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Pearson Edexcel
International
Advanced Level

Centre Number | | | | | |

Candidate Number | | | | |

Mechanics M1

Advanced/Advanced Subsidiary

Monday 23 January 2017 – Afternoon
Time: 1 hour 30 minutes

Paper Reference
WME01/01

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

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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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 $\frac{1}{2}\,\text{m s}^{-2}$ from rest at R until it is moving with speed $15\,\text{m s}^{-1}$. For the next 200 seconds the train maintains a constant speed of $15\,\text{m s}^{-1}$. The train then decelerates uniformly at $\frac{1}{4}\,\text{m s}^{-2}$ 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)

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Question 1 continued

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

(a) Find the acceleration of P.

(2)

At time t seconds, P has velocity $\mathbf{v}$ 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 $2\mathbf{i} + \mathbf{j}$ at time $t = T$

(c) find the value of T.

(3)

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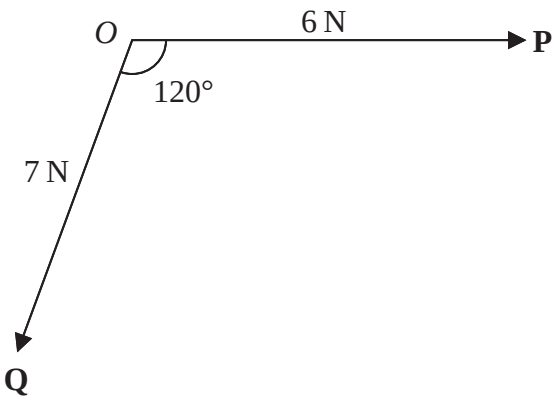

Figure 1

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)

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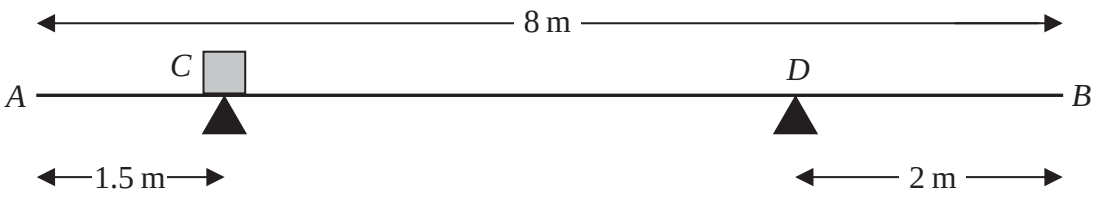

Figure 2

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 $2R$ newtons.

(b) Find the distance AE.

(6)

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

(1)

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5. Two particles P and Q have masses $4m$ and km respectively. They are moving towards each other in opposite directions along the same straight line on a smooth horizontal table when they collide directly. Immediately before the collision the speed of P is $3u$ and the speed of Q is u. Immediately after the collision both particles have speed $2u$ and the direction of motion of Q has been reversed.

(a) Find, in terms of k, m and u, the magnitude of the impulse received by Q in the collision.

(3)

(b) Find the two possible values of k.

(5)

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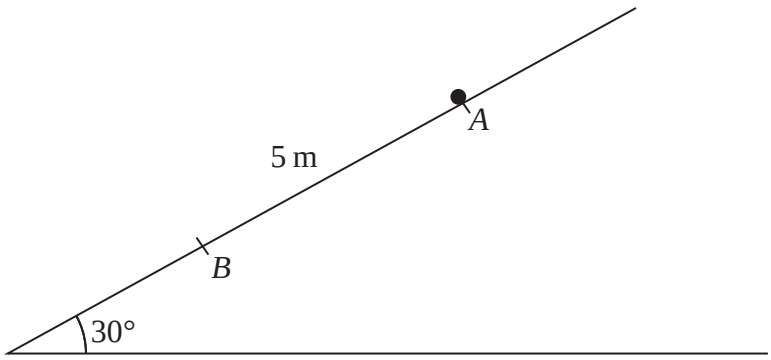

Figure 3

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)

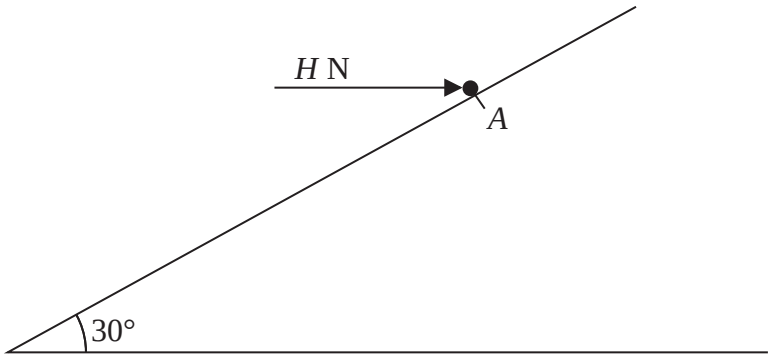

Figure 4

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)

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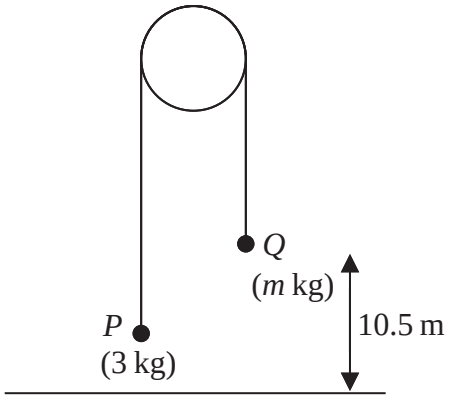

Figure 5

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 $0 \leqslant t \leqslant T_3$

(2)

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