Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER			

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MATHEMATICS **9709/41**

Paper 4 Mechanics 1 **(M1)** **October/November 2017**

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.
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 block of mass 3 kg is initially at rest on a smooth horizontal floor. A force of 12 N, acting at an angle of 25° above the horizontal, is applied to the block. Find the distance travelled by the block in the first 5 seconds of its motion. [4]

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2 A tractor of mass 3700 kg is travelling along a straight horizontal road at a constant speed of 12 m s^{-1}. The total resistance to motion is 1150 N.

(i) Find the power output of the tractor's engine. [1]

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The tractor comes to a hill inclined at 4° above the horizontal. The power output is increased to 25 kW and the resistance to motion is unchanged.

(ii) Find the deceleration of the tractor at the instant it begins to climb the hill. [3]

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(iii) Find the constant speed that the tractor could maintain on the hill when working at this power. [2]

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3 A roller-coaster car (including passengers) has a mass of 840 kg. The roller-coaster ride includes a section where the car climbs a straight ramp of length 8 m inclined at 30° above the horizontal. The car then immediately descends another ramp of length 10 m inclined at 20° below the horizontal. The resistance to motion acting on the car is 640 N throughout the motion.

(i) Find the total work done against the resistance force as the car ascends the first ramp and descends the second ramp. [2]

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(ii) The speed of the car at the bottom of the first ramp is $14\,\text{m}\,\text{s}^{-1}$. Use an energy method to find the speed of the car when it reaches the bottom of the second ramp. [4]

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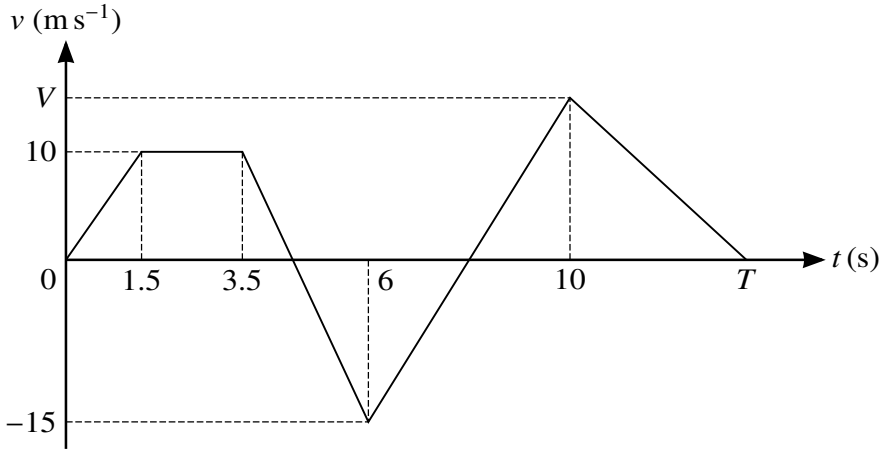
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The diagram shows the velocity-time graph of a particle which moves in a straight line. The graph consists of 5 straight line segments. The particle starts from rest at a point A at time $t = 0$, and initially travels towards point B on the line.

(i) Show that the acceleration of the particle between $t = 3.5$ and $t = 6$ is $-10\,\text{m s}^{-2}$. [1]

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(ii) The acceleration of the particle between $t = 6$ and $t = 10$ is $7.5\,\text{m s}^{-2}$. When $t = 10$ the velocity of the particle is $V\,\text{m s}^{-1}$. Find the value of V. [2]

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(iii) The particle comes to rest at B at time T s. Given that the total distance travelled by the particle between $t = 0$ and $t = T$ is 100 m, find the value of T. [4]

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5 A particle starts from a point O and moves in a straight line. The velocity of the particle at time t s after leaving O is v m s^{-1}, where

$$v = 1.5 + 0.4t \quad \text{for } 0 \leqslant t \leqslant 5,$$
$$v = \frac{100}{t^2} - 0.1t \quad \text{for } t \geqslant 5.$$

(i) Find the acceleration of the particle during the first 5 seconds of motion. [1]

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(ii) Find the value of t when the particle is instantaneously at rest. [2]

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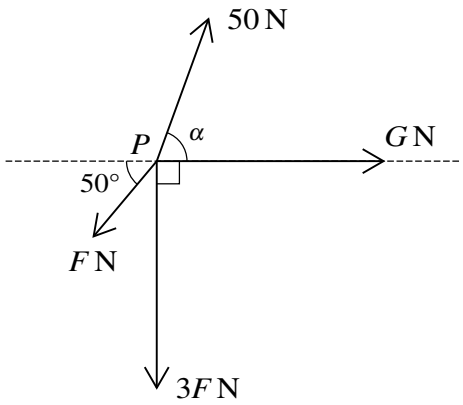
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(iii) Find the total distance travelled by the particle in the first 10 seconds of motion. [5]

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Coplanar forces, of magnitudes F N, $3F$ N, G N and 50 N, act at a point P, as shown in the diagram.

(i) Given that $F = 0$, $G = 75$ and $\alpha = 60°$, find the magnitude and direction of the resultant force. [4]

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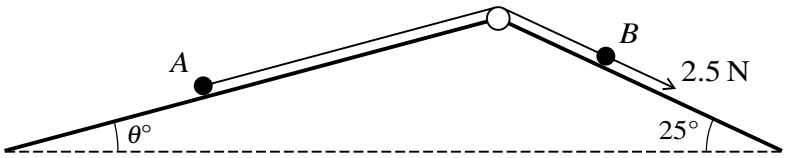
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(ii) Given instead that $G = 0$ and the forces are in equilibrium, find the values of F and α. [5]

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Two particles A and B of masses 0.9 kg and 0.4 kg respectively are attached to the ends of a light inextensible string. The string passes over a fixed smooth pulley which is attached to the top of two inclined planes. The particles are initially at rest with A on a smooth plane inclined at angle $\theta°$ to the horizontal and B on a plane inclined at angle 25° to the horizontal. The string is taut and the particles can move on lines of greatest slope of the two planes. A force of magnitude 2.5 N is applied to B acting down the plane (see diagram).

(i) For the case where $\theta = 15$ and the plane on which B rests is smooth, find the acceleration of B. [5]

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(ii) For a different value of θ, the plane on which B rests is rough with coefficient of friction between the plane and B of 0.8. The system is in limiting equilibrium with B on the point of moving in the direction of the 2.5 N force. Find the value of θ. [5]

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