Original equation

$$a = \frac{v_f - v_i}{\Delta t}$$

- Mulitply both sides of the equation by Δt and simplify.

$$a\Delta t = \left(\frac{v_f - v_i}{\Delta t}\right)\Delta t$$

$$v_f - v_i = a\Delta t$$

- Add v_i to both sides of the equation and simplify.

$$v_f - v_i + v_i = a\Delta t + v_i$$

$$v_f = v_i + a\Delta t$$

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Original equation

$$\Delta d = v\Delta t$$

but, this is valid only if motion is constant. If the motion is accelerated and uniform, the velocity is actually the **average** velocity that occurs during the motion.

Therefore,

$$\Delta d = \frac{v_i + v_f}{2}\Delta t$$

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Using

$$\Delta d = \frac{v_i + v_f}{2}\Delta t$$

- Recall the expression you developed for final velocity. $v_f = v_i + a\Delta t$
- Substitute this value into the first equation. $\Delta d = \frac{v_i + (v_i + a\Delta t)}{2}\Delta t$
- Combine like terms. $\Delta d = \left(\frac{2v_i + a\Delta t}{2}\right)\Delta t$
- Multiply through by Δt. $\Delta d = \frac{2v_i\Delta t}{2} + \frac{a\Delta t^2}{2}$
- Simplify. $\Delta d = v_i\Delta t + \frac{1}{2}a\Delta t^2$

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Challenge!

Knowing that $a = \frac{v_f - v_i}{\Delta t}$ *and that* $\Delta d = \frac{v_i + v_f}{2}\Delta t$

Try to derive the equation

$$v_f^2 = v_i^2 + 2a\Delta d$$

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