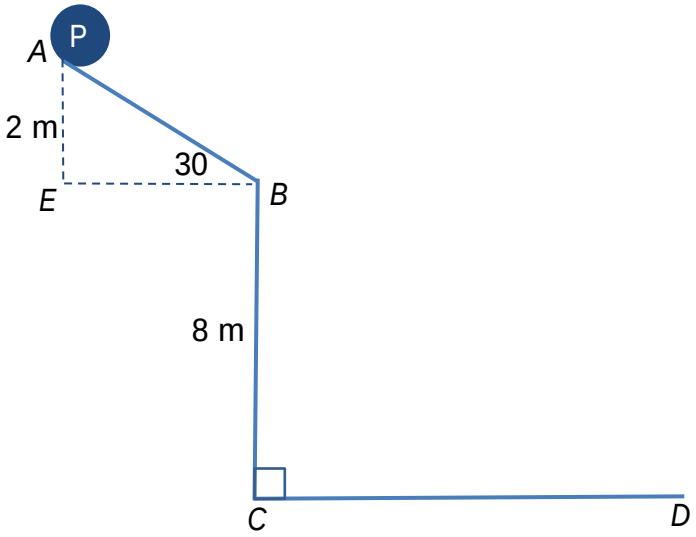
A particle, *P*, of mass 2 kg slides from rest down the rough slope *AB,* which is inclined at 30° to the horizontal. The coefficient of friction between the particle and the slope is $\frac{1}{4}$. The vertical distances *AE* and *BC* are 2 *m* and 8 *m* respectively.



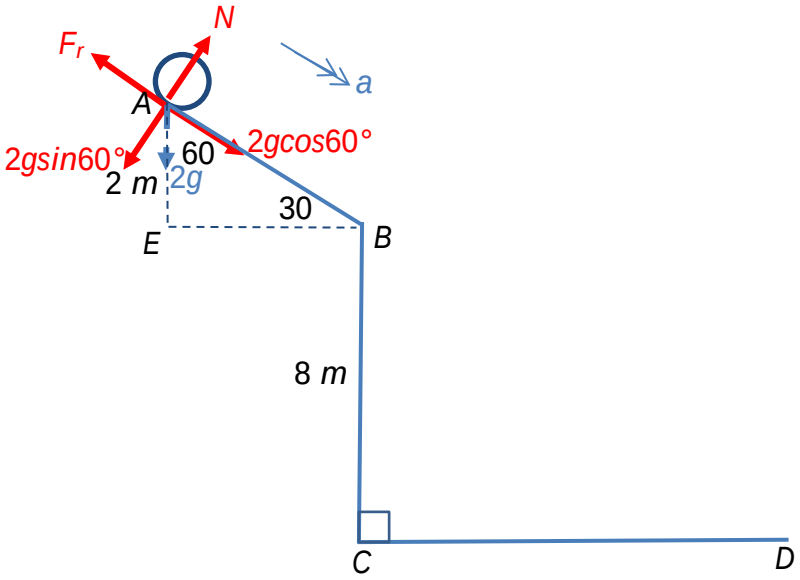
1. Using the acceleration due to gravity as *g* ms^{-2}, find the exact value v, the velocity of the particle at *B*, in terms of *g* and $\sqrt{3}$.

2. Using *g* as 9.8 *ms*$^{-2}$ and the value of v accurate to 2 decimal places, find the horizontal distance *CD*, where D is the point where the particle lands.

Teacher notes

The investigation makes use of trigonometry, components, friction, the equations of motion, Newton's laws of motion and projectile motion.

1. From *A* to *B* down the slope



$$sin30° = \frac{2}{AB}$$

$$AB = \frac{2}{sin30°} = 4\ m$$

$$F_r = \mu N = \frac{1}{4} \times 2gsin60° = \frac{\sqrt{3}g}{4}$$

Using $F = ma$ down the slope

$$2gcos60° - F_r = 2a$$

$$2g \times \frac{1}{2} - \frac{\sqrt{3}g}{4} = 2a$$

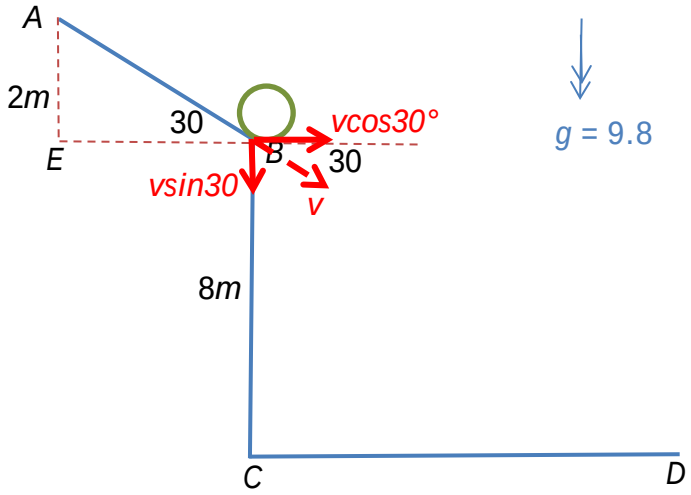
$$a = \frac{g}{8}\left(4 - \sqrt{3}\right) ms^{-2}$$

Using $v^2 = u^2 + 2as$ down the slope

$$v^2 = 0 + 2 \times \frac{g}{8}\left(4 - \sqrt{3}\right) \times 4 = g\left(4 - \sqrt{3}\right)$$

$$\underline{v = \sqrt{g(4 - \sqrt{3})} \approx 4.71\ ms^{-1}}$$

2. From *B* to *D*



Vertically with positive direction down

$s = 8, a = 9.8, u \approx 2.36, t =?$

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

$8 = 2.36t + 4.9t^2$

$4.9t^2 + 2.36t - 8 = 0$

$t \approx 1.06\ secs$

Horizontally there is no acceleration

Using $s = vt$

From part 1, $v \approx 4.71cos30° = 4.08\ ms^{-1}$

$\underline{CD \approx 4.08 \times 1.06 = 4.3253\ m}$