Cambridge International AS & A Level

**Cambridge Assessment International Education**
Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME

CENTRE NUMBER | | | | | |

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*3771035418*

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

Paper 4 Mechanics 1 **(M1)** **February/March 2019**

**1 hour 15 minutes**

Candidates answer on the Question Paper.

Additional Materials: List of Formulae (MF9)

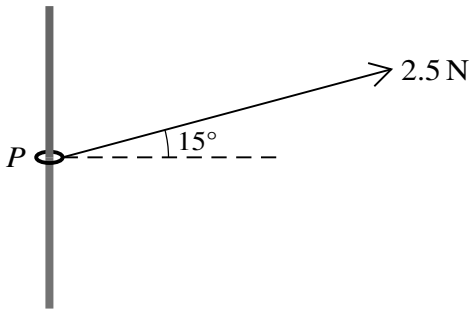
**READ THESE INSTRUCTIONS FIRST**

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.

**1**




A small ring $P$ of mass 0.03 kg is threaded on a rough vertical rod. A light inextensible string is attached to the ring and is pulled upwards at an angle of 15° to the horizontal. The tension in the string is 2.5 N (see diagram). The ring is in limiting equilibrium and on the point of sliding up the rod. Find the coefficient of friction between the ring and the rod. [4]

**2** A particle is projected vertically upwards with speed $30\,\text{m}\,\text{s}^{-1}$ from a point on horizontal ground.

**(i)** Show that the maximum height above the ground reached by the particle is 45 m. [2]

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**(ii)** Find the time that it takes for the particle to reach a height of 33.75 m above the ground for the first time. Find also the speed of the particle at this time. [4]

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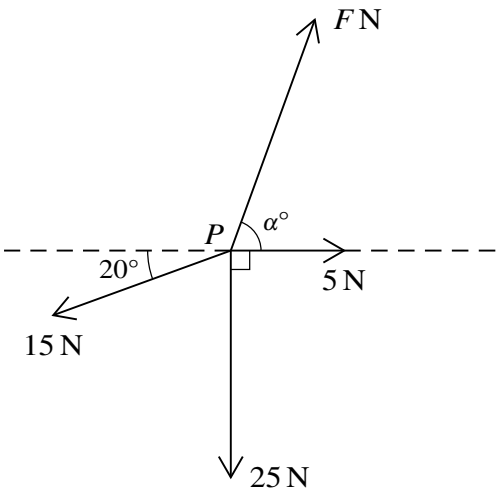
**3**




Four coplanar forces of magnitudes $F$ N, 5 N, 25 N and 15 N are acting at a point $P$ in the directions shown in the diagram. Given that the forces are in equilibrium, find the values of $F$ and $\alpha$. [6]

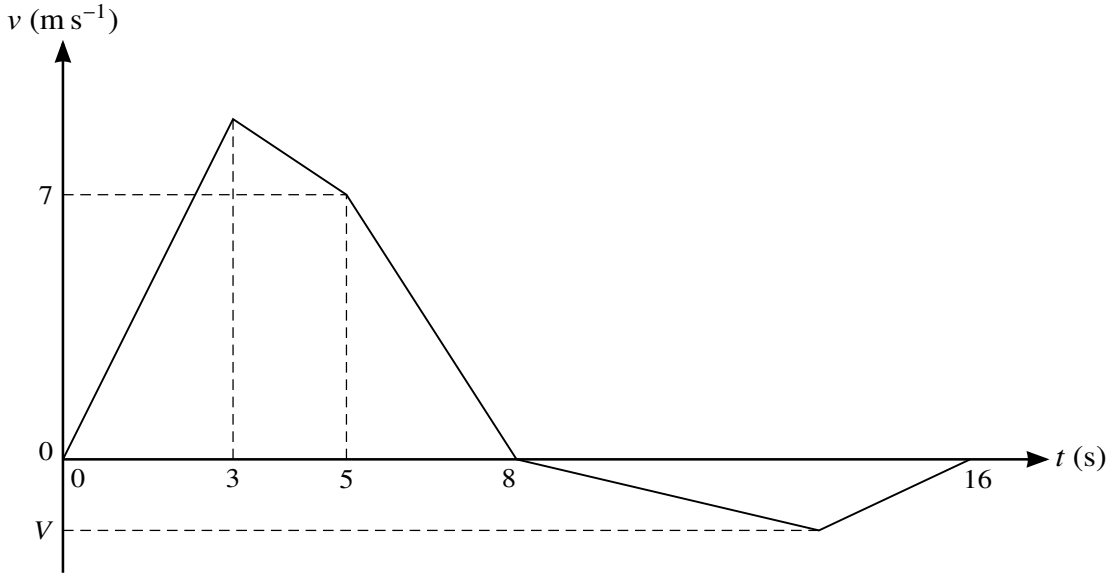
**4** A car of mass 1500 kg is pulling a trailer of mass 300 kg along a straight horizontal road at a constant speed of $20\,\text{m}\,\text{s}^{-1}$. The system of the car and trailer is modelled as two particles, connected by a light rigid horizontal rod. The power of the car's engine is 6000 W. There are constant resistances to motion of $R$ N on the car and 80 N on the trailer.

**(i)** Find the value of $R$. [2]

The power of the car's engine is increased to 12 500 W. The resistance forces do not change.

**(ii)** Find the acceleration of the car and trailer and the tension in the rod at an instant when the speed of the car is $25\ \text{m s}^{-1}$. [5]

**5**




The velocity of a particle moving in a straight line is $v$ m s$^{-1}$ at time $t$ seconds after leaving a fixed point $O$. The diagram shows a velocity-time graph which models the motion of the particle from $t = 0$ to $t = 16$. The graph consists of five straight line segments. The acceleration of the particle from $t = 0$ to $t = 3$ is 3 m s$^{-2}$. The velocity of the particle at $t = 5$ is 7 m s$^{-1}$ and it comes to instantaneous rest at $t = 8$. The particle then comes to rest again at $t = 16$. The minimum velocity of the particle is $V$ m s$^{-1}$.

**(i)** Find the distance travelled by the particle in the first 8 s of its motion. [3]

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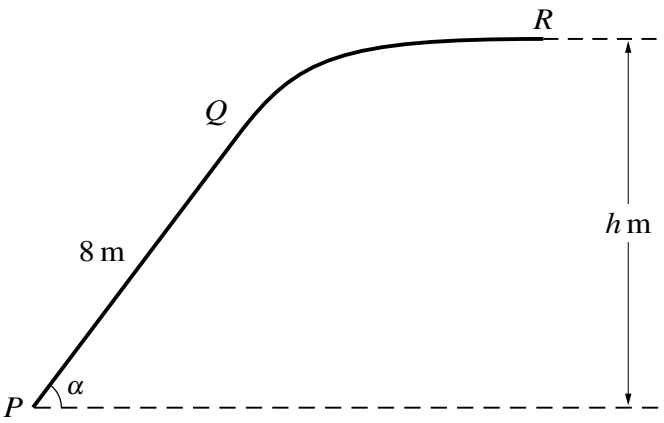
**(ii)** Given that when the particle comes to rest at $t = 16$ its displacement from $O$ is 32 m, find the value of $V$. [4]

**6** A particle moves in a straight line. It starts from rest at a fixed point $O$ on the line. Its acceleration at time $t$ s after leaving $O$ is $a$ m s$^{-2}$, where $a = 0.4t^3 - 4.8t^{\frac{1}{2}}$.

**(i)** Show that, in the subsequent motion, the acceleration of the particle when it comes to instantaneous rest is 16 m s$^{-2}$. [6]

**(ii)** Find the displacement of the particle from $O$ at $t = 5$. [3]

**7**




The diagram shows the vertical cross-section $PQR$ of a slide. The part $PQ$ is a straight line of length 8 m inclined at angle $\alpha$ to the horizontal, where $\sin\alpha = 0.8$. The straight part $PQ$ is tangential to the curved part $QR$, and $R$ is $h$ m above the level of $P$. The straight part $PQ$ of the slide is rough and the curved part $QR$ is smooth. A particle of mass 0.25 kg is projected with speed 15 m s$^{-1}$ from $P$ towards $Q$ and comes to rest at $R$. The coefficient of friction between the particle and $PQ$ is 0.5.

**(i)** Find the work done by the friction force during the motion of the particle from $P$ to $Q$. [4]

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**(ii)** Hence find the speed of the particle at $Q$. [4]

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**(iii)** Find the value of $h$. [3]

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## Additional Page

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