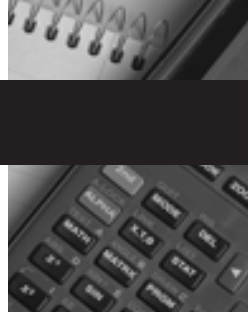

Student Edition Solutions

Motion In One Dimension

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Motion In One Dimension, Practice A

Givens	*Solutions*
1. $v_{avg} = 0.98$ m/s east $\Delta t = 34$ min	$\Delta x = v_{avg}\Delta t = (0.98\text{ m/s})(34\text{ min})(60\text{ s/min})$ $\Delta x = 2.0 \times 10^3\text{ m} = \boxed{2.0\text{ km east}}$
2. $\Delta t = 15$ min $v_{avg} = 12.5$ km/h south	$\Delta x = v_{avg}\Delta t = (12.5\text{ km/h})(15\text{ min})\left(\frac{1\text{ h}}{60\text{ min}}\right)$ $\Delta x = \boxed{3.1\text{ km}}$
3. $\Delta t = 9.5$ min $v_{avg} = 1.2$ m/s north	$\Delta x = v_{avg}\Delta t = (1.2\text{ m/s})\ (9.5\text{ min})(60\text{ s/min})$ $\Delta x = \boxed{680\text{ m north}}$
4. $v_{avg} = 48.0$ km/h east $\Delta x = 144$ km east	$\Delta t = \frac{\Delta x}{v_{avg}} = \frac{144\text{ km}}{48.0\text{ km/h}} = \boxed{3.00\text{ h}}$
5. $v_{avg} = 56.0$ km/h east $\Delta x = 144$ km east	$\Delta t = \frac{\Delta x}{v_{avg}} = \frac{144\text{ km}}{56.0\text{ km/h}} = 2.57\text{ h}$ time saved $= 3.00\text{ h} - 2.57\text{ h} = \boxed{0.43\text{ h} = 25.8\text{ min}}$
6. $\Delta x_1 = 280$ km south $v_{avg,1} = 88$ km/h south $\Delta t_2 = 24$ min $v_{avg,2} = 0$ km/h $\Delta x_3 = 210$ km south $v_{avg,3} = 75$ km/h south	**a.** $\Delta t_{tot} = \Delta t_1 + \Delta t_2 + \Delta t_3 = \frac{\Delta x_1}{v_{avg,1}} + \Delta t_2 + \frac{\Delta x_3}{v_{avg,3}}$ $\Delta t_{tot} = \left(\frac{280\text{ km}}{88\text{ km/h}}\right) + (24\text{ min})\left(\frac{1\text{ h}}{60\text{ min}}\right) + \left(\frac{210\text{ km}}{75\text{ km/h}}\right)$ $\Delta t_{tot} = 3.2\text{ h} + 0.40\text{ h} + 2.8\text{ h} = \boxed{6.4\text{ h} = 6\text{ h }24\text{ min}}$ **b.** $v_{avg,\ tot} = \frac{\Delta x_{tot}}{\Delta t_{tot}} = \frac{\Delta x_1 + \Delta x_2 + \Delta x_3}{\Delta t_1 + \Delta t_2 + \Delta t_3}$ $\Delta x_2 = v_{avg,2}\Delta t_2 = (0\text{ km/h})(24\text{ min})\left(\frac{1\text{ h}}{60\text{ min}}\right) = 0\text{ km}$ $v_{avg,\ tot} = \frac{280\text{ km} + 0\text{ km} + 210\text{ km}}{6.4\text{ h}} = \frac{490\text{ km}}{6.4\text{ h}} = \boxed{77\text{ km/h south}}$

Motion In One Dimension, Section 1 Review

1. $v = 3.5$ mm/s $\quad \Delta x = 8.4$ cm	$\Delta t = \frac{\Delta x}{v} = \frac{8.4\text{ cm}}{0.35\text{ cm/s}} = \boxed{24\text{ s}}$
2. $v = 1.5$ m/s $\quad \Delta x = 9.3$ m	$\Delta t = \frac{\Delta x}{v} = \frac{9.3\text{ m}}{1.5\text{ m/s}} = \boxed{6.2\text{ s}}$

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Givens | *Solutions*

3. $\Delta x_1 = 50.0$ m south

$\Delta t_1 = 20.0$ s

$\Delta x_2 = 50.0$ m north

$\Delta t_2 = 22.0$ s

a. $v_{avg,1} = \frac{\Delta x_1}{\Delta t_1} = \frac{50.0 \text{ m}}{20.0 \text{ s}} = \boxed{2.50 \text{ m/s south}}$

b. $v_{avg,2} = \frac{\Delta x_2}{\Delta t_2} = \frac{50.0 \text{ m}}{22.0 \text{ s}} = \boxed{2.27 \text{ m/s north}}$

$\Delta x_{tot} = \Delta x_1 + \Delta x_2 = (-50.0 \text{ m}) + (50.0 \text{ m}) = 0.0 \text{ m}$

$\Delta t_{tot} = \Delta t_1 + \Delta t_2 = 20.0 \text{ s} + 22.0 \text{ s} = 42.0 \text{ s}$

$v_{avg} = \frac{\Delta x_{tot}}{\Delta t_{tot}} = \frac{0.0 \text{ m}}{42.0 \text{ s}} = \boxed{0.0 \text{ m/s}}$

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4. $v_1 = 0.90$ m/s

$v_2 = 1.90$ m/s

$\Delta x = 780$ m

a. $\Delta t_1 = \frac{\Delta x}{v_1} = \frac{780 \text{ m}}{0.90 \text{ m/s}} = 870 \text{ s}$

$\Delta t_2 = \frac{\Delta x}{v_2} = \frac{780 \text{ m}}{1.90 \text{ m/s}} = 410 \text{ s}$

$\Delta t_1 - \Delta t_2 = 870 \text{ s} - 410 \text{ s} = \boxed{460 \text{ s}}$

$\Delta t_1 - \Delta t_2 = (5.50 \text{ min})(60 \text{ s/min}) = 3.30 \times 10^2 \text{ s}$

b. $\Delta x_1 = v_1 \Delta t_1$

$\Delta x_2 = v_2 \Delta t_2$

$\Delta x_1 = \Delta x_2$

$v_1 \Delta t_1 = v_2 \Delta t_2$

$v_1[\Delta t_2 + (3.30 \times 10^2 \text{ s})] = v_2 \Delta t_2$

$v_1 \Delta t_2 + v_1(3.30 \times 10^2 \text{ s}) = v_2 \Delta t_2$

$\Delta t_2 (v_1 - v_2) = -v_1(3.30 \times 10^2 \text{ s})$

$\Delta t_2 = \frac{-v_1(3.30 \times 10^2 \text{ s})}{v_1 - v_2} = \frac{-(0.90 \text{ m/s})(3.30 \times 10^2 \text{ s})}{0.90 \text{ m/s} - 1.90 \text{ m/s}} = \frac{-(0.90 \text{ m/s})(3.30 \times 10^2 \text{ s})}{-1.00 \text{ m/s}}$

$\Delta t_2 = 3.0 \times 10^2 \text{ s}$

$\Delta t_1 = \Delta t_2 + (3.30 \times 10^2 \text{ s}) = (3.0 \times 10^2 \text{ s}) + (3.30 \times 10^2 \text{ s}) = 630 \text{ s}$

$\Delta x_1 = v_1 \Delta t_1 = (0.90 \text{ m/s})(630 \text{ s}) = \boxed{570 \text{ m}}$

$\Delta x_2 = v_2 \Delta t_2 = (1.90 \text{ m/s})(3.0 \times 10^2 \text{ s}) = \boxed{570 \text{ m}}$

Motion In One Dimension, Practice B

1. $a_{avg} = -4.1 \text{ m/s}^2$

$v_i = 9.0$ m/s

$v_f = 0.0$ m/s

$\Delta t = \frac{\Delta v}{a_{avg}} = \frac{v_f - v_i}{a_{avg}} = \frac{0.0 \text{ m/s} - 9.0 \text{ m/s}}{-4.1 \text{ m/s}^2} = \frac{-9.0 \text{ m/s}}{-4.1 \text{ m/s}^2} = \boxed{2.2 \text{ s}}$

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2. $a_{avg} = 2.5 \text{ m/s}^2$

$v_i = 7.0$ m/s

$v_f = 12.0$ m/s

$\Delta t = \frac{\Delta v}{a_{avg}} = \frac{v_f - v_i}{a_{avg}} = \frac{12.0 \text{ m/s} - 7.0 \text{ m/s}}{2.5 \text{ m/s}^2} = \frac{5.0 \text{ m/s}}{2.5 \text{ m/s}^2} = \boxed{2.0 \text{ s}}$

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3. $a_{avg} = -1.2 \text{ m/s}^2$

$v_i = 6.5$ m/s

$v_f = 0.0$ m/s

$\Delta t = \frac{v_f - v_i}{a_{avg}} = \frac{0.0 \text{ m/s} - 6.5 \text{ m/s}}{-1.2 \text{ m/s}^2} = \frac{-6.5 \text{ m/s}}{-1.2 \text{ m/s}^2} = \boxed{5.4 \text{ s}}$

Givens	*Solutions*
4. $v_i = -1.2$ m/s $v_f = -6.5$ m/s $\Delta t = 25$ min	$a_{avg} = \frac{v_f - v_i}{\Delta t} = \frac{-6.5 \text{ m/s} - (-1.2 \text{ m/s})}{(25 \text{ min})(60 \text{ s/min})} = \frac{-5.3 \text{ m/s}}{1500 \text{ s}} = \boxed{-3.5 \times 10^{-3} \text{ m/s}^2}$
5. $a_{avg} = 4.7 \times 10^{-3}$ m/s^2 $\Delta t = 5.0$ min $v_i = 1.7$ m/s	**a.** $\Delta v = a_{avg} \Delta t = (4.7 \times 10^{-3} \text{ m/s}^2)(5.0 \text{ min})(60 \text{ s/min}) = \boxed{1.4 \text{ m/s}}$ **b.** $v_f = \Delta v + v_i = 1.4 \text{ m/s} + 1.7 \text{ m/s} = \boxed{3.1 \text{ m/s}}$

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Motion In One Dimension, Practice C

1. $v_i = 0.0$ m/s $v_f = 6.6$ m/s $\Delta t = 6.5$ s	$\Delta x = \frac{1}{2}(v_i + v_f)\Delta t = \frac{1}{2}(0.0 \text{ m/s} + 6.6 \text{ m/s})(6.5 \text{ s}) = \boxed{21 \text{ m}}$
2. $v_i = 15.0$ m/s $v_f = 0.0$ m/s $\Delta t = 2.50$ s	$\Delta x = \frac{1}{2}(v_i + v_f)\Delta t = \frac{1}{2}(15.0 \text{ m/s} + 0.0 \text{ m/s})(2.50 \text{ s}) = \boxed{18.8 \text{ m}}$
3. $v_i = 21.8$ m/s $\Delta x = 99$ m $v_f = 0.0$ m/s	$\Delta t = \frac{2\Delta x}{v_i + v_f} = \frac{(2)(99 \text{ m})}{21.8 \text{ m/s} + 0.0 \text{ m/s}} = \boxed{9.1 \text{ s}}$
4. $v_i = 6.4$ m/s $\Delta x = 3.2$ km $\Delta t = 3.5$ min	$v_f = \frac{2\Delta x}{\Delta t} - v_i = \frac{(2)(3.2 \times 10^3 \text{ m})}{(3.5 \text{ min})(60 \text{ s/min})} - 6.4 \text{ m/s} = 3.0 \times 10^1 \text{ m/s} - 6.4 \text{ m/s} = \boxed{24 \text{ m/s}}$

Motion In One Dimension, Practice D

1. $v_i = 6.5$ m/s $a = 0.92$ m/s^2 $\Delta t = 3.6$ s	$v_f = v_i + a\Delta t = 6.5 \text{ m/s} + (0.92 \text{ m/s}^2)(3.6 \text{ s})$ $v_f = 6.5 \text{ m/s} + 3.3 \text{ m/s} = \boxed{9.8 \text{ m/s}}$ $\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $\Delta x = (6.5 \text{ m/s})(3.6 \text{ s}) + \frac{1}{2}(0.92 \text{ m/s}^2)(3.6 \text{ s})^2$ $\Delta x = 23 \text{ m} + 6.0 \text{ m} = \boxed{29 \text{ m}}$
2. $v_i = 4.30$ m/s $a = 3.00$ m/s^2 $\Delta t = 5.00$ s	$v_f = v_i + a\Delta t = 4.30 \text{ m/s} + (3.00 \text{ m/s}^2)(5.00 \text{ s})$ $v_f = 4.30 \text{ m/s} + 15.0 \text{ m/s} = \boxed{19.3 \text{ m/s}}$ $\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $\Delta x = (4.30 \text{ m/s})(5.00 \text{ s}) + \frac{1}{2}(3.00 \text{ m/s}^2)(5.00 \text{ s})^2$ $\Delta x = 21.5 \text{ m} + 37.5 \text{ m} = \boxed{59.0 \text{ m}}$

Givens	*Solutions*
3. $v_i = 0.0$ m/s $\Delta t = 5.0$ s $a = -1.5$ m/s^2	$v_f = v_i + a\Delta t = 0 \text{ m/s} + (-1.5 \text{ m/s}^2)(5.0 \text{ s}) = \boxed{-7.5 \text{ m/s}}$ $\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2 = (0 \text{ m/s})(5.0 \text{ s}) + \frac{1}{2}(-1.5 \text{ m/s}^2)(5.0 \text{ s})^2 = -19 \text{ m}$ distance traveled = $\boxed{19 \text{ m}}$
4. $v_i = 15.0$ m/s $a = -2.0$ m/s^2 $v_f = 10.0$ m/s	$\Delta t = \frac{v_f - vi}{a} = \frac{10.0 \text{ m/s} - 15.0 \text{ m/s}}{-2.0 \text{ m/s}^2} = \frac{-5.0}{-2.0} \text{ s} = \boxed{2.5 \text{ s}}$ $\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $\Delta x = (15.0 \text{ m/s})(2.5 \text{ s}) + \frac{1}{2}(-2.0 \text{ m/s}^2)(2.5 \text{ s})^2$ $\Delta x = 38 \text{ m} + (-6.2 \text{ m}) = 32 \text{ m}$ distance traveled during braking = $\boxed{32 \text{ m}}$

Motion In One Dimension, Practice E

1. $v_i = 0$ m/s $a = 0.500$ m/s^2 $\Delta x = 6.32$ m	$v_f = \sqrt{v_i^2 + 2a\Delta x}$ $v_f = \sqrt{(0 \text{ m/s})^2 + (2)(0.500 \text{ m/s}^2)(6.32 \text{ m})} = \sqrt{6.32 \text{ m}^2/\text{s}^2} = \pm 2.51 \text{ m/s}$ $v_f = \boxed{+2.51 \text{ m/s}}$
2. $v_i = +7.0$ m/s $a = +0.80$ m/s^2 $\Delta x = 245$ m	**a.** $v_f = \sqrt{v_i^2 + 2a\Delta x}$ $v_f = \sqrt{(7.0 \text{ m/s})^2 + (2)(0.80 \text{ m/s}^2)(245 \text{ m})}$ $v_f = \sqrt{49 \text{ m}^2/\text{s}^2 + 390 \text{ m}^2/\text{s}^2} = \sqrt{440 \text{ m}^2/\text{s}^2} = \pm 21 \text{ m/s}$ $v_f = \boxed{+21 \text{ m/s}}$
$\Delta x = 125$ m	**b.** $v_f = \sqrt{(7.0 \text{ m/s})^2 + (2)(0.80 \text{ m/s}^2)(125 \text{ m})}$ $v_f = \sqrt{49 \text{ m}^2/\text{s}^2 + (2.0 \times 10^2 \text{ m}^2/\text{s}^2)} = \sqrt{250 \text{ m}^2/\text{s}^2}$ $v_f = \pm 16 \text{ m/s} = \boxed{+16 \text{ m/s}}$
$\Delta x = 67$ m	**c.** $v_f = \sqrt{(7.0 \text{ m/s})^2 + (2)(0.80 \text{ m/s}^2)(67 \text{ m})} = \sqrt{49 \text{ m}^2/\text{s}^2 + 110 \text{ m}^2/\text{s}^2}$ $v_f = \sqrt{160 \text{ m}^2/\text{s}^2} = \pm 13 \text{ m/s} = \boxed{+13 \text{ m/s}}$
3. $v_i = 0$ m/s $a = 2.3$ m/s^2 $\Delta x = 55$ m	**a.** $v_f = \sqrt{v_i^2 + 2a\Delta x} = \sqrt{(0 \text{ m/s})^2 + (2)(2.3 \text{ m/s}^2)(55 \text{ m})}$ $v_f = \sqrt{250 \text{ m}^2/\text{s}^2} = \pm 16 \text{ m/s}$ car speed = $\boxed{16 \text{ m/s}}$ **b.** $\Delta t = \frac{v_f}{a} = \frac{16 \text{ m/s}}{2.3 \text{ m/s}^2} = \boxed{7.0 \text{ s}}$
4. $v_i = 6.5$ m/s $v_f = 1.5$ m/s $a = -2.7$ m/s^2	$\Delta x = \frac{v_f^2 - v_i^2}{2a} = \frac{(1.5 \text{ m/s})^2 - (6.5 \text{ m/s})^2}{(2)(-2.7 \text{ m/s}^2)} = \frac{-40 \text{ m}^2/\text{s}^2}{-5.4 \text{ m/s}^2} = \boxed{7.4 \text{ m}}$

Givens	*Solutions*
5. $v_i = 0.0$ m/s $v_f = 33$ m/s $\Delta x = 240$ m	$a = \frac{v_f^2 - v_i^2}{2\Delta x} = \frac{(33 \text{ m/s})^2 - (0.0 \text{ m/s})^2}{(2)(240 \text{ m})} = \boxed{2.3 \text{ m/s}^2}$
6. $a = 0.85$ m/s^2 $v_i = 83$ km/h $v_f = 94$ km/h	$v_i = (83 \text{ km/h})(10^3 \text{ m/km})(1 \text{ h}/3600 \text{ s}) = 23 \text{ m/s}$ $v_f = (94 \text{ km/h})(10^3 \text{ m/km})(1 \text{ h}/3600 \text{ s}) = 26 \text{ ms}$ $\Delta x = \frac{v_f^2 - v_i^2}{2a} = \frac{(26 \text{ m/s})^2 - (23 \text{ m/s})^2}{(2)(0.85 \text{ m/s}^2)}$ $\Delta x = \frac{680 \text{ m}^2/\text{s}^2 - 530 \text{ m}^2/\text{s}^2}{(2)(0.85 \text{ m/s}^2)}$ $\Delta x = \frac{150 \text{ m}^2/\text{s}^2}{(2)(0.85 \text{ m/s}^2)} = 88 \text{ m}$ distance traveled = $\boxed{88 \text{ m}}$

Motion In One Dimension, Section 2 Review

1. $a = +2.60$ m/s^2 $v_i = 24.6$ m/s $v_f = 26.8$ m/s	$\Delta t = \frac{v_f - v_i}{a} = \frac{26.8 \text{ m/s} - 24.6 \text{ m/s}}{2.60 \text{ m/s}^2}$ $\Delta t = \frac{2.2 \text{ m/s}}{2.60 \text{ m/s}^2} = \boxed{0.85 \text{ s}}$
3. $v_i = 0$ m/s $v_f = 12.5$ m/s $\Delta t = 2.5$ s	**a.** $a = \frac{v_f - v_i}{\Delta t} = \frac{12.5 \text{ m/s} - 0 \text{ m/s}}{2.5 \text{ s}} = \boxed{+5.0 \text{ m/s}^2}$ **b.** $\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2 = (0 \text{ m/s})(2.5 \text{ s}) + \frac{1}{2}(5.0 \text{ m/s}^2)(2.5 \text{ s})^2 = \boxed{+16 \text{ m}}$ **c.** $v_{avg} = \frac{\Delta x}{\Delta t} = \frac{16 \text{ m}}{2.5 \text{ s}} = \boxed{+6.4 \text{ m/s}}$

Motion In One Dimension, Practice F

1. $\Delta y = -239$ m $v_i = 0$ m/s $a = -3.7$ m/s^2	**a.** $v_f = \sqrt{v_i^2 + 2a\,\Delta y} = \sqrt{(0 \text{ m/s})^2 + (2)(-3.7 \text{ m/s}^2)(-239 \text{ m})}$ $v_f = \sqrt{1.8 \times 10^3 \text{ m}^2/\text{s}^2} = \pm 42 \text{ m/s}$ $v_f = \boxed{-42 \text{ m/s}}$ **b.** $\Delta t = \frac{v_f - v_i}{a} = \frac{-42 \text{ m/s} - 0 \text{ m/s}}{-3.7 \text{ m/s}^2} = \boxed{11 \text{ s}}$
2. $\Delta y = -25.0$ m $v_i = 0$ m/s $a = -9.81$ m/s^2	**a.** $v_f = \sqrt{v_i^2 + 2a\Delta y} = \sqrt{(0 \text{ m/s})^2 + (2)(-9.81 \text{ m/s}^2)(-25.0 \text{ m})}$ $v_f = \sqrt{4.90 \times 10^2 \text{ m}^2/\text{s}^2} = \boxed{-22.1 \text{ m/s}}$ **b.** $\Delta t = \frac{v_f - v_i}{a} = \frac{-22.1 \text{ m/s} - 0 \text{ m/s}}{-9.81 \text{ m/s}^2} = \boxed{2.25 \text{ s}}$

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Givens	*Solutions*
3. $v_i = +8.0$ m/s $a = -9.81$ m/s^2 $\Delta y = 0$ m	**a.** $v_f = \sqrt{v_i^2 + 2a\Delta y} = \sqrt{(8.0 \text{ m/s})^2 + (2)(-9.81 \text{ m/s}^2)(0 \text{ m})}$ $v_f = \sqrt{64 \text{ m}^2/\text{s}^2} = \pm 8.0 \text{ m/s} = \boxed{-8.0 \text{ m/s}}$ **b.** $\Delta t = \frac{v_f - v_i}{a} = \frac{-8.0 \text{ m/s} - 8.0 \text{ m/s}}{-9.81 \text{ m/s}^2} = \frac{-16.0 \text{ m/s}}{-9.81 \text{ m/s}^2} = \boxed{1.63 \text{ s}}$
4. $v_i = +6.0$ m/s $v_f = +1.1$ m/s^2 $a = -9.81$ m/s^2	$\Delta y = \frac{v_f^2 - v_i^2}{2a} = \frac{(1.1 \text{ m/s})^2 - (6.0 \text{ m/s})^2}{(2)(-9.81 \text{ m/s}^2)}$ $\Delta y = \frac{1.2 \text{ m}^2/\text{s}^2 - 36 \text{ m}^2/\text{s}^2}{-19.6 \text{ m/s}^2} = \frac{-35 \text{ m}^2/\text{s}^2}{-19.6 \text{ m/s}^2} = \boxed{+1.8 \text{ m}}$

Motion In One Dimension, Section 3 Review

2. $v_i = 0$ m/s $\Delta t = 1.5$ s $a = -9.81$ m/s^2	$\Delta y = v_i \Delta t + \frac{1}{2}a\Delta t^2 = (0 \text{ m/s})(1.5 \text{ s}) + \frac{1}{2}(-9.81 \text{ m/s}^2)(1.5 \text{ s})^2$ $\Delta y = 0 \text{ m} + (-11 \text{ m}) = -11 \text{ m}$ the distance to the water's surface = $\boxed{11 \text{ m}}$

Motion In One Dimension, Chapter Review

7. $\Delta t = 0.530$ h $v_{avg} = 19.0$ km/h east	$\Delta x = v_{avg}\Delta t = (19.0 \text{ km/h})(0.530 \text{ h}) = \boxed{10.1 \text{ km east}}$
8. $\Delta t = 2.00$ h, 9.00 min, 21.0 s $v_{avg} = 5.436$ m/s	$\Delta x = v_{avg}\Delta t = (5.436 \text{ m/s})\ [(2.00 \text{ h})(3600 \text{ s/h}) + (9.00 \text{ min})(60 \text{ s/min}) + 21.0 \text{ s}]$ $\Delta x = (5.436 \text{ m/s})(7200 \text{ s} + 540 \text{ s} + 21.0 \text{ s}) = (5.436 \text{ m/s})(7760 \text{ s})$ $\Delta x = 4.22 \times 10^4 \text{ m} = \boxed{4.22 \times 10^1 \text{ km}}$
9. $\Delta t = 5.00$ s distance between poles = 70.0 m	**a.** $\Delta x_A = \boxed{+70.0 \text{ m}}$ **b.** $\Delta x_B = 70.0 \text{ m} + 70.0 \text{ m} = \boxed{+140.0 \text{ m}}$ **c.** $v_{avg,A} = \frac{\Delta x_A}{\Delta t} = \frac{70.0 \text{ m}}{5.0 \text{ s}} = \boxed{+14 \text{ m/s}}$ **d.** $v_{avg,B} = \frac{\Delta x_B}{\Delta t} = \frac{140 \text{ m}}{5.0 \text{ s}} = \boxed{+28 \text{ m/s}}$

Givens	*Solutions*
10. $v_1 = 80.0$ km/h $\Delta t_1 = 30.0$ min $v_2 = 105$ km/h $\Delta t_2 = 12.0$ min $v_3 = 40.0$ km/h $\Delta t_3 = 45.0$ min $v_4 = 0$ km/h $\Delta t_4 = 15.0$ min	**a.** $\Delta x_1 = v_1\Delta t_1 = (80.0 \text{ km/h})(30.0 \text{ min})(1 \text{ h}/60 \text{ min}) = 40.0 \text{ km}$ $\Delta x_2 = v_2\Delta t_2 = (105 \text{ km/h})(12.0 \text{ min})(1 \text{ h}/60 \text{ min}) = 21.0 \text{ km}$ $\Delta x_3 = v_3\Delta t_3 = (40.0 \text{ km/h})(45.0 \text{ min})(1 \text{ h}/60 \text{ min}) = 30.0 \text{ km}$ $\Delta x_4 = v_4\Delta t_4 = (0 \text{ km/h})(15.0 \text{ min})(1 \text{ h}/60 \text{ min}) = 0 \text{ km}$ $v_{avg} = \dfrac{\Delta x_{tot}}{\Delta t_{tot}} = \dfrac{\Delta x_1 + \Delta x_2 + \Delta x_3 + \Delta x_4}{\Delta t_1 + \Delta t_2 + \Delta t_3 + \Delta t_4}$ $v_{avg} = \dfrac{40.0 \text{ km} + 21.0 \text{ km} + 30.0 \text{ km} + 0 \text{ km}}{(30.0 \text{ min} + 12.0 \text{ min} + 45.0 \text{ min} + 15.0 \text{ min})(1 \text{ h}/60 \text{ min})}$ $v_{avg} = \dfrac{91.0 \text{ km}}{(102.0 \text{ min})(1 \text{ h}/60 \text{ min})} = \boxed{53.5 \text{ km/h}}$ **b.** $\Delta x_{tot} = \Delta x_1 + \Delta x_2 + \Delta x_3 + \Delta x_4$ $\Delta x_{tot} = 40.0 \text{ km} + 21.0 \text{ km} + 30.0 \text{ km} + 0 \text{ km} = \boxed{91.0 \text{ km}}$
11. $v_A = 9.0$ km/h east $= +9.0$ km/h $x_{i,A} = 6.0$ km west of flagpole $= -6.0$ km $v_B = 8.0$ km/h west $= -8.0$ km/h $x_{i,B} = 5.0$ km east of flagpole $= +5.0$ km x = distance from flagpole to point where runners' paths cross	$\Delta x_A = v_A \Delta t = x - x_{i,A}$ $\Delta x_B = v_B \Delta t = x - x_{i,B}$ $\Delta x_A - \Delta x_B = (x - x_{i,A}) - (x - x_{i,B}) = x_{i,B} - x_{i,A}$ $\Delta x_A - \Delta x_B = v_A \Delta t - v_B \Delta t = (v_A - v_B)\Delta t$ $\Delta t = \dfrac{x_{i,B} - x_{i,A}}{v_A - v_B} = \dfrac{5.0 \text{ km} - (-6.0 \text{ km})}{9.0 \text{ km/h} - (-8.0 \text{ km/h})} = \dfrac{11.0 \text{ km}}{17.0 \text{ km/h}}$ $\Delta t = 0.647$ h $\Delta x_A = v_A\Delta t = (9.0 \text{ km/h})(0.647 \text{ h}) = 5.8 \text{ km}$ $\Delta x_B = v_B\Delta t = (-8.0 \text{ km/h})(0.647 \text{ h}) = -5.2 \text{ km}$ for runner *A*, $x = \Delta x_A + x_{i,A} = 5.8 \text{ km} + (-6.0 \text{ km}) = -0.2 \text{ km}$ $x = \boxed{0.2 \text{ km west of the flagpole}}$ for runner *B*, $x = \Delta x_B + x_{i,B} = -5.2 \text{ km} + (5.0 \text{ km}) = -0.2 \text{ km}$ $x = \boxed{0.2 \text{ km west of the flagpole}}$

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Givens	Solutions
16. $v_i = +5.0$ m/s $a_{avg} = +0.75$ m/s^2 $v_f = +8.0$ m/s	$\Delta t = \frac{\Delta v}{a_{avg}} = \frac{v_f - v_i}{a_{avg}} = \frac{8.0 \text{ m/s} - 5.0 \text{ m/s}}{0.75 \text{ m/s}^2} = \frac{3.0 \text{ m/s}}{0.75 \text{ m/s}^2}$ $\Delta t = \boxed{4.0 \text{ s}}$
17. For 0 s to 5.0 s: $v_i = -6.8$ m/s $v_f = -6.8$ m/s $\Delta t = 5.0$ s	For 0 s to 5.0 s, $a_{avg} = \frac{v_f - v_i}{\Delta t} = \frac{-6.8 \text{ m/s} - (-6.8 \text{ m/s})}{5.0 \text{ s}} = \boxed{0.0 \text{ m/s}^2}$
For 5.0 s to 15.0 s: $v_i = -6.8$ m/s $v_f = +6.8$ m/s $\Delta t = 10.0$ s	For 5.0 s to 15.0 s, $a_{avg} = \frac{v_f - v_i}{\Delta t} = \frac{6.8 \text{ m/s} - (-6.8 \text{ m/s})}{10.0 \text{ s}} = \frac{13.6 \text{ m/s}}{10.0 \text{ s}} = \boxed{+1.36 \text{ m/s}^2}$
For 0 s to 20.0 s: $v_i = -6.8$ m/s $v_f = +6.8$ m/s $\Delta t = 20.0$ s	For 0 s to 20.0 s, $a_{avg} = \frac{v_f - v_i}{\Delta t} = \frac{6.8 \text{ m/s} - (-6.8 \text{ m/s})}{20.0 \text{ s}} = \frac{13.6 \text{ m/s}}{20.0 \text{ s}} = \boxed{+0.680 \text{ m/s}^2}$
18. $v_i = 75.0$ km/h $= 21.0$ m/s $v_f = 0$ km/h $= 0$ m/s $\Delta t = 21$ s	$\Delta x = \frac{1}{2}(v_i + v_f)\Delta t = \frac{1}{2}(21.0 \text{ m/s} + 0 \text{ m/s})(21.0 \text{ s}) = \frac{1}{2}(21.0 \text{ m/s})(21 \text{ s})$ $\Delta x = \boxed{220 \text{ m}}$
19. $v_i = 0$ m/s $v_f = 18$ m/s $\Delta t = 12$ s	$\Delta x = \frac{1}{2}(v_i + v_f)\Delta t = \frac{1}{2}(0 \text{ m/s} + 18 \text{ m/s})(12 \text{ s}) = \boxed{110 \text{ m}}$
20. $v_i = +7.0$ m/s $a = +0.80$ m/s^2 $\Delta t = 2.0$ s	$v_f = v_i + a\Delta t = 7.0 \text{ m/s} + (0.80 \text{ m/s}^2)(2.0 \text{ s}) = 7.0 \text{ m/s} + 1.6 \text{ m/s} = \boxed{+8.6 \text{ m/s}}$
21. $v_i = 0$ m/s $a = -3.00$ m/s^2 $\Delta t = 5.0$ s	**a.** $v_f = v_i + a\Delta t = 0 \text{ m/s} + (-3.00 \text{ m/s}^2)(5.0 \text{ s}) = \boxed{-15 \text{ m/s}}$ **b.** $\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2 = (0 \text{ m/s})(5.0 \text{ s}) + \frac{1}{2}(-3.00 \text{ m/s}^2)(5.0 \text{ s})^2 = \boxed{-38 \text{ m}}$
22. $v_i = 0$ m/s $\Delta t_1 = 5.0$ s $a_1 = +1.5$ m/s^2 $\Delta t_2 = 3.0$ s $a_2 = -2.0$ m/s^2	For the first time interval, $v_f = v_i + a_1\Delta t_1 = 0 \text{ m/s} + (1.5 \text{ m/s}^2)(5.0 \text{ s}) = +7.5 \text{ m/s}$ $\Delta x_1 = v_i\Delta t_1 + \frac{1}{2}a_1\Delta t_1^2 = (0 \text{ m/s})(5.0 \text{ s}) + \frac{1}{2}(1.5 \text{ m/s}^2)(5.0 \text{ s})^2 = +19 \text{ m}$ For the second time interval, $v_i = +7.5$ m/s $v_f = v_i + a_2\Delta t_2 = 7.5 \text{ m/s} + (-2.0 \text{ m/s}^2)(3.0 \text{ s}) = 7.5 \text{ m/s} - 6.0 \text{ m/s} = \boxed{+1.5 \text{ m/s}}$ $\Delta x_2 = v_i\Delta t_2 + \frac{1}{2}a_2\Delta t_2 = (7.5 \text{ m/s})(3.0 \text{ s}) + \frac{1}{2}(-2.0 \text{ m/s}^2)(3.0 \text{ s})^2 = 22 \text{ m} - 9.0 \text{ m} = +13 \text{ m}$ $\Delta x_{tot} = \Delta x_1 + \Delta x_2 = 19 \text{ m} + 13 \text{ m} = \boxed{+32 \text{ m}}$

Givens	*Solutions*
23. $a = 1.40\ m/s^2$ $v_i = 0\ m/s$ $v_f = 7.00\ m/s$	$\Delta x = \frac{v_f^2 - v_i^2}{2a} = \frac{(7.00\ m/s)^2 - (0\ m/s)^2}{(2)(1.40\ m/s^2)} = \frac{49.0\ m^2/s^2}{2.80\ m/s^2} = \boxed{17.5\ m}$
24. $v_i = 0\ m/s$ $a = 0.21\ m/s^2$ $\Delta x = 280\ m$	**a.** $v_f = \sqrt{v_i^2 + 2a\Delta x} = \sqrt{(0\ m/s)^2 + (2)(0.21\ m/s^2)(280\ m)} = \sqrt{120\ m^2/s^2} = \pm 11\ m/s$ $\boxed{v_f = 11\ m/s}$ **b.** $\Delta t = \frac{v_f - v_i}{a} = \frac{11\ m/s - 0\ m/s}{0.21\ m/s^2} = \boxed{52\ s}$
25. $v_i = +1.20\ m/s$ $a = -0.31\ m/s^2$ $\Delta x = +0.75\ m$	$v_f = \sqrt{v_i^2 + 2a\Delta x} = \sqrt{(1.20\ m/s)^2 + (2)(-0.31\ m/s^2)(0.75\ m)}$ $v_f = \sqrt{1.44\ m^2/s^2 - 0.46\ m^2/s^2} = \sqrt{0.98\ m^2/s^2} = \pm 0.99\ m/s = \boxed{+0.99\ m/s}$
30. $v_i = 0\ m/s$ $\Delta y = -80.0\ m$ $a = -9.81\ m/s^2$	When $v_i = 0\ m/s$, $v^2 = 2a\Delta y \qquad v = \sqrt{2a\Delta y}$ $v = \sqrt{(2)(-9.81\ m/s^2)(-80.0\ m)}$ $v = \pm\sqrt{1570\ m^2/s^2}$ $v = \boxed{-39.6\ m/s}$
31. $v_i = 0\ m/s$ $a = -9.81\ m/s^2$ $\Delta y = -76.0\ m$	When $v_i = 0\ m/s$, $\Delta t = \sqrt{\frac{2\Delta y}{a}} = \sqrt{\frac{(2)(-76.0\ m)}{-9.81\ m/s^2}} = \boxed{3.94\ s}$
32. $v_{i,1} = +25\ m/s$ $v_{i,2} = 0\ m/s$ $a = -9.81\ m/s^2$ $y_{i,1} = 0\ m$ $y_{i,2} = 15\ m$ y = distance from ground to point where both balls are at the same height	$\Delta y_1 = y - y_{i,1} = v_{i,1}\Delta t + \frac{1}{2}a\Delta t^2$ $\Delta y_2 = y - y_{i,2} = v_{i,2}\Delta t + \frac{1}{2}a\Delta t^2$ $\Delta y_1 - \Delta y_2 = (y - y_{i,1}) - (y - y_{i,2}) = y_{i,2} - y_{i,1}$ $\Delta y_1 - \Delta y_2 = (v_{i,1}\Delta t + \frac{1}{2}a\Delta t^2) - (v_{i,2}\Delta t + \frac{1}{2}a\Delta t^2) = (v_{i,1} - v_{i,2})\ \Delta t$ $\Delta y_1 - \Delta y_2 = y_{i,2} - y_{i,1} = (v_{i,1} - v_{i,2})\Delta t$ $\Delta t = \frac{y_{i,2} - y_{i,1}}{v_{i,1} - v_{i,2}} = \frac{15\ m - 0\ m}{25\ m/s - 0\ m/s} = \frac{15\ m}{25\ m/s} = \boxed{0.60\ s}$
33. $v_{avg} = 27\ 800\ km/h$ $r_{earth} = 6380\ km$ $\Delta x = 320.0\ km$	circumference $= 2\pi(r_{earth} + \Delta x)$ $\Delta t = \frac{circumference}{v_{avg}} = \frac{2\pi(6380\ km + 320.0\ km)}{27\ 800\ km/h} = \frac{2\pi(6.70 \times 10^3\ km)}{27\ 800\ km/h} = \boxed{1.51\ h}$

Givens	Solutions

34.

a. For $\Delta y = 0.20$ m = maximum height of ball, $\Delta t = \boxed{0.20\ \text{s}}$

b. For $\Delta y = 0.10$ m = one-half maximum height of ball,

$\Delta t = \boxed{0.06\ \text{s as ball goes up}}$

$\Delta t = \boxed{0.34\ \text{s as ball comes down}}$

c. Estimating v from $t = 0.04$ s to $t = 0.06$ s:

$$v = \frac{\Delta x}{\Delta t} = \frac{0.10\ \text{m} - 0.07\ \text{m}}{0.06\ \text{s} - 0.04\ \text{s}} = \frac{0.03\ \text{m}}{0.02\ \text{s}} = \boxed{+2\ \text{m/s}}$$

Estimating v from $t = 0.09$ s to $t = 0.11$ s:

$$v = \frac{\Delta x}{\Delta t} = \frac{0.15\ \text{m} - 0.13\ \text{m}}{0.11\ \text{s} - 0.09\ \text{s}} = \frac{0.02\ \text{m}}{0.02\ \text{s}} = \boxed{+1\ \text{m/s}}$$

Estimating v from $t = 0.14$ s to $t = 0.16$ s:

$$v = \frac{\Delta x}{\Delta t} = \frac{0.19\ \text{m} - 0.18\ \text{m}}{0.16\ \text{s} - 0.14\ \text{s}} = \frac{0.01\ \text{m}}{0.02\ \text{s}} = \boxed{+\ 0.5\ \text{m/s}}$$

Estimating v from $t = 0.19$ s to $t = 0.21$ s:

$$v = \frac{\Delta x}{\Delta t} = \frac{0.20\ \text{m} - 0.20\ \text{m}}{0.21\ \text{s} - 0.19\ \text{s}} = \boxed{0\ \text{m/s}}$$

d. $$a = \frac{\Delta v}{\Delta t} = \frac{0\ \text{m/s} - 2\ \text{m/s}}{0.20\ \text{s} - 0\ \text{s}} = \frac{-2\ \text{m/s}}{0.20\ \text{s}} = \boxed{-10\ \text{m/s}^2}$$

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35. $\Delta x_{AB} = \Delta x_{BC} = \Delta x_{CD}$

$\Delta t_{AB} + \Delta t_{BC} + \Delta t_{CD} =$ 5.00 min

$$\Delta t_{AB} = \frac{\Delta x_{AB}}{v_{AB,avg}} = \frac{\Delta x_{AB}}{\frac{(v_B + 0)}{2}} = \frac{2\Delta x_{AB}}{v_B}$$

Because the train's velocity is constant from B to C, $\Delta t_{BC} = \frac{\Delta x_{BC}}{v_B}$.

$$\Delta t_{CD} = \frac{\Delta x_{CD}}{v_{CD,avg}} = \frac{\Delta x_{CD}}{\frac{(0 + v_B)}{2}} = \frac{2\Delta x_{CD}}{v_B}$$

Because $\Delta x_{AB} = \Delta x_{BC} = \Delta x_{CD}$, $\frac{\Delta t_{AB}}{2} = \Delta t_{BC} = \frac{\Delta t_{CD}}{2}$, or

$\Delta t_{AB} = \Delta t_{CD} = 2\Delta t_{BC}$.

We also know that $\Delta t_{AB} + \Delta t_{BC} + \Delta t_{CD} = 5.00$ min.

Thus, the time intervals are as follows:

a. $\Delta t_{AB} = \boxed{2.00\ \text{min}}$

b. $\Delta t_{BC} = \boxed{1.00\ \text{min}}$

c. $\Delta t_{CD} = \boxed{2.00\ \text{min}}$

Givens	*Solutions*
36. $\Delta y = -19.6$ m $v_{i,1} = -14.7$ m/s $v_{i,2} = +14.7$ m/s $a = -9.81$ m/s^2	**a.** $v_{f,1} = \sqrt{v_{i,1}^2 + 2a\Delta y} = \sqrt{(-14.7 \text{ m/s})^2 + (2)(-9.81 \text{ m/s}^2)(-19.6 \text{ m})}$ $v_{f,1} = \sqrt{216 \text{ m}^2/\text{s}^2 + 385 \text{ m}^2/\text{s}^2} = \sqrt{601 \text{ m}^2/\text{s}^2} = \pm 24.5 \text{ m/s} = -24.5 \text{ m/s}$ $v_{f,2} = \sqrt{v_{i,2}^2 + 2a\Delta y} = \sqrt{(14.7 \text{ m/s})^2 + (2)(-9.81 \text{ m/s}^2)(-19.6 \text{ m})}$ $v_{f,2} = \sqrt{216 \text{ m}^2/\text{s}^2 + 385 \text{ m}^2/\text{s}^2} = \sqrt{601 \text{ m}^2/\text{s}^2} = \pm 24.5 \text{ m/s} = -24.5 \text{ m/s}$ $\Delta t_1 = \frac{v_{f,1} - v_{i,1}}{a} = \frac{-24.5 \text{ m/s} - (-14.7 \text{ m/s})}{-9.81 \text{ m/s}^2} = \frac{-9.8 \text{ m/s}}{-9.81 \text{ m/s}^2} = 1.0 \text{ s}$ $\Delta t_2 = \frac{v_{f,2} - v_{i,2}}{a} = \frac{-24.5 \text{ m/s} - 14.7 \text{ m/s}}{-9.81 \text{ m/s}^2} = \frac{-39.2 \text{ m/s}}{-9.81 \text{ m/s}^2} = 4.00 \text{ s}$ difference in time $= \Delta t_2 - \Delta t_1 = 4.00 \text{ s} - 1.0 \text{ s} = \boxed{3.0 \text{ s}}$
	b. $v_{f,1} = \boxed{-24.5 \text{ m/s}}$ (See **a.**) $v_{f,2} = \boxed{-24.5 \text{ m/s}}$ (See **a.**)
$\Delta t = 0.800$ s	**c.** $\Delta y_1 = v_{i,1}\Delta t + \frac{1}{2}a\Delta t^2 = (-14.7 \text{ m/s})(0.800 \text{ s}) + \frac{1}{2}(-9.81 \text{ m/s}^2)(0.800 \text{ s})^2$ $\Delta y_1 = -11.8 \text{ m} - 3.14 \text{ m} = -14.9 \text{ m}$ $\Delta y_2 = v_{i,2}\Delta t + \frac{1}{2}a\Delta t^2 = (14.7 \text{ m/s})(0.800 \text{ s}) + \frac{1}{2}(-9.81 \text{ m/s}^2)(0.800 \text{ s})^2$ $\Delta y_2 = 11.8 \text{ m} - 3.14 \text{ m} = +8.7 \text{ m}$ distance between balls $= \Delta y_2 - \Delta y_1 = 8.7 \text{ m} - (-14.9 \text{ m}) = \boxed{23.6 \text{ m}}$
37. For the first time interval: $v_i = 0$ m/s $a = +29.4$ m/s^2 $\Delta t = 3.98$ s	While the rocket accelerates, $\Delta y_1 = v_1\Delta t + \frac{1}{2}a\Delta t^2 = (0 \text{ m/s})(3.98 \text{ s}) + \frac{1}{2}(29.4 \text{ m/s}^2)(3.98 \text{ s})^2 = +233 \text{ m}$ $v_f = v_i + a\Delta t = 0 \text{ m/s} + (29.4 \text{ m/s}^2)(3.98 \text{ s}) = +117 \text{ m/s}$
For the second time interval: $v_i = +117$ m/s $a = -9.81$ m/s^2 $v_f = 0$ m/s	After the rocket runs out of fuel, $\Delta y_2 = \frac{v_f^2 - v_i^2}{2a} = \frac{(0 \text{ m/s})^2 - (117 \text{ m/s})^2}{(2)(-9.81 \text{ m/s}^2)} = +698 \text{ m}$ total height reached by rocket $= \Delta y_1 + \Delta y_2 = 233 \text{ m} + 698 \text{ m} = \boxed{931 \text{ m}}$

Givens	Solutions

38. $v_1 = 85$ km/h

$v_2 = 115$ km/h

$\Delta x = 16$ km

a. $\Delta t_1 = \frac{\Delta x}{v_1} = \frac{16\text{ km}}{85\text{ km/h}} = 0.19\text{ h}$

$\Delta t_2 = \frac{\Delta x}{v_2} = \frac{16\text{ km}}{115\text{ km/h}} = 0.14\text{ h}$

The faster car arrives $\Delta t_1 - \Delta t_2 = 0.19\text{ h} - 0.14\text{ h} = \boxed{0.05\text{ h}}$ earlier.

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$\Delta t_1 - \Delta t_2 = 15$ min $= 0.25$ h

b. $\Delta x = \Delta t_1 v_1 = \Delta t_2 v_2$

$\Delta x\,(v_2 - v_1) = \Delta x v_2 - \Delta x v_1 = (\Delta t_1 v_1)v_2 - (\Delta t_2 v_2)v_1$

$\Delta x\,(v_2 - v_1) = (\Delta t_1 - \Delta t_2)v_2 v_1$

$$\Delta x = (\Delta t_1 - \Delta t_2)\left(\frac{v_2 v_1}{v_2 - v_1}\right) = (0.25\text{ h})\left(\frac{(115\text{ km/h})(85\text{ km/h})}{(115\text{ km/h}) - (85\text{ km/h})}\right)$$

$$\Delta x = (0.25\text{ h})\left(\frac{(115\text{ km/h})(85\text{ km/h})}{(30\text{ km/h})}\right) = \boxed{81\text{ km}}$$

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39. $v_i = -1.3$ m/s

$a = -9.81\text{ m/s}^2$

$\Delta t = 2.5$ s

$v_f = v_i + a\Delta t = -1.3\text{ m/s} + (-9.81\text{ m/s}^2)(2.5\text{ s})$

$v_f = -1.3\text{ m/s} - 25\text{ m/s} = \boxed{-26\text{ m/s}}$

$\Delta x_{kit} = \frac{1}{2}(v_i + v_f)\Delta t = \frac{1}{2}(-1.3\text{ m/s} - 26\text{ m/s})(2.5\text{ s})$

$\Delta x_{kit} = \frac{1}{2}(-27\text{ m/s})(2.5\text{ s}) = -34\text{ m}$

$\Delta x_{climber} = (-1.3\text{ m/s})(2.5\text{ s}) = -3.2\text{ m}$

The distance between the kit and the climber is $\Delta x_{climber} - \Delta x_{kit}$.

$\Delta x_{climber} - \Delta x_{kit} = -3.2\text{ m} - (-34\text{ m}) = \boxed{31\text{ m}}$

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40. $v_i = +0.50$ m/s

$\Delta t = 2.5$ s

$a = -9.81\text{ m/s}^2$

a. $v_f = v_i + a\Delta t = 0.50\text{ m/s} + (-9.81\text{ m/s}^2)(2.5\text{ s}) = 0.50\text{ m/s} - 25\text{ m/s}$

$v_f = \boxed{-24\text{ m/s}}$

b. $\Delta x_{fish} = \frac{1}{2}(v_i + v_f)\Delta t = \frac{1}{2}(0.50\text{ m/s} - 24\text{ m/s})(2.5\text{ s})$

$\Delta x_{fish} = \frac{1}{2}(-24\text{ m/s})(2.5\text{ s}) = -30\text{ m}$

$\Delta x_{pelican} = (0.50\text{ m/s})(2.5\text{ s}) = +1.2\text{ m}$

The distance between the fish and the pelican is $\Delta x_{pelican} - \Delta x_{fish}$.

$\Delta x_{pelican} - \Delta x_{fish} = 1.2\text{ m} - (-30\text{ m}) = \boxed{31\text{ m}}$

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41. $v_i = 56$ km/h

$v_f = 0$ m/s

$a = -3.0\text{ m/s}^2$

$\Delta x_{tot} = 65$ m

For the time interval during which the ranger decelerates,

$$\Delta t = \frac{v_f - v_i}{a} = \frac{0\text{ m/s} - (56 \times 10^3\text{ m/h})(1\text{ h}/3600\text{ s})}{-3.0\text{ m/s}^2} = 5.2\text{ s}$$

$\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2 = (56 \times 10^3\text{ m/h})(1\text{ h}/3600\text{ s})(5.2\text{ s}) + \frac{1}{2}(-3.0\text{ m/s}^2)(5.2\text{ s})^2$

$\Delta x = 81\text{ m} - 41\text{ m} = 4.0 \times 10^1\text{ m}$

maximum reaction distance $= \Delta x_{tot} - \Delta x = 65\text{ m} - (4.0 \times 10^1\text{ m}) = 25\text{ m}$

$$\text{maximum reaction time} = \frac{\text{maximum reaction distance}}{v_i}$$

$$\text{maximum reaction time} = \frac{25\text{ m}}{(56 \times 10^3\text{ m/h})(1\text{ h}/3600\text{ s})} = \boxed{1.6\text{ s}}$$

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42. $v_s = 30.0$ m/s

$v_{i,p} = 0$ m/s

$a_p = 2.44$ m/s^2

a. $\Delta x_s = \Delta x_p$

$\Delta x_s = v_s \Delta t$

Because $v_{i,p} = 0$ m/s,

$\Delta x_p = \frac{1}{2} a_p \Delta t^2$

$v_s \Delta t = \frac{1}{2} a_p \Delta t^2$

$$\Delta t = \frac{2v_s}{a_p} = \frac{(2)(30.0 \text{ m/s})}{2.44 \text{ m/s}^2} = \boxed{24.6 \text{ s}}$$

b. $\Delta x_s = v_s \Delta t = (30.0 \text{ m/s})(24.6 \text{ s}) = \boxed{738 \text{ m}}$

or $\Delta x_p = \frac{1}{2} a_p \Delta t^2 = \frac{1}{2}(2.44 \text{ m/s}^2)(24.6 \text{ s})^2 = \boxed{738 \text{ m}}$

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43. For Δt_1:

$v_i = 0$ m/s

$a = +13.0$ m/s^2

$v_f = v$

For Δt_2:

$a = 0$ m/s^2

v = constant velocity

$\Delta x_{tot} = +5.30 \times 10^3$ m

$\Delta t_{tot} = \Delta t_1 + \Delta t_2 = 90.0$ s

When $v_i = 0$ m/s,

$\Delta x_1 = \frac{1}{2} a \Delta t_1^{\,2}$

$\Delta t_2 = 90.0 \text{ s} - \Delta t_1$

$\Delta x_2 = v \Delta t_2 = v(90.0 \text{ s} - \Delta t_1)$

$\Delta x_{tot} = \Delta x_1 + \Delta x_2 = \frac{1}{2} a \Delta t_1^{\,2} + v(90.0 \text{ s} - \Delta t_1)$

$v = v_f$ during the first time interval $= a\Delta t_1$

$\Delta x_{tot} = \frac{1}{2} a \Delta t_1^{\,2} + a\Delta t_1(90.0 \text{ s} - \Delta t_1) = \frac{1}{2} a \Delta t_1^{\,2} + (90.0 \text{ s}) a \Delta t_1 - a \Delta t_1^{\,2}$

$\Delta x_{tot} = -\frac{1}{2} a \Delta t_1^{\,2} + (90.0 \text{ s}) a \Delta t_1$

$\frac{1}{2} a \Delta t_1^{\,2} - (90.0 \text{ s}) a \Delta t_1 + \Delta x_{tot} = 0$

Using the quadratic equation,

$$\Delta t_1 = \frac{(90.0 \text{ s})(a) \pm \sqrt{[-(90.0 \text{ s})(a)]^2 - 4\left(\frac{1}{2}a\right)(\Delta x_{tot})}}{2\left(\frac{1}{2}a\right)}$$

$$\Delta t_1 = \frac{(90.0 \text{ s})(13.0 \text{ m/s}^2) \pm \sqrt{[-(90.0 \text{ s})(13.0 \text{ m/s}^2)]^2 - 2(13.0 \text{ m/s})(5.30 \times 10^3 \text{ m})}}{13.0 \text{ m/s}^2}$$

$$\Delta t_1 = \frac{1170 \text{ m/s} \pm \sqrt{(1.37 \times 10^6 \text{ m}^2/\text{s}^2) - (1.38 \times 10^5 \text{ m}^2/\text{s}^2)}}{13.0 \text{ m/s}^2}$$

$$\Delta t_1 = \frac{1170 \text{ m/s} \pm \sqrt{1.23 \times 10^6 \text{ m}^2/\text{s}^2}}{13.0 \text{ m/s}^2} = \frac{1170 \text{ m/s} \pm 1110 \text{ m/s}}{13.0 \text{ m/s}^2} = \frac{60 \text{ m/s}}{13.0 \text{ m/s}^2} = \boxed{5 \text{ s}}$$

$\Delta t_2 = \Delta t_{tot} - \Delta t_1 = 90.0 \text{ s} - 5 \text{ s} = \boxed{85 \text{ s}}$

$v = a\Delta t_1 = (13.0 \text{ m/s}^2)(5 \text{ s}) = \boxed{+60 \text{ m/s}}$

Givens	Solutions
44. $\Delta x_1 = +5800$ m $a = -7.0$ m/s^2 $v_i = +60$ m/s (see **43.**) $v_f = 0$ m/s	**a.** $\Delta x_2 = \frac{v_f^2 - v_i^2}{2a} = \frac{(0\text{ m/s})^2 - (60\text{ m/s})^2}{(2)(-7.0\text{ m/s}^2)} = +300\text{ m}$ sled's final position $= \Delta x_1 + \Delta x_2 = 5800\text{ m} + 300\text{ m} = \boxed{6100\text{ m}}$ **b.** $\Delta t = \frac{v_f - v_i}{a} = \frac{0\text{ m/s} - 60\text{ m/s}}{-7.0\text{ m/s}^2} = \boxed{9\text{ s}}$
45. $v_i = +10.0$ m/s $v_f = -8.0$ m/s $\Delta t = 0.012$ s	$a_{avg} = \frac{v_f - v_i}{\Delta t} = \frac{-8.0\text{ m/s} - 10.0\text{ m/s}}{0.012\text{ s}} = \boxed{-1.5 \times 10^3\text{ m/s}^2}$
46. $v_i = -10.0$ m/s $\Delta y = -50.0$ m $a = -9.81$ m/s^2	**a.** $v_f = \sqrt{v_i^2 + 2a\Delta y} = \sqrt{(-10.0\text{ m/s})^2 + (2)(-9.81\text{ m/s}^2)(-50.0\text{ m})}$ $v_f = \sqrt{1.00 \times 10^2\text{ m}^2/\text{s}^2 + 981\text{ m}^2/\text{s}^2} = \sqrt{1081\text{ m}^2/\text{s}^2} = \pm 32.9\text{ m/s} = -32.9\text{ m/s}$ $\Delta t = \frac{v_f - v_i}{a} = \frac{-32.9\text{ m/s} - (-10.0\text{ m/s})}{-9.81\text{ m/s}^2} = \frac{-22.9\text{ m/s}}{-9.81\text{ m/s}^2} = \boxed{2.33\text{ s}}$ **b.** $v_f = \boxed{-32.9\text{ m/s}}$ (See **a.**)
47. $\Delta y = -50.0$ m $v_{i,1} = +2.0$ m/s $\Delta t_1 = \Delta t_2 + 1.0$ s $a = -9.81$ m/s^2	**a.** $v_{f,1} = \sqrt{v_{i,1}^2 + 2a\Delta y} = \sqrt{(2.0\text{ m/s})^2 + (2)(-9.81\text{ m/s}^2)(-50.0\text{ m})}$ $v_{f,1} = \sqrt{4.0\text{ m}^2/\text{s}^2 + 981\text{ m}^2/\text{s}^2} = \sqrt{985\text{ m}^2/\text{s}^2} = \pm 31.4\text{ m/s} = -31.4\text{ m/s}$ $\Delta t_1 = \frac{v_{f,1} - v_{i,1}}{a} = \frac{-31.4\text{ m/s} - 2.0\text{ m/s}}{-9.81\text{ m/s}^2} = \frac{-33.4\text{ m/s}}{-9.81\text{ m/s}^2} = \boxed{3.40\text{ s}}$ **b.** $\Delta t_2 = \Delta t_1 - 1.0\text{ s} = 3.40\text{ s} - 1.0\text{ s} = 2.4\text{ s}$ $\Delta y = v_{i,2}\Delta t_2 + \frac{1}{2}a\Delta t_2^2$ $v_{i,2} = \frac{\Delta y - \frac{1}{2}a\Delta t_2^2}{\Delta t_2} = \frac{-50.0\text{ m} - \frac{1}{2}(-9.81\text{ m/s}^2)(2.4\text{ s})^2}{2.4\text{ s}}$ $v_{i,2} = \frac{-50.0\text{ m} + 28\text{ m}}{2.4\text{ s}} = \frac{-22\text{ m}}{2.4\text{ s}} = \boxed{-9.2\text{ m/s}}$ **c.** $v_{f,1} = \boxed{-31.4\text{ m/s}}$ (See **a.**) $v_{f,2} = v_{i,2} + a\Delta t_2 = -9.2\text{ m/s} + (-9.81\text{ m/s}^2)(2.4\text{ s})$ $v_{f,2} = -9.2\text{ m/s} - 24\text{ m/s} = \boxed{-33\text{ m/s}}$

Givens	*Solutions*
48. For the first time interval:	**a.** $v_{f,1} = \sqrt{v_{i,1}^2 + 2a_1\Delta y_1} = \sqrt{(50.0 \text{ m/s})^2 + (2)(2.00 \text{ m/s}^2)(150 \text{ m})}$
$v_{i,1} = +50.0$ m/s	$v_{f,1} = \sqrt{(2.50 \times 10^3 \text{ m}^2/\text{s}^2) + (6.0 \times 10^2 \text{ m}^2/\text{s}^2)} = \sqrt{3.10 \times 10^3 \text{ m}^2/\text{s}^2}$
$a_1 = +2.00$ m/s^2	
$\Delta y_1 = +150$ m	$v_{f,1} = \pm 55.7 \text{ m/s} = +55.7 \text{ m/s}$
For the second time interval:	$\Delta y_2 = \dfrac{v_{f,2}^2 - v_{i,2}^2}{2a_2} = \dfrac{(0 \text{ m/s})^2 - (55.7 \text{ m/s})^2}{(2)(-9.81 \text{ m/s}^2)} = +158 \text{ m}$
$v_{i,2} = +55.7$ m/s	maximum height $= \Delta y_1 + \Delta y_2 = 150 \text{ m} + 158 \text{ m} = \boxed{310 \text{ m}}$
$v_{f,2} = 0$ m/s	
$a_2 = -9.81$ m/s^2	
	b. For the first time interval,
	$\Delta t_{up,1} = \dfrac{2\Delta y_1}{v_{i,1} + v_{f,1}} = \dfrac{(2)(150 \text{ m})}{50.0 \text{ m/s} + 55.7 \text{ m/s}} = \dfrac{(2)(150 \text{ m})}{105.7 \text{ m/s}} = 2.8 \text{ s}$
	For the second time interval,
	$\Delta t_{up,2} = \dfrac{2\Delta y_2}{v_{i,2} + v_{f,2}} = \dfrac{(2)(158 \text{ m})}{55.7 \text{ m/s} + 0 \text{ m/s}} = 5.67 \text{ s}$
	$\Delta t_{up,tot} = \Delta t_{up,1} + \Delta t_{up,2} = 2.8 \text{ s} + 5.67 \text{ s} = \boxed{8.5 \text{ s}}$
For the trip down:	**c.** Because $v_i = 0$ m/s, $\Delta t_{down} = \sqrt{\dfrac{2\Delta y}{a}} = \dfrac{\sqrt{(2)(-310 \text{ m})}}{-9.81 \text{ m/s}^2} = \sqrt{63 \text{ s}^2} = 7.9 \text{ s}$
$\Delta y = -310$ m	$\Delta t_{tot} = \Delta t_{up,tot} + \Delta t_{down} = 8.5 \text{ s} + 7.9 \text{ s} = \boxed{16.4 \text{ s}}$
$v_i = 0$ m/s	
$a = -9.81$ m/s^2	

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Givens / *Solutions*

49. $a_1 = +5.9\ \text{m/s}^2$

$a_2 = +3.6\ \text{m/s}^2$

$\Delta t_1 = \Delta t_2 - 1.0\ \text{s}$

Because both cars are initially at rest,

a. $\Delta x_1 = \frac{1}{2}a_1\Delta t_1^2$

$\Delta x_2 = \frac{1}{2}a_2\Delta t_2^2$

$\Delta x_1 = \Delta x_2$

$\frac{1}{2}a_1\Delta t_1^2 = \frac{1}{2}a_2\Delta t_2^2$

$a_1(\Delta t_2 - 1.0\ \text{s})^2 = a_2\Delta t_2^2$

$a_1[\Delta t_2^2 - (2.0\ \text{s})(\Delta t_2) + 1.0\ \text{s}^2] = a_2\Delta t_2^2$

$(a_1)(\Delta t_2)^2 - a_1(2.0\ \text{s})\Delta t_2 + a_1(1.0\ \text{s}^2) = a_2\Delta t_2^2$

$(a_1 - a_2)\Delta t_2^2 - a_1(2.0\ \text{s})\Delta t_2 + a_1(1.0\ \text{s}^2) = 0$

Using the quadratic equation,

$$\Delta t_2 = \frac{(a_1)(2.0\ \text{s}) \pm \sqrt{[-a_1(2.0\ \text{s})]^2 - 4(a_1 - a_2)a_1(1.0\ \text{s}^2)}}{2(a_1 - a_2)}$$

$a_1 - a_2 = 5.9\ \text{m/s}^2 - 3.6\ \text{m/s}^2 = 2.3\ \text{m/s}^2$

$$\Delta t_2 = \frac{(5.9\ \text{m/s}^2)(2.0\ \text{s}) \pm \sqrt{[-(5.9\ \text{m/s}^2)(2.0\ \text{s})]^2 - (4)(2.3\ \text{m/s}^2)(5.9\ \text{m/s}^2)(1.0\ \text{s}^2)}}{(2)(2.3\ \text{m/s}^2)}$$

$$\Delta t_2 = \frac{12\ \text{m/s} \pm \sqrt{140\ \text{m}^2/\text{s}^2 - 54\ \text{m}^2/\text{s}^2}}{(2)(2.3\ \text{m/s}^2)} = \frac{12\ \text{m/s} \pm \sqrt{90\ \text{m}^2/\text{s}^2}}{(2)(2.3\ \text{m/s}^2)}$$

$$\Delta t_2 = \frac{12\ \text{m/s} \pm 9\ \text{m/s}}{(2)(2.3\ \text{m/s}^2)} = \frac{21\ \text{m/s}}{(2)(2.3\ \text{m/s}^2)} = \boxed{4.6\ \text{s}}$$

$\Delta t_1 = \Delta t_2 - 1.0\ \text{s} = 4.6\ \text{s} - 1.0\ \text{s} = \boxed{3.6\ \text{s}}$

b. $\Delta x_1 = \frac{1}{2}a_1\Delta t_1^2 = \frac{1}{2}(5.9\ \text{m/s}^2)(3.6\ \text{s})^2 = 38\ \text{m}$

or $\Delta x_2 = \frac{1}{2}a_2\Delta t_2^2 = \frac{1}{2}(3.6\ \text{m/s}^2)(4.6\ \text{s})^2 = 38\ \text{m}$

distance both cars travel = $\boxed{38\ \text{m}}$

c. $v_1 = a_1\Delta t_1 = (5.9\ \text{m/s}^2)(3.6\ \text{s}) = \boxed{+21\ \text{m/s}}$

$v_2 = a_2\Delta t_2 = (3.6\ \text{m/s}^2)(4.6\ \text{s}) = \boxed{+17\ \text{m/s}}$

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50. $v_{i,1} = +25\ \text{m/s}$

$v_{i,2} = +35\ \text{m/s}$

$\Delta x_2 = \Delta x_1 + 45\ \text{m}$

$a_1 = -2.0\ \text{m/s}^2$

$v_{f,1} = 0\ \text{m/s}$

$v_{f,2} = 0\ \text{m/s}$

a. $\Delta t_1 = \dfrac{v_{f,1} - v_{i,1}}{a_1} = \dfrac{0\ \text{m/s} - 25\ \text{m/s}}{-2.0\ \text{m/s}^2} = \boxed{13\ \text{s}}$

b. $\Delta x_1 = \frac{1}{2}(v_{i,1} + v_{f,1})\Delta t_1 = \frac{1}{2}(25\ \text{m/s} + 0\ \text{m/s})(13\ \text{s}) = +163\ \text{m}$

$\Delta x_2 = \Delta x_1 + 45\ \text{m} = 163\ \text{m} + 45\ \text{m} = +208\ \text{m}$

$a_2 = \dfrac{v_{f,2}^2 - v_{i,2}^2}{2\Delta x_2} = \dfrac{(0\ \text{m/s})^2 - (35\ \text{m/s})^2}{(2)(208\ \text{m})} = \boxed{-2.9\ \text{m/s}^2}$

c. $\Delta t_2 = \dfrac{v_{f,2} - v_{i,2}}{a_2} = \dfrac{0\ \text{m/s} - 35\ \text{m/s}}{-2.9\ \text{m/s}^2} = \boxed{12\ \text{s}}$

Givens | *Solutions*

51. $\Delta x_1 = 20.0$ m

$v_1 = 4.00$ m/s

$\Delta x_2 = v_2(0.50 \text{ s}) + 20.0$ m

$$\Delta t = \frac{\Delta x_1}{v_1} = \frac{20.0 \text{ m}}{4.00 \text{ m/s}} = 5.00 \text{ s}$$

$$v_2 = \frac{\Delta x_2}{\Delta t} = \frac{v_2(0.50 \text{ s}) + 20.0 \text{ m}}{\Delta t}$$

$$v_2\Delta t = v_2(0.50 \text{ s}) + 20.0 \text{ m}$$

$$v_2(\Delta t - 0.50 \text{ s}) = 20.0 \text{ m}$$

$$v_2 = \frac{20.0 \text{ m}}{\Delta t - 0.50 \text{ s}} = \frac{20.0 \text{ m}}{(5.00 \text{ s} - 0.50 \text{ s})} = \frac{20.0 \text{ m}}{4.50 \text{ s}} = \boxed{4.44 \text{ m/s}}$$

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4. $\Delta t = 5.2$ h

$v_{avg} = 73$ km/h south

$$\Delta x = v_{avg}\Delta t = (73 \text{ km/h})(5.2 \text{ h}) = \boxed{3.8 \times 10^2 \text{ km south}}$$

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5. $\Delta t = 3.0$ s

$$\Delta x = 4.0 \text{ m} + (-4.0 \text{ m}) + (-2.0 \text{ m}) + 0.0 \text{ m} = \boxed{-2.0 \text{ m}}$$

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6. $\Delta x = -2.0$ m (see **5.**)

$\Delta t = 3.0$ s

$$v_{avg} = \frac{\Delta x}{\Delta t} = \frac{-2.0 \text{ m}}{3.0 \text{ s}} = \boxed{-0.67 \text{ m/s}}$$

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8. $v_i = 0$ m/s

$a = 3.3 \text{ m/s}^2$

$\Delta t = 7.5$ s

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

$$\Delta x = (0 \text{ m/s})(7.5 \text{ s}) + \tfrac{1}{2}(3.3 \text{ m/s}^2)(7.5 \text{ s})^2 = 0 \text{ m} + 93 \text{ m} = \boxed{93 \text{ m}}$$

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11. $\Delta t_1 = 10.0 \text{ min} - 0 \text{ min}$

$= 10.0$ min

$\Delta t_2 = 20.0 \text{ min} - 10.0 \text{ min}$

$= 10.0$ min

$\Delta t_3 = 30.0 \text{ min} - 20.0 \text{ min}$

$= 10.0$ min

a. $\Delta x_1 = (2.4 \times 10^3 \text{ m}) - (0 \times 10^3 \text{ m}) = \boxed{+2.4 \times 10^3 \text{ m}}$

$$v_1 = \frac{\Delta x_1}{\Delta t_1} = \frac{(2.4 \times 10^3 \text{ m})}{(10.0 \text{ min})(60 \text{ s/min})} = \boxed{+4.0 \text{ m/s}}$$

b. $\Delta x_2 = (3.9 \times 10^3 \text{ m}) - (2.4 \times 10^3 \text{ m}) = \boxed{+1.5 \times 10^3 \text{ m}}$

$$v_2 = \frac{\Delta x_2}{\Delta t_2} = \frac{(1.5 \times 10^3 \text{ m})}{(10.0 \text{ min})(60 \text{ s/min})} = \boxed{+2.5 \text{ m/s}}$$

c. $\Delta x_3 = (4.8 \times 10^3 \text{ m}) - (3.9 \times 10^3 \text{ m}) = \boxed{+9 \times 10^2 \text{ m}}$

$$v_3 = \frac{\Delta x_3}{\Delta t_3} = \frac{(9 \times 10^2 \text{ m})}{(10.0 \text{ min})(60 \text{ s/min})} = \boxed{+2 \text{ m/s}}$$

d. $\Delta x_{tot} = \Delta x_1 + \Delta x_2 + \Delta x_3 = (2.4 \times 10^3 \text{ m}) + (1.5 \times 10^3 \text{ m}) + (9 \times 10^2 \text{ m})$

$\Delta x_{tot} = \boxed{+4.8 \times 10^3 \text{ m}}$

$$v_{avg} = \frac{\Delta x_{tot}}{\Delta t_{tot}} = \frac{\Delta x_1 + \Delta x_2 + \Delta x_3}{\Delta t_1 + \Delta t_2 + \Delta t_3} = \frac{(4.8 \times 10^3 \text{ m})}{(30.0 \text{ min})(60 \text{ s/min})}$$

$v_{avg} = \boxed{+2.7 \text{ m/s}}$

Givens	Solutions
13. $v_i = +3.0$ m/s $a_1 = +0.50$ m/s^2 $\Delta t = 7.0$ s $a_2 = -0.60$ m/s^2 $v_f = 0$ m/s	**a.** $v_f = a_1\Delta t + v_i = (0.50 \text{ m/s}^2)(7.0 \text{ s}) + 3.0 \text{ m/s} = 3.5 \text{ m/s} + 3.0 \text{ m/s} = \boxed{+6.5 \text{ m/s}}$ **b.** $\Delta t = \frac{v_f - v_i}{a_2} = \frac{0 \text{ m/s} - 3.0 \text{ m/s}}{-0.60 \text{ m/s}^2} = \boxed{5.0 \text{ s}}$

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Givens	Solutions
14. $v_i = 16$ m/s east $= +16$ m/s $v_f = 32$ m/s east $= +32$ m/s $\Delta t = 10.0$ s	**a.** $a = \frac{v_f - v_i}{\Delta t} = \frac{32 \text{ m/s} - 16 \text{ m/s}}{10.0 \text{ s}} = \frac{16 \text{ m/s}}{10.0 \text{ s}} = +1.6 \text{ m/s}^2 = \boxed{1.6 \text{ m/s}^2 \text{ east}}$ **b.** $\Delta x = \frac{1}{2}(v_i + v_f)\Delta t = \frac{1}{2}(16 \text{ m/s} + 32 \text{ m/s})(10.0 \text{ s}) = \frac{1}{2}(48 \text{ m/s})(10.0 \text{ s})$ $\Delta x = +240$ m $v_{avg} = \frac{\Delta x}{\Delta t} = \frac{240 \text{ m}}{10.0 \text{ s}} = +24 \text{ m/s} = \boxed{24 \text{ m/s east}}$ **c.** distance traveled $= \boxed{+240 \text{ m}}$ (See **b.**)

Givens	Solutions
15. $v_i = +25.0$ m/s $y_i = +2.0$ m/s $a = -9.81$ m/s^2 For the trip up: $v_f = 0$ m/s	**a.** For the trip up, $\Delta t = \frac{v_f - v_i}{a} = \frac{0 \text{ m/s} - 25.0 \text{ m/s}}{-9.81 \text{ m/s}^2} = \boxed{2.55 \text{ s}}$ $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2 = (25.0 \text{ m/s})(2.55 \text{ s}) + \frac{1}{2}(-9.81 \text{ m/s}^2)(2.55 \text{ s})^2$ $\Delta y = 63.8 \text{ m} - 31.9 \text{ m} = +31.9 \text{ m}$
For the trip down: $v_i = 0$ m/s $\Delta y = (-31.9 \text{ m} - 2.0 \text{ m})$ $= -33.9$ m	**b.** For the trip down, because $v_i = 0$ m/s, $\Delta t = \sqrt{\frac{2\Delta y}{a}} = \sqrt{\frac{(2)(-33.9 \text{ m})}{-9.81 \text{ m/s}^2}} = \sqrt{6.91 \text{ s}^2} = 2.63 \text{ s}$ total time $= 2.55 \text{ s} + 2.63 \text{ s} = \boxed{5.18 \text{ s}}$