



## Cambridge International AS & A Level

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**MATHEMATICS**

**9709/43**

Paper 4 Mechanics

**October/November 2022**

**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  $10 \text{ m s}^{-2}$ .

### 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 **16** pages. Any blank pages are indicated.

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1 A particle  $P$  is projected vertically upwards with speed  $u \text{ m s}^{-1}$  from a point on the ground.  $P$  reaches its greatest height after 3 s.

(a) Find  $u$ . [1]

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(b) Find the greatest height of  $P$  above the ground. [2]

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2 A box of mass 5 kg is pulled at a constant speed of  $1.8 \text{ m s}^{-1}$  for 15 s up a rough plane inclined at an angle of  $20^\circ$  to the horizontal. The box moves along a line of greatest slope against a frictional force of 40 N. The force pulling the box is parallel to the line of greatest slope.

(a) Find the change in gravitational potential energy of the box. [2]

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(b) Find the work done by the pulling force. [2]

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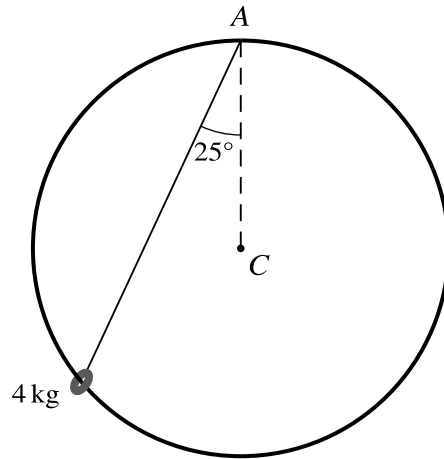
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A ring of mass 4 kg is threaded on a smooth circular rigid wire with centre  $C$ . The wire is fixed in a vertical plane and the ring is kept at rest by a light string connected to  $A$ , the highest point of the circle. The string makes an angle of  $25^\circ$  to the vertical (see diagram).

Find the tension in the string and the magnitude of the normal reaction of the wire on the ring. [6]

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(b) Find the distance travelled by  $P$  during the first 10 seconds of its motion. [2]

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(b) It is given instead that  $AB = 36$  m.

Verify that  $X$  and  $Y$  collide after 3 s.

[2]

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6 A car of mass 1750 kg is pulling a caravan of mass 500 kg. The car and the caravan are connected by a light rigid tow-bar. The resistances to the motion of the car and caravan are 650 N and 150 N respectively.

(a) The car and caravan are moving along a straight horizontal road at a constant speed of  $24 \text{ m s}^{-1}$ .

(i) Find the power of the car's engine. [2]

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(ii) The engine's power is now suddenly increased to 40 kW.

Find the instantaneous acceleration of the car and caravan and find the tension in the tow-bar. [5]

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(b) The car and caravan now travel up a straight hill, inclined at an angle  $\sin^{-1} 0.14$  to the horizontal, at a constant speed of  $v \text{ m s}^{-1}$ . The car's engine is working at 31 kW. The resistances to the motion of the car and caravan are unchanged.

Find  $v$ . [3]

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The 1.5 kg particle is released from rest. In the subsequent motion the two particles collide and coalesce. The time taken for the combined particle to travel from  $B$  to  $C$  is 2 s. The coefficient of friction between the combined particle and the plane is still 0.75.

(b) Find  $x$ . [6]

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(c) Find the total loss of energy of the particles from the time the 1.5 kg particle is released until the combined particle reaches  $C$ . [3]

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