



ADVANCED GCE MATHEMATICS

Mechanics 2

4729

QUESTION PAPER

Candidates answer on the printed answer book.

OCR supplied materials:

- Printed answer book 4729
- List of Formulae (MF1)

Other materials required:

- Scientific or graphical calculator

**Monday 10 January 2011
Morning**

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 in the centre of 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. Pencil may be used for graphs and diagrams only.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Answer **all** the questions.
- 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 $g \text{ m s}^{-2}$. 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.

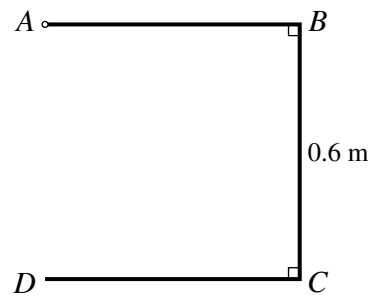
- The number of marks is given in brackets [] at the end of each question or part question on the question paper.
- **You are reminded of the need for clear presentation in your answers.**
- The total number of marks for this paper is **72**.
- The printed answer book consists of **12** pages. The question paper consists of **4** 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 destroyed.

2

1



A uniform square frame $ABCD$ has sides of length 0.6 m . The side AD is removed from the frame, and the open frame $ABCD$ is attached at A to a fixed point (see diagram).

- (i) Calculate the distance of the centre of mass of the open frame from A . [5]

The open frame rotates about A in the plane $ABCD$ with angular speed 3 rad s^{-1} .

- (ii) Calculate the speed of the centre of mass of the open frame. [2]

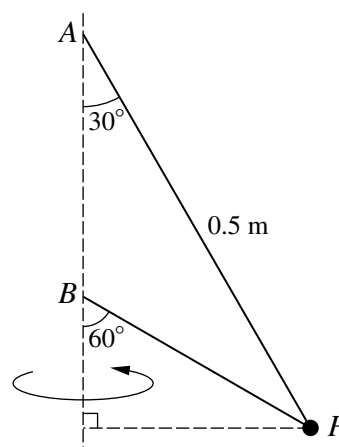
- 2 The resistance to the motion of a car is $kv^{\frac{3}{2}}\text{ N}$, where $v\text{ m s}^{-1}$ is the car's speed and k is a constant. The power exerted by the car's engine is $15\,000\text{ W}$, and the car has constant speed 25 m s^{-1} along a horizontal road.

- (i) Show that $k = 4.8$. [3]

With the engine operating at a much lower power, the car descends a hill of inclination α , where $\sin \alpha = \frac{1}{15}$. At an instant when the speed of the car is 16 m s^{-1} , its acceleration is 0.3 m s^{-2} .

- (ii) Given that the mass of the car is 700 kg , calculate the power of the engine. [5]

3



A particle P of mass 0.4 kg is attached to one end of each of two light inextensible strings which are both taut. The other end of the longer string is attached to a fixed point A , and the other end of the shorter string is attached to a fixed point B , which is vertically below A . The string AP makes an angle of 30° with the vertical and is 0.5 m long. The string BP makes an angle of 60° with the vertical. P moves with constant angular speed in a horizontal circle with centre vertically below B (see diagram). The tension in the string AP is twice the tension in the string BP . Calculate

- (i) the tension in each string, [4]

- (ii) the angular speed of P . [4]

3

- 4 A block of mass 25 kg is dragged 30 m up a slope inclined at 5° to the horizontal by a rope inclined at 20° to the slope. The tension in the rope is 100 N and the resistance to the motion of the block is 70 N. The block is initially at rest. Calculate

(i) the work done by the tension in the rope, [2]

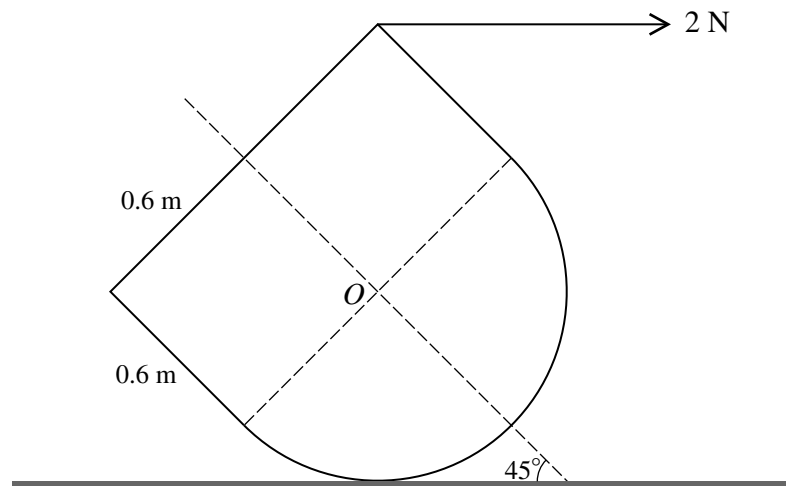
(ii) the change in the potential energy of the block, [2]

(iii) the speed of the block after it has moved 30 m up the slope. [4]

- 5 A uniform solid is made of a hemisphere with centre O and radius 0.6 m, and a cylinder of radius 0.6 m and height 0.6 m. The plane face of the hemisphere and a plane face of the cylinder coincide. (The formula for the volume of a sphere is $\frac{4}{3}\pi r^3$.)

(i) Show that the distance of the centre of mass of the solid from O is 0.09 m. [5]

(ii)



The solid is placed with the curved surface of the hemisphere on a rough horizontal surface and the axis inclined at 45° to the horizontal. The equilibrium of the solid is maintained by a horizontal force of 2 N applied to the highest point on the circumference of its plane face (see diagram). Calculate

(a) the mass of the solid, [4]

(b) the set of possible values of the coefficient of friction between the surface and the solid. [3]

[Questions 6 and 7 are printed overleaf.]

4

- 6 A small ball B is projected with speed 14 m s^{-1} at an angle of elevation 30° from a point O on a horizontal plane, and moves freely under gravity.

(i) Calculate the height of B above the plane when moving horizontally. [2]

B has mass 0.4 kg . At the instant when B is moving horizontally it receives an impulse of magnitude $I \text{ N s}$ in its direction of motion which immediately increases the speed of B to 15 m s^{-1} .

(ii) Calculate I . [3]

For the instant when B returns to the plane, calculate

(iii) the speed and direction of motion of B , [4]

(iv) the time of flight, and the distance of B from O . [5]

- 7 Three small smooth spheres A , B and C of masses 0.2 kg , 0.7 kg and $m \text{ kg}$ respectively are free to move in a straight line on a smooth horizontal table. Initially B and C are stationary and A is moving with velocity 1.8 m s^{-1} directly towards B . The coefficient of restitution for the collision between A and B is e . Immediately after this collision the speed of A is greater than the speed of B .

(i) Calculate the set of possible values of e . [9]

It is now given that the speed of B immediately after the collision with A is 0.75 m s^{-1} . B continues its motion and strikes C directly in a perfectly elastic collision. B has speed 0.25 m s^{-1} immediately after its collision with C .

(ii) Calculate the two possible values of m . [6]

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.



ADVANCED GCE MATHEMATICS

Mechanics 2

4729

PRINTED ANSWER BOOK

Candidates answer on this printed answer book.

OCR supplied materials:

- Question paper 4729 (inserted)
- List of Formulae (MF1)

Other materials required:

- Scientific or graphical calculator

Monday 10 January 2011
Morning

Duration: 1 hour 30 minutes



Candidate forename		Candidate surname	
-----------------------	--	----------------------	--

Centre number						Candidate number				
---------------	--	--	--	--	--	------------------	--	--	--	--

INSTRUCTIONS TO CANDIDATES

These instructions are the same on the printed answer book and the question paper.

- The question paper will be found in the centre of 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. Pencil may be used for graphs and diagrams only.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Answer **all** the questions.
- 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 $g \text{ m s}^{-2}$. 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 **4** pages. Any blank pages are indicated.

1 (i)		
	1 (ii)	

2 (i)	
2 (ii)	

3 (i)	
	3 (ii)

4 (i)	
4 (ii)	
4 (iii)	

5 (i)		
	5 (ii) (a)	

5(ii)(a)	(continued)
5(ii)(b)	

6 (i)	
	6 (ii)
6 (iii)	

6 (iii)	(continued)
6 (iv)	

[illegible]

7 (i)	(continued)
7 (ii)	

7 (ii)	(continued)



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.