Solutions to Straight Line Motion

1. a) 1000 m b) 600 m East c) $\frac{1000\,m}{120\,s} = 8.3\,m/s$

   d) $\bar{V} = \frac{d}{t}$

   $\frac{600\,m\ W}{120\,s} = 5\,m/s\ W$

2. $\text{Speed} = \frac{\text{distance}}{\text{time}} = \frac{10{,}000\,m}{1{,}560\,s} = 6.4\,m/s$

3. a) 1 mile = 1.6 km

   5.75 miles

   9.2 km

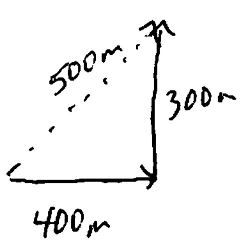
   b) 2.25 miles South

   3.6 km South

   c) $\frac{9.2\,km}{10{,}800} = .85\,m/s$

   d) .33 m/s South

4. a) 700 m b) 500 m @ 36.9° NE



$\tan^{-1}\left(\frac{300}{400}\right)$

   c) $\frac{700\,m}{40\,s} = 17.5\,m/s$ d) $\frac{500\,m}{40\,s} = 12.5\,m/s$ @ 36.9° NE

5. OMIT

6. OMIT

7) $a = \frac{\Delta V}{t}$

$a = \frac{150\,m/s - 0\,m/s}{.5\,s}$

$a = 300\,m/s^2$

8) a) $a=\frac{\Delta V}{t}=\frac{30m/s-0m/s}{12s}=2.5m/s^2$

b) $d=V_it+\frac{1}{2}at^2$

$d=\cancel{(0m/s)(12s)}+\frac{1}{2}(2.5m/s^2)(12s)^2$

$d=180m$

9) a) $a=\frac{V_f-V_i}{t}$

$2.5m/s=\frac{10m/s}{t}$ $\quad \frac{10m/s}{2.5}=4s$

b) same ΔV so $4s$

c) i) $d=V_it+\frac{1}{2}at^2$

$d=(20m/s)(4s)+\frac{1}{2}(2.5m/s^2)(4)^2$

$d=80m+20m$

$d=100m$

ii) $d=(50m/s)(4s)+\frac{1}{2}(2.5m/s^2)(4s)^2$

$d=200m+20m$

$d=220m$

10) $a=\frac{V_f-V_i}{t}=\frac{2m/s-5m/s}{10s}=-.3m/s^2$

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

$d=(5m/s)(10s)+\frac{1}{2}(-.3m/s^2)(10s)^2$

$d=50m+(-15m)$

$d=+35m$

11) $V_f^2=V_i^2+2ad$

$(60m/s)^2=(40m/s)^2+2a(350m)$

$2000m^2/s^2=700m(a)$

$a=2.9m/s^2$

$a=\frac{\Delta V}{t}$

$a=\frac{20m/s}{t}$

$t=\frac{20m/s}{2.9m/s^2}$

$t=6.9s\approx 7s$

12) $V_f^2 = V_i^2 + 2ad$

$V_f^2 = (3m/s)^2 + 2(4.5m/s^2)(45m)$

$\sqrt{V_f^2} = \sqrt{9m^2/s^2 + 405m^2/s^2}$

$V_f = 20.3\,m/s$

$a = \frac{\Delta V}{t}$

$t = \frac{\Delta V}{a}$

$t = \frac{20.3m/s - 3m/s}{4.5m/s}$

$t = 3.8s$

13) a) $a = \frac{\Delta V}{t} = \frac{(-4m/s) - 2m/s}{.75s}$ $\boxed{= -8m/s^2}$

b) $V_f = V_i + at$

$0m/s = 2m/s + (-8m/s^2)(t)$

$-2m/s = -8m/s^2\, t$

$\boxed{t = .25s}$

c) $d = V_i t + \frac{1}{2}at^2$

$d = (2m/s)(.75s) + \frac{1}{2}(-8m/s^2)(.75s)^2$

$d = 1.5m - (4m/s^2)(.5625s)$

$\boxed{d = -.75m}$ or West

e) $\bar{V} = \frac{2m/s + (-4m/s)}{2} = -1m/s$

~~speed~~ ~~$|V|$~~ ~~m/s~~

$1m/s = \frac{d}{.75s} = -.75m/s$

$\boxed{.75m/s \text{ west}}$

d) 1st part

$V_f^2 = V_i^2 + 2ad$

$0m/s^2 = (2m/s)^2 + 2(-8m/s^2)(d)$

$.25m = d$

2nd Part

$(-4m/s)^2 = (0m/s)^2 + 2(-8m/s^2)d$

$16m^2/s^2 = -16m/s^2\, d$

$d = -1m$

$\boxed{D_{total} = 1.25m}$

f) $s = \frac{dist}{time}$

$= \frac{1.25m}{.75s}$

$= 1.67m/s$

14)

a) $\bar{V} = \frac{V_1 + V_2}{2}$ $\qquad 60\,m/s = \frac{0\,m/s + V_f}{2}$

$V_f = 120\,m/s$

b) $a = \frac{\Delta V}{t}$

$a = \frac{120\,m/s - 0\,m/s}{50\,s}$

$a = 2.4\,m/s^2$

c)

$V_f^2 = V_i^2 + 2ad$

$(120\,m/s)^2 = (0\,m/s)^2 + 2(2.4\,m/s^2)\,d$

$14{,}400\,m^2/s^2 = 4.8\,m/s^2\,d$

$d = 3000\,m$

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

$1500\,m = \cancel{(0\,m/s)t} + \frac{1}{2}(2.4\,m/s^2)(t)^2$

$1500\,m = 1.2\,m/s^2\,t^2$

$1250\,m = t^2$

$t = 35.4\,s$

15) Find time it takes woman to reach the river.

$V = \frac{d}{t}$

$2.5\,m/s = \frac{4000\,m}{t}$

$t = 1600\,s$ ← that will be total time dog runs

$d = vt$

$d = (4.5\,m/s)(1600\,s)$

$d = 7200\,m$

16)

a) $V_f = V_i + at$

$V_f = 12\,m/s + (-4\,m/s^2)(3\,s)$

$V_f = 12\,m/s - 12\,m/s$

$V_f = 0\,m/s$

b) $V_f^2 = V_i^2 + 2ad$

$(0\,m/s)^2 = (12\,m/s)^2 + 2(-4\,m/s^2)\,d$

$-144\,m^2/s^2 = -8\,m/s^2\,d$

$d = {}^{+}18\,m$

17.

$$a = \frac{\Delta v}{t}$$

$$75\,m/s^2 = \frac{-5\,m/s - (-30\,m/s)}{t}$$

$$t = .33\,s$$

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

$$d = (-30\,m/s)(.33\,s) + \tfrac{1}{2}(75\,m/s^2)(.33\,s)^2$$

$$d = -9.9\,m + 4.1\,m$$

$$d = -5.8\,m$$

or

5.8m down

18. a)

$$a = \frac{\Delta v}{t}$$

$$v_f = v_i + at$$

$$0\,m/s = 30\,m/s + (-5\,m/s^2)(t)$$

$$\frac{-30\,m/s}{-5\,m/s^2} = t$$

$$t = 6\,s$$

$$v_f^2 = v_i^2 + 2ad$$

$$(0\,m/s)^2 = (30\,m/s)^2 + 2(-5\,m/s^2)d$$

$$\frac{-900\,m^2/s^2}{-10\,m/s^2} = d$$

$$d = +90\,m$$

b) $\frac{-60}{-5} = 12\,s$ $\frac{-3600}{-10} = 360\,m$

time doubles distance x4

19. a) $V_f = V_i + at$

$V_f = 0\,m/s + (9.8\,m/s^2)(5.4\,s)$

$V_f = 52.9\,m/s$ down or $+52.9\,m/s$

b) $d = V_i t + \frac{1}{2}at^2$

$d = \cancel{(0\,m/s)(5.4\,s)} + \frac{1}{2}(9.8\,m/s^2)(5.4\,s)^2$

$d = {}^{+}142.9\,m$

or

142.9 m down

c) Find displacement at both, and subtract

@ 3sec

$d_3 = V_i t + \frac{1}{2}at^2$

$d_3 = \cancel{(0\,m/s)(3\,s)} + \frac{1}{2}(9.8\,m/s^2)(3\,s)^2$

$d_3 = 44.1\,m$

@ 2sec

$d_2 = V_i t + \frac{1}{2}at^2$

$d_2 = \cancel{(0\,m/s)(2)} + \frac{1}{2}(9.8\,m/s^2)(2\,s)^2$

$d_2 = 19.6\,m$

$d_3 - d_2$

$44.1\,m - 19.6\,m = 24.5\,m$ down from 2-3

20) a) $V = 0\,m/s$

b) $V_f = V_i + at$

$0\,m/s = 40\,m/s + (-9.8\,m/s^2)t$

$-40\,m/s = -9.8\,m/s^2\, t$

$t = 4.1\,s$

c) $V_f^2 = V_i^2 + 2ad$

$(0\,m/s)^2 = (40\,m/s)^2 + 2(-9.8\,m/s^2)d$

$-1600\,\frac{m^2}{s^2} = -19.6\,d$

$d = {}^{+}81.6\,m$

d) same height

$V_f = V_i$

40 m/s down

or

$-40\,m/s$

e) $d_{total} = 0\,m$

f) $T_{tot} = 2t$

$t_{up} = t_{down}$

$T_{tot} = 8.2\,s$

21) $\uparrow$ + $\downarrow$ +

a) $V_f = V_i + at$

$V_f = 0\,m/s + (9.8\,m/s^2)(3\,s)$

$V_{f_3} = 29.4\,m/s$ down or $+29.4\,m/s$

b) $d = V_i t + \frac{1}{2}at^2$

$50\,m = (0\,m/s)\cancel{(t)} + \frac{1}{2}(9.8\,m/s^2)(t^2)$

$50\,m = 4.9\,m/s^2\, t^2$

$\sqrt{10.2} = \sqrt{t^2}$

$t = 3.2\,s$

c) $V_f^2 = V_i^2 + 2ad$

$V_f^2 = (0\,m/s)^2 + 2(9.8\,m/s^2)(50)$

$\sqrt{V_f^2} = \sqrt{980\,m^2/s^2}$

$V_f = 31.3\,m/s$ down or $+31.3\,m/s$

d) $9.8\,m/s^2$ down (Always in free fall) or $+9.8\,m/s^2$

22. $\leftarrow$ + $\downarrow$ +

a) $d = V_i t + \frac{1}{2}at^2$

$75\,m = (15\,m/s)t + \frac{1}{2}(9.8\,m/s^2)t^2$

quadratic formula $\rightarrow$ $-4.9\,m/s^2\, t^2 - 15\,m/s\, t + 75\,m = 0$

$\cancel{t = -5.7}$ $\boxed{t = 2.67}$

no (-) time

*could have also solved b first in two steps

b) $V_f^2 = V_i^2 + 2ad$

$V_f^2 = (15\,m/s)^2 + 2(9.8\,m/s^2)(75\,m)$

$\sqrt{V_f^2} = \sqrt{225\,m + 1470}$

$V_f = {}^{+}41.2\,m/s$ or down

23) $\uparrow$ + $\rightarrow$ +

a) $V_f = V_i + at$

$0\,m/s = (15\,m/s) + (-9.8\,m/s^2)t$

$-15\,m/s = -9.8\,m/s^2\, t$

$t = 1.53\,s$

b) $V_f^2 = V_i^2 + 2ad$

$(0\,m/s)^2 = (15\,m/s)^2 + 2(-9.8\,m/s^2)d$

$-225\,m^2/s^2 = -19.6\,m/s^2\, d$

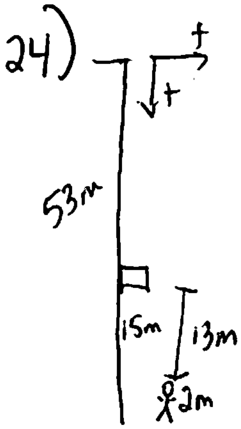
$d = {}^{+}11.5\,m$ or up

c) same height

$V_f = V_i$

$-15\,m/s$ or $15\,m/s$ down

24)



Find the speed of block at 15m above man

$V_f^2 = V_i^2 + 2ad$

$V_f^2 = (0\,m/s)^2 + 2(9.8\,m/s^2)(38\,m)$

$\sqrt{V_f^2} = \sqrt{744.8\,m^2/s^2}$

$V_f = 27.3\,m/s$

Now find time to fall and hit the top of man

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

$13\,m = (27.3\,m/s)t + \frac{1}{2}(9.8\,m/s^2)t^2$

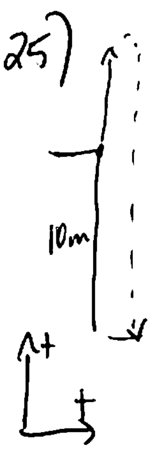
$-4.9t^2 - 27.3\,m/s\,t + 13\,m = 0$

quadratic formula

$\cancel{t = -6\,s}$ $\boxed{t = .44\,s}$

no negative time

25)



$V_f^2 = V_i^2 + 2ad$

a) $d_{tot} = -10\,m$ or 10m down

b) $V_f^2 = V_i^2 + 2ad$

$(-25\,m/s)^2 = V_i^2 + 2(-9.8\,m/s^2)(-10\,m)$

$625\,m^2/s^2 = V_i^2 + 196\,m^2/s^2$

$V_i = 20.7\,m/s$

c) $d = V_i t + \frac{1}{2}at^2$

$-10\,m = (20.7\,m/s)t + \frac{1}{2}(-9.8\,m/s^2)t^2$

$+4.9t^2 - 20.7\,m/s\,t - 10\,m = 0$

$t = \cancel{-.44\,s}$ or $\boxed{t = 4.66\,s}$

no negative time

d) $V_f^2 = V_i^2 + 2ad$

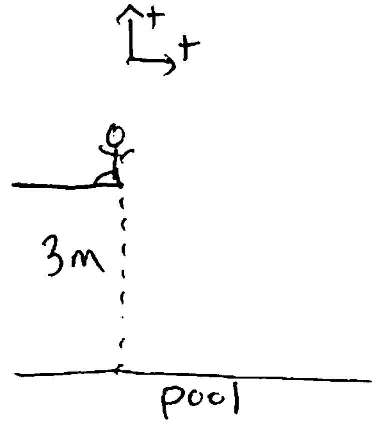
$0\,m/s = (20.7\,m/s)^2 + 2(-9.8\,m/s^2)d$

$-428.5\,m^2/s^2 = -19.6\,m/s^2\,d$

$+21.9\,m = d$

above canyon.

26)



a) $V_{top} = 0\,m/s$

b) $V_f^2 = V_i^2 + 2ad$

$(0\,m/s)^2 = (5\,m/s)^2 + 2(-9.8\,m/s^2)d$

$\dfrac{-25\,m}{-19.6\,m/s^2} = d$

$d = 1.28\,m$ (above board)

$+\ 3\,m$ (diving board height)

$4.28\,m$ above pool

c) $V_f = V_i + at$

$0\,m/s = 5\,m/s + (-9.8\,m/s^2)t$

$\dfrac{-5\,m/s}{-9.8\,m/s^2} = t$

$.51\,s = t$

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

$-3\,m = (5\,m/s)t + \frac{1}{2}(-9.8\,m/s^2)t^2$

$+4.9\,m/s^2\,t^2 - 5\,m/s\,t - 3\,m = 0$

$\cancel{t = -.42}$ $t = 1.44$

no (-) time

$t_{tot} = 1.44\,s$

* could have also been found piece meal

e) $V_f^2 = V_i^2 + 2ad$

$V_f^2 = (5\,m/s^2)^2 + 2(-9.8\,m/s^2)(-3\,m)$

$\sqrt{V_f^2} = \sqrt{83.8\,m^2/s^2}$

$V_f = 9.15\,m/s$ down

or $-9.15\,m/s$

27) $t_{total} = 3.5\,s$ ∴ time up is $1.75\,s$

$V_f = V_i + at$

$0\,m/s = V_i + (-9.8)(1.75\,s)$

$V_i = 17.15\,m/s$

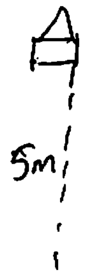
$V_f^2 = V_i^2 + 2ad$

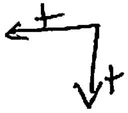
$(0\,m/s)^2 = (17.15\,m/s)^2 + 2(-9.8\,m/s^2)d$

$-294.1\,m^2/s^2 = -19.6\,m/s^2\,d$

$d = 15\,m$ up

28)





a) $d = V_i t + \frac{1}{2}at^2$

$5m = \cancel{(0 m/s)(t)} + \frac{1}{2}(9.8 m/s^2)t^2$

$5m = 4.9 m/s^2\, t^2$

$t = 1 sec$

b) $V_f^2 = V_i^2 + 2ad$

$V_f^2 = (0 m/s)^2 + 2(9.8 m/s^2)(5m)$

$\sqrt{V_f^2} = \sqrt{98 m^2/s^2}$

$V_f = {}^{+}9.9 m/s$ or down

c) $d = V_i t + \frac{1}{2}at^2$

$5m = (+5 m/s)t + \frac{1}{2}(9.8 m/s^2)t^2$

$-4.9 m/s^2\, t^2 - 5 m/s\, t + 5m = 0$

$\cancel{t = -1.64}$ $\boxed{t = .62 s}$

no neg time

d) $V_f^2 = V_i^2 + 2ad$

$V_f^2 = (5 m/s)^2 + 2(9.8 m/s^2)(5m)$

$V_f^2 = 25 m/s^2 + 98 m/s^2$

$V_f = {}^{+}11.1 m/s$

or

down