Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel GCE

Centre Number	Candidate Number

Wednesday 5 June 2019

Morning (Time: 1 hour 30 minutes)	Paper Reference **6677/01**

Mechanics M1

Advanced/Advanced Subsidiary

You must have:
Mathematical Formulae and Statistical Tables (Pink)

Total Marks

Candidates may use any calculator permitted 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). Coloured pencils and highlighter pens must not be used.
- **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 in the spaces provided – *there may be more space than you need.*
- You should show sufficient working to make your methods clear. Answers without working may not gain full credit.
- Whenever a numerical value of g is required, take $g = 9.8$ m s^{-2}, and give your answer to either two significant figures or three significant figures.
- When a calculator is used, the answer should be given to an appropriate degree of accuracy.

Information

- The total mark for this paper is 75.
- 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.

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

Three forces, $(p\mathbf{i} + 2\mathbf{j})$ N, $(3\mathbf{i} - q\mathbf{j})$ N and $(q\mathbf{i} + 2p\mathbf{j})$ N, where p and q are constants, act on a particle of mass 2 kg. The forces cause the particle to move with acceleration $(\mathbf{i} - 3\mathbf{j})$ m s^{-2}.

(a) Find the direction of the acceleration, giving your answer as a bearing to the nearest degree.

(3)

(b) Find the value of p and the value of q.

(5)

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Question 1 continued

Q1

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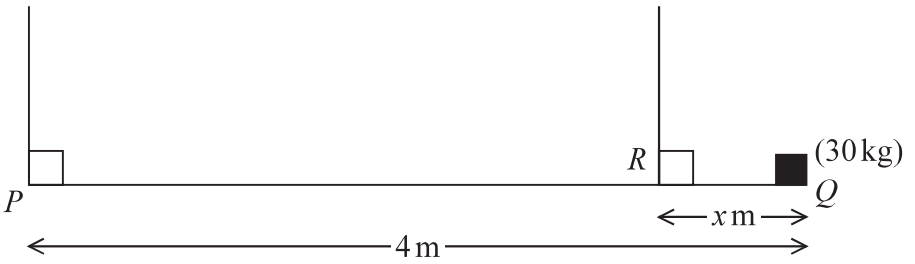

Figure 1

A girder PQ has length 4 m and mass 60 kg. A load of mass 30 kg is placed on the girder at Q. The loaded girder is held in equilibrium in a horizontal position by two vertical ropes. The ropes are attached to the girder at the points P and R, where $RQ = x$ metres, as shown in Figure 1. The tension in the rope at R is four times the tension in the rope at P. The girder is modelled as a uniform rod, the ropes as light inextensible strings and the load as a particle.

Find

(i) the tension in the rope at P,

(ii) the value of x.

(7)

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Question 2 continued

Q2

(Total 7 marks)

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3. At time $t = 0$, a toy rocket is fired vertically upwards from rest from a point A on the ground. The rocket moves with constant acceleration $2.8\,\text{m s}^{-2}$. At time $t = 5.25\,\text{s}$, the rocket runs out of fuel and then moves vertically upwards under gravity. At time $t = T$ seconds, the rocket reaches its greatest height above A. The rocket is modelled as a particle.

(a) Find the value of T.

(5)

(b) Without doing any further calculations, sketch a velocity-time graph for the motion of the rocket from when it was fired to when it returns to A, showing the value of T on the t-axis.

(2)

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Question 3 continued

Q3

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4. Two particles, P and Q, of masses m and $4m$ respectively are moving on a smooth horizontal plane when they collide directly. Immediately **before** the collision the particles are moving towards each other along the same straight line.

Immediately **after** the collision, the direction of motion of P is the same as the direction of motion of Q, the speed of P is $\frac{3u}{2}$ and the speed of Q is $\frac{u}{8}$. In the collision Q exerts an impulse of magnitude $\frac{7mu}{2}$ on P.

(a) Give a reason why the direction of motion of P is reversed by the collision.

(1)

(b) Find, in terms of u, the speed of P immediately before the collision.

(3)

(c) Find, in terms of u, the speed of Q immediately before the collision.

(3)

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Question 4 continued

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Question 4 continued

Q4

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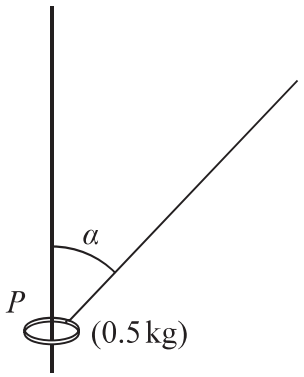

Figure 2

A ring P of mass 0.5 kg is attached to one end of a light inextensible string. The ring is threaded on a fixed rough vertical wire. The ring is held in equilibrium with the string taut. The string makes an angle α with the wire, where $\tan\alpha = \frac{4}{3}$, as shown in Figure 2. The coefficient of friction between P and the wire is $\frac{1}{4}$. The ring is modelled as a particle.

(a) Given that P is on the point of sliding up the wire, find the tension in the string.

(7)

(b) Find the magnitude of the smallest tension in the string which will keep the ring in equilibrium, given that the string remains at angle α to the wire.

(4)

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Question 5 continued

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Question 5 continued

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Question 5 continued

(Total 11 marks)

Q5

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6. [*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.*]

Two ships, P and Q, are moving with constant velocities. The velocity of P is $(3\mathbf{i} - 2\mathbf{j})\,\text{km h}^{-1}$ and the velocity of Q is $(5\mathbf{i} + 6\mathbf{j})\,\text{km h}^{-1}$.

At 9 am, the position vector of P is $(\mathbf{i} + 4\mathbf{j})$ km and the position vector of Q is $(7\mathbf{i} + 8\mathbf{j})$ km.

(a) (i) Write down the position vector of P at time t hours after 9 am.

(ii) Write down the position vector of Q at time t hours after 9 am.

(3)

At time t hours after 9 am, $\overrightarrow{QP} = \mathbf{r}$ km.

(b) Show that $\mathbf{r} = (-6 - 2t)\mathbf{i} + (-4 - 8t)\mathbf{j}$

(2)

(c) Hence find the distance between the ships when P is south west of Q.

(5)

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Question 6 continued

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Question 6 continued

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Q6

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7. A car is moving with constant speed along a straight horizontal road. Whenever the brakes are applied they produce a deceleration of $5\,m\,s^{-2}$. The driver sees a STOP sign which is at the point S on the road ahead. Unfortunately due to the time he takes to react, he does not apply the brakes immediately and the car overshoots the sign. Had he applied the brakes 0.5 s sooner the car would have come to rest at S. The car is modelled as a particle.

(a) Show that, at the instant the car passes S, the speed of the car is $2.5\,m\,s^{-1}$.

(2)

(b) Find how far the car travels past S before coming to rest.

(2)

At the instant when the driver sees the sign, the speed of the car is $64.8\,km\,h^{-1}$. The total time from the instant when the driver first sees the sign to the instant when the car comes to rest is 4.2 seconds.

(c) Find the total distance travelled by the car, from the instant when the driver first sees the sign to the instant when the car reaches the sign.

(7)

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Question 7 continued

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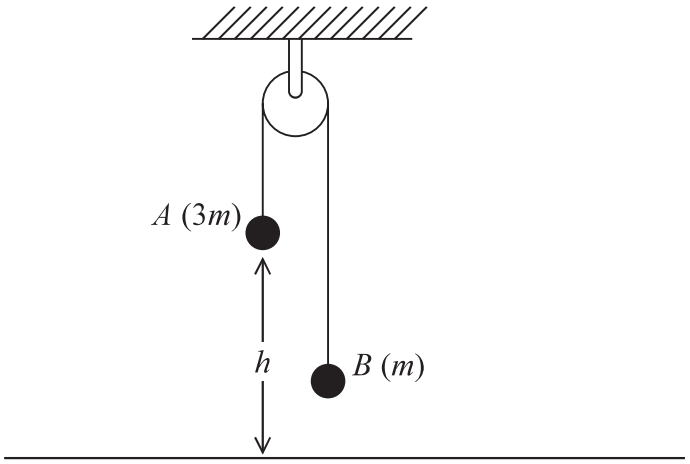

Figure 3

Two particles, A and B, have masses $3m$ and m respectively. The particles are attached to the ends of a light inextensible string which passes over a light smooth fixed pulley. The system is held at rest with the string taut. The hanging parts of the string are vertical and A is at a height h above a horizontal floor, as shown in Figure 3. The system is now released from rest and in the subsequent motion B does not reach the pulley.

For the motion of A and B before A hits the floor,

(a) (i) write down an equation of motion for A,

(ii) write down an equation of motion for B.

(4)

(b) Hence show that, until A hits the floor, the acceleration of A is $0.5\,g$

(2)

(c) State how, in your solution, you have used the fact that the string is modelled as being inextensible.

(1)

The speed of A at the instant immediately before it hits the floor is V.

(d) Find V in terms of g and h.

(2)

As a result of hitting the floor, A rebounds with speed $\frac{1}{2}V$.

(e) Find, in terms of m, g and h, the magnitude of the impulse exerted by the floor on A.

(3)

(f) Find, in terms of h, the height of A above the floor when A next comes to rest.

(2)

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Q8

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TOTAL FOR PAPER: 75 MARKS

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