Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

5307579194

MATHEMATICS **9709/43**

Paper 4 Mechanics 1 **(M1)** **May/June 2018**

1 hour 15 minutes

Candidates answer on the Question Paper.

Additional Materials: List of Formulae (MF9)

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name in the spaces at the top of this page.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** the questions in the space provided. If additional space is required, you should use the lined page at the end of this booklet. The question number(s) must be clearly shown.
Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place in the case of angles in degrees, unless a different level of accuracy is specified in the question.
Where a numerical value for the acceleration due to gravity is needed, use $10\,\text{m}\,\text{s}^{-2}$.
The use of an electronic calculator is expected, where appropriate.
You are reminded of the need for clear presentation in your answers.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.
The total number of marks for this paper is 50.

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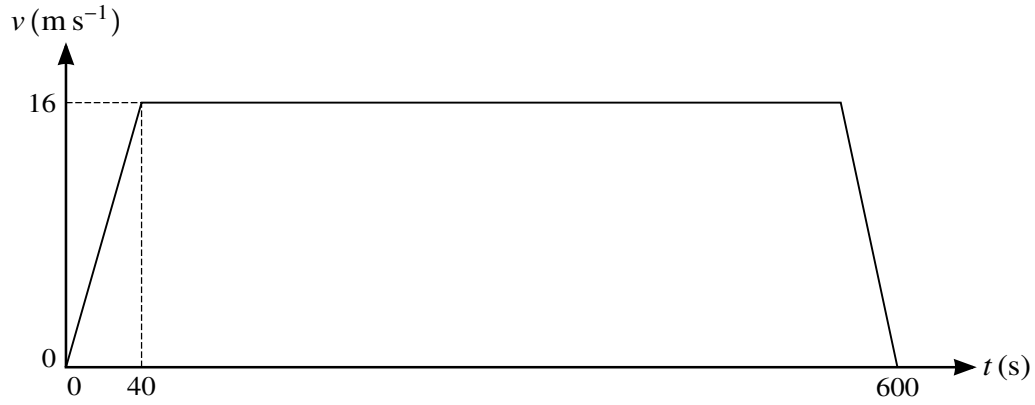

The diagram shows the velocity-time graph for a train which travels from rest at one station to rest at the next station. The graph consists of three straight line segments. The distance between the two stations is 9040 m.

(i) Find the acceleration of the train during the first 40 s. [1]

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(ii) Find the length of time for which the train is travelling at constant speed. [2]

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(iii) Find the distance travelled by the train while it is decelerating. [2]

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2 A small ball is projected vertically downwards with speed $5\,\text{m}\,\text{s}^{-1}$ from a point A at a height of 7.2 m above horizontal ground. The ball hits the ground with speed $V\,\text{m}\,\text{s}^{-1}$ and rebounds vertically upwards with speed $\frac{1}{2}V\,\text{m}\,\text{s}^{-1}$. The highest point the ball reaches after rebounding is B. Find V and hence find the total time taken for the ball to reach the ground from A and rebound to B. [5]

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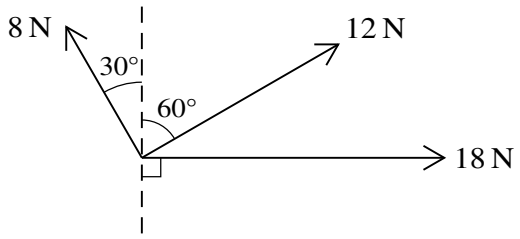

Coplanar forces of magnitudes 8 N, 12 N and 18 N act at a point in the directions shown in the diagram. Find the magnitude and direction of the single additional force acting at the same point which will produce equilibrium. [6]

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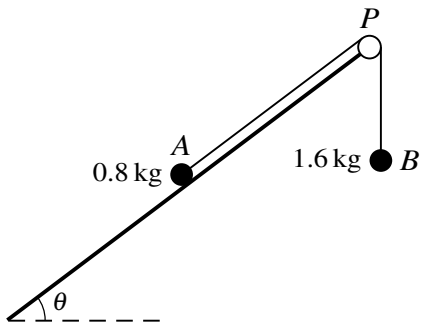

Two particles A and B, of masses 0.8 kg and 1.6 kg respectively, are connected by a light inextensible string. Particle A is placed on a smooth plane inclined at an angle θ to the horizontal, where $\sin\theta = \frac{3}{5}$. The string passes over a small smooth pulley P fixed at the top of the plane, and B hangs freely (see diagram). The section AP of the string is parallel to a line of greatest slope of the plane. The particles are released from rest with both sections of the string taut. Use an energy method to find the speed of the particles after each particle has moved a distance of 0.5 m, assuming that A has not yet reached the pulley. [6]

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5 A particle of mass 3 kg is on a rough plane inclined at an angle of 20° to the horizontal. A force of magnitude P N acting parallel to a line of greatest slope of the plane is used to keep the particle in equilibrium. The coefficient of friction between the particle and the plane is 0.35. Show that the least possible value of P is 0.394, correct to 3 significant figures, and find the greatest possible value of P. [6]

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6 A car of mass 1400 kg travelling at a speed of v m s^{-1} experiences a resistive force of magnitude $40v$ N. The greatest possible constant speed of the car along a straight level road is 56 m s^{-1}.

(i) Find, in kW, the greatest possible power of the car's engine. [2]

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(ii) Find the greatest possible acceleration of the car at an instant when its speed on a straight level road is 32 m s^{-1}. [3]

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(iii) The car travels down a hill inclined at an angle of $\theta°$ to the horizontal at a constant speed of $50\,\text{m}\,\text{s}^{-1}$. The power of the car's engine is 60 kW. Find the value of θ. [4]

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7 A particle P moves in a straight line starting from a point O. The velocity $v\,\text{m}\,\text{s}^{-1}$ of P at time $t\,\text{s}$ is given by

$$v = 12t - 4t^2 \quad \text{for } 0 \leqslant t \leqslant 2,$$
$$v = 16 - 4t \quad \text{for } 2 \leqslant t \leqslant 4.$$

(i) Find the maximum velocity of P during the first 2 s. [3]

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(ii) Determine, with justification, whether there is any instantaneous change in the acceleration of P when $t = 2$. [2]

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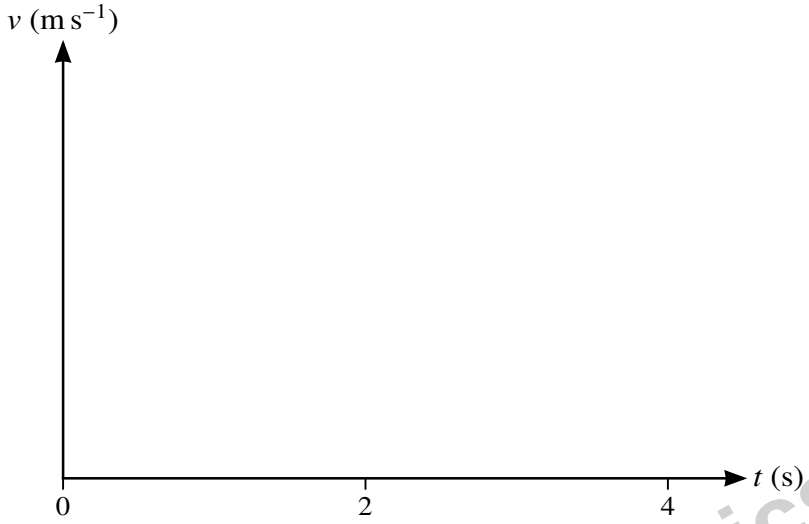
(iii) Sketch the velocity-time graph for $0 \leqslant t \leqslant 4$. [3]



(iv) Find the distance travelled by P in the interval $0 \leqslant t \leqslant 4$. [5]

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Additional Page

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