

Write your name here

Surname

Other names

**Pearson Edexcel**  
**International**  
**Advanced Level**

Centre Number

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Candidate Number

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# Mechanics M2

## Advanced/Advanced Subsidiary

Wednesday 21 January 2015 – Afternoon  
**Time: 1 hour 30 minutes**

Paper Reference

**WME02/01****You must have:**

Mathematical Formulae and Statistical Tables (Blue)

Total Marks

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**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  $g = 9.8 \text{ m s}^{-2}$ , 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.

Turn over ►

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**Question 2 continued**

Lined writing area for the answer to Question 2, consisting of 30 horizontal lines.

**(Total 9 marks)**

Q2



- 3. At time  $t$  seconds ( $t \geq 0$ ) a particle  $P$  has position vector  $\mathbf{r}$  metres, with respect to a fixed origin  $O$ , where

$$\mathbf{r} = \left( \frac{1}{8}t^4 - 2\lambda t^2 + 5 \right) \mathbf{i} + (5t^2 - \lambda t) \mathbf{j}$$

and  $\lambda$  is a constant.

When  $t = 4$ ,  $P$  is moving parallel to the vector  $\mathbf{j}$ .

- (a) Show that  $\lambda = 2$  (5)

- (b) Find the speed of  $P$  when  $t = 4$  (1)

- (c) Find the acceleration of  $P$  when  $t = 4$  (2)

When  $t = 0$ ,  $P$  is at the point  $A$ . When  $t = 4$ ,  $P$  is at the point  $B$ .

- (d) Find the distance  $AB$ . (4)

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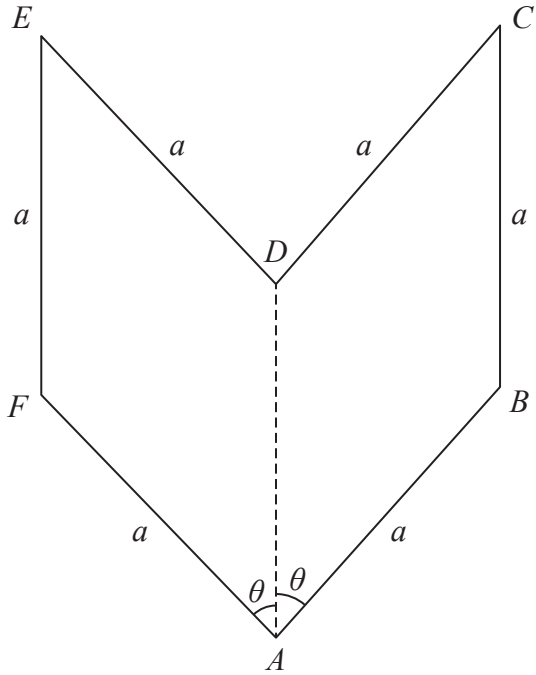


Figure 1

The uniform plane lamina  $ABCDEF$  shown in Figure 1 is made from two identical rhombuses. Each rhombus has sides of length  $a$  and angle  $BAD = \text{angle } DAF = \theta$ . The centre of mass of the lamina is  $0.9a$  from  $A$ .

(a) Show that  $\cos \theta = 0.8$  (5)

The weight of the lamina is  $W$ . A particle of weight  $kW$  is fixed to the lamina at the point  $A$ . The lamina is freely suspended from  $B$  and hangs in equilibrium with  $DA$  horizontal.

(b) Find the value of  $k$ . (4)

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**Question 4 continued**

Lined area for writing the answer to Question 4 continued.





**Question 4 continued**

Lined writing area for the answer to Question 4. The page contains 28 horizontal lines for writing.

**(Total 9 marks)**

**Q4**



5.

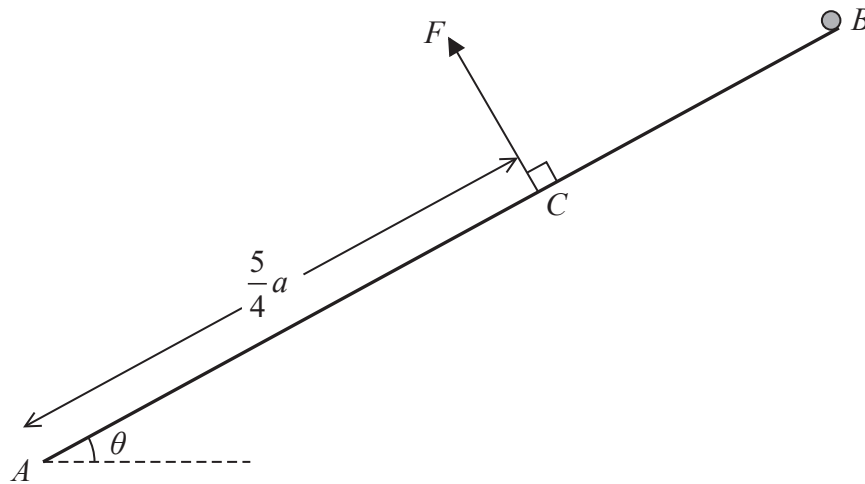


Figure 2

A uniform rod  $AB$ , of mass  $m$  and length  $2a$ , is freely hinged to a fixed point  $A$ . A particle of mass  $km$  is fixed to the rod at  $B$ . The rod is held in equilibrium, at an angle  $\theta$  to the horizontal, by a force of magnitude  $F$  acting at the point  $C$  on the rod, where  $AC = \frac{5}{4}a$ , as shown in Figure 2. The line of action of the force at  $C$  is at right angles to  $AB$  and in the vertical plane containing  $AB$ .

Given that  $\tan \theta = \frac{3}{4}$

(a) show that  $F = \frac{16}{25}mg(1 + 2k)$ , (4)

(b) find, in terms of  $m$ ,  $g$  and  $k$ ,

(i) the horizontal component of the force exerted by the hinge on the rod at  $A$ ,

(ii) the vertical component of the force exerted by the hinge on the rod at  $A$ . (5)

Given also that the force acting on the rod at  $A$  acts at  $45^\circ$  above the horizontal,

(c) find the value of  $k$ . (3)

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6.

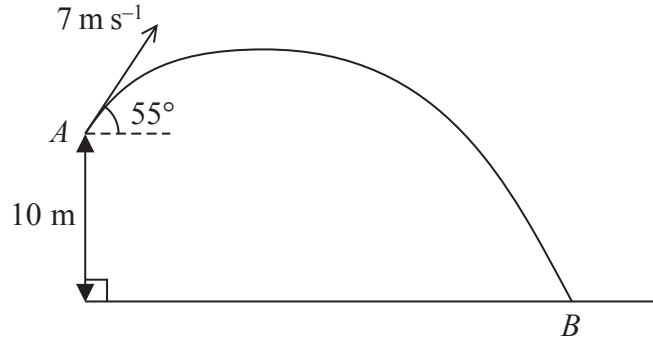


Figure 3

A small ball  $P$  is projected with speed  $7 \text{ m s}^{-1}$  from a point  $A$   $10 \text{ m}$  above horizontal ground. The angle of projection is  $55^\circ$  above the horizontal. The ball moves freely under gravity and hits the ground at the point  $B$ , as shown in Figure 3.

Find

- (a) the speed of  $P$  as it hits the ground at  $B$ , (4)
- (b) the direction of motion of  $P$  as it hits the ground at  $B$ , (3)
- (c) the time taken for  $P$  to move from  $A$  to  $B$ . (5)

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**Question 6 continued**

A series of horizontal lines for writing answers, consisting of 27 rows.



P 4 5 0 6 2 A 0 2 1 2 8



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**Question 6 continued**

Lined writing area for the answer to Question 6.

**(Total 12 marks)**

**Q6**



7. Three particles  $P$ ,  $Q$  and  $R$  lie at rest in a straight line on a smooth horizontal surface with  $Q$  between  $P$  and  $R$ . Particle  $P$  has mass  $m$ , particle  $Q$  has mass  $2m$  and particle  $R$  has mass  $3m$ . The coefficient of restitution between each pair of particles is  $e$ . Particle  $P$  is projected towards  $Q$  with speed  $3u$  and collides directly with  $Q$ .

- (a) Find, in terms of  $u$  and  $e$ ,
  - (i) the speed of  $Q$  immediately after the collision,
  - (ii) the speed of  $P$  immediately after the collision.

**(6)**

(b) Find the range of values of  $e$  for which the direction of motion of  $P$  is reversed as a result of the collision with  $Q$ .

**(2)**

Immediately after the collision between  $P$  and  $Q$ , particle  $R$  is projected towards  $Q$  with speed  $u$  so that  $R$  and  $Q$  collide directly. Given that  $e = \frac{2}{3}$

- (c) show that there will be a second collision between  $P$  and  $Q$ .
- (6)**

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**Question 7 continued**

Lined area for writing the answer to Question 7.





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**Question 7 continued**

Handwriting practice area consisting of 25 horizontal lines.

**Q7**

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**(Total 14 marks)**

**TOTAL FOR PAPER: 75 MARKS**

**END**

