Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

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MATHEMATICS **9709/41**

Paper 4 Mechanics 1 **(M1)** **May/June 2014**

1 hour 15 minutes

Additional Materials: Answer Booklet/Paper
Graph Paper
List of Formulae (MF9)

READ THESE INSTRUCTIONS FIRST

If you have been given an Answer Booklet, follow the instructions on the front cover of the Booklet.
Write your Centre number, candidate number and name on all the work you hand in.
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.
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.
Questions carrying smaller numbers of marks are printed earlier in the paper, and questions carrying larger numbers of marks later in the paper.

This document consists of **4** printed pages.

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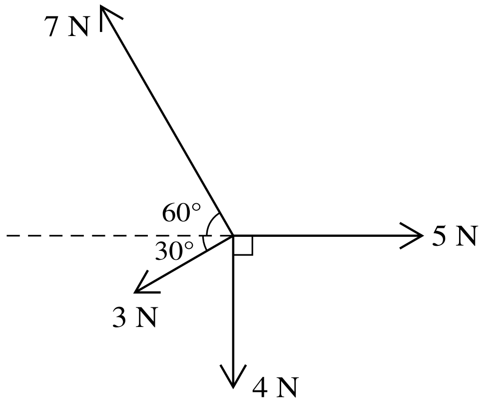
1 A train is moving at constant speed $V\,\mathrm{m\,s^{-1}}$ along a horizontal straight track. Given that the power of the train's engine is 1330 kW and the total resistance to the train's motion is 28 kN, find the value of V. [3]

2 A rough plane is inclined at an angle of $\alpha°$ to the horizontal. A particle of mass 0.25 kg is in equilibrium on the plane. The normal reaction force acting on the particle has magnitude 2.4 N. Find

(i) the value of α, [2]

(ii) the least possible value of the coefficient of friction. [2]

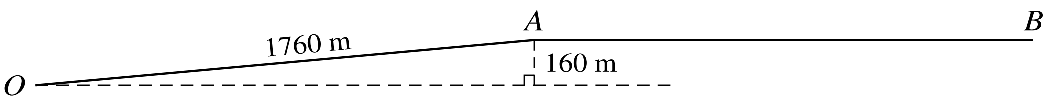
3



Four coplanar forces act at a point. The magnitudes of the forces are 5 N, 4 N, 3 N and 7 N, and the directions in which the forces act are shown in the diagram. Find the magnitude and direction of the resultant of the four forces. [6]

4 A particle is projected vertically upwards with speed $9\,\mathrm{m\,s^{-1}}$ from a point 3.15 m above horizontal ground. The particle moves freely under gravity until it hits the ground. For the particle's motion from the instant of projection until the particle hits the ground, find the total distance travelled and the total time taken. [6]

5



A car of mass 1100 kg starts from rest at O and travels along a road OAB. The section OA is straight, of length 1760 m, and inclined to the horizontal with A at a height of 160 m above the level of O. The section AB is straight and horizontal (see diagram). While the car is moving the driving force of the car is 1800 N and the resistance to the car's motion is 700 N. The speed of the car is $v\,\mathrm{m\,s^{-1}}$ when the car has travelled a distance of x m from O.

(i) For the car's motion from O to A, write down its increase in kinetic energy in terms of v and its increase in potential energy in terms of x. Hence find the value of k for which $kv^2 = x$ for $0 \leqslant x \leqslant 1760$. [4]

(ii) Show that $v^2 = 2x - 3200$ for $x \geqslant 1760$. [4]

6

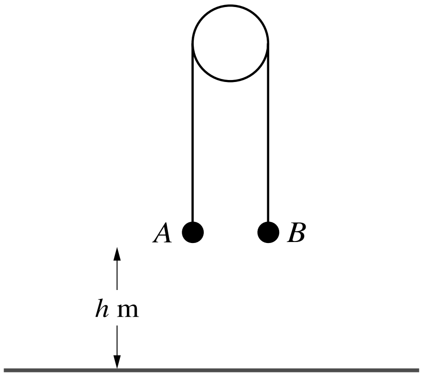


Fig. 1

Particles A of mass 0.25 kg and B of mass 0.75 kg are attached to opposite ends of a light inextensible string which passes over a fixed smooth pulley. The system is held at rest with the string taut and its straight parts vertical. Both particles are at a height of h m above the floor (see Fig. 1). The system is released from rest, and 0.6 s later, when both particles are in motion, the string breaks. The particle A does not reach the pulley in the subsequent motion.

(i) Find the acceleration of A and the distance travelled by A before the string breaks. [4]

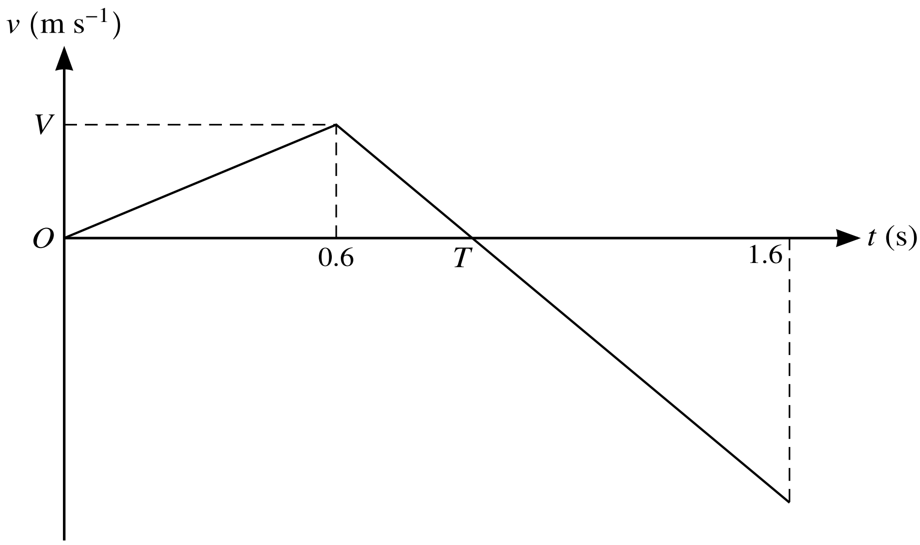


Fig. 2

The velocity-time graph shown in Fig. 2 is for the motion of particle A until it hits the floor. The velocity of A when the string breaks is V m s^{-1} and T s is the time taken for A to reach its greatest height.

(ii) Find the value of V and the value of T. [3]

(iii) Find the distance travelled by A upwards and the distance travelled by A downwards and hence find h. [3]

[Question 7 is printed on the next page.]

7 Two cyclists P and Q travel along a straight road ABC, starting simultaneously at A and arriving simultaneously at C. Both cyclists pass through B 400 s after leaving A. Cyclist P starts with speed $3\,\mathrm{m\,s^{-1}}$ and increases this speed with constant acceleration $0.005\,\mathrm{m\,s^{-2}}$ until he reaches B.

(i) Show that the distance AB is 1600 m and find P's speed at B. [3]

Cyclist Q travels from A to B with speed $v\,\mathrm{m\,s^{-1}}$ at time t seconds after leaving A, where

$$v = 0.04t - 0.0001t^2 + k,$$

and k is a constant.

(ii) Find the value of k and the maximum speed of Q before he has reached B. [6]

Cyclist P travels from B to C, a distance of 1400 m, at the speed he had reached at B. Cyclist Q travels from B to C with constant acceleration $a\,\mathrm{m\,s^{-2}}$.

(iii) Find the time taken for the cyclists to travel from B to C and find the value of a. [4]