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**Pearson  
Edexcel GCE**

Centre Number

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Candidate Number

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# Mechanics M1

## Advanced/Advanced Subsidiary

Wednesday 14 June 2017 – 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  $g = 9.8 \text{ m s}^{-2}$ , 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.

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Question 3 continued

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7. [In this question  $\mathbf{i}$  and  $\mathbf{j}$  are horizontal unit vectors due east and due north respectively and position vectors are given relative to a fixed origin  $O$ .]

Two ships,  $P$  and  $Q$ , are moving with constant velocities.

The velocity of  $P$  is  $(9\mathbf{i} - 2\mathbf{j})\text{km h}^{-1}$  and the velocity of  $Q$  is  $(4\mathbf{i} + 8\mathbf{j})\text{km h}^{-1}$

(a) Find the direction of motion of  $P$ , giving your answer as a bearing to the nearest degree.

(3)

When  $t=0$ , the position vector of  $P$  is  $(9\mathbf{i} + 10\mathbf{j})\text{km}$  and the position vector of  $Q$  is  $(\mathbf{i} + 4\mathbf{j})\text{km}$ . At time  $t$  hours, the position vectors of  $P$  and  $Q$  are  $\mathbf{p}$  km and  $\mathbf{q}$  km respectively.

(b) Find an expression for

(i)  $\mathbf{p}$  in terms of  $t$ ,

(ii)  $\mathbf{q}$  in terms of  $t$ .

(3)

(c) Hence show that, at time  $t$  hours,

$$\overrightarrow{QP} = (8 + 5t)\mathbf{i} + (6 - 10t)\mathbf{j}$$

(2)

(d) Find the values of  $t$  when the ships are 10km apart.

(6)

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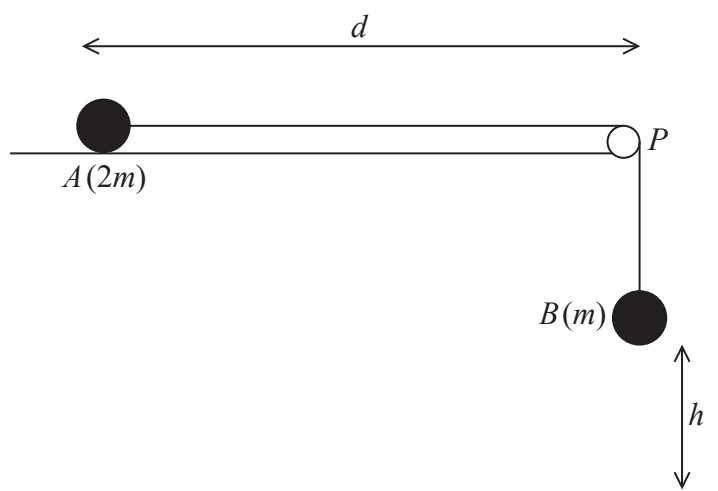


Figure 3

Two particles,  $A$  and  $B$ , have masses  $2m$  and  $m$  respectively. The particles are attached to the ends of a light inextensible string. Particle  $A$  is held at rest on a fixed rough horizontal table at a distance  $d$  from a small smooth light pulley which is fixed at the edge of the table at the point  $P$ . The coefficient of friction between  $A$  and the table is  $\mu$ , where  $\mu < \frac{1}{2}$ .

The string is parallel to the table from  $A$  to  $P$  and passes over the pulley. Particle  $B$  hangs freely at rest vertically below  $P$  with the string taut and at a height  $h$ , ( $h < d$ ), above a horizontal floor, as shown in Figure 3. Particle  $A$  is released from rest with the string taut and slides along the table.

- (a) (i) Write down an equation of motion for  $A$ .
- (ii) Write down an equation of motion for  $B$ .

(4)

- (b) Hence show that, until  $B$  hits the floor, the acceleration of  $A$  is  $\frac{g}{3}(1 - 2\mu)$ .

(3)

- (c) Find, in terms of  $g$ ,  $h$  and  $\mu$ , the speed of  $A$  at the instant when  $B$  hits the floor.

(2)

After  $B$  hits the floor,  $A$  continues to slide along the table. Given that  $\mu = \frac{1}{3}$  and that  $A$  comes to rest at  $P$ ,

- (d) find  $d$  in terms of  $h$ .

(5)

- (e) Describe what would happen if  $\mu = \frac{1}{2}$

(1)

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