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 9 questions in this question paper. The total mark for this paper is 88.
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. [*In this question* **i** *and* **j** *are perpendicular unit vectors in a horizontal plane.*]

Three forces, $(-10\mathbf{i} + a\mathbf{j})$ N, $(b\mathbf{i} - 5\mathbf{j})$ N and $(2a\mathbf{i} + 7\mathbf{j})$ N, where a and b are constants, act on a particle P of mass 3 kg. The acceleration of P is $(3\mathbf{i} + 4\mathbf{j})$ m s^{-2}

(a) Find the value of a and the value of b.

(5)

At time $t = 0$ seconds the speed of P is u m s^{-1} and at time $t = 4$ seconds the velocity of P is $(20\mathbf{i} + 20\mathbf{j})$ m s^{-1}.

(b) Find the value of u.

(4)

(Total 9 marks)

2.

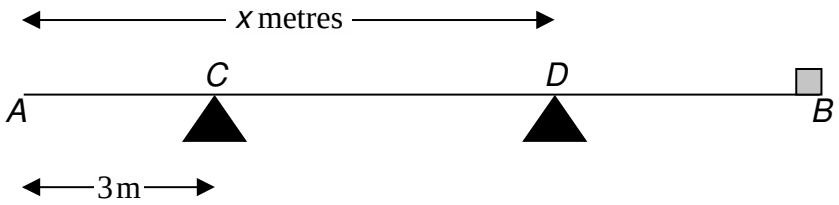

Figure 1

A plank AB has length 8 m and mass 12 kg. The plank rests on two supports. One support is at C, where $AC = 3$ m and the other support is at D, where $AD = x$ metres. A block of mass 3 kg is placed on the plank at B, as shown in Figure 1. The plank rests in equilibrium in a horizontal position. The magnitude of the force exerted on the plank by the support at D is twice the magnitude of the force exerted on the plank by the support at C. The plank is modelled as a uniform rod and the block is modelled as a particle.

Find the value of x.

(7)

(Total 7 marks)

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3. [*In this question* **i** *and* **j** *are horizontal unit vectors due east and due north respectively and position vectors are given relative to a fixed origin O*]

A particle P is moving with velocity $(\mathbf{i} - 2\mathbf{j})$ km h^{-1}. At time $t = 0$ hours, the position vector of P is $(-5\mathbf{i} + 9\mathbf{j})$ km. At time t hours, the position vector of P is $\mathbf{p}$ km.

(a) Find an expression for $\mathbf{p}$ in terms of t.

(2)

The point A has position vector $(3\mathbf{i} + 2\mathbf{j})$ km.

(b) Find the position vector of P when P is due west of A.

(4)

Another particle Q is moving with velocity $\left[(2b - 1)\mathbf{i} + (5 - 2b)\mathbf{j}\right]$ km h^{-1} where b is a constant.

Given that the particles are moving along parallel lines,

(c) find the value of b.

(4)

(Total 10 marks)

4.

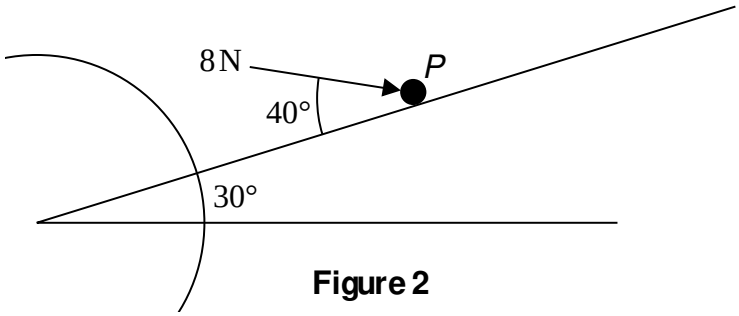

Figure 2

A particle P of mass 0.5 kg is at rest on a rough plane which is inclined to the horizontal at 30°. The particle is held in equilibrium by a force of magnitude 8 N, acting at an angle of 40° to the plane, as shown in Figure 2. The line of action of the force lies in the vertical plane containing P and a line of greatest slope of the plane. The coefficient of friction between P and the plane is μ. Given that P is on the point of sliding up the plane, find the value of μ.

(9)

(Total 9 marks)

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5. Two cars A and B are moving in the same direction along a straight horizontal road.

Car A is moving with uniform acceleration 0.4 m s^{-2} and car B is moving with uniform acceleration 0.5 m s^{-2}. At the instant when B is 200 m behind A, the speed of A is 35 m s^{-1} and the speed of B is 44 m s^{-1}. Find the speed of B when it overtakes A.

(9)

(Total 9 marks)

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6. A train moves on a straight horizontal track between two stations A and B. The train starts from rest at A and moves with constant acceleration 1m s^{-2} until it reaches a speed of V m s^{-1}. The train maintains this speed of V m s^{-1} for the next T seconds before slowing down with constant deceleration 0.5 m s^{-2}, coming to rest at B. The journey from A to B takes 180 s and the distance between the stations is 4800 m.

(a) Sketch a speed-time graph for the motion of the train from A to B.

(2)

(b) Show that $T = 180 - 3V$.

(2)

(c) Find the value of V.

(7)

(Total 11 marks)

7.

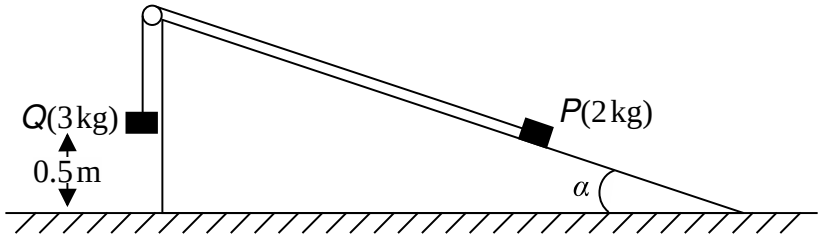

Figure 3

Two particles P and Q have masses 2 kg and 3 kg respectively. The particles are attached to the ends of a light inextensible string. The string passes over a smooth light pulley which is fixed at the top of a rough plane. The plane is inclined to horizontal ground at an angle α, where $\tan\alpha = \frac{3}{4}$. Initially P is held at rest on the inclined plane with the part of the string from P to the pulley parallel to a line of greatest slope of the plane. The particle Q hangs freely below the pulley at a height of 0.5 m above the ground, as shown in Figure 3. The coefficient of friction between P and the plane is μ. The system is released from rest, with the string taut, and Q strikes the ground before P reaches the pulley. The speed of Q at the instant when it strikes the ground is 1.4 m s^{-1}.

(a) For the motion before Q strikes the ground, find the tension in the string.

(5)

(b) Find the value of μ.

(8)

(Total 13 marks)

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8. At time t seconds ($t \geq 0$), a particle P has position vector $\mathbf{r}$ metres with respect to a fixed origin O, where

$$\mathbf{r} = \left(t^3 - \frac{9}{2}t^2 - 24t\right)\mathbf{i} + \left(-t^3 + 3t^2 + 12t\right)\mathbf{j}$$

At time T seconds, P is moving in a direction parallel to the vector $-\mathbf{i} - \mathbf{j}$

Find

(a) the value of T,

(5)

(b) the magnitude of the acceleration of P at the instant when $t = T$.

(5)

(Total 10 marks)

9.

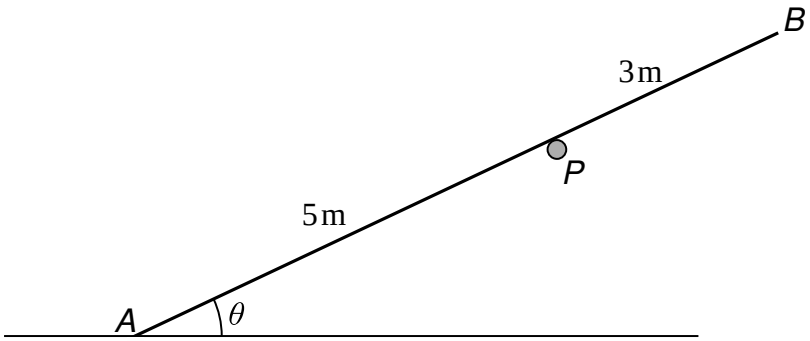

Figure 4

A uniform rod AB of length 8 m and weight W newtons rests in equilibrium against a rough horizontal peg P. The end A is on rough horizontal ground. The friction is limiting at both A and P. The distance AP is 5 m, as shown in Figure 4. The rod rests at angle θ to the horizontal, where $\tan\theta = \frac{4}{3}$. The rod is in a vertical plane which is perpendicular to P.

The coefficient of friction between the rod and P is $\frac{1}{4}$ and the coefficient of friction between the rod and the ground is μ.

(a) Show that the magnitude of the normal reaction between the rod and P is $0.48W$ newtons.

(3)

(b) Find the value of μ.

(7)

(Total 10 marks)

TOTAL FOR PAPER: 88 MARKS