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 99.
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. A train moves along a straight horizontal track between two stations *R* and *S*. Initially the train is at rest at *R*. The train accelerates uniformly at $\frac{1}{2}$ m s^{-2} from rest at *R* until it is moving with speed 15 m s^{-1}. For the next 200 seconds the train maintains a constant speed of 15 m s^{-1}. The train then decelerates uniformly at $\frac{1}{4}$ m s^{-2} until it comes to rest at *S*.

Find

(*a*) the time taken by the train to travel from *R* to *S*,

(3)

(*b*) the distance from *R* to *S*,

(4)

(*c*) the average speed of the train during the journey from *R* to *S*.

(2)

(Total 9 marks)

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2. A particle *P* of mass 0.5 kg moves under the action of a single constant force (2**i** + 3**j**)N.

(*a*) Find the acceleration of *P*.

(2)

At time *t* seconds, *P* has velocity **v** m s^{-1}. When $t = 0$, $\mathbf{v} = 4\mathbf{i}$

(*b*) Find the speed of *P* when $t = 3$

(4)

Given that *P* is moving parallel to the vector 2**i** + **j** at time $t = T$

(*c*) find the value of *T*.

(3)

(Total 9 marks)

3.

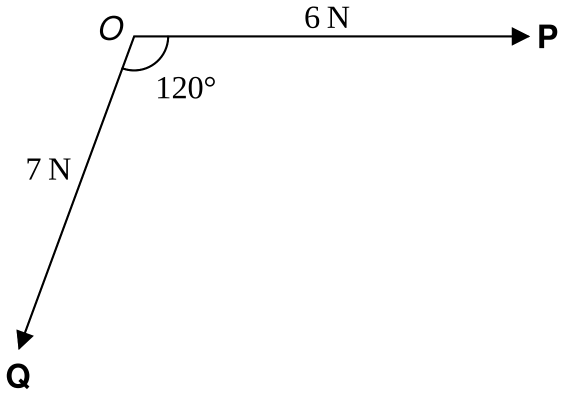

Figure 1

Two forces **P** and **Q** act on a particle at a point *O*. Force **P** has magnitude 6 N and force **Q** has magnitude 7 N. The angle between the line of action of **P** and the line of action of **Q** is 120°, as shown in Figure 1.

The resultant of **P** and **Q** is **R**.

Find

(i) the magnitude of **R**,

(ii) the angle between the line of action of **R** and the line of action of **P**.

(8)

(Total 8 marks)

4.

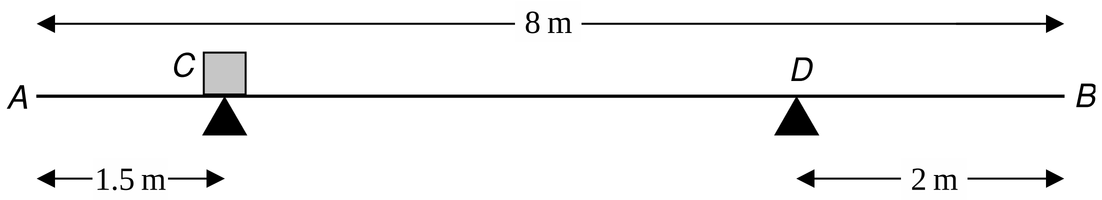

Figure 2

A plank *AB* of mass 20 kg and length 8 m is resting in a horizontal position on two supports at *C* and *D*, where *AC* = 1.5 m and *DB* = 2 m. A package of mass 8 kg is placed on the plank at *C*, as shown in Figure 2. The plank remains horizontal and in equilibrium. The plank is modelled as a uniform rod and the package is modelled as a particle.

(*a*) Find the magnitude of the normal reaction

(i) between the plank and the support at *C*,

(ii) between the plank and the support at *D*.

(6)

The package is now moved along the plank to the point *E*. When the package is at *E*, the magnitude of the normal reaction between the plank and the support at *C* is *R* newtons and the magnitude of the normal reaction between the plank and the support at *D* is 2*R* newtons.

(*b*) Find the distance *AE*.

(6)

(*c*) State how you have used the fact that the package is modelled as a particle.

(1)

(Total 13 marks)

5.

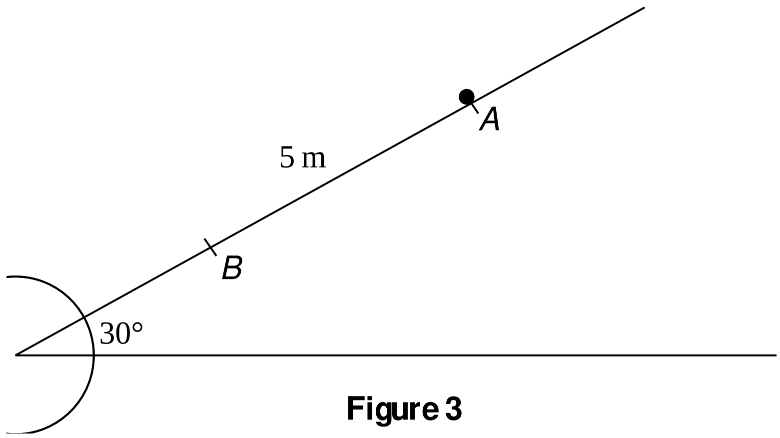

Figure 3

A particle P of mass 4 kg is held at rest at the point A on a rough plane which is inclined at 30° to the horizontal. The point B lies on the line of greatest slope of the plane that passes through A. The point B is 5 m down the plane from A, as shown in Figure 3. The coefficient of friction between the plane and P is 0.3.

The particle is released from rest at A and slides down the plane.

(*a*) Find the speed of P at the instant it reaches B.

(7)

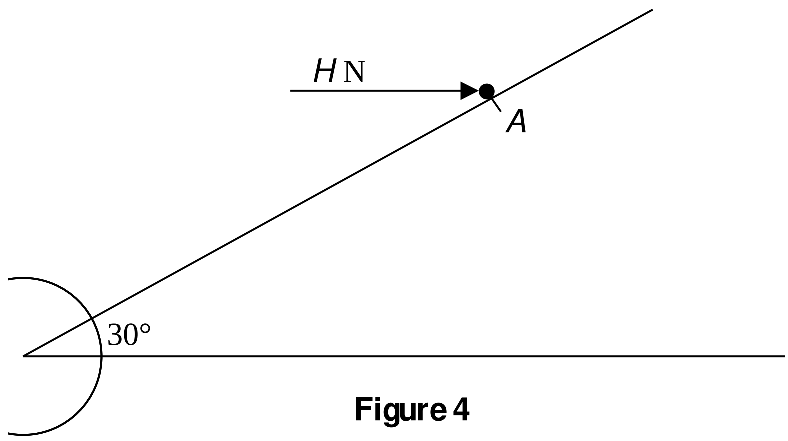

Figure 4

The particle is now returned to A and is held in equilibrium by a horizontal force of magnitude H newtons, as shown in Figure 4. The line of action of the force lies in the vertical plane containing the line of greatest slope of the plane through A. The particle is on the point of moving up the plane.

(*b*) Find the value of H.

(7)

(Total 14 marks)

6.

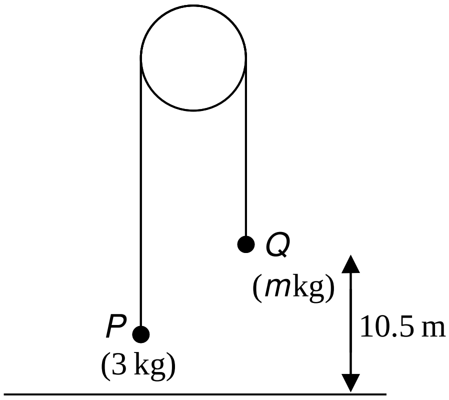

Figure 5

Two particles P and Q have masses 3 kg and m kg respectively ($m > 3$). The particles are connected by a light inextensible string which passes over a smooth light fixed pulley. The system is held at rest with the string taut and the hanging parts of the string vertical. The particle Q is at a height of 10.5 m above the horizontal ground, as shown in Figure 5. The system is released from rest and Q moves downwards. In the subsequent motion P does not reach the pulley. After the system is released, the tension in the string is 33.6 N.

(*a*) Show that the magnitude of the acceleration of P is 1.4 m s^{-2}.

(3)

(*b*) Find the value of m.

(3)

The system is released from rest at time $t = 0$. At time T_1 seconds after release, Q strikes the ground and does not rebound. The string goes slack and P continues to move upwards.

(*c*) Find the value of T_1

(3)

At time T_2 seconds after release, P comes to instantaneous rest.

(*d*) Find the value of T_2

(3)

At time T_3 seconds after release ($T_3 > T_1$) the string becomes taut again.

(*e*) Sketch a velocity-time graph for the motion of P in the interval $0 \leq t \leq T_3$

(2)

(Total 14 marks)

7. A particle P moves along a straight line. At time $t = 0$, P passes the point A on the line and at time t seconds the velocity of P is v m s^{-1} where

$$v = (2t - 3)(t - 2)$$

At $t = 3$, P reaches the point B. Find the total distance moved by P as it travels from A to B.

(6)

(Total 6 marks)

8.

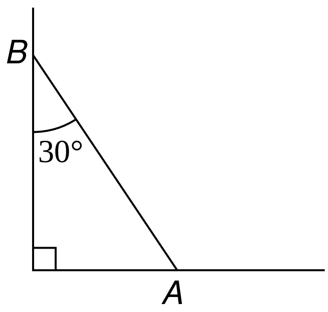

Figure 6

A uniform rod AB has mass m and length $2a$. The end A is in contact with rough horizontal ground and the end B is in contact with a smooth vertical wall. The rod rests in equilibrium in a vertical plane perpendicular to the wall and makes an angle of 30° with the wall, as shown in Figure 6. The coefficient of friction between the rod and the ground is μ.

(*a*) Find, in terms of m and g, the magnitude of the force exerted on the rod by the wall.

(4)

(*b*) Show that $\mu \geq \frac{\sqrt{3}}{6}$

(3)

A particle of mass km is now attached to the rod at B. Given that $\mu = \frac{\sqrt{3}}{5}$ and that the rod is now in limiting equilibrium,

(*c*) find the value of k.

(6)

(Total 13 marks)

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9. At time $t = 0$ seconds, a golf ball is hit from a point O on horizontal ground. The horizontal and vertical components of the initial velocity of the ball are $3U$ m s^{-1} and U m s^{-1} respectively. The ball hits the ground at the point A, where $OA = 120$ m. The ball is modelled as a particle moving freely under gravity.

(*a*) Show that $U = 14$

(5)

(*b*) Find the speed of the ball immediately before it hits the ground at A.

(2)

(*c*) Find the values of t when the ball is moving at an angle α to the horizontal, where $\tan \alpha = \frac{1}{4}$.

(6)

(Total 13 marks)

TOTAL FOR PAPER: 99 MARKS