Name_____
Physics 110 Quiz #3, April 14, 2023

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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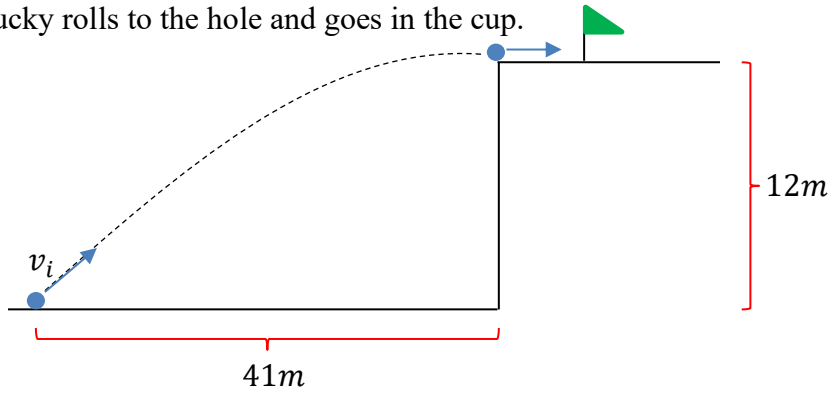
1. The Masters is one of four championship courses in the sport of golf. It is played annually every spring in Augusta, Ga. For the most part, the course is played on reasonably level ground. However, this year the organizers decide to inject a little more fun and challenge into the course. Suppose that the first hole is located on the edge of a cliff $12m$ above the ground. The golfer hits the ball from the ground $41m$ from the edge of the cliff as shown below. The golf ball lands horizontally with a speed $26.6\frac{m}{s}$ at the edge of the cliff and if you're lucky rolls to the hole and goes in the cup.



a. What is the time of flight of the golf ball to the edge of the cliff?

$$x_f = x_i + v_{ix}t + \frac{1}{2}a_x t^2 = v_{ix}t \rightarrow t = \frac{x_f}{v_{ix}} = \frac{41m}{26.6\frac{m}{s}} = 1.54s$$

b. What is the initial vertical velocity v_{iy} of the golf ball after it was hit from the ground?

$$v_{fy} = 0 = v_{iy} + a_y t = v_{iy} - gt \rightarrow v_{iy} = gt = 9.8\frac{m}{s^2} \times 1.54s = 15.1\frac{m}{s}$$

Or,

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

$$v_{iy} = \frac{12m + \frac{1}{2} \times 9.8\frac{m}{s^2} \times (1.54s)^2}{1.54s} = 15.2\frac{m}{s}$$

c. What was the initial launch speed v_i of the golf ball from the ground?

$$v_i = \sqrt{v_{ix}^2 + v_{iy}^2} = \sqrt{\left(26.6\frac{m}{s}\right)^2 + \left(15.1\frac{m}{s}\right)^2} = 30.6\frac{m}{s}$$

d. Suppose that the ball just barely misses the horizontal part of the cliff and impacts the cliff wall instead. After impact with the wall, the ball comes to rest and falls vertically to the ground below. What will be the impact speed of the ball just before it strikes *the ground*?

$$y_f = y_i + v_{iy}t + \frac{1}{2}a_y t^2 = -\frac{1}{2}gt^2 \rightarrow t = \sqrt{\frac{2y_f}{-g}} = \sqrt{\frac{2 \times (-12m)}{9.8\frac{m}{s^2}}} = 1.57s$$

$$v_{fy} = v_{iy} + a_y t = -gt = -9.8\frac{m}{s^2} \times 1.57s = -15.3\frac{m}{s}$$

or

$$v_{fy}^2 = v_{iy}^2 + 2a_y\Delta y \rightarrow v_{fy} = \sqrt{2a_y\Delta y} = \sqrt{2 \times \left(-9.8\frac{m}{s^2}\right) \times (-12m)} = 15.3\frac{m}{s}$$

e. If the golf ball has a mass of $46g$, what force (magnitude and direction) does the ground exert on golf ball to bring it to rest? When the ball strikes the ground, it makes a small divot, $1cm$ deep.

$$v_{fy}^2 = v_{iy}^2 + 2a_y\Delta y \rightarrow a_y = \frac{v_{fy}^2 - v_{iy}^2}{2\Delta y} = \frac{\left(0\frac{m}{s}\right)^2 - \left(-15.3\frac{m}{s}\right)^2}{2 \times (-0.015m - 0m)} = 11705\frac{m}{s^2}$$

$$F_y = F_{ground} - F_W = ma_y \rightarrow F_{ground} = F_W + ma_y = m(g + a_y)$$

$$F_{ground} = 0.046kg \times \left(9.8\frac{m}{s^2} + 11705\frac{m}{s^2}\right) = 539N$$