Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel Level 3 GCE

Centre Number	Candidate Number

Mock Paper

Paper Reference **9MA0-31**

Mathematics

Advanced

Paper 3B – Mechanics

You must have:
Mathematical Formulae and Statistical Tables, calculator

Total Marks

Candidates may use any calculator allowed by Pearson regulations.
Calculators must not have the facility for symbolic algebra manipulation, differentiation and integration, or have retrievable mathematical formulae stored in them.

Instructions

Use **black** ink or ball-point pen.
If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
Fill in the boxes at the top of this page with your name, centre number and candidate number.
Answer **all** questions and ensure that your answers to parts of questions are clearly labelled.
Answer the questions.
You should show sufficient working to make your methods clear. Answers without working may not gain full credit.
Inexact answers should be given to three significant figures unless otherwise stated.

Information

A booklet 'Mathematical Formulae and Statistical Tables' is provided.
There are 8 questions in this question paper. The total mark for this paper is 80.
The marks for **each** question are shown in brackets
– *use this as a guide as to how much time to spend on each question*.

Advice

Read each question carefully before you start to answer it.
Try to answer every question.
Check your answers if you have time at the end.

1.

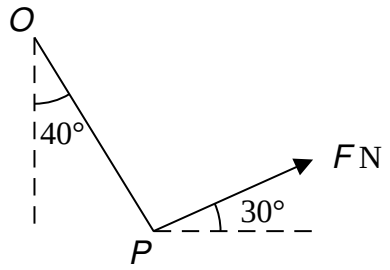

Figure 1

A particle P of weight 5 N is attached to one end of a light string. The other end of the string is attached to a fixed point O. A force of magnitude F newtons is applied to P. The line of action of the force is inclined to the horizontal at 30° and lies in the same vertical plane as the string. The particle P is in equilibrium with the string making an angle of 40° with the downward vertical, as shown in Figure 1.

Find

(i) the tension in the string,

(ii) the value of F.

(Total 7 marks)

2.

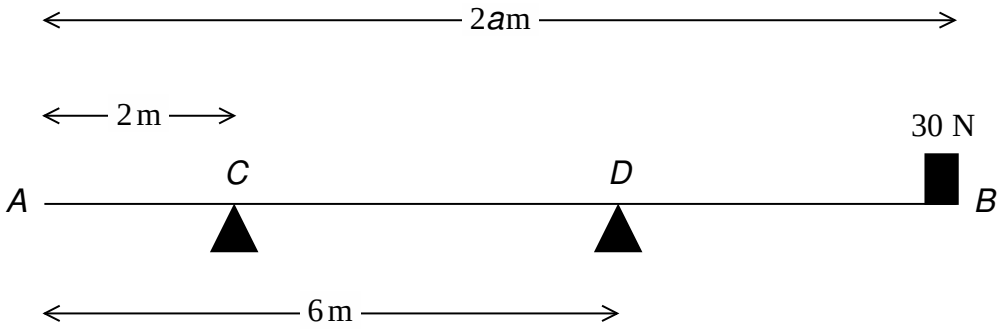

Figure 2

A wooden beam AB has weight 140 N and length $2a$ metres. The beam rests horizontally in equilibrium on two supports at C and D, where $AC = 2$ m and $AD = 6$ m. A block of weight 30 N is placed on the beam at B and the beam remains horizontal and in equilibrium, as shown in Figure 2. The reaction on the beam at D has magnitude 120 N. The block is modelled as a particle and the beam is modelled as a uniform rod.

(a) Find the value of a.

(4)

The support at D is now moved to a point E on the beam and the beam remains horizontal and in equilibrium with the block at B. The magnitude of the reaction on the beam at C is now equal to the magnitude of the reaction on the beam at E.

(b) Find the distance AE.

(5)

(Total 9 marks)

5. Two trains, P and Q, move on horizontal parallel straight tracks. Initially both are at rest in a station and level with each other. At time $t = 0$, P starts off and moves with constant acceleration for 10 s up to a speed of 25 m s^{-1} and then moves at a constant speed of 25 m s^{-1}. At time $t = 20$, where t is measured in seconds, train Q starts to move in the same direction as P. Train Q accelerates with the same initial constant acceleration as P, up to a speed of 40 m s^{-1} and then moves at a constant speed of 40 m s^{-1}. Train Q overtakes P at time $t = T$, after both trains have reached their constant speeds.

(a) Sketch, on the same axes, the speed-time graphs of both trains for $0 \leqslant t \leqslant T$.

(3)

(b) Find the value of t at the instant when both trains are moving at the same speed.

(2)

(c) Find the value of T.

(8)

(Total 13 marks)

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6. [*In this question* **i** *and* **j** *are horizontal unit vectors due east and due north respectively.*]

A particle P moves with constant acceleration $(-2\mathbf{i} + 3\mathbf{j})$ m s^{-2}. At time t seconds, the velocity of P is $\mathbf{v}$ m s^{-1}. When $t = 0$, $\mathbf{v} = 10\mathbf{i} + 4\mathbf{j}$.

(a) Find the direction of motion of P when $t = 6$, giving your answer as a bearing to the nearest degree.

(5)

(b) Find the value of t when P is moving north east.

(4)

(Total 9 marks)

7.

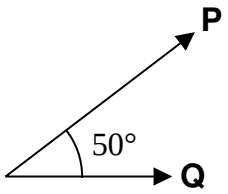

Figure 3

Two forces, **P** and **Q**, act on a particle. The force **P** has magnitude 8 N and the force **Q** has magnitude 5 N. The angle between the directions of **P** and **Q** is 50°, as shown in Figure 3. The resultant of **P** and **Q** is the force **R**.

(*a*) Find, to 3 significant figures, the magnitude of **R**.

(4)

(*b*) Find, to the nearest degree, the size of the angle between the direction of **P** and the direction of **R**.

(4)

(Total 8 marks)

8.

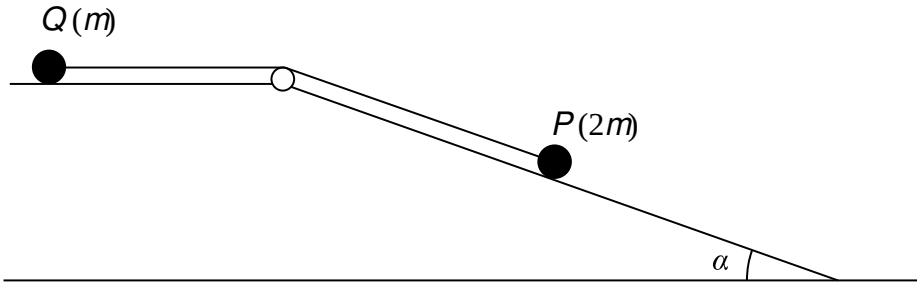

Figure 4

Two particles, P and Q, with masses $2m$ and m respectively, are attached to the ends of a light inextensible string. The string passes over a small smooth pulley which is fixed at the edge of a rough horizontal table. Particle Q is held at rest on the table and particle P is on the surface of a smooth inclined plane. The top of the plane coincides with the edge of the table. The plane is inclined to the horizontal at an angle α, where $\tan \alpha = \frac{3}{4}$, as shown in Figure 4. The string lies in a vertical plane containing the pulley and a line of greatest slope of the plane. The coefficient of friction between Q and the table is $\frac{1}{2}$. Particle Q is released from rest with the string taut and P begins to slide down the plane.

(a) By writing down an equation of motion for each particle,

(i) find the initial acceleration of the system,

(ii) find the tension in the string.

(10)

Suppose now that the coefficient of friction between Q and the table is μ and when Q is released it remains at rest.

(b) Find the smallest possible value of μ.

(4)

(Total 14 marks)

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3. A particle P moves along the x-axis. At time $t = 0$, P passes through the origin with speed 6 m s^{-1} in the positive x direction. The acceleration of P at time t seconds, where $t \geqslant 0$, is $(4t - 8)$ m s^{-2} in the positive x direction.

(a) (i) Show that P is instantaneously at rest when $t = 1$

(ii) Find the other value of t for which P is instantaneously at rest.

(5)

(b) Find the total distance travelled by P in the interval $1 \leqslant t \leqslant 4$

(4)

(Total 9 marks)

4.

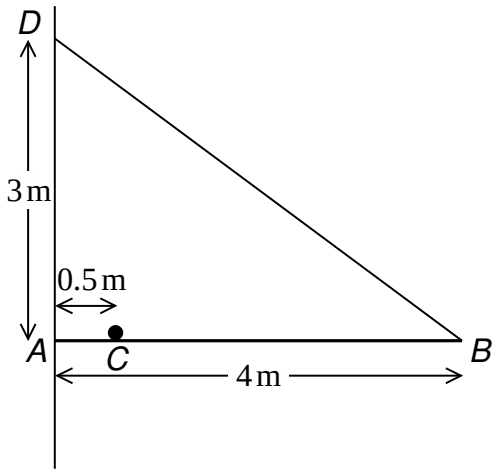

Figure 5

A uniform rod AB has mass 5 kg and length 4 m. The rod is held in a horizontal position by a light inextensible string. The end A of the rod rests against a rough vertical wall. One end of the string is attached to the rod at B and the other end is attached to the wall at a point D. The point D is vertically above A, with $AD = 3$ m. A particle of mass 2 kg is attached to the rod at C, where $AC = 0.5$ m, as shown in Figure 1. The rod is in equilibrium in a vertical plane perpendicular to the wall. The coefficient of friction between the rod and the wall is μ.

Find

(a) the tension in the string,

(4)

(b) the magnitude of the force exerted by the wall on the rod at A,

(5)

(c) the range of possible values of μ.

(2)

(Total 11 marks)

TOTAL FOR PAPER: 80 MARKS