Solutionbank M1

Heinemann Modular Maths for Edexcel AS and A-level

7 Projectiles

Exercise B, Question 17

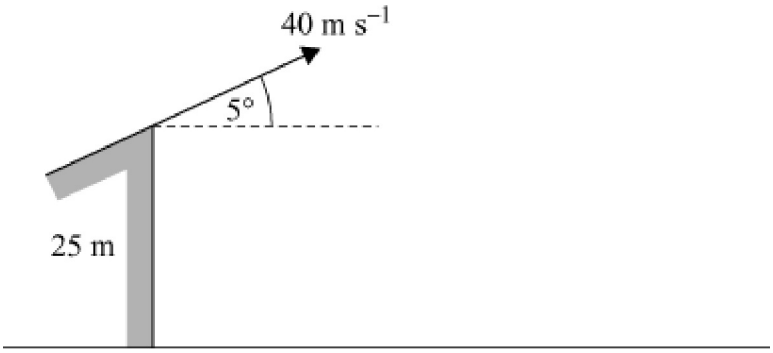
Question:

A stuntman in a film drives a car off the top of a vertical cliff. The top of the cliff is 25 metres above the level of the sea. When it leaves the cliff the car is travelling at 40 m s^{-1} at an angle of 5° above the horizontal. The diagram shows the cliff and the initial velocity of the car.
Model the car as a particle and assume that, while it is in the air, it moves under the influence of gravity alone.

(a) Show that the car hits the sea approximately 2.64 seconds after it leaves the top of the cliff.

(b) Find the horizontal distance of the car from the cliff when the car hits the sea.

(c) Find the speed of the car when it hits the sea. [A]



Solution:

(a) The position of the car, relative to the top of the cliff, is given by

$x = 40 \cos 5° \, t$ [1]

$y = 40 \sin 5° \, t - \frac{1}{2}gt^2$

When the car hits the sea, $y = -25$

$\therefore \; -25 = 40 \sin 5° \, t - \frac{1}{2}gt^2$

$4.9t^2 - 3.486t - 25 = 0$

$t = \frac{3.486 \pm \sqrt{(3.486)^2 + 4 \times 4.9 \times 25}}{2 \times 4.9}$

Time = 2.64 s (positive value only is required)

(b) From [1] $x = 40 \cos 5° \times 2.64$
$= 105.29$

$\therefore$ Distance is 105 m

(c) Using $v = u + at$, vertical speed is $40 \sin 5° - g \times 2.64$
$= -22.39$

Horizontal speed is $40 \cos 5° = 39.848$

$\therefore$ Speed is $\sqrt{22.39^2 + 39.848^2}$
$= 45.7 \text{ m s}^{-1}$.