Solutionbank M1

Heinemann Modular Maths for Edexcel AS and A-level

5 Newton's laws of motion

Exercise B, Question 23

Question:

A child is sliding at a constant speed of 4 m s^{-1} down a long slide. The child has a mass of 45 kg. The slide is inclined at an angle of 40° to the horizontal. Assume that a constant friction force, of magnitude 89 N, acts on the child.

(a) Use the data given to explain why air resistance must be taken into account when modelling the motion of the child. Find the magnitude of the air resistance acting on the child, when he is travelling at a constant speed of 4 m s^{-1}.

(b) Assume that the magnitude of the air resistance is proportional to the speed of the child. The next time that he uses the slide he starts from rest and accelerates. Find his acceleration, when he is moving at 1 m s^{-1}. [A]

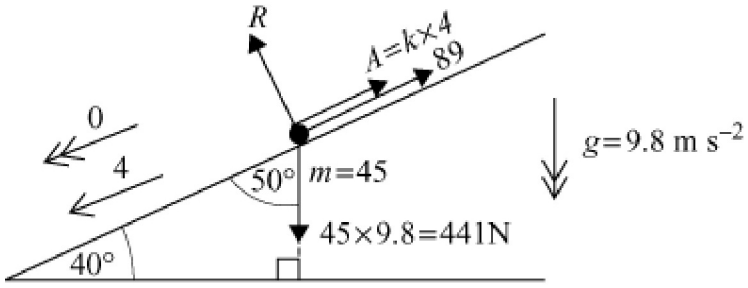
Solution:

(a) The force A is air resistance.
If A is ignored then Resultant force down slide

$= 441 \times \cos 50° - 89$

$= 194.46...$ N

If the child has constant speed then there is no acceleration and Newton's 2nd Law guarantees there should be no resultant force on the child, so there must be air resistance of 194 N to counter the resultant force.



(b) Newton's 2nd Law slide (for the constant motion described in (a).)

$441 \cos 50° - 89 - k \times 4 = 45 \times 0$

$\therefore \frac{441 \cos 50° - 89}{4} = k$

$k = 48.617...$

Newton's 2nd Law down slide

$$441 \cos 50° - 89 - 48.617 \times 1 = 45 \times a$$

$$\therefore \frac{(441 \cos 50° - 89 - 48.617 \times 1)}{45} = a$$

$$a = 3.2411...$$

$$a = 3.24 \text{ m s}^{-2} \text{ (3 s.f.)}$$