Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER			

8414681023

MATHEMATICS **9709/41**

Paper 4 Mechanics 1 **(M1)** **May/June 2018**

1 hour 15 minutes

Candidates answer on the Question Paper.

Additional Materials: List of Formulae (MF9)

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name in the spaces at the top of this page.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** the questions in the space provided. If additional space is required, you should use the lined page at the end of this booklet. The question number(s) must be clearly shown.
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.

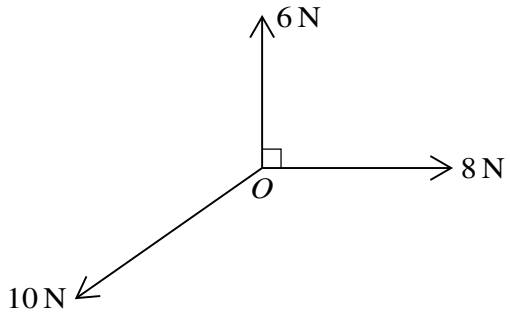
This document consists of **14** printed pages and **2** blank pages.

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1 A particle P is projected vertically upwards with speed $24\,\text{m}\,\text{s}^{-1}$ from a point 5 m above ground level. Find the time from projection until P reaches the ground. [3]

2



The diagram shows three coplanar forces acting at the point O. The magnitudes of the forces are 6 N, 8 N and 10 N. The angle between the 6 N force and the 8 N force is 90°. The forces are in equilibrium. Find the other angles between the forces. [4]

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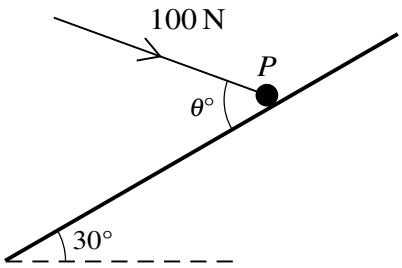
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A particle P of mass 8 kg is on a smooth plane inclined at an angle of 30° to the horizontal. A force of magnitude 100 N, making an angle of θ° with a line of greatest slope and lying in the vertical plane containing the line of greatest slope, acts on P (see diagram).

(i) Given that P is in equilibrium, show that $\theta = 66.4$, correct to 1 decimal place, and find the normal reaction between the plane and P. [4]

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(ii) Given instead that $\theta = 30$, find the acceleration of P. [2]

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4 A particle P moves in a straight line starting from a point O. At time t s after leaving O, the displacement s m from O is given by $s = t^3 - 4t^2 + 4t$ and the velocity is v m s^{-1}.

(i) Find an expression for v in terms of t. [2]

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(ii) Find the two values of t for which P is at instantaneous rest. [2]

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(iii) Find the minimum velocity of P. [3]

5 A sprinter runs a race of 200 m. His total time for running the race is 20 s. He starts from rest and accelerates uniformly for 6 s, reaching a speed of 12 m s^{-1}. He maintains this speed for the next 10 s, before decelerating uniformly to cross the finishing line with speed V m s^{-1}.

(i) Find the distance travelled by the sprinter in the first 16 s of the race. Hence sketch a displacement-time graph for the 20 s of the sprinter's race. [6]

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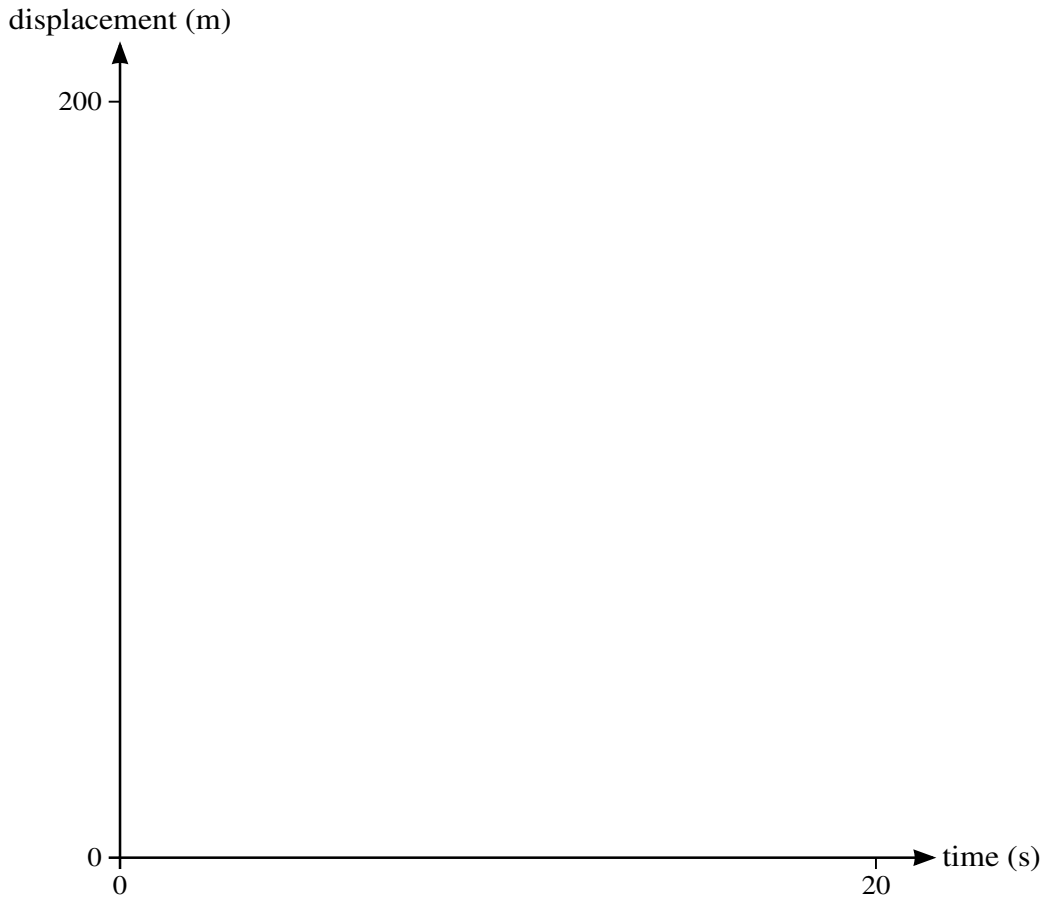
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(ii) Find the value of V. [2]

6 A car has mass 1250 kg.

(i) The car is moving along a straight level road at a constant speed of $36\,\text{m}\,\text{s}^{-1}$ and is subject to a constant resistance of magnitude 850 N. Find, in kW, the rate at which the engine of the car is working. [2]

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(ii) The car travels at a constant speed up a hill and is subject to the same resistance as in part **(i)**. The hill is inclined at an angle of $\theta°$ to the horizontal, where $\sin\theta° = 0.1$, and the engine is working at 63 kW. Find the speed of the car. [3]

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(iii) The car descends the same hill with the engine of the car working at a constant rate of 20 kW. The resistance is not constant. The initial speed of the car is $20\,\text{m}\,\text{s}^{-1}$. Eight seconds later the car has speed $24\,\text{m}\,\text{s}^{-1}$ and has moved 176 m down the hill. Use an energy method to find the total work done against the resistance during the eight seconds. [5]

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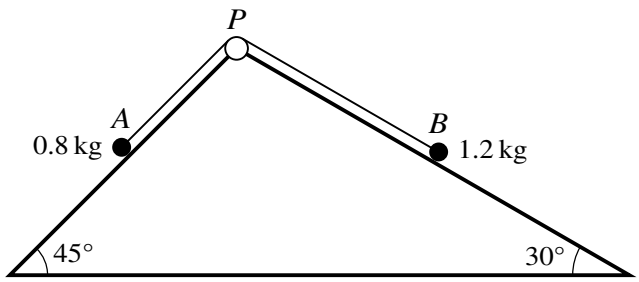
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The diagram shows a triangular block with sloping faces inclined to the horizontal at 45° and 30°. Particle A of mass 0.8 kg lies on the face inclined at 45° and particle B of mass 1.2 kg lies on the face inclined at 30°. The particles are connected by a light inextensible string which passes over a small smooth pulley P fixed at the top of the faces. The parts AP and BP of the string are parallel to lines of greatest slope of the respective faces. The particles are released from rest with both parts of the string taut. In the subsequent motion neither particle reaches the pulley and neither particle reaches the bottom of a face.

(i) Given that both faces are smooth, find the speed of A after each particle has travelled a distance of 0.4 m. [6]

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(ii) It is given instead that both faces are rough. The coefficient of friction between each particle and a face of the block is μ. Find the value of μ for which the system is in limiting equilibrium. [6]

Additional Page

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