

Solutionbank M1

Heinemann Modular Maths for Edexcel AS and A-level

5 Newton's laws of motion

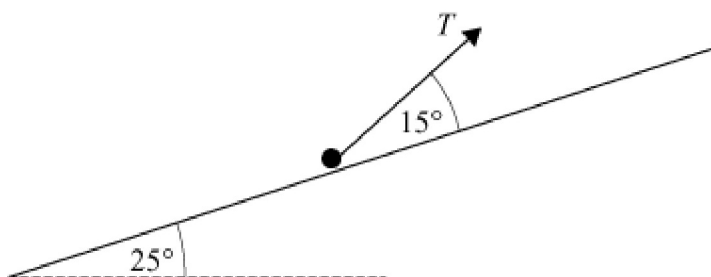
Exercise A, Question 5

Question:

A sledge of mass 16 kg is being pulled up the side of a hill of inclination 25° , at a constant velocity. The coefficient of friction between the sledge and the hill is 0.4, and the rope pulling the sledge exerts a force of magnitude T N at 15° to the hill.

Find:

- the magnitude of the tension in the rope, and
- the magnitude of the normal reaction between the hill and the sledge.



Solution:

- Newton 1 along slope

$$T \cos 15^\circ - F - 156.8 \cos 65^\circ = 0$$

$$F = T \cos 15^\circ - 156.8 \cos 65^\circ$$

- Newton 1 perpendicular to slope

$$R + T \sin 15^\circ - 156.8 \sin 65^\circ = 0$$

$$R = 156.8 \sin 65^\circ - T \sin 15^\circ$$

- Limiting equilibrium

$$F = 0.4 \times R$$

$$T \cos 15^\circ - 156.8 \cos 65^\circ = 0.4 \times [156.8 \sin 65^\circ - T \sin 15^\circ]$$

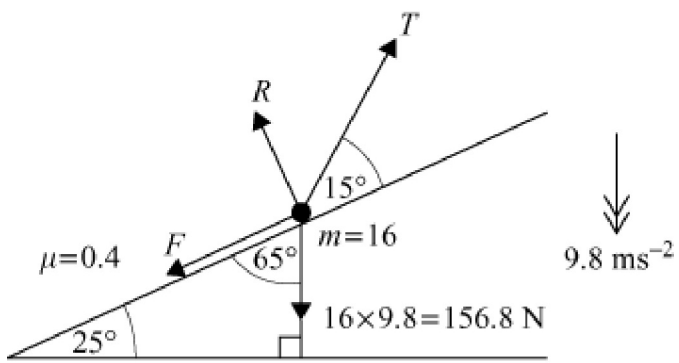
$$\therefore T \cos 15^\circ = 0.4 [156.8 \sin 65^\circ - T \sin 15^\circ] + 156.8 \cos 65^\circ$$

$$\therefore T (\cos 15^\circ + 0.4 \sin 15^\circ) = 0.4 \times 156.8 \sin 65^\circ + 156.8 \cos 65^\circ$$

$$\therefore T = \frac{(0.4 \times 156.8 \sin 65^\circ + 156.8 \cos 65^\circ)}{(\cos 15^\circ + 0.4 \sin 15^\circ)}$$

$$T = 115.11\dots$$

$$T = 115 \text{ N (3 s.f.)}$$



$$\therefore R = 156.8 \times \sin 65^\circ - 115.23 \times \sin 15^\circ$$

$$(b) R = 112.31 \dots$$

$$R = 112 \text{ N (3 s.f.)}$$