



Cambridge International AS & A Level

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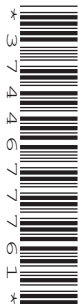
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MATHEMATICS

9709/42

Paper 4 Mechanics

May/June 2024

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 ms^{-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.

- 1 A cyclist and bicycle have a total mass of 72 kg. The cyclist rides along a horizontal road against a total resistance force of 28 N.

Find the total work done by the cyclist to increase his speed from 8 m s^{-1} to 16 m s^{-1} while travelling a distance of 100 metres. [3]

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2 A particle P moves in a straight line. At time t s after leaving a point O on the line, P has velocity v m s^{-1} , where $v = 44t - 6t^2 - 36$.

(a) Find the set of values of t for which the acceleration of the particle is positive. [2]

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(b) Find the two values of t at which P returns to O . [3]

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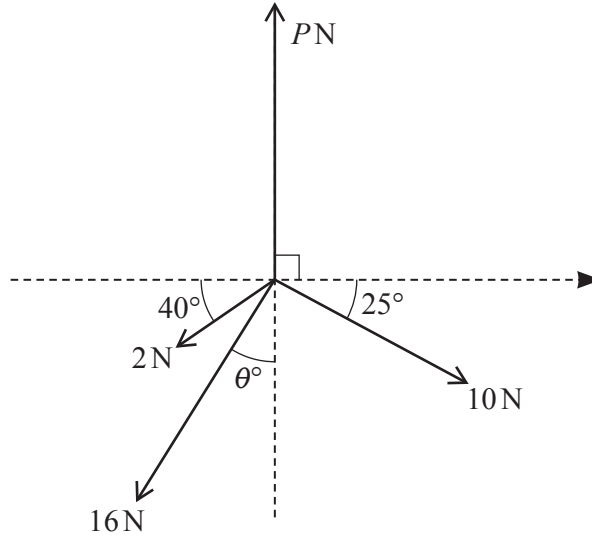
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Four coplanar forces of magnitude PN , 10 N , 16 N and 2 N act at a point in the directions shown in the diagram. It is given that the forces are in equilibrium.

Find the values of θ and P .

[6]

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4 A car has mass 1400 kg. When the speed of the car is $v \text{ ms}^{-1}$ the magnitude of the resistance to motion is $kv^2 \text{ N}$ where k is a constant.

(a) The car moves at a constant speed of 24 ms^{-1} up a hill inclined at an angle of α to the horizontal where $\sin \alpha = 0.12$. At this speed the magnitude of the resistance to motion is 480 N.

(i) Find the value of k . [1]

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(ii) Find the power of the car's engine. [3]

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(b) The car now moves at a constant speed on a straight level road.

Given that its engine is working at 54 kW, find this speed. [3]

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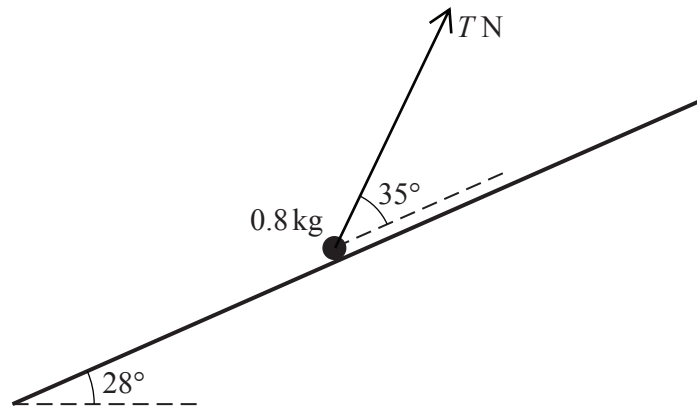
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A particle of mass 0.8 kg lies on a rough plane which is inclined at an angle of 28° to the horizontal. The particle is kept in equilibrium by a force of magnitude $T\text{ N}$. This force acts at an angle of 35° above a line of greatest slope of the plane (see diagram). The coefficient of friction between the particle and the plane is 0.2 .

Find the least and greatest possible values of T .

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6 Three particles A , B and C of masses 5 kg, 1 kg and 2 kg respectively lie at rest in that order on a straight smooth horizontal track XYZ . Initially A is at X , B is at Y and C is at Z . Particle A is projected towards B with a speed of 6 m s^{-1} and at the same instant C is projected towards B with a speed of $v \text{ m s}^{-1}$. In the subsequent motion, A collides and coalesces with B to form particle D . Particle D then collides and coalesces with C to form particle E and E moves towards Z .

(a) Show that after the second collision the speed of E is $\frac{15-v}{4} \text{ m s}^{-1}$. [3]

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(b) The total loss of kinetic energy of the system due to the two collisions is 63 J.
Use the result from (a) to show that $v = 3$. [3]

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(c) It is given that the distance XY is 36 m and the distance YZ is 98 m.

(i) Find the time between the two collisions. [4]

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(ii) Find the time between the instant that A is projected from X and the instant that E reaches Z . [1]

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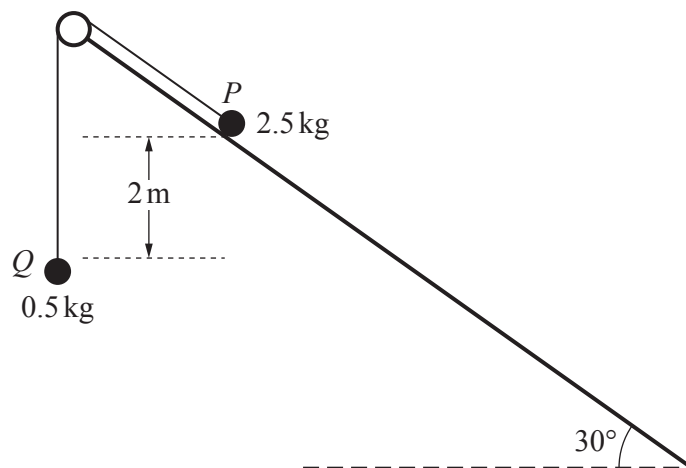
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Two particles P and Q of masses 2.5 kg and 0.5 kg respectively are connected by a light inextensible string that passes over a small smooth pulley fixed at the top of a plane inclined at an angle of 30° to the horizontal. Particle P is on the plane and Q hangs below the pulley such that the level of Q is 2 m below the level of P (see diagram).

Particle P is released from rest with the string taut and slides down the plane. The plane is rough with coefficient of friction 0.2 between the plane and P .

(a) Find the acceleration of P . [5]

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