

Cambridge International AS & A Level

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MATHEMATICS

9709/42

Paper 4 Mechanics

February/March 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 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 [].

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- 1** A crane is used to raise a block of mass 600 kg vertically upwards at a constant speed through a height of 15 m. There is a resistance to the motion of the block, which the crane does 10 000 J of work to overcome.

(a) Find the total work done by the crane.

[2]

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- (b) Given that the average power exerted by the crane is 12.5 kW, find the total time for which the block is in motion.

[2]

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- 2 A particle P is projected vertically upwards from horizontal ground with speed $u \text{ m s}^{-1}$. P reaches a maximum height of 20 m above the ground.

(a) Find the value of u .

[2]

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(b) Find the total time for which P is at least 15 m above the ground.

[3]

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- 3** A car of mass m kg is towing a trailer of mass 300 kg down a straight hill inclined at 3° to the horizontal at a constant speed. There are resistance forces on the car and on the trailer, and the total work done against the resistance forces in a distance of 50 m is 40 000 J. The engine of the car is doing no work and the tow-bar is light and rigid.

(a) Find the value of m . [3]

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The resistance force on the trailer is 200 N.

(b) Find the tension in the tow-bar between the car and the trailer. [2]

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- 4 The total mass of a cyclist and her bicycle is 70 kg. The cyclist is riding with constant power of 180 W up a straight hill inclined at an angle α to the horizontal, where $\sin \alpha = 0.05$. At an instant when the cyclist's speed is 6 m s^{-1} , her acceleration is -0.2 m s^{-2} . There is a constant resistance to motion of magnitude $F \text{ N}$.

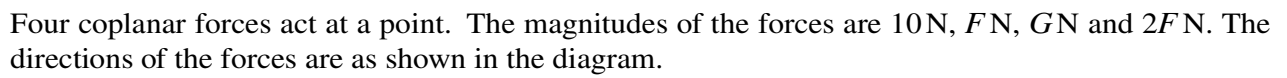
(a) Find the value of F .

[4]

[illegible]

- (b)** Find the steady speed that the cyclist could maintain up the hill when working at this power. [2]

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- (b) Given instead that $F = 3$, find the value of G for which the resultant of the forces is perpendicular to the 10 N force. [2]

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- 6** A cyclist starts from rest at a fixed point O and moves in a straight line, before coming to rest k seconds later. The acceleration of the cyclist at time t s after leaving O is $a \text{ m s}^{-2}$, where $a = 2t^{-\frac{1}{2}} - \frac{3}{5}t^{\frac{1}{2}}$ for $0 < t \leq k$.

(a) Find the value of k .

[4]

[illegible]

(b) Find the maximum speed of the cyclist.

[3]

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- (c) Find an expression for the displacement from O in terms of t . Hence find the total distance travelled by the cyclist from the time at which she reaches her maximum speed until she comes to rest. [4]

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- 7 A bead, A , of mass 0.1 kg is threaded on a long straight rigid wire which is inclined at $\sin^{-1}(\frac{7}{25})$ to the horizontal. A is released from rest and moves down the wire. The coefficient of friction between A and the wire is μ . When A has travelled 0.45 m down the wire, its speed is 0.6 m s^{-1} .

(a) Show that $\mu = 0.25$.

[6]

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