

DAVE'S EXPLANATION FOR THE DISTANCE EQUATION:

$$x = x_0 + v_0 t + \frac{1}{2} a t^2$$

One day, Isaac Newton was sitting under an apple tree eating his lunch, and an apple fell on his head. Newton thought to himself, "Hmm, today, I think I will invent gravity." And so he did. While he was at it, he invented calculus too. He pulled his NASA space pen out of his shirt pocket (because all physicists carry space pens¹ in their shirt pockets - it just goes well with their black ties and white short sleeve dress shirts and nerdy eyeglasses), then he pulled

$$F = ma$$

out of his ass, and wrote it down. And thus, the great and wonderful Newtonian Mechanics was born.

Then Newton said, "This 'a' - what a novel idea. I'll call 'a' the change in velocity with respect to time. Also, I think I'll call this a derivative."

$$a = \frac{dv}{dt} \quad \text{where } v \text{ is velocity and } t \text{ is time.}$$

Then Newton said, "Yunno, it would be nice to be able to solve for the velocity. Good thing I just invented calculus, because now I have to do an integral."

¹ Except for the Russians, who, instead of spending billions of dollars developing pens that work in space, just used a pencil.

$$v = \int (a) dt = at + c$$

Newton looked at the equation he had just written down, and said "Hey that 'c' just represents some arbitrary constant, and if $t = 0$, I want the velocity to be the starting velocity. So I'll just replace 'c' with v_o ."

$$v = at + v_o$$

Newton thought to himself, "Hmm, this looks suspiciously like something I'd see in some introductory physics textbook!" Then he noticed that velocity is just the change in position with respect to time - again, a derivative.

$$v = \frac{dx}{dt}$$

So if he were to solve for x by applying his integral again, he could produce:

$$x = \int (at + v_o) dt = v_o t + \frac{1}{2} at^2 + c$$

And then Newton said, "WTF - I keep getting this stupid constant of integration. Maybe I should stick in the initial position for the constant, and call $c = x_o$."

$$x = x_o + v_o t + \frac{1}{2} at^2$$

which, lo and behold, is the magic distance equation which you find in your textbook. So while you are all cursing Newton for making your life more difficult, at least now you know where it comes from. And knowing is half the battle.

If it helps, Newton was pansy. You could've taken him.