Example: The bus

One morning as you walk to the bus stop you see the bus begin to pull away from the stop. Suppose you are located 30. m from the stop at the instant the bus begins to accelerate at $0.50 m/s^2$ away from you. If you can run at $5.0 m/s$ with your backpack full of books, how long will it take to reach the bus? How far will you need to run?

Origin - Bus stop

Bus	You
$x_0 = 0$ m	$x_0 = -30.$ m
$v_0 = 0 m/s$	$v_0 = 5.0 m/s$
$\Delta t = ?$	$\Delta t = ?$
$x = ?$	$x = ?$
$a = 0.50 m/s^2$	$a = 0 m/s^2$

Equation

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

$$x = \cancel{x_0}^{0} + \cancel{v_0 \Delta t}^{0} + \frac{1}{2}\left(0.50 m/s^2\right) \Delta t^2 \qquad x = -30.\text{m} + 5.0 m/s\, \Delta t + \cancel{\frac{1}{2} a \Delta t^2}^{0}$$

Solve for t

$$0.25\ m/s^2\ t^2 = -30.\ m + 5.0\ m/s\ t$$

$$0 = -30.\ m + 5.0\ m/s\ t - 0.25\ m/s^2\ t^2$$

t = nonreal

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You miss the bus!

How close must you be to catch the bus in this case?

Nonreal result occurs when $b^2 - 4ac$ is negative

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

Therefore we want to know when

$$b^2 = 4ac \quad \text{or} \quad \frac{b^2}{4a} = c$$

Under this condition we obtain a real double root.

In our case,

$$\frac{(5.0\,m/s)^2}{4(-0.25\,m/s^2)} = -25\,m$$

If you had been within 25 m of the bus stop you could have reached it in time.