

OCR

Oxford Cambridge and RSA

Wednesday 3 June 2015 – Morning

A2 GCE MATHEMATICS

4730/01 Mechanics 3**QUESTION PAPER**

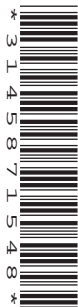
Candidates answer on the Printed Answer Book.

OCR supplied materials:

- Printed Answer Book 4730/01
- 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 $g \text{ m s}^{-2}$. 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.

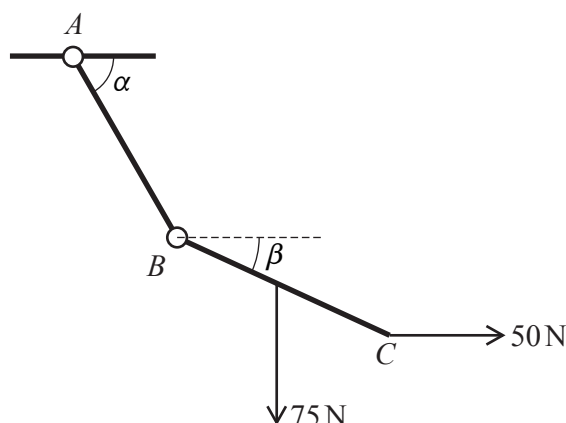
INSTRUCTION TO EXAMS OFFICER/INVIGILATOR

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2

- 1 A particle P of mass 0.2 kg is moving on a smooth horizontal surface with speed 3 m s^{-1} , when it is struck by an impulse of magnitude $I\text{ N s}$. The impulse acts horizontally in a direction perpendicular to the original direction of motion of P , and causes the direction of motion of P to change by an angle α , where $\tan \alpha = \frac{5}{12}$.
- (i) Show that $I = 0.25$. [4]
- (ii) Find the speed of P after the impulse acts. [2]

2



Two uniform rods AB and BC , each of length $2L$, are freely jointed at B , and AB is freely jointed to a fixed point at A . The rods are held in equilibrium in a vertical plane by a light horizontal string attached at C . The rods AB and BC make angles α and β to the horizontal respectively. The weight of rod BC is 75 N , and the tension in the string is 50 N (see diagram).

- (i) Show that $\tan \beta = \frac{3}{4}$. [3]
- (ii) Given that $\tan \alpha = \frac{12}{5}$, find the weight of AB . [5]

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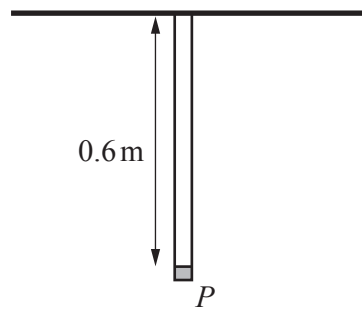
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3

3



A small object P is attached to one end of each of two vertical light elastic strings. One string is of natural length 0.4 m and has modulus of elasticity 10 N ; the other string is of natural length 0.5 m and has modulus of elasticity 12 N . The upper ends of both strings are attached to a fixed horizontal beam and P hangs in equilibrium 0.6 m below the beam (see diagram).

- (i) Show that the weight of P is 7.4 N and find the total elastic potential energy stored in the two strings when P is hanging in equilibrium. [6]

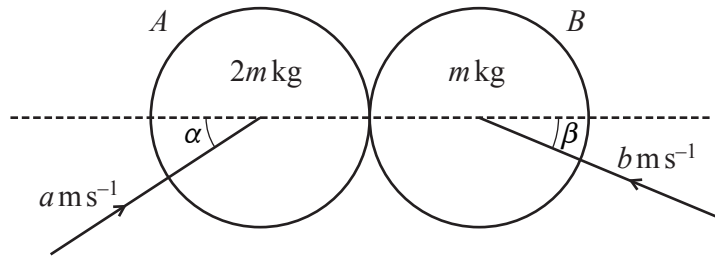
P is then held at a point 0.7 m below the beam with the strings vertical. P is released from rest.

- (ii) Show that, throughout the subsequent motion, P performs simple harmonic motion, and find the period. [7]

- 4 A particle of mass 0.4 kg , moving on a smooth horizontal surface, passes through a point O with velocity 10 m s^{-1} . At time $t\text{ s}$ after the particle passes through O , the particle has a displacement $x\text{ m}$ from O , has a velocity $v\text{ m s}^{-1}$ away from O , and is acted on by a force of magnitude $\frac{1}{8}v\text{ N}$ acting towards O . Find

- (i) the time taken for the velocity of the particle to reduce from 10 m s^{-1} to 5 m s^{-1} , [5]
(ii) the average velocity of the particle over this time. [6]

5



Two uniform smooth spheres A and B , of equal radius, have masses $2m$ kg and m kg respectively. The spheres are moving on a horizontal surface when they collide. Before the collision, A is moving with speed a ms⁻¹ in a direction making an angle α with the line of centres and B is moving towards A with speed b ms⁻¹ in a direction making an angle β with the line of centres (see diagram). After the collision, A moves with velocity 2 ms⁻¹ in a direction perpendicular to the line of centres and B moves with velocity 2 ms⁻¹ in a direction making an angle of 45° with the line of centres. The coefficient of restitution between A and B is $\frac{2}{3}$.

(i) Show that $a \cos \alpha = \frac{5}{6}\sqrt{2}$ and find $b \cos \beta$. [7]

(ii) Find the values of a and α . [4]

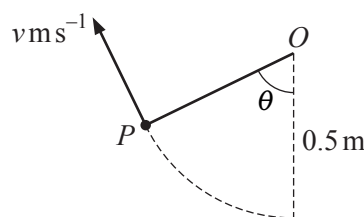
6 A particle P starts from rest from a point A and moves in a straight line with simple harmonic motion about a point O . At time t seconds after the motion starts the displacement of P from O is x m towards A . The particle P is next at rest when $t = 0.25\pi$ having travelled a distance of 1.2 m.

(i) Find the maximum velocity of P . [3]

(ii) Find the value of x and the velocity of P when $t = 0.7$. [4]

(iii) Find the other values of t , for $0 < t < 1$, at which P 's speed is the same as when $t = 0.7$. Find also the corresponding values of x . [4]

7



One end of a light inextensible string of length 0.5 m is attached to a fixed point O . A particle P of mass 0.2 kg is attached to the other end of the string. P is projected horizontally from the point 0.5 m below O with speed u ms⁻¹. When the string makes an angle of θ with the downward vertical the particle has speed v ms⁻¹ (see diagram).

(i) Show that, while the string is taut, the tension, T N, in the string is given by

$$T = 5.88 \cos \theta + 0.4u^2 - 3.92. \quad [5]$$

(ii) Find the least value of u for which the particle will move in a complete circle. [3]

(iii) If in fact $u = 3.5$ ms⁻¹, find the speed of the particle at the point where the string first becomes slack. [4]

END OF QUESTION PAPER