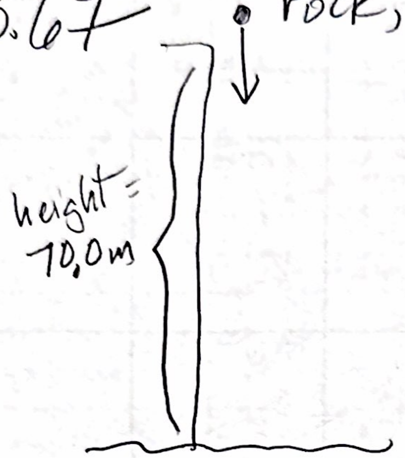
3.67 rock, $v_i = -14.0\,m/s$ ("thrown down")




a) At time $t = 0.500\,s$,

$$\Delta t = t_f - t_i = 0.5 - 0.0 = \underline{0.50\,s}$$

$$v_f = v_i + at = (-14) + (-9.80)(0.5) = \boxed{-18.9\,m/s}$$

$$\Delta y = v_i t + \tfrac{1}{2}at^2 = (-14)(0.5) + \tfrac{1}{2}(-9.8)(0.5)^2 = \boxed{-8.23\,m}$$

b) At $t = 1.00\,s$, we can either use $t_i, v_i, x_i$ from $t_f, v_f, x_f$ in last problem, or we can continue using $t_i, v_i$ & $x_i$ from the beginning of the problem – we should get the same results. Let's verify:

Using $v_f$, $x_f$ & $t_f$ from last problem as initial values for this problem:

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

$$v_f = (-18.9) + (-9.8)(\underbrace{1.00 - 0.5}_{t_f - t_i})$$

$$\boxed{= -23.8\,m/s}$$

$$\Delta x = x_f - x_i = v_i \Delta t + \tfrac{1}{2}a(\Delta t)^2$$

$$x_f - (-8.23) = (-18.9)(1.00 - 0.5) + \tfrac{1}{2}(-9.8)(1.00 - 0.5)^2$$

$$x_f = \boxed{-18.9\,m}$$

or

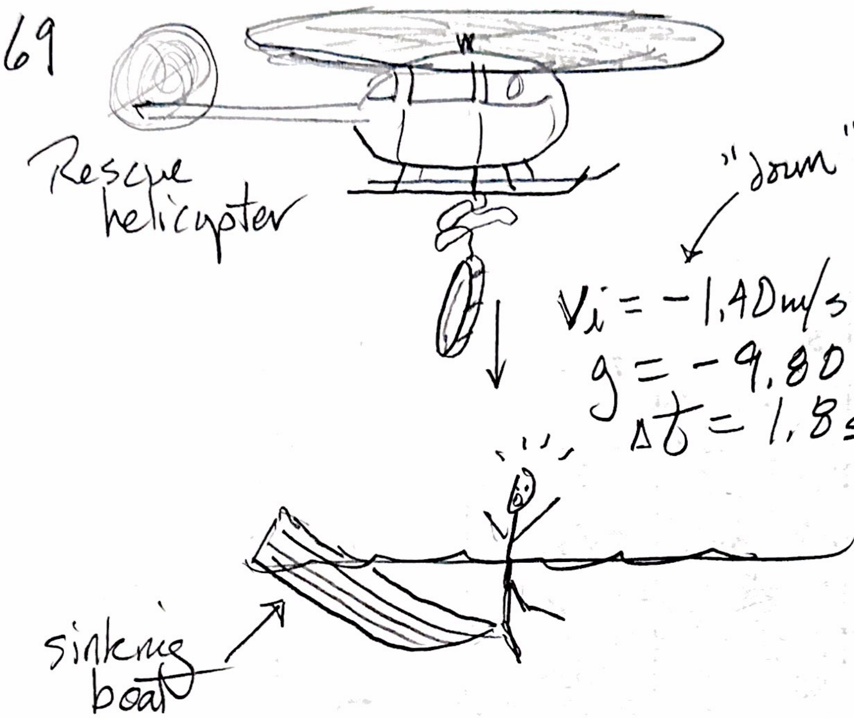
Using $v_f$, $x_f$, $t_f$ from beginning of problem:

$$v_f = v_i + a\Delta t = (-14) + (-9.8)(1.00 - 0) = \boxed{-23.8\,m}$$

$$x_f = x_i + v_i\Delta t + \tfrac{1}{2}a\Delta t^2 = 0 + (-14)(1 - 0) + \tfrac{1}{2}(-9.8)(1 - 0)^2 = \boxed{-18.9\,m}$$

Most people prefer this strategy. Initial conditions often have a 0 (zero), making calculation easier!

3.69




$$\left.\begin{aligned} v_i &= -1.40\,m/s \\ g &= -9.80\,m/s \\ \Delta t &= 1.8\,s \end{aligned}\right\}$$

a) Knowns

b) How high is helicopter?

Unknown = $\Delta y$, so

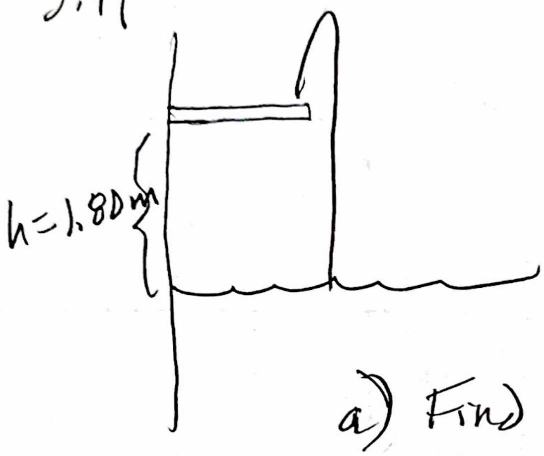
$$\Delta y = v_i t + \frac{1}{2} a t^2$$

$$\Delta y = (-1.40\,m/s)(1.8\,s) + \frac{1}{2}(-9.80\,m/s^2)(1.8\,s)^2$$

$$= \boxed{-18.4\,m}$$

Displacement of life preserver, so helicopter is $\boxed{18.4\,m}$ above water

3.71




$V_i = 4.00$ m/s
$a = -9.80$ m/s$^2$
$y_i = 0$? or $1.80$ m?

Either one will work, as long as you're consistent

a) Find highest point above the board.
Okay, so we're measuring relative to board. Call that position $y=0$, then.

$\Delta y = v_i t + \frac{1}{2}at^2$, or $y_f = y_i + v_i t + \frac{1}{2}at^2$

$y_f = 0 + (4.00\text{ m/s})t + \frac{1}{2}(-9.80)t^2$

I DON'T KNOW $t$!
I could try to find it, but it's probably smarter to get a different formula that matches my knowns & unknowns

$V_f^2 = V_i^2 + 2a\Delta y$
At highest point, $V_f$ vertically $= 0$, so

$0^2 = (4)^2 + 2(-9.80)(y_f - 0)$

$y_f = \boxed{0.82\text{m}}$ above board

b) time in air? $\Delta y = v_i t + \frac{1}{2}at^2$

$-1.80\text{m} = 4t + \frac{1}{2}(-9.8)t^2$

Quadratic expression, with solutions $t = \{-0.32, 1.14\}$
Choose the positive time, so $t = \boxed{1.14\text{s}}$

c) velocity when hitting water?
$V_f^2 = V_i^2 + 2a\Delta y$, so $V_f = \sqrt{4^2 + 2(-9.8)(-1.8)} = \boxed{-7.16\text{ m/s}}$
Choose negative root b/c she's moving down

3.78

Acceleration $a(t) = pt^2 - qt^3$, where $p$ & $q$ are positive constants.

$x_i = 0$ & $v = 0$.

a) $v(t) = ?$

Velocity is the anti-derivative of acceleration, so $v(t) = \int a \cdot dt$

$$v = \int pt^2 - qt^3 \cdot dt$$

$$v = \frac{1}{3}pt^3 - \frac{1}{4}t^4 + C$$

This constant represents the initial value of $v$, which they said was 0, so

$$v = \boxed{\frac{1}{3}pt^3 - \frac{1}{4}t^4}$$

b) $x(t) = \int v \cdot dt$, so...

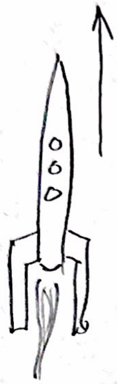
$$= \int \frac{1}{3}pt^3 - \frac{1}{4}t^4 \cdot dt$$

$$x = \frac{1}{12}pt^4 - \frac{1}{20}t^5 + C$$

Again, this constant represents initial position $x_i$, which they said was 0, so

$$x = \boxed{\frac{1}{12}pt^4 - \frac{1}{20}t^5}$$

3.79



$a = A - Bt^{1/2}$ during time interval $t=0$ to $t_0$, so

$$\Delta t = t_f - t_i = t_0 - 0 = \underline{t_0}.$$

a) If x is in meters & t is in seconds, units of A & B are...?

<u>A needs to be in $m/s^2$</u>, the usual units of accel. $Bt^{1/2}$ also needs to be $m/s^2$. Because $t^{1/2}$ is seconds$^{1/2}$, or $\sqrt{s}$, <u>B should have</u> $\underline{\frac{m}{s^2} \cdot \frac{1}{\sqrt{s}}}$ for units, or $\boxed{m \cdot s^{-5/2} = m/s^{5/2}}$

b) How does velocity vary if rocket starts from rest?

$$V = \int a \cdot dt = \int_0^{t_0} A - Bt^{1/2} \cdot dt$$

$$= At - \frac{2}{3}Bt^{3/2} \Big|_0^{t_0}$$

$$V = \boxed{At_0 - \frac{2}{3}Bt_0^{3/2}}$$

c) How does x vary as a function of time?

$$x = \int_0^{t_0} v \cdot dt = \int_0^{t_0} At_0 - \frac{2}{3}Bt_0^{3/2} \cdot dt$$

$$x = \frac{1}{2}At^2 - \frac{4}{15}Bt^{5/2} \Big|_0^{t_0}$$

$$\boxed{= \frac{1}{2}At_0^2 - \frac{4}{15}Bt_0^{5/2}}$$