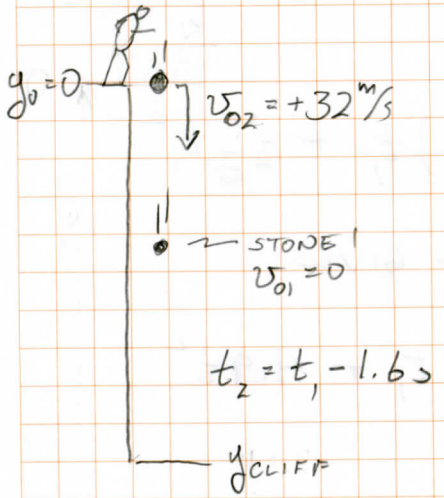
SET 1, PR 2.

A STONE IS THROWN INTO A LAKE AT 32 m/s 1.6 s AFTER ANOTHER IS DROPPED. BOTH HIT AT SAME TIME. HOW HIGH IS THE CLIFF?



SET UP DISTANCE EQUATIONS

STONE 1: $y_c = \cancel{y_{01}^{0}} + \cancel{v_{01}^{0} t_1} + \frac{1}{2} g t_1^2$

$y_c = \frac{1}{2} g t_1^2 \Rightarrow t_1 = \sqrt{\frac{2y_c}{g}}$

STONE 2: $y_c = \cancel{y_{02}^{0}} + v_{02} t_2 + \frac{1}{2} g t_2^2$ $\quad t_1^2 - 2(1.6)t_1 + 2.56$

$y_c = v_{02}(t_1 - 1.6) + \frac{1}{2} g (t_1 - 1.6)^2$

$y_c = v_{02} t_1 - 1.6 v_{02} + \left(\frac{1}{2} g t_1^2 - 1.6 g t_1 + 1.28 g\right)$

EQUATE THESE

$\cancel{\frac{1}{2} g t_1^2} = v_{02} t_1 - 1.6 v_{02} + \cancel{\frac{1}{2} g t_1^2} - 1.6 g t_1 + 1.28 g$

$(v_{02} - 1.6 g) t_1 = 1.6 v_{02} - 1.28 g$

$$t_1 = \frac{1.6 v_{02} - 1.28 g}{v_{02} - 1.6 g} = \frac{(1.6)(32) - (1.28)(9.8)}{(32) - (1.6)(9.8)} = \frac{38.64}{16.32}$$

$t_1 = 2.36$

SUBSTITUTE INTO EQUATION FOR STONE 1

$y_c = \frac{1}{2}(9.8)(2.36)^2$

$$\boxed{y_c = 27.5 \text{ m}}$$

OR SOLVE DIRECTLY FOR y_{CLIFF} → SEE BACK

FROM STONE 1

$$t_1 = \sqrt{\frac{2y_c}{g}} \simeq \sqrt{\frac{2}{9.8}}\sqrt{y_c} = 0.452\sqrt{y_c}$$

FROM STONE 2

$$y_c = 1.28g - 1.6v_{02} + (v_{02} - 1.6g)t_1 + \tfrac{1}{2}gt_1^2$$

FOR $g = 9.8\frac{m}{s^2}$, $v_{02} = 32\frac{m}{s}$ THIS GIVES

$$y_c = (0.452 - 51.2) + (32 - 15.7)t_1 + 4.9t^2$$

$$y_c = -38.7 + 16.3t_1 + 4.9t^2$$

SUBSTITUTE FOR t_1

$$y_c = -38.7 + (16.3)(0.452)\sqrt{y_c} + (4.9)(0.452)^2 y_c$$

$$y_c = -38.7 + 7.37\sqrt{y_c} + y_c$$

$$\sqrt{y_c} = \frac{38.7}{7.37} = 5.25$$

$$\boxed{y_c = 27.5\,m}$$

THIS WAS UGLIER!