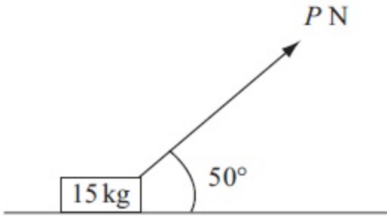
Question 1:

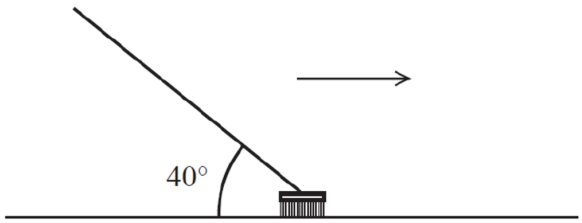


A small box of mass 15 kg rests on a rough horizontal plane. The coefficient of friction between the box and the plane is 0.2 . A force of magnitude P newtons is applied to the box at 50° to the horizontal. The box is on the point of sliding along the plane.

Find the value of P, giving your answer to 2 significant figures.

[6]

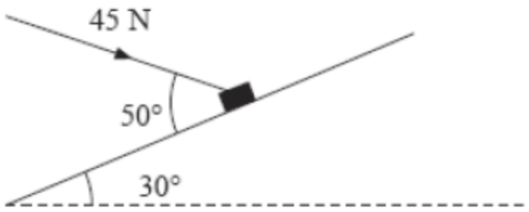
Question 2:



A broom is being used to sweep a horizontal floor. The handle of the broom makes a constant angle of 40° with the horizontal. The broom head is modelled as a particle of mass 0.5 kg and the handle of the broom is modelled as a light rod. The coefficient of friction between the broom head and the floor is $\frac{1}{4}$. The broom head is pushed along the floor in a straight line at constant speed. Find the magnitude of the force that is being applied along the handle of the broom to the broom head.

[6]

Question 3:



A package of mass 4 kg lies on a rough plane inclined at 30° to the horizontal. The package is held in equilibrium by a force of magnitude 45 N acting at an angle of 50° to the plane. The force is acting in a vertical plane through a line of greatest slope of the plane. The package is in equilibrium on the point of moving up the plane. The package is modelled as a particle.

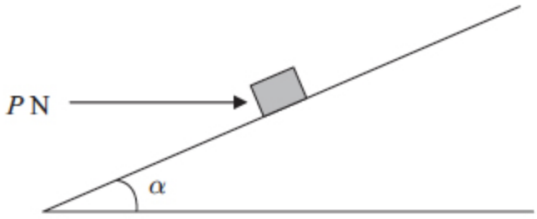
(a) Find the magnitude of the normal reaction of the plane on the package.

[5]

(b) Find the coefficient of friction between the plane and the package.

[6]

Question 4:



A small package of mass 1.1 kg is held in equilibrium on a rough plane by a horizontal force. The plane is inclined at an angle α to the horizontal, where $\tan\alpha = \frac{3}{4}$. The force acts in a vertical plane containing a line of greatest slope of the plane and has magnitude P newtons.

The coefficient of friction between the package and the plane is 0.5 and the package is modelled as a particle. The package is in equilibrium and on the point of slipping down the plane.

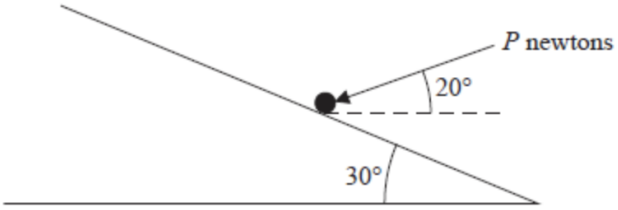
(a) Find the magnitude of the normal reaction between the package and the plane.

[6]

(b) Find the value of P.

[5]

Question 5:



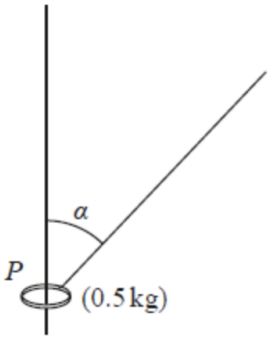
A particle of mass 2 kg lies on a rough plane. The plane is inclined to the horizontal at 30°.

The coefficient of friction between the particle and the plane is $\frac{1}{4}$. The particle is held in equilibrium by a force of magnitude P newtons. The force makes an angle of 20° with the horizontal and acts in a vertical plane containing a line of greatest slope of the plane.

Find the range of possible values of P.

[10]

Question 6:



A ring P of mass 0.5 kg is attached to one end of a light inextensible string. The ring is threaded on a fixed rough vertical wire. The ring is held in equilibrium with the string taut. The string makes an angle α with the wire, where $\tan\alpha = \frac{4}{3}$.

The coefficient of friction between P and the wire is $\frac{1}{4}$. The ring is modelled as a particle.

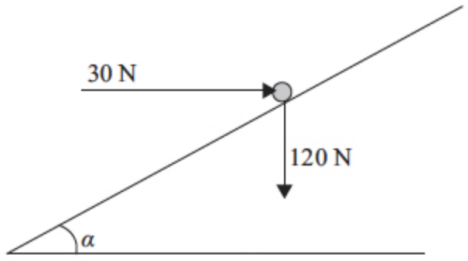
(a) Given that P is on the point of sliding up the wire, find the tension in the string.

[7]

(b) Find the magnitude of the smallest tension in the string which will keep the ring in equilibrium, given that the string remains at angle α to the wire.

[4]

Question 7:

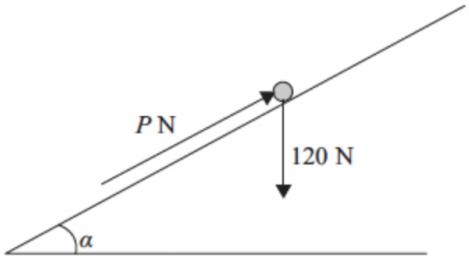


A particle of weight 120 N is placed on a fixed rough plane which is inclined at an angle α to the horizontal, where $\tan\alpha = \frac{3}{4}$. The coefficient of friction between the particle and the plane is $\frac{1}{2}$.

The particle is held at rest in equilibrium by a horizontal force of magnitude 30 N, which acts in the vertical plane containing the line of greatest slope of the plane through the particle.

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

[4]



The horizontal force is removed and replaced by a force of magnitude P newtons acting up the slope along the line of greatest slope of the plane through the particle. The particle remains in equilibrium.

(b) Find the range of possible values of P.

[8]

(c) Find the magnitude and direction of the frictional force acting on the particle when $P = 30$.

[3]

Numerical Answers:

(1) $P = 37$ N

(2) $P = 2.02$ N

(3) (a) $R = 68.4$ N
(b) $\mu = 0.14$

(4) (a) $R = 9.8$ N
(b) $P = 1.96$ N

(5) $6.66 \leq P \leq 31.12$

(6) (a) $T = 12.3$ N
(b) $T = 6.13$ N

(7) (a) $R = 114$ N
(b) $24 \leq P \leq 120$
(c) $F_f = 42$ N acting up the plane