Projectiles Example

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6.

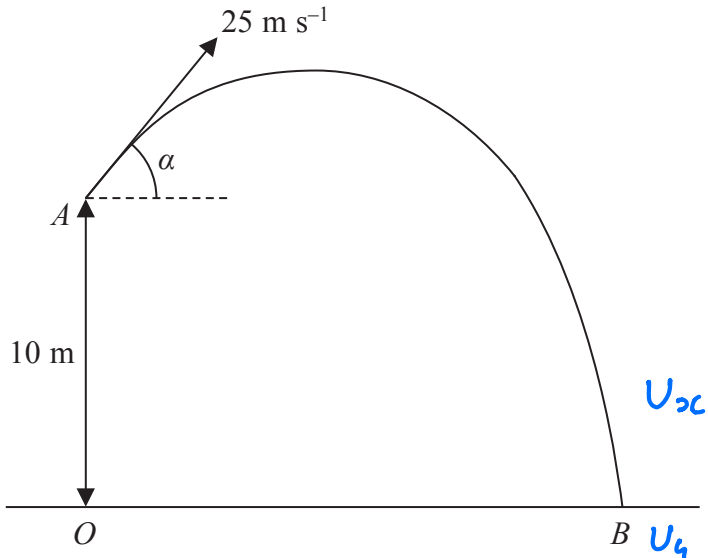

Figure 4

A particle P is projected from a point A with speed 25 m s^{-1} at an angle of elevation α, where $\sin\alpha = \frac{4}{5}$. The point A is 10 m vertically above the point O which is on horizontal ground, as shown in Figure 4. The particle P moves freely under gravity and reaches the ground at the point B.

Calculate

(a) the greatest height above the ground of P, as it moves from A to B,

(3)

(b) the distance OB.

(6)

The point C lies on the path of P. The direction of motion of P at C is perpendicular to the direction of motion of P at A.

(c) Find the time taken by P to move from A to C.

(4)

$\cos\alpha = \frac{3}{5}$

$\tan\alpha = \frac{4}{3}$

$u_x = v_x = 25\cos\alpha = 15 \text{ m s}^{-1}$

$u_y = 25\sin\alpha = 20 \text{ m s}^{-1}$

$v^2 = u^2 + 2a(s - s_0)$

$v_y^2 = u_y^2 - 19.6(s - 10)$

At top $\quad 0 = 20^2 - 19.6y + 196$

$19.6y = 596$

$y = \frac{596}{19.6} = 30.4 \text{ m}$

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Question 6 continued

b) Hits ground when $y = 0$

$s - s_0 = ut + \frac{1}{2}at^2$

$y - 10 = u_y t - 4.9t^2$

At ground $0 - 10 = 20t - 4.9t^2$

$4.9t^2 - 20t - 10 = 0$

By calc $t = 4.532$, ~~-0.450~~

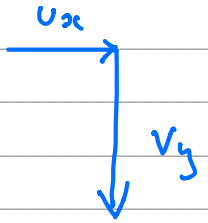
$OB = u_x \times t$

$= 15 \times 4.532$

$= 67.98$ m

≈ 68 m

c) Direction at C has gradient $-\frac{1}{\tan\theta} = -\frac{3}{4}$



$v_y = u_x \times -\frac{3}{4}$

$v_y = 15 \times -\frac{3}{4} = -\frac{45}{4}$

$v = u + at$

$v_y = u_y - 9.8t$

$-\frac{45}{4} = 20 - 9.8t$

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Question 6 continued

$$9.8t = 20 + \frac{45}{4}$$

$$t = \frac{20 + \frac{45}{4}}{9.8}$$

$$t = 3.19 \text{ s}$$