

Solutionbank M1

Heinemann Modular Maths for Edexcel AS and A-level

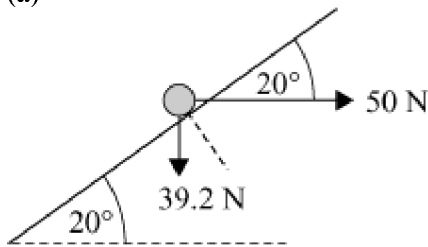
4 Forces

Exercise G, Question 8

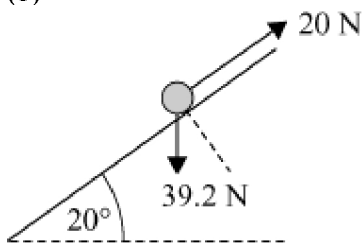
Question:

The situations below show a particle of mass 4 kg at rest on an inclined plane, subject to a given external force. Draw a force diagram showing all the forces acting on the particle. Find the normal reaction, the friction force, and the range of values of the coefficient of friction in each case.

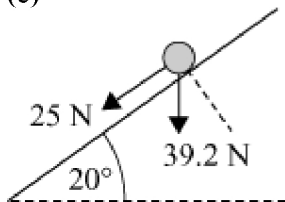
(a)



(b)



(c)



Solution:

(a) Along plane

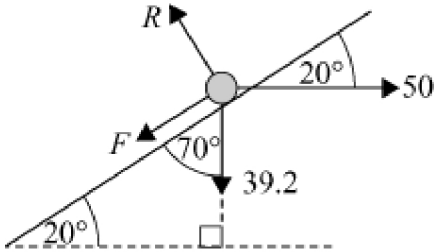
$$\begin{aligned}
 F + 39.2 \cos 70^\circ &= 50 \cos 20^\circ \\
 \therefore F &= 50 \cos 20^\circ - 39.2 \cos 70^\circ \\
 F &= 33.6 \text{ N (3 s.f.)}
 \end{aligned}$$

Perpendicular to plane

$$\begin{aligned}
 R &= 39.2 \sin 70^\circ + 50 \sin 20^\circ \\
 R &= 53.9 \text{ N (3 s.f.)}
 \end{aligned}$$

Equilibrium if

$$\begin{aligned}
 F &\leq \mu R \\
 50 \cos 20^\circ - 39.2 \cos 70^\circ &\leq \mu (39.2 \sin 70^\circ + 50 \sin 20^\circ) \\
 \frac{50 \cos 20^\circ - 39.2 \cos 70^\circ}{39.2 \sin 70^\circ + 50 \sin 20^\circ} &\leq \mu \\
 \text{i.e. } \mu &\geq 0.62253.. \\
 \text{i.e. } \mu &\geq 0.623 \text{ (3 s.f.)}
 \end{aligned}$$



(b) Along plane

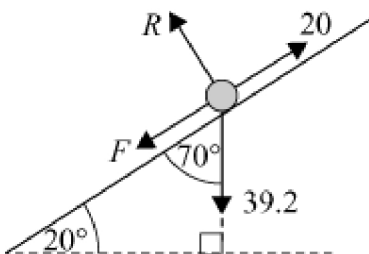
$$\begin{aligned}
 F + 39.2 \cos 70^\circ &= 20 \\
 \therefore F &= 20 - 39.2 \cos 70^\circ \\
 F &= 6.59 \text{ N (3 s.f.)}
 \end{aligned}$$

Perpendicular to plane

$$\begin{aligned}
 R &= 39.2 \sin 70^\circ \\
 R &= 36.8 \text{ N (3 s.f.)}
 \end{aligned}$$

Equilibrium if

$$\begin{aligned}
 F &\leq \mu R \\
 20 - 39.2 \cos 70^\circ &\leq \mu \times 39.2 \sin 70^\circ \\
 \frac{20 - 39.2 \cos 70^\circ}{39.2 \sin 70^\circ} &\leq \mu \\
 \mu &\geq 0.17897.. \\
 \mu &\geq 0.179 \text{ (3 s.f.)}
 \end{aligned}$$



(c) Along plane

$$\begin{aligned}
 F &= 25 + 39.2 \cos 70^\circ \\
 F &= 38.4 \text{ N (3 s.f.)}
 \end{aligned}$$

Perpendicular to plane

$$R = 39.2 \sin 70^\circ$$

$$R = 36.8 \text{ N (3 s.f.)}$$

Equilibrium if

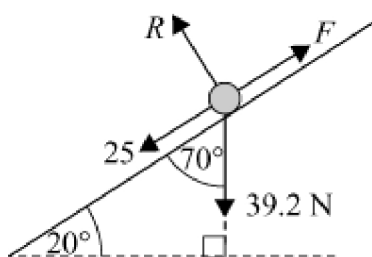
$$F \leq \mu R$$

$$25 + 39.2 \cos 70^\circ \leq \mu \times 39.2 \sin 70^\circ$$

$$\frac{25 + 39.2 \cos 70^\circ}{39.2 \sin 70^\circ} \leq \mu$$

$$\mu \geq 1.0426..$$

$$\mu \geq 1.04 \text{ (3 s.f.)}$$



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