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8. [*In this question, the unit vectors* **i** *and* **j** *are in a vertical plane, with* **i** *being horizontal and* **j** *being vertically upwards.*]

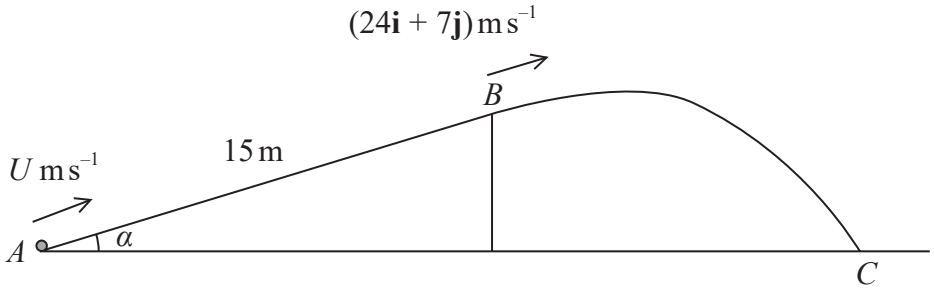


Figure 3

A rough ramp is fixed to horizontal ground.

The ramp is inclined to the ground at an angle α, where $\tan\alpha = \frac{7}{24}$

The point A is at the bottom of the ramp and the point B is at the top of the ramp.
The line AB is a line of greatest slope of the ramp and $AB = 15\,\text{m}$, as shown in Figure 3.

A particle P of mass 0.3 kg is projected with speed $U\,\text{m s}^{-1}$ from A directly towards B.
At the instant P reaches the point B, the velocity of P is $(24\mathbf{i} + 7\mathbf{j})\,\text{m s}^{-1}$
The particle leaves the ramp at B, and moves freely under gravity until it hits the horizontal ground at the point C.

The coefficient of friction between P and the ramp is $\frac{1}{5}$

(a) Find the work done against friction as P moves from A to B.

(3)

(b) Use the work-energy principle to find the value of U.

(4)

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

(3)

At the instant immediately before P hits the ground at C, the particle is moving downwards at $\theta°$ to the horizontal.

(d) Find the value of θ

(4)

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