OCR
RECOGNISING ACHIEVEMENT

ADVANCED SUBSIDIARY GCE **4761/01**

MATHEMATICS (MEI)

Mechanics 1

FRIDAY 23 MAY 2008 Morning

Time: 1 hour 30 minutes

Additional materials (enclosed): None

Additional materials (required):
Answer Booklet (8 pages)
Graph paper
MEI Examination Formulae and Tables (MF2)

INSTRUCTIONS TO CANDIDATES

- Write your name in capital letters, your Centre Number and Candidate Number in the spaces provided on the Answer Booklet.
- Read each question carefully and make sure you know what you have to do before starting your answer.
- Answer **all** the questions.
- 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 $g\,\mathrm{m\,s^{-2}}$. Unless otherwise instructed, when a numerical value is needed, use $g = 9.8$.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets [ ] at the end of each question or part question.
- The total number of marks for this paper is **72**.
- 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.

This document consists of **6** printed pages and **2** blank pages.

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.

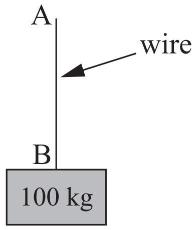

Fig. 1.1

(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}.

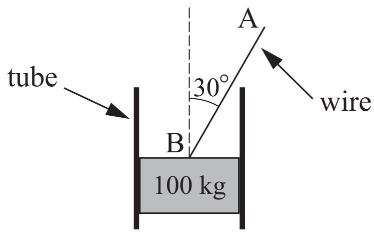

Fig. 1.2

(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 $\begin{pmatrix} -1 \\ 2 \end{pmatrix}$ m s^{-2} for $0 \leqslant t \leqslant 4$, where t is the time in seconds.

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

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

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

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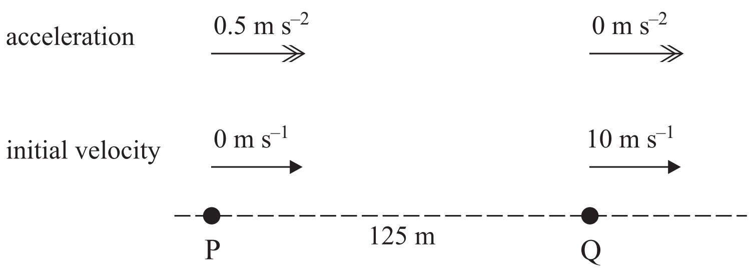

Fig. 4

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.

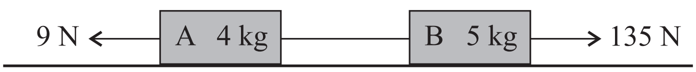

Fig. 5

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

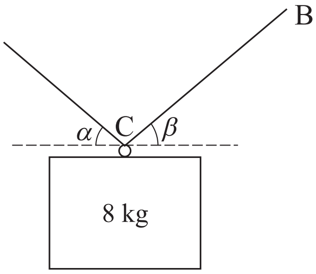

Fig. 7.1

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.

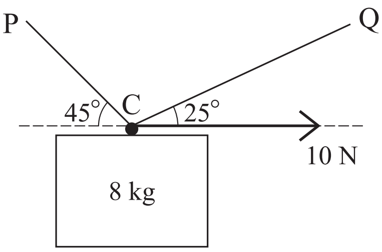

Fig. 7.2

(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 $-4 \leqslant t \leqslant 6$.

(i) Write down the displacement of the particle when $t = 0$. [1]

(ii) Find an expression in terms of t for the velocity, $v\,\mathrm{m\,s^{-1}}$, 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 $-4 \leqslant t \leqslant 6$. [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 $-4 \leqslant t \leqslant 6$. [3]

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