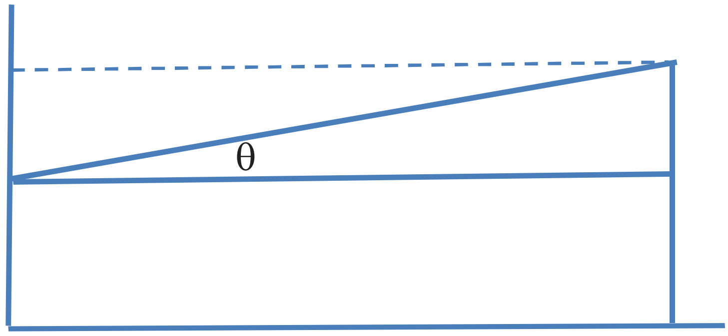
Equations of Motion – Graphical Interpretation



Consider car with initial velocity u accelerating to velocity v in time t.

Label the graph yourself with u v and t.

Now if the acceleration is constant we define $a = (v - u) / t$

Now by inspection of the graph we can see that acceleration is $\tan \theta$.

and $v - u = a t$

Now the area of the triangle represents the total distance travelled – "s".

Consider the total area as a trapezium then $s = \frac{1}{2} (u + v) t$ 2nd equ.

Or consider the total area as two separate shapes then

$s = u t + \frac{1}{2} t (v - u)$

$s = u t + \frac{1}{2} a t^2$ 3rd equ.

Now we could differentiate this expression with respect to time

$ds / dt = u + a t$

and as $ds / dt = v$ we immediately recover $v = u + at$ 1st equ.

And we can compare this with the standard linear equation $y = m x + c$

Finally we could calculate the large rectangle and subtract the upper triangle.

$s = v t - \frac{1}{2} a t^2$ 4th equ.

Higher differentials

If we differentiate again we define acceleration as dv / dt or d^2s / dt^2

Jerk (j) is defined as d^3s / dt^3 Snap (n) is defined as d^4s / dt^4

The general terms are $s = s_0 + u t + \frac{1}{2} a t^2 + \frac{1}{6} j t^3 + \frac{1}{24} n t^4$

and $v = v_0 + a t + \frac{1}{2} j t^2 + \frac{1}{6} n t^3$

and $a = a_0 + j t + \frac{1}{2} n t^2$

and $j = j_0 + n t$ a beautiful pattern

Rg

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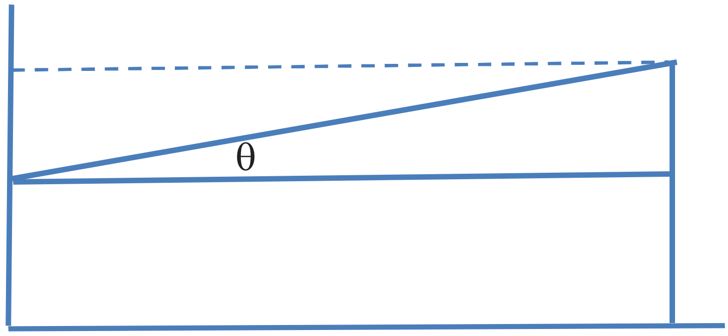

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