Answer on Question #49940-Physics-Mechanics-Kinematics-Dynamics

A particle is projected with a speed of 25 m/s at 30° above the horizontal. Find the time taken to reach the highest point of the trajectory.

Find the magnitude and direction of the velocity after 2s.

Solution

The time taken to reach the highest point of the trajectory is the half of time of flight of projectile:

$$t = \frac{1}{2}t_{flight} = \frac{1}{2}\frac{2v_0 \sin\theta}{g} = \frac{v_0 \sin\theta}{g} = \frac{25\frac{\text{m}}{\text{s}}\sin 30°}{10\frac{m}{s^2}} = 1.25s.$$

The horizontal component of the velocity of the object remains unchanged throughout the motion:

$$v_x = v_0 \cos\theta = 25\frac{\text{m}}{\text{s}}\cos 30°.$$

The vertical component of the velocity after 2s is

$$v_y = v_0 \sin\theta - gt = 25\frac{\text{m}}{\text{s}}\sin 30° - 10\frac{m}{s^2}\cdot 2s = -7.5\frac{m}{s}.$$

The magnitude of the velocity after 2s is

$$v = \sqrt{v_x^2 + v_y^2} = \sqrt{\left(25\frac{\text{m}}{\text{s}}\cos 30°\right)^2 + \left(-7.5\frac{m}{s}\right)^2} = 23\frac{m}{s}.$$

The angle above the horizontal is

$$\alpha = \tan^{-1}\left(\frac{v_y}{v_x}\right) = \tan^{-1}\left(\frac{-7.5\frac{m}{s}}{25\frac{\text{m}}{\text{s}}\cos 30°}\right) = -19°.$$

The velocity after 2s is $23\frac{m}{s}$ at 19° below the horizontal.