University Physics 1A

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Kinematic Equations

The following equations can be derived though calculus:

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

$$v = v_0 + at$$

$$v^2 = (v_0)^2 + 2a(x - x_0)$$

One additional equation can be derived from the combinations of the above equations:

$$x - x_0 = \frac{1}{2}(v + v_0)t$$

These equations are only valid when the acceleration is constant and assume that motion begins at $t = 0$. If we assume that motion begins at $t = t_i$:

$$x = x_i + v_i(t - t_i) + \frac{1}{2}a(t - t_i)^2$$

$$v = v_0 + a(t - t_i)$$

These equations are useful in situations without friction, air resistance, etc, such as freefall (where acceleration $a = -9.81 m/s^2$ assuming y is positive upwards).

$$g \equiv 9.81 m/s^2$$

$$a_{gravity} = -g$$

Example

Driver A is driving along a road at constant velocity $v_A = 50m/s$. As driver A passes police car P, P starts accelerating at $2m/s^2$. How long will it take for P to catch A? This question implies that the two cars must be at the same point at the same time.

$$\begin{aligned} x_A = x_P = x_{A_0} + v_{A_0}t + \frac{1}{2}a_A t^2 &= x_{P_0}t + v_{P_0} + \frac{1}{2}a_P t^2 \\ 0 + 50t + \frac{1}{2}(0)t^2 &= 0 + 0t + \frac{1}{2}(2)t^2 \\ 50t &= t^2 \\ t^2 - 50t &= 0 \\ t(t-50) &= 0 \end{aligned}$$

The two solutions for this are $t = 0s$ and $t = 50s$. We can rule out $t = 0$ because that's when driver A first passes police car P.

Reminders and Homework

Complete the homework on TheExpertTA and WebAssign.
Remember to bring the Activities Manual

You can find all my notes at `http://omgimanerd.tech/notes`. If you have any questions, comments, or concerns, please contact me at alvin@omgimanerd.tech