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| Candidate surname | Other names |
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Centre Number | Candidate Number

# Pearson Edexcel International Advanced Level

## 考前模拟卷 - A Level Clouds出品

Afternoon (Time: 1 hour 30 minutes)

**Paper reference** **WME03/01**

# Mathematics

## International Advanced Subsidiary/Advanced Level
## Mechanics M3

**You must have:**
Mathematical Formulae and Statistical Tables (Yellow), calculator

Total Marks

**Candidates may use any calculator permitted by Pearson regulations. 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).
- **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 $g = 9.8\,\text{m}\,\text{s}^{-2}$, and give your answer to either 2 significant figures or 3 significant figures.

## Information

- A booklet 'Mathematical Formulae and Statistical Tables' is provided.
- There are 6 questions in this question paper. 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.
- If you change your mind about an answer, cross it out and put your new answer and any working underneath.

*Turn over* ▶

Pearson

**1.** A rough disc is rotating at a constant angular speed of 5 revolutions per minute about a vertical axis. The axis is perpendicular to the plane of the disc and passes through the centre of the disc. A particle, $P$, of mass $m$ kg is placed on the disc at distance 0.2 m from the axis. The particle does not move relative to the disc. The coefficient of friction between $P$ and the disc is $\mu$.

Find the smallest possible value of $\mu$.

**(6)**

**Question 1 continued**

**(Total for Question 1 is 6 marks)**

**2.**

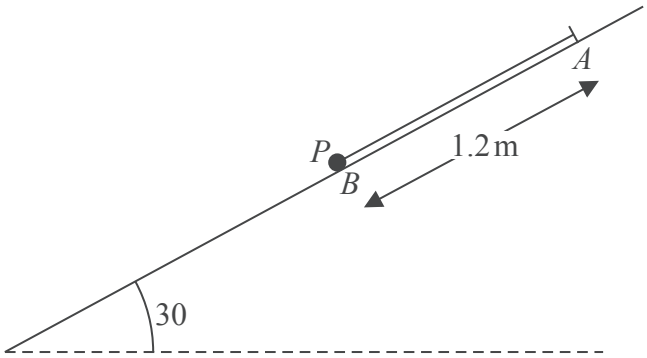


**Figure 1**

Figure 1 shows a light elastic string, of modulus of elasticity $\lambda$ newtons and natural length 0.6 m. One end of the string is attached to a fixed point $A$ on a rough plane which is inclined at 30° to the horizontal. The other end of the string is attached to a particle $P$ of mass 0.5 kg. The string lies along a line of greatest slope of the plane. The particle is held at rest on the plane at the point $B$, where $B$ is lower than $A$ and $AB = 1.2$m. The particle then receives an impulse of magnitude 1.5 N s in the direction parallel to the string, causing $P$ to move up the plane towards $A$. The coefficient of friction between $P$ and the plane is 0.7. Given that $P$ comes to rest at the instant when the string becomes slack, find the value of $\lambda$.

**(8)**

**Question 2 continued**

**(Total for Question 2 is 8 marks)**

**3.**

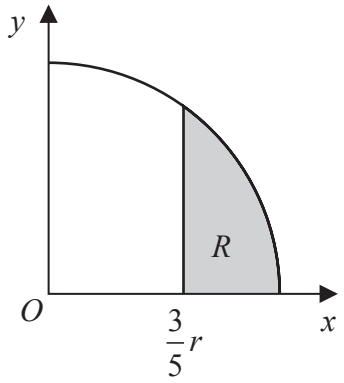


**Figure 2**

The region $R$, shown shaded in Figure 2, is bounded by the circle with centre $O$ and radius $r$, the line with equation $x = \frac{3}{5}r$ and the $x$-axis. The region is rotated through one complete revolution about the $x$-axis to form a uniform solid $S$.

(a) Use algebraic integration to show that the $x$ coordinate of the centre of mass of $S$ is $\frac{48}{65}r$.

**(8)**

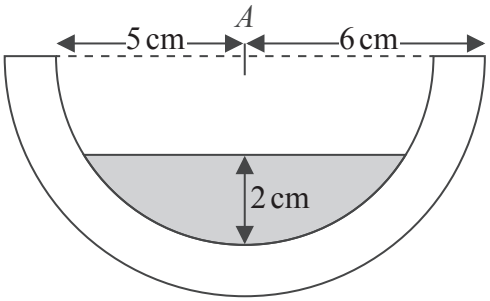


**Figure 3**

A bowl is made from a uniform solid hemisphere of radius 6 cm by removing a hemisphere of radius 5 cm. Both hemispheres have the same centre $A$ and the same axis of symmetry. The bowl is fixed with its open plane face uppermost and horizontal. Liquid is poured into the bowl. The depth of the liquid is 2 cm, as shown in Figure 3. The mass of the empty bowl is $5M$ kg and the mass of the liquid is $2M$ kg.

(b) Find, to 3 significant figures, the distance from $A$ to the centre of mass of the bowl with its liquid.

**(8)**

**Question 3 continued**

**Question 3 continued**

**Question 3 continued**

**(Total for Question 3 is 16 marks)**

**4.** A particle $P$ of mass 0.5 kg moves on the $x$-axis under the action of a single force.

At time $t$ seconds, $t \geqslant 0$

- $OP = x$ metres, $0 \leqslant x < \frac{\pi}{2}$
- the force has magnitude $\sin 2x$ N and is directed towards the origin $O$
- $P$ is moving in the positive $x$ direction with speed $v\,\text{m s}^{-1}$

At time $t = 0$, $P$ passes through the origin with speed $2\,\text{m s}^{-1}$

(a) Show that $v = 2\cos x$

**(6)**

(b) Show that $t = \frac{1}{2}\ln\left(\sqrt{2}+1\right)$ when $x = \frac{\pi}{4}$

**(5)**

**Question 4 continued**

**(Total for Question 4 is 11 marks)**

**5.**

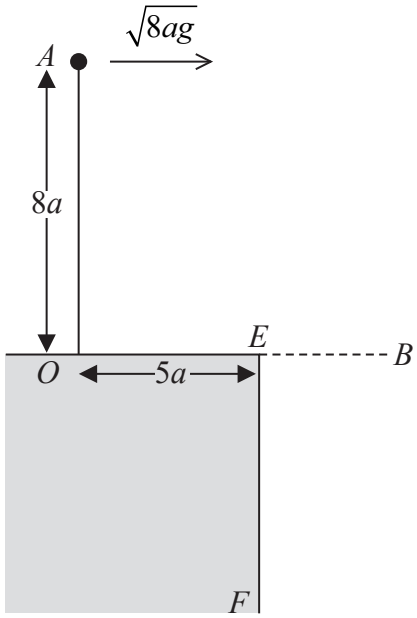


**Figure 4**

A particle of mass $m$ is attached to one end of a light inextensible string of length $8a$. The other end of the string is fixed to the point $O$ on the smooth horizontal surface of a desk. The point $E$ is on the edge of the desk, where $OE = 5a$ and $OE$ is perpendicular to the edge of the desk. The particle is held at the point $A$, vertically above $O$, with the string taut.

The particle is projected horizontally from $A$ with speed $\sqrt{8ag}$ in the direction $OE$, as shown in Figure 4.

When the particle is above the level of $OE$ the particle is moving in a vertical circle with radius $8a$.

Given that, when the string makes an angle $\theta$ with the upward vertical through $O$, the tension in the string is $T$,

(a) show that $T = 3mg(1 - \cos\theta)$

**(7)**

At the instant when the string is horizontal, the particle passes through the point $B$.

(b) Find the instantaneous change in the tension in the string as the particle passes through $B$.

**(3)**

The particle hits the vertical side $EF$ of the desk and rebounds. As a result of the impact, the particle loses one third of the kinetic energy it had immediately before the impact.

In the subsequent motion the string becomes slack when it makes an angle $\alpha$ with the upward vertical through $O$.

(c) Show that $\cos\alpha = \frac{7}{12}$

**(7)**

**Question 5 continued**

**Question 5 continued**

**Question 5 continued**

**Question 5 continued**

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**Question 5 continued**

**(Total for Question 5 is 17 marks)**

**6.** A particle $P$ of mass $m$ is attached to one end of a light elastic string of natural length $l$. The other end of the string is attached to a fixed point on a ceiling. The particle $P$ hangs in equilibrium at a distance $D$ below the ceiling.

The particle $P$ is now pulled vertically downwards until it is a distance $3l$ below the ceiling and released from rest.

Given that $P$ comes to instantaneous rest just before it reaches the ceiling,

(a) show that $D = \frac{5l}{3}$

**(6)**

(b) Show that, while the elastic string is stretched, $P$ moves with simple harmonic motion, with period $2\pi\sqrt{\frac{2l}{3g}}$

**(6)**

(c) Find, in terms of $g$ and $l$, the exact time from the instant when $P$ is released to the instant when the elastic string first goes slack.

**(5)**

**Question 6 continued**

**Question 6 continued**

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**Question 6 continued**

**Question 6 continued**

**(Total for Question 6 is 17 marks)**

**TOTAL FOR PAPER IS 75 MARKS**