Cambridge Assessment International Education

# Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER | | | | | |

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*4965349912*

**MATHEMATICS** **9709/43**

Paper 4 Mechanics **May/June 2023**

**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 [ ].

This document has **12** pages.


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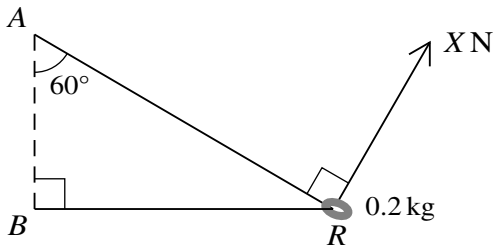
**1** Two particles $P$ and $Q$, of masses 0.1 kg and 0.4 kg respectively, are free to move on a smooth horizontal plane. Particle $P$ is projected with speed $4\,\text{m}\,\text{s}^{-1}$ towards $Q$ which is stationary. After $P$ and $Q$ collide, the speeds of $P$ and $Q$ are equal.

Find the two possible values of the speed of $P$ after the collision. [3]

**2** A car of mass 1500 kg is towing a trailer of mass $m$ kg along a straight horizontal road. The car and the trailer are connected by a tow-bar which is horizontal, light and rigid. There is a resistance force of $F$ N on the car and a resistance force of 200 N on the trailer. The driving force of the car's engine is 3200 N, the acceleration of the car is $1.25\,\text{m s}^{-2}$ and the tension in the tow-bar is 300 N.

Find the value of $m$ and the value of $F$. [4]

**3**




A smooth ring $R$ of mass 0.2 kg is threaded on a light string $ARB$. The ends of the string are attached to fixed points $A$ and $B$ with $A$ vertically above $B$. The string is taut and angle $ABR = 90°$. The angle between the part $AR$ of the string and the vertical is 60°. The ring is held in equilibrium by a force of magnitude $X$ N, acting on the ring in a direction perpendicular to $AR$ (see diagram).

Calculate the tension in the string and the value of $X$. [5]

**4** A lorry of mass 15 000 kg moves on a straight horizontal road in the direction from $A$ to $B$. It passes $A$ and $B$ with speeds $20\,\text{m s}^{-1}$ and $25\,\text{m s}^{-1}$ respectively. The power of the lorry's engine is constant and there is a constant resistance to motion of magnitude 6000 N. The acceleration of the lorry at $B$ is 0.5 times the acceleration of the lorry at $A$.

**(a)** Show that the power of the lorry's engine is 200 kW, and hence find the acceleration of the lorry when it is travelling at $20\,\text{m s}^{-1}$. [5]

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The lorry begins to ascend a straight hill inclined at 1° to the horizontal. It is given that the power of the lorry's engine and the resistance force do not change.

**(b)** Find the steady speed up the hill that the lorry could maintain. [2]

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**5** A particle starts from rest from a point $O$ and moves in a straight line. The acceleration of the particle at time $t$ s after leaving $O$ is $a\,\text{m s}^{-2}$, where $a = kt^{\frac{1}{2}}$ for $0 \leqslant t \leqslant 9$ and where $k$ is a constant. The velocity of the particle at $t = 9$ is $1.8\,\text{m s}^{-1}$.

**(a)** Show that $k = 0.1$. [3]

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For $t > 9$, the velocity $v\,\text{m s}^{-1}$ of the particle is given by $v = 0.2(t - 9)^2 + 1.8$.

**(b)** Show that the distance travelled in the first 9 seconds is one tenth of the distance travelled between $t = 9$ and $t = 18$. [4]

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**(c)** Find the greatest acceleration of the particle during the first 10 seconds of its motion. [3]

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**6** An elevator is pulled vertically upwards by a cable. The elevator accelerates at $0.4\,\text{m}\,\text{s}^{-2}$ for 5 s, then travels at constant speed for 25 s. The elevator then decelerates at $0.2\,\text{m}\,\text{s}^{-2}$ until it comes to rest.

**(a)** Find the greatest speed of the elevator and hence draw a velocity-time graph for the motion of the elevator. [3]

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**(b)** Find the total distance travelled by the elevator. [2]

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The mass of the elevator is 1200 kg and there is a crate of mass $m$ kg resting on the floor of the elevator.

**(c)** Given that the tension in the cable when the elevator is decelerating is 12 250 N, find the value of $m$. [3]

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**(d)** Find the greatest magnitude of the force exerted on the crate by the floor of the elevator, and state its direction. [3]

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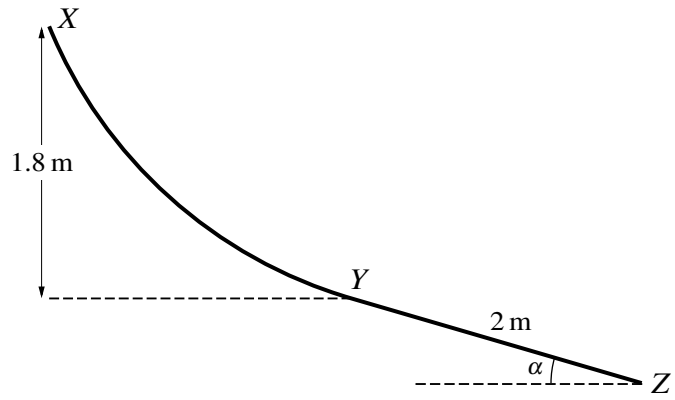
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**7**




The diagram shows the vertical cross-section $XYZ$ of a rough slide. The section $YZ$ is a straight line of length 2 m inclined at an angle of $\alpha$ to the horizontal, where $\sin \alpha = 0.28$. The section $YZ$ is tangential to the curved section $XY$ at $Y$, and $X$ is 1.8 m above the level of $Y$. A child of mass 25 kg slides down the slide, starting from rest at $X$. The work done by the child against the resistance force in moving from $X$ to $Y$ is 50 J.

**(a)** Find the speed of the child at $Y$. [4]

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It is given that the child comes to rest at $Z$.

**(b)** Use an energy method to find the coefficient of friction between the child and $YZ$, giving your answer as a fraction in its simplest form. [6]

## 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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