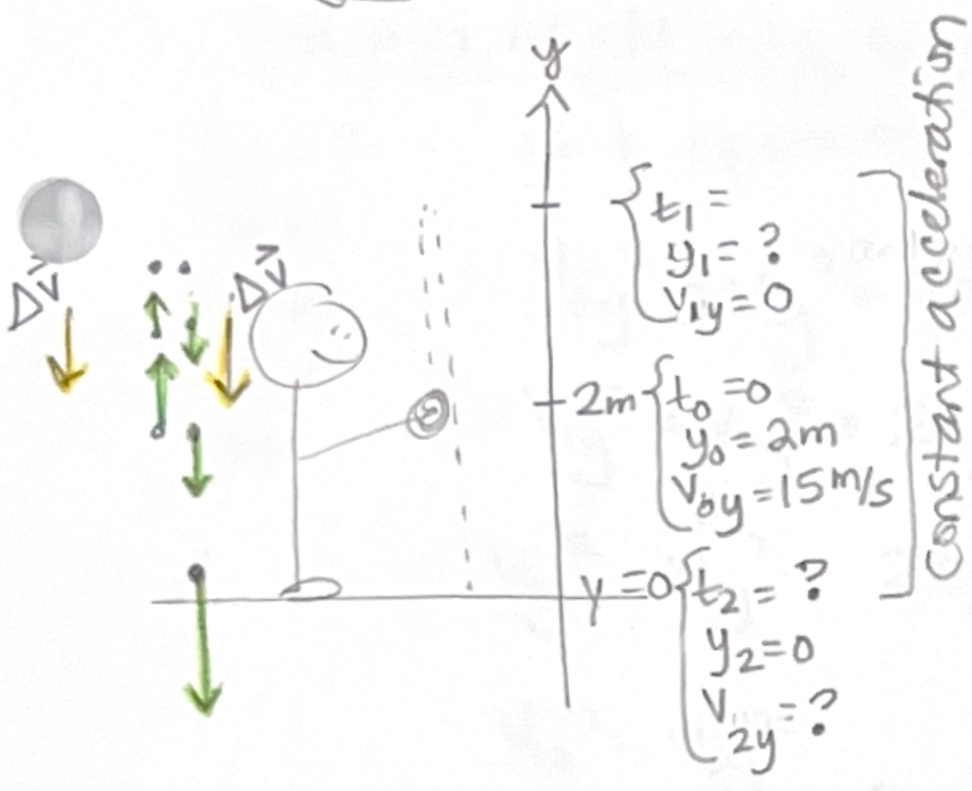
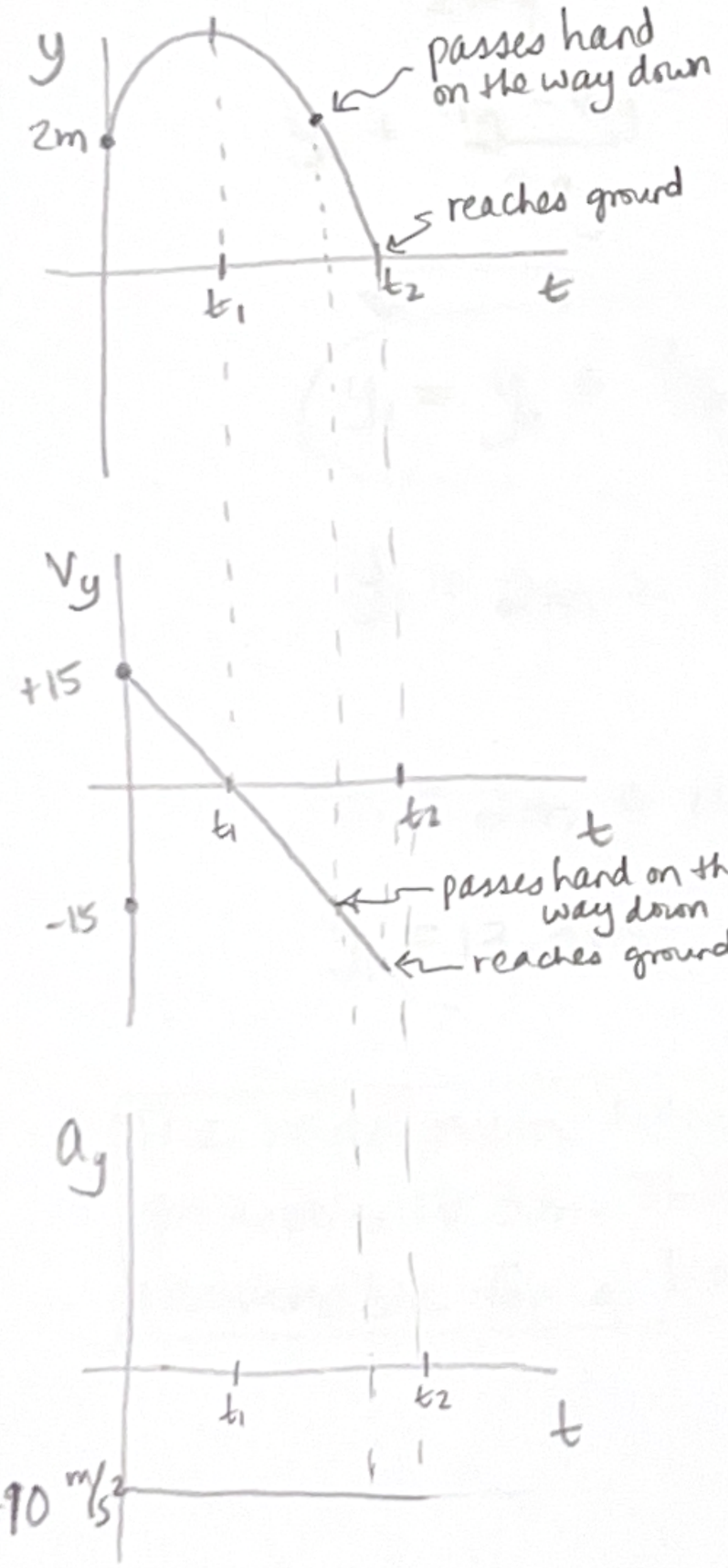
Activity 3 (p. 60 #21)



object model: point particle



a. t_0 to t_2. Find t_2

Δy ✓
v_{iy} ✓
v_{fy} ?
a_y ✓
Δt = ?

use no v_{fy} equation

$$y_f = y_i + v_{iy}\Delta t + \frac{1}{2} a_y \Delta t^2$$

$$y_2 = y_0 + v_{0y}\Delta t + \frac{1}{2} a_y \Delta t^2$$

Would need quadratic formula to solve for Δt. Avoid the quadratic formula.

Instead, Find v_{fy} first

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

$$v_{2y}^2 = v_{0y}^2 + 2a_y(y_2 - y_0)$$

$$v_{2y}^2 = (15\ m/s)^2 + 2(-10\ m/s^2)(0 - 2m)$$

$$v_{2y}^2 = 225\ \frac{m^2}{s^2} + 40\ \frac{m^2}{s^2}$$

$$v_{2y}^2 = 265\ \frac{m^2}{s^2}$$

$$v_{2y} = \pm 16.3\ \frac{m}{s}$$

I choose the negative answer, $v_{2y} = -16.3\ m/s$

Now find Δt

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

$$v_{2y} = v_{0y} + a_y\Delta t$$

$$\Delta t = \frac{v_{2y} - v_{0y}}{a_y}$$

$$\Delta t = \frac{-16.3\ m/s - 15\ m/s}{-10\ m/s^2} = 3.13\ s$$

The time in the air is 3.1 s. This is a reasonable time for a tossed ball

b. Find max height using t_0 to t_1

Δy =?
v_{iy} ✓
v_{fy} ✓
a_y ✓
Δt

no t equation

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

$$v_{1y}^2 = v_{0y}^2 + 2a_y(y_1 - y_0)$$

$$v_{1y}^2 - v_{0y}^2 = 2a_y(y_1 - y_0)$$

$$\frac{v_{1y}^2 - v_{0y}^2}{2a_y} = y_1 - y_0$$

$$y_0 + \frac{v_{1y}^2 - v_{0y}^2}{2a_y} = y_1$$

$$y_1 = y_0 + \frac{v_{1y}^2 - v_{0y}^2}{2a_y}$$

$$y_1 = 2m + \frac{(0)^2 - (15\,m/s)^2}{2(-10\,m/s^2)}$$

$$y_1 = 2m + 11.3m$$

$$y_1 = 13.3m$$

The maximum height above ground is 13.3 m. This is reasonable for a ball toss.

c. velocity at ground using t_0 to t_2

OH! I already found this in (a).

The velocity of the ball at impact is (16.3 m/s, down). This is reasonable because it is greater speed than the upward toss, as it should be since it fell below the toss point on the way down.