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.

Notes

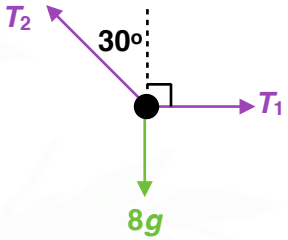
An object is in ***equilibrium*** if and only if the sum of the forces in any direction is zero.

Triangle or polygon of forces — when the forces expressed as vectors of an object in equilibrium are placed top to tail, they form a closed polygon.

Triangle of forces — when 3 forces acting on a particle are in equilibrium you can ***either resolve in perpendicular directions*** (e.g. horizontal and vertical) ***or create a triangle*** and use sine/cosine rule to find sides and angles.

N.B. Where 2 angles are needed to be calculated, use the triangle of forces to solve the problem.

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:

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

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

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

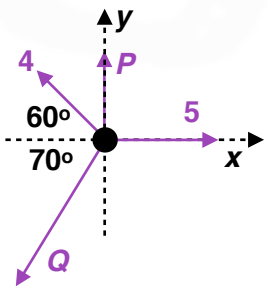
$R(\rightarrow)$: $T_1 = T_2 \sin 30$

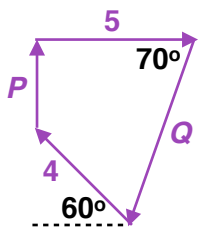
$T_1 = 45.3$ N (3 s.f.)

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

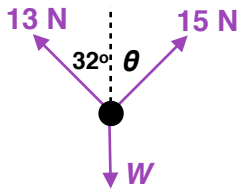
Polygon of forces — if there are 2 or more than 3 forces, they form a closed polygon but you will need to resolve in perpendicular directions to find the resultant.

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.





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.



Video: Equilibrium (3 forces acting)

Solutions to Starter and E.g.s

Exercise
p494 21D Qu 1i, 2-6

Summary
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Triangle of forces — when 3 forces acting on a particle are in equilibrium you can ***either resolve in perpendicular directions*** (e.g. horizontal and vertical) ***or create a triangle*** and use sine/cosine rule to find sides and angles.

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