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Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

4405618753

MATHEMATICS **9709/42**

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 A particle of mass 0.6 kg is projected with a speed of 4 m s^{-1} down a line of greatest slope of a smooth plane inclined at 10° to the horizontal.

Use an energy method to find the speed of the particle after it has moved 15 m down the plane. [3]

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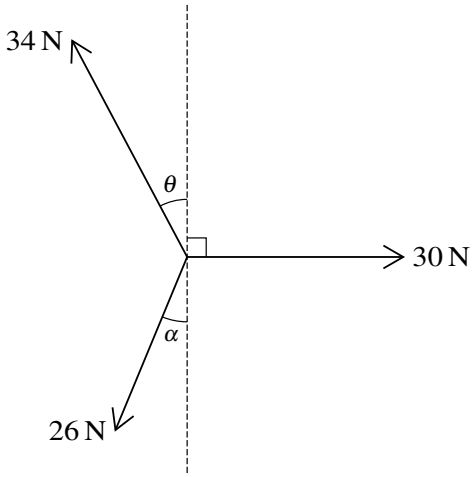

Coplanar forces of magnitudes 34 N, 30 N and 26 N act at a point in the directions shown in the diagram.

Given that $\sin\alpha = \frac{5}{13}$ and $\sin\theta = \frac{8}{17}$, find the magnitude and direction of the resultant of the three forces. [6]

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3 A ring of mass 0.3 kg is threaded on a horizontal rough rod. The coefficient of friction between the ring and the rod is 0.8. A force of magnitude 8 N acts on the ring. This force acts at an angle of 10° above the horizontal in the vertical plane containing the rod.

Find the time taken for the ring to move, from rest, 0.6 m along the rod. [6]

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4 A particle of mass 12 kg is stationary on a rough plane inclined at an angle of 25° to the horizontal. A pulling force of magnitude P N acts at an angle of 8° above a line of greatest slope of the plane. This force is used to keep the particle in equilibrium. The coefficient of friction between the particle and the plane is 0.3.

Find the greatest possible value of P. [6]

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5 A car of mass 1250 kg is pulling a caravan of mass 800 kg along a straight road. The resistances to the motion of the car and caravan are 440 N and 280 N respectively. The car and caravan are connected by a light rigid tow-bar.

(a) The car and caravan move along a horizontal part of the road at a constant speed of $30\,\text{m}\,\text{s}^{-1}$.

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

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(ii) Given that this power is suddenly decreased by 8 kW, find the instantaneous deceleration of the car and caravan and the tension in the tow-bar. [4]

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(b) The car and caravan now travel along a part of the road inclined at $\sin^{-1} 0.06$ to the horizontal. The car and caravan travel up the incline at constant speed with the engine of the car working at 28 kW.

(i) Find this constant speed. [3]

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(ii) Find the increase in the potential energy of the caravan in one minute. [2]

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6 A particle A is projected vertically upwards from level ground with an initial speed of $30\,\text{m}\,\text{s}^{-1}$. At the same instant a particle B is released from rest 15 m vertically above A. The mass of one of the particles is twice the mass of the other particle. During the subsequent motion A and B collide and coalesce to form particle C.

Find the difference between the two possible times at which C hits the ground. [8]

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7 A particle P moving in a straight line starts from rest at a point O and comes to rest 16 s later. At time t s after leaving O, the acceleration a m s^{-2} of P is given by

$$\begin{aligned} a &= 6 + 4t \qquad 0 \leqslant t < 2, \\ a &= 14 \qquad\quad 2 \leqslant t < 4, \\ a &= 16 - 2t \qquad 4 \leqslant t \leqslant 16. \end{aligned}$$

There is no sudden change in velocity at any instant.

(a) Find the values of t when the velocity of P is 55 m s^{-1}. [5]

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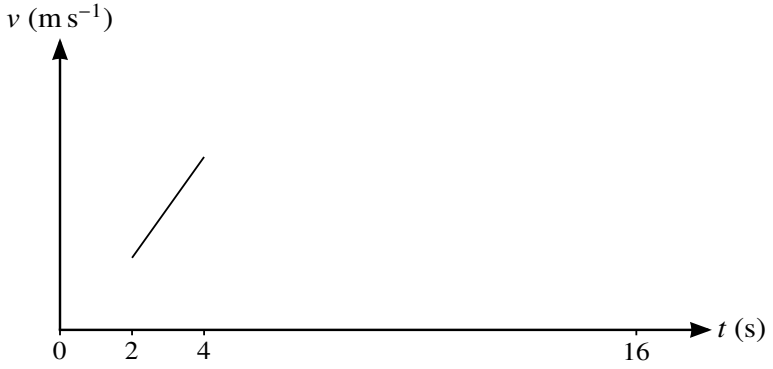
(b) Complete the sketch of the velocity-time diagram. [2]



(c) Find the distance travelled by P when it is decelerating. [3]

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