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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 105.
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 suitcase of mass 40 kg is being dragged in a straight line along a rough horizontal floor at constant speed using a thin strap. The strap is inclined at 20° above the horizontal. The coefficient of friction between the suitcase and the floor is $\frac{3}{4}$. The strap is modelled as a light inextensible string and the suitcase is modelled as a particle. Find the tension in the strap.

(Total 7 marks)

2.

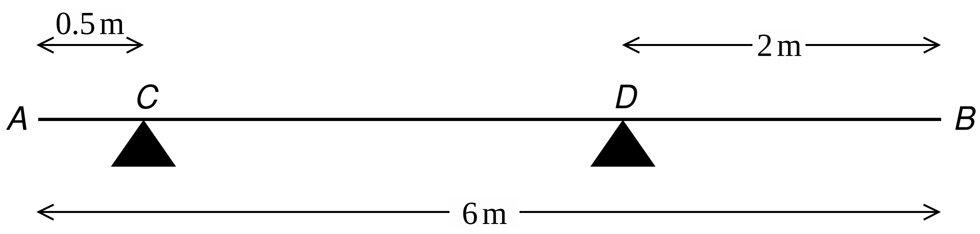

Figure 1

A metal girder *AB*, of weight 1080 N and length 6 m, rests in equilibrium in a horizontal position on two supports, one at *C* and one at *D*, where *AC* = 0.5 m and *BD* = 2 m, as shown in Figure 1. A boy of weight 400 N stands on the girder at *B* and the girder remains horizontal and in equilibrium. The boy is modelled as a particle and the girder is modelled as a uniform rod.

(*a*) Find

(i) the magnitude of the reaction on the girder at *C*,

(ii) the magnitude of the reaction on the girder at *D*.

(6)

The boy now stands at a point *E* on the girder, where *AE* = x metres, and the girder remains horizontal and in equilibrium. Given that the magnitude of the reaction on the girder at *D* is now 520 N greater than the magnitude of the reaction on the girder at *C*,

(*b*) find the value of x.

(5)

(Total 11 marks)

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3. Two forces $\mathbf{F}_1$ and $\mathbf{F}_2$ act on a particle. The force $\mathbf{F}_1$ has magnitude 8 N and acts due east. The resultant of $\mathbf{F}_1$ and $\mathbf{F}_2$ is a force of magnitude 14 N acting in a direction whose bearing is 120°.

Find

(i) the magnitude of $\mathbf{F}_2$,

(4)

(ii) the direction of $\mathbf{F}_2$, giving your answer as a bearing to the nearest degree.

(5)

(Total 9 marks)

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4. A small ball is projected vertically upwards from a point O with speed 14.7 m s^{-1}. The point O is 2.5 m above the ground. The motion of the ball is modelled as that of a particle moving freely under gravity.

Find

(*a*) the maximum height above the ground reached by the ball,

(4)

(*b*) the time taken for the ball to first reach a height of 1 m above the ground,

(4)

(*c*) the speed of the ball at the instant before it strikes the ground for the first time.

(3)

(Total 11 marks)

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5. An athlete goes for a run along a straight horizontal road. Starting from rest, she accelerates at 0.6 m s^{-2} up to a speed of V m s^{-1}. She then maintains this constant speed of V m s^{-1} before finally decelerating at 0.2 m s^{-2} back to rest. She covers a total distance of 1500 m in 270 s.

(*a*) Sketch a speed-time graph to represent the athlete's run.

(2)

(*b*) Show that she accelerates for $\frac{5V}{3}$ seconds.

(2)

(*c*) Show that $V^2 - kV + 450 = 0$, where k is a constant to be found.

(6)

(*d*) Find the value of V, justifying your answer.

(4)

(Total 14 marks)

6.

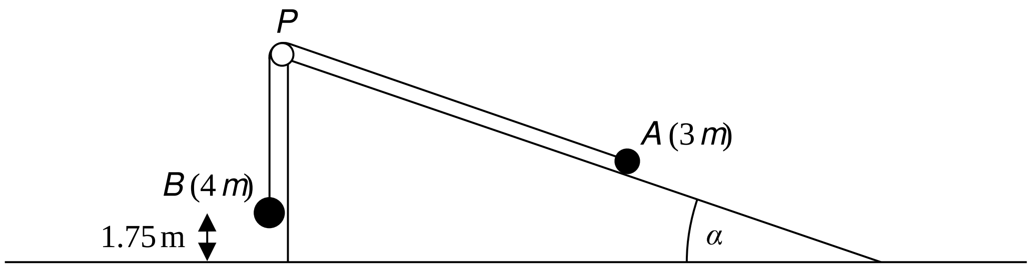

Figure 2

Figure 2 shows two particles A and B, of masses $3m$ and $4m$ respectively, attached to the ends of a light inextensible string. Initially A is held at rest on the surface of a fixed rough inclined plane. The plane is inclined to the horizontal at an angle α where $\tan \alpha = \frac{3}{4}$. The coefficient of friction between A and the plane is $\frac{1}{4}$. The string passes over a small smooth light pulley P which is fixed at the top of the plane. The part of the string from A to P is parallel to a line of greatest slope of the plane. The particle B hangs freely and is vertically below P. The system is released from rest with the string taut and with B at a height of 1.75 m above the ground. In the subsequent motion, A does not hit the pulley.

For the period before B hits the ground,

(*a*) write down an equation of motion for each particle.

(4)

(*b*) Hence show that the acceleration of B is $\frac{8}{35}g$.

(5)

(*c*) Explain how you have used the fact that the string is inextensible in your calculation.

(1)

When B hits the ground, B does not rebound and comes immediately to rest.

(*d*) Find the distance travelled by A from the instant when the system is released to the instant when A first comes to rest.

(7)

(Total 17 marks)

7.

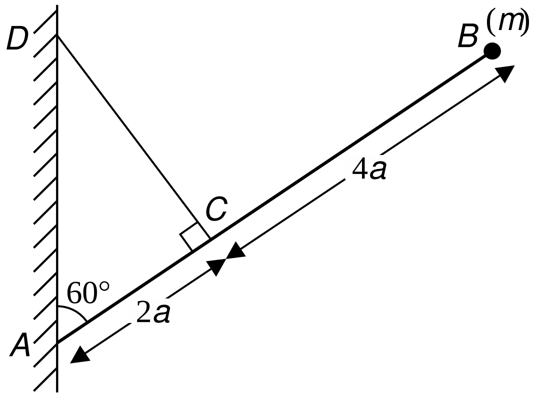

Figure 3

A uniform rod *AB* has mass *m* and length 6*a*. The end *A* rests against a rough vertical wall. One end of a light inextensible string is attached to the rod at the point *C*, where *AC* = 2*a*. The other end of the string is attached to the wall at the point *D*, where *D* is vertically above *A*, with the string perpendicular to the rod. A particle of mass *m* is attached to the rod at the end *B*. The rod is in equilibrium in a vertical plane which is perpendicular to the wall. The rod is inclined at 60° to the wall, as shown in Figure 3.

Find, in terms of *m* and *g*,

(*a*) the tension in the string,

(4)

(*b*) the magnitude of the horizontal component of the force exerted by the wall on the rod.

(3)

The coefficient of friction between the wall and the rod is μ. Given that the rod is in limiting equilibrium,

(*c*) find the value of μ.

(5)

(Total 12 marks)

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8. A particle P moves on the x-axis. At time t seconds, $t \geq 0$, the acceleration of P is $(2t - 3)$ m s^{-2} in the positive x direction. At time t seconds, the velocity of P is v m s^{-1} in the positive x direction. When $t = 3$, $v = 2$

(*a*) Find v in terms of t.

(4)

The particle first comes to instantaneous rest at the point A and then comes to instantaneous rest again at the point B.

(*b*) Find the distance AB.

(6)

(Total 10 marks)

9.

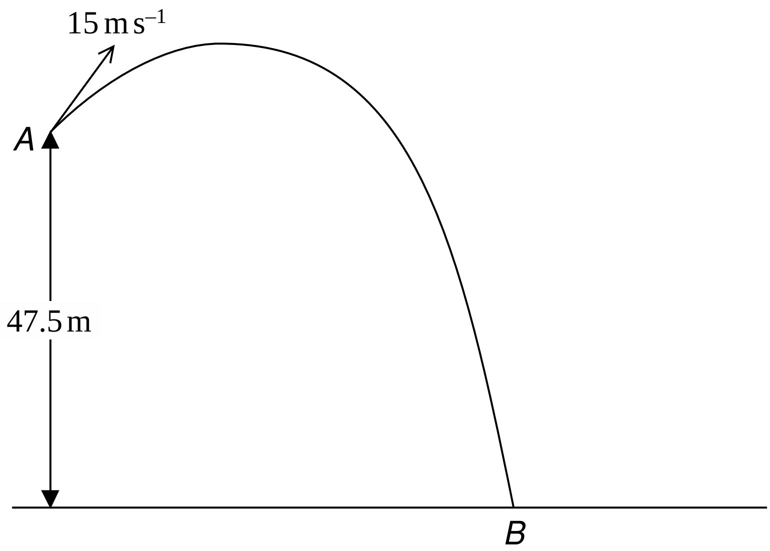

Figure 4

A small ball P is projected with speed 15 m s^{-1} from a point A which is 47.5 m above a horizontal beach. The ball moves freely under gravity and hits the beach at the point B, as shown in Figure 4.

(*a*) By considering energy, find the speed of P immediately before it hits the beach.

(4)

The ball was projected from A at an angle θ above the horizontal, where $\sin \theta = \frac{3}{5}$

(*b*) Find the greatest height above the beach of P as it moved from A to B.

(3)

(*c*) Find the least speed of P as it moved between A and B.

(1)

(*d*) Find the horizontal distance from A to B.

(6)

(Total 14 marks)

TOTAL FOR PAPER: 105 MARKS