

Answer on Question 64822, Physics, Other

Question:

Julie throws a ball to her friend Sarah. The ball leaves Julie's hand a distance 1.5 m above the ground with an initial speed of 17 m/s at an angle 34° ; with respect to the horizontal. Sarah catches the ball 1.5 m above the ground.

- 1) What is the horizontal component of the ball's velocity right before Sarah catches it?
- 2) What is the vertical component of the ball's velocity right before Sarah catches it?
- 3) What is the time the ball is in the air?
- 4) What is the distance between the two girls?

Solution:

1) Let's find the horizontal component (or x -component) of the ball's velocity right before Sarah catches it (as the ball moves from Julie to Sarah, its horizontal component of velocity, v_{ix} , remains constant):

$$v_{ix} = v_i \cos \theta = 17 \frac{\text{m}}{\text{s}} \cdot \cos 34^\circ = 14.1 \frac{\text{m}}{\text{s}}$$

2) Let's find the vertical component (or y -component) of the ball's velocity right before Sarah catches it (as the ball moves from Julie to Sarah, its vertical component of velocity right before Sarah catches it, v_{fy} , will have the same magnitude as at launch, but opposite direction):

$$v_{fy} = -v_{iy} = -v_i \sin \theta = -17 \frac{\text{m}}{\text{s}} \cdot \sin 34^\circ = -9.5 \frac{\text{m}}{\text{s}}$$

The sign minus indicates that the vertical component of the ball's velocity directed downward.

- 3) At the maximum height the ball's velocity equal to zero, so we can write:

$$v_{fy} = v_{iy} + gt_{max},$$

$$0 = v_{iy} + gt_{max}.$$

From this formula we can obtain the time to reach the maximum height:

$$t_{max} = \frac{-v_{iy}}{g} = \frac{-9.5 \frac{m}{s}}{-9.8 \frac{m}{s^2}} = 0.97 \text{ s.}$$

Then, we can find the total time of flight of the ball in the air:

$$t_{flight} = 2t_{max} = 2 \cdot 0.97 \text{ s} = 1.94 \text{ s.}$$

4) Finally, we can find the distance between the two girls:

$$x = v_{ix} t_{flight} = 14.1 \frac{m}{s} \cdot 1.94 \text{ s} = 27.35 \text{ m.}$$

Answer:

$$1) v_{fx} = 14.1 \frac{m}{s}.$$

$$2) v_{fy} = -9.5 \frac{m}{s}.$$

$$3) t_{flight} = 1.94 \text{ s.}$$

$$4) x = 27.35 \text{ m.}$$

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