Solutionbank M1

Heinemann Modular Maths for Edexcel AS and A-level

4 Forces

Exercise G, Question 5

Question:

A particle of mass 6 kg is at rest on a rough plane of inclination α to the horizontal. Find the greatest horizontal force that can be applied to the particle if it is to remain in equilibrium, in each of the following cases:

(a) $\alpha = 20°$, $\mu = 0.1$

(b) $\alpha = 30°$, $\mu = 0.9$

(c) $\alpha = 50°$, $\mu = 0.7$.

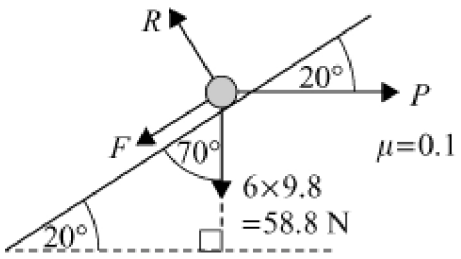
Solution:

(a) Resolving along plane

$$F + 58.8 \cos 70° = P \cos 20°$$
$$\therefore F = P \cos 20° - 58.8 \cos 70°$$

Resolving perpendicular to plane
$R = P \sin 20° + 58.8 \sin 70°$
Limiting equilibrium

$$F = 0.1 \times R$$
$$\therefore P \cos 20° - 58.8 \cos 70° = 0.1 (P \sin 20° + 58.8 \sin 70°)$$
$$\therefore P (\cos 20° - 0.1 \sin 20°) = 0.1 \times 58.8 \sin 70° + 58.8 \cos 70°$$
$$P = \frac{(0.1 \times 58.8 \sin 70° + 58.8 \cos 70°)}{(\cos 20° - 0.1 \sin 20°)}$$
$$P = 28.311...$$
$$P = 28.3 \text{ N (3 s.f.)}$$



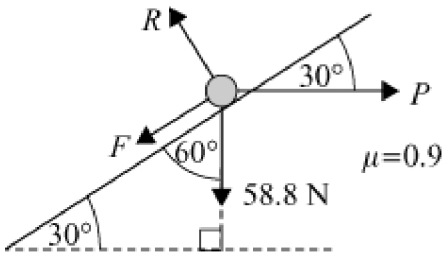
(b) Resolving along plane

$$F + 58.8 \cos 60° = P \cos 30°$$
$$\therefore F = P \cos 30° - 58.8 \cos 60°$$

Resolving perpendicular to plane

$R = P \sin 30° + 58.8 \sin 60°$
Limiting equilibrium

$$F = 0.9 \times R$$
$$\therefore P \cos 30° - 58.8 \cos 60° = 0.9 (P \sin 30° + 58.8 \sin 60°)$$
$$\therefore P (\cos 30° - 0.9 \sin 30°) = 58.8 \sin 60° \times 0.9 + 58.8 \cos 60°$$
$$\therefore P = \frac{(58.8 \sin 60° \times 0.9 + 58.8 \cos 60°)}{(\cos 30° - 0.9 \sin 30°)}$$
$$P = 180.83...$$
i.e. $P = 181$ N (3 s.f.)

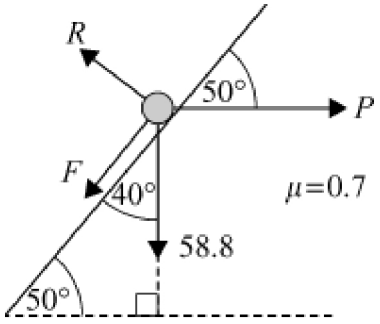


(c) Resolving along plane

$$F + 58.8 \cos 40° = P \cos 50°$$
$$\therefore F = P \cos 50° - 58.8 \cos 40°$$

Resolving perpendicular to plane
$R = P \sin 50° + 58.8 \sin 40°$
Limiting equilibrium

$$F = 0.7 \times R$$
$$\therefore P \cos 50° - 58.8 \cos 40° = 0.7 (P \sin 50° + 58.8 \sin 40°)$$
$$\therefore P (\cos 50° - 0.7 \sin 50°) = 0.7 \times 58.8 \sin 40° + 58.8 \cos 40°$$
$$\therefore P = \frac{0.7 \times 58.8 \sin 40° + 58.8 \cos 40°}{\cos 50° - 0.7 \sin 50°}$$
$$P = 671.01...$$
$$P = 671 \text{ N (3 s.f.)}$$



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