

# Systems in Equilibrium

## Question Paper

<b>Level</b>	A Level
<b>Subject</b>	Maths
<b>Exam Board</b>	AQA
<b>Module</b>	Mechanics 1
<b>Topic</b>	Statics and Forces
<b>Sub Topic</b>	Systems in equilibrium
<b>Booklet</b>	Question Paper

**Time Allowed:** 35 minutes

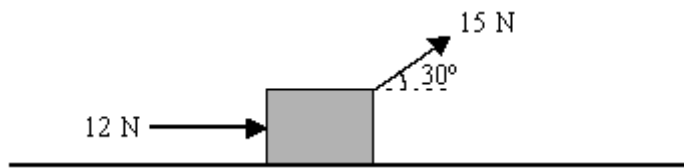
**Score:** /30

**Percentage:** /100

**Grade Boundaries:**

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

**Q1.** The diagram shows a small box resting on a rough horizontal surface.

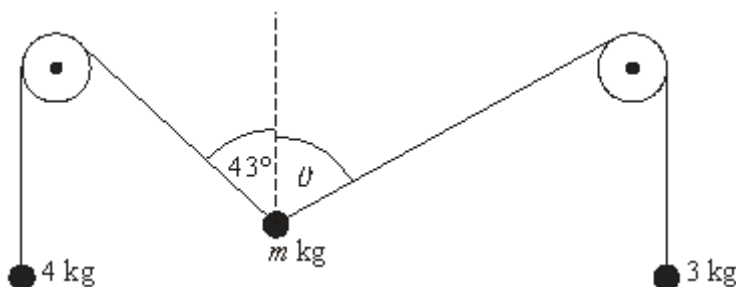


The box is of weight  $W$  newtons. It is pushed with a horizontal force of 12 newtons, and pulled with a force of 15 newtons at an angle of  $30^\circ$  to the horizontal.

The box rests in limiting equilibrium.

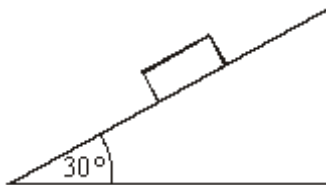
- (a) Draw a diagram to show all the forces acting on the box. (2)
- (b) Show that the frictional force acting on the box is approximately 25 newtons. (3)
- (c) The coefficient of friction between the box and the surface is  $\frac{1}{3}$ .  
Find the normal reaction force between the box and the surface. (2)
- (d) Find the value of  $W$ . (3)
- (Total 10 marks)**

**Q2.** Two light, inextensible strings are attached to a particle of mass  $m$  kg. Each string passes over a fixed, smooth, light pulley. The other end of one string is attached to a particle of mass 4 kg. The other end of the second string is attached to a particle of mass 3 kg. The diagram shows the system in its equilibrium position. The angles marked on the diagram are between the strings and the vertical.



- (a) Calculate the tension in each of the strings. (2)
- (b) Show that  $\theta = 65.4^\circ$ , correct to three significant figures. (5)
- (c) Find  $m$ . (4)
- (Total 11 marks)**

**Q3.** A block, of mass 7 kg, is placed on a rough slope that is inclined at  $30^\circ$  to the horizontal, as shown in the diagram. The block remains at rest in this position.



- (a) Draw a diagram to show the forces acting on the block. (1)
- (b) Find the magnitude of the normal reaction force acting on the block. (2)
- (c) Find the magnitude of the friction force acting on the block. (2)
- (d) The coefficient of friction between the block and the plane is  $\mu$ . Find an inequality that  $\mu$  must satisfy. (2)
- (e) A similar block, of mass 14 kg, is placed on the slope. Does this block remain at rest or slide? Give a reason for your answer. (2)
- (Total 9 marks)**

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