Solutionbank M1

Heinemann Modular Maths for Edexcel AS and A-level

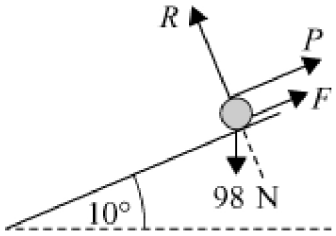
4 Forces

Exercise G, Question 2

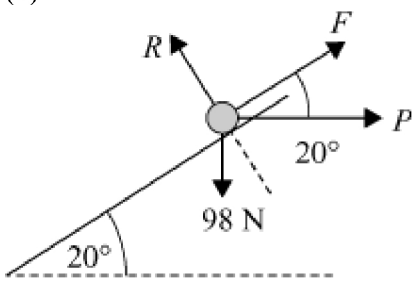
Question:

The situations below show a particle of mass 10 kg at rest on an inclined plane, where the coefficient of friction is 0.1. Find the magnitude, P, of the applied force, if the particle is on the point of sliding down the plane.

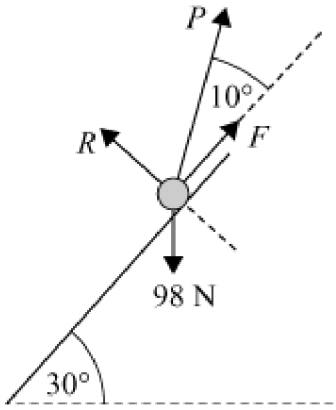
(a)



(b)



(c)



Solution:

(a) Resolving perpendicular to plane
$R = 98 \times \sin 80°$
Resolving along the plane

$$P + F = 98 \times \cos 80°$$
$$\therefore F = 98 \cos 80° - P$$

Limiting equilibrium

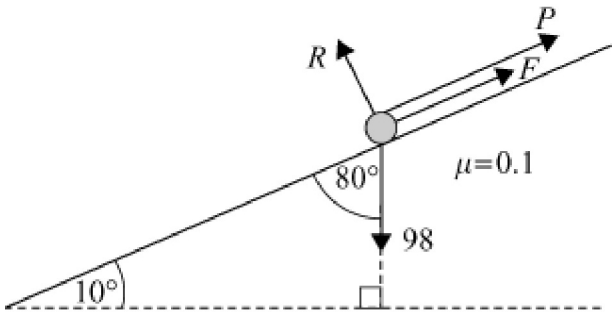
F $= 0.1 \times R$

$98 \cos 80° - P$ $= 0.1 \times 98 \times \sin 80°$

$\therefore 98 \cos 80° - 0.1 \times 98 \times \sin 80°$ $= P$

P $= 7.3664$

P $= 7.37$ N (3 s.f.)



(b) Resolving perpendicular to plane

$R = 98 \sin 70° + P \sin 20°$

Resolving along the plane

$F + P \cos 20° = 98 \cos 70°$

$\therefore F = 98 \cos 70° - P \cos 20°$

Limiting equilibrium

F $= 0.1 \times R$

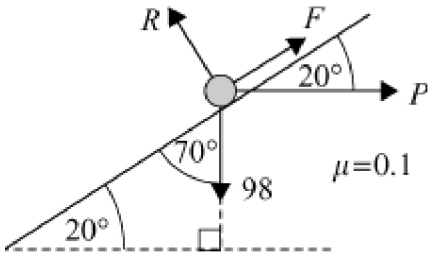
$\therefore 98 \cos 70° - P \cos 20°$ $= 0.1 (98 \sin 70° + P \sin 20°)$

$\therefore 98 \cos 70° - 0.1 \times 98 \sin 70°$ $= P (\cos 20° + 0.1 \sin 20°)$

$\therefore \dfrac{98 \cos 70° - 0.1 \times 98 \sin 70°}{\cos 20° + 0.1 \times \sin 20°}$ $= P$

P $= 24.960....$

P $= 25.0$ N (3 s.f.)



(c) Resolving along the plane

$F + P \cos 10° - 98 \cos 60° = 0$

$\therefore F = 98 \cos 60° - P \cos 10°$

Resolving perpendicular to the plane

$R + P \sin 10° = 98 \sin 60°$

$\therefore R = 98 \sin 60° - P \sin 10°$

Limiting equilibrium

$F = 0.1 \times R$

$\therefore 98 \cos 60° - P \cos 10° = 0.1 (98 \sin 60° - P \sin 10°)$

$\therefore 98 \cos 60° - 0.1 \times 98 \sin 60° = P [\cos 10° - 0.1 \times \sin 10°]$

$\therefore \frac{(98 \cos 60° - 0.1 \times 98 \sin 60°)}{(\cos 10° - 0.1 \times \sin 10°)} = P$

$\therefore P = 41.876....$

$\therefore P = 41.9$ N (3 s.f.)