

Wednesday 18 May 2016 – Morning

A2 GCE MATHEMATICS

4729/01 Mechanics 2

QUESTION PAPER

Candidates answer on the Printed Answer Book.

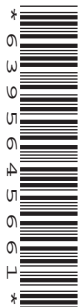
OCR supplied materials:

- Printed Answer Book 4729/01
- List of Formulae (MF1)

Other materials required:

- Scientific or graphical calculator

Duration: 1 hour 30 minutes



INSTRUCTIONS TO CANDIDATES

These instructions are the same on the Printed Answer Book and the Question Paper.

- The Question Paper will be found inside the Printed Answer Book.
- Write your name, centre number and candidate number in the spaces provided on the Printed Answer Book. Please write clearly and in capital letters.
- **Write your answer to each question in the space provided in the Printed Answer Book.** Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Do **not** write in the bar codes.
- You are permitted to use a scientific or graphical calculator in this paper.
- Give non-exact numerical answers correct to 3 significant figures unless a different degree of accuracy is specified in the question or is clearly appropriate.
- The acceleration due to gravity is denoted by $g \text{ ms}^{-2}$. Unless otherwise instructed, when a numerical value is needed, use $g = 9.8$.

INFORMATION FOR CANDIDATES

This information is the same on the Printed Answer Book and the Question Paper.

- The number of marks is given in brackets [] at the end of each question or part question on the Question Paper.
- **You are reminded of the need for clear presentation in your answers.**
- The total number of marks for this paper is **72**.
- The Printed Answer Book consists of **12** pages. The Question Paper consists of **8** pages. Any blank pages are indicated.

INSTRUCTION TO EXAMS OFFICER/INVIGILATOR

- Do not send this Question Paper for marking; it should be retained in the centre or recycled. Please contact OCR Copyright should you wish to re-use this document.

Answer **all** the questions.

- 1 A car of mass 1400 kg is travelling on a straight horizontal road against a constant resistance to motion of 600 N. At a certain instant the car is accelerating at 0.3 m s^{-2} and the engine of the car is working at a rate of 23 kW.

(i) Find the speed of the car at this instant. [3]

Subsequently the car moves up a hill inclined at 10° to the horizontal at a steady speed of 12 m s^{-1} . The resistance to motion is still a constant 600 N.

(ii) Calculate the power of the car's engine as it moves up the hill. [3]

- 2 A and B are two points on a line of greatest slope of a plane inclined at 55° to the horizontal. A is below the level of B and $AB = 4 \text{ m}$. A particle P of mass 2.5 kg is projected up the plane from A towards B and the speed of P at B is 6.7 m s^{-1} . The coefficient of friction between the plane and P is 0.15. Find

(i) the work done against the frictional force as P moves from A to B , [3]

(ii) the initial speed of P at A . [4]

3

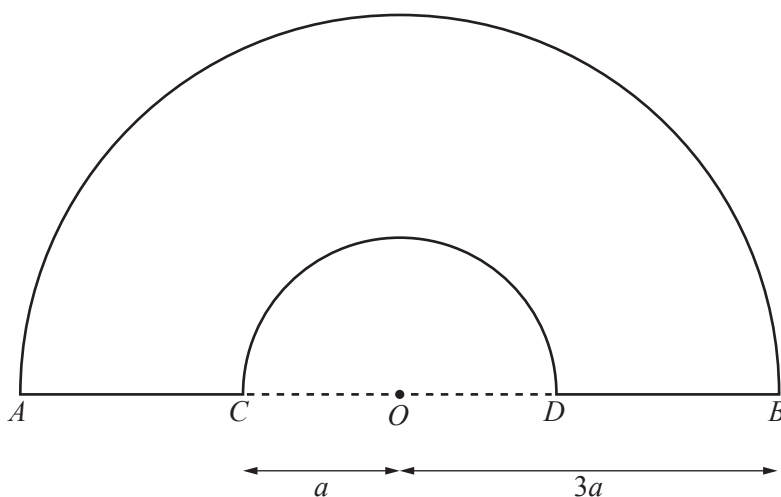


Fig. 1

A uniform lamina $ABDC$ is bounded by two semicircular arcs AB and CD , each with centre O and of radii $3a$ and a respectively, and two straight edges, AC and DB , which lie on the line AOB (see Fig. 1).

(i) Show that the distance of the centre of mass of the lamina from O is $\frac{13a}{3\pi}$. [5]

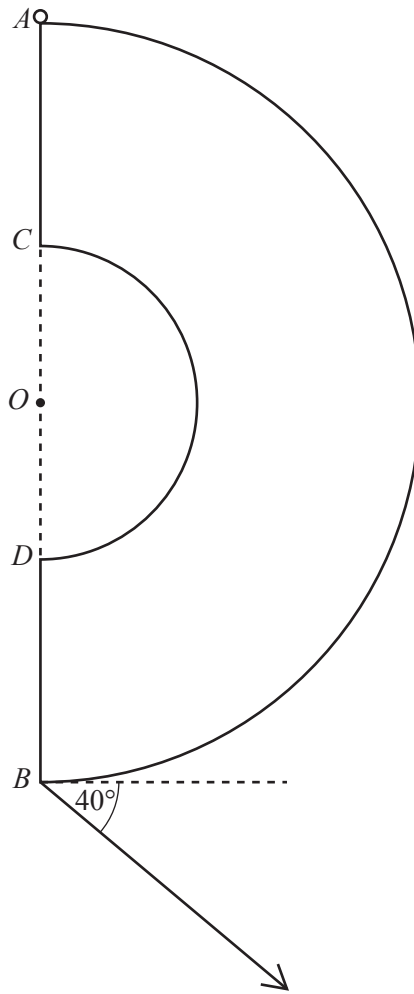
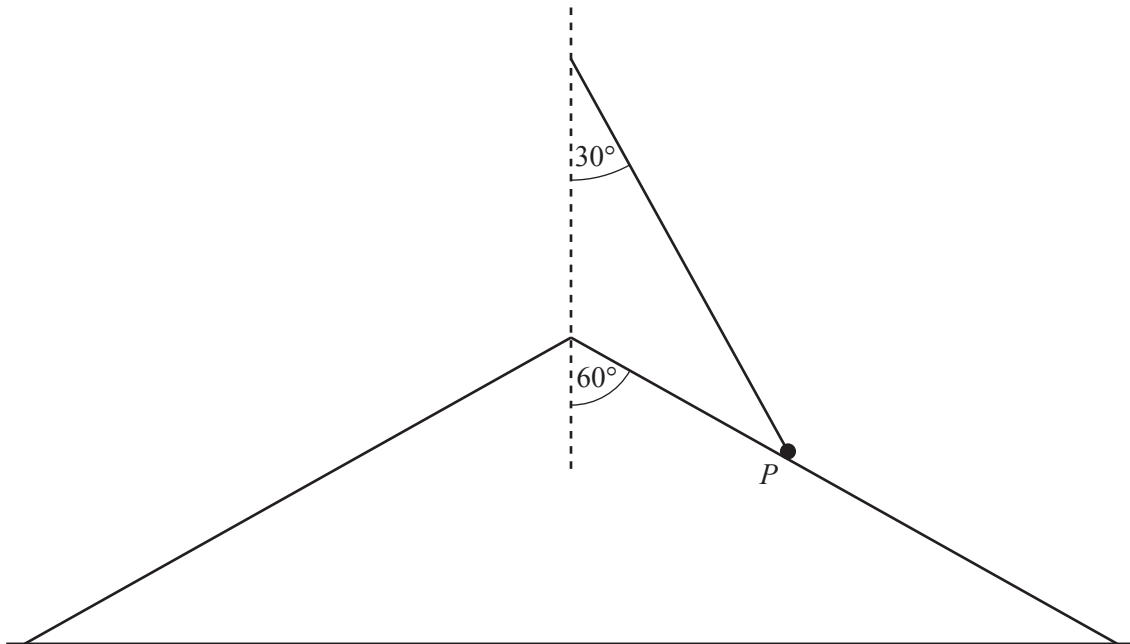


Fig. 2

The lamina has mass 3 kg and is freely pivoted to a fixed point at A . The lamina is held in equilibrium with AB vertical by means of a light string attached to B . The string lies in the same plane as the lamina and is at an angle of 40° below the horizontal (see Fig. 2).

- (ii) Calculate the tension in the string. [3]
- (iii) Find the direction of the force acting on the lamina at A . [4]



A smooth solid cone of semi-vertical angle 60° is fixed to the ground with its axis vertical. A particle P of mass m is attached to one end of a light inextensible string of length a . The other end of the string is attached to a fixed point vertically above the vertex of the cone. P rotates in a horizontal circle on the surface of the cone with constant angular velocity ω . The string is inclined to the downward vertical at an angle of 30° (see diagram).

(i) Show that the magnitude of the contact force between the cone and the particle is $\frac{1}{6}m(2\sqrt{3}g - 3a\omega^2)$. [6]

(ii) Given that $a = 0.5$ m and $m = 3.5$ kg, find, in either order, the greatest speed for which the particle remains in contact with the cone and the corresponding tension in the string. [3]

5 A uniform ladder AB , of weight W and length $2a$, rests with the end A in contact with rough horizontal ground and the end B resting against a smooth vertical wall. The ladder is inclined at an angle θ to the horizontal, where $\sin \theta = \frac{12}{13}$. A man of weight $6W$ is standing on the ladder at a distance x from A and the system is in equilibrium.

(i) Show that the magnitude of the frictional force exerted by the ground on the ladder is $\frac{5W}{24}\left(1 + \frac{6x}{a}\right)$. [5]

The coefficient of friction between the ladder and the ground is $\frac{1}{3}$.

(ii) Find, in terms of a , the greatest value of x for which the system is in equilibrium. [3]

The bottom of the ladder A is moved closer to the wall so that the ladder is now inclined at an angle α to the horizontal. The man of weight $6W$ can now stand at the top of the ladder B without the ladder slipping.

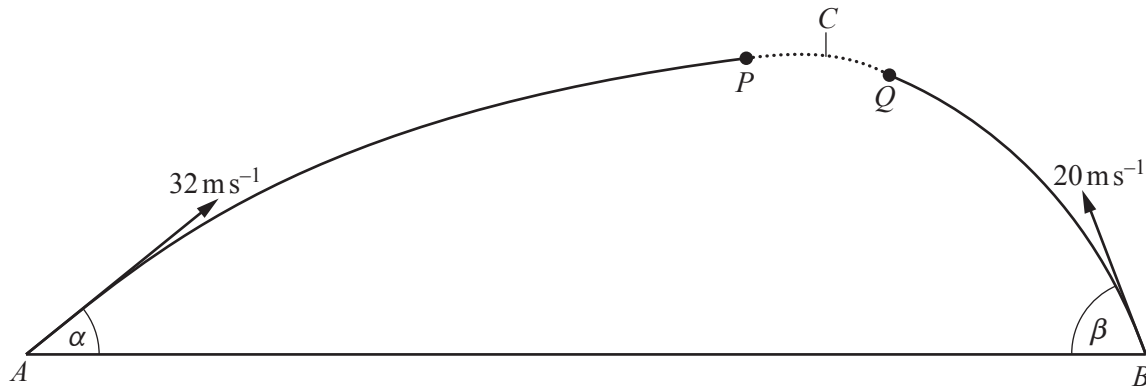
(iii) Find the least possible value of $\tan \alpha$. [3]

- 6 The masses of two particles A and B are 4 kg and 3 kg respectively. The particles are moving towards each other along a straight line on a smooth horizontal surface. A has speed 8 m s^{-1} and B has speed 10 m s^{-1} before they collide. The kinetic energy lost due to the collision is 121.5 J.

(i) Find the speed and direction of motion of each particle after the collision. [8]

(ii) Find the coefficient of restitution between A and B . [2]

7



A particle P is projected with speed 32 m s^{-1} at an angle of elevation α , where $\sin \alpha = \frac{3}{5}$, from a point A on horizontal ground. At the same instant a particle Q is projected with speed 20 m s^{-1} at an angle of elevation β , where $\sin \beta = \frac{24}{25}$, from a point B on the same horizontal ground. The particles move freely under gravity in the same vertical plane and collide with each other at the point C at the instant when they are travelling horizontally (see diagram).

(i) Calculate the height of C above the ground and the distance AB . [4]

Immediately after the collision P falls vertically. P hits the ground and rebounds vertically upwards, coming to instantaneous rest at a height 5 m above the ground.

(ii) Given that the mass of P is 3 kg, find the magnitude and direction of the impulse exerted on P by the ground. [4]

The coefficient of restitution between the two particles is $\frac{1}{2}$.

(iii) Find the distance of Q from C at the instant when Q is travelling in a direction of 25° below the horizontal. [9]

END OF QUESTION PAPER

BLANK PAGE

BLANK PAGE

**Copyright Information**

OCR is committed to seeking permission to reproduce all third-party content that it uses in its assessment materials. OCR has attempted to identify and contact all copyright holders whose work is used in this paper. To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced in the OCR Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download from our public website (www.ocr.org.uk) after the live examination series.

If OCR has unwittingly failed to correctly acknowledge or clear any third-party content in this assessment material, OCR will be happy to correct its mistake at the earliest possible opportunity.

For queries or further information please contact the Copyright Team, First Floor, 9 Hills Road, Cambridge CB2 1GE.

OCR is part of the Cambridge Assessment Group; Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.