2.28

Var	Given value	Units	Description
$v_{i,1}$	90	$\frac{km}{h}$	initial velocity in $\frac{km}{h}$
v_f		$\frac{m}{s}$	final velocity
v_i		$\frac{m}{s}$	initial velocity in $\frac{m}{s}$
a	–2.0	$\frac{m}{s^2}$	acceleration
t	5	s	time interval

$$v_i = v_{i,1} \rightarrow \frac{m}{s}$$

$$= \left(90\,\frac{km}{h}\right)\left(1000\,\frac{m}{km}\right)\left(2.777777778\times10^{-4}\,\frac{h}{s}\right)$$

$$= 25\,\frac{m}{s}$$ ✓

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

$$= \left(25\,\frac{m}{s}\right) + \left(-2.0\,\frac{m}{s^2}\right)(5\,s)$$

$$= 15.\,\frac{m}{s}$$ ✓

2.30

Var	Given value	Units	Description
v_f	17	$\frac{m}{s}$	final velocity
v_i	8.0	$\frac{m}{s}$	initial velocity
a		$\frac{m}{s^2}$	acceleration
Δx	30.	m	displacement
t		s	time

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

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

$$a = \frac{v_f^2 - v_i^2}{2\Delta x}$$

$$= \frac{\left(17\,\frac{m}{s}\right)^2 - \left(8.0\,\frac{m}{s}\right)^2}{2(30.\,m)}$$

$$= 3.7\,\frac{m}{s^2}$$ ✔

2.30 (continued)

$$\Delta x = \frac{1}{2}(v_i + v_f)\,t$$

$$2\,\Delta x = (v_i + v_f)\,t$$

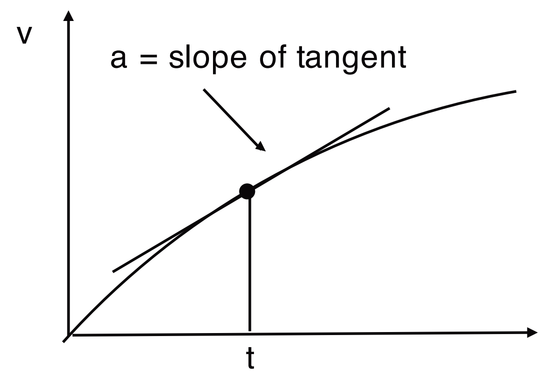
$$t = \frac{2\,\Delta x}{v_i + v_f}$$

$$= \frac{2(30.\,\text{m})}{\left(8.0\,\frac{\text{m}}{\text{s}}\right) + \left(17\,\frac{\text{m}}{\text{s}}\right)}$$

$$= 2.4\,\text{s}$$ ✓

2.32

Draw a tangent to the point on the curve at the time desired. Using any two points on this tangent line, calculate the slope which is equal to the acceleration. The slope at 10s is about 4.7 $\frac{m}{s^2}$ and at 30 s, about 1.2 $\frac{m}{s^2}$.



2.34

Var	Given value	Units	Description
$v_{i,1}$		$\frac{m}{s}$	initial velocity for part a in $\frac{m}{s}$
v_1	60.0	$\frac{mi}{h}$	initial velocity for part a in $\frac{mi}{h}$
Δx_1		m	displacement for part a in m
Δx_a	147	ft	displacement for part a in ft
v_f	0	$\frac{m}{s}$	final velocity
a_1		$\frac{m}{s^2}$	acceleration in part a
$v_{i,2}$		$\frac{m}{s}$	initial velocity for part b in $\frac{m}{s}$
v_2	80.0	$\frac{mi}{h}$	initial velocity for part b in $\frac{mi}{h}$
Δx_2		m	displacement for part b in m
Δx_b	264	m	displacement for part b in ft
a_2		$\frac{m}{s^2}$	acceleration in part b

$$v_{i,1} = v_1 \rightarrow \frac{m}{s}$$

$$= \left(60.0\,\frac{mi}{h}\right)\left(1609.3\,\frac{m}{mi}\right)\left(2.777777778\times10^{-4}\,\frac{h}{s}\right)$$

$$= 26.8\,\frac{m}{s}$$ ✓

2.34 (continued)

$$\Delta x_1 = \Delta x_a \rightarrow \text{m}$$

$$= (147\,\text{ft})\left(0.3048\,\frac{\text{m}}{\text{ft}}\right)$$

$$= 44.81\,\text{m} \checkmark$$

$$v_f^{\,2} = v_{i,1}^{\,2} + 2\,a_1\,\Delta x_1$$

$$v_f^{\,2} - v_{i,1}^{\,2} = 2\,a_1\,\Delta x_1$$

$$\frac{v_f^{\,2} - v_{i,1}^{\,2}}{2} = a_1\,\Delta x_1$$

$$a_1 = \frac{v_f^{\,2} - v_{i,1}^{\,2}}{2\,\Delta x_1}$$

$$= \frac{\left(0\,\frac{\text{m}}{\text{s}}\right)^2 - \left(26.8\,\frac{\text{m}}{\text{s}}\right)^2}{2\,(44.81\,\text{m})}$$

$$= -8.01\,\frac{\text{m}}{\text{s}^2} \checkmark$$

2.34 (continued)

$$v_{i,2} = v_2 \rightarrow \frac{m}{s}$$

$$= \left(80.0\,\tfrac{mi}{h}\right)\left(1609.3\,\tfrac{m}{mi}\right)\left(2.777777778\times10^{-4}\,\tfrac{h}{s}\right)$$

$$= 35.8\,\frac{m}{s}$$ ✓

$$\Delta x_2 = \Delta x_b \rightarrow m$$

$$= (264\,m)$$

$$= 264\,m$$ ✓

$$a_2 = \frac{v_f^{\,2} - v_{i,2}^{\,2}}{2\,\Delta x_2}$$

$$= \frac{\left(0\,\tfrac{m}{s}\right)^2 - \left(35.8\,\tfrac{m}{s}\right)^2}{2\,(264\,m)}$$

$$= -2.43\,\frac{m}{s^2}$$ ✓

2.36

Var	Given value	Units	Description
r		m	radius of cylinder
r_{mm}	50.	mm	radius of cylinder
c		m	circumference of cylinder corss–section
Δx		m	displacement
v_i	0	$\frac{m}{s}$	initial velocity
t	10.	s	time
a	1.7	$\frac{m}{s^2}$	acceleration
R			revolutions

$$r = r_{mm} \rightarrow \mathrm{m}$$

$$= (50.\,\mathrm{mm})\left(1.000000000 \times 10^{-3}\,\frac{\mathrm{m}}{\mathrm{mm}}\right)$$

$$= 0.050\,\mathrm{m}$$ ✓

$$c = 2\pi r$$

$$= 2\pi(0.050\,\mathrm{m})$$

$$= 0.31\,\mathrm{m}$$ ✓

2.36 (continued)

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

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

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

$$= \frac{1}{2}\left(1.7 \frac{\text{m}}{\text{s}^2}\right)(10.\,\text{s})^2$$

$$= 85.\,\text{m}$$ ✓

$$R = \frac{\Delta x}{c}$$

$$= \frac{85.\,\text{m}}{0.31\,\text{m}}$$

$$= 2.7 \times 10^2$$ ✓

2.38

Var	Given value	Units	Description
a_a		$\frac{km}{h^2}$	average acceleration in part a
$v_{f,a}$	48	$\frac{km}{h}$	final velocity in part a
$v_{i,a}$	0	$\frac{km}{h}$	initial velocity in part a
t_a		h	time in part a in h
$t_{a,s}$	3.6	s	time in part a in s
a_b		$\frac{km}{h^2}$	average acceleration in part b
$v_{f,b}$	96	$\frac{km}{h}$	final velocity in part b
$v_{i,b}$	48	$\frac{km}{h}$	initial velocity in part b
t_b		h	time in part b in h
$t_{b,s}$	8.4	s	time in part b in s
$v_{f,c}$	140	$\frac{km}{h}$	final velocity on course
$v_{i,c}$	0	$\frac{km}{h}$	initial velocity
a_c		$\frac{km}{h^2}$	copnstant acceleration for whole course
Δx	0.40	km	total displacement

$$t_a = t_{a,s} \rightarrow \text{h}$$

$$= (3.6\,\text{s})\left(2.777777778\times10^{-4}\,\frac{\text{h}}{\text{s}}\right)$$

$$= 1.0\times10^{-3}\,\text{h}$$ ✓

2.38 (continued)

$$a_{\text{a}} = \frac{v_{\text{f,a}} - v_{\text{i,a}}}{t_{\text{a}}}$$

$$= \frac{\left(48\,\frac{\text{km}}{\text{h}}\right) - \left(0\,\frac{\text{km}}{\text{h}}\right)}{1.0\times10^{-3}\,\text{h}}$$

$$= 4.8\times10^{4}\,\frac{\text{km}}{\text{h}^{2}}$$ ✓

$$t_{\text{b}} = t_{\text{b,s}} \to \text{h}$$

$$= (8.4\,\text{s})\left(2.777777778\times10^{-4}\,\frac{\text{h}}{\text{s}}\right)$$

$$= 2.3\times10^{-3}\,\text{h}$$ ✓

$$a_{\text{b}} = \frac{v_{\text{f,b}} - v_{\text{i,b}}}{t_{\text{b}}}$$

$$= \frac{\left(96\,\frac{\text{km}}{\text{h}}\right) - \left(48\,\frac{\text{km}}{\text{h}}\right)}{2.3\times10^{-3}\,\text{h}}$$

$$= 2.1\times10^{4}\,\frac{\text{km}}{\text{h}^{2}}$$ ✓

2.38 (continued)

$$v_{f,c}^{\ 2} = v_{i,c}^{\ 2} + 2\,a_c\,\Delta x$$

$$\frac{v_{f,c}^{\ 2} - v_{i,c}^{\ 2}}{2} = a_c\,\Delta x$$

$$a_c = \frac{v_{f,c}^{\ 2} - v_{i,c}^{\ 2}}{2\,\Delta x}$$

$$= \frac{\left(140\,\frac{\text{km}}{\text{h}}\right)^2 - \left(0\,\frac{\text{km}}{\text{h}}\right)^2}{2\,(0.40\,\text{km})}$$

$$= 2.5\times10^4\,\frac{\text{km}}{\text{h}^2}$$ ✔

2.40

Var	Given value	Units	Description
v_{ave}		$\frac{m}{s}$	velocity of train
v	10.	$\frac{km}{h}$	velocity of train
Δx	12	m	length of train car
t		s	

$$v_{ave} = v \rightarrow \frac{m}{s}$$

$$= \left(10.\ \frac{km}{h}\right)\left(1000\ \frac{m}{km}\right)\left(2.777777778\times 10^{-4}\ \frac{h}{s}\right)$$

$$= 2.8\ \frac{m}{s}$$ ✓

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

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

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

$$= \frac{12\,m}{2.8\ \frac{m}{s}}$$

$$= 4.3\,s$$ ✓

So 5 rocks (one at zero seconds and then 4 more)

2.40 (continued)

Var	Given value	Units	Description
a	0.50	$\frac{m}{s^2}$	
v_i	12	$\frac{m}{s}$	
t_b		s	

$$\Delta x = v_i t_b + \frac{1}{2} a t_b^2$$

$$\frac{1}{2} a t_b^2 + v_i t_b - \Delta x = 0$$

Use the quadratic equation to solve for "t".

$$t_b = \frac{-v_i + \sqrt{v_i^2 - 4\frac{1}{2} a(-\Delta x)}}{2\frac{1}{2} a}$$

$$= \frac{-\left(12.00\,\frac{m}{s}\right) + \sqrt{\left(12.00\,\frac{m}{s}\right)^2 - 4\frac{1}{2}\left(0.500\,\frac{m}{s^2}\right)(-(12\,m))}}{2\frac{1}{2}\left(0.500\,\frac{m}{s^2}\right)}$$

$$= 1\,s$$ ✔

So 2 rocks (one at zero seconds and then 1 more)