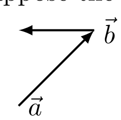
Vectors and Vector Math

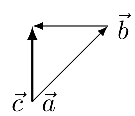
- Scalar $\equiv$ number, units $\equiv$ magnitude
- Vector $\equiv$ number, units, direction $\equiv$ magnitude, direction

Vectors allow for easier representation of position, velocity, and acceleration. A vector of velocity looks like $\vec{v}$ and can be drawn to look like the following.



Vector addition takes two vectors and aligns them tail to tip. For example, suppose the following vectors $\vec{a}$, $\vec{b}$ and $\vec{c}$ such that $\vec{a} + \vec{b} = \vec{c}$.





Vector addition is communative. $\vec{a} + \vec{b} = \vec{b} + \vec{a}$ Vector addition is associativ. $\vec{a} + (\vec{b} + \vec{c}) = (\vec{a} + \vec{b}) + \vec{c}$

Unit Vectors are vectors of magnitude of 1 that extend in only the x, y, or z direction alone a 3D cartessian system. The vectors are $\hat{i}$, $\hat{j}$ and $\hat{k}$ respectively. Notation for vectors, when expanded, looks like $\vec{A} = (A_x\hat{i} - A_y\hat{j} + A_z\hat{k})$ which could be $= (12\hat{i} - 7\hat{j} + 14\hat{k})$. Vector addition becomes standard addition, and multplying vectors by scalars only needs to be distributed.

Circular Motion

Angular vectors use radius unit vector ($\hat{r}$) and an inclination unit vector ($\hat{\theta}$). Position around a circle can be determined if given an average velocity and time.

Let $T = \frac{2\pi r}{v}$ where r is the radius and v is the velocity.

Position: $\vec{r}(t) = r\cos\frac{2\pi r}{T}\hat{i} + r\sin\frac{2\pi r}{T}\hat{j}$

Velocity (derivative of position): $\vec{v}(t) = -r\frac{2\pi}{T}\sin\frac{2\pi r}{T}\hat{i} + r\frac{2\pi}{T}\cos\frac{2\pi r}{T}\hat{j}$

Acceleration (derivative of velocity): $\vec{a}(t) = -r\frac{4\pi^2}{T^2}\cos\frac{2\pi r}{T}\hat{i} - r\frac{4\pi^2}{T^2}\sin\frac{2\pi r}{T}\hat{j}$

Or

$\vec{a}_{centrip} = -\frac{v^2}{r}\hat{r}$