

**ADVANCED SUBSIDIARY GCE
MATHEMATICS (MEI)**

Mechanics 1

4761/01

QUESTION PAPER

Candidates answer on the Printed Answer Book

OCR Supplied Materials:

- Printed Answer Book 4761/01
- MEI Examination Formulae and Tables (MF2)

Other Materials Required:

- Scientific or graphical calculator

**Friday 23 May 2008
Morning**

Duration: 1 hour 30 minutes

INSTRUCTIONS TO CANDIDATES

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

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the spaces provided on the Printed Answer Book.
- **The questions are on the inserted Question Paper.**
- **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 and make sure that 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 graphical calculator in this paper.
- Final answers should be given to a degree of accuracy appropriate to the context.
- 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 advised that an answer may receive **no marks** unless you show sufficient detail of the working to indicate that a correct method is being used.
- 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 destroyed.

Section A (36 marks)

- 1 Fig. 1.1 shows a circular cylinder of mass 100 kg being raised by a light, inextensible vertical wire AB. There is negligible air resistance.

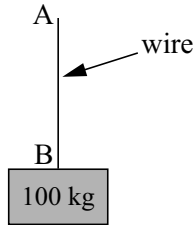


Fig. 1.1

- (i) Calculate the acceleration of the cylinder when the tension in the wire is 1000 N. [3]

- (ii) Calculate the tension in the wire when the cylinder has an upward acceleration of 0.8 m s^{-2} . [2]

The cylinder is now raised inside a fixed smooth vertical tube that prevents horizontal motion but provides negligible resistance to the upward motion of the cylinder. When the wire is inclined at 30° to the vertical, as shown in Fig. 1.2, the cylinder again has an upward acceleration of 0.8 m s^{-2} .

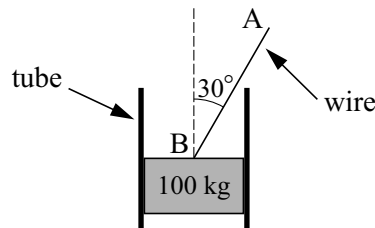


Fig. 1.2

- (iii) Calculate the new tension in the wire. [3]

- 2 A particle has a position vector \mathbf{r} , where $\mathbf{r} = 4\mathbf{i} - 5\mathbf{j}$ and \mathbf{i} and \mathbf{j} are unit vectors in the directions east and north respectively.

- (i) Sketch \mathbf{r} on a diagram showing \mathbf{i} and \mathbf{j} and the origin O. [1]

- (ii) Calculate the magnitude of \mathbf{r} and its direction as a bearing. [4]

- (iii) Write down the vector that has the same direction as \mathbf{r} and three times its magnitude. [1]

- 3 An object of mass 5 kg has a constant acceleration of $\begin{pmatrix} -1 \\ 2 \end{pmatrix} \text{ m s}^{-2}$ for $0 \leq t \leq 4$, where t is the time in seconds.

(i) Calculate the force acting on the object. [2]

When $t = 0$, the object has position vector $\begin{pmatrix} -2 \\ 3 \end{pmatrix} \text{ m}$ and velocity $\begin{pmatrix} 4 \\ 5 \end{pmatrix} \text{ m s}^{-1}$.

(ii) Find the position vector of the object when $t = 4$. [3]

4

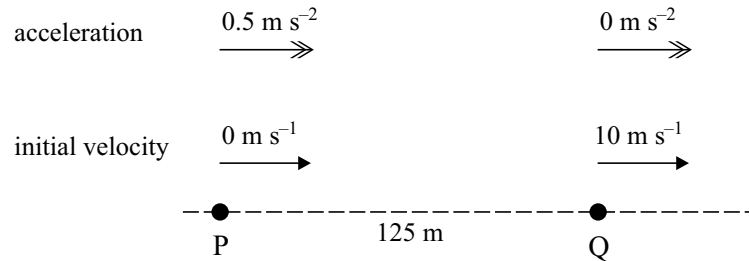


Fig. 4

Particles P and Q move in the same straight line. Particle P starts from rest and has a constant acceleration towards Q of 0.5 m s^{-2} . Particle Q starts 125 m from P at the same time and has a constant speed of 10 m s^{-1} away from P. The initial values are shown in Fig. 4.

(i) Write down expressions for the distances travelled by P and by Q at time t seconds after the start of the motion. [2]

(ii) How much time does it take for P to catch up with Q and how far does P travel in this time? [5]

- 5 Boxes A and B slide on a smooth, horizontal plane. Box A has a mass of 4 kg and box B a mass of 5 kg. They are connected by a light, inextensible, horizontal wire. Horizontal forces of 9 N and 135 N act on A and B in the directions shown in Fig. 5.

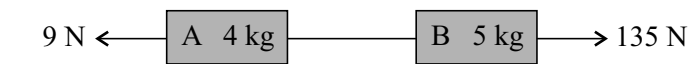


Fig. 5

Calculate the tension in the wire joining the boxes. [4]

- 6 In this question take $g = 10$.

A golf ball is hit from ground level over horizontal ground. The initial velocity of the ball is 40 m s^{-1} at an angle α to the horizontal, where $\sin \alpha = 0.6$ and $\cos \alpha = 0.8$. Air resistance may be neglected.

(i) Find an expression for the height of the ball above the ground t seconds after projection. [2]

(ii) Calculate the horizontal range of the ball. [4]

Section B (36 marks)

7

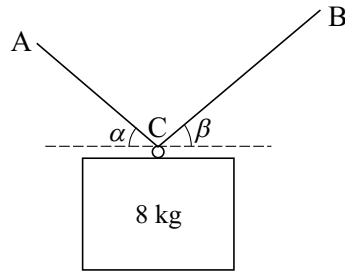


Fig. 7.1

A box of mass 8 kg is supported by a continuous light string ACB that is fixed at A and at B and passes through a smooth ring on the box at C, as shown in Fig. 7.1. The box is in equilibrium and the tension in the string section AC is 60 N.

- (i) What information in the question indicates that the tension in the string section CB is also 60 N? [2]
- (ii) Show that the string sections AC and CB are equally inclined to the horizontal (so that $\alpha = \beta$ in Fig. 7.1). [2]
- (iii) Calculate the angle of the string sections AC and CB to the horizontal. [5]

In a different situation the same box is supported by two separate light strings, PC and QC, that are tied to the box at C. There is also a horizontal force of 10 N acting at C. This force and the angles between these strings and the horizontal are shown in Fig. 7.2. The box is in equilibrium.

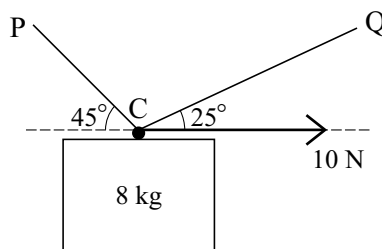


Fig. 7.2

- (iv) Calculate the tensions in the two strings. [8]

- 8 The displacement, x m, from the origin O of a particle on the x -axis is given by

$$x = 10 + 36t + 3t^2 - 2t^3,$$

where t is the time in seconds and $-4 \leq t \leq 6$.

- (i) Write down the displacement of the particle when $t = 0$. [1]
- (ii) Find an expression in terms of t for the velocity, $v \text{ m s}^{-1}$, of the particle. [2]
- (iii) Find an expression in terms of t for the acceleration of the particle. [2]
- (iv) Find the maximum value of v in the interval $-4 \leq t \leq 6$. [3]
- (v) Show that $v = 0$ only when $t = -2$ and when $t = 3$. Find the values of x at these times. [5]
- (vi) Calculate the *distance* travelled by the particle from $t = 0$ to $t = 4$. [3]
- (vii) Determine how many times the particle passes through O in the interval $-4 \leq t \leq 6$. [3]

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Section A (36 marks)

1 (i)	
1 (ii)	
1 (iii)	

3 (i)	
3 (ii)	

Section B (36 marks)

7 (i)	
7 (ii)	
7 (iii)	

7 (iii)	(continued)
7 (iv)	

8 (i)	
8 (ii)	
8 (iii)	
8 (iv)	

8 (v)	
8 (vi)	
8 (vii)	

8 (vii)	(continued)



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