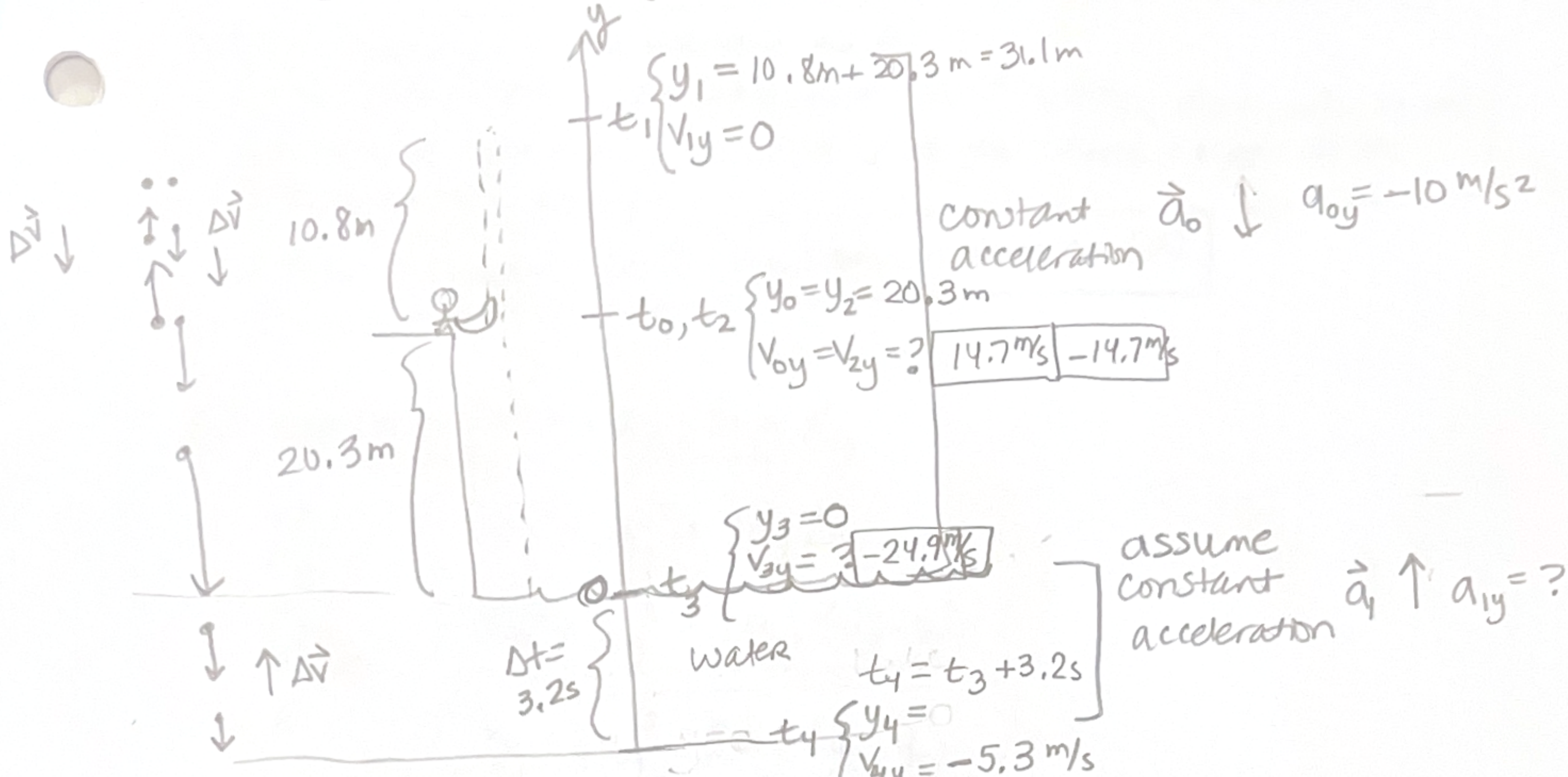
Activity 4 (Analyzing Free Fall Motion)



object model: point particle

(a) t_0 to t_1, Find V_{0y}:

Δy ✓
V_{iy} ?
V_{fy} ✓
a_y ✓
Δt

no Δt: $V_{fy}^2 = V_{iy}^2 + 2a_y\Delta y$

$$V_{1y}^2 = V_{0y}^2 + 2a_{0y}\Delta y$$

$$V_{0y}^2 = V_{1y}^2 - 2a_{0y}\Delta y$$

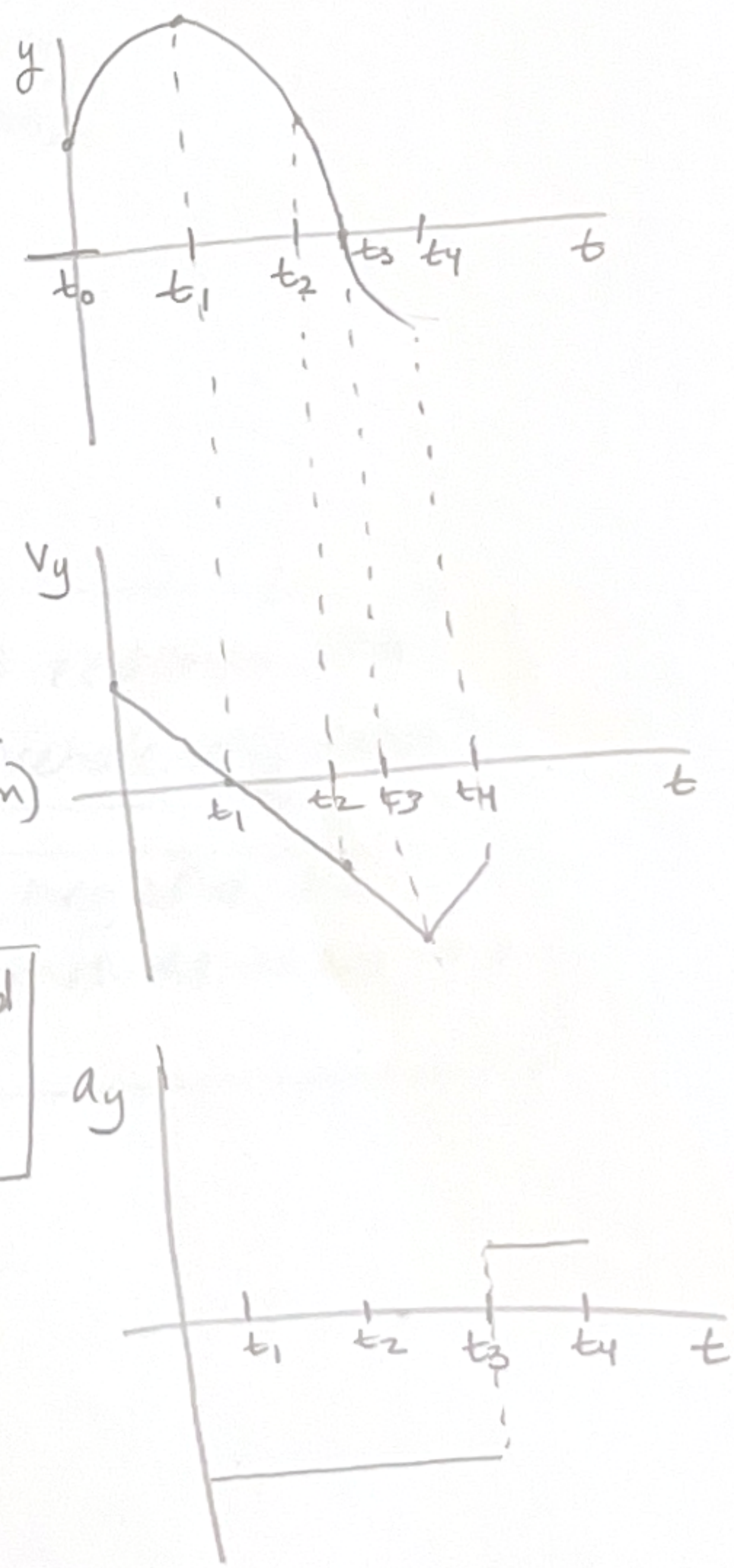
$$V_{0y} = \sqrt{V_{1y}^2 - 2a_{0y}(y_1 - y_0)}$$

$$= \sqrt{0 - 2(-10\ m/s^2)(31.1m - 20.3m)}$$

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

The banana began its upward flight with a velocity of (14.7 m/s, vertically up).

This is reasonable because it has correct units and the order of magnitude makes sense for a thrown banana



Analyzing Free Fall Motion, Activity 4, continued

(b) The velocity of the banana as it passes the cliff on the way down is (14.7 m/s, vertically down) based on symmetry, since it is at the same height as its toss at this instant.

This is reasonable for the same reason as (a).

(c) use $t=0$ to $t=t_3$, find V_{3y}

Δy ✓
V_{iy} ✓
V_{fy}
a_y ✓
Δt

$$V_{fy}^2 = V_{iy}^2 + 2a_y \Delta y$$

$$V_{3y}^2 = V_{0y}^2 + 2a_{0y}(y_3 - y_0)$$

$$V_{3y} = \sqrt{V_{0y}^2 + 2a_{0y}(y_3 - y_0)}$$

$$V_{3y} = \sqrt{(14.7\,m/s)^2 + 2(-10\,m/s^2)(0 - 20.3m)}$$

$$V_{3y} = \sqrt{216.09\frac{m^2}{s^2} + 406\frac{m^2}{s^2}}$$

$$V_{3y} = \pm 24.9\,m/s$$

choose $V_{3y} = -24.9\,m/s$

The velocity of the banana when it reaches the surface of the water is (24.9 m/s, vertically down).

This is reasonable because it is negative, has correct units, and is greater in magnitude than the toss speed.

Analyzing Free Fall Motion, Activity 4, continued

d) Find acceleration in water, using t_3 to t_4

$\Delta y =$
$V_{iy} = ✓$
$V_{fy} = ✓$
$a_y = ?$
$\Delta t = ✓$

$$V_{fy} = V_{iy} + a_y \Delta t$$

$$V_{4y} = V_{3y} + a_{1y} \Delta t$$

$$a_{1y} = \frac{V_{4y} - V_{3y}}{\Delta t}$$

$$a_{1y} = \frac{-5.3 \, m/s - (-24.9 \, m/s)}{3.2s}$$

$$a_{1y} = \frac{-5.3 \, m/s + 24.9 \, m/s}{3.2s}$$

$$a_{1y} = \boxed{6.1 \, m/s^2}$$

The banana has an acceleration of (6.1 m/s², vertically up) while in the water.

This is reasonable because the units are correct, and it had about 3s to change velocity from about −25 m/s to −5 m/s, so it should change around +6 m/s each second. It also matches the $\vec{a}$ vector on my sketch.