Answer on Question #65620-Physics-Mechanics | Relativity

2. A body is projected with a velocity of 20 m/s in a direction making an angle 60° with the horizontal. Calculate (i) position after 0.5 seconds and (ii) velocity after 0.5 seconds

Solution

(i)

$$x = v_0 \cos\theta\, t = 20 \cos 60\, (0.5) = 5\, m.$$

$$y = v_0 \sin\theta\, t - \frac{gt^2}{2} = 20 \sin 60\, (0.5) - \frac{9.8}{2}(0.5)^2 = 7.4\, m.$$

(ii)

$$v_x = v_0 \cos\theta = 20 \cos 60 = 10 \frac{m}{s}.$$

$$v_y = v_0 \sin\theta - gt = 20 \sin 60 - (9.8)(0.5) = 12.4 \frac{m}{s}.$$

3. The maximum vertical height of a projectile is 10 m. If the magnitude of the initial velocity is 28 m/s, what is the direction of the initial velocity? (g=9.8 m/s2)

Solution

$$h = \frac{v_0^2}{2g} \sin^2\theta$$

The direction of the initial velocity is

$$\theta = \sin^{-1} \sqrt{\frac{2gh}{v_0^2}} = \sin^{-1} \sqrt{\frac{2(9.8)(10)}{28^2}} = 30°$$

4. A bullet fired from a gun with a velocity of 140 m/s strikes the ground at the same level as the gun at a distance of 1 km. Find the angle of inclination with the horizontal at which the bullet is fired. (g=9.8 m/s2)

Solution

$$d = \frac{v_0^2}{g} \sin 2\theta$$

The angle of inclination with the horizontal is

$$\theta = \frac{1}{2} \sin^{-1} \left(\frac{gd}{v_0^2} \right) = \frac{1}{2} \sin^{-1} \left(\frac{(9.8)(1000)}{140^2} \right) = 15°$$

5. A bullet is fired at an angle of 15° with the horizontal and hits the ground 6 km away. Is it possible to hit a target 10 km away by adjusting the angle of projection assuming the initial speed to be the same?

Solution

$$d = \frac{v_0^2}{g}\sin 2\theta$$

$$\frac{d_1}{d_2} = \frac{\sin 2\theta_1}{\sin 2\theta_2}$$

$$\sin 2\theta_2 = \frac{d_2}{d_1}\sin 2\theta_1 = \frac{10}{6}\sin 2(15) = \frac{5}{6} < 1$$

Yes, it is possible.