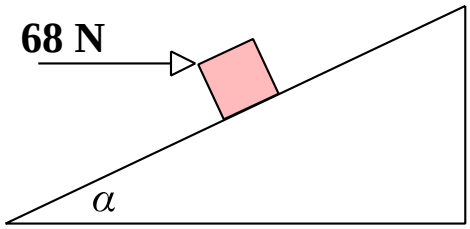
Lesson 4

A-Level Applied Mathematics
Mechanics : Statics : Year 2

4.1 The Horizontal Push



A sledge of mass 8 kg is held at rest in equilibrium on a rough inclined plane (that's covered in snow) by a boy pushing with a horizontal force of magnitude 68 N.

The plane is inclined to the horizontal at an angle α, where $\tan \alpha = \frac{8}{15}$.

The line of action of the force lies in the vertical plane containing the sledge and a line of greatest slope of the plane.

The coefficient of friction between the sledge and the inclined plane is μ.

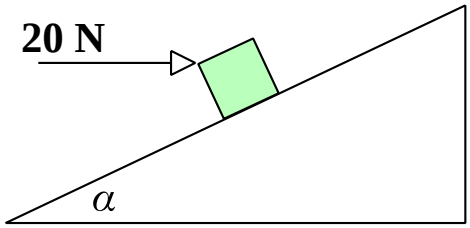
Given that the sledge is on the point of sliding up the plane, find the value of μ.

[9 marks]

4.2 Exercise

Question 1

M1 Exam question, 19th May 2003, Q4

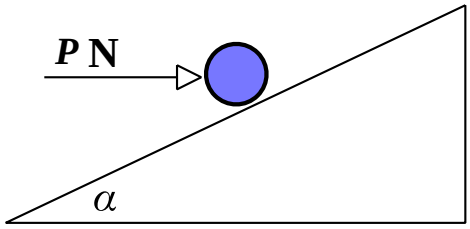


A parcel of mass 5 kg lies on a rough plane inclined at an angle α to the horizontal, where $\tan \alpha = \frac{3}{4}$. The parcel is held in equilibrium by the action of a horizontal force of magnitude 20 N, as shown. The force acts in a vertical plane through a line of greatest slope of the plane. The parcel is on the point of sliding down the plane. Find the coefficient of friction between the parcel and the plane.

[8 marks]

Question 2

M1 Exam question, 24th May 2010, Q7



A particle of mass 0.4 kg is held at rest on a fixed rough plane by a horizontal force of magnitude P newtons. The force acts in the vertical plane containing the line of greatest slope of the inclined plane which passes through the particle.

The plane is inclined to the horizontal at an angle α, where $\tan \alpha = \frac{3}{4}$ as shown.

The coefficient of friction between the particle and the plane is $\frac{1}{3}$.

Given that the particle is on the point of sliding up the plane, find

(a) the magnitude of the normal reaction between the particle and the plane,

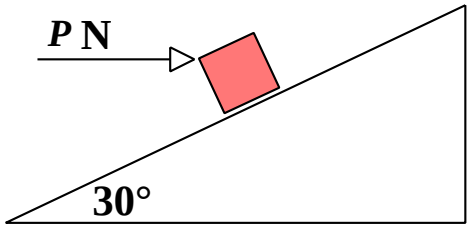
[5 marks]

(b) the value of P

[5 marks]

Question 3

M1 Exam question, 23th May 2002, Q4



A box of mass 6 kg lies on a rough plane inclined at an angle of 30° to the horizontal. The box is held in equilibrium by means of a horizontal force of magnitude *P* newtons, as shown. The line of action of the force is in the same vertical plane as a line of greatest slope of the plane. The coefficient of friction between the box and the plane is 0.4. The box is modelled as a particle

Given that the box is in limiting equilibrium and on the point of moving up the plane, find,

(a) the normal reaction exerted on the box by the plane

[4 marks]

(b) the value of P

[3 marks]

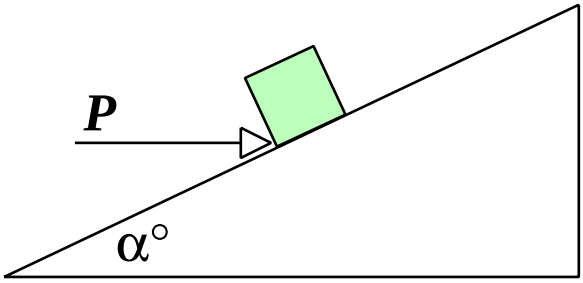
The horizontal force is removed.

(c) Show that the box will now start to move down the plane

[5 marks]

Question 4

This is an examination question from June 1997



A box of mass m is placed on a plane, which is inclined at an angle α to the horizontal, where $\tan \alpha = \frac{3}{4}$. The plane is rough and the coefficient of friction between the box and the plane is $\frac{1}{2}$. The box is kept in equilibrium on the plane by applying a horizontal force of magnitude P to it, acting in a vertical plane containing a line of greatest slope of the plane, as shown. Given that P has the smallest possible value which will enable the box to remain in equilibrium,

(a) draw a diagram, showing all the forces acting on the box, and indicating clearly the direction in which they act.

(b) find P in terms of m and g.

If instead P were to have the largest value which would enable the box to stay in equilibrium on the plane,

(c) state how the diagram of forces acting on the box should, if at all, be changed.

[12 marks]