GradeMax

Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER | | | | | |

CANDIDATE NUMBER | | | | |

2275268691

MATHEMATICS **9709/43**

Paper 4 Mechanics **October/November 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 [ ].

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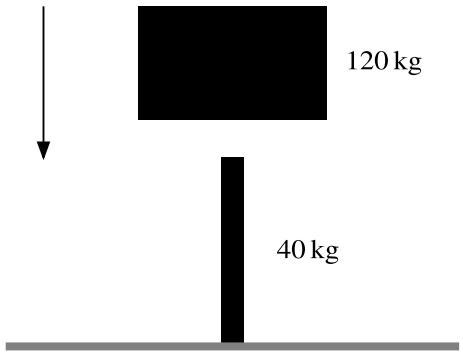
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A metal post is driven vertically into the ground by dropping a heavy object onto it from above. The mass of the object is 120 kg and the mass of the post is 40 kg (see diagram). The object hits the post with speed 8 m s^{-1} and remains in contact with it after the impact.

(a) Calculate the speed with which the combined post and object moves immediately after the impact. [2]

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(b) There is a constant force resisting the motion of magnitude 4800 N.

Calculate the distance the post is driven into the ground. [3]

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2 A particle of mass 8 kg is suspended in equilibrium by two light inextensible strings which make angles of 60° and 45° above the horizontal.

(a) Draw a diagram showing the forces acting on the particle. [1]

(b) Find the tensions in the strings. [6]

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3 A ball of mass 1.6 kg is released from rest at a point 5 m above horizontal ground. When the ball hits the ground it instantaneously loses 8 J of kinetic energy and starts to move upwards.

(a) Use an energy method to find the greatest height that the ball reaches after hitting the ground. [3]

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(b) Find the total time taken, from the initial release of the ball until it reaches this greatest height. [3]

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4 A car of mass 1400 kg is moving on a straight road against a constant force of 1250 N resisting the motion.

(a) The car moves along a horizontal section of the road at a constant speed of $36\,m\,s^{-1}$.

(i) Calculate the work done against the resisting force during the first 8 seconds. [2]

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(ii) Calculate, in kW, the power developed by the engine of the car. [2]

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(iii) Given that this power is suddenly increased by 12 kW, find the instantaneous acceleration of the car. [3]

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(b) The car now travels at a constant speed of $32\,\text{m}\,\text{s}^{-1}$ up a section of the road inclined at $\theta°$ to the horizontal, with the engine working at 64 kW.

Find the value of θ. [2]

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5 A particle P moves in a straight line, starting from rest at a point O on the line. At time t s after leaving O the acceleration of P is $k(16 - t^2)$ m s^{-2}, where k is a positive constant, and the displacement from O is s m. The velocity of P is 8 m s^{-1} when $t = 4$.

(a) Show that $s = \frac{1}{64}t^2(96 - t^2)$. [5]

(b) Find the speed of P at the instant that it returns to O. [3]

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(c) Find the maximum displacement of the particle from O. [3]

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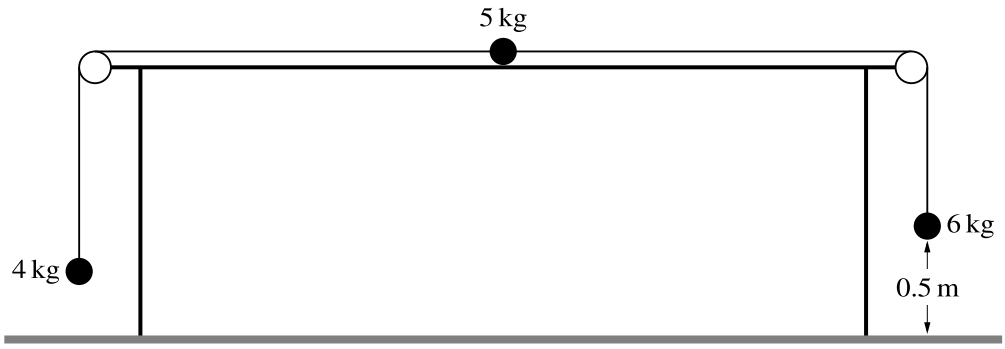
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The diagram shows a particle of mass 5 kg on a rough horizontal table, and two light inextensible strings attached to it passing over smooth pulleys fixed at the edges of the table. Particles of masses 4 kg and 6 kg hang freely at the ends of the strings. The particle of mass 6 kg is 0.5 m above the ground. The system is in limiting equilibrium.

(a) Show that the coefficient of friction between the 5 kg particle and the table is 0.4. [2]

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The 6 kg particle is now replaced by a particle of mass 8 kg and the system is released from rest.

(b) Find the acceleration of the 4 kg particle and the tensions in the strings. [5]

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(c) In the subsequent motion the 8 kg particle hits the ground and does not rebound.

Find the time that elapses after the 8 kg particle hits the ground before the other two particles come to instantaneous rest. (You may assume this occurs before either particle reaches a pulley.) [5]

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