Write your name here

Surname	Other names

Pearson Edexcel
International
Advanced Level

Centre Number | | | | | |

Candidate Number | | | | |

Mechanics M2

Advanced/Advanced Subsidiary

Tuesday 9 June 2015 – Morning
Time: 1 hour 30 minutes

Paper Reference
WME02/01

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 particle of mass 0.3 kg is moving with velocity $(5\mathbf{i} + 3\mathbf{j})$ m s^{-1} when it receives an impulse $(-3\mathbf{i} + 3\mathbf{j})$ N s. Find the change in the kinetic energy of the particle due to the impulse.

(6)

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2. At time t seconds, $t \geqslant 0$, a particle P has velocity $\mathbf{v}$ m s^{-1}, where

$$\mathbf{v} = (27 - 3t^2)\mathbf{i} + (8 - t^3)\mathbf{j}$$

When $t = 1$, the particle P is at the point with position vector $\mathbf{r}$ m relative to a fixed origin O, where $\mathbf{r} = -5\mathbf{i} + 2\mathbf{j}$

Find

(a) the magnitude of the acceleration of P at the instant when it is moving in the direction of the vector $\mathbf{i}$,

(5)

(b) the position vector of P at the instant when $t = 3$

(5)

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Question 2 continued

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3. A thin uniform wire of mass $12m$ is bent to form a right-angled triangle ABC. The lengths of the sides AB, BC and AC are $3a$, $4a$ and $5a$ respectively. A particle of mass $2m$ is attached to the triangle at B and a particle of mass $3m$ is attached to the triangle at C. The bent wire and the two particles form the system S.

The system S is freely suspended from A and hangs in equilibrium.

Find the size of the angle between AB and the downward vertical.

(10)

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Question 3 continued

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4.

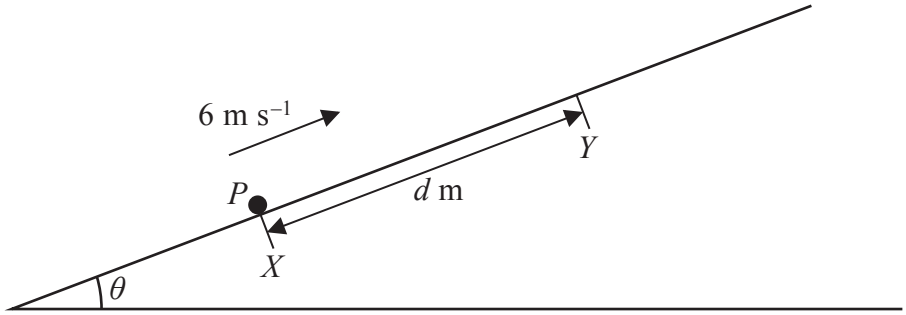

Figure 1

A particle P of mass 6.5 kg is projected up a fixed rough plane with initial speed 6 m s^{-1} from a point X on the plane, as shown in Figure 1. The particle moves up the plane along the line of greatest slope through X and comes to instantaneous rest at the point Y, where $XY = d$ metres. The plane is inclined at an angle θ to the horizontal, where $\tan\theta = \frac{5}{12}$. The coefficient of friction between P and the plane is $\frac{1}{3}$.

(a) Use the work-energy principle to show that, to 2 significant figures, $d = 2.7$

(7)

After coming to rest at Y, the particle P slides back down the plane.

(b) Find the speed of P as it passes through X.

(4)

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Question 4 continued

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5. Three particles A, B and C lie at rest in a straight line on a smooth horizontal table with B between A and C. The masses of A, B and C are $3m$, $4m$, and $5m$ respectively. Particle A is projected with speed u towards particle B and collides directly with B. The coefficient of restitution between A and B is $\frac{1}{3}$.

(a) Show that the impulse exerted by A on B in this collision has magnitude $\frac{16}{7}mu$

(7)

After the collision between A and B there is a direct collision between B and C.

After this collision between B and C, the kinetic energy of C is $\frac{72}{245}mu^2$

(b) Find the coefficient of restitution between B and C.

(6)

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Question 5 continued

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6.

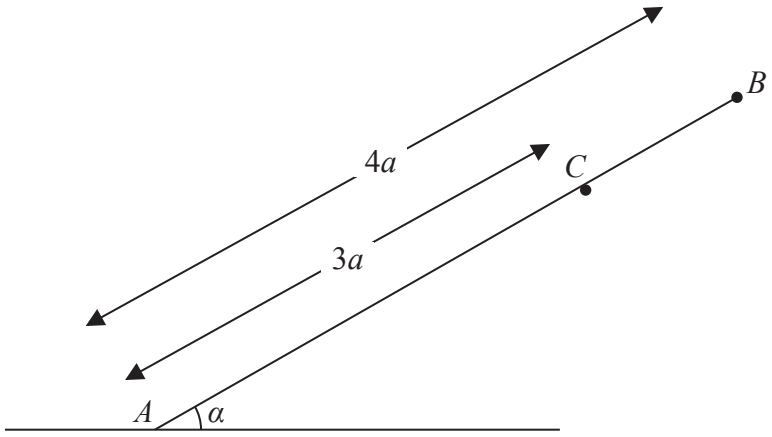

Figure 2

A uniform rod AB has length $4a$ and weight W. A particle of weight kW, $k < 1$, is attached to the rod at B. The rod rests in equilibrium against a fixed smooth horizontal peg. The end A of the rod is on rough horizontal ground, as shown in Figure 2. The rod rests on the peg at C, where $AC = 3a$, and makes an angle α with the ground, where $\tan \alpha = \frac{1}{3}$. The peg is perpendicular to the vertical plane containing AB.

(a) Give a reason why the force acting on the rod at C is perpendicular to the rod.

(1)

(b) Show that the magnitude of the force acting on the rod at C is

$$\frac{\sqrt{10}}{5} W\left(1 + 2k\right)$$

(4)

The coefficient of friction between the rod and the ground is $\frac{3}{4}$.

(c) Show that for the rod to remain in equilibrium $k \leqslant \frac{2}{11}$.

(7)

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Question 6 continued

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7. [*In this question, the unit vectors* **i** *and* **j** *are in a vertical plane,* **i** *being horizontal and* **j** *being vertically upwards.*]

At time $t = 0$, a particle P is projected with velocity $(4\mathbf{i} + 9\mathbf{j})$ m s^{-1} from a fixed point O on horizontal ground. The particle moves freely under gravity. When P is at the point H on its path, P is at its greatest height above the ground.

(a) Find the time taken by P to reach H.

(2)

At the point A on its path, the position vector of P relative to O is $(k\mathbf{i} + k\mathbf{j})$ m, where k is a positive constant.

(b) Find the value of k.

(4)

(c) Find, in terms of k, the position vector of the other point on the path of P which is at the same vertical height above the ground as the point A.

(3)

At time T seconds the particle is at the point B and is moving perpendicular to $(4\mathbf{i} + 9\mathbf{j})$

(d) Find the value of T.

(4)

Leave blank

Question 7 continued