Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME	

CENTRE NUMBER						CANDIDATE NUMBER				

MATHEMATICS **9709/43**

Paper 4 Mechanics **May/June 2021**

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 Particles P of mass 0.4 kg and Q of mass 0.5 kg are free to move on a smooth horizontal plane. P and Q are moving directly towards each other with speeds $2.5\,\mathrm{m\,s^{-1}}$ and $1.5\,\mathrm{m\,s^{-1}}$ respectively. After P and Q collide, the speed of Q is twice the speed of P.

Find the two possible values of the speed of P after the collision. [4]

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2 A cyclist is travelling along a straight horizontal road. She is working at a constant rate of 150 W. At an instant when her speed is $4\,\mathrm{m\,s^{-1}}$, her acceleration is $0.25\,\mathrm{m\,s^{-2}}$. The resistance to motion is 20 N.

(a) Find the total mass of the cyclist and her bicycle. [3]

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The cyclist comes to a straight hill inclined at an angle θ above the horizontal. She ascends the hill at constant speed $3\,\mathrm{m\,s^{-1}}$. She continues to work at the same rate as before and the resistance force is unchanged.

(b) Find the value of θ. [2]

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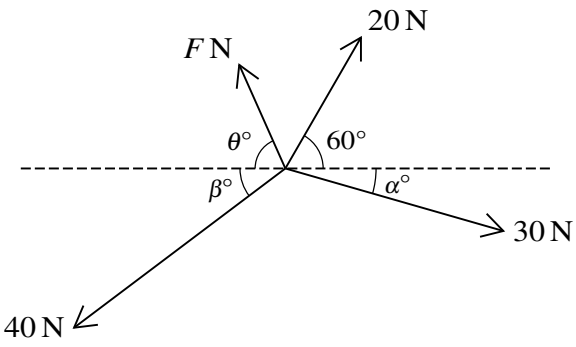

Four coplanar forces act at a point. The magnitudes of the forces are 20 N, 30 N, 40 N and F N. The directions of the forces are as shown in the diagram, where $\sin\alpha° = 0.28$ and $\sin\beta° = 0.6$.

Given that the forces are in equilibrium, find F and θ. [6]

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4 A particle is projected vertically upwards with speed $u\,\mathrm{m\,s^{-1}}$ from a point on horizontal ground. After 2 seconds, the height of the particle above the ground is 24 m.

(a) Show that $u = 22$. [2]

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(b) The height of the particle above the ground is more than h m for a period of 3.6 s.

Find h. [4]

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5 A car of mass 1400 kg is towing a trailer of mass 500 kg down a straight hill inclined at an angle of 5° to the horizontal. The car and trailer are connected by a light rigid tow-bar. At the top of the hill the speed of the car and trailer is $20\,\mathrm{m\,s^{-1}}$ and at the bottom of the hill their speed is $30\,\mathrm{m\,s^{-1}}$.

(a) It is given that as the car and trailer descend the hill, the engine of the car does 150 000 J of work, and there are no resistance forces.

Find the length of the hill. [5]

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(b) It is given instead that there is a resistance force of 100 N on the trailer, the length of the hill is 200 m, and the acceleration of the car and trailer is constant.

Find the tension in the tow-bar between the car and trailer. [4]

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6 A particle moves in a straight line and passes through the point A at time $t = 0$. The velocity of the particle at time t s after leaving A is v m s^{-1}, where

$$v = 2t^2 - 5t + 3.$$

(a) Find the times at which the particle is instantaneously at rest. Hence or otherwise find the minimum velocity of the particle. [4]

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(b) Sketch the velocity-time graph for the first 3 seconds of motion. [3]

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(c) Find the distance travelled between the two times when the particle is instantaneously at rest. [3]

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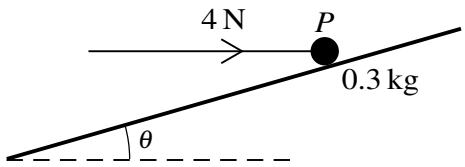

A particle P of mass 0.3 kg rests on a rough plane inclined at an angle θ to the horizontal, where $\sin\theta = \frac{7}{25}$. A horizontal force of magnitude 4 N, acting in the vertical plane containing a line of greatest slope of the plane, is applied to P (see diagram). The particle is on the point of sliding up the plane.

(a) Show that the coefficient of friction between the particle and the plane is $\frac{3}{4}$. [4]

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The force acting horizontally is replaced by a force of magnitude 4 N acting up the plane parallel to a line of greatest slope.

(b) Find the acceleration of P. [3]

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(c) Starting with P at rest, the force of 4 N parallel to the plane acts for 3 seconds and is then removed.

Find the total distance travelled until P comes to instantaneous rest. [3]

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Additional Page

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