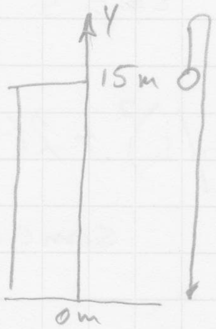
P.23 8 1. B. The velocity starts @ $v=0$ (slope $=0$) & becomes increasingly negative as time goes on – falling faster

Dr Bob

2.



$v_i = 10\,m/s$ $\quad x_i = 15\,m$

$v_f = ?$ $\quad x_f = 0\,m$

$a = -9.8\,m/s^2$ $\quad t_i = 0\,s$

$t_f = ?$

$$v_f^2 = v_i^2 + 2a(y_f - y_i)$$

$$= (10\,m/s)^2 + 2(-9.8\,m/s^2)(0\,m - 15\,m)$$

$$v_f^2 = 394\,m^2/s^2$$

$$v_f = \pm 19.85\,m/s$$

Choose the negative root, because ball is moving downwards which is in the negative direction for my coordinate system.

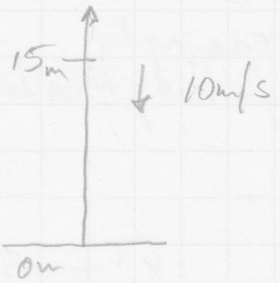
$$\boxed{v_f = -19.85\,m/s}$$

$$v_f - v_i = a\,\Delta t$$

$$\Delta t = t_f - \cancelto{0}{t_i} = \frac{v_f - v_i}{a} = \frac{-19.85\,m/s - 10\,m/s}{-9.8\,m/s^2}$$

$$\boxed{\Delta t = 3.05\,s}$$

3.



$V_i = -10\,m/s$ $\quad a = -9.8\,m/s^2$
$V_f = ?$ $\quad t_i = 0s$
$X_i = 15\,m$
$X_f = 0\,m$ $\quad t_f = ?$

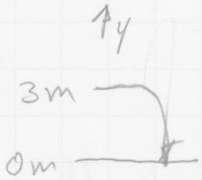
$$V_f^2 = V_i^2 + 2a\Delta X = (-10\,m/s)^2 + 2(-9.8\,m/s^2)(-15\,m)$$

$$\boxed{V_f = -19.85\,m/s}$$ same as #2.

$$t_f = \frac{V_f - V_i}{a} = \frac{-19.85\,m/s - (-10\,m/s)}{-9.8\,m/s^2}$$ see #2

$$\boxed{t_f = 1.01s}$$

4.



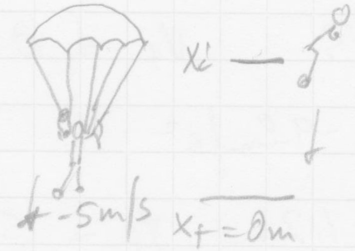
$X_i = 3m$ $\quad a = -9.8\,m/s^2$
$X_f = 0m$ $\quad V_f = ?$

We have to assume $V_i = 0\,m/s$

$$V_f^2 = V_i^2 + 2a\Delta y$$
$$= (0)^2 + 2(-9.8\,m/s^2)(0m - 3m)$$
$$V_f^2 = 58.8\,m^2/s^2$$

$$\boxed{V_f = -7.67\,m/s}$$

5.



$x_i = ?$

$x_f = 0m$

$a = -9.8\,m/s^2$

$v_i = 0\,m/s$

$v_f = -5\,m/s$

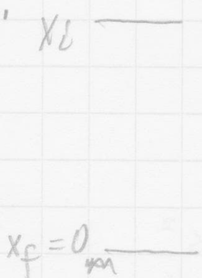
$$v_f^2 = v_i^2 + 2a\Delta x$$

$$\Delta x = \frac{v_f^2 - v_i^2}{2a} = \frac{(-5\,m/s)^2 - (0\,m/s)^2}{2(-9.8\,m/s^2)}$$

$$\boxed{\Delta x = 1.28m}$$

Units $\frac{\cancel{m^2}/\cancel{s^2}}{\cancel{m}/\cancel{s^2}} = m$

6.



$x_i = ?$ $\quad t_i = 0s$ $\quad \Delta t = t_f - \cancel{t_i}^{\,0}$

$x_f = 0m$ $\quad t_f = 1.43s$ $\quad \Delta t = t_f$

$v_i = 0\,m/s$ $\quad a = -9.8\,m/s^2$

$$\cancel{x_f}^{\,0} = x_i + \cancel{v_i}^{\,0} t_f + \tfrac{1}{2} a (t_f)^2$$

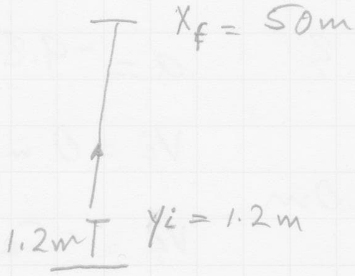
$$x_i = -\tfrac{1}{2} a t_f^2$$

$$= -\tfrac{1}{2}(-9.8\,m/s^2)(1.43s)^2$$

$$\boxed{x_i = 10.0\,m}$$

Platform Diving

7.



$V_i = ?$ $\quad V_f = 0\,m/s$

$a = -9.8\,m/s^2$

$y_i = 1.2m$ $\quad y_f = 50m$

$$\cancel{V_f}^{2} \to 0 = V_i^2 + 2a\,\Delta x$$

$$V_i^2 = -2a\,\Delta x$$

$$= -2(-9.8\,m/s^2)(50m - 1.2m)$$

$$V_i^2 = 956.48\,m^2/s^2$$

$$\boxed{V_i = 30.9\,m/s}$$

8.

$V_i = 10\,m/s$

$x_i = 0m$

$a = -9.8\,m/s^2$

$V_f = 0\,m/s$

a) $x_f = ?$ Find $\Delta t = ?$ first.

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

$$\Delta t = \frac{V_f - V_i}{a} = \frac{0\,m/s - 10\,m/s}{-9.8\,m/s^2}$$

$\Delta t = 1.02s$ to the top of trajectory

$$x_f = \cancel{x_i} \to 0 + V_i\Delta t + \tfrac{1}{2}a\Delta t^2$$

$$= (10\,m/s)(1.02s) + \tfrac{1}{2}(-9.8\,m/s^2)(1.02s)^2$$

$$\boxed{x_f = 5.10\,m}$$

8. (cont'd)

b) $t_f = ?$ $\qquad X_f = x_i = 0\,m$

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

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

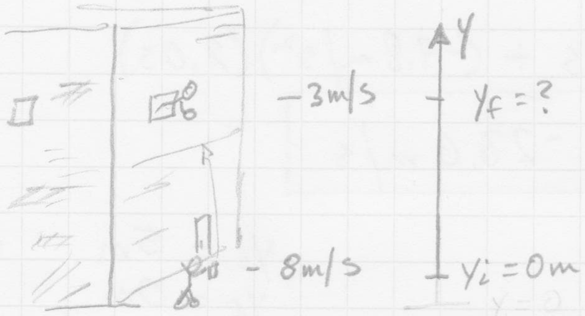
$$\Delta t = \frac{-2 V_i}{a} = \frac{-2(10\cancel{m}/\cancel{s})}{-9.8\,\cancel{m}/s^{\cancel{2}}}$$

$$\boxed{\Delta t = 2.04\,s}$$

As much time going up as coming down.

c) $a = -9.8\,m/s^2$ The acceleration is constant throughout the flight.

9.



$y_i = 0m$ $\qquad a = -9.8\,m/s^2$
$V_i = 8\,m/s$
$V_f = 3\,m/s$
$t_i = 0s$

$t_f = ?$ $\qquad y_f = ?$

a) $$V_f^2 = V_i^2 + 2a\Delta y$$

$$\Delta y = \frac{V_f^2 - V_i^2}{2a} = \frac{(3\,m/s)^2 - (8\,m/s)^2}{2(-9.8\,m/s^2)}$$

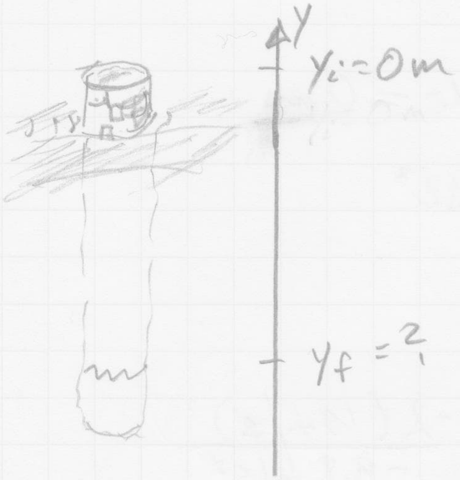
$$\boxed{\Delta y = 2.8\,m}$$

b) $$V_f - V_i = a\Delta t$$

$$\Delta t = \frac{V_f - V_i}{a} = \frac{3\,m/s - 8\,m/s}{-9.8\,m/s^2} = 0.51\,s$$

$$\boxed{\Delta t = 0.51\,s}$$

10.



$t_i = 0s$ $v_i = -4.0 m/s$
$t_f = 2.0s$ $V_f = ?$
$\Delta t = 2.0s$
$y_i = 0m$ $a = -9.8 m/s^2$

$y_f = ?$

a) $y_f = ?$

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

$$= 0m + (-4 m/s)(2s) + \tfrac{1}{2}(-9.8 m/s^2)(2s)^2$$

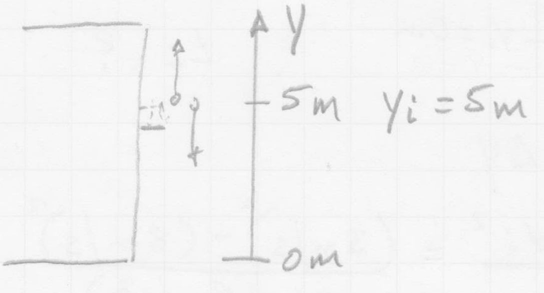
$$\boxed{y_f = {}^-27.6\,m}$$

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

$$V_f = -4.0 m/s + (-9.8 m/s^2)(2.0s)$$

$$\boxed{V_f = {}^-23.6\,m/s}$$

11.



$y_i = 5m$ $a = -9.8 m/s$
$y_f = 0m$
$V_{1i} = 10 m/s$
$t_{1i} = t_{2i} = 0s$

The wording of this problem is ambiguous, because it doesn't give magnitude of the second balls velocity. I will assume that he drops the second ball, so $V_{2i} = 0 m/s$.

$t_{f1} = ?$ $t_{f2} = ?$

11. (cont'd)

Ball A

$\cancel{Y_{1f}}^{0} = \cancel{Y_{1i}} + V_{1i}\,\Delta t_1 + \frac{1}{2}a(\Delta t_1)^2$

$$\frac{1}{2}(-9.8\,m/s^2)(\Delta t_1)^2 + (10\,m/s)\,\Delta t_1 + 5\,m = 0$$

$$(-4.9\,m/s^2)(\Delta t_1)^2 + (10\,m/s)\,\Delta t_1 + 5\,m = 0$$

$$\Delta t_1 = \frac{(10\,m/s) \pm \sqrt{(10\,m/s)^2 - 4(-4.9\,m/s^2)(5\,m)}}{2(-4.9\,m/s^2)}$$

$$\Delta t_1 = -0.415\,s \;,\; 2.46\,s$$

Only positive root makes sense
(The ball can not hit the ground before it is thrown).

$$\Delta t_1 = 2.46\,s$$

Ball B

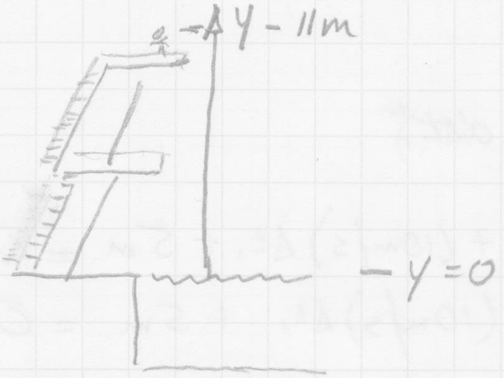
$$\cancel{Y_{2f}}^{0} = Y_{2i} + \cancel{V_{2i}}^{0}\,\Delta t + \frac{1}{2}a(\Delta t_2)^2$$

$$(\Delta t_2)^2 = \frac{-2\,Y_{2i}}{a} = \frac{-2(5\,m)}{-9.8\,m/s^2}$$

$$\Delta t = \pm\sqrt{\frac{-10\,m}{-9.8\,m/s^2}}$$

$$\boxed{\Delta t = 1.01\,s}$$

12.



Break the problem into two parts.
Part I falling through the air,
Ignore air resistance,
Part II Falling through water.

Part I

$y_i = 11m$ $\quad v_i = 0m/s$ $\quad t_i = 0s$ $\quad a = -9.8m/s$

$y_f = 0m$ $\quad v_f = ?$ $\quad t_f = ?$

$$v_f^2 = \cancel{v_i^2}^{\to 0} + 2a\Delta y$$

$$v_f^2 = 2(-9.8m/s^2)(0m - 11m) = 215.6m^2/s^2$$

$$v_f = \pm 14.7m/s$$

Choose negative root, because it is falling downwards.

Part II

$y_i = 0m$ $\quad v_i = -14.7m/s$ $\quad t_i = 0s$ $\quad a = 30m/s^2$

$y_f = ?$ $\quad v_f = 0\ m/s$ $\quad t_f = ?$

$$\cancel{v_f^2}^{\to 0} = v_i^2 + 2a\Delta y$$

$$\Delta y = \frac{-(v_i)^2}{2a} = \frac{-(-14.7m/s)^2}{2(30m/s^2)}$$