PEARSON EDEXCEL A-LEVEL PHYSICS · 9PH0

PHYSICS



EXAM QUESTION PACK

TOPIC 2: MECHANICS

MOMENTS

SCORE	PERCENTAGE
/85	%

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Q1.

* A stationary radium nucleus decays by emitting an alpha particle. The speed of the recoiling nucleus is small compared to the speed of the alpha particle.

Explain why the nucleus recoils and why its speed is small compared to that of the alpha particle.

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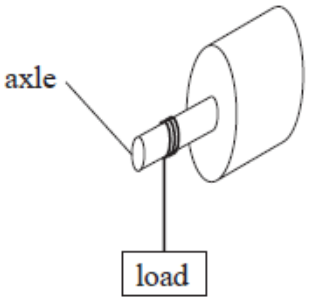
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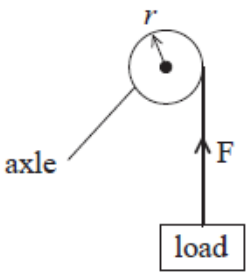
(Total for question = 4 marks)

Q2.

Motors usually have a rotating component which can do work *W*.

(a) A motor lifts a load in a time *t*. The axle of the motor has a radius *r* and exerts a force *F*.





The power produced by a motor can be calculated by using the following word equation.

Power = moment of the force exerted by the rotating axle × angular velocity

Derive this equation, starting with power $P = \frac{W}{t}$.

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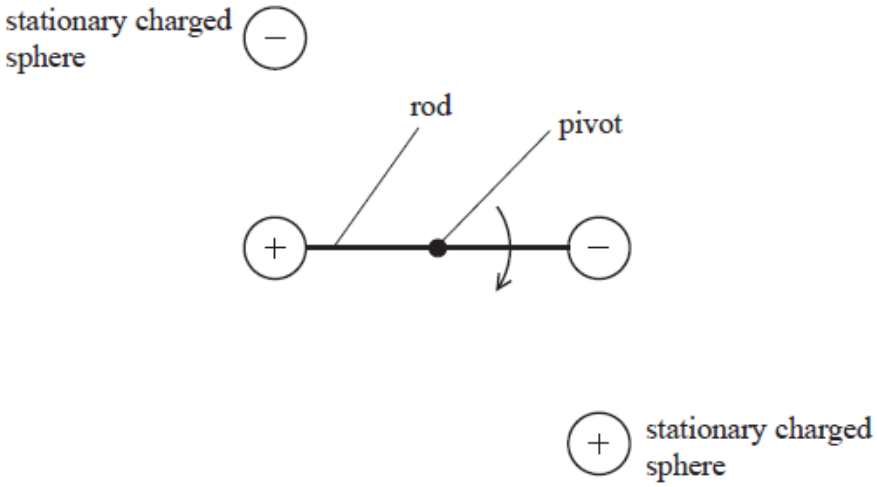
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(b) An electrostatic motor was first demonstrated by Benjamin Franklin in 1750.

The diagram shows a simplified version of part of this motor.

This consists of a rod, with an oppositely charged sphere at either end, which rotates around a fixed pivot. Two stationary charged spheres apply a force on the spheres at either end of the rod.

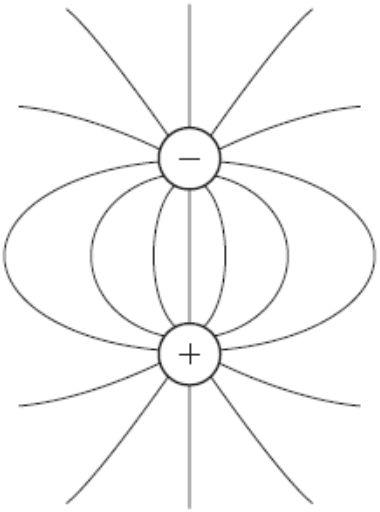


(i) In the diagram below, electric field lines have been drawn around one pair of these spheres.

Add to the diagram to show

- the directions of the field lines
- the lines of equipotential.

(3)



(ii) The distance between the centres of each charged sphere in this pair is 5.0 cm.

Show that the force between this pair of charged spheres is about 0.04 N.

charge on each sphere = 0.10 μC

(2)

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(c) The table shows the typical power and the corresponding angular velocity required for three different appliances.

	Power / W	Angular velocity / rad s^{-1}
Electric car	2.0×10^4	300
Vacuum cleaner	1.4×10^3	1000
Small pond pump	0.5	200

Deduce which of these appliances, in principle, could use the electrostatic motor in (b).

You should use the word equation in (a) and assume that the length of the rod in the electrostatic motor is 8.0 cm.

Assume that the electrostatic motor would deliver a constant force throughout one complete rotation.

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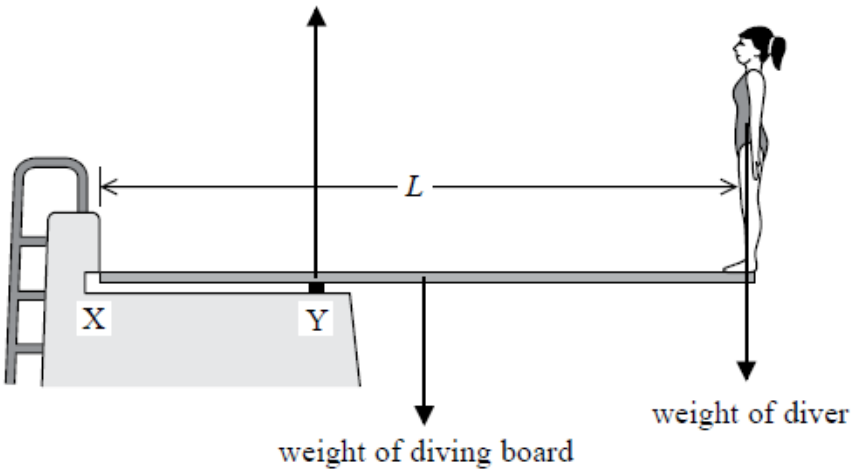
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(Total for question = 13 marks)

Q3.

The diagram shows a diver of weight 680 N on a diving board.



The diving board has a length *L* of 3.6 m and is fixed at the end labelled X. It is supported at position Y which is 0.9 m from X. The diving board is uniform and has a weight of 390 N.

By taking moments about X, determine the upward force exerted by the support at Y on the diving board.

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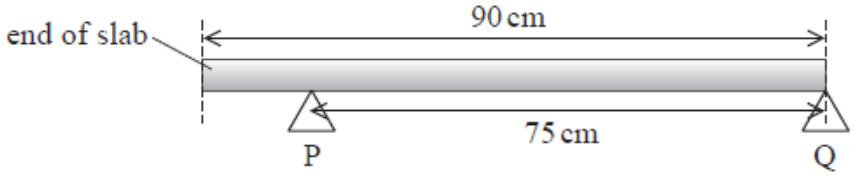
Force = ...

(Total for question = 5 marks)

Q4.

A uniform paving slab is to be used as a garden step.

The paving slab has a weight of 310 N and a length of 90 cm and will be supported at two points, P and Q, as shown. The distance between P and Q will be 75 cm.



This might be unsafe because a person who places all their weight at the end of the slab might tip the slab.

A person of mass 70 kg stands at the end of the slab.

Deduce whether the slab will tip.

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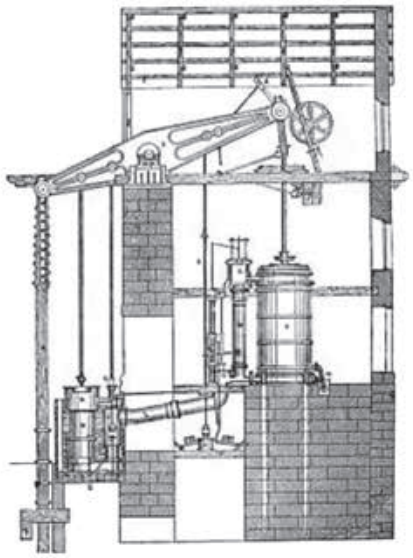
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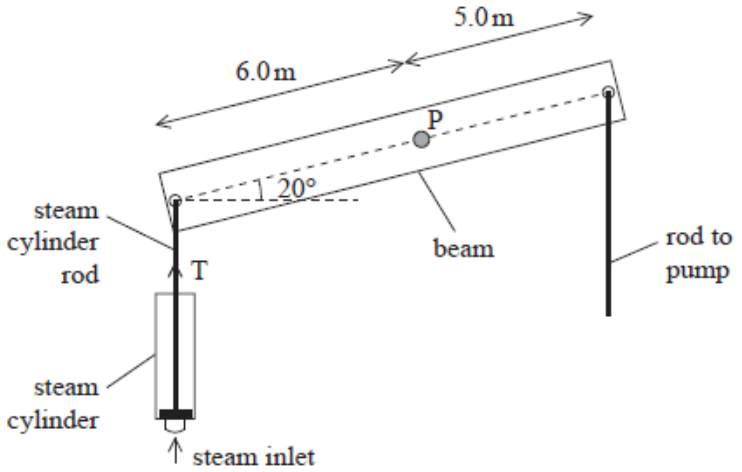
(Total for question = 4 marks)

Q5.

Beam engines contributed to powering the Industrial Revolution in Britain in the 18th century. A beam engine consisted of a beam which could rock to and fro around a well-oiled pivot. Attached to the beam there are two rods, one connected to a piston in a steam cylinder and the other connected to a pump.



The diagram below shows a simplified arrangement of a beam engine.



The beam has a constant thickness and a mass of 3.05×10^4 kg. The length of the beam is 11.0 m. The pivot P is positioned 6.0 m from the steam cylinder end of the beam.

In its resting position the steam cylinder rod is supported by the base of the steam cylinder with the beam at an angle of 20° to the horizontal.

The steam cylinder rod exerts a force *T* on the beam. The force exerted on the beam by the pump rod can be neglected.

Calculate the force *T*.

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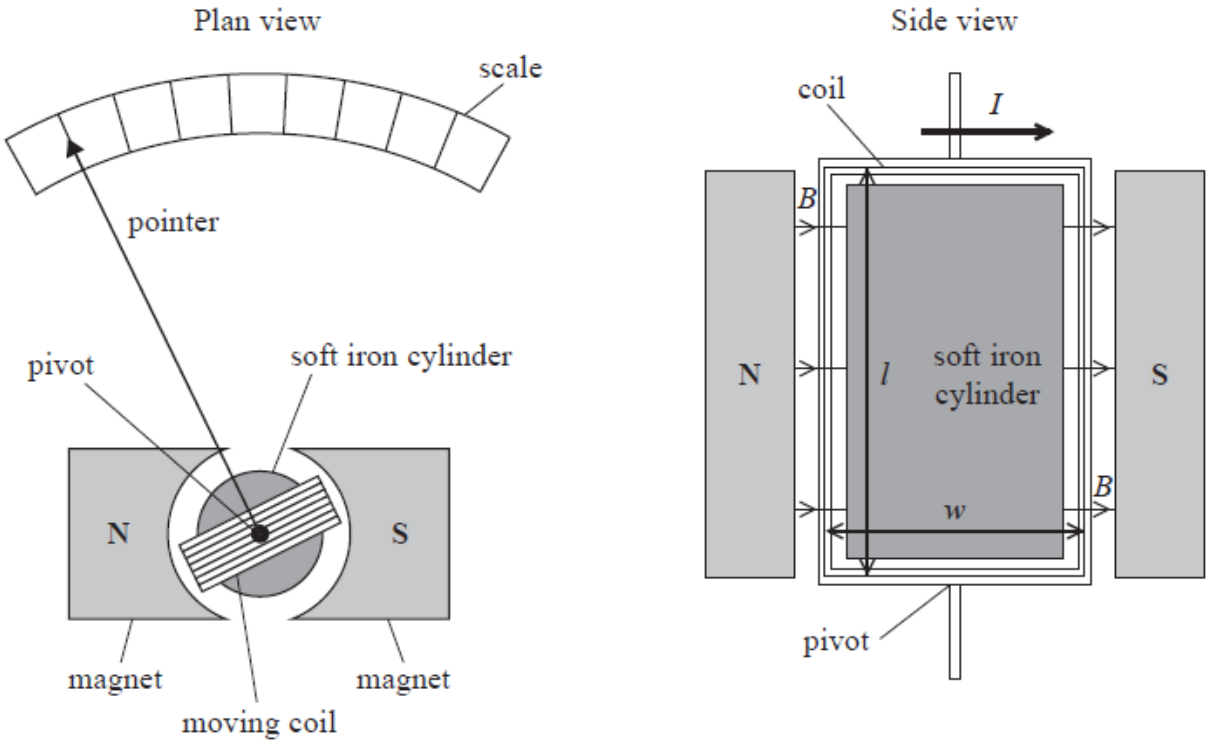
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T = ...

(Total for question = 4 marks)

Q6.

The diagrams show the plan view and side view of a moving coil ammeter.



The fixed soft iron cylinder and magnets produce a uniform magnetic field of magnetic flux density B. The coil is able to rotate within this magnetic field. The coil has width w and length l. There is a current I in the coil in the direction shown in the side view diagram.

(i) Explain which way the coil will rotate.

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(ii) Show that the moment M on the coil about the pivot, due to the magnetic field, is given by

$$M = BAIN$$

where
A is the cross-sectional area of the coil
N is the number of turns of wire on the coil.

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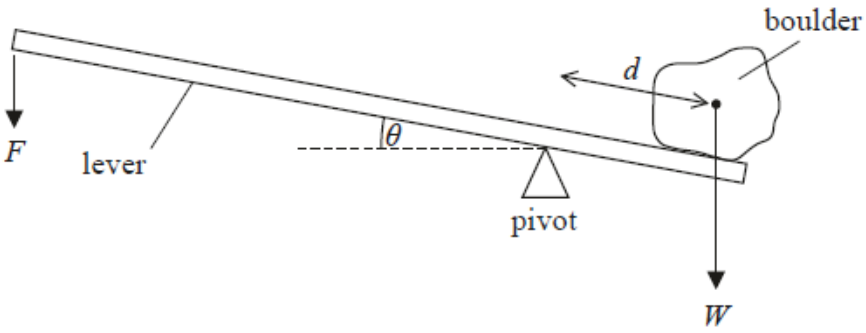
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(Total for question = 6 marks)

Q7.

A person uses a pivoted lever to lift a boulder of weight W as shown.



The centre of gravity of the boulder is a distance *d* from the pivot. The angle of the lever to the horizontal is *θ*.

Which expression is equal to the moment of *W* about the pivot?

☒ **A** *Wd*

☒ **B** *Wd* cos *θ*

☒ **C** *Wd* sin *θ*

☒ **D** *Wd* tan *θ*

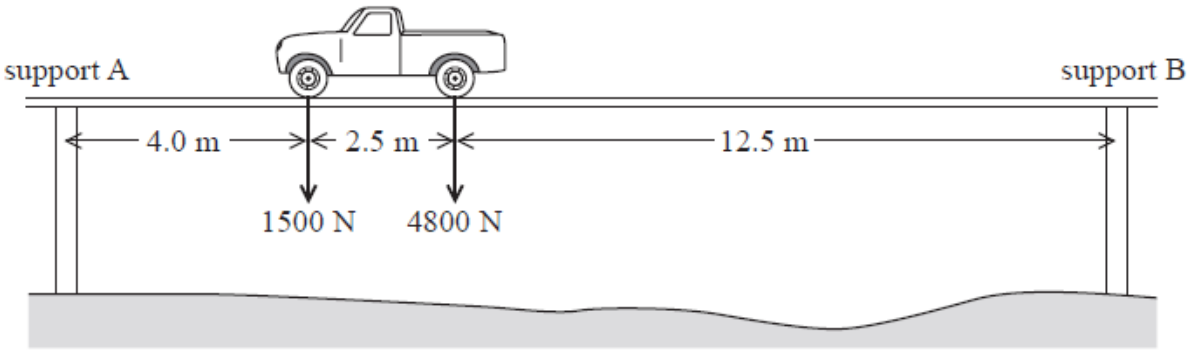
(Total for question = 1 mark)

Q8.

A beam bridge is a rigid structure that consists of one horizontal beam supported at each end.

The diagram shows a bridge with a uniform beam of mass 8 500 kg.

A small truck is crossing the beam bridge. The position of the truck and the forces of the truck on the bridge are shown, but are not drawn to scale.



(a) (i) State the conditions necessary for the bridge to be in equilibrium.

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(ii) Calculate the vertical forces at each of the bridge supports.

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Force at A = ...

Force at B = ...

The Volgograd Bridge is a concrete beam bridge across the River Volga in Russia.



In 2010 the bridge was closed to traffic due to windy conditions leading to resonance of the structure.

(i) Explain what is meant by resonance in this context.

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(ii) To suppress the oscillations of the bridge, dampers were installed.

Explain how damping resulted in the suppression of the oscillations of the bridge.

(3)

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(iii) Each damper contains an enclosure filled with a fluid. When this fluid is subjected to a magnetic field, the viscosity of the fluid greatly increases.

Describe how the behaviour of the fluid would change in a magnetic field and how this would be useful for the operation of the dampers.

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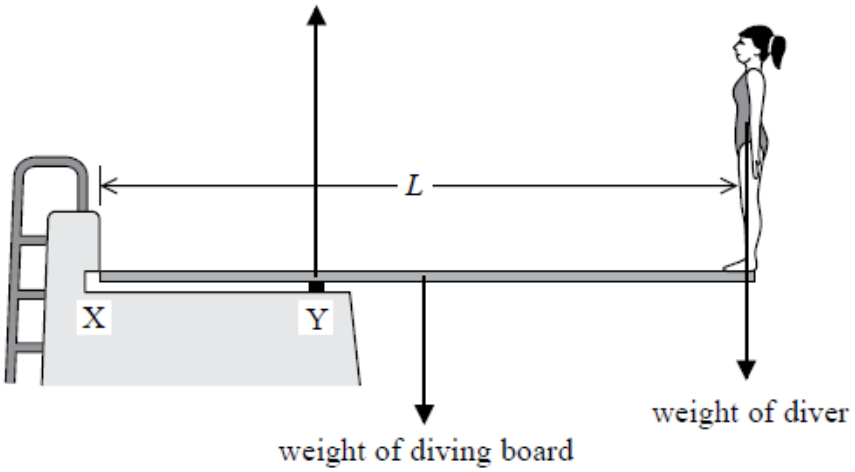
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(Total for question = 14 marks)

Q1.

Q1.

The diagram shows a diver of weight 680 N on a diving board.



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By taking moments about X, determine the upward force exerted by the support at Y on the diving board.

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Force = ...

(Total for question = 5 marks)

Q2.

A uniform paving slab is to be used as a garden step.

State what is meant by the centre of gravity of an extended body.

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(Total for question = 1 mark)

Q3.

The diagram shows a battery-powered clock on a wall. It has a minute hand and an hour hand.



(a) Calculate the average angular velocity of the minute hand.

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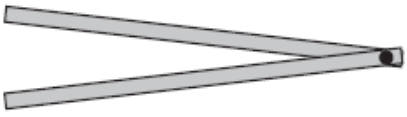
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Angular velocity = ...

(b) The diagram shows the position of the minute hand when the time is 1 : 44 and when the time is 1 : 46.



The diagram is not to scale.

Show that the work done against the force of gravity to move the minute hand from 1 : 44 to 1 : 46 is about 1 mJ.

mass of minute hand = 14 g

length of minute hand = 8.0 cm

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(c) The clock uses a 1.5 V cell and draws a maximum current of 8.0 μA.

After a time, the maximum power of the cell has reduced to 65% of its initial value making the clock run slowly.

Calculate the time taken for the minute hand to move from the 1 : 44 position to the 1 : 46 position.

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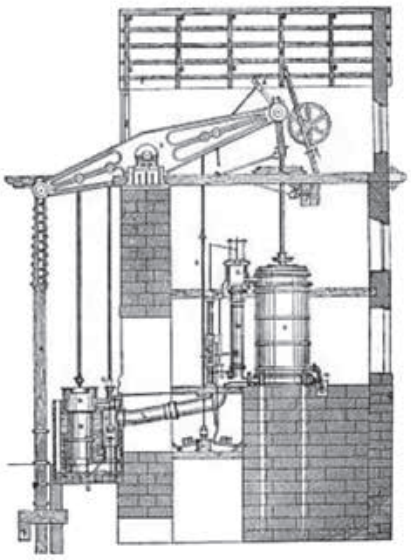
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Time taken = ...

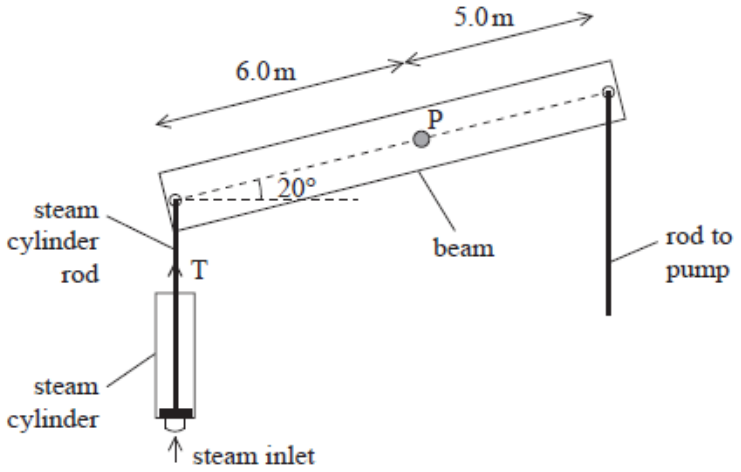
(Total for question = 10 marks)

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T = ...

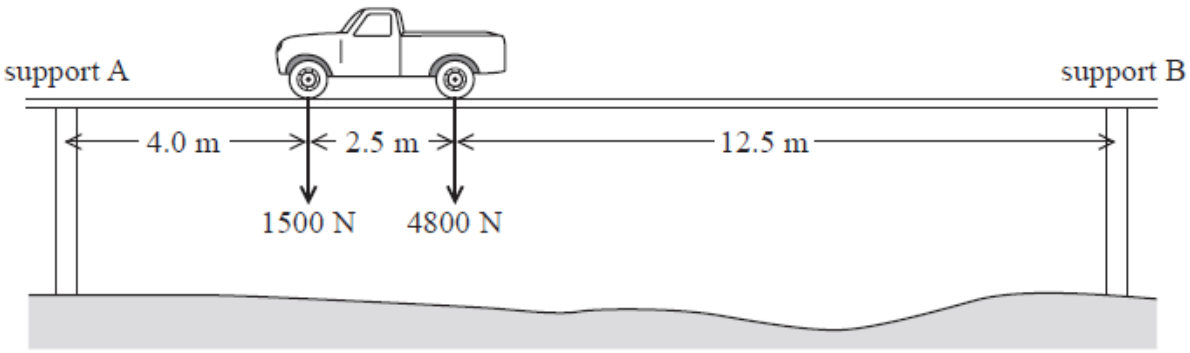
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