Write your name here

Surname	Other names

Pearson Edexcel GCE

Centre Number | Candidate Number

Mechanics M1

Advanced/Advanced Subsidiary

Wednesday 6 June 2018 – Morning
Time: 1 hour 30 minutes

Paper Reference
6677/01

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

Total Marks

Candidates may use any calculator allowed by the regulations of the Joint Council for Qualifications. 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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Pearson

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1. Two particles, P and Q, have masses $3m$ and m respectively. They are moving in opposite directions towards each other along the same straight line on a smooth horizontal plane and collide directly. The speeds of P and Q immediately before the collision are $2u$ and $4u$ respectively. The magnitude of the impulse received by each particle in the collision is $\frac{21mu}{4}$.

(a) Find the speed of P after the collision.

(3)

(b) Find the speed of Q after the collision.

(3)

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Question 1 continued

(Total 6 marks)

Q1

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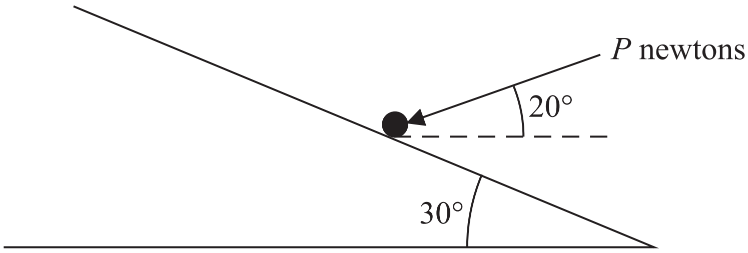

Figure 1

A particle of mass 2 kg lies on a rough plane. The plane is inclined to the horizontal at 30°. The coefficient of friction between the particle and the plane is $\frac{1}{4}$. The particle is held in equilibrium by a force of magnitude P newtons. The force makes an angle of 20° with the horizontal and acts in a vertical plane containing a line of greatest slope of the plane, as shown in Figure 1. Find the least possible value of P.

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Question 2 continued

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Question 2 continued

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Question 2 continued

Q2

(Total 10 marks)

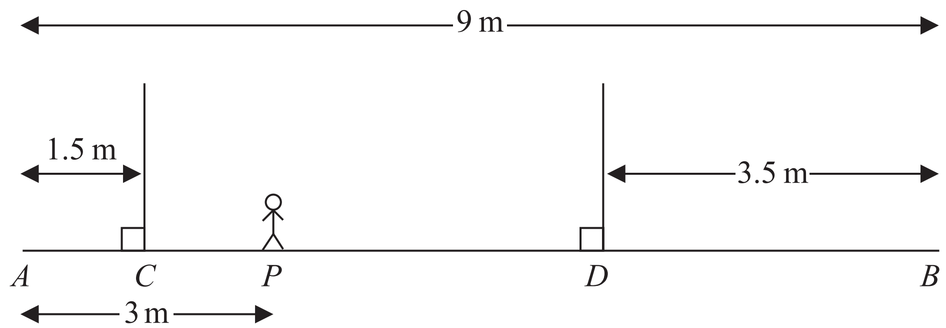
3. 

Figure 2

A wooden beam AB, of mass 150 kg and length 9 m, rests in a horizontal position supported by two vertical ropes. The ropes are attached to the beam at C and D, where $AC = 1.5$ m and $BD = 3.5$ m. A gymnast of mass 60 kg stands on the beam at the point P, where $AP = 3$ m, as shown in Figure 2. The beam remains horizontal and in equilibrium.

By modelling the gymnast as a particle, the beam as a uniform rod and the ropes as light inextensible strings,

(a) find the tension in the rope attached to the beam at C.

(3)

The gymnast at P remains on the beam at P and another gymnast, who is also modelled as a particle, stands on the beam at B. The beam remains horizontal and in equilibrium. The mass of the gymnast at B is the largest possible for which the beam remains horizontal and in equilibrium.

(b) Find the tension in the rope attached to the beam at D.

(4)

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Question 3 continued

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4. A ball of mass 0.2 kg is projected vertically downwards with speed U m s^{-1} from a point A which is 2.5 m above horizontal ground. The ball hits the ground. Immediately after hitting the ground, the ball rebounds vertically with a speed of 10 m s^{-1}. The ball receives an impulse of magnitude 7 N s in its impact with the ground. By modelling the ball as a particle and ignoring air resistance, find

(a) the value of U.

(6)

After hitting the ground, the ball moves vertically upwards and passes through a point B which is 1 m above the ground.

(b) Find the time between the instant when the ball hits the ground and the instant when the ball first passes through B.

(4)

(c) Sketch a velocity-time graph for the motion of the ball from when it was projected from A to when it first passes through B. (You need not make any further calculations to draw this sketch.)

(3)

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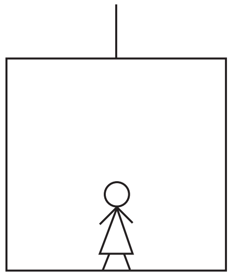

Figure 3

A lift of mass 250 kg is being raised by a vertical cable attached to the top of the lift. A woman of mass 60 kg stands on the horizontal floor inside the lift, as shown in Figure 3. The lift ascends vertically with constant acceleration $2\,\text{m}\,\text{s}^{-2}$. There is a constant downwards resistance of magnitude 100 N on the lift. By modelling the woman as a particle,

(a) find the magnitude of the normal reaction exerted by the floor of the lift on the woman.

(3)

The tension in the cable must not exceed 10 000 N for safety reasons, and the maximum upward acceleration of the lift is $3\,\text{m}\,\text{s}^{-2}$. A typical occupant of the lift is modelled as a particle of mass 75 kg and the cable is modelled as a light inextensible string. There is still a constant downwards resistance of magnitude 100 N on the lift.

(b) Find the maximum number of typical occupants that can be safely carried in the lift when it is ascending with an acceleration of $3\,\text{m}\,\text{s}^{-2}$.

(7)

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Question 5 continued

Q5

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

Two forces $\mathbf{F}_1$ and $\mathbf{F}_2$ act on a particle P of mass 0.5 kg.

$\mathbf{F}_1 = (4\mathbf{i} - 6\mathbf{j})$ N and $\mathbf{F}_2 = (p\mathbf{i} + q\mathbf{j})$ N.

Given that the resultant force of $\mathbf{F}_1$ and $\mathbf{F}_2$ is in the same direction as $-2\mathbf{i} - \mathbf{j}$,

(a) show that $p - 2q = -16$

(5)

Given that $q = 3$

(b) find the magnitude of the acceleration of P,

(5)

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

(3)

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Question 6 continued

Q6

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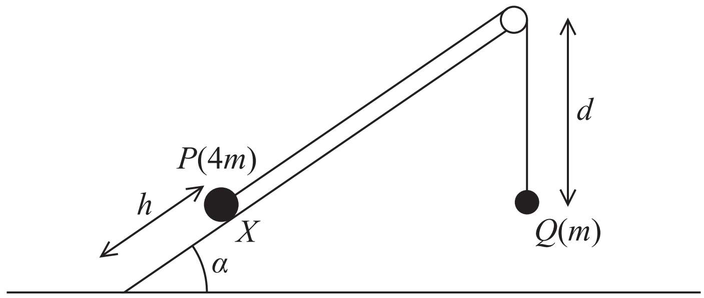

Figure 4

A particle P of mass $4m$ is held at rest at the point X on the surface of a rough inclined plane which is fixed to horizontal ground. The point X is a distance h from the bottom of the inclined plane. The plane is inclined to the horizontal at an angle α where $\tan \alpha = \frac{3}{4}$. The coefficient of friction between P and the plane is $\frac{1}{4}$. The particle P is attached to one end of a light inextensible string. The string passes over a small smooth pulley which is fixed at the top of the plane. The other end of the string is attached to a particle Q of mass m which hangs freely at a distance d, where $d > h$, below the pulley, as shown in Figure 4.

The string lies in a vertical plane through a line of greatest slope of the inclined plane. The system is released from rest with the string taut and P moves down the plane.

For the motion of the particles before P hits the ground,

(a) state which of the information given above implies that the magnitudes of the accelerations of the two particles are the same,

(1)

(b) write down an equation of motion for each particle,

(5)

(c) find the acceleration of each particle.

(5)

When P hits the ground, it immediately comes to rest. Given that Q comes to instantaneous rest before reaching the pulley,

(d) show that $d > \frac{28h}{25}$.

(5)

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Question 7 continued

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Q7

(Total 16 marks)

TOTAL FOR PAPER: 75 MARKS

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