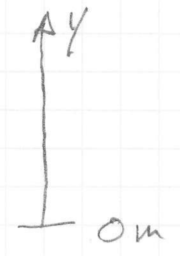
P. 242

Dr. Bob

1.



a) $V_i \neq 0\,m/s$ $V_f = 0\,m/s$

b) $y_i < y_f$ $V_i > 0\,m/s$ $V_f = 0\,m/s$

c) $V_i = 0\,m/s$ $V_f \neq 0$

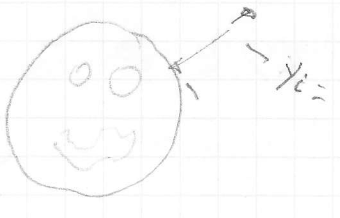
d) $y_i = 0\,m$ $V_i > 0$

e) $y_i > 0\,m$ $V_i = 0\,m/s$ $V_f < 0\,m/s$

f) $y_f = 0\,m$

2. A. The magnitude of the velocity should increase linearly - Constant accelleration means constant slope on a V vs. t. graph.

3.



$y_i = 1.8m$ $V_i = 0\,m/s$

$y_f = 0\,m$ $V_f = ?$

$t_i = 0\,s$ $t_f = ?$

$a = -1.6\,m/s^2$

$$\overset{0}{\cancel{y_f}} = y_i + \overset{0\,m/s}{\cancel{v_i}} \Delta t + \tfrac{1}{2} a \Delta t^2$$

$$-y_i = \tfrac{1}{2} a \, \Delta t^2$$

$$\Delta t = \sqrt{\frac{-2 y_i}{a}} = \sqrt{\frac{-2(1.8m)}{-1.6\,m/s^2}}$$

$$\boxed{\Delta t = 1.5\,s}$$

It would take a feather exactly the same amount of time to fall since the Moon does not have an atmosphere to slow the feather down.

4.

a = constant.

$X_i = 0m$ $V_i = 0m/s$ $a = ?$ $t_i = 0s$

$X_f = 1500m$ $V_f = ?$ $t_f = 50s$

a) $$X_f = \cancelto{0}{X_i} + \cancelto{0}{V_i}\Delta t + \tfrac{1}{2}a\,\Delta t^2$$

$$X_f = \tfrac{1}{2}a\,\Delta t^2$$

$$\frac{2X_f}{\Delta t^2} = a$$

$$a = \frac{2(1500m)}{(50s)^2} = 1.2m/s^2$$

$$\boxed{a = 1.2m/s^2}$$

b). $V_f = ?$

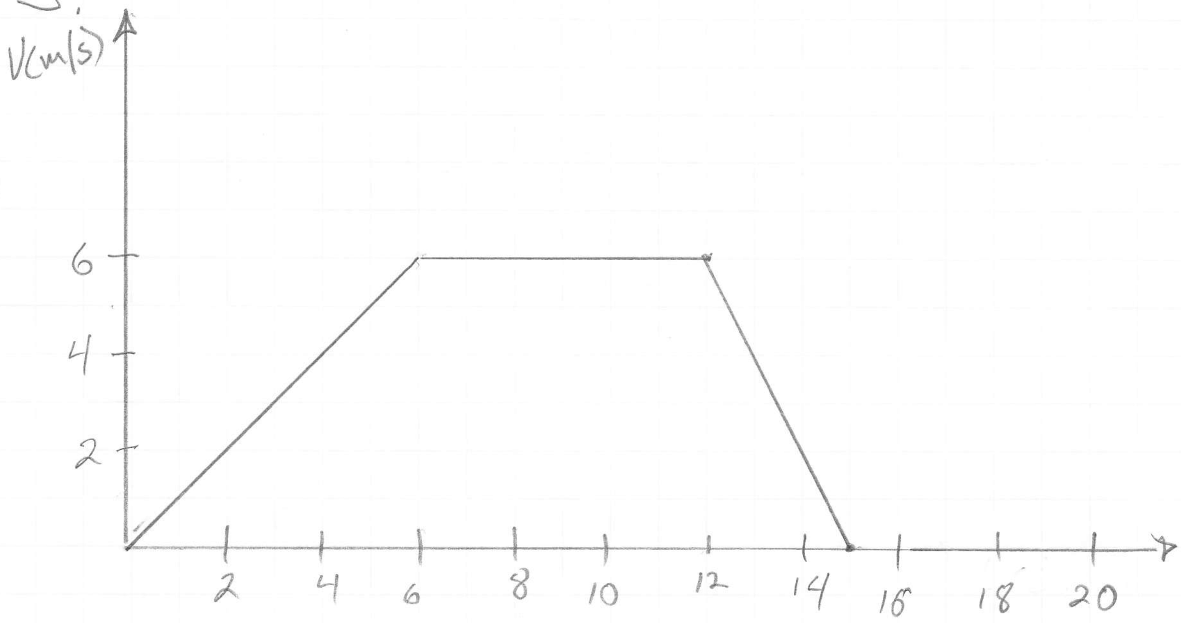
$$V_f = \cancelto{0}{V_i} + a\,\Delta t$$

$$= (1.2m/s^2)(50\cancel{s})$$

$$V_f = 60\cancel{m}/\cancel{s}\left(\frac{3600\cancel{s}}{1h}\right)\left(\frac{1km}{1000\cancel{m}}\right)$$

$$\boxed{V_f = 216\,km/h}$$

5.



6. D - negative velocity

C - small negative velocity

B - Zero velocity

A - small positive velocity

E - Large positive velocity

The slope is the velocity on a position (x(m)) vs time (t(s)) graph.

7.

$V_i = 12 m/s$
$x_i = 0$
$t_i = 0$

$a = 6.0 m/s^2$

$x_f = 63 m$
$V_f = ?$
$t_f = ?$

Find V_f first.

$$V_f^2 = V_i^2 + 2a\Delta x = (12 m/s)^2 + 2(6.0 m/s^2)(63 m)$$

$$V_f = \pm\sqrt{900 m^2/s^2}$$

$$V_f = 30 m/s$$

choose positive root she's moving to the right in this coordinate system.

7. (cont'd)

$$V_f = V_i + a\Delta t$$

$$\Delta t = \frac{V_f - V_i}{a} = \frac{30 m/s - 12 m/s}{6.0 m/s^2}$$

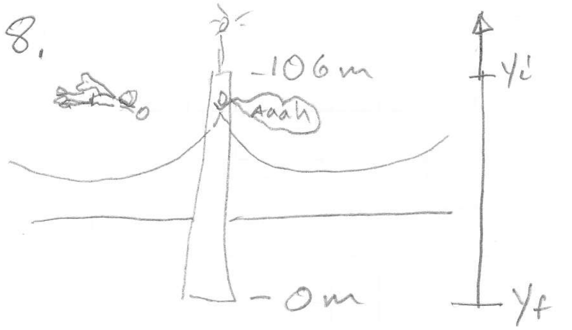
$$\boxed{\Delta t = 3.0 s}$$

units $\frac{m/s}{m/s^2}$

$= \frac{1}{1/s} = \frac{1}{s^{-1}}$

$= s$

8.



$V_i = 0 m/s$

$V_f = ?$

$t_i = 0 s$

$t_f = ?$

$y_i = 106 m$

$y_f = 0 m$

$a = -9.80 m/s^2$

$t_f = ?$

$$\overset{0}{\cancel{y_f}} = y_i + \overset{0}{\cancel{V_i}}\Delta t + \frac{1}{2} a \Delta t^2$$

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

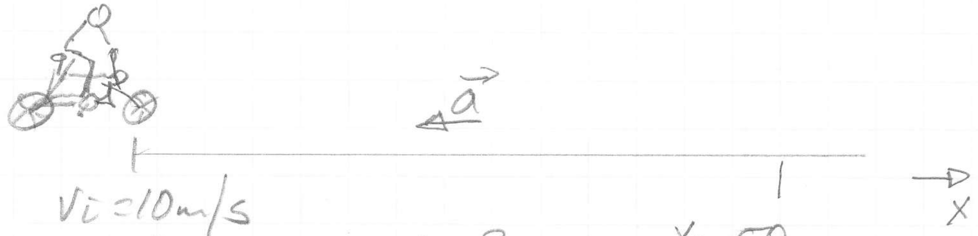
$$\Delta t^2 = \frac{-2y_i}{a}$$

$$\Delta t = \pm\left[\frac{-2y_i}{a}\right]^{1/2} = \pm\left[\frac{-2(106 m)}{-9.8 m/s^2}\right]^{1/2}$$

$$\boxed{\Delta t = 4.65 s}$$

Not realistic, but what super hero movie is?

9.



$V_i = 10 m/s$
$x_i = 0 m$
$t_i = 0 s$

$a = ?$

$X_f = 50 m$
$V_f = 6.0 m/s$
$t_f = ?$

Find 'a' first.

$$V_f^2 = V_i^2 + 2a\Delta X$$

$$a = \frac{V_f^2 - V_i^2}{2\Delta X} = \frac{(6.0m/s)^2 - (10m/s^2)^2}{2(50m)}$$

$$a = -0.64 m/s^2$$

$a < 0$, because it is pointing to the left.

Now find where the bicycle stops.

$X_f = ?$ $V_f = 0 m/s$

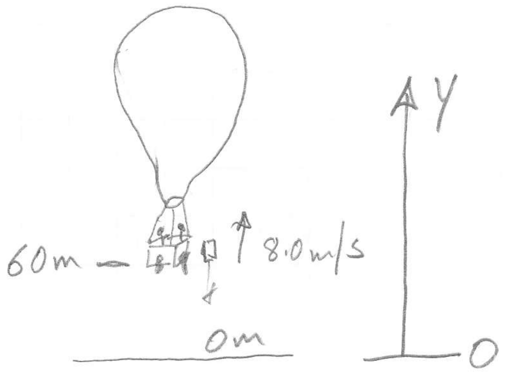
$$V_f^2 = V_i^2 + 2a\Delta X$$

$$\Delta X = \frac{V_f^2 - V_i^2}{2(a)} = \frac{(0)^2 - (10m/s)^2}{2(-0.64m/s^2)}$$

$$X_f - \overset{0}{\cancel{X_i}} = 78.1m$$

$\boxed{\text{This is } \boxed{28.1 m} \text{ beyond the 50m}}$

10.



Sand bag

$t_i = 0s$
$t_f = ?$

$V_i = 8.0 m/s$
$V_f = ?$
$Y_i = 60 m$
$Y_f = 0 m$
$a = -9.8 m/s^2$

$$\overset{0}{\cancel{Y_f}} = y_i + V_i \Delta t + \frac{1}{2} a \Delta t^2$$

$$0 = \frac{1}{2}(-9.8 m/s^2) \Delta t^2 + (8.0 m/s) \Delta t + 60 m$$

$$0 = (-4.9 m/s^2) \Delta t^2 + (8.0 m/s) \Delta t + 60 m$$

$$\Delta t = \frac{-8.0 m/s \pm [(8.0 m/s)^2 - 4(-4.9 m/s^2)(60 m)]^{1/2}}{2(-4.9 m/s^2)}$$

$$\Delta t = 0.81 \pm 3.6 s$$

$$\boxed{\Delta t = 4.4 s}$$

Choose positive root, because of causality.

Now find velocities at 3.4s & 4.4s

$\underline{t = 3.4s}$ $\quad V_f = V_i + a \Delta t = (8.0 m/s) + (-9.8 m/s^2) 3.4s$

$$V_f = -25.3 m/s$$

$\underline{t = 4.4s}$ $\quad V_f = (8.0 m/s) + (-9.8 m/s^2)(4.4s)$

$$V_f = -35.1 m/s$$

$\underline{\text{Now } \Delta Y = ?}$

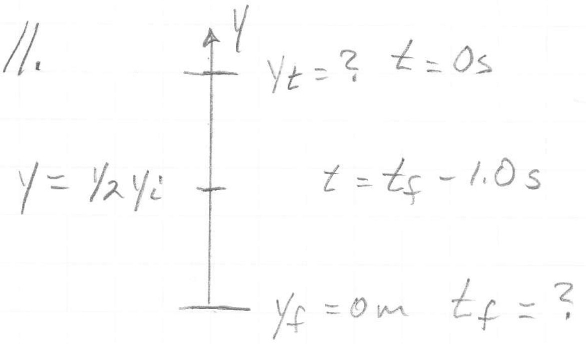
$V_i = -25.3 m/s$
$V_f = -35.1 m/s$

$$V_f^2 = V_i^2 + 2a \Delta Y$$

$$\Delta Y = \frac{V_f^2 - V_i^2}{2a} = \frac{(-35.1 m/s)^2 - (-25.3 m/s)^2}{2(-9.8 m/s^2)}$$

$$\boxed{\Delta Y = -30.2 m}$$ Falls 30.2m in last 1s.

11.



$a = -9.80\ m/s^2$

$V_i = 0\ m/s$

y_t = height at top.

Part I First half of the fall.

$y_f = \frac{1}{2} y_t$
$y_i = y_t$

$$V_f^2 = \cancelto{0}{V_i^2} + 2a\,\Delta y$$

$$V_f^2 = 2a(y_t/2 - y_t) = 2a(-\tfrac{1}{2} y_t)$$

$$V_f = -\sqrt{-a y_t}$$

Choose negative root falling downwards.

Part II Second half of fall for 1s.

$V_i = -(-a y_t)^{1/2}$ $t_i = 0s$ $y_i = \frac{1}{2} y_t$

$V_f = ?$ $t_f = 1s$ $y_f = 0m$

$$\cancelto{0}{y_f} = y_i + V_i\,\Delta t + \tfrac{1}{2} a\,\Delta t^2$$

$$0 = \tfrac{1}{2} y_t - (-a y_t)^{1/2} \Delta t + \tfrac{1}{2} a\,\Delta t^2$$

$$0 = \tfrac{1}{2} y_t - \left(-(-9.8 m/s^2)\, y_t\right)^{1/2}(1s) + \tfrac{1}{2}(-9.8\ m/s^2)(1s)^2$$

$$0 = \tfrac{1}{2} y_t - (3.13\ m^{1/2}/\cancel{s})\, y_t^{1/2}(1\cancel{s}) - 4.9m$$

$$0 = \tfrac{1}{2} y_t - 3.13\ m^{1/2}\, y_t^{1/2} - 4.9m$$

Quadratic Equation

$$0 = y_t - 6.26\ m^{1/2}\, y_t^{1/2} - 9.8m$$

$$y_t^{1/2} = \frac{6.26\ m^{1/2} \pm \left[(6.26\ m^{1/2})^2 - 4(1)(-9.8m)\right]^{1/2}}{2(1)}$$

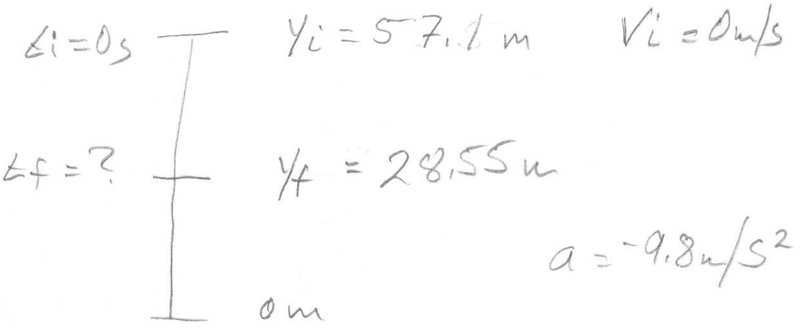
$$y_t^{1/2} = 3.13\ m^{1/2} \pm 4.43\ m^{1/2}$$

Choose positive root; y_t is above $y = 0m$

$$y_t^{1/2} = 7.56\ m^{1/2}$$

$$\boxed{y_t = 57.1 m}$$

Verify Answer



$$y_f = y_i + \cancelto{0}{v_i} \Delta t + \frac{1}{2} a (\Delta t)^2$$

$$y_f - y_i = \frac{1}{2} a \Delta t^2 \qquad \Delta t^2 = 2(y_f - y_i)/a$$

First half of fall

$$\Delta t = \sqrt{\frac{2(y_f - y_i)}{a}} = \sqrt{\frac{2(28.55\cancel{m} - 57.1\cancel{m})}{-9.8\cancel{m}/s^2}}$$

$$\Delta t = 2.41 s$$

2nd half of fall

$$\Delta t = \sqrt{\frac{2(0\cancel{m} - 57.1\cancel{m})}{-9.8\cancel{m}/s^2}}$$

$$\Delta t = 3.41 s$$

These two times are 1s apart