GradeMax

Cambridge International AS & A Level

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

CANDIDATE NAME

CENTRE NUMBER | | | | | |

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*6736258106*

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

Paper 4 Mechanics 1 **(M1)** **February/March 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 **12** printed pages.


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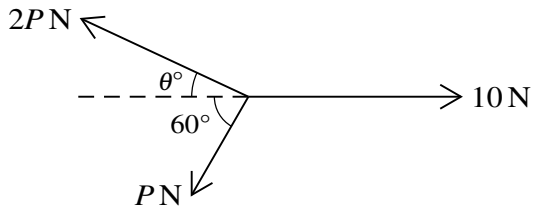
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**1** Two particles $A$ and $B$, of masses 0.8 kg and 0.2 kg respectively, are connected by a light inextensible string that passes over a fixed smooth pulley. The particles hang vertically. The system is released from rest. Show that the acceleration of $A$ has magnitude $6\,\text{m}\,\text{s}^{-2}$ and find the tension in the string. [4]

**2**

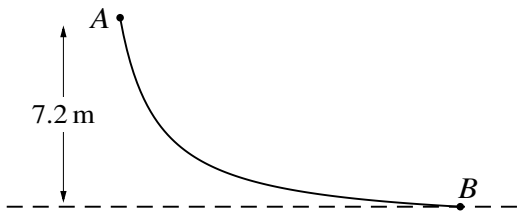



The three coplanar forces shown in the diagram are in equilibrium. Find the values of $\theta$ and $P$. [4]

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**3**




A girl, of mass 40 kg, slides down a slide in a water park. The girl starts at the point $A$ and slides to the point $B$ which is 7.2 metres vertically below the level of $A$, as shown in the diagram.

**(i)** Given that the slide is smooth and that the girl starts from rest at $A$, find the speed of the girl at $B$. [2]

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**(ii)** It is given instead that the slide is rough. On one occasion the girl starts from rest at $A$ and reaches $B$ with a speed of $10\,\text{m}\,\text{s}^{-1}$. On another occasion the girl is pushed from $A$ with an initial speed $V\,\text{m}\,\text{s}^{-1}$ and reaches $B$ with speed $11\,\text{m}\,\text{s}^{-1}$. Given that the work done against friction is the same on both occasions, find $V$. [3]

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**4** A particle of mass 12 kg is on a rough plane inclined at an angle of 25° to the horizontal. A force of magnitude $P$ N acts on the particle. This force is horizontal and the particle is on the point of moving up a line of greatest slope of the plane. The coefficient of friction between the particle and the plane is 0.8. Find the value of $P$. [6]

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**5** A small rocket is fired vertically upwards, starting from rest at ground level, and moves with constant acceleration. The rocket reaches a height of 200 m after 10 s.

**(i)** Show that the speed of the rocket after 10 s is $40\,\text{m}\,\text{s}^{-1}$ and find the acceleration of the rocket during the first 10 s. [4]

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**(ii)** After 10 s, the rocket's fuel stops burning and there is no upward force acting on the rocket. Find the maximum height above ground level reached by the rocket. [2]

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**(iii)** Find the total time from the instant the rocket is fired until it returns to the ground. [4]

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**6** A car of mass 1200 kg has a greatest possible constant speed of $60\,\text{m s}^{-1}$ along a straight level road. When the car is travelling at a speed of $v\,\text{m s}^{-1}$ there is a resistive force of magnitude $35v$ N.

**(i)** Find the greatest possible power of the car. [2]

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**(ii)** The car travels along a straight level road. Show that, at an instant when its speed is $30\,\text{m s}^{-1}$, the greatest possible acceleration of the car is $2.625\,\text{m s}^{-2}$. [3]

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**(iii)** The car travels at a constant speed up a hill inclined at an angle of $\sin^{-1}\left(\frac{7}{48}\right)$ to the horizontal. Find the greatest possible speed of the car. [5]

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**7** A particle $P$ moves in a straight line. The velocity $v\,\text{m s}^{-1}$ at time $t$ s is given by

$$v = 4 + 0.2t \qquad \text{for } 0 \leqslant t \leqslant 10,$$

$$v = -2 + \frac{800}{t^2} \qquad \text{for } 10 \leqslant t \leqslant 20.$$

**(i)** Find the acceleration of $P$ during the first 10 s. [1]

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**(ii)** Find the acceleration of $P$ when $t = 20$. [2]

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**(iii)** Sketch the velocity-time graph for $0 \leqslant t \leqslant 20$. [3]

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**(iv)** Find the total distance travelled by $P$ in the interval $0 \leqslant t \leqslant 20$. [5]

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## Additional Page

If you use the following lined page to complete the answer(s) to any question(s), the question number(s) must be clearly shown.

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