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Other names

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

Centre Number

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Candidate Number

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# Mechanics M2

## Advanced/Advanced Subsidiary

Thursday 28 January 2016 – Morning  
**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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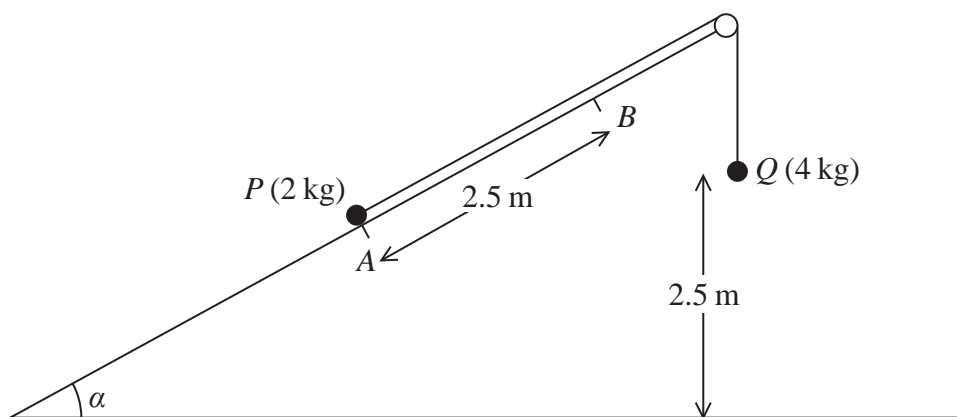


Figure 1

Two particles  $P$  and  $Q$ , of mass 2 kg and 4 kg respectively, are connected by a light inextensible string. Initially  $P$  is held at rest at the point  $A$  on a rough fixed plane inclined

at  $\alpha$  to the horizontal ground, where  $\sin \alpha = \frac{3}{5}$ . The string passes over a small smooth

pulley fixed at the top of the plane. The particle  $Q$  hangs freely below the pulley and 2.5 m above the ground, as shown in Figure 1. The part of the string from  $P$  to the pulley lies along a line of greatest slope of the plane. The system is released from rest with the string taut. At the instant when  $Q$  hits the ground,  $P$  is at the point  $B$  on the plane. The coefficient of friction between  $P$  and the plane is  $\frac{1}{4}$ .

(a) Find the work done against friction as  $P$  moves from  $A$  to  $B$ . (4)

(b) Find the total potential energy lost by the system as  $P$  moves from  $A$  to  $B$ . (3)

(c) Find, using the work-energy principle, the speed of  $P$  as it passes through  $B$ . (4)

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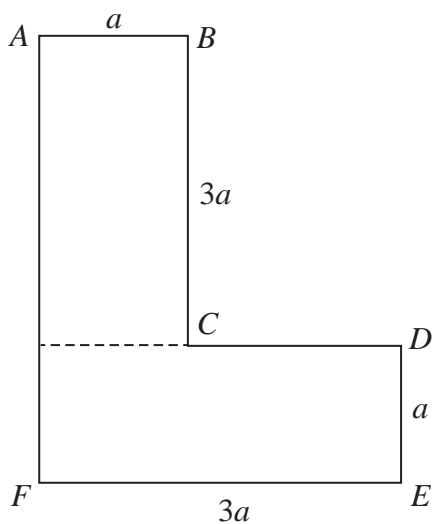


Figure 2

The uniform lamina  $ABCDEF$ , shown in Figure 2, consists of two identical rectangles with sides of length  $a$  and  $3a$ . The mass of the lamina is  $M$ . A particle of mass  $kM$  is attached to the lamina at  $E$ . The lamina, with the attached particle, is freely suspended from  $A$  and hangs in equilibrium with  $AF$  at an angle  $\theta$  to the downward vertical.

Given that  $\tan \theta = \frac{4}{7}$ , find the value of  $k$ .

(10)

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**Question 5 continued**

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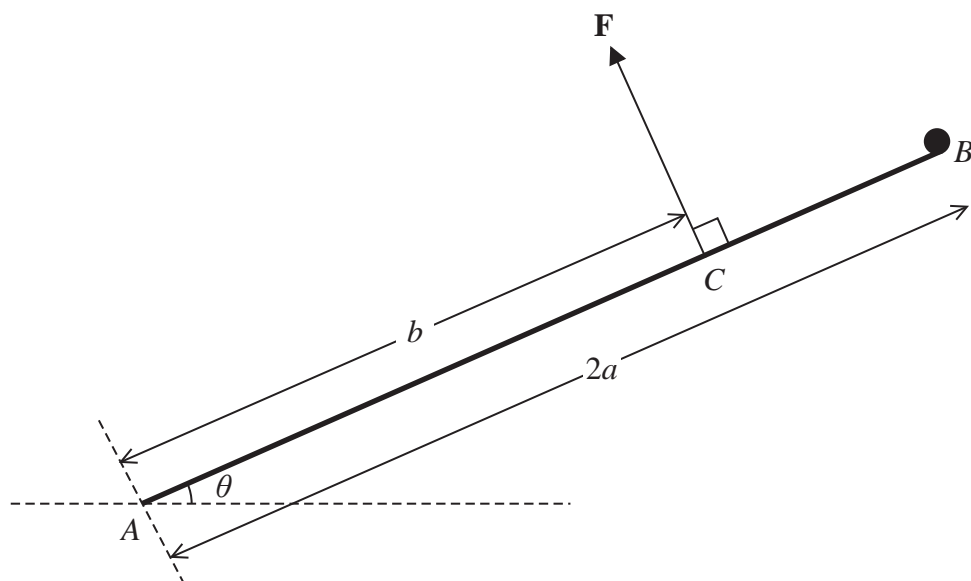


Figure 3

A uniform rod  $AB$ , of mass  $3m$  and length  $2a$ , is freely hinged at  $A$  to a fixed point on horizontal ground. A particle of mass  $m$  is attached to the rod at the end  $B$ . The system is held in equilibrium by a force  $\mathbf{F}$  acting at the point  $C$ , where  $AC = b$ . The rod makes an acute angle  $\theta$  with the ground, as shown in Figure 3. The line of action of  $\mathbf{F}$  is perpendicular to the rod and in the same vertical plane as the rod.

- (a) Show that the magnitude of  $\mathbf{F}$  is  $\frac{5mga}{b} \cos \theta$  (4)

The force exerted on the rod by the hinge at  $A$  is  $\mathbf{R}$ , which acts upwards at an angle  $\phi$  above the horizontal, where  $\phi > \theta$ .

- (b) Find
- the component of  $\mathbf{R}$  parallel to the rod, in terms of  $m$ ,  $g$  and  $\theta$ ,
  - the component of  $\mathbf{R}$  perpendicular to the rod, in terms of  $a$ ,  $b$ ,  $m$ ,  $g$  and  $\theta$ . (5)
- (c) Hence, or otherwise, find the range of possible values of  $b$ , giving your answer in terms of  $a$ . (2)

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**Question 6 continued**

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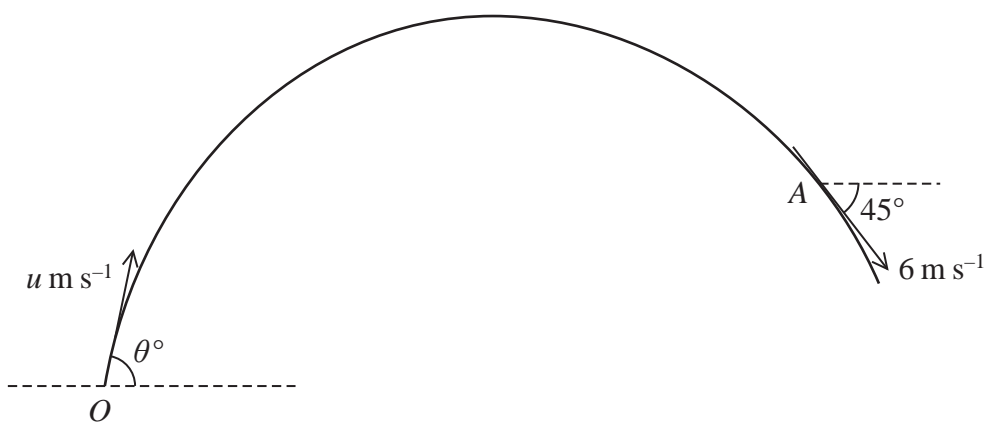
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**Figure 4**

At time  $t = 0$ , a particle  $P$  of mass  $0.7 \text{ kg}$  is projected with speed  $u \text{ m s}^{-1}$  from a fixed point  $O$  at an angle  $\theta^\circ$  to the horizontal. The particle moves freely under gravity. At time  $t = 2$  seconds,  $P$  passes through the point  $A$  with speed  $6 \text{ m s}^{-1}$  and is moving downwards at  $45^\circ$  to the horizontal, as shown in Figure 4.

Find

- (a) the value of  $\theta$ , (6)
- (b) the kinetic energy of  $P$  as it reaches the highest point of its path. (3)

For an interval of  $T$  seconds, the speed,  $v \text{ m s}^{-1}$ , of  $P$  is such that  $v \leq 6$

- (c) Find the value of  $T$ . (5)

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