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Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

MATHEMATICS **9709/43**

Paper 4 Mechanics 1 **(M1)** **October/November 2016**

1 hour 15 minutes

Additional Materials: List of Formulae (MF9)

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READ THESE INSTRUCTIONS FIRST

An answer booklet is provided inside this question paper. You should follow the instructions on the front cover of the answer booklet. If you need additional answer paper ask the invigilator for a continuation booklet.

Answer **all** the questions.
Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place in the case of angles in degrees, unless a different level of accuracy is specified in the question.
Where a numerical value for the acceleration due to gravity is needed, use $10\,\text{m}\,\text{s}^{-2}$.
The use of an electronic calculator is expected, where appropriate.
You are reminded of the need for clear presentation in your answers.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.
The total number of marks for this paper is 50.

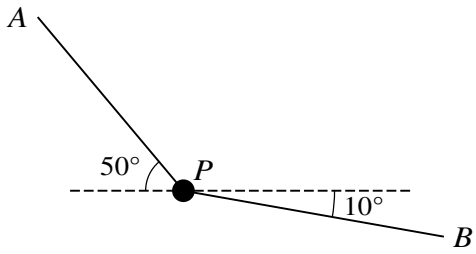
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1 A crane is used to raise a block of mass 50 kg vertically upwards at constant speed through a height of 3.5 m. There is a constant resistance to motion of 25 N.

(i) Find the work done by the crane. [3]

(ii) Given that the time taken to raise the block is 2 s, find the power of the crane. [2]

2



The diagram shows a small object P of mass 20 kg held in equilibrium by light ropes attached to fixed points A and B. The rope PA is inclined at an angle of 50° above the horizontal, the rope PB is inclined at an angle of 10° below the horizontal, and both ropes are in the same vertical plane. Find the tension in the rope PA and the tension in the rope PB. [5]

3



Particles P and Q, of masses 7 kg and 3 kg respectively, are attached to the two ends of a light inextensible string. The string passes over two small smooth pulleys attached to the two ends of a horizontal table. The two particles hang vertically below the two pulleys. The two particles are both initially at rest, 0.5 m below the level of the table, and 0.4 m above the horizontal floor (see diagram).

(i) Find the acceleration of the particles and the speed of P immediately before it reaches the floor. [4]

(ii) Determine whether Q comes to instantaneous rest before it reaches the pulley directly above it. [2]

4 A ball A is released from rest at the top of a tall tower. One second later, another ball B is projected vertically upwards from ground level near the bottom of the tower with a speed of $20\,\text{m s}^{-1}$. The two balls are at the same height 1.5 s after ball B is projected.

(i) Show that the height of the tower is 50 m. [3]

(ii) Find the length of time for which ball B has been in motion when ball A reaches the ground. Hence find the total distance travelled by ball B up to the instant when ball A reaches the ground. [5]

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5 A particle P starts from a fixed point O and moves in a straight line. At time t s after leaving O, the velocity v m s^{-1} of P is given by $v = 6t - 0.3t^2$. The particle comes to instantaneous rest at point X.

(i) Find the distance OX. [4]

A second particle Q starts from rest from O, at the same instant as P, and also travels in a straight line. The acceleration a m s^{-2} of Q is given by $a = k - 12t$, where k is a constant. The displacement of Q from O is 400 m when $t = 10$.

(ii) Find the value of k. [4]

6 A cyclist is cycling with constant power of 160 W along a horizontal straight road. There is a constant resistance to motion of 20 N. At an instant when the cyclist's speed is 5 m s^{-1}, his acceleration is 0.15 m s^{-2}.

(i) Show that the total mass of the cyclist and bicycle is 80 kg. [3]

The cyclist comes to a hill inclined at 2° to the horizontal. When the cyclist starts climbing the hill, he increases his power to a constant 300 W. The resistance to motion remains 20 N.

(ii) Show that the steady speed up the hill which the cyclist can maintain when working at this power is 6.26 m s^{-1}, correct to 3 significant figures. [2]

(iii) Find the acceleration at an instant when the cyclist is travelling at 90% of the speed in part **(ii)**. [4]

7 A box of mass 50 kg is at rest on a plane inclined at 10° to the horizontal.

(i) Find an inequality for the coefficient of friction between the box and the plane. [2]

In fact the coefficient of friction between the box and the plane is 0.19.

(ii) A girl pushes the box with a force of 50 N, acting down a line of greatest slope of the plane, for a distance of 5 m. She then stops pushing. Use an energy method to find the speed of the box when it has travelled a further 5 m. [5]

The box then comes to a plane inclined at 20° below the horizontal. The box moves down a line of greatest slope of this plane. The coefficient of friction is still 0.19 and the girl is not pushing the box.

(iii) Find the acceleration of the box. [2]

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