

# Solutionbank M1

Heinemann Modular Maths for Edexcel AS and A-level

## 5 Newton's laws of motion

### Exercise A, Question 7

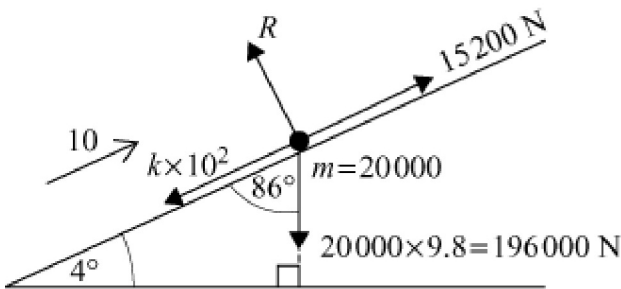
#### Question:

A lorry of mass 20 tonnes can travel up a slope inclined at  $4^\circ$  to the horizontal at a steady speed of  $10 \text{ m s}^{-1}$ , when the force produced by the engine is  $15.2 \text{ kN}$ . Assume that the air resistance is proportional to the square of the speed and ignoring other forms of resistance, find the maximum speed of the lorry when freewheeling down the same hill.

#### Solution:

Newton 1, up slope

$$\begin{aligned}
 15200 - k \times 10^2 - 196000 \cos 86^\circ &= 0 \\
 \therefore 15200 - 196000 \cos 86^\circ &= 100k \\
 \therefore k &= \frac{(15200 - 196000 \cos 86^\circ)}{100} \\
 k &= 15.277\dots
 \end{aligned}$$



Newton 1, down slope

$$\begin{aligned}
 196000 \cos 86^\circ - 15.277v_1^2 &= 0 \\
 \therefore \frac{196000 \cos 86^\circ}{15.277} &= v_1^2 \\
 v_1^2 &= 894.93\dots \\
 \therefore v_1 &= 29.915\dots \\
 v_1 &= 29.9 \text{ m s}^{-1} \text{ (3 s.f.) is maximum speed down the slope.}
 \end{aligned}$$

