$$V_f = V_0 + at$$

$$\Delta x = \frac{1}{2}at^2 + V_0 t$$

$$x = \frac{-b \pm \sqrt{b^2-4ac}}{2a}$$

$$V_f \; {-V_0} = V_0 \; {-V_0} + at$$

$$\frac{V_f - V_0}{a} = \frac{at}{a}$$

$$t = \left(\frac{V_f - V_0}{a}\right)$$

$$\Delta x = \frac{1}{2}at^2 + V_0 t$$

$$2 \cdot \Delta x = \left[\frac{1}{2}a\left(\frac{V_f - V_0}{a}\right)^2 + V_0\left(\frac{V_f - V_0}{a}\right)\right]$$

$$2\Delta x = a\left(\frac{V_f - V_0}{a}\right)^2 + 2V_0\left(\frac{V_f - V_0}{a}\right)$$

$$2\Delta x = a\frac{(V_f - V_0)(V_f - V_0)}{a^2} + 2V_0\left(\frac{V_f - V_0}{a}\right)$$

$$2\Delta x = \frac{V_f^2 - 2V_0V_f + V_0^2 + 2V_0V_f - 2V_0^2}{a}$$

$$a \cdot 2\Delta x = \frac{V_f^2 - V_0^2}{a} \cdot a$$

$$2\Delta x a = V_f^2 - V_0^2$$

$$\boxed{V_f^2 = V_0^2 + 2a\Delta x}$$

$$V_f^2 = V_0^2 + 2a(x_f - x_0)$$

The fuel in a bottle rocket burns for 2s. While burning, the rocket moves upward with an acceleration of 30 m/s^2. What is the vertical distance traveled while the fuel is still burning and how fast is it traveling at the end of the burn?

① What is given + what do I need to find?

$t = 2s$

$a = 30\,m/s^2$

$\Delta x = ?$ 120m

$V_f = ?$

$V_0 = 0$

② find an equation

$\Delta x = \frac{1}{2}at^2 + V_0 t$

③ solve equation for unknown

④ plug in values

$\Delta x = \frac{1}{2}at^2$

$= \frac{1}{2}(30\,m/s^2)(2s)^2$

⑤ solve

$= 60$

② $V_f = V_0 + at$

③ ④ $V_f = 0 + (30\,m/s^2)(2s)$

$V_f = 60\,m/s$