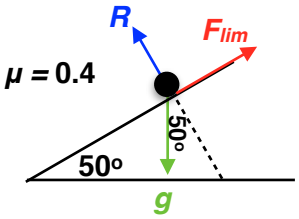
Further Equilibrium Problems

Starter

1. **(Review of last lesson)** A block of mass 1 kg is sliding down a rough plane of length 2 m, which is inclined at an angle of 50^o to the horizontal. The coefficient of friction is 0.4. If the block is released from the rest at the top of the plane, find how long it will take to reach the bottom of the plane.



Working:

$R(\perp)$: $\quad R = g\cos 50$

$F_{lim} = \mu R$: $\quad F_{lim} = 0.4g\cos 50$

$F = ma(//)$: $\quad g\sin 50 - F_{lim} = a$

$g\sin 50 - 0.4g\cos 50 = a$

$a = 4.988$

$u = 0, a = 4.988, s = 2, t = ?$

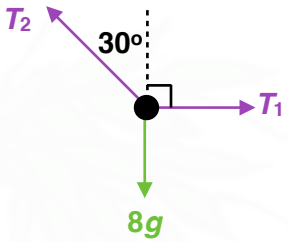
No v $\Rightarrow$ $s = ut + \frac{1}{2}at^2$: $\quad 2 = 0 + \frac{1}{2}\times 4.988 \times t^2$

$t^2 = \frac{4}{4.988}$

$t = 0.896$ s

It will take 0.896 s to reach the bottom of the plane.

E.g. 1 A body of mass 8 kg held in equilibrium by two light inextensible strings. One string is horizontal and the other string makes an angle of 30^o with the vertical. Find the tension in each string.



Working:

$R(\uparrow)$: $\quad T_2\cos 30 = 8g$

$T_2 \times \frac{\sqrt{3}}{2} = 8g$

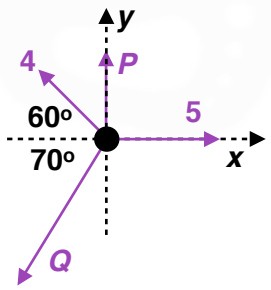
$T_2 = \frac{16g}{\sqrt{3}} = \frac{16g\sqrt{3}}{3} = 90.5$ N (3 s.f.)

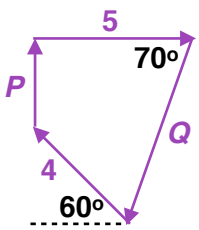
$R(\rightarrow)$: $\quad T_1 = T_2\sin 30$

$T_1 = 45.3$ N (3 s.f.)

The tensions the strings are 90.5 N and 45.3 N (both to 3 s.f.).

E.g. 2 The diagram shows all the forces acting on a particle. Given that the particle is in equilibrium, find the magnitudes of the forces P and Q.





Working:

$R(\rightarrow)$: $\quad Q\cos 70 + 4\cos 60 = 5$

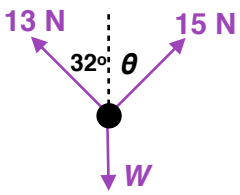
$Q\cos 70 = 5 - 4\cos 60$

$Q = 8.77$ N (3 s.f.)

$R(\uparrow)$: $\quad P + 4\sin 60 = Q\sin 20$

$P = 4.78$ N (3 s.f.)

E.g. 3 The diagram shows a particle suspended from two light inextensible strings. The particle is in equilibrium. Find the weight of the particle, W, and the angle θ.



Working:

$R(\rightarrow)$: $15\sin\theta = 13\sin 32$

$\theta = 27.3^{\circ}$ (3 s.f.)

$R(\uparrow)$: $W = 13\cos 32 + 15\cos 27.3$

$W = 24.3$ N

Video: Equilibrium (3 forces acting)

Solutions to Starter and E.g.s

Exercise

p494 21D Qu 1i, 2-6