OCR
Oxford Cambridge and RSA

Wednesday 20 May 2015 – Morning

A2 GCE MATHEMATICS (MEI)

4763/01 Mechanics 3

QUESTION PAPER

Candidates answer on the Printed Answer Book.

OCR supplied materials:
- Printed Answer Book 4763/01
- MEI Examination Formulae and Tables (MF2)

Other materials required:
- Scientific or graphical calculator

Duration: 1 hour 30 minutes

INSTRUCTIONS TO CANDIDATES

These instructions are the same on the Printed Answer Book and the Question Paper.

- The Question Paper will be found inside the Printed Answer Book.
- Write your name, centre number and candidate number in the spaces provided on the Printed Answer Book. Please write clearly and in capital letters.
- **Write your answer to each question in the space provided in the Printed Answer Book**. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- You are permitted to use a scientific or graphical calculator in this paper.
- Final answers should be given to a degree of accuracy appropriate to the context.
- The acceleration due to gravity is denoted by $g\,\mathrm{m\,s^{-2}}$. Unless otherwise instructed, when a numerical value is needed, use $g = 9.8$.

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- You are advised that an answer may receive **no marks** unless you show sufficient detail of the working to indicate that a correct method is being used.
- The total number of marks for this paper is **72**.
- The Printed Answer Book consists of **16** pages. The Question Paper consists of **8** pages. Any blank pages are indicated.

INSTRUCTION TO EXAMS OFFICER / INVIGILATOR

- Do not send this Question Paper for marking; it should be retained in the centre or recycled. Please contact OCR Copyright should you wish to re-use this document.

1 **(i)** Give the dimensions of force, work and power. **[3]**

The force due to air resistance acting on a car is given by λv^2, where v is the speed and λ is a constant for that car.

(ii) Find the dimensions of λ. **[2]**

The power P of the car and its maximum speed U are related by the equation $P = \lambda U^3$.

(iii) Show that this equation is dimensionally consistent. **[2]**

The time t taken for the car to accelerate from speed $\frac{1}{3}U$ to speed $\frac{2}{3}U$ is given by $t = km^{\alpha}P^{\beta}\lambda^{\gamma}$, where m is the mass of the car and k is a dimensionless constant.

(iv) Find α, β and γ. **[4]**

Car C has mass 800 kg, power 35 kW, maximum speed $45\,\text{m s}^{-1}$, and takes 9.18 s to accelerate from $15\,\text{m s}^{-1}$ to $30\,\text{m s}^{-1}$.

(v) Find the value of λ for Car C

(A) in SI units (based on kilograms, metres and seconds),

(B) in a system of units based on pounds, miles and hours, given that

1 pound = 0.454 kg, 1 mile = 1609 m, 1 hour = 3600 s. **[3]**

(vi) Car D has mass 1250 kg, power 75 kW and maximum speed $54\,\text{m s}^{-1}$. Find the time taken for Car D to accelerate from $18\,\text{m s}^{-1}$ to $36\,\text{m s}^{-1}$. **[4]**

2 **(a)** A particle P of mass m is attached to a fixed point O by a light inextensible string of length a. P is moving without resistance in a complete vertical circle with centre O and radius a. When P is at the highest point of the circle, the tension in the string is T_1. When OP makes an angle θ with the upward vertical, the tension in the string is T_2. Show that

$$T_2 = T_1 + 3mg(1 - \cos\theta).$$ **[6]**

(b) The fixed point A is 1.2 m vertically above the fixed point C. A particle Q of mass 0.9 kg is joined to A, to C, and to a particle R of mass 1.5 kg, by three light inextensible strings of lengths 1.3 m, 0.5 m and 1.8 m respectively. The particle Q moves in a horizontal circle with centre C, and R moves in a horizontal circle at the same constant angular speed as Q, in such a way that A, C, Q and R are always coplanar. The string QR makes an angle of 60° with the downward vertical. This situation is shown in Fig. 2.

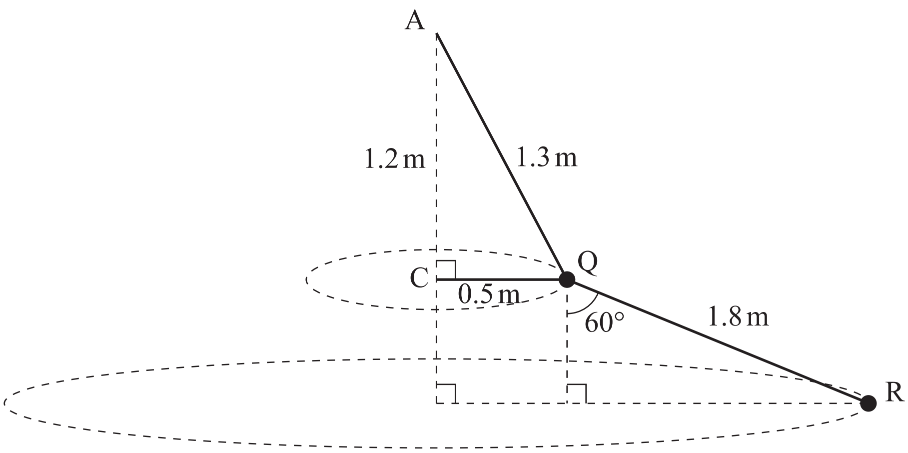

Fig. 2

(i) Find the tensions in the strings QR and AQ. **[5]**

(ii) Find the angular speed of the system. **[3]**

(iii) Find the tension in the string CQ. **[4]**

Question 3 begins on page 4.

3 Fig. 3 shows the fixed points A and F which are 9.5 m apart on a smooth horizontal surface and points B and D on the line AF such that AB = DF = 3.0 m. A small block of mass 10.5 kg is joined to A by a light elastic string of natural length 3.0 m and stiffness 12 N m^{-1}; the block is joined to F by a light elastic string of natural length 3.0 m and stiffness 30 N m^{-1}. The block is released from rest at B and then slides along part of the line AF. The block has zero acceleration when it is at a point C, and it comes to instantaneous rest at a point E.

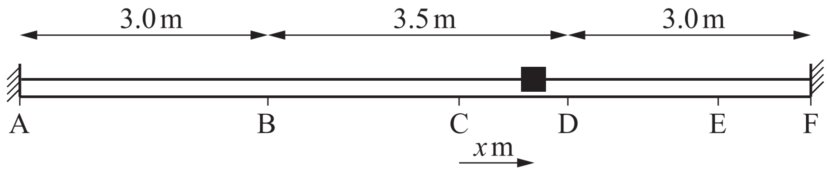

Fig. 3

(i) Find the distance BC. **[3]**

At time t s the displacement of the block from C is x m, measured in the direction AF.

(ii) Show that, when the block is between B and D, $\frac{d^2x}{dt^2} = -4x$. **[4]**

(iii) Find the maximum speed of the block. **[2]**

(iv) Find the distance of the block from C when its speed is 4.8 m s^{-1}. **[2]**

(v) Find the time taken for the block to travel from B to D. **[4]**

(vi) Find the distance DE. **[3]**

4 **(a)** A uniform lamina occupies the region bounded by the x-axis and the curve $y = \dfrac{x^2(a-x)}{a^2}$ for $0 \leqslant x \leqslant a$. Find the coordinates of the centre of mass of this lamina. **[9]**

(b) The region A is bounded by the x-axis, the y-axis, the curve $y = \sqrt{x^2+16}$ and the line $x = 3$. The region B is bounded by the y-axis, the curve $y = \sqrt{x^2+16}$ and the line $y = 5$. These regions are shown in Fig. 4.

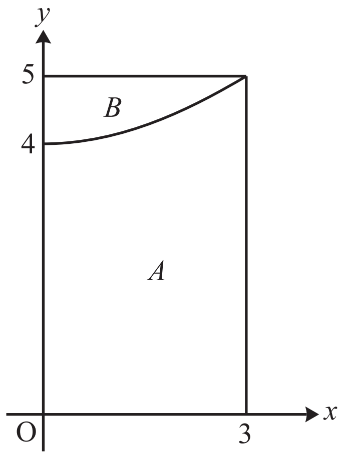

Fig. 4

(i) Find the x-coordinate of the centre of mass of the uniform solid of revolution formed when the region A is rotated through 2π radians about the x-axis. **[5]**

(ii) Using your answer to part **(i)**, or otherwise, find the x-coordinate of the centre of mass of the uniform solid of revolution formed when the region B is rotated through 2π radians about the x-axis. **[4]**

END OF QUESTION PAPER

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Candidate forename		Candidate surname	

Centre number						Candidate number				

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1 (i)	
1 (ii)	
1 (iii)	

1 (iv)

1 (v)(*A*)	
1 (v)(*B*)	

1 (vi)	

2 (a)

2 (b)(i)	

2 (b)(ii)	

2(b)(iii)	

3 (i)	
3 (ii)	

3 (iii)

3 (iv)

3 (v)

3 (vi)

4 (a)	
	(answer space continued on next page)

4 (a)	**(continued)**

4(b)(i)	

4(b)(ii)	

Annotations and abbreviations

Annotation in scoris	**Meaning**
✓and ✗	
BOD	Benefit of doubt
FT	Follow through
ISW	Ignore subsequent working
M0, M1	Method mark awarded 0, 1
A0, A1	Accuracy mark awarded 0, 1
B0, B1	Independent mark awarded 0, 1
SC	Special case
^	Omission sign
MR	Misread
Highlighting	
Other abbreviations in mark scheme	**Meaning**
E1	Mark for explaining
U1	Mark for correct units
G1	Mark for a correct feature on a graph
M1 dep*	Method mark dependent on a previous mark, indicated by *
cao	Correct answer only
oe	Or equivalent
rot	Rounded or truncated
soi	Seen or implied
www	Without wrong working

Subject-specific Marking Instructions for GCE Mathematics (MEI) Mechanics strand

a. Annotations should be used whenever appropriate during your marking.

The A, M and B annotations must be used on your standardisation scripts for responses that are not awarded either 0 or full marks. It is vital that you annotate standardisation scripts fully to show how the marks have been awarded.

For subsequent marking you must make it clear how you have arrived at the mark you have awarded.

b. An element of professional judgement is required in the marking of any written paper. Remember that the mark scheme is designed to assist in marking incorrect solutions. Correct *solutions* leading to correct answers are awarded full marks but work must not be judged on the answer alone, and answers that are given in the question, especially, must be validly obtained; key steps in the working must always be looked at and anything unfamiliar must be investigated thoroughly.

Correct but unfamiliar or unexpected methods are often signalled by a correct result following an *apparently* incorrect method. Such work must be carefully assessed. When a candidate adopts a method which does not correspond to the mark scheme, award marks according to the spirit of the basic scheme; if you are in any doubt whatsoever (especially if several marks or candidates are involved) you should contact your Team Leader.

c. The following types of marks are available.

M
A suitable method has been selected and *applied* in a manner which shows that the method is essentially understood. Method marks are not usually lost for numerical errors, algebraic slips or errors in units. However, it is not usually sufficient for a candidate just to indicate an intention of using some method or just to quote a formula; the formula or idea must be applied to the specific problem in hand, eg by substituting the relevant quantities into the formula. In some cases the nature of the errors allowed for the award of an M mark may be specified.

A
Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. Accuracy marks cannot be given unless the associated Method mark is earned (or implied). Therefore M0 A1 cannot ever be awarded.

B
Mark for a correct result or statement independent of Method marks.

E
A given result is to be established or a result has to be explained. This usually requires more working or explanation than the establishment of an unknown result.

Unless otherwise indicated, marks once gained cannot subsequently be lost, eg wrong working following a correct form of answer is ignored. Sometimes this is reinforced in the mark scheme by the abbreviation isw. However, this would not apply to a case where a candidate passes through the correct answer as part of a wrong argument.

d. When a part of a question has two or more 'method' steps, the M marks are in principle independent unless the scheme specifically says otherwise; and similarly where there are several B marks allocated. (The notation 'dep *' is used to indicate that a particular mark is dependent on an earlier, asterisked, mark in the scheme.) Of course, in practice it may happen that when a candidate has once gone wrong in a part of a question, the work from there on is worthless so that no more marks can sensibly be given. On the other hand, when two or more steps are successfully run together by the candidate, the earlier marks are implied and full credit must be given.

e. The abbreviation ft implies that the A or B mark indicated is allowed for work correctly following on from previously incorrect results. Otherwise, A and B marks are given for correct work only — differences in notation are of course permitted. A (accuracy) marks are not given for answers obtained from incorrect working. When A or B marks are awarded for work at an intermediate stage of a solution, there may be various alternatives that are equally acceptable. In such cases, exactly what is acceptable will be detailed in the mark scheme rationale. If this is not the case please consult your Team Leader.

Sometimes the answer to one part of a question is used in a later part of the same question. In this case, A marks will often be 'follow through'. In such cases you must ensure that you refer back to the answer of the previous part question even if this is not shown within the image zone. You may find it easier to mark follow through questions candidate-by-candidate rather than question-by-question.

f. Unless units are specifically requested, there is no penalty for wrong or missing units as long as the answer is numerically correct and expressed either in SI or in the units of the question. (eg lengths will be assumed to be in metres unless in a particular question all the lengths are in km, when this would be assumed to be the unspecified unit.)

We are usually quite flexible about the accuracy to which the final answer is expressed and we do not penalise over-specification.

When a value is given in the paper
Only accept an answer correct to at least as many significant figures as the given value. This rule should be applied to each case.

When a value is not given in the paper
Accept any answer that agrees with the correct value to 2 s.f.

ft should be used so that only one mark is lost for each distinct accuracy error, except for errors due to premature approximation which should be penalised only once in the examination.

There is no penalty for using a wrong value for *g*. E marks will be lost except when results agree to the accuracy required in the question.

g. Rules for replaced work

If a candidate attempts a question more than once, and indicates which attempt he/she wishes to be marked, then examiners should do as the candidate requests.

If there are two or more attempts at a question which have not been crossed out, examiners should mark what appears to be the last (complete) attempt and ignore the others.

NB Follow these maths-specific instructions rather than those in the assessor handbook.

h. For a *genuine* misreading (of numbers or symbols) which is such that the object and the difficulty of the question remain unaltered, mark according to the scheme but following through from the candidate's data. A penalty is then applied; 1 mark is generally appropriate, though this may differ for some units. This is achieved by withholding one A mark in the question.

Marks designated as cao may be awarded as long as there are no other errors. E marks are lost unless, by chance, the given results are established by equivalent working.

'Fresh starts' will not affect an earlier decision about a misread.

Note that a miscopy of the candidate's own working is not a misread but an accuracy error.

i. If a graphical calculator is used, some answers may be obtained with little or no working visible. Allow full marks for correct answers (provided, of course, that there is nothing in the wording of the question specifying that analytical methods are required). Where an answer is wrong but there is some evidence of method, allow appropriate method marks. Wrong answers with no supporting method score zero. If in doubt, consult your Team Leader.

j. If in any case the scheme operates with considerable unfairness consult your Team Leader.

Question			Answer	Marks	Guidance	
1	(i)		$[\text{ Force }] = \text{M L T}^{-2}$ $[\text{ Work }] = \text{M L}^2\,\text{T}^{-2}$ $[\text{ Power }] = \text{M L}^2\,\text{T}^{-3}$	B1 B1 B1 **[3]**		*Deduct one mark if kg, m, s used consistently for M, L, T*
1	(ii)		$[\lambda] = \left[\dfrac{F}{v^2}\right] = \dfrac{\text{M L T}^{-2}}{(\text{L T}^{-1})^2}$ $= \text{M L}^{-1}$	M1 A1 **[2]**	Obtaining dimensions of λ FT $[\text{ Force }] \times \text{L}^{-2}\,\text{T}^2$	M0 if $P = \lambda U^3$ used B2 (BOD) for correct answer with no working
1	(iii)		$[\lambda U^3] = (\text{M L}^{-1})(\text{L T}^{-1})^3 = \text{M L}^2\,\text{T}^{-3}$ Same as power, so dimensionally consistent	M1 E1 **[2]**	Obtaining dimensions of λU^3 Correctly shown	Must be simplified
1	(iv)		$\text{T} = \text{M}^{\alpha}(\text{M L}^2\,\text{T}^{-3})^{\beta}(\text{M L}^{-1})^{\gamma}$ $\beta = -\frac{1}{3}$ $\alpha + \beta + \gamma = 0,\quad 2\beta - \gamma = 0$ $\alpha = 1,\quad \gamma = -\frac{2}{3}$	B1 M1 A1A1 **[4]**	One equation correct (FT) CAO	Equation from powers of M or L If A0 give SC1 for non-zero values with $\gamma = 2\beta$ OR $\alpha + \beta + \gamma = 0$ *(SC1 will usually imply M1)*
1	(v)	(*A*) (*B*)	$\lambda = \dfrac{P}{U^3} = \dfrac{35000}{45^3} = 0.384\ \ (\text{kg m}^{-1})$ (3 sf) $0.3841 \times \dfrac{1}{0.454} \times 1609$ $= 1360\ \ (\text{lb mi}^{-1})$ (3 sf)	B1 M1 A1 **[3]**	For conversion factor $\dfrac{1609}{0.454}$ CAO	OR changing *both* $P\ (= 1.389 \times 10^9)$ *and* $U\ (= 100.7)$ to new units

Question			Answer	Marks	Guidance	
1	(vi)		$\lambda_D = \frac{75000}{54^3}$ $(=0.476)$	M1		
			$t_D = 9.18 \times \frac{1250}{800} \times \left(\frac{75}{35}\right)^{-\frac{1}{3}} \times \left(\frac{0.4763}{0.3841}\right)^{-\frac{2}{3}}$	M1 M1	Two ratios and powers correct Correct expression for new time	Or equation for k $(k = 0.1983)$
		OR	$t = kmP^{-\frac{1}{3}}(PU^{-3})^{-\frac{2}{3}} = kmP^{-1}U^2$ $t_D = 9.18 \times \frac{1250}{800} \times \left(\frac{75}{35}\right)^{-1} \times \left(\frac{54}{45}\right)^2$		M1 Expressing t in terms of m, P, U M1 Two ratios and powers correct M1 Correct expression for new time	Or equation for k $(k = 0.1983)$
			Time is 9.639 s	A1 **[4]**	CAO	
2	(a)		$T_1 + mg = m\frac{v_1^2}{a}$	B1		*Condone r for a*
			$\frac{1}{2}mv_2^2 = \frac{1}{2}mv_1^2 + mga(1-\cos\theta)$	M1 A1	Equation involving KE and PE	
			$T_2 + mg\cos\theta = m\frac{v_2^2}{a}$	B1		*Condone same v for B1B1*
			$T_2 - T_1 = \frac{mv_2^2}{a} - \frac{mv_1^2}{a} + mg(1-\cos\theta)$ $T_2 - T_1 = 2mg(1-\cos\theta) + mg(1-\cos\theta)$ $T_2 = T_1 + 3mg(1-\cos\theta)$	M1 E1 **[6]**	Eliminating v_1 and v_2	*Dependent on previous M1*

Question			Answer	Marks	Guidance	
2	(b)	(i)	$T_{QR}\cos 60° = 1.5\times 9.8$ Tension in QR is 29.4 N $T_{AQ}\cos\theta = 0.9\times 9.8 + T_{QR}\cos 60°$ $\frac{12}{13}T_{AQ} = 8.82 + 14.7$ Tension in AQ is 25.48 N	M1 A1 M1 A1 A1 **[5]**	Resolving vertically for R Resolving vertically for Q FT e.g. CAO	 θ is the angle CAQ $T\cos 22.6 = 0.9\times 9.8 + 29.4\cos 60°$
2	(b)	(ii)	 $T_{QR}\sin 60° = 1.5(0.5 + 1.8\sin 60°)\omega^2$ Angular speed is 2.87 rad s^{-1} (3 sf)	M1 A1 A1 **[3]**	Using $1.5r\omega^2$ FT is $\sqrt{0.2804\,T_{QR}}$	Allow $1.5\frac{v^2}{r}$ provided $v = r\omega$ also seen
2	(b)	(iii)	$T_{CQ} + T_{AQ}\sin\theta - T_{QR}\sin 60° = (0.9)(0.5)\omega^2$ $T_{CQ} + 25.48\times\frac{5}{13} - 29.4\sin 60° = 0.45\times 2.871^2$ Tension in CQ is 19.4 N (3 sf)	B1B1 M1 A1 **[4]**	For LHS and RHS (CAO) Numerical equation for T_{CQ} CAO	 At most one error (FT including in B1's) and no missing terms
3	(i)		 If BC = y, $12y = 30(3.5 - y)$ Distance BC is 2.5 m	M1 A1 A1 **[3]**	Using stiffness × extension to find tension in *both* strings Correct equation for a distance	Must use extension. Condone use of modulus for full marks

Question			Answer	Marks	Guidance	
3	(ii)			B1	For $30(1.0-x)$ *or* $12(2.5+x)$	FT if BC is wrong
				M1	Equation of motion	Two forces in terms of x, and acc'n
			$30(1.0-x)-12(2.5+x)=10.5\dfrac{d^2x}{dt^2}$	A1	Allow (±) $10.5a$ on RHS	FT if BC is wrong
			$\dfrac{d^2x}{dt^2}=-4x$	E1		*When necessary, replacing a by* $-\dfrac{d^2x}{dt^2}$ *requires some explanation*
				[4]		
3	(iii)		Maximum speed is $A\omega$	M1	OR Using energy to obtain an equation for v at C	$\frac{1}{2}(30)(3.5^2)=\frac{1}{2}(30)(1.0^2)+\frac{1}{2}(12)(2.5^2)+\frac{1}{2}(10.5)v^2$
			Maximum speed is 5 m s^{-1}	A1	FT is $2\times$ BC	
				[2]		
3	(iv)		$4.8^2=4(2.5^2-x^2)$	M1	Using $v^2=\omega^2(A^2-x^2)$	OR Using energy to obtain an equation for a distance
			Distance from C is 0.7 m	A1	CAO	Condone ± 0.7
				[2]		
3	(v)		$x=-2.5\cos 2t$	B1	$\pm 2.5\sin 2t$ *or* $\pm 2.5\cos 2t$	FT if BC is wrong (or A or ω)
				M1	Using $x=1.0$ to obtain a time	
			$1.0=-2.5\cos 2t$	M1	Fully correct strategy for finding the required time	e.g. $0.2058+\dfrac{1}{4}\times\dfrac{2\pi}{2}$
			Time is 0.991 s (3 sf)	A1	CAO	
				[4]		

Question			Answer	Marks	Guidance	
3	(vi)			M1	Using change of elastic energy to obtain an equation for a distance	OR Fully correct strategy using two stages of SHM
			$\frac{1}{2}(30)(3.5^2)=\frac{1}{2}(12)(\text{BE}^2)$	A1		Correct (FT) equation for a distance
			BE = 5.534 Distance DE is 2.03 m (3 sf)	A1 **[3]**	CAO	
4	(a)		Area is $\int_0^a \frac{x^2(a-x)}{a^2}\,dx$	M1		
			$=\left[\frac{x^3}{3a}-\frac{x^4}{4a^2}\right]_0^a \quad (=\frac{a^2}{12})$	A1		
			$\int xy\,dx$	M1		
			$=\int_0^a \frac{x^3(a-x)}{a^2}\,dx=\left[\frac{x^4}{4a}-\frac{x^5}{5a^2}\right]_0^a \quad (=\frac{a^3}{20})$	A1		
			$\bar{x}=\frac{\frac{1}{20}a^3}{\frac{1}{12}a^2}=\frac{3a}{5}$	A1		
			$\int \frac{1}{2}y^2\,dx=\int_0^a \frac{x^4(a-x)^2}{2a^4}\,dx$	M1	For $\int ... y^2\,dx$	
			$=\left[\frac{x^5}{10a^2}-\frac{x^6}{6a^3}+\frac{x^7}{14a^4}\right]_0^a \quad (=\frac{a^3}{210})$	A2	Give A1 if just one error (e.g. omission of factor ½)	
			$\bar{y}=\frac{\frac{1}{210}a^3}{\frac{1}{12}a^2}=\frac{2a}{35} \quad (\approx 0.0571a)$	A1 **[9]**		

Question			Answer	Marks	Guidance	
4	(b)	(i)	Volume is $\int_0^3 \pi(x^2+16)\,dx$	M1	π may be omitted throughout	*Condone consistent use of* $2\pi y^2$ *etc*
			$=\pi\left[\frac{x^3}{3}+16x\right]_0^3 \quad (=57\pi)$	A1		
			$\int \pi xy^2\,dx$	M1		
			$=\int_0^3 \pi x(x^2+16)\,dx \quad =\pi\left[\frac{x^4}{4}+8x^2\right]_0^3 \quad (=\frac{369}{4}\pi)$	A1		
			$\bar{x}=\frac{\frac{369}{4}\pi}{57\pi}=\frac{123}{76} \quad (\approx 1.62)$	A1		
				[5]		
4	(b)	(ii)	Volume of *A* and *B* combined is $\pi\times 5^2\times 3=75\pi$			
				M1	CM of composite body	
			$(18\pi)\bar{x}_B+(57\pi)\left(\frac{123}{76}\right)=(75\pi)(1.5)$	A2	Give A1 if just one error	FT values from (i)
		OR	$\int_0^3 \pi x\left(25-(x^2+16)\right)dx$		M1	
			$=\frac{81}{4}\pi$		A1	
			$(18\pi)\bar{x}_B=\frac{81}{4}\pi$		A1 FT	
			$\bar{x}_B=\frac{9}{8} \quad (=1.125)$	A1	CAO	
				[4]		

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4763 Mechanics 3

General Comments

Most candidates demonstrated a sound understanding of the topics being examined, and were able to complete the paper in the time allowed. The relevant techniques were generally applied confidently and accurately, and the work was usually presented well. The best answered questions were those on dimensional analysis and centres of mass; the questions on circular motion and elasticity were not answered quite so well.

Comments on Individual Questions

Q.1(i)-(iv) These questions on dimensional analysis were answered correctly by most candidates.

Q.1(v) Most candidates correctly gave the value of λ in SI units, and many then converted it to the new units using the dimensions found in part (ii). Another approach, quite often used, was to convert P and U into the new units before calculating $\lambda = P / U^3$, and this tended to be less successful. Conversion factors were frequently inverted.

Q.1(vi) The most common method was to use the equation from part (iv) to find the value of k, find the value of λ for Car D (this step was often omitted), and then use the equation from part (iv) again to find the new time. Some candidates used the slightly more efficient method of considering ratios, which avoids the need to find k (although it still requires finding the new value of λ).

Q.2(a) Most candidates gave the radial equations of motion involving the tensions at the highest point and at the general point. Some candidates assumed that the speeds in the two positions were equal. To make further progress it was necessary to relate the two speeds using the conservation of energy (kinetic and gravitational). The algebra required to eliminate the two speeds and obtain the given result was usually done correctly, but it was very often more complicated than it needed to be.

Q.2(b)(i) To find the tensions it was necessary to resolve vertically for any two of Q, R, Q and R together. All three possible combinations were seen, the most common being R followed by Q. Many candidates were not sufficiently careful when selecting the appropriate forces for each equation.

Q.2(b)(ii) Most candidates correctly considered the radial equation of motion for R. The most common error was to use an incorrect value for the radius.

Q.2(b)(iii) Here it was necessary to form the radial equation of motion for Q, involving the tensions in all three strings. Candidates who were sufficiently careful often completed this successfully.

Q.3(i) The equilibrium position C was usually found correctly.

Q.3(ii) To obtain full marks in this part, candidates were required to form an equation of motion in which the tension in each string appeared explicitly in terms of x. A large number of candidates failed to do this.

Q.3(iii)-(v) Most candidates were able to apply the standard simple harmonic motion formulae successfully in these parts.

Q.3(vi) To earn any marks in this part it was essential to realise that the simple harmonic motion performed from B to D changes (to a different centre and period) when the right-hand string goes slack. The best way to find E was to use conservation of energy (kinetic and elastic). Many candidates used the simplest method (considering B and E); another popular choice was C and E, and another was D and E (even though this involved finding the speed at D first).

Q.4(a) The technique for finding the centre of mass of a lamina was very well-understood and usually applied accurately. Errors sometimes occurred in the *y*-coordinate, such as losing the factor ½ at some stage of the working, or mishandling the powers of *a*.

Q.4(b)(i) The centre of mass of the solid of revolution was usually found correctly.

Q.4(b)(ii) Most candidates treated this as a composite body problem, using their answer from part (i); the only common error here was the loss of a factor π from some of the terms. Some candidates did try to tackle the new solid of revolution directly, but very few of these achieved any marks.

GCE Mathematics (MEI)

				Max Mark	a	b	c	d	e	u
4751	01	C1 – MEI Introduction to advanced mathematics (AS)	Raw	72	63	58	53	48	43	0
			UMS	100	80	70	60	50	40	0
4752	01	C2 – MEI Concepts for advanced mathematics (AS)	Raw	72	56	50	44	39	34	0
			UMS	100	80	70	60	50	40	0
4753	01	(C3) MEI Methods for Advanced Mathematics with Coursework: Written Paper	Raw	72	56	51	46	41	36	0
4753	02	(C3) MEI Methods for Advanced Mathematics with Coursework: Coursework	Raw	18	15	13	11	9	8	0
4753	82	(C3) MEI Methods for Advanced Mathematics with Coursework: Carried Forward Coursework Mark	Raw	18	15	13	11	9	8	0
			UMS	100	80	70	60	50	40	0
4754	01	C4 – MEI Applications of advanced mathematics (A2)	Raw	90	74	67	60	54	48	0
			UMS	100	80	70	60	50	40	0
4755	01	FP1 – MEI Further concepts for advanced mathematics (AS)	Raw	72	62	57	53	49	45	0
			UMS	100	80	70	60	50	40	0
4756	01	FP2 – MEI Further methods for advanced mathematics (A2)	Raw	72	65	58	52	46	40	0
			UMS	100	80	70	60	50	40	0
4757	01	FP3 – MEI Further applications of advanced mathematics (A2)	Raw	72	59	52	46	40	34	0
			UMS	100	80	70	60	50	40	0
4758	01	(DE) MEI Differential Equations with Coursework: Written Paper	Raw	72	63	57	51	45	38	0
4758	02	(DE) MEI Differential Equations with Coursework: Coursework	Raw	18	15	13	11	9	8	0
4758	82	(DE) MEI Differential Equations with Coursework: Carried Forward Coursework Mark	Raw	18	15	13	11	9	8	0
			UMS	100	80	70	60	50	40	0
4761	01	M1 – MEI Mechanics 1 (AS)	Raw	72	62	54	46	39	32	0
			UMS	100	80	70	60	50	40	0
4762	01	M2 – MEI Mechanics 2 (A2)	Raw	72	54	47	40	33	27	0
			UMS	100	80	70	60	50	40	0
4763	01	M3 – MEI Mechanics 3 (A2)	Raw	72	64	56	48	41	34	0
			UMS	100	80	70	60	50	40	0
4764	01	M4 – MEI Mechanics 4 (A2)	Raw	72	53	45	38	31	24	0
			UMS	100	80	70	60	50	40	0
4766	01	S1 – MEI Statistics 1 (AS)	Raw	72	61	54	47	41	35	0
			UMS	100	80	70	60	50	40	0
4767	01	S2 – MEI Statistics 2 (A2)	Raw	72	65	60	55	50	46	0
			UMS	100	80	70	60	50	40	0
4768	01	S3 – MEI Statistics 3 (A2)	Raw	72	64	58	52	47	42	0
			UMS	100	80	70	60	50	40	0
4769	01	S4 – MEI Statistics 4 (A2)	Raw	72	56	49	42	35	28	0
			UMS	100	80	70	60	50	40	0
4771	01	D1 – MEI Decision mathematics 1 (AS)	Raw	72	56	51	46	41	37	0
			UMS	100	80	70	60	50	40	0
4772	01	D2 – MEI Decision mathematics 2 (A2)	Raw	72	54	49	44	39	34	0
			UMS	100	80	70	60	50	40	0
4773	01	DC – MEI Decision mathematics computation (A2)	Raw	72	46	40	34	29	24	0
			UMS	100	80	70	60	50	40	0
4776	01	(NM) MEI Numerical Methods with Coursework: Written Paper	Raw	72	56	50	45	40	34	0
4776	02	(NM) MEI Numerical Methods with Coursework: Coursework	Raw	18	14	12	10	8	7	0
4776	82	(NM) MEI Numerical Methods with Coursework: Carried Forward Coursework Mark	Raw	18	14	12	10	8	7	0
			UMS	100	80	70	60	50	40	0
4777	01	NC – MEI Numerical computation (A2)	Raw	72	55	47	39	32	25	0
			UMS	100	80	70	60	50	40	0
4798	01	FPT - Further pure mathematics with technology (A2)	Raw	72	57	49	41	33	26	0
			UMS	100	80	70	60	50	40	0

GCE Statistics (MEI)

				Max Mark	a	b	c	d	e	u
G241	01	Statistics 1 MEI (Z1)	Raw	72	61	54	47	41	35	0
			UMS	100	80	70	60	50	40	0
G242	01	Statistics 2 MEI (Z2)	Raw	72	55	48	41	34	27	0
			UMS	100	80	70	60	50	40	0
G243	01	Statistics 3 MEI (Z3)	Raw	72	56	48	41	34	27	0
			UMS	100	80	70	60	50	40	0

GCE Quantitative Methods (MEI)

				Max Mark	a	b	c	d	e	u
G244	01	Introduction to Quantitative Methods MEI	Raw	72	58	50	43	36	28	0
G244	02	Introduction to Quantitative Methods MEI	Raw	18	14	12	10	8	7	0
			UMS	100	80	70	60	50	40	0
G245	01	Statistics 1 MEI	Raw	72	61	54	47	41	35	0
			UMS	100	80	70	60	50	40	0
G246	01	Decision 1 MEI	Raw	72	56	51	46	41	37	0
			UMS	100	80	70	60	50	40	0