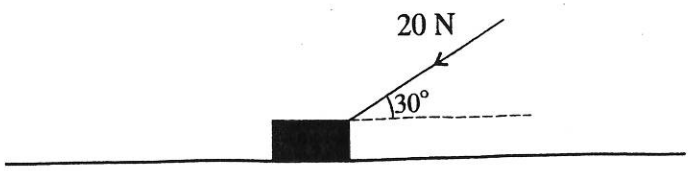
Friction (Ch 5)

4



A block of mass 3 kg is placed on a horizontal surface. A force of magnitude 20 N acts downwards on the block at an angle of 30° to the horizontal (see diagram).

Jan '09

(i) Given that the surface is smooth, calculate the acceleration of the block. **[3]**

(ii) Given instead that the block is in limiting equilibrium, calculate the coefficient of friction between the block and the surface. **[5]**

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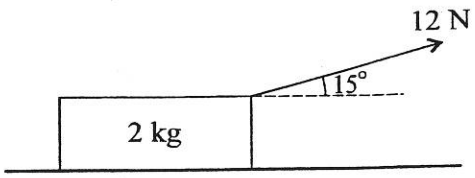


A block of mass 2 kg is at rest on a rough horizontal plane, acted on by a force of magnitude 12 N at an angle of 15° upwards from the horizontal (see diagram).

(i) Find the frictional component of the contact force exerted on the block by the plane. [2]

Jan '06

(ii) Show that the normal component of the contact force exerted on the block by the plane has magnitude 16.5 N, correct to 3 significant figures. [2]

It is given that the block is on the point of sliding.

(iii) Find the coefficient of friction between the block and the plane. [2]

The force of magnitude 12 N is now replaced by a horizontal force of magnitude 20 N. The block starts to move.

(iv) Find the acceleration of the block. [5]

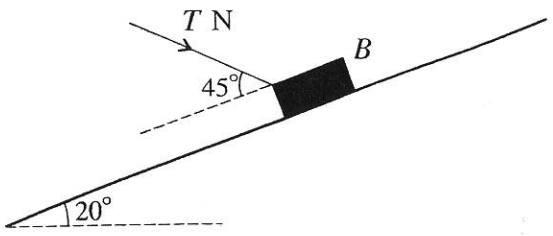
6 A block B of weight 10 N is projected down a line of greatest slope of a plane inclined at an angle of 20° to the horizontal. B travels down the plane at constant speed.

(i) **(a)** Find the components perpendicular and parallel to the plane of the contact force between B and the plane. **[2]**

(b) Hence show that the coefficient of friction is 0.364, correct to 3 significant figures. **[2]**

(ii)

Jun '09



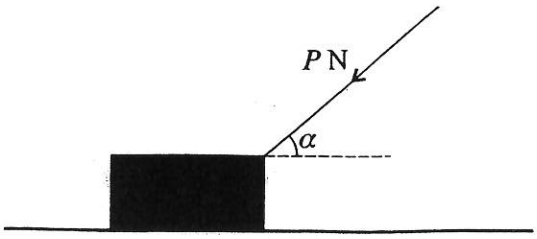
B is in limiting equilibrium when acted on by a force of T N directed towards the plane at an angle of 45° to a line of greatest slope (see diagram). Given that the frictional force on B acts down the plane, find T. **[7]**

5 A block of mass m kg is at rest on a horizontal plane. The coefficient of friction between the block and the plane is 0.2.

(i) When a horizontal force of magnitude 5 N acts on the block, the block is on the point of slipping. Find the value of m. [3]

Jun '06

(ii)



When a force of magnitude P N acts downwards on the block at an angle α to the horizontal, as shown in the diagram, the frictional force on the block has magnitude 6 N and the block is again on the point of slipping. Find

(a) the value of α in degrees,

(b) the value of P.

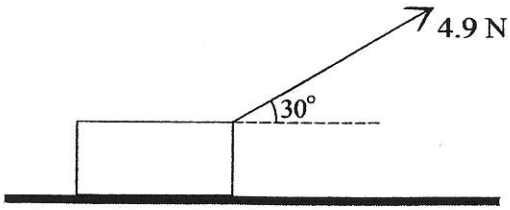
[8]

6 A block of weight 14.7 N is at rest on a horizontal floor. A force of magnitude 4.9 N is applied to the block.

(i) The block is in limiting equilibrium when the 4.9 N force is applied horizontally. Show that the coefficient of friction is $\frac{1}{3}$. [2]

Jun '08

(ii)



When the force of 4.9 N is applied at an angle of 30° above the horizontal, as shown in the diagram, the block moves across the floor. Calculate

(a) the vertical component of the contact force between the floor and the block, and the magnitude of the frictional force, [5]

(b) the acceleration of the block. [5]

(iii) Calculate the magnitude of the frictional force acting on the block when the 4.9 N force acts at an angle of 30° to the upward vertical, justifying your answer fully. [4]

7 A particle of mass 0.1 kg is at rest at a point A on a rough plane inclined at 15° to the horizontal. The particle is given an initial velocity of 6 m s^{-1} and starts to move up a line of greatest slope of the plane. The particle comes to instantaneous rest after 1.5 s.

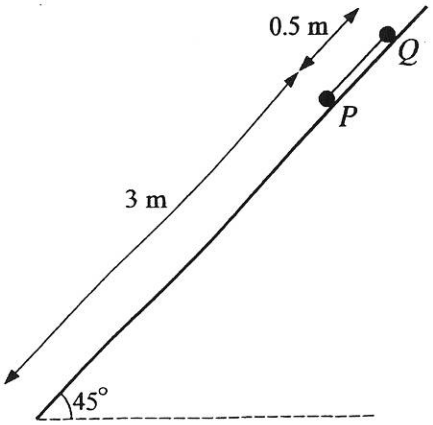
(i) Find the coefficient of friction between the particle and the plane. [7]

Jun '16

(ii) Show that, after coming to instantaneous rest, the particle moves down the plane. [2]

(iii) Find the speed with which the particle passes through A during its downward motion. [6]

7



Jun '08

Two particles P and Q are joined by a taut light inextensible string which is parallel to a line of greatest slope on an inclined plane on which the particles are initially held at rest. The string is 0.5 m long, and the plane is inclined at 45° to the horizontal. P is below the level of Q and 3 m from the foot of the plane (see diagram). Each particle has mass 0.2 kg. Contact between P and the plane is smooth. The coefficient of friction between Q and the plane is 1. The particles are released from rest and begin to move down the plane.

(i) Show that the magnitude of the frictional force acting on Q is 1.386 N, correct to 4 significant figures. [2]

(ii) Show that the particles accelerate at 3.465 m s^{-2}, correct to 4 significant figures, and calculate the tension in the string. [5]

(iii) Calculate the speed of the particles at the instant when Q reaches the initial position of P. [2]

At the instant when Q reaches the initial position of P, Q becomes detached from the string and the two particles travel independently to the foot of the plane.

(iv) Show that Q descends at constant speed, and calculate the time interval between the arrival of P and the arrival of Q at the foot of the plane. [7]

7 A particle P of mass 0.5 kg moves upwards along a line of greatest slope of a rough plane inclined at an angle of 40° to the horizontal. P reaches its highest point and then moves back down the plane. The coefficient of friction between P and the plane is 0.6.

(i) Show that the magnitude of the frictional force acting on P is 2.25 N, correct to 3 significant figures. [3]

Jan '07

(ii) Find the acceleration of P when it is moving

(a) up the plane,

(b) down the plane.

[4]

(iii) When P is moving up the plane, it passes through a point A with speed 4 m s^{-1}.

(a) Find the length of time before P reaches its highest point.

(b) Find the total length of time for P to travel from the point A to its highest point and back to A.

[8]