EXAMPLE:

1. A marble is accelerating down a ramp at a rate of $3.5\ m/s^2$. If it started with an initial velocity of $0.50\ m/s$. How far does it travel in 5.0 seconds?

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

$= (0.5\ m/s)(5\ s) + \frac{1}{2}(3.5\ m/s^2)(5\ s)^2$

$= 46.25\ m$

$= 46\ m$

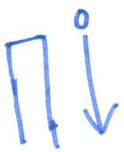
$a = 3.5\ m/s^2$

$v_0 = 0.50\ m/s$

$t = 5.0\ sec$

$d = ?$

2. How long will it take a stone to fall from a 20.0 metre building to the ground if it accelerates at a constant rate of $9.8\ m/s^2$?



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

$d = \frac{1}{2}at^2$ because $v_0 = 0$

$2d = at^2$

$\frac{2d}{a} = t^2$

$\pm\sqrt{\frac{2d}{a}} = t$

$d = -20.0\ m$

$a = -9.8\ m/s^2$

$v_0 = 0\ m/s$

$t = ?$

$\pm\sqrt{\frac{2(-20)}{-9.8}} = \pm 2.02\ sec$

$= \pm 2.0\ sec$

$= 2.0\ sec$

Neg is silly

3. A skier, initially at rest, begins accelerating down a hill at $1.6\ m/s^2$. How fast will they be travelling after a distance of 58 m?

$V_f^2 = V_0^2 + 2ad$

$V_f = \pm\sqrt{2ad}$

$= \pm\sqrt{2\left(1.6\frac{m}{s^2}\right)(58m)}$

$= \pm\sqrt{185.6\ \frac{m^2}{s^2}}$

$= \pm 14\ m/s \rightarrow$ **14 m/s**

$V_0 = 0$

$a = 1.6\ m/s^2$

$d = 58\ m$

$V_f = ?$

4. A parachutist falls 215 m in 7.0 seconds after leaving the place. If she is constantly accelerating what is her speed after 7.0 seconds?

$d = \bar{v}t \rightarrow \frac{d}{t} = \bar{v}$

$\frac{-215m}{7.0sec} = -30.7143\ m/s$

$d = -215\ m$

$t = 7.0sec$

$V_f = ?$

$V_0 = 0\ m/s$

$\bar{v} = \frac{V_f + V_0}{2}$

$2\bar{v} = V_f \rightarrow -61.4 = V_f$

Speed is 61 m/s

5. A car accelerates from rest to a top speed of $42\ m/s$ in 4.0 seconds and then drives at that speed for 25 seconds. How far will they have travelled in total?

Part 1 $\bar{v} = \frac{v_f + v_0}{2} = \frac{42 m/s}{2} = 21 m/s$

$v_f = 42 m/s$
$v_0 = 0$
$t = 4.0\ sec$
$d = ?$

$d = \bar{v} t = \frac{21 m}{s} \times 4.0 sec$

$= 84 m$

Part 2

$d = \bar{v} t$

$= \frac{42 m}{s} \times 25 sec$

$= 1050 m$

$\bar{v} = 42 m/s$
$t = 25 sec$

Total: $84 m + 1050 m = 1134 m$

$\approx 1100 m$

Quadratic formula problems

If we are solving for time using the equation $d = v_o t + \frac{1}{2}at^2$ and initial velocity is not zero, then we need to use the quadratic formula to solve the problem.

Example:

How long will it take a stone to fall from a 20.0 metre building to the ground if it accelerates at a constant rate of 9.8 m/s^2 downwards and it was thrown upwards initially with a velocity of 15.0 m/s ?

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

$v_0 = 15 m/s$

$a = -9.8 m/s^2$

$d = -20.0 m$

$t = ?$

Want: $ax^2 + bx + c = 0$

$0 = v_0 t + \frac{1}{2}at^2 - d$

$0 = \frac{1}{2}at^2 + v_0 t - d$

$0 = \frac{1}{2}(-9.8)t^2 + 15t - (-20.0)$

$0 = -4.9t^2 + 15t + 20$

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

$\frac{-15 \pm \sqrt{15^2 - 4(-4.9)(20)}}{2(-4.9)}$

$t = -1.0$ sec or $4.065 \approx 4.1$ sec