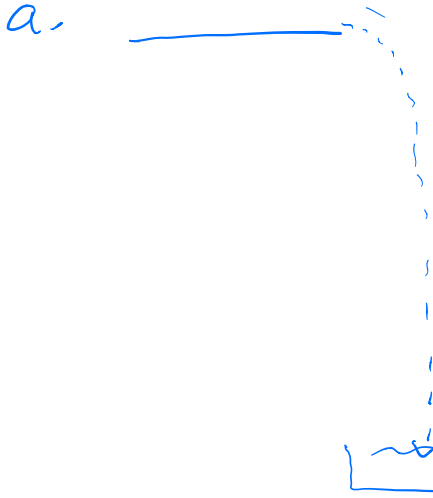
2–67 Visitors at an amusement park watch divers step off a platform 21.3 m (70 ft) above a pool of water. According to the announcer, the divers enter the water at a speed of 56 mi/h (25 m/s). Air resistance may be ignored. a) Is the announcer correct in this claim? b) Is it possible for a diver to leap directly upward off the board so that, missing the board on the way down, she enters the water at 25.0 m/s? If so, what initial upward speed is required? Is the required initial speed physically attainable?

a.



top: $y_i = 21.3\ m$

$v_i = 0$

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

bottom $y_f = 0$

$v_f = ?$

Way #1

$v_f^2 = v_i^2 + 2a(\Delta y)$

$v_f^2 = 0 - 2g(y_f - y_i)$

$v_f^2 = 0 - 2(9.8\ m/s^2)(0m - 21.3m)$

$v_f^2 = 417.48\ m^2/s^2$

$v_f = -\sqrt{v_f^2} = \boxed{-20.4\ m/s}$

(about 46 mph) (pick − sign because diver is going down.)

The claim is wrong!

Way #2: Solve for t and then plug in to the velocity equation.

$$y_f = y_i + \underbrace{v_i}_{0} t - \frac{1}{2} g t^2$$

$$(y_f - y_i) = -\frac{1}{2} g t^2$$

$$\Delta y = -\frac{1}{2} g t^2$$

$$t = \sqrt{-2\Delta y / g}$$

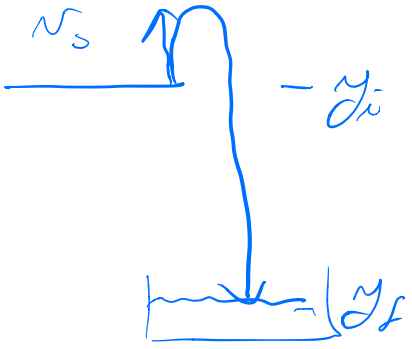
$$t = \sqrt{\frac{-2(0 - 21.3\,m)}{9.8\,m/s^2}} = 2.085\,s$$

Then $v_f = v_i - gt$

$v_f = 0 - (9.8\,m/s^2)(2.085\,s)$

$\boxed{v_f = -20.4\,m/s}$

b. what if you toss up?



still have

$y_i = 21.3\,m \quad y_f = 0$

want $v_f = -25.0\,m/s$

what is v_i ?

$$v_f^2 = v_i^2 + 2a(\Delta y)$$

$$v_f^2 = v_i^2 - 2g(\Delta y)$$

Solve for v_i

$$v_i^2 = v_f^2 + 2g(\Delta y)$$

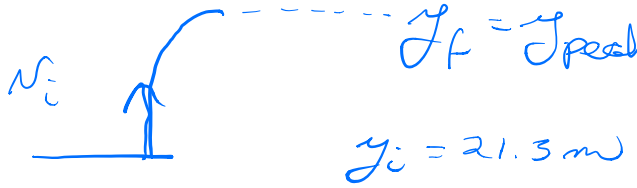
$v_i^2 = (-25.0\,m/s)^2 +$

$2(9.8\,m/s^2)(0\,m - 21.3\,m)$

$v_i^2 = 207.5\,m^2/s^2$

$\boxed{v_i = 14.4\,m/s}$

Bonus: is 14.4 m/s plausible?
If you could jump at 14.4 m/s, how high could you jump?



at peak, $v_f = 0$. What is y_f?

$$v_f^2 = v_i^2 + 2a(\Delta y)$$
$$v_f^2 = v_i^2 - 2g(\Delta y)$$
$$(v_f^2 - v_i^2) = -2g(\Delta y)$$
$$\Delta y = \frac{v_f^2 - v_i^2}{-2g} =$$

$$\Delta y = \frac{(0 - (14.4\ m/s)^2)}{-2(9.8\ m/s^2)} \approx \boxed{10.6\ m}$$

This means you could jump 10.6 m — well over 30 ft! This would easily break the world high jump record, and is completely unrealistic.