

Solutionbank M1

Heinemann Modular Maths for Edexcel AS and A-level

5 Newton's laws of motion

Exercise B, Question 8

Question:

Kate and Joe are playing on a children's slide. The slide is straight and inclined at an angle of 30° to the horizontal, as shown in the diagram. Kate's mass is 25 kg and the coefficient of friction between Kate and the slide is 0.25.

(a) Kate slides down the slide.

(i) Show that the frictional force between her and the slide is approximately 53 N.

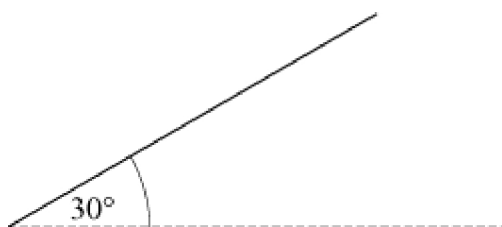
(ii) Find her acceleration.

(b) On one occasion, before Kate slides down, she is held at rest on the slide by Joe. He exerts a force on her which is parallel to the slide.

(i) Find the minimum possible value of this force.

(ii) Joe then releases Kate and she slides down. Find her speed after sliding 5 metres from her release point.

[A]



Solution:

(a) (i) Newton's 2nd Law perpendicular to slide

$$R - 245 \sin 60^\circ = 25 \times 0$$

$$\therefore R = 245 \sin 60^\circ$$

$$R = 212.17... \text{ N}$$

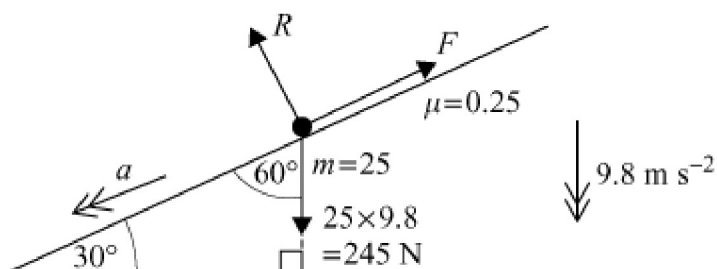
Limiting friction

$$F = 0.25 \times R$$

$$\therefore F = 0.25 \times 212.17$$

$$F = 53.044...$$

i.e. frictional force is approximately 53 N



(ii) Newton's 2nd Law down slide

$$245 \cos 60^\circ - F = 25 \times a$$

$$\therefore \frac{245 \cos 60^\circ - 53.044}{25} = a$$

$$\text{i.e. } a = 2.7782..$$

$$a = 2.78 \text{ m s}^{-2} \text{ (3 s.f.)}$$

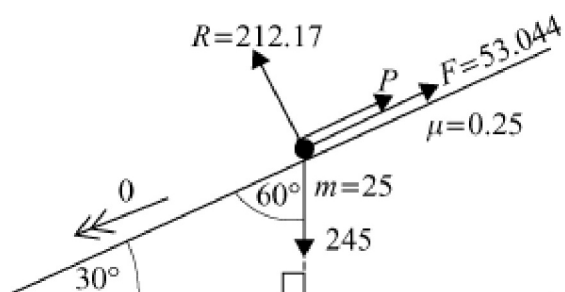
(b) (i) Newton's 2nd Law up slide

$$P + 53.044 - 245 \cos 60^\circ = 25 \times 0$$

$$\therefore P = 245 \cos 60^\circ - 53.044$$

$$P = 69.456$$

$$P = 69.5 \text{ N (3 s.f.)}$$



$$v^2 = u^2 + 2as \text{ down slide}$$

$$v^2 = 0^2 + 2 \times 2.7782 \times 5$$

$$\text{(ii) } v^2 = 27.782$$

$$v = 5.2708..$$

$$v = 5.27 \text{ m s}^{-1} \text{ (3 s.f.)}$$

