OCR
RECOGNISING ACHIEVEMENT

ADVANCED GCE

MATHEMATICS

4729

Mechanics 2

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 m s^{-2}. Unless otherwise instructed, when a numerical value is needed, use $g = 9.8$.

INFORMATION FOR CANDIDATES

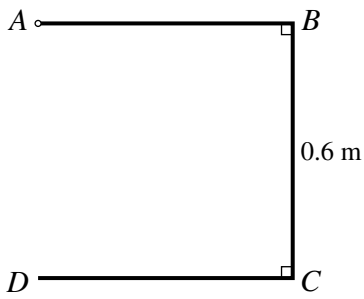
This information is the same on the printed answer book and the question paper.

- 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.

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 $3\,\text{rad}\,\text{s}^{-1}$.

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

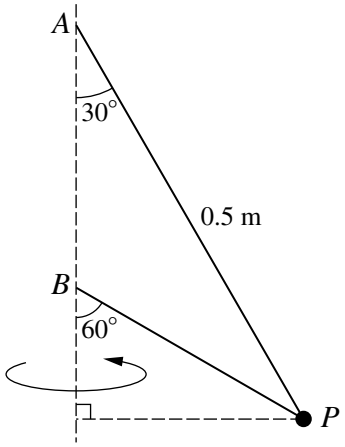
2 The resistance to the motion of a car is $kv^{\frac{3}{2}}$ N, where $v\,\text{m}\,\text{s}^{-1}$ is the car's speed and k is a constant. The power exerted by the car's engine is 15 000 W, and the car has constant speed $25\,\text{m}\,\text{s}^{-1}$ along a horizontal road.

(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 $16\,\text{m}\,\text{s}^{-1}$, its acceleration is $0.3\,\text{m}\,\text{s}^{-2}$.

(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]**

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]**

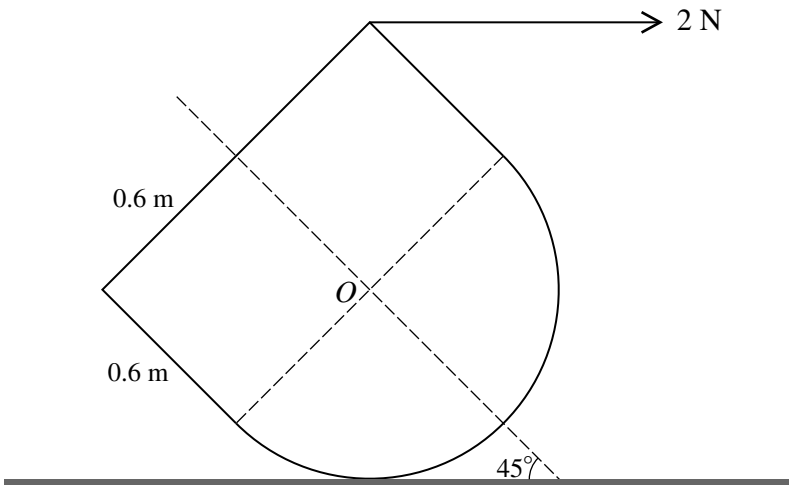
(ii) the change in the potential energy of the block, **[2]**

(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.]

6 A small ball B is projected with speed $14\,\mathrm{m\,s^{-1}}$ 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 N s in its direction of motion which immediately increases the speed of B to $15\,\mathrm{m\,s^{-1}}$.

(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 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 $1.8\,\mathrm{m\,s^{-1}}$ 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 $0.75\,\mathrm{m\,s^{-1}}$. B continues its motion and strikes C directly in a perfectly elastic collision. B has speed $0.25\,\mathrm{m\,s^{-1}}$ immediately after its collision with C.

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

OCR
RECOGNISING ACHIEVEMENT

ADVANCED GCE

MATHEMATICS

4729

Mechanics 2

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 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)	

7 (i)

7 (i)	**(continued)**
7 (ii)	

7 (ii)	**(continued)**