

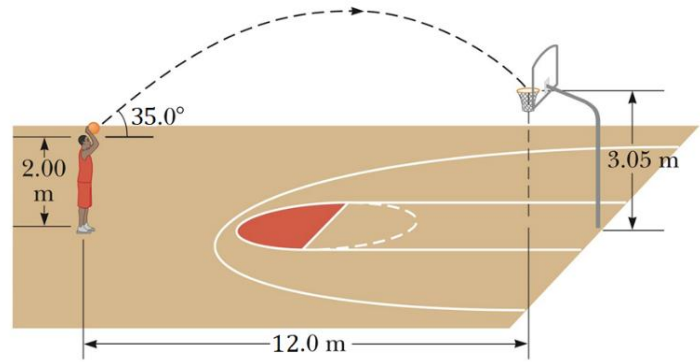
Quiz 1a – Jan. 16, 2020 (5 points)

Name: Solution

St. #: _____

Please answer the question in the space provided.

Show all work. Time limit: **10 minutes.** Return this quiz form to the TA/instructor.



A 2.00 m tall basketball player is standing on the floor exactly 12.0 m from the basket as shown in the figure. The height of the basket is 3.05 m and he shoots the ball at an angle of 35.0° with the horizontal. At what initial speed must the player throw the ball so that it goes directly through the hoop without hitting the backboard?

This is an example of projectile motion so the acceleration in y -direction is $a_y = -9.8 \text{ m/s}^2$ and the acceleration in x is zero. The horizontal component of velocity is $v_{xi} = v_i \cos 35^\circ$. The vertical component is $v_{yi} = v_i \sin 35^\circ$.

The time required for the ball to move 12.0 m is: $t = \Delta x / v_{xi} = \Delta x / (v_i \cos 35^\circ)$.

We apply the kinematic equation in the y -direction and substitute in the heights, the time:

$$y_f = y_i + v_{yi}t + \frac{1}{2}a_yt^2$$

$$y_f = y_i + (v_i \sin 35^\circ) \left(\frac{\Delta x}{v_i \cos 35^\circ} \right) + \frac{1}{2}(a_y) \left(\frac{\Delta x}{v_i \cos 35^\circ} \right)^2$$

$$y_f = y_i + (\cancel{v_i} \sin 35^\circ) \left(\frac{\Delta x}{\cancel{v_i} \cos 35^\circ} \right) + \frac{1}{2}(a_y) \left(\frac{\Delta x}{v_i \cos 35^\circ} \right)^2$$

$$y_f = y_i + \Delta x \tan 35^\circ + \left(\frac{a_y \Delta x}{2 \cos^2 35^\circ} \right) \left(\frac{1}{v_i^2} \right)$$

We can now put in our known values and solve for v_i (suppressing units):

$$3.05 = 2.00 + (12.0) \tan 35^\circ + \left(\frac{(-9.8)(12^2)}{2 \cos^2 35^\circ} \right) \left(\frac{1}{v_i^2} \right)$$

$$-7.352 = -\frac{1051.549}{v_i^2}$$

$$v_i = \sqrt{\frac{1051.549}{7.352}} = 11.96 \frac{\text{m}}{\text{s}}$$

Ver. b: $\Delta x = 14.0 \text{ m}$, $\theta = 45.0^\circ$, $v_i = 12.18 \text{ m/s}$

Ver. c: $\Delta x = 8.0 \text{ m}$, $\theta = 30.0^\circ$, $v_i = 10.82 \text{ m/s}$