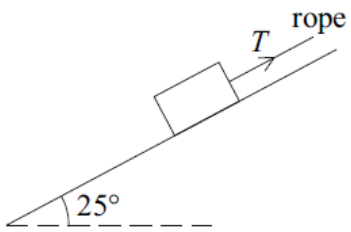
Mechanics 1 Resolving Forces Questions

8 A rough slope is inclined at an angle of 25° to the horizontal. A box of weight 80 newtons is on the slope. A rope is attached to the box and is parallel to the slope. The tension in the rope is of magnitude T newtons. The diagram shows the slope, the box and the rope.



(a) The box is held in equilibrium by the rope.

(i) Show that the normal reaction force between the box and the slope is 72.5 newtons, correct to three significant figures. *(3 marks)*

(ii) The coefficient of friction between the box and the slope is 0.32. Find the magnitude of the maximum value of the frictional force which can act on the box. *(2 marks)*

(iii) Find the least possible tension in the rope to prevent the box from moving down the slope. *(4 marks)*

(iv) Find the greatest possible tension in the rope. *(3 marks)*

(v) Show that the mass of the box is approximately 8.16 kg. *(1 mark)*

(b) The rope is now released and the box slides down the slope. Find the acceleration of the box. *(3 marks)*

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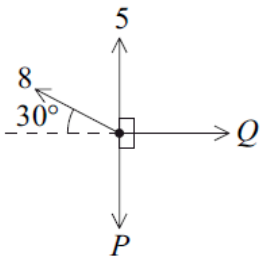
2 A particle is in equilibrium under the action of four horizontal forces of magnitudes 5 newtons, 8 newtons, P newtons and Q newtons, as shown in the diagram.

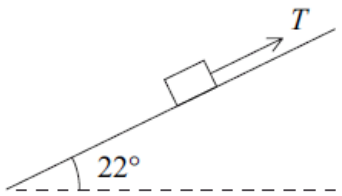


(a) Show that $P = 9$. *(3 marks)*

(b) Find the value of Q. *(2 marks)*

4 A block is being pulled up a rough plane inclined at an angle of 22° to the horizontal by a rope parallel to the plane, as shown in the diagram.

The mass of the block is 0.7 kg, and the tension in the rope is T newtons.



(a) Draw a diagram to show the forces acting on the block. *(1 mark)*

(b) Show that the normal reaction force between the block and the plane has magnitude 6.36 newtons, correct to three significant figures. *(3 marks)*

(c) The coefficient of friction between the block and the plane is 0.25. Find the magnitude of the frictional force acting on the block during its motion. *(2 marks)*

(d) The tension in the rope is 5.6 newtons. Find the acceleration of the block. *(4 marks)*

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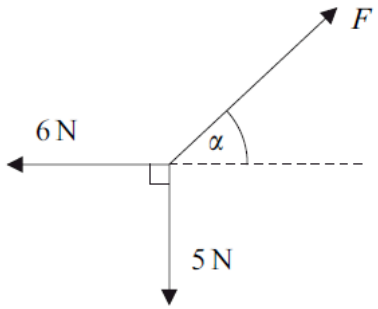
3 The diagram shows three forces which act in the same plane and are in equilibrium.



(a) Find F. *(3 marks)*

(b) Find α. *(3 marks)*

6 A trolley, of mass 100 kg, rolls at a constant speed along a straight line down a slope inclined at an angle of 4° to the horizontal.

Assume that a constant resistance force, of magnitude P newtons, acts on the trolley as it moves. Model the trolley as a particle.

(a) Draw a diagram to show the forces acting on the trolley. *(1 mark)*

(b) Show that $P = 68.4$ N, correct to three significant figures. *(3 marks)*

(c) (i) Find the acceleration of the trolley if it rolls down a slope inclined at 5° to the horizontal and experiences the same constant force of magnitude P that you found in part (b). *(4 marks)*

(ii) Make one criticism of the assumption that the resistance force on the trolley is constant. *(1 mark)*

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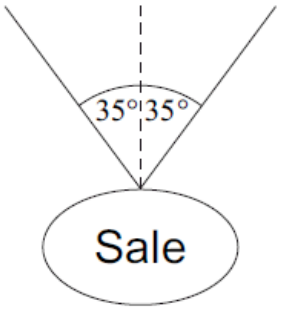
3 A sign, of mass 2 kg, is suspended from the ceiling of a supermarket by two light strings. It hangs in equilibrium with each string making an angle of 35° to the vertical, as shown in the diagram. Model the sign as a particle.



(a) By resolving forces horizontally, show that the tension is the same in each string. *(2 marks)*

(b) Find the tension in each string. *(5 marks)*

(c) If the tension in a string exceeds 40 N, the string will break. Find the mass of the heaviest sign that could be suspended as shown in the diagram. *(3 marks)*

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6 A box, of mass 3 kg, is placed on a slope inclined at an angle of 30° to the horizontal. The box slides down the slope. Assume that air resistance can be ignored.

(a) A simple model assumes that the slope is smooth.

(i) Draw a diagram to show the forces acting on the box. *(1 mark)*

(ii) Show that the acceleration of the box is $4.9\,\text{m}\,\text{s}^{-2}$. *(2 marks)*

(b) A revised model assumes that the slope is rough. The box slides down the slope from rest, travelling 5 metres in 2 seconds.

(i) Show that the acceleration of the box is $2.5\,\text{m}\,\text{s}^{-2}$. *(2 marks)*

(ii) Find the magnitude of the friction force acting on the box. *(3 marks)*

(iii) Find the coefficient of friction between the box and the slope. *(5 marks)*

(iv) In reality, air resistance affects the motion of the box. Explain how its acceleration would change if you took this into account. *(2 marks)*