Surname	Other na	ames
Pearson Edexcel nternational Advanced Level	Centre Number	Candidate Number
Mechanic	c M3	
Advanced/Advance		
	d Subsidiary	Paper Reference WME03/01

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.

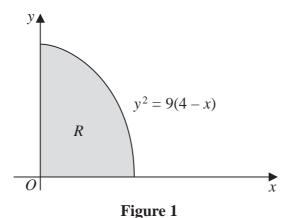
P 4 8 3 2 7 A 0 1 2 4

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1.



The shaded region R is bounded by the curve with equation $y^2 = 9(4 - x)$, the positive x-axis and the positive y-axis, as shown in Figure 1. A uniform solid S is formed by rotating R through 360° about the x-axis.

Use algebraic integration to find the x coordinate of the centre of mass of S.

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(a) Find an expression, in terms of t, for the velocity of P at time t seconds. (2) The particle passes through the point A with speed $\frac{10}{3}$ ms ⁻¹ . (b) Find the distance OA. (5)	2.	A particle <i>P</i> of mass 0.6 kg is moving along the positive <i>x</i> -axis in the positive direction. The only force acting on <i>P</i> acts in the direction of <i>x</i> increasing and has magnitude $\left(3t + \frac{1}{2}\right)$ N, where <i>t</i> seconds is the time after <i>P</i> leaves the origin <i>O</i> . When $t = 0$, <i>P</i> is at rest at <i>O</i> .
(b) Find the distance <i>OA</i> .		
		The particle passes through the point A with speed $\frac{1}{3}$ ms ⁻¹ .

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3.

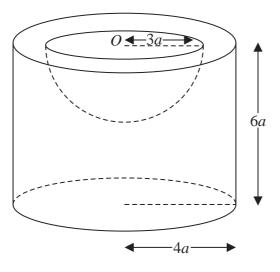


Figure 2

A uniform right circular solid cylinder has radius 4a and height 6a. A solid hemisphere of radius 3a is removed from the cylinder forming a solid S. The upper plane face of the cylinder coincides with the plane face of the hemisphere. The centre of the upper plane face of the cylinder is O and this is also the centre of the plane face of the hemisphere, as shown in Figure 2. Find the distance from O to the centre of mass of S.

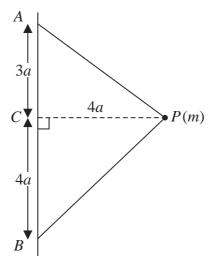


Figure 3

A light inextensible string has its ends attached to two fixed points A and B. The point A is vertically above B and AB = 7a. A particle P of mass m is fixed to the string and moves with constant angular speed ω in a horizontal circle of radius 4a. The centre of the circle is C, where C lies on AB and AC = 3a, as shown in Figure 3. Both parts of the string are taut.

(a) Show that the tension in
$$AP$$
 is $\frac{5}{7}m(4a\omega^2 + g)$. (8)

(b) Find the tension in BP.

(2)

(c) Deduce that
$$\omega \geqslant \sqrt{\frac{g}{ka}}$$
, stating the value of k .



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5. A particle *P* of mass 4m is attached to one end of a light elastic string of natural length l and modulus of elasticity 3mg. The other end of the string is attached to a fixed point O on a rough horizontal table. The particle lies at rest at the point A on the table, where $OA = \frac{4}{3}l$. The coefficient of friction between P and the table is μ .

(a) Show that $\mu \geqslant \frac{1}{4}$

The particle is now moved along the table to the point *B*, where OB = 2l, and released from rest. Given that $\mu = \frac{2}{5}$

(b) show that *P* comes to rest before the string becomes slack.

(5)



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6. One end of a light elastic string, of natural length 5l and modulus of elasticity 20mg, is attached to a fixed point A. A particle P of mass 2m is attached to the free end of the string and P hangs freely in equilibrium at the point B.

(a) Find the distance AB.

(3)

The particle is now pulled vertically downwards from B to the point C and released from rest. In the subsequent motion the string does not become slack.

(b) Show that P moves with simple harmonic motion with centre B.

(5)

(c) Find the period of this motion.

(2)

The greatest speed of *P* during this motion is $\frac{1}{5}\sqrt{gl}$

(d) Find the amplitude of this motion.

(3)

The point D is the midpoint of BC and the point E is the highest point reached by P.

(e) Find the time taken by P to move directly from D to E.

(4)



Question 6 continued	



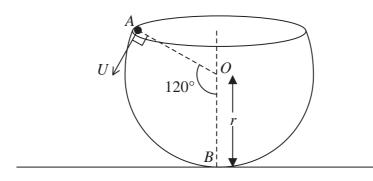


Figure 4

A hollow sphere has internal radius r and centre O. A bowl with a plane circular rim is formed by removing part of the sphere. The bowl is fixed to a horizontal floor with the rim uppermost and horizontal. The point B is the lowest point of the inner surface of the bowl. The point A, where angle $AOB = 120^{\circ}$, lies on the rim of the bowl, as shown in Figure 4. A particle P of mass m is projected from A, with speed U at 90° to OA, and moves on the smooth inner surface of the bowl. The motion of P takes place in the vertical plane OAB.

(a) Find, in terms of m, g, U and r, the magnitude of the force exerted on P by the bowl at the instant when P passes through B.

(8)

(b) Find, in terms of g, U and r, the greatest height above the floor reached by P.

(4)

Given that $U > \sqrt{2gr}$

(c) show that, after leaving the surface of the bowl, P does not fall back into the bowl.

(5)



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