

Friday 6 June 2014 – Afternoon

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

- 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.

1 A particle P of mass 0.3 kg is moving on a smooth horizontal surface with speed 0.8 m s^{-1} when it is struck by a horizontal impulse. The magnitude of the impulse is 0.6 N s .

(i) (a) Find the greatest possible speed of P after the impulse acts.

(b) Find the least possible speed of P after the impulse acts.

[3]

(ii) In fact the speed of P after the impulse acts is 2.5 m s^{-1} . Find the angle the impulse makes with the original direction of travel of P and draw a sketch to make this direction clear.

[4]

2 One end of a light elastic string, of natural length 0.6 m and modulus of elasticity 30 N , is attached to a fixed point O . A particle P of weight 48 N is attached to the other end of the string. P is released from rest at a point $d \text{ m}$ vertically below O . Subsequently P just reaches O .

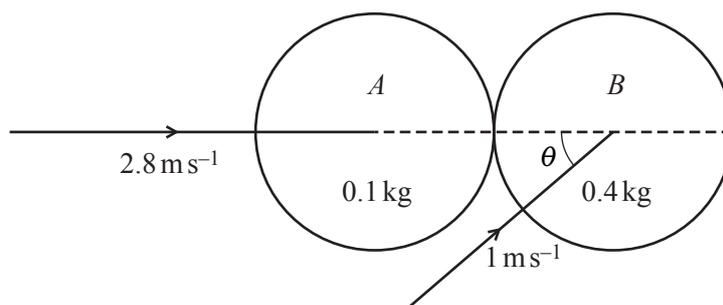
(i) Find d .

[4]

(ii) Find the magnitude and direction of the acceleration of P when it has travelled 1.3 m from its point of release.

[4]

3



Two uniform smooth spheres A and B of equal radius are moving on a horizontal surface when they collide. A has mass 0.1 kg and B has mass 0.4 kg . Immediately before the collision A is moving with speed 2.8 m s^{-1} along the line of centres, and B is moving with speed 1 m s^{-1} at an angle θ to the line of centres, where $\cos \theta = 0.8$ (see diagram). Immediately after the collision A is stationary. Find

(i) the coefficient of restitution between A and B ,

[5]

(ii) the angle turned through by the direction of motion of B as a result of the collision.

[4]



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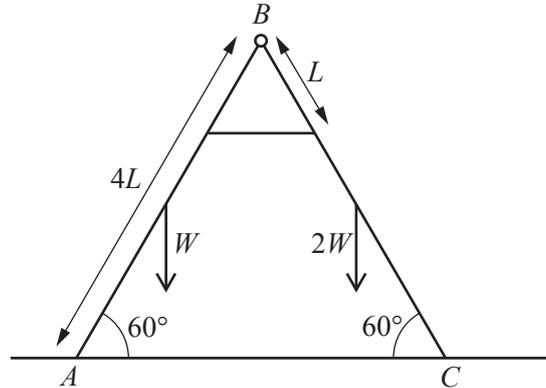
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- 4 A particle P of mass 0.4 kg is projected horizontally with speed 2 m s^{-1} from a fixed point O on a smooth horizontal surface. At time $t\text{ s}$ after projection P is $x\text{ m}$ from O and is moving away from O with speed $v\text{ m s}^{-1}$. There is a force of magnitude $1.6v^2\text{ N}$ resisting the motion of P .
- (i) Find an expression for $\frac{dv}{dx}$ in terms of v , and hence show that $v = 2e^{-4x}$. [5]
- (ii) Find the distance travelled by P in the 0.5 seconds after it leaves O . [5]

5

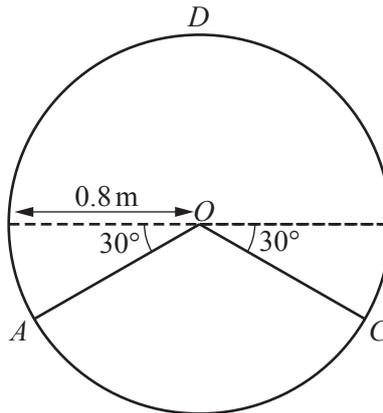


Two uniform rods AB and BC , each of length $4L$, are freely jointed at B , and rest in a vertical plane with A and C on a smooth horizontal surface. The weight of AB is W and the weight of BC is $2W$. The rods are joined by a horizontal light inextensible string fixed to each rod at a point distance L from B , so that each rod is inclined at an angle of 60° to the horizontal (see diagram).

- (i) By considering the equilibrium of the whole body, show that the force acting on BC at C is $1.75W$ and find the force acting on AB at A . [4]
- (ii) Find the tension in the string in terms of W . [4]
- (iii) Find the horizontal and vertical components of the force acting on AB at B , and state the direction of the component in each case. [3]

Question 6 begins on page 4.

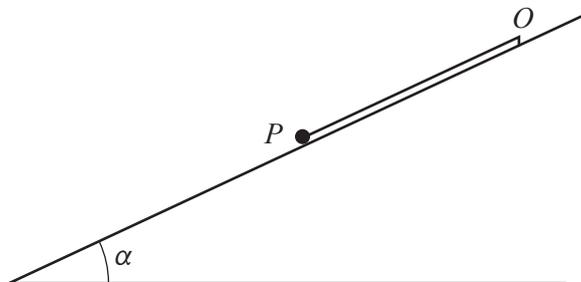
6



A hollow cylinder is fixed with its axis horizontal. O is the centre of a vertical cross-section of the cylinder and D is the highest point on the cross-section. A and C are points on the circumference of the cross-section such that AO and CO are both inclined at an angle of 30° below the horizontal diameter through O . The inner surface of the cylinder is smooth and has radius 0.8 m (see diagram). A particle P , of mass $m\text{ kg}$, and a particle Q , of mass $5m\text{ kg}$, are simultaneously released from rest from A and C , respectively, inside the cylinder. P and Q collide; the coefficient of restitution between them is 0.95 .

- (i) Show that, immediately after the collision, P moves with speed 6.3 ms^{-1} , and find the speed and direction of motion of Q . [8]
- (ii) Find, in terms of m , an expression for the normal reaction acting on P when it subsequently passes through D . [6]

7



One end of a light elastic string, of natural length 0.3 m , is attached to a fixed point O on a smooth plane that is inclined at an angle α to the horizontal, where $\sin \alpha = 0.2$. A particle P of mass $m\text{ kg}$ is attached to the other end of the string. The string lies along a line of greatest slope of the plane and has modulus of elasticity $2.45m\text{ N}$ (see diagram).

- (i) Show that in the equilibrium position the extension of the string is 0.24 m . [2]

P is given a velocity of 0.3 ms^{-1} down the plane from the equilibrium position.

- (ii) Show that P performs simple harmonic motion with period 2.20 s (correct to 3 significant figures), and find the amplitude of the motion. [6]
- (iii) Find the distance of P from O and the velocity of P at the instant 1.5 seconds after P is set in motion. [5]