Lesson 6

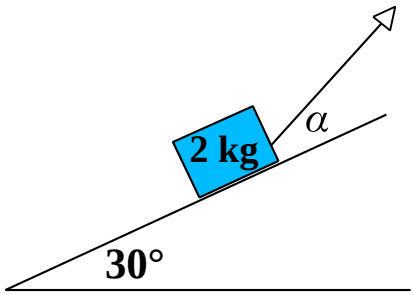
A-Level Applied Mathematics
Mechanics : Statics : Year 2

6.1 Awkward Angle Push and Pull

These are the 'worst case' type of Statics questions likely to be examined.

6.2 Example

M1 Exam question, 13th May 2013, Q3

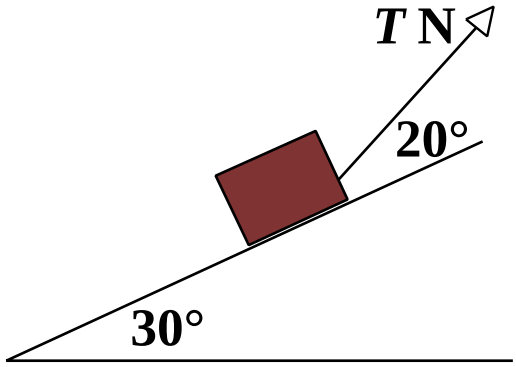


A box of mass 2 kg is held in equilibrium on a fixed rough inclined plane by a rope.
The rope lies in a vertical plane containing a line of greatest slope of the inclined plane.
The rope is inclined to the plane at an angle α, where $\tan \alpha = \frac{3}{4}$.
The plane is at an angle of 30° to the horizontal, as shown.
The coefficient of friction between the box and the inclined plane is $\frac{1}{3}$.
The box is on the point of slipping up the plane.
By modelling the box as a particle and the rope as a light inextensible string, find the tension in the rope.

[8 marks]

6.3 Exercise

Question 1



A box of mass 1.5 kg is placed on a plane which is inclined at an angle of 30° to the horizontal. The coefficient of friction between the box and plane is $\frac{1}{3}$

The box is kept in equilibrium by a light string which lies in a vertical plane containing a line of greatest slope of the plane.
The string makes an angle of 20° with the plane, as shown.
The box is in limiting equilibrium and is about to move up the plane.
The tension in the string is T newtons.
The box is modelled as a particle.

(i) Draw a good sized, clear diagram to show all of the significant forces that act on the box. Any forces that are not either perpendicular or parallel to the plane should be resolved into component parts which are.

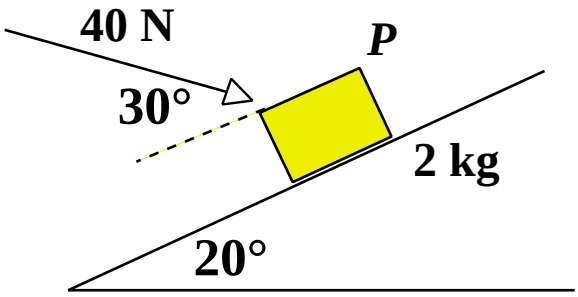
[4 marks]

(ii) Find the value of T

[10 marks]

Question 2

A-Level Examination Question from June 2016, M1, Q5



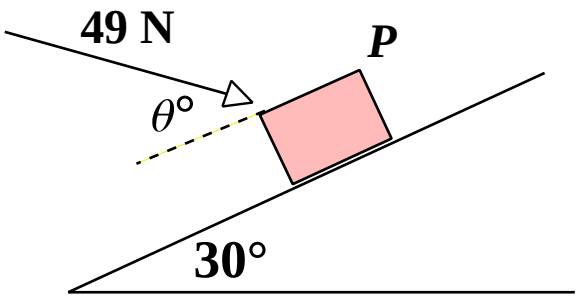
A particle *P* of mass 2 kg is held at rest in equilibrium on a rough plane by a constant force of magnitude 40 N.
The direction of the force is inclined to the plane at an angle of 30°.
The plane is inclined to the horizontal at an angle of 20°, as shown.
The line of action of the force lies in the vertical plane containing *P* and a line of greatest slope of the plane.
The coefficient of friction between *P* and the plane is μ.

Given that *P* is on the point of sliding up the plane, find the value of μ

[10 marks]

Question 3

A-Level Examination Question from January 2008, M1, Q4



A particle *P* of mass 6 kg lies on the surface of a smooth plane. The plane is inclined at an angle of 30° to the horizontal. The particle is held in equilibrium by a force of magnitude 49 N, acting at an angle θ to the plane, as shown.
The force acts in a vertical plane through a line of greatest slope of the plane.

(a) Show that $\cos\theta = \frac{3}{5}$

[3 marks]

(b) Find the normal reaction between *P* and the plane

[4 marks]

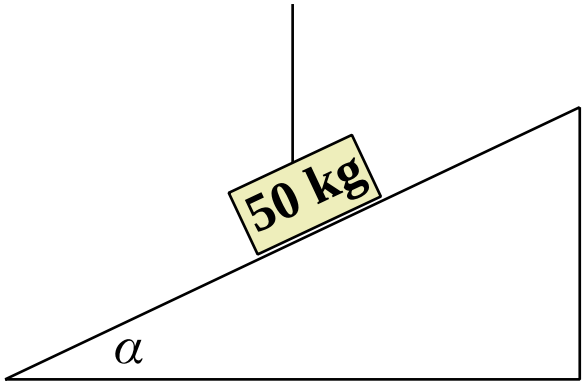
The direction of the force of magnitude 49 N is now changed.
It is applied horizontally to *P* so that *P* moves up the plane.
The force again acts in a vertical lane through a line of greatest slope of the plane.

(c) Find the initial acceleration of *P*

[4 marks]

Question 4

A-Level Examination Question from January 2015, M1, Q2



A block of mass 50 kg lies on a rough plane which is inclined to the horizontal at an angle α, where $tan\ \alpha = \frac{7}{24}$. The block is held at rest by a vertical rope, as shown, and is on the point of sliding down the plane. The block is modelled as a particle and the rope is modelled as a light inextensible string. Given that the friction force acting on the block has magnitude 65.8 N, find

(a) the tension in the rope

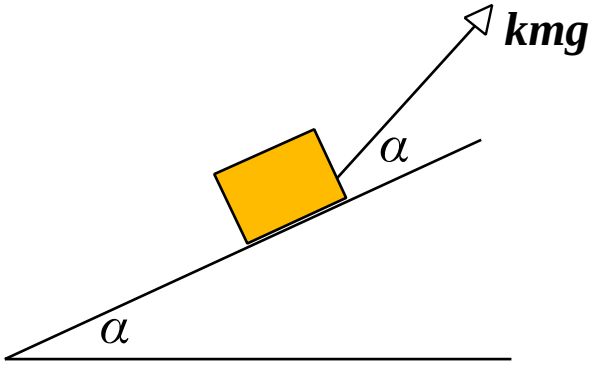
[4 marks]

(b) the coefficient of friction between the block and the plane

[4 marks]

Question 5

A-Level Examination Question from January 2014, M1, Q4



A fixed rough plane is inclined to the horizontal at an angle α, where $\tan\alpha = \frac{3}{4}$

A small box of mass m is at rest on the plane. A force of magnitude kmg, where k is a constant, is applied to the box. The line of action of the force is at angle α to the line of greatest slope of the plane through the box, as shown, and lies in the same vertical plane as this line of greatest slope. The coefficient of friction between the box and the plane is μ. The box is on the point of slipping up the plane. By modelling the box as a particle, find k in terms of μ.

[11 marks]