Answer on Question #61935 - Physics - Mechanics | Relativity

Question:

A football quarterback is moving straight backward at a speed of 1.71 m/s when he throws a pass to a player 21.1 m straight downfield. The ball is thrown at an angle of 40.3° relative to the ground and is caught at the same height as it is released. What is the initial velocity of the ball relative to the quarterback? (Assume downfield to be in the +x-direction. Enter the magnitude in m/s and the direction in degrees counterclockwise from the +x-axis.)

Answer:

We can find speed of a ball:

$$v = \sqrt{\frac{lg}{\sin(2\theta)}} = \sqrt{\frac{21.1 \cdot 9.8}{\sin(2 \cdot 40.3°)}} = 14.477 \frac{m}{sec};$$

Now, using components we can find absolute value of the initial velocity of the ball relative to the quarterback v_B:

$$v_{Qx} = -2 \frac{m}{sec}, v_{Qx} = 0 \frac{m}{sec};$$

$$v_x = v \cos(\theta) = 11.041 \frac{m}{sec}, v_y = v \sin(\theta) = 9.364 \frac{m}{sec};$$

$$v_{Bx} = v_x - v_{Qx} = 13.041 \frac{m}{sec};$$

$$v_{By} = v_y + v_{Qy} = 9.364 \frac{m}{sec};$$

$$v_B = \sqrt{v_{Bx}^2 + v_{By}^2} = 16.055 \frac{m}{sec};$$

Now we will find direction of v_B:

$$\varphi = \arctan\left(\frac{v_{By}}{v_{Bx}}\right) = 35.68°;$$

Initial velocity of the ball relative to the quarterback is $16.055 \frac{m}{sec}$ and the direction is $35.68°$ counterclockwise from the +x-axis.