Cambridge International AS & A Level

**Cambridge International Examinations**
Cambridge International Advanced Subsidiary and Advanced Level

| CANDIDATE NAME | |
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*4548248144*

**MATHEMATICS** **9709/42**

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.

This document consists of **11** printed pages and **1** blank page.

**1** A particle of mass 0.2 kg is resting in equilibrium on a rough plane inclined at 20° to the horizontal.

**(i)** Show that the friction force acting on the particle is 0.684 N, correct to 3 significant figures. [1]

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The coefficient of friction between the particle and the plane is 0.6. A force of magnitude 0.9 N is applied to the particle down a line of greatest slope of the plane. The particle accelerates down the plane.

**(ii)** Find this acceleration. [4]

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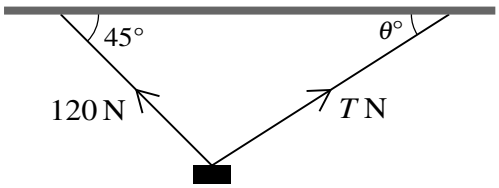
**2**




A block of mass 15 kg hangs in equilibrium below a horizontal ceiling attached to two strings as shown in the diagram. One of the strings is inclined at 45° to the horizontal and the tension in this string is 120 N. The other string is inclined at $\theta°$ to the horizontal and the tension in this string is $T$ N. Find the values of $T$ and $\theta$. [6]

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**3** A car travels along a straight road with constant acceleration. It passes through points $A$, $B$ and $C$. The car passes point $A$ with velocity $14\,\mathrm{m\,s^{-1}}$. The two sections $AB$ and $BC$ are of equal length. The times taken to travel along $AB$ and $BC$ are 5 s and 3 s respectively.

**(i)** Write down an expression for the distance $AB$ in terms of the acceleration of the car. Write down a similar expression for the distance $AC$. Hence show that the acceleration of the car is $4\,\mathrm{m\,s^{-2}}$. [4]

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**(ii)** Find the speed of the car as it passes point $C$. [2]

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**4** A particle $P$ is projected vertically upwards from horizontal ground with speed $12\,\mathrm{m\,s^{-1}}$.

**(i)** Find the time taken for $P$ to return to the ground. [2]

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The time in seconds after $P$ is projected is denoted by $t$. When $t = 1$, a second particle $Q$ is projected vertically upwards with speed $10\,\mathrm{m\,s^{-1}}$ from a point which is 5 m above the ground. Particles $P$ and $Q$ move in different vertical lines.

**(ii)** Find the set of values of $t$ for which the two particles are moving in the same direction. [4]

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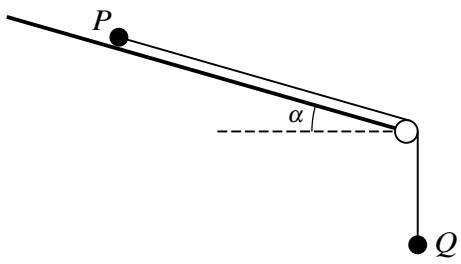
**5** A cyclist is riding up a straight hill inclined at an angle $\alpha$ to the horizontal, where $\sin\alpha = 0.04$. The total mass of the bicycle and rider is 80 kg. The cyclist is riding at a constant speed of $4\ \mathrm{m\,s^{-1}}$. There is a force resisting the motion. The work done by the cyclist against this resistance force over a distance of 25 m is 600 J.

**(i)** Find the power output of the cyclist. [4]

The cyclist reaches the top of the hill, where the road becomes horizontal, with speed $4\,\mathrm{m\,s^{-1}}$. The cyclist continues to work at the same rate on the horizontal part of the road.

**(ii)** Find the speed of the cyclist 10 seconds after reaching the top of the hill, given that the work done by the cyclist during this period against the resistance force is 1200 J. [4]

**6**




Two particles $P$ and $Q$, each of mass $m$ kg, are attached to the ends of a light inextensible string. The string passes over a fixed smooth pulley which is attached to the edge of a rough plane. The plane is inclined at an angle $\alpha$ to the horizontal, where $\tan\alpha = \frac{7}{24}$. Particle $P$ rests on the plane and particle $Q$ hangs vertically, as shown in the diagram. The string between $P$ and the pulley is parallel to a line of greatest slope of the plane. The system is in limiting equilibrium.

**(i)** Show that the coefficient of friction between $P$ and the plane is $\frac{4}{3}$. [5]

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A force of magnitude 10 N is applied to $P$, acting up a line of greatest slope of the plane, and $P$ accelerates at $2.5\,\mathrm{m\,s^{-2}}$.

**(ii)** Find the value of $m$. [5]

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**7** A particle starts from rest and moves in a straight line. The velocity of the particle at time $t$ s after the start is $v$ m s$^{-1}$, where

$$v = -0.01t^3 + 0.22t^2 - 0.4t.$$

**(i)** Find the two positive values of $t$ for which the particle is instantaneously at rest. [2]

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**(ii)** Find the time at which the acceleration of the particle is greatest. [3]

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**(iii)** Find the distance travelled by the particle while its velocity is positive. [4]

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