2.42

Var	Given value	Units	Description
v_f		$\frac{ft}{s}$	final velocity
v_i	0	$\frac{ft}{s}$	initial velocity
a	–32	$\frac{ft}{s^2}$	acc. due to gravity
Δx	–105	ft	displacement
$v_{f,2}$		$\frac{mi}{h}$	final velocity

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

$$v_f = \sqrt{v_i^2 + 2 a \Delta x}$$

$$= \sqrt{\left(0 \frac{ft}{s}\right)^2 + 2\left(-32 \frac{ft}{s^2}\right)(-105\,ft)}$$

$$= 81.97560613 \frac{ft}{s}$$ ✓

$$v_{f,2} = v_f \rightarrow \frac{mi}{h}$$

$$v_{f,2} = v_f \rightarrow \frac{mi}{h}$$

2.42 (continued)

$$= \left(81.97560613\,\tfrac{\text{ft}}{\text{s}}\right)\left(1.894\times10^{-4}\,\tfrac{\text{mi}}{\text{ft}}\right)\left(3600\,\tfrac{\text{s}}{\text{h}}\right)$$

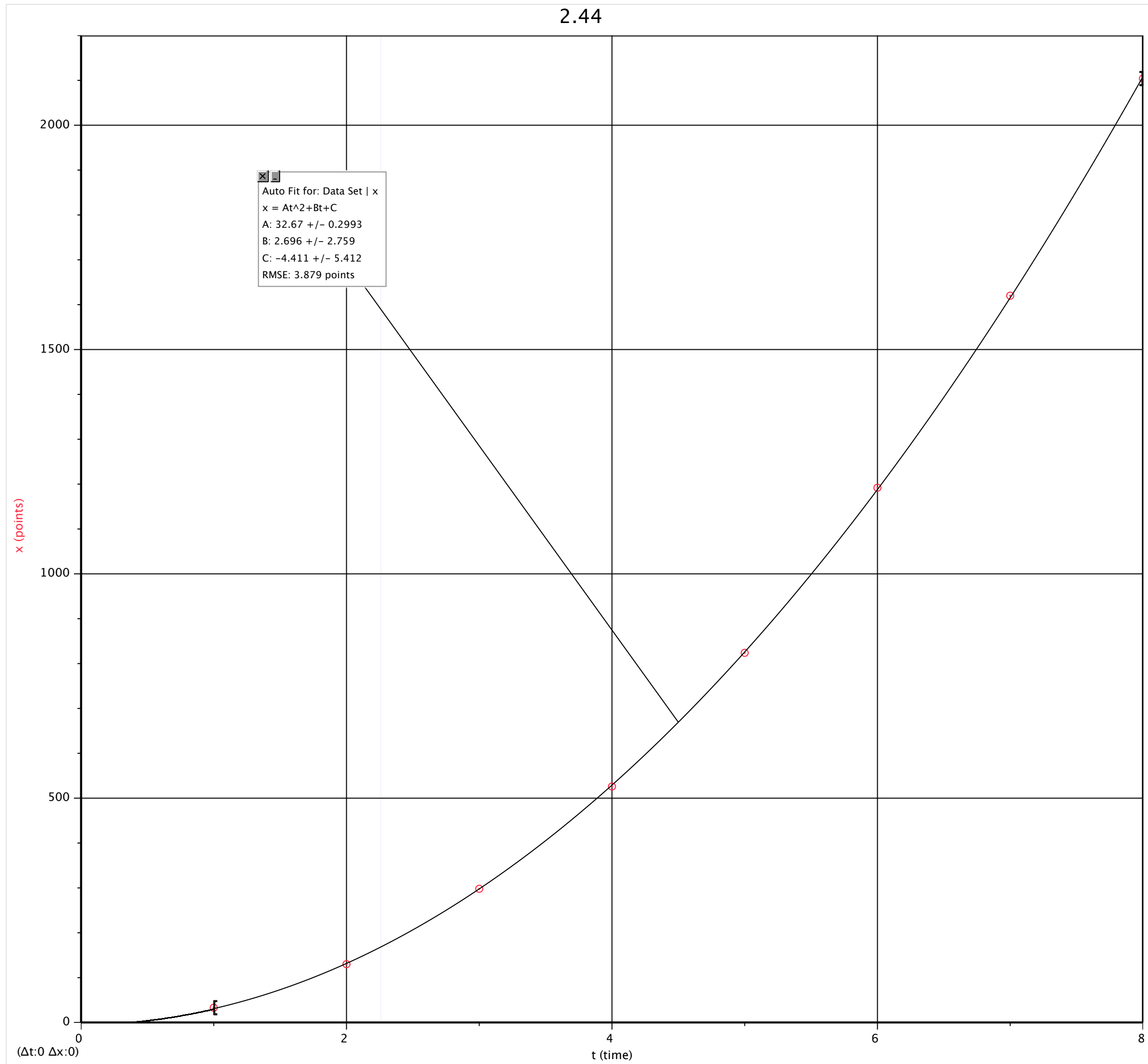
$$= 55.89\,\frac{\text{mi}}{\text{h}}$$ ✓

	Data Set		
	t (time)	x (points)	
1	1	33	
2	2	130	
3	3	298	
4	4	526	
5	5	824	
6	6	1192	
7	7	1620	
8	8	2104	
9			
10			
11			
12			

$1/2at^2 + v_0t - \Delta x = 0$

$32.67t^2 + 2.696t - 4.411 = 0$

$1/2a = 32.67 \text{points/time}^2$



2.46

Var	Given value	Units	Description
v_i	0	$\frac{m}{s}$	initial velocity
v	17400	$\frac{mi}{h}$	initial velocity
t		s	time
t_{min}	10.	min	time
v_f		$\frac{m}{s}$	final velocity
a		$\frac{m}{s^2}$	acceleration
g	9.80	$\frac{m}{s^2}$	Acceleration due to gravity
$ratio$			

$$v_f = v \rightarrow \frac{m}{s}$$

$$= \left(17400\,\frac{mi}{h}\right)\left(1609.3\,\frac{m}{mi}\right)\left(2.777777778\times10^{-4}\,\frac{h}{s}\right)$$

$$= 7778.3\,\frac{m}{s}$$ ✔

$$t = t_{min} \rightarrow s$$

$$= (10.\,min)\left(60\,\frac{s}{min}\right)$$

2.46 (continued)

$$= 6.0\times10^{2}\ \text{s} \quad ✓$$

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

$$= \frac{\left(7778.3\ \frac{\text{m}}{\text{s}}\right) - \left(0\ \frac{\text{m}}{\text{s}}\right)}{6.0\times10^{2}\ \text{s}}$$

$$= 13.\ \frac{\text{m}}{\text{s}^2} \quad ✓$$

$$ratio = \frac{a}{g}$$

$$= \frac{13.\ \frac{\text{m}}{\text{s}^2}}{9.80\ \frac{\text{m}}{\text{s}^2}}$$

$$= 1.3 \quad ✓$$

2.48

Var	Given value	Units	Description
v_f		$\frac{m}{s}$	final velocity when 5 m off the ground
v_i	0	$\frac{m}{s}$	velocity at top of path
a	–9.8	$\frac{m}{s^2}$	acceleration due to gravity
Δx	–20.	m	displacement from top of path to 5 m off ground

The velocity when 5m high is the same magnitude both up and down at this height from the ground. For the second half of the trip, the initial velocity at the top of the path is zero.

$$\Delta x = 5\,m - 25\,m = -20\,m$$

$$v_f^{\,2} = v_i^{\,2} + 2\,a\,\Delta x$$

$$v_f = \left(v_i^{\,2} + 2\,a\,\Delta x\right)^{\frac{1}{2}}$$

$$= \left(\left(0\,\frac{m}{s}\right)^2 + 2\left(-9.8\,\frac{m}{s^2}\right)(-20.\,m)\right)^{\frac{1}{2}}$$

$$= 20.\,\frac{m}{s}$$ ✔

2.50

Var	Given value	Units	Description
v_{ave}	–1.2	$\frac{m}{s}$	average velocity of parachute
Δx	–30.	m	height of cliff
t		s	time for parachuet to reach ground

$$v_{ave} = \frac{\Delta x}{t}$$

$$t\, v_{ave} = \Delta x$$

$$t = \frac{\Delta x}{v_{ave}}$$

$$= \frac{-30.\,m}{-1.2\,\frac{m}{s}}$$

$$= 25.\,s$$ ✓

Var	Given value	Units	Description
a	–9.8	$\frac{m}{s^2}$	acc due to gravity
t_s		s	time for stone to reach ground

$$\Delta x = \frac{1}{2} a\, t_s^{\,2}$$

2.50 (continued)

$$\Delta x = \frac{1}{2} a t_s^{\,2}$$

$$2\Delta x = a t_s^{\,2}$$

$$\frac{2\Delta x}{a} = t_s^{\,2}$$

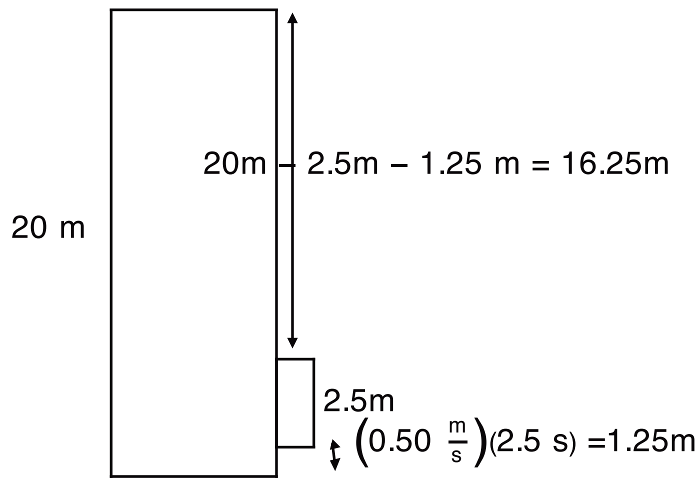
$$t_s = \sqrt{\frac{2\Delta x}{a}}$$

$$= \sqrt{\frac{2(-30.\,\text{m})}{-9.8\,\frac{\text{m}}{\text{s}^2}}}$$

$$= 2.5\,\text{s}$$ ✓

20 s + 2.5 s = 22.5 s which is less time so stone passes parachute

2.52



Var	Given value	Units	Description
v_{elev}	0.500	$\frac{m}{s}$	velocity of elevator
Δx_{elev}		m	how far the elevator rises before the wrench hits
t		s	time to hit
Δx_{wrench}		m	displacement of wrench
a	9.8	$\frac{m}{s^2}$	acc due to grav
x	16.25	m	initial distance between elevator roof and where wrench is dropped from

$$\Delta x_{wrench} = \frac{1}{2} a t^2$$

$$v_{elev} = \frac{\Delta x_{elev}}{t}$$

2.52 (continued)

$$t\, v_{\text{elev}} = \Delta x_{\text{elev}}$$

$$t = \frac{\Delta x_{\text{elev}}}{v_{\text{elev}}}$$

$$\Delta x_{\text{wrench}} = \frac{1}{2} a \left(\frac{\Delta x_{\text{elev}}}{v_{\text{elev}}} \right)^2$$

$$\Delta x_{\text{wrench}} + \Delta x_{\text{elev}} = x$$

$$\Delta x_{\text{wrench}} = x - \Delta x_{\text{elev}}$$

$$\frac{1}{2} \left(\frac{1}{v_{\text{elev}}} \right)^2 a\, \Delta x_{\text{elev}}{}^2 + \Delta x_{\text{elev}} - x = 0$$

$$\Delta x_{\text{elev}} = \frac{-1 \pm \sqrt{1 - 4 \frac{1}{2} \left(\frac{1}{v_{\text{elev}}} \right)^2 a (-x)}}{2 \frac{1}{2} \left(\frac{1}{v_{\text{elev}}} \right)^2 a}$$

$$\Delta x_{\text{elev}} = \frac{-1 + \sqrt{1 - 4 \frac{1}{2} \left(\frac{1}{v_{\text{elev}}} \right)^2 a (-x)}}{2 \frac{1}{2} \left(\frac{1}{v_{\text{elev}}} \right)^2 a}$$

2.52 (continued)

$$= \frac{-1 + \sqrt{1 - 4\,\frac{1}{2}\left(\frac{1}{0.500\,\frac{\text{m}}{\text{s}}}\right)^2 \left(9.8\,\frac{\text{m}}{\text{s}^2}\right)\left(-(16.25\,\text{m})\right)}}{2\,\frac{1}{2}\left(\frac{1}{0.500\,\frac{\text{m}}{\text{s}}}\right)^2 \left(9.8\,\frac{\text{m}}{\text{s}^2}\right)}$$

$$= 0.89\,\text{m}$$ ✓

$$0.89\,m + 1.25\,m + 2.5\,m = 4.64\,m$$