Solutionbank M1

Heinemann Modular Maths for Edexcel AS and A-level

4 Forces

Exercise G, Question 6

Question:

A particle, of mass 12 kg, is at rest on a rough plane, inclined at an angle α to the horizontal. Find the least force, which is parallel to the plane, that must 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) $\alpha = 30°$, $\mu = 0.5$

(c) $\alpha = 50°$, $\mu = 1.0$.

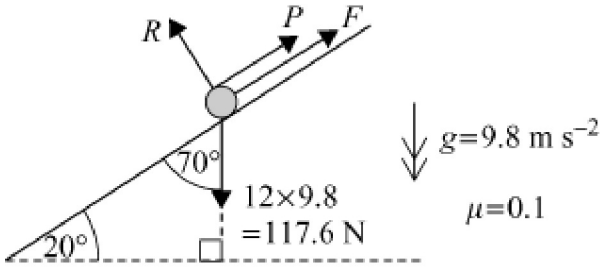
Solution:

(a) Resolving along plane

$$F + P = 117.6 \cos 70°$$
$$F = 117.6 \cos 70° - P$$

Resolving perpendicular to plane
$R = 117.6 \sin 70°$
Limiting equilibrium

$$F = 0.1 \times R$$
$$\therefore 117.6 \cos 70° - P = 0.1 \times 117.6 \sin 70°$$
$$\therefore 117.6 \ (\cos 70° - 0.1 \sin 70°) = P$$
$$\therefore P = 29.170...$$
$$P = 29.2 \text{ N (3 s.f.)}$$



(b) Along plane

$$F + P = 117.6 \cos 60°$$
$$F = 117.6 \cos 60° - P$$

Perpendicular to plane
$R = 117.6 \sin 60°$
Limiting equilibrium

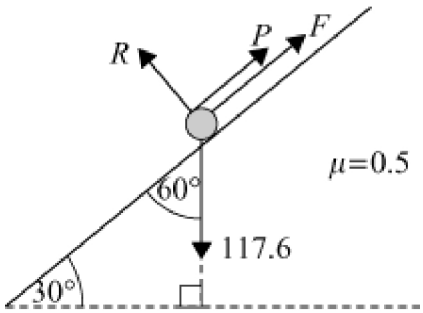
$F = 0.5 \times R$

$\therefore 117.6 \cos 60° - P = 0.5 \times 117.6 \sin 60°$

$\therefore 117.6 (\cos 60° - 0.5 \sin 60°) = P$

$\therefore P = 7.8777...$

$P = 7.88$ N (3 s.f.)



(c) Along plane

$F + P = 117.6 \cos 40°$

$F = 117.72 \cos 40° - P$

Perpendicular to plane

$R = 117.6 \sin 40°$

Limiting equilibrium

$F = 1.0 \times R$

$\therefore 117.6 \cos 40° - P = 1.0 \times 117.6 \sin 40°$

$\therefore 117.6 (\cos 40° - 1.0 \sin 40°) = P$

$P = 14.495...$

$P = 14.5$ N (3 s.f.)