Name_____

Physics 110 Quiz #2, April 11, 2025

Please show all work, thoughts and/or reasoning to receive partial credit. The quiz is worth 10 points total.

I affirm that I have carried out my academic endeavors with full academic honesty.

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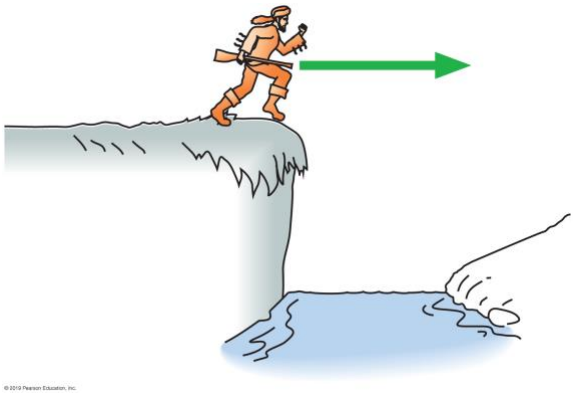
1. In 1780, in what is now referred to as "Brady's Leap," Captain Sam Brady of the US Continental Army escaped certain death from his enemies by running horizontally off the edge of a cliff above Ohio's Cuyahoga River, which is confined at that spot to a gorge. He landed safely on the far side of the river, and it was reported that he leapt $22ft{\sim}7.3m$ across the river while falling $20ft{\sim}6.7m$. How long would it have taken Capt. Brady to fall to the ground on the other side of the riverbank, if he ran horizontally off the cliff?



Taking the origin of the coordinate system at the edge of the cliff with up the positive y-direction and to the right the positive x-direction we have:

$$y_f = y_i + v_{iy}t + \frac{1}{2}a_y t^2 \rightarrow y_f = -\frac{1}{2}gt^2 \rightarrow t = \sqrt{\frac{2y_f}{-g}}$$

$$t = \sqrt{\frac{2(-6.7m)}{-9.8\frac{m}{s^2}}} = 1.17s$$

2. With what horizontal speed would Capt. Brady have needed to leave the left edge of the cliff to land on the riverbank on the right side of the river?

$$x_f = x_i + v_{ix}t + \frac{1}{2}a_x t^2 \rightarrow x_f = v_{ix}t \rightarrow v_{ix} = \frac{x_f}{t} = \frac{7.3m}{1.17s} = 6.24\frac{m}{s}$$

3. What is the vertical component of Capt. Brady's impact velocity with the ground on the right-hand side of the riverbank?

$$v_{fy} = v_{iy} + a_y t \rightarrow v_{fy} = -gt = -9.8\frac{m}{s^2} \times 1.17s = -11.5\frac{m}{s}$$

4. What was Capt. Brady's impact velocity with the ground on the right-hand side of the riverbank?

$$v_f = \sqrt{v_{fx}^2 + v_{fy}^2} = \sqrt{\left(6.24\frac{m}{s}\right)^2 + \left(-11.5\frac{m}{s}\right)^2} = 13.1\frac{m}{s}$$

$\tan\phi = \frac{v_{fy}}{v_{fx}} \rightarrow \phi = \tan^{-1}\left(\frac{v_{fy}}{v_{fx}}\right) = \tan^{-1}\left(\frac{-11.5\frac{m}{s}}{6.24\frac{m}{s}}\right) = -61.5^0$ or 61.5^0 below the horizontal.

5. Capt. Brady would have had to run over some distance, ending at the edge of the cliff, to ensure that he had the speed needed in part 2, to make it across the gorge. Modern measurements show that a human has an average acceleration of $3.51\frac{m}{s^2} \sim 11\frac{ft}{s^2}$. Through what horizontal distance would Capt. Brady have had to run to get to the edge of the cliff with the speed in part 2?

$$v_{fx}^2 = v_{ix}^2 + 2a_x\Delta x \rightarrow \Delta x = \frac{v_{fx}^2}{2a_x} = \frac{\left(6.24\frac{m}{s}\right)^2}{2 \times 3.51\frac{m}{s^2}} = 5.6m$$