

Solutionbank M1

Heinemann Modular Maths for Edexcel AS and A-level

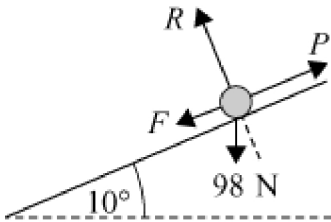
4 Forces

Exercise G, Question 3

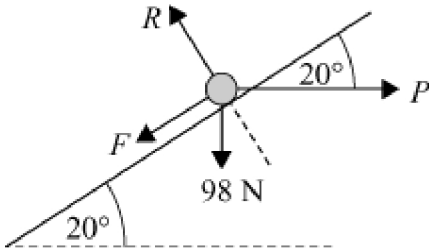
Question:

The situations below show a particle of mass 10 kg at rest on a rough inclined plane, where the coefficient of friction is 0.1. Find the magnitude, P , of the force applied to the particle, if it is on the point of moving up the plane.

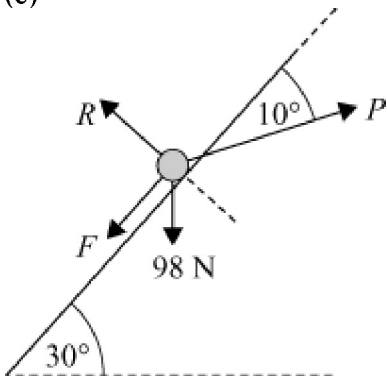
(a)



(b)



(c)



Solution:

(a) Resolving along plane

$$P = F + 98 \cos 80^\circ$$

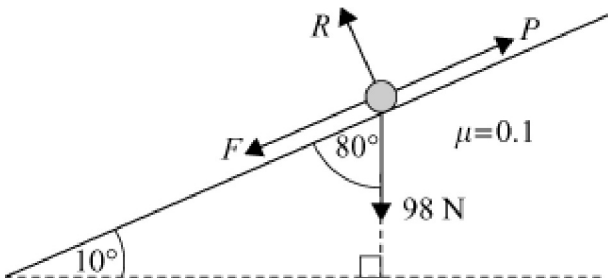
$$\therefore F = P - 98 \cos 80^\circ$$

Resolving perpendicular to plane

$$R = 98 \sin 80^\circ$$

Limiting equilibrium

$$\begin{aligned}
 F &= 0.1 \times R \\
 \therefore P - 98 \cos 80^\circ &= 0.1 \times 98 \sin 80^\circ \\
 \therefore P &= 98 \cos 80^\circ + 0.1 \times 98 \sin 80^\circ \\
 P &= 26.668\dots \\
 P &= 26.7 \text{ N (3 s.f.)}
 \end{aligned}$$



(b) Resolving along plane

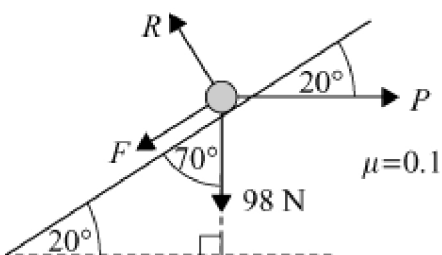
$$\begin{aligned}
 F + 98 \cos 70^\circ &= P \cos 20^\circ \\
 \therefore F &= P \cos 20^\circ - 98 \cos 70^\circ
 \end{aligned}$$

Resolving perpendicular to plane

$$R = P \sin 20^\circ + 98 \sin 70^\circ$$

Limiting equilibrium

$$\begin{aligned}
 F &= 0.1 \times R \\
 \therefore P \cos 20^\circ - 98 \cos 70^\circ &= 0.1 (P \sin 20^\circ + 98 \sin 70^\circ) \\
 \therefore P (\cos 20^\circ - 0.1 \times \sin 20^\circ) &= 0.1 \times 98 \sin 70^\circ + 98 \cos 70^\circ \\
 \therefore P &= \frac{ (0.1 \times 98 \sin 70^\circ + 98 \cos 70^\circ) }{ (\cos 20^\circ - 0.1 \times \sin 20^\circ) } \\
 P &= 47.186\dots \\
 P &= 47.2 \text{ N (3 s.f.)}
 \end{aligned}$$



(c) Resolving along plane

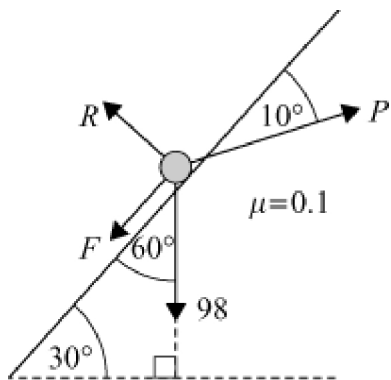
$$\begin{aligned}
 F + 98 \cos 60^\circ &= P \cos 10^\circ \\
 \therefore F &= P \cos 10^\circ - 98 \cos 60^\circ
 \end{aligned}$$

Resolving perpendicular to plane

$$R = 98 \sin 60^\circ + P \sin 10^\circ$$

Limiting equilibrium

$$\begin{aligned}
 F &= 0.1 \times R \\
 P \cos 10^\circ - 98 \cos 60^\circ &= 0.1 (98 \sin 60^\circ + P \sin 10^\circ) \\
 \therefore P (\cos 10^\circ - 0.1 \times \sin 10^\circ) &= 0.1 \times 98 \sin 60^\circ + 98 \cos 60^\circ \\
 P &= \frac{ (0.1 \times 98 \sin 60^\circ + 98 \cos 60^\circ) }{ (\cos 10^\circ - 0.1 \times \sin 10^\circ) } \\
 P &= 59.421.. \\
 P &= 59.4 \text{ N (3 s.f.)}
 \end{aligned}$$



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