Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

MATHEMATICS **9709/42**

Paper 4 Mechanics 1 **(M1)** **May/June 2016**

1 hour 15 minutes

Additional Materials: List of Formulae (MF9)

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READ THESE INSTRUCTIONS FIRST

An answer booklet is provided inside this question paper. You should follow the instructions on the front cover of the answer booklet. If you need additional answer paper ask the invigilator for a continuation booklet.

Answer **all** the questions.
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.

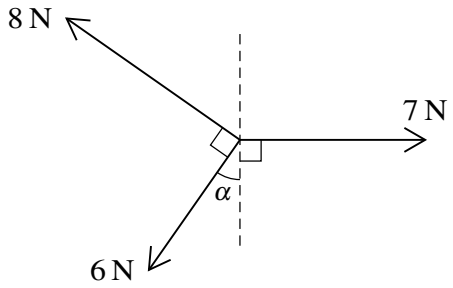
At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.
The total number of marks for this paper is 50.

This document consists of **3** printed pages, **1** blank page and **1** insert.

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1



Coplanar forces of magnitudes 7 N, 6 N and 8 N act at a point in the directions shown in the diagram. Given that $\sin\alpha = \frac{3}{5}$, find the magnitude and direction of the resultant of the three forces. [5]

2 A particle P moves in a straight line, starting from a point O. At time t s after leaving O, the velocity of P, v m s^{-1}, is given by $v = 4t^2 - 8t + 3$.

(i) Find the two values of t at which P is at instantaneous rest. [2]

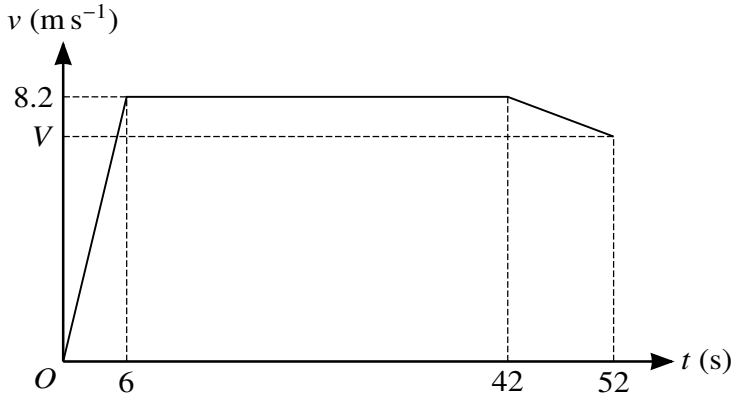
(ii) Find the distance travelled by P between these two times. [3]

3 A particle of mass 8 kg is projected with a speed of 5 m s^{-1} up a line of greatest slope of a rough plane inclined at an angle α to the horizontal, where $\sin\alpha = \frac{5}{13}$. The motion of the particle is resisted by a constant frictional force of magnitude 15 N. The particle comes to instantaneous rest after travelling a distance x m up the plane.

(i) Express the change in gravitational potential energy of the particle in terms of x. [2]

(ii) Use an energy method to find x. [4]

4



A sprinter runs a race of 400 m. His total time for running the race is 52 s. The diagram shows the velocity-time graph for the motion of the sprinter. He starts from rest and accelerates uniformly to a speed of 8.2 m s^{-1} in 6 s. The sprinter maintains a speed of 8.2 m s^{-1} for 36 s, and he then decelerates uniformly to a speed of V m s^{-1} at the end of the race.

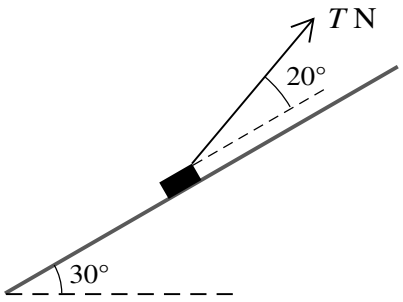
(i) Calculate the distance covered by the sprinter in the first 42 s of the race. [2]

(ii) Show that $V = 7.84$. [3]

(iii) Calculate the deceleration of the sprinter in the last 10 s of the race. [2]

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5



A block of mass 2.5 kg is placed on a plane which is inclined at an angle of 30° to the horizontal. The block is kept in equilibrium by a light string making an angle of 20° above a line of greatest slope. The tension in the string is T N, as shown in the diagram. The coefficient of friction between the block and plane is $\frac{1}{4}$. The block is in limiting equilibrium and is about to move up the plane. Find the value of T. [7]

6 A car of mass 1100 kg is moving on a road against a constant force of 1550 N resisting the motion.

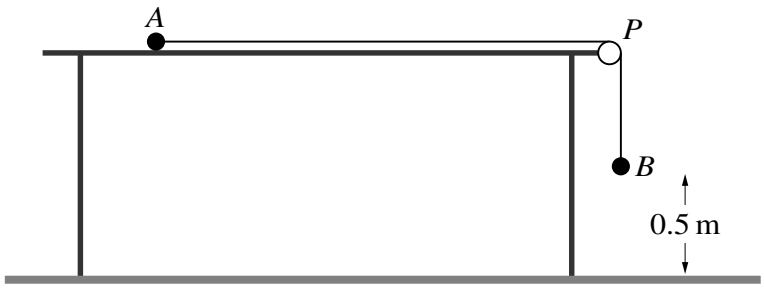
(i) The car moves along a straight horizontal road at a constant speed of 40 m s^{-1}.

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

(b) Given that this power is suddenly decreased by 22 kW, find the instantaneous deceleration of the car. [3]

(ii) The car now travels at constant speed up a straight road inclined at 8° to the horizontal, with the engine working at 80 kW. Assuming the resistance force remains the same, find this constant speed. [3]

7



A particle A of mass 1.6 kg rests on a horizontal table and is attached to one end of a light inextensible string. The string passes over a small smooth pulley P fixed at the edge of the table. The other end of the string is attached to a particle B of mass 2.4 kg which hangs freely below the pulley. The system is released from rest with the string taut and with B at a height of 0.5 m above the ground, as shown in the diagram. In the subsequent motion A does not reach P before B reaches the ground.

(i) Given that the table is smooth, find the time taken by B to reach the ground. [5]

(ii) Given instead that the table is rough and that the coefficient of friction between A and the table is $\frac{3}{8}$, find the total distance travelled by A. You may assume that A does not reach the pulley. [7]

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