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Cambridge Assessment International Education

# Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

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**MATHEMATICS** **9709/45**

Paper 4 Mechanics **October/November 2025**

**1 hour 15 minutes**

You must answer on the question paper.

You will need: List of formulae (MF19)

**INSTRUCTIONS**

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- If additional space is needed, you should use the lined page at the end of this booklet; the question number or numbers must be clearly shown.
- You should use a calculator where appropriate.
- You must show all necessary working clearly; no marks will be given for unsupported answers from a calculator.
- Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place for angles in degrees, unless a different level of accuracy is specified in the question.
- Where a numerical value for the acceleration due to gravity ($g$) is needed, use $10\,\text{m}\,\text{s}^{-2}$.

**INFORMATION**

- The total mark for this paper is 50.
- The number of marks for each question or part question is shown in brackets [ ].

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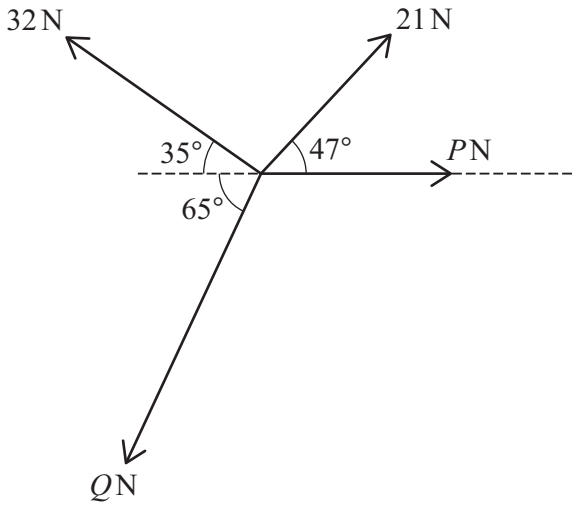
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**1**




Coplanar forces of magnitudes $P$ N, $Q$ N, 32 N and 21 N act at a point in the directions shown in the diagram. The forces are in equilibrium.

Find the value of $P$ and the value of $Q$. [5]

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**2** An athlete runs along a straight horizontal road. The athlete starts from rest and accelerates at $0.5\,\text{m s}^{-2}$ reaching a speed of $V\,\text{m s}^{-1}$. The athlete maintains this speed of $V\,\text{m s}^{-1}$ for $T$s before decelerating at $0.2\,\text{m s}^{-2}$ back to rest. The athlete covers a total distance of 1350 m in 246 seconds.

**(a)** Sketch the velocity-time graph for the motion of the athlete. [1]




**(b)** Find $T$ in terms of $V$, and hence show that $7V^2 - 492V + 2700 = 0$. [4]

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**(c)** Find the value of $V$, giving a justification for your answer. [2]

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**3** A car of mass 800 kg is moving on a straight road.

When the car is moving at a constant speed of $20\,\text{m}\,\text{s}^{-1}$ on a horizontal section of the road, the engine of the car is working at $P$ W.

When the car is moving at a constant speed of $12\,\text{m}\,\text{s}^{-1}$ up a section of the road inclined at $\sin^{-1} 0.15$ to the horizontal, the engine of the car is also working at $P$ W.

On both sections of the road there is a constant force of magnitude $R$ N resisting the motion of the car.

**(a)** Find the value of $R$ and the value of $P$. [5]

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**(b)** Find the acceleration of the car when it is moving at $10\,m\,s^{-1}$ up the inclined section of the road with the engine working at 32 kW. [3]

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**4** A particle $P$ moves in a straight line. At time $t$ s after leaving a point $O$ on the line, the acceleration $a\,\text{m s}^{-2}$ of $P$ is given by $a = kt - 3$, where $k$ is a positive constant. At time $t = 0$, the velocity of $P$ is $1\,\text{m s}^{-1}$.

**(a)** Given that $P$ is never at instantaneous rest, show that $k > 4.5$. [4]

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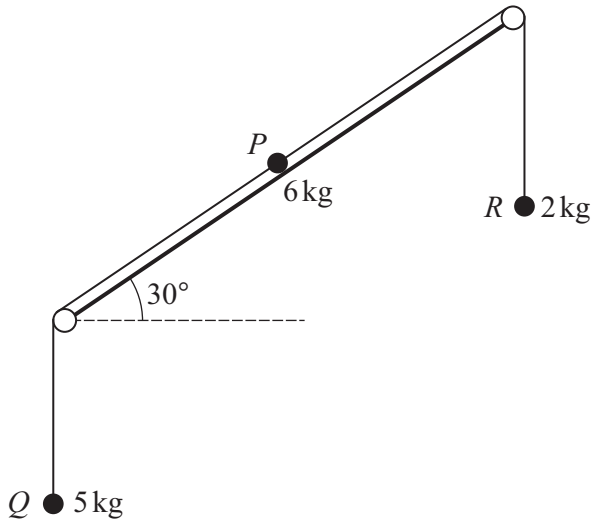
**(b)** Given instead that $k = 2.5$, find the total distance travelled by $P$ in the interval $1 \leqslant t \leqslant 3$. [6]

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**5**




The diagram shows a particle $P$ of mass 6 kg on a rough plane inclined at an angle of 30° to the horizontal. Two light inextensible strings are attached to $P$. The strings pass over small smooth pulleys, which are fixed at the ends of the plane. The non-vertical parts of the string are parallel to a line of greatest slope of the plane. Particles $Q$ and $R$, of masses 5 kg and 2 kg respectively, hang vertically at the ends of the strings.

Both strings are taut, and the system is released from rest.

It is given that the tension in the string attached to $Q$ is twice the tension in the string attached to $R$.

**(a)** Find, in terms of $g$, the tension in each of the strings and the magnitude of the acceleration of the particles. [5]

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**(b)** Find the coefficient of friction between $P$ and the plane. [5]

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**(c)** It is given that when the system is released from rest, $P$ is at the midpoint of the plane. In the subsequent motion, $R$ does not reach the pulley at the top of the plane, and $P$ takes 1.5 s to reach the pulley at the bottom of the plane.

Find the total length of the plane. [2]

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**6** Two particles $A$ and $B$ of masses $km$ and $m$ respectively, where $k$ and $m$ are constants, are free to move in a straight line on a smooth horizontal plane. Particle $A$ is projected towards $B$ with speed $2u$ and at the same instant $B$ is projected towards $A$ with speed $u$.

The particles collide. After the collision the speed of $A$ is $u$ and both particles move in the same direction as $A$'s original motion.

It is given that 35% of the total kinetic energy is lost in the collision. Find, in terms of $u$, the speed of $B$ after the collision. [8]

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