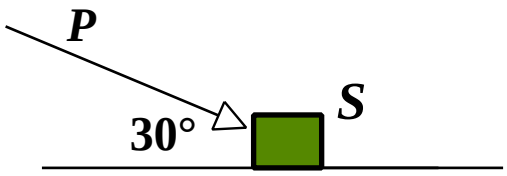
Lesson 5

A-Level Applied Mathematics
Mechanics : Statics : Year 2

5.1 Practice (Homework)

Question 1
M1 past exam question, 4th November 2003, Q3

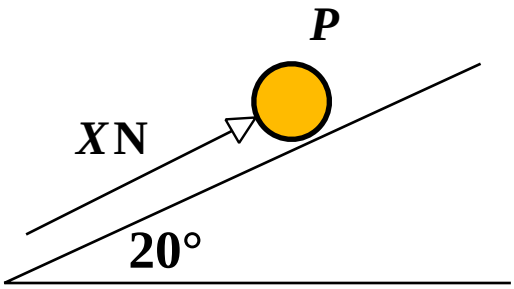


A heavy suitcase S of mass 50 kg is moving along a horizontal floor under the action of a force of magnitude P newtons.
The force acts at 30° to the floor, as shown in the diagram.
S moves in a straight line at constant speed.
The suitcase is modelled as a particle and the floor as a rough horizontal plane.
The coefficient of friction between S and the floor is $\frac{2}{3}$.

Calculate the value of P.

Question 2

M1 Exam question, 12th January 2005, Q4



A particle *P* of mass 2.5 kg rests in equilibrium on a rough plane under the action of a force of magnitude *X* newtons acting up the line of greatest slope of the plane, as shown.

The plane is inclined at 20° to the horizontal.

The coefficient of friction between *P* and the plane is 0.4.

The particle is in limiting equilibrium and is on the point of moving up the plane.

Calculate

(a) the normal reaction of the plane on *P*

[2 marks]

(b) the value of *X*

[4 marks]

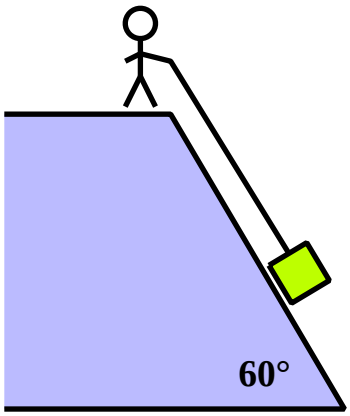
The force of magnitude X newtons is now removed

(c) Show that P remains in equilibrium on the plane.

[4 marks]

Question 3

M1 past exam question, 2nd November 2004, Q8.



A heavy package is held in equilibrium on a slope by a rope.
The package is attached to one end of the rope, the other end being held by a man standing at the top of the slope.
The package is modelled as a particle of mass 20 kg.
The slope is modelled as a rough plane inclined at 60° to the horizontal.
The rope is modelled as a light inextensible string.
The string is assumed to be parallel to a line of greatest slope of the plane, as shown.
At the contact between the package and the slope, the coefficient of friction is 0.4

(a) Find the minimum tension in the rope for the package to stay in equilibrium on the slope.

[8 marks]

The man now pulls the package up the slope.
Given that the package moves at constant speed,

(b) find the tension in the rope.

[4 marks]

(c) State how you have used, in your answer to part **(b)**, the fact that the package moves

(i) up the slope,

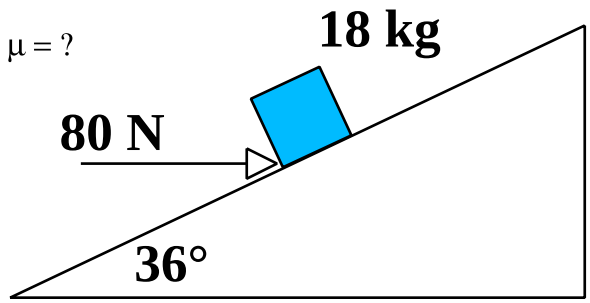
(ii) at constant speed.

[2 marks]

Question 4

A horizontal force of 80 N is just sufficient to prevent a crate of mass 18 kg from sliding down a rough slope, inclined at 36° to the horizontal, as shown.

This question is about determining the coefficient of friction, μ, between the crate and the slope.



(i) What is the weight of the box ?

(ii) The weight is to be resolved into component parts.

(a) What is the component parallel to the slope ?

(b) What is the component perpendicular to the slope ?

(iii) The 80 N force is to be resolved into component parts.

(a) What is the component parallel to the slope ?

(b) What is the component perpendicular to the slope ?

(iv) Draw a good sized diagram showing all forces acting on the block except for weight and the 80 N force.
In place of the weight, insert your two part (ii) answers.
In place of the 80 N force, insert your two part (iii) answers.

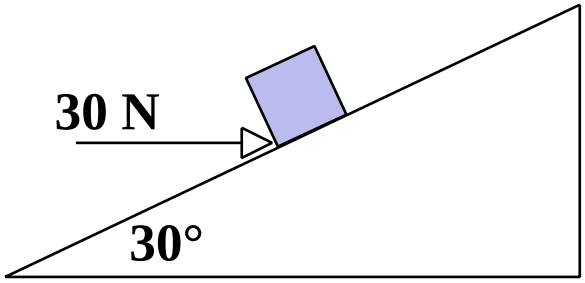
(v) Calculate the normal reaction, R.

(vi) Is the friction, F_r acting up or down the slope ?
Calculate F_r.

(vii) Hence determine the value of μ, the coefficient of friction, between the crate and the slope.

Question 5

This is an examination question from June 2001



A small parcel of mass 3 kg is held in equilibrium on a rough plane by the action of a horizontal force of magnitude 30 N acting in a vertical plane through a line of greatest slope. The plane is inclined at an angle of 30° to the horizontal, as shown. The parcel is modelled as a particle.
The parcel is on the point of moving up the slope.

(a) Draw a diagram showing all the forces acting on the parcel.

[2 marks]

(b) Find the normal reaction on the parcel.

[4 marks]

(c) Find the coefficient of friction between the parcel and the plane.

[5 marks]