OCR
Oxford Cambridge and RSA

AS Level Mathematics B (MEI)

H630/01 Pure Mathematics and Mechanics
Question Paper

Wednesday 16 May 2018 – Morning
Time allowed: 1 hour 30 minutes

You must have:
- Printed Answer Booklet

You may use:
- a scientific or graphical calculator

7020447828

INSTRUCTIONS
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Complete the boxes provided on the Printed Answer Booklet with your name, centre number and candidate number.
- Answer **all** the questions.
- **Write your answer to each question in the space provided in the Printed Answer Booklet.** If additional space is required, you should use the lined page(s) at the end of the Printed Answer Booklet. The question number(s) must be clearly shown.
- Do **not** write in the barcodes.
- 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 $g = 9.8$.

INFORMATION
- The total number of marks for this paper is **70**.
- The marks for each question are shown in brackets **[ ]**.
- 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 used. You should communicate your method with correct reasoning.
- The Printed Answer Booklet consists of **16** pages. The Question Paper consists of **8** pages.

Formulae AS Level Mathematics B (MEI) (H630)

Binomial series

$$(a+b)^n = a^n + {}^nC_1 a^{n-1} b + {}^nC_2 a^{n-2} b^2 + \ldots + {}^nC_r a^{n-r} b^r + \ldots + b^n \qquad (n \in \mathbb{N}),$$

where ${}^nC_r = {}_nC_r = \binom{n}{r} = \dfrac{n!}{r!(n-r)!}$

$$(1+x)^n = 1 + nx + \frac{n(n-1)}{2!}x^2 + \ldots + \frac{n(n-1)\ldots(n-r+1)}{r!}x^r + \ldots \qquad (|x| < 1,\ n \in \mathbb{R})$$

Differentiation from first principles

$$\mathrm{f}'(x) = \lim_{h \to 0} \frac{\mathrm{f}(x+h) - \mathrm{f}(x)}{h}$$

Sample variance

$$s^2 = \frac{1}{n-1} S_{xx} \text{ where } S_{xx} = \Sigma(x_i - \bar{x})^2 = \Sigma x_i^2 - \frac{(\Sigma x_i)^2}{n} = \Sigma x_i^2 - n\bar{x}^2$$

Standard deviation, $s = \sqrt{\text{variance}}$

The binomial distribution

If $X \sim \mathrm{B}(n, p)$ then $\mathrm{P}(X = r) = {}^nC_r p^r q^{n-r}$ where $q = 1 - p$

Mean of X is np

Kinematics

Motion in a straight line

$v = u + at$

$s = ut + \frac{1}{2}at^2$

$s = \frac{1}{2}(u+v)t$

$v^2 = u^2 + 2as$

$s = vt - \frac{1}{2}at^2$

Answer **all** the questions.

1 Write $\frac{8}{3-\sqrt{5}}$ in the form $a+b\sqrt{5}$, where a and b are integers to be found. **[2]**

2 Find the binomial expansion of $(3-2x)^3$. **[4]**

3 A particle is in equilibrium under the action of three forces in newtons given by

$$\mathbf{F}_1 = \begin{pmatrix} 8 \\ 0 \end{pmatrix}, \quad \mathbf{F}_2 = \begin{pmatrix} 2a \\ -3a \end{pmatrix} \quad \text{and} \quad \mathbf{F}_3 = \begin{pmatrix} 0 \\ b \end{pmatrix}.$$

Find the values of the constants a and b. **[3]**

4 Fig. 4 shows a block of mass $4m$ kg and a particle of mass m kg connected by a light inextensible string passing over a smooth pulley. The block is on a horizontal table, and the particle hangs freely. The part of the string between the pulley and the block is horizontal. The block slides towards the pulley and the particle descends. In this motion, the friction force between the table and the block is $\frac{1}{2}mg$ N.

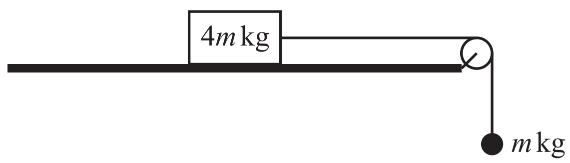


Fig. 4

Find expressions for

- the acceleration of the system,
- the tension in the string. **[4]**

5 **(i)** Sketch the graphs of $y = 4\cos x$ and $y = 2\sin x$ for $0° \leqslant x \leqslant 180°$ on the same axes. **[2]**

(ii) Find the exact coordinates of the point of intersection of these graphs, giving your answer in the form $(\arctan a, k\sqrt{b})$, where a and b are integers and k is rational. **[4]**

(iii) A student argues that without the condition $0° \leqslant x \leqslant 180°$ all the points of intersection of the graphs would occur at intervals of 360° because both $\sin x$ and $\cos x$ are periodic functions with this period. Comment on the validity of the student's argument. **[1]**

6 **In this question you must show detailed reasoning.**

You are given that $\mathrm{f}(x) = 4x^3 - 3x + 1$.

(i) Use the factor theorem to show that $(x+1)$ is a factor of $\mathrm{f}(x)$. **[2]**

(ii) Solve the equation $\mathrm{f}(x) = 0$. **[3]**

7 A toy boat of mass 1.5 kg is pushed across a pond, starting from rest, for 2.5 seconds. During this time, the boat has an acceleration of $2\,\mathrm{m\,s^{-2}}$. Subsequently, when the only horizontal force acting on the boat is a constant resistance to motion, the boat travels 10 m before coming to rest. Calculate the magnitude of the resistance to motion. **[6]**

8 **In this question you must show detailed reasoning.**

Fig. 8 shows the graph of a quadratic function. The graph crosses the axes at the points (−1, 0), (0, −4) and (2, 0).

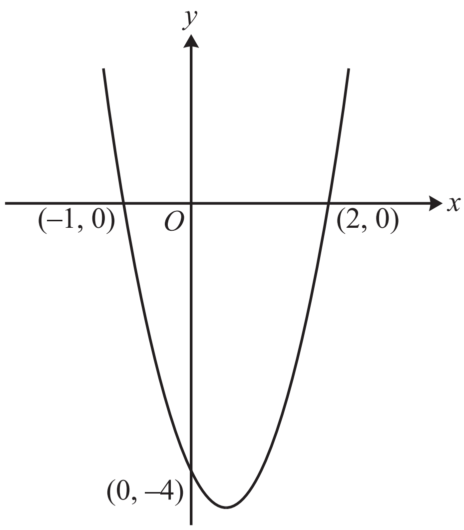


Fig. 8

Find the area of the finite region bounded by the curve and the x-axis. **[8]**

9 The curve $y = (x-1)^2$ maps onto the curve C_1 following a stretch scale factor $\frac{1}{2}$ in the x-direction.

(i) Show that the equation of C_1 can be written as $y = 4x^2 - 4x + 1$. **[2]**

The curve C_2 is a translation of $y = 4.25x - x^2$ by $\begin{pmatrix} 0 \\ -3 \end{pmatrix}$.

(ii) Show that the normal to the curve C_1 at the point (0, 1) is a tangent to the curve C_2. **[7]**

10 Rory runs a distance of 45 m in 12.5 s. He starts from rest and accelerates to a speed of $4\,\mathrm{m\,s^{-1}}$. He runs the remaining distance at $4\,\mathrm{m\,s^{-1}}$.

Rory proposes a model in which the acceleration is constant until time T seconds.

(i) Sketch the velocity-time graph for Rory's run using this model. **[2]**

(ii) Calculate T. **[2]**

(iii) Find an expression for Rory's displacement at time t s for $0 \leqslant t \leqslant T$. **[2]**

(iv) Use this model to find the time taken for Rory to run the first 4 m. **[1]**

Rory proposes a refined model in which the velocity during the acceleration phase is a quadratic function of t. The graph of Rory's quadratic goes through (0, 0) and has its maximum point at (S, 4). In this model the acceleration phase lasts until time S seconds, after which the velocity is constant.

(v) Sketch a velocity-time graph that represents Rory's run using this refined model. **[1]**

(vi) State with a reason whether S is greater than T or less than T. (You are not required to calculate the value of S.) **[1]**

11 The intensity of the sun's radiation, y watts per square metre, and the average distance from the sun, x astronomical units, are shown in Fig. 11 for the planets Mercury and Jupiter.

	x	y
Mercury	0.3075	14 400
Jupiter	4.950	55.8

Fig. 11

The intensity y is proportional to a power of the distance x.

(i) Write down an equation for y in terms of x and two constants. **[1]**

(ii) Show that the equation can be written in the form $\ln y = a + b \ln x$. **[2]**

(iii) In the Printed Answer Booklet, complete the table for $\ln x$ and $\ln y$ correct to 4 significant figures. **[2]**

(iv) Use the values from part **(iii)** to find a and b. **[3]**

(v) Hence rewrite your equation from part **(i)** for y in terms of x, using suitable numerical values for the constants. **[2]**

(vi) Sketch a graph of the equation found in part **(v)**. **[2]**

(vii) Earth is 1 astronomical unit from the sun. Find the intensity of the sun's radiation for Earth. **[1]**

END OF QUESTION PAPER

BLANK PAGE

BLANK PAGE

OCR
Oxford Cambridge and RSA

AS Level Mathematics B (MEI)

H630/01 Pure Mathematics and Mechanics
Printed Answer Booklet

Wednesday 16 May 2018 – Morning
Time allowed: 1 hour 30 minutes

You must have:
- Question Paper H630/01 (inserted)

You may use:
- a scientific or graphical calculator

First name										
Last name										
Centre number						Candidate number				

INSTRUCTIONS
- The Question Paper will be found inside the Printed Answer Booklet.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Complete the boxes provided on the Printed Answer Booklet with your name, centre number and candidate number.
- Answer **all** the questions.
- **Write your answer to each question in the space provided in the Printed Answer Booklet.** If additional space is required, you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the barcodes.
- 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 $g\,\text{m}\,\text{s}^{-2}$. Unless otherwise instructed, when a numerical value is needed, use $g = 9.8$.

INFORMATION
- 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 used. You should communicate your method with correct reasoning.
- The Printed Answer Booklet consists of **16** pages. The Question Paper consists of **8** pages.

DC (RW) 164683

1	
2	
3	

4

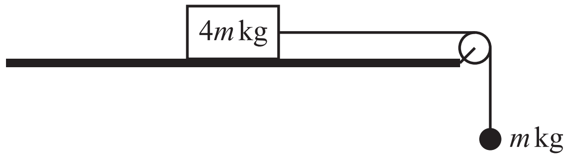


Fig. 4

5 (i)	
5 (ii)	
5 (iii)	

6 (i)	
6 (ii)	

7

8

(answer space continued on next page)

8	**(continued)**
9 (i)	

9 (ii)

10 (i)	
10 (ii)	
10 (iii)	

10 (iv)	
10 (v)	
10 (vi)	

11 (i)

11 (ii)

11 (iii)

	$\ln x$	$\ln y$
Mercury		
Jupiter		

11 (iv)

11 (v)	
11 (vi)	
11 (vii)	

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).

Oxford Cambridge and RSA

GCE

Mathematics B (MEI)

Unit **H630/01**: Pure Mathematics and Mechanics

Advanced Subsidiary GCE

Mark Scheme for June 2018

This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

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 a result or establishing a given result
dep*	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
AG	Answer given
awrt	Anything which rounds to
BC	By Calculator
DR	This indicates that the instruction **In this question you must show detailed reasoning** appears in the question.

Subject-specific Marking Instructions for AS Level Mathematics B (MEI)

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, escalate the question to your Team Leader who will decide on a course of action with the Principal Examiner.
If you are in any doubt whatsoever 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, e.g. 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, e.g. 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, what is acceptable will be detailed in the mark scheme. If this is not the case please, escalate the question to your Team Leader who will decide on a course of action with the Principal Examiner.
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. (e.g. 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; over-specification is usually only penalised where the scheme explicitly says so. 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. Follow through 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.

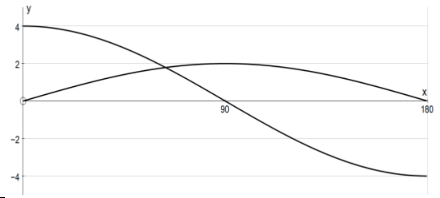
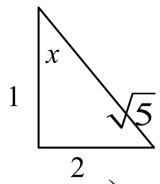
g Rules for replaced work: if a candidate attempts a question more than once, and indicates which attempt he/she wishes to be marked, then examiners should do as the candidate requests; if there are two or more attempts at a question which have not been crossed out, examiners should mark what appears 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.

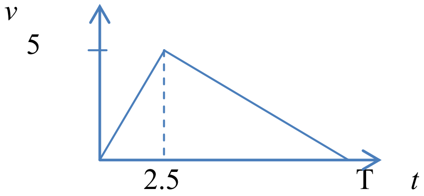
i If a graphical calculator is used, some answers may be obtained with little or no working visible. Allow full marks for correct answers (provided, of course, that there is nothing in the wording of the question specifying that analytical methods are required). Where an answer is wrong but there is 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	AOs		Guidance
1			$\frac{8}{(3-\sqrt{5})}\times\frac{(3+\sqrt{5})}{(3+\sqrt{5})}=6+2\sqrt{5}$	M1 A1 [2]	1.1a 1.1b	Attempt to rationalize the denominator Must be in correct notation	Allow full credit for correct answer
2			EITHER $(3)^3+3(3)^2(-2x)+3(3)(-2x)^2+(-2x)^3$ $=27-54x+36x^2-8x^3$	M1 M1 A1 A1 [4]	1.1a 1.1b 1.1b 1.1b	Use of Binomial coefficients Powers of 3 and (-2x) Condone no brackets or (2x) used. At least 3 simplified terms correct All correct and simplified	
			OR $(3-2x)^2=(9-12x+4x^2)$ $(3-2x)(9-12x+4x^2)$ $=27-54x+36x^2-8x^3$	M1 M1 A1 A1 [4]		Attempting to square Multiplying their answer by third bracket At least 3 simplified terms correct All correct and simplified	

Question			Answer	Marks	AOs		Guidance
3			$\begin{pmatrix}8\\0\end{pmatrix}+\begin{pmatrix}2a\\-3a\end{pmatrix}+\begin{pmatrix}0\\b\end{pmatrix}=0$	M1	2.5	Setting up a correct vector equilibrium equation or two separate equations.	
			$a=-4$,	A1	1.1b		
			$b=-12$	A1 [3]	1.1b		
4			$T-\frac{1}{2}mg=4ma$	B1	3.1b	Award for first of these two equations	M1 dependent on at least one B1 earned
			$mg-T=ma$	B1	3.1b	Signs consistent with first equation	
			$a=\dfrac{g}{10}$ m s^{-2}, $T=\dfrac{9mg}{10}$ N	M1dep	1.1a	Attempting to solve the simultaneous equations leading to either T or a soi	Allow 0.98 m s^{-2}, and
				A1 [4]	1.1b	Both T and a needed simplified	$T=\dfrac{441m}{50}=8.82m$ N
5	i		$y=4\cos x$ $y=2\sin x$  	B1	1.2	Correct shapes and relative sizes	
				B1 [2]	1.2	Graphs labelled with correct amplitudes clear Ignore any graph beyond the given interval	
	ii		$4\cos x=2\sin x$				
			$\tan x=2$	M1	3.1a	Forming equation leading to tan$x = k$ oe	
			$x=\arctan 2$	A1	1.1b	Award for 63.4^0 for this first A mark	
			 $4\cos x=4\times\dfrac{1}{\sqrt{5}}=\dfrac{4}{5}\sqrt{5}$	M1	1.1a	Attempting to find exact value for cos$x$ or sin$x$	Do not allow for using 63.4^0
			Point of intersection is $\left(\arctan 2,\dfrac{4}{5}\sqrt{5}\right)$	A1 [4]	1.1b	Must be a coordinate in this form	
	iii		The student's argument is invalid as the period of tan$x$ is 180^0.	E1 [1]	2.3	Must state or imply that the argument is invalid and give a correct reason	Allow for "roots occur every 180^0" oe

Question			Answer	Marks	AOs		Guidance
6	i		$f(-1) = 4\times(-1)^3 - 3(-1) + 1 = -4 + 3 + 1 = 0$	M1	2.1	**DR** Use of f(-1) must be seen. Do not allow for algebraic divison.	Allow without conclusion if preceded by "If $f(-1)=0$ then $(x+1)$ will be a factor" or similar
			Therefore $(x+1)$ is a factor	A1 [2]	2.2a	Clear conclusion must be made	
	ii		$f(x) = (x+1)(4x^2 - 4x + 1) = 0$	M1	1.1a	**DR** Attempt to divide or to factorise by inspection with $4x^2$	Allow full credit for $(x+1)(4x-2)(x-0.5)$
				A1	1.1b	correct quadratic factor seen or implied by correct linear factors	
			$= (x+1)(2x-1)^2 = 0$				No marks for solving the cubic on the calculator
			$x = -1,\ \frac{1}{2}$ [repeated]	A1 [3]	1.1b	Both roots seen derived from 3 correct linear factors or use of quadratic formula	
7			EITHER acceleration phase	M1	3.1b	Use of *suvat* equation(s) to find velocity. Do not allow if s = 10 used	Must recognise two phases of motion for first 4 marks
			$v = 0 + 2.5\times 2 = 5$ m s^{-1}	A1	1.1b		
			slowing phase $v^2 = u^2 + 2as$	M1	3.1b	Use of *suvat* equation(s) with s = 10 to find acceleration	
			$0 = 5^2 + 2a\times 10$ $a = -1.25$ m s^{-2}	A1	1.1b	FT their velocity. Must be correct sign.	
			$[-R] = 1.5\times(-1.25) = -1.875$	M1	1.1a	Use of Newton's second law.	Consistent sign convention needed for full credit.
			Magnitude of R = 1.875 N (1.88 to 3sf)	A1 [6]	1.1b	FT their a $a \neq 2$ Must be positive	

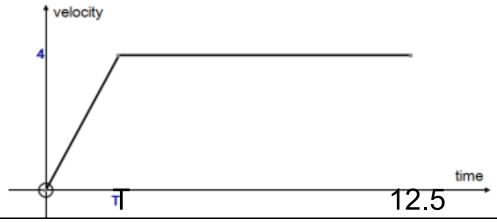
Question			Answer	Marks	AOs		Guidance
			OR acceleration phase $v = 0 + 2.5 \times 2 = 5$ m s^{-1}	M1 A1		Use of *suvat* equation(s) to find velocity. Do not allow if s = 10 used	Must recognise two phases of motion for first 4 marks
			 using the distance to find the time it takes to stop *using areas* (second triangle): $\frac{1}{2}(T - 2.5) \times 5 = 10$ $T = 6.5$ so time to stop is 4 s. So $0 = 5 + 4a$ Giving $a = -1.25$ m s^{-2}	M1 A1		Use of area and *suvat* equation(s) to find acceleration Must be correct sign	
			$[-R] = 1.5 \times (-1.25) = -1.875$ Magnitude of R = 1.875 N (1.88 to 3sf)	M1 A1 **[6]**		Use of Newton's second law. FT their a $a \neq 2$ Must be positive	Consistent sign convention needed for full credit.

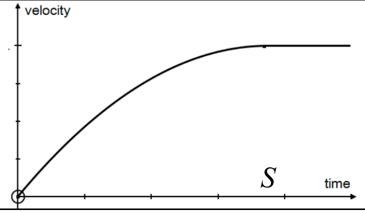
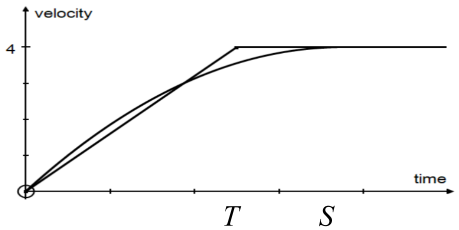
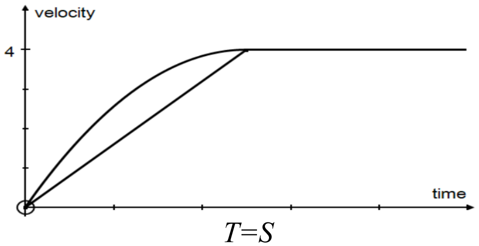
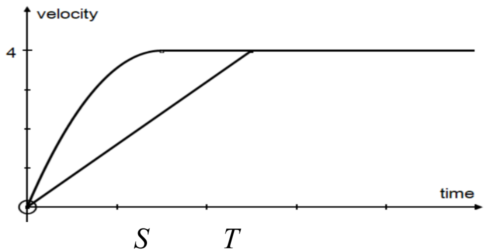
Question			Answer	Marks	AOs		Guidance
8			EITHER			**DR**	
			Equation of the form $y = k(x+1)(x-2)$	M1	1.1a	Allow with $k = 1$ and without $y =$	Ignore = 0 if seen
			(0, –4) on curve so $k = 2$	M1	3.1a	Attempt to find $k \neq 1$	
				A1	1.1b	All correct	
			OR				
			Equation of the form $y = ax^2 + bx + c$				
			(0, -4) on curve $c = -4$	(M1)		Uses one point to form an equation	Allow for c = -4 seen
			(-1, 0) on the curve $0 = a - b - 4$	(M1)		Uses both other points and attempts to solve simultaneous equations	
			(2, 0) on the curve $0 = 4a - 2b - 4$				
			Solving simultaneous equations $a = 2,\ b = -2$	(A1)		All correct	
			BOTH				
			Area = $\int_{-1}^{2}(2x^2 - 2x - 4)\,dx$				
			$\left[\frac{2x^3}{3} - x^2 - 4x\right]_{-1}^{2}$	M1	1.1a	Integration – allow without limits – condone one error	
				A1	1.1b	FT their quadratic	
			$\left(\frac{2\times 2^3}{3} - 2^2 - 4\times 2\right) - \left(\frac{2\times(-1)^3}{3} - (-1)^2 - 4\times(-1)\right)$	M1	1.1a	Substitution of limits clearly seen Complete argument leading to exact answer.	
			$= -\frac{20}{3} - \frac{7}{3} = -9$	A1	2.1	Allow for 9 if there is an argument to explain the change of sign even if -9 not seen.	
			Area is 9 below the x-axis.	E1	2.4	Must give modulus and explain the change of sign. FT if their definite integral is negative.	"Area must be positive" is not sufficient explanation.
				[8]			

Question			Answer	Marks	AOs		Guidance
9	(i)		Using $y = f\left(\frac{x}{a}\right)$ $y = \left(\frac{x}{½} - 1\right)^2 = (2x-1)^2$ $= 4x^2 - 4x + 1$	M1 A1 [2]	1.1a 2.1	Allow for 2 instead of ½ used for method mark or attempt to write equation of quadratic that touches axis at (0.5, 0) **AG** Must be a convincing argument that references either stretch or $f(2x)$ or similar	$(2x-1)^2$ seen is sufficient for M1
	(ii)		EITHER C_2 is $y = 4.25x - x^2 - 3$	B1	3.1a	Finding the equation of C_2. Any form	
			Normal to $y = 4x^2 - 4x + 1$ $\frac{dy}{dx} = 8x - 4$	M1	1.1a	Finding the derivative	
			At (0.1) $\frac{dy}{dx} = -4$ Gradient of normal is $\frac{1}{4}$	M1	1.1b	Finding negative reciprocal of their gradient	
			(0, 1) on line so equation of normal is $y = \frac{1}{4}x + 1$	A1	1.1a	FT their value for derivative	
			Intersection of normal and C_2 $\frac{1}{4}x + 1 = 4.25x - x^2 - 3$	M1	3.1a	Attempt to solve simultaneous equations	
			$4x^2 - 16x + 16 = 0$ EITHER $(x-2)^2 = 0$ OR discriminant $16^2 - 4 \times 4 \times 16 = 0$	A1	1.1b	Repeated factor or root, or zero discriminant seen.	
			Repeated root so the normal is a tangent to C_2	E1 [7]	3.2a	Must interpret their solution in the context.	

Question			Answer	Marks	AOs		Guidance
			OR C_2 is $y = 4.25x - x^2 - 3$	B1		Finding the equation of C_2. Any form	
			Normal to $y = 4x^2 - 4x + 1$ $\frac{dy}{dx} = 8x - 4$ At (0.1) $\frac{dy}{dx} = -4$	M1		Finding the derivative	
			Gradient of normal is $\frac{1}{4}$	M1		Finding negative reciprocal of their gradient	
			Equation of normal is $y = \frac{1}{4}x + 1$	A1		FT their value for derivative	
			Point on C_1 where gradient is $\frac{1}{4}$ $\frac{dy}{dx} = 4.25 - 2x = \frac{1}{4}$	M1		Attempting to find the point on C_1 where tangent parallel to the normal found.	
			giving $x = 2$ $y = 1.5$	A1		Both coordinates required	
			EITHER So the equation of the tangent is $y - \frac{3}{2} = \frac{1}{4}(x - 2)$ Which is the same equation as the normal to C_1	E1		Correct equation for the tangent in form that makes it clear it is the same line as the normal.	
			OR show that point (2, 1.5) lies on normal So the normal to C_1 is a tangent to C_2	(E1) [7]			

Question			Answer	Marks	AOs		Guidance
			SPECIAL CASE when the candidate tries to show that the normal to C_2 is a tangent to C_1 C_2 is $y = 4.25x - x^2 - 3$	B1		Finding the equation of C_2. Any form	
			Normal to $y = 4.25x - x^2 - 3$ $\frac{dy}{dx} = 4.25 - 2x$	M1		Finding the derivative	
			At (0, 1) $\frac{dy}{dx} = 4.25$ Gradient of normal is $-\frac{4}{17}$	A1		Finding negative reciprocal of their gradient	
			Equation of normal is $y = -\frac{4}{17}x + 1$	A0			(0, 1) does not lie on C_2
			EITHER point of intersection with C_1 $4x^2 - 4x + 1 = -\frac{4}{17}x + 1$	M1		Attempt to solve simultaneous equations	
			OR Attempt to find both coordinates of the point on C_1 with gradient $-\frac{4}{17}$ $\frac{dy}{dx} = 8x - 4 = -\frac{4}{17}$	(M1)		Attempting to find the point on C_1 where tangent parallel to the normal found. **No further marks are available** **4/7 maximum**	

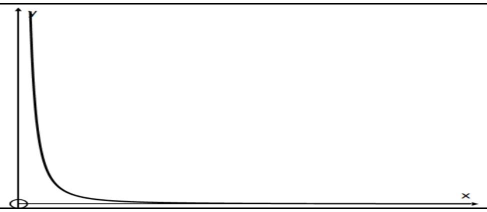
Question			Answer	Marks	AOs		Guidance
10	i			B1 B1 [2]	1.1a 1.1a	Two line segments with one horizontal $(T, 4)$ and $(12.5, 4)$ labelled or indicated on scales. Allow their 2.5 marked instead of T. On axes labelled v and t oe	
	ii		$\frac{1}{2}\times 4\times\left(12.5+\left(12.5-T\right)\right)=45$ $T=2.5$	M1 A1 [2]	3.1a 1.1b	Attempt to find area of trapezium or both the the triangle $\left(\frac{1}{2}T\times 4\right)$ and the rectangle $\left(12.5-T\right)\times 4$. cao	*Suvat* equations can be used for two phases of motion.
	iii		EITHER $a=\frac{4}{2.5}=1.6\ \text{m s}^{-2}$ $s=\frac{1}{2}\times 1.6t^2=0.8t^2$	M1 A1 [2]	1.1a 3.3	Soi FT their T	
			OR $a=\frac{4}{2.5}=1.6\ \text{m s}^{-2}$ $v=\int a\ \text{d}t=1.6t+c$ When $t=0,\ v=0$ so $c=0$ $s=\int v\ \text{d}t=0.8t^2+c$ When $t=0,\ s=0$ so $c=0$ Giving $s=0.8t^2$	M1 A1 [2]		Soi FT their T Must be complete solution – do not award without consideration of $+c$ at least once	
	iv		$0.8t^2=4$ $t=\sqrt{5}=2.24$ s	B1FT [1]	3.4	FT their quadratic model in (iii)	

Question			Answer	Marks	AOs		Guidance
	v			B1 [1]	1.1a	Must have curved section of the graph decreasing gradient. *S* must be labelled.	
	vi		Total distance (area under the graph) can only be equal if $S > T$ If $S > T$  If $S = T$  If $S < T$ 	E1 [1]	3.5c	Needs to give reason relating to the refinement of the model. Graphs not required	"It takes longer to reach 4 ms^{-1}" is not sufficient reason

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>AOs</th><th></th><th>Guidance</th></tr>
<tr><td>11</td><td>i</td><td></td><td>$y = kx^n$</td><td>B1
[1]</td><td>3.3</td><td>Allow any letters used for constant of proportionality and power.</td><td></td></tr>
<tr><td></td><td>ii</td><td></td><td>$\ln y = \ln\left(kx^n\right)$
$\ln y = \ln k + \ln\left(x^n\right) = \ln k + n\ln x$</td><td>M1

E1
[2]</td><td>2.1

2.1</td><td>Taking natural logs of both sides and one correct use of laws of logs used.
Convincing argument.
AG</td><td></td></tr>
<tr><td></td><td>iii</td><td></td><td><table><tr><th></th><th>lnx</th><th>lny</th></tr><tr><td>Mercury</td><td>-1.179</td><td>9.575</td></tr><tr><td>Jupiter</td><td>1.599</td><td>4.022</td></tr></table></td><td>B1
B1
[2]</td><td>1.1b
1.1b</td><td>At least 2 correct values
All correct and to 4sf</td><td></td></tr>
<tr><td></td><td>iv</td><td></td><td>EITHER
$b = \dfrac{9.575 - 4.022}{-1.179 - 1.599} = -1.999$ (-2.00 to 3sf)
$a = 7.218$</td><td>M1
A1
A1
[3]</td><td>1.1a
3.1a
1.1b</td><td>using gradient formula
Allow -2
a correct to at least 2 sf</td><td>These values could be found using the calculator STATS mode, so allow without working</td></tr>
<tr><td></td><td></td><td></td><td>OR
$9.575 = a - 1.179b$
$4.022 = a + 1.599b$
Giving $a = 7.218$
$b = -1.999$ (-2.00 to 3sf)</td><td>M1

A1
A1
[3]</td><td></td><td>Setting up pair of equations by substitution of their values. Allow one slip.
a correct to at least 2 sf
b correct to at least 2 sf</td><td>Simultaneous equations can be solved using calcuator</td></tr>
<tr><td></td><td>v</td><td></td><td>$y = 1363x^{-2.00}$</td><td>B1
B1
[2]</td><td>2.2a
3.3</td><td>FT their equation in (i)
awrt 1300 or 1400, or $e^{7.2}$ or better. FT their a
Allow for x^{-2} or better. FT their b</td><td></td></tr>
<tr><td></td><td>vi</td><td></td><td></td><td>B1

B1

[2]</td><td>1.2

1.1b</td><td>Appropriate curve with at least one horizontal asymptote or vertical asymptote shown

Both asymptotes correct
Ignore $x < 0$ if shown</td><td>FT their equation in (v) provided their function is a decreasing function</td></tr>
<tr><td></td><td>vii</td><td></td><td>Earth $x = 1$, $y = 1363 \times 1^{-2} = 1360$ W m^{-2} (3sf)</td><td>B1
[1]</td><td>3.4</td><td>FT their (v)</td><td></td></tr>
</table>

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>AOs</th><th></th><th>Guidance</th></tr>
<tr><td></td><td></td><td></td><td>SCHEME FOR CANDIDATES USING LOG BASE 10</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>ii</td><td></td><td></td><td>SC1</td><td></td><td>Correct use of log instead of ln and no other error</td><td></td></tr>
<tr><td></td><td>iii</td><td></td><td><table><tr><th></th><th>ln$x$</th><th>ln$y$</th></tr><tr><td>Mercury</td><td>-0.5122</td><td>4.158</td></tr><tr><td>Jupiter</td><td>0.6946</td><td>1.747</td></tr></table></td><td>B0
B1</td><td></td><td>All correct. Must be 4 sf</td><td></td></tr>
<tr><td></td><td>iv</td><td></td><td>As in main scheme
a = 3.1336
b = -1.999</td><td>M1

A1
A1</td><td></td><td></td><td></td></tr>
<tr><td></td><td>v</td><td></td><td>$y = 1360x^{-2}$</td><td>B1

B1</td><td></td><td>FT their equation in (i)
awrt 1300 or 1400, or $e^{3.1}$ (= 22.2), $10^{3.1}$ or better.
FT their a
allow for x^{-2} or better. FT their b</td><td></td></tr>
<tr><td></td><td>vii</td><td></td><td>Earth $x=1$, $y=1363\times1^{-2}=1360$ W m^{-2} (3sf)</td><td>B1</td><td></td><td>FT their (v)</td><td></td></tr>
</table>

OCR (Oxford Cambridge and RSA Examinations)
The Triangle Building
Shaftesbury Road
Cambridge
CB2 8EA

OCR Customer Contact Centre

Education and Learning
Telephone: 01223 553998
Facsimile: 01223 552627
Email: general.qualifications@ocr.org.uk

www.ocr.org.uk

OCR (Oxford Cambridge and RSA Examinations)
Head office
Telephone: 01223 552552
Facsimile: 01223 552553

Qualification Accredited

Oxford Cambridge and RSA

AS LEVEL

Examiners' report

MATHEMATICS B (MEI)

H630
For first teaching in 2017

H630/01 Summer 2018 series

Version 1

www.ocr.org.uk/mathematics

Contents

Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates. The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report. A full copy of the question paper can be downloaded from OCR.

Paper H630/01 series overview

This paper produced a wide spread of marks, although few candidates achieved more than 60 out of 70 marks. In general, the Pure questions were better answered than the Mechanics, as many candidates did not demonstrate even a basic understanding of the principles involved in setting up equations of motion. The mean mark for this paper was considerable lower than that for paper 2.

The new specification has an emphasis on unstructured or longer questions which candidates found more challenging. Some abandoned questions where follow-through marks would have been available. Questions requiring candidates to explain their reasoning in words or to assess the validity of an argument were also not well answered.

Candidates seemed not to be sure when it was appropriate to use their calculators, for example to solve simultaneous equations, so guidance on this is given in the detail of this report.

Question 1

1 Write $\dfrac{8}{3-\sqrt{5}}$ in the form $a+b\sqrt{5}$, where a and b are integers to be found. **[2]**

This was well answered, although some arithmetic mistakes were seen in the simplifying.

Check numerical answers with a calculator.

Question 2

2 Find the binomial expansion of $(3-2x)^3$. **[4]**

This was well answered by the majority of candidates although a significant number did not correctly use brackets round the (-2x) and so lost a method mark and the accuracy marks. Some also made the mistake of writing $3^3 = 9$.

Check numerical answers with a calculator.

Question 3

3 A particle is in equilibrium under the action of three forces in newtons given by

$$\mathbf{F}_1 = \begin{pmatrix} 8 \\ 0 \end{pmatrix}, \quad \mathbf{F}_2 = \begin{pmatrix} 2a \\ -3a \end{pmatrix} \quad \text{and} \quad \mathbf{F}_3 = \begin{pmatrix} 0 \\ b \end{pmatrix}.$$

Find the values of the constants a and b. **[3]**

Many candidates did not form an equilibrium equation in vector form nor a pair of equilibrium equations for the two directions. Many made the mistake of writing $F_1 + F_2 = F_3$ or similar and received no marks. Others had correct equations to obtain the method mark but subsequent sign errors cost the accuracy marks.

In future teaching, emphasise to candidates the importance of setting up their equilibrium equation i.e. total force = 0

Question 4

4 Fig. 4 shows a block of mass $4m$ kg and a particle of mass m kg connected by a light inextensible string passing over a smooth pulley. The block is on a horizontal table, and the particle hangs freely. The part of the string between the pulley and the block is horizontal. The block slides towards the pulley and the particle descends. In this motion, the friction force between the table and the block is $\frac{1}{2}mg$ N.

Fig. 4

Find expressions for

- the acceleration of the system,
- the tension in the string. **[4]**

This question was a very standard question but many candidates did not correctly use Newton's 2nd law to form equations of motion. Those who attempted to write down a single equation for the whole system (the round-the-corner method) were rarely successful. Some wrongly included the weight of the object on the table in its equation of motion. Many candidates had fragments of working that were not clear - examiners used the mass to indicate which part(s) of the system was being considered and required the correct forces acting on that part. Some who had correct equations then lost a mark as they did not simplify their expressions for *a* and *T* fully.

Prepare candidates to consider each part of the system separately and to identify which forces are acting on that object in the direction of its motion.

There is evidence of candidates confusing mass and weight, essentially using $F = mga$ instead of Newton's 2nd law.

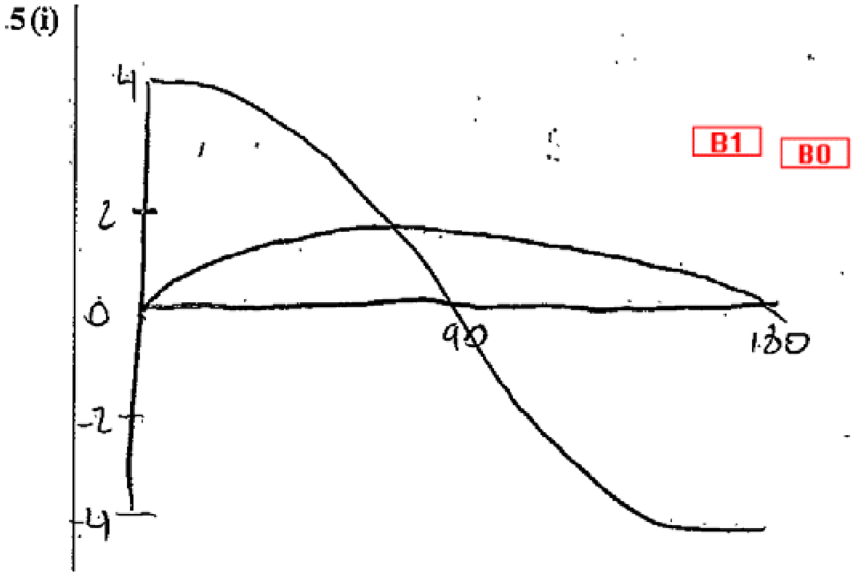
Question 5 (i)

5 **(i)** Sketch the graphs of $y = 4\cos x$ and $y = 2\sin x$ for $0° \leqslant x \leqslant 180°$ on the same axes. **[2]**

The graphs were generally well done although many candidates lost a mark as they did not indicate which graph was which. Some just drew the basic graphs of *y* = sin *x* and *y* = cos *x* with an amplitude of 1. Only rarely did candidates draw the graph of *y* = cos 4*x*. Some candidates who used their calculators to produce points to plot *y* = 4cos *x* gave too few points and drew a line from (0, 4) to (180, -4)

Make sure all graphs are fully labelled.

Exemplar 1



Question 5 (ii)

(ii) Find the exact coordinates of the point of intersection of these graphs, giving your answer in the form $(\arctan a, k\sqrt{b})$, where a and b are integers and k is rational. **[4]**

Key point call out

The question has specifically asked for the exact coordinates, it is not enough to use the calculator here to find decimal answers.

Many candidates divided by cos *x* to obtain an equation for tan *x*, but there were many who got mixed up and obtained $\tan x = \frac{1}{2}$ or even $\tan x = 0$. Most did not think to use Pythagoras' theorem to find the *y* coordinate of the point of intersection.

Where a value for tan *x* is known, draw a simple right angled triangle and using Pythagoras' theorem to give the values for sin *x* or cos *x*.

Question 5 (iii)

(iii) A student argues that without the condition $0° \leqslant x \leqslant 180°$ all the points of intersection of the graphs would occur at intervals of 360° because both $\sin x$ and $\cos x$ are periodic functions with this period. Comment on the validity of the student's argument. **[1]**

Few candidates used the periodicity of tan *x* to answer this question but many correct answers explained that there would be another point of intersection for $180° \leq x \leq 360°$.

Make sure that you clearly state whether the argument is valid or not and make sure this does not contradict your evidence.

Question 6 (i)

6 In this question you must show detailed reasoning.

You are given that $f(x) = 4x^3 - 3x + 1$.

(i) Use the factor theorem to show that $(x+1)$ is a factor of $f(x)$. **[2]**

This question specified a method that was to be tested, so no marks were obtained by candidates who used algebraic division here – marks for this skill were credited in part (ii). Most candidates were able to evaluate $f(-1) = 0$ but this did not obtain full marks without the detailed reasoning that this meant that $(x+1)$ was a factor of $f(x)$.

Question 6 (ii)

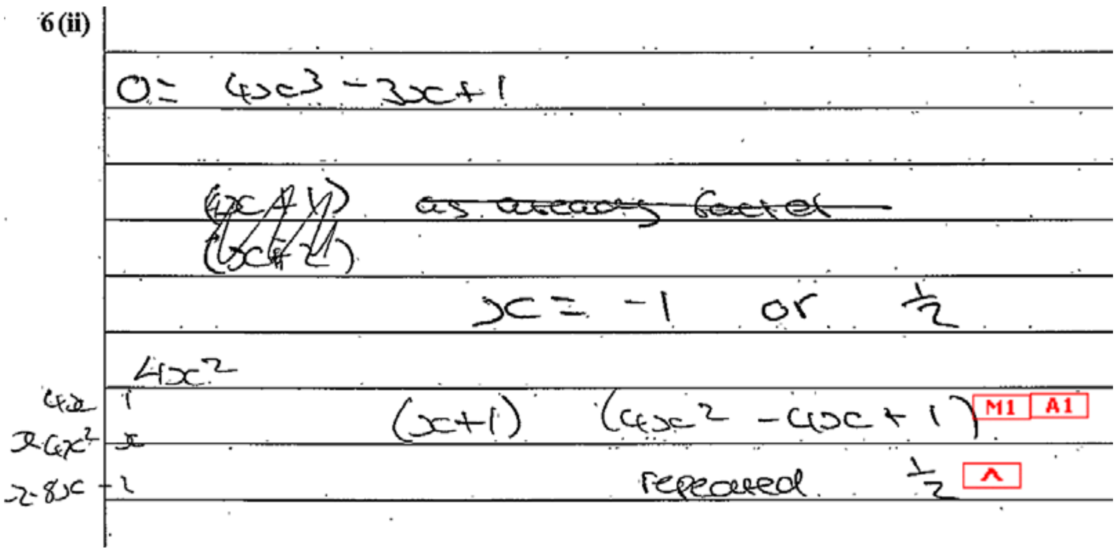
(ii) Solve the equation $f(x) = 0$. **[3]**

Key point call out

This question required detailed reasoning – all the lines of working must be clear to obtain full marks.

There were many good answers seen but some candidates who correctly divided then did not state what the roots of the equation were. Some candidates used their calculators to find the roots of the equation but were not able to give the correct linear factors of $f(x)$ that were needed for full marks as in this exemplar.

Exemplar 2


6 (ii)
$0 = 4x^3 - 3x + 1$
$x = -1$ or $\frac{1}{2}$
$4x^2$
$(x+1) \quad (4x^2 - 4x + 1)$ M1 A1
repeated $\frac{1}{2}$ ^

Question 7

7 A toy boat of mass 1.5 kg is pushed across a pond, starting from rest, for 2.5 seconds. During this time, the boat has an acceleration of $2\,\text{m}\,\text{s}^{-2}$. Subsequently, when the only horizontal force acting on the boat is a constant resistance to motion, the boat travels 10 m before coming to rest. Calculate the magnitude of the resistance to motion. **[6]**

Many good clear solutions were seen, however some candidates did not realise that this question covered two phases of motion and used all the numbers in the question in a single set of *suvat* equations. Some simply extracted the values of mass and acceleration from the first phase of motion and multiplied them together. Some candidates who obtained a negative value for resistance did not notice that it was the magnitude of the resistance that was required, so a positive answer was needed.

Look out for two phases of motion and set up different equations for the two phases. Use the value of the velocity at the end of the first phase to link the two phases.

Key point call out

This question required an extended answer with three separate method marks. The mark allocation [6] indicates that several steps are required to solve the problem.

Question 8

8 In this question you must show detailed reasoning.

Fig. 8 shows the graph of a quadratic function. The graph crosses the axes at the points $(-1, 0)$, $(0, -4)$ and $(2, 0)$.

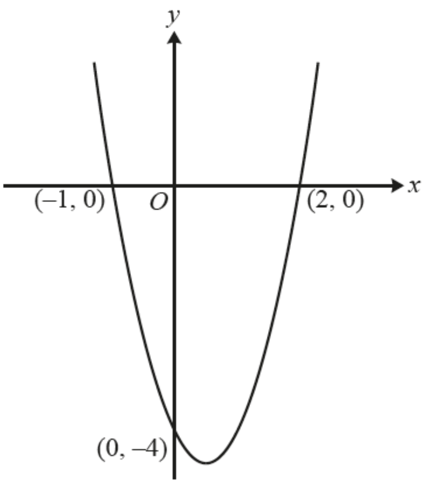


Fig. 8

Find the area of the finite region bounded by the curve and the x-axis. **[8]**

There were many very good answers to this question but many lost the final mark as they did not explain why their area is given as positive when the definitive integral gives a negative value. Only a few candidates used their calculators to evaluate their definite integral but lost marks as this was a detailed reasoning question that required all the lines of working to be clear. Examiners needed to see the indefinite integral and the substitution of limits. Some candidates made their answers unnecessarily complicated by splitting the required area into two or more regions.

Many candidates struggled to obtain the correct equation of the curve, either using $y = (x+1)(x-2)$ or $y = x^2 - 4$ but most of the rest of the marks in this question were obtained following through their equation if it was quadratic.

Make sure you do not write -9 = 9 without explaining the change of sign. Candidates needed to comment that the area is below the *x*-axis.

Do not abandon a long question if there is a problem with the first part. Use any vaguely sensible equation to demonstrate your ability to integrate and use limits – it is not enough to describe this process in words.

Question 9 (i)

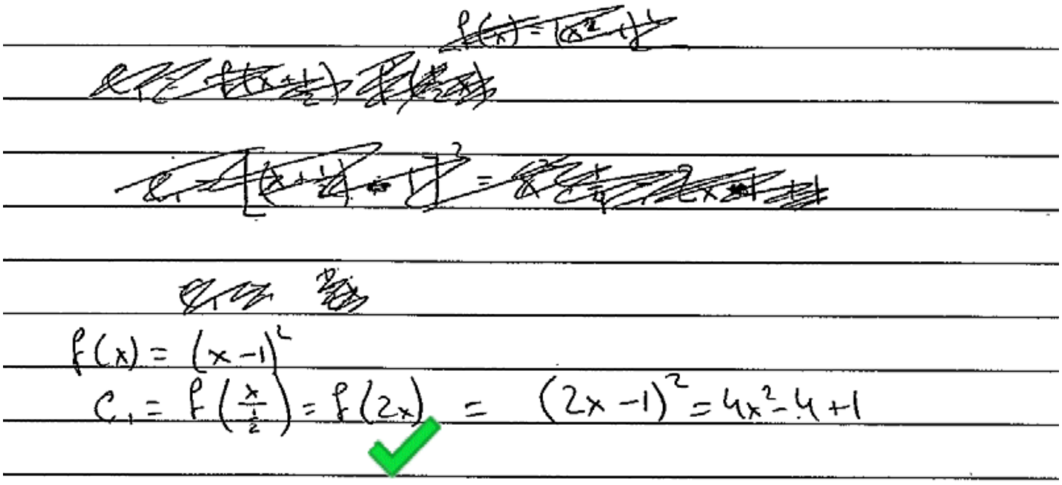
9 The curve $y=(x-1)^2$ maps onto the curve C_1 following a stretch scale factor $\frac{1}{2}$ in the x-direction.

(i) Show that the equation of C_1 can be written as $y=4x^2-4x+1$. **[2]**

Many candidates were credited one of two marks for this question as $(2x-1)^2$ was seen. The best answers used function notation to explain the effect of the stretch in the *x*-direction.

The following exemplar shows a candidate who is not sure what algebra is needed to achieve the given transformation. The given answer is used to identify the correct method and the notation makes it very clear that the full argument is given.

Exemplar 3



Question 9 (ii)

The curve C_2 is a translation of $y=4.25x-x^2$ by $\begin{pmatrix}0\\-3\end{pmatrix}$.

(ii) Show that the normal to the curve C_1 at the point (0, 1) is a tangent to the curve C_2. **[7]**

There were many good solutions to this question. Some candidates correctly obtained the equation of the normal and the equation of C_2 but then did not know how to proceed. Some incorrectly assumed that the point (0, 1) was a point of intersection of the two curves. Some candidates found the point on C_2 which had the correct gradient but then did not go on to show that the tangent here was the same line as the normal to C_1 and not simply parallel to it.

Question 10 (i)

10 Rory runs a distance of 45 m in 12.5 s. He starts from rest and accelerates to a speed of $4\,\mathrm{m\,s^{-1}}$. He runs the remaining distance at $4\,\mathrm{m\,s^{-1}}$.

Rory proposes a model in which the acceleration is constant until time T seconds.

(i) Sketch the velocity-time graph for Rory's run using this model. **[2]**

Most candidates gave a graph with two straight line segments but marks were often lost for graphs that were not fully labelled.

Make sure you label the axes and show the values of *v* and *t* at the significant points.

Question 10 (ii)

(ii) Calculate T. **[2]**

Candidates who used the area under the graph were usually successful. Candidates using the *suvat* equations often incorrectly combined values from the two separate phases of motion into a single equation.

Question 10 (iii)

(iii) Find an expression for Rory's displacement at time t s for $0 \leqslant t \leqslant T$. **[2]**

This was not well answered, as many candidates did not realise that the value of the acceleration was the key to this question. Many incorrectly used $s = \frac{1}{2}(u+v)t$ with $u = 0$ and $v = 4$, and the resulting linear expression did not qualify for follow-through marks in part (iv).

Question 10 (iv)

(iv) Use this model to find the time taken for Rory to run the first 4 m. **[1]**

This was usually credited to candidates who had had a quadratic expression for *s* in part (iii) as follow-through was allowed.

Question 10 (v)

Rory proposes a refined model in which the velocity during the acceleration phase is a quadratic function of t. The graph of Rory's quadratic goes through $(0, 0)$ and has its maximum point at $(S, 4)$. In this model the acceleration phase lasts until time S seconds, after which the velocity is constant.

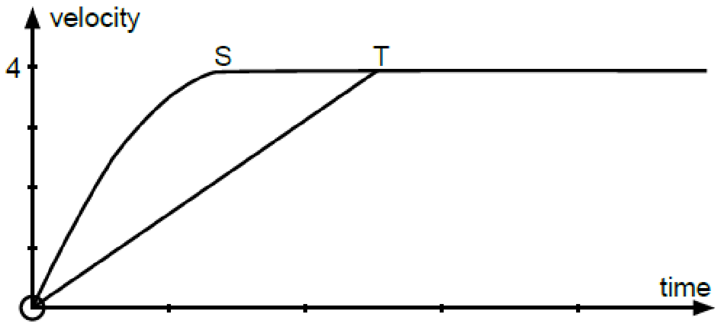
(v) Sketch a velocity-time graph that represents Rory's run using this refined model. **[1]**

Most candidates who attempted this question got it right. The mark was only credited where the curved part of the graph had a decreasing gradient.

Question 10 (vi)

(vi) State with a reason whether S is greater than T or less than T. (You are not required to calculate the value of S.) **[1]**

Very few candidates were credited this mark. Many argued that the decreasing gradient implied it would take longer to reach maximum speed – the incorrect underlying assumption here was that the gradient at the origin would be the same, so these arguments were not credited the mark. This model gives the same total distance in 12.5 s and only answers which compared distances or areas were eligible for the mark. The easiest way to decide was to sketch the graphs with $S < T$ and to realise that this meant the total distance would be larger and so to argue that $S > T$.



Question 11 (i)

11 The intensity of the sun's radiation, y watts per square metre, and the average distance from the sun, x astronomical units, are shown in Fig. 11 for the planets Mercury and Jupiter.

	x	y
Mercury	0.3075	14 400
Jupiter	4.950	55.8

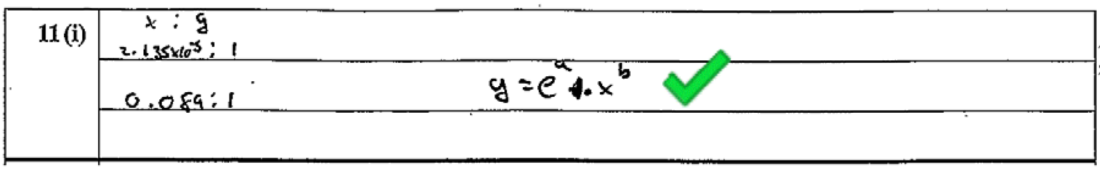
Fig. 11

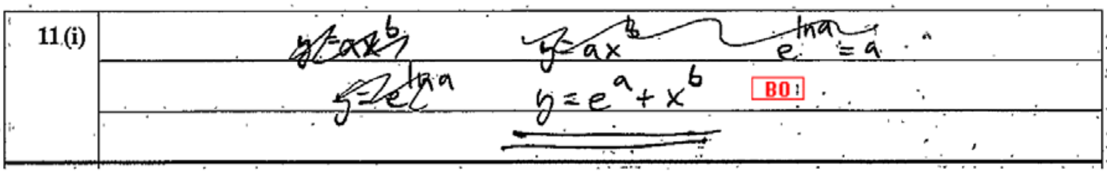
The intensity y is proportional to a power of the distance x.

(i) Write down an equation for y in terms of x and two constants. **[1]**

Many candidates seemed unprepared for this question which is covered by the specification point Ma14. Some tried to work backwards from the given answer in part (ii) but many made fundamental errors in the laws of logarithms and gave an expression which was the sum of two terms. There was some evidence that candidates who had had $y = ax^b$ returned to their answer and changed it when they obtained $y = \ln a + b \ln x$ in part (ii) which they did not recognise as being in the correct form. These two exemplars illustrate a successful and an unsuccessful attempt to use the given answer.

Exemplar 4





Question 11 (ii)

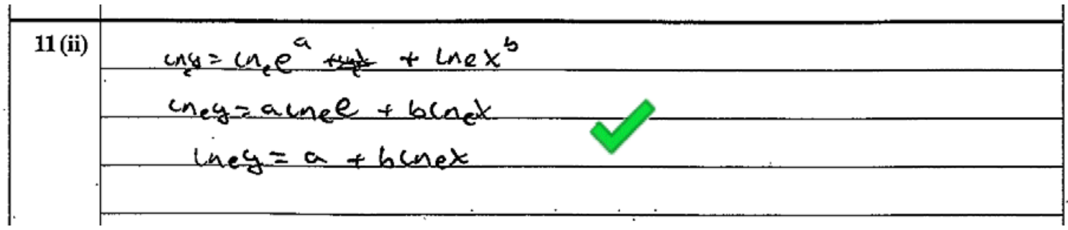
(ii) Show that the equation can be written in the form $\ln y = a + b\ln x$. **[2]**

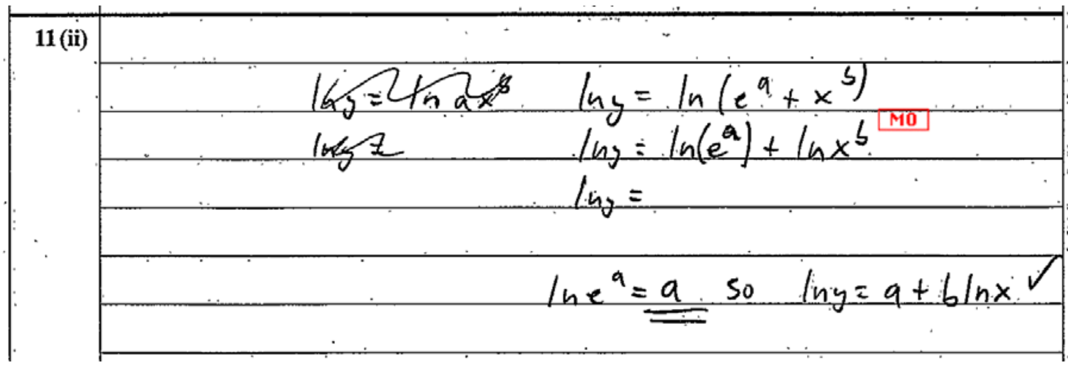
The method mark here was credited to candidates who took logarithms on both sides and demonstrated at least one correct use of the laws of logarithms, usually for correctly dealing with $\ln x^b$ or similar. Candidates who had the sum of terms in part (i) were not credited the mark for adding the logarithms of separate terms.

Candidates who did not know how to answer part (i) could access many of the subsequent marks by working from the equation given in here in part (ii). There was some evidence of candidates giving up on all of question 11 without realising that there were many marks accessible.

Prepare candidates to work through questions working from a given result even if they are unable to show where that result came from.

Exemplar 5





Question 11 (iii)

(iii) In the Printed Answer Booklet, complete the table for $\ln x$ and $\ln y$ correct to 4 significant figures. **[2]**

This was successfully done by the majority of candidates. It only required the use of the calculator and correct rounding to 4 significant figures – some candidates lost a mark for incorrect rounding. It was rare to see $\log_{10}$ used instead of natural logarithms.

Question 11 (iv)

(iv) Use the values from part **(iii)** to find a and b. **[3]**

Key point call out

It was expected that candidates used their calculator to answer this question – hence the relatively low mark allocation when the numbers were quite difficult to work with. Many calculators will give the equation of a regression line with this two-point data set. Calculators can also be used to solve the simultaneous equations that arise from the alternative method in the markscheme.

Candidates using the gradient method were often successful here. Many candidates using the alternative method were daunted by the complexity of the arithmetic here and made errors in the solution of their simultaneous equations.

Question 11 (v)

(v) Hence rewrite your equation from part **(i)** for y in terms of x, using suitable numerical values for the constants. **[2]**

Many candidates were hampered by incorrect work in parts (i) and (ii) and so did not realise that e^a was required. It was possible to obtain both marks here using their values in the given equation in part (ii) but this was rarely seen. Follow-through marks were given for using e^a and *b* in whatever equation had been seen in part (i).

Question 11 (vi)

(vi) Sketch a graph of the equation found in part **(v)**. **[2]**

When attempted, many candidates correctly drew a graph with the positive *x*-axis as an asymptote but many thought their curve would cross the vertical axis at their *a.* As two points on the curve were given in the question, no marks were given for an increasing function.

Question 11 (vii)

(vii) Earth is 1 astronomical unit from the sun. Find the intensity of the sun's radiation for Earth. **[1]**

This was an easy mark to obtain for candidates who substituted $x = 1$ into their equation even when the answer made little sense in the context.

Supporting you

For further details of this qualification please visit the subject webpage.

Review of results

If any of your students' results are not as expected, you may wish to consider one of our review of results services. For full information about the options available visit the OCR website. If university places are at stake you may wish to consider priority service 2 reviews of marking which have an earlier deadline to ensure your reviews are processed in time for university applications.

activeresults

Active Results offers a unique perspective on results data and greater opportunities to understand students' performance.

It allows you to:

- Review reports on the **performance of individual candidates**, cohorts of students and whole centres
- **Analyse results** at question and/or topic level
- **Compare your centre** with OCR national averages or similar OCR centres.
- Identify areas of the curriculum where students excel or struggle and help **pinpoint strengths and weaknesses** of students and teaching departments.

http://www.ocr.org.uk/administration/support-and-tools/active-results/

CPD Hub
Your route to OCR's teacher training

Attend one of our popular CPD courses to hear exam feedback directly from a senior assessor or drop in to an online Q&A session.

https://www.cpdhub.ocr.org.uk

The small print

We'd like to know your view on the resources we produce. By clicking on the 'Like' or 'Dislike' button you can help us to ensure that our resources work for you. When the email template pops up please add additional comments if you wish and then just click 'Send'. Thank you.

Whether you already offer OCR qualifications, are new to OCR, or are considering switching from your current provider/awarding organisation, you can request more information by completing the Expression of Interest form which can be found here: www.ocr.org.uk/expression-of-interest

OCR acknowledges the use of the following content:
Square down and Square up: alexwhite/Shutterstock.com

Please get in touch if you want to discuss the accessibility of resources we offer to support delivery of our qualifications: resources.feedback@ocr.org.uk

Looking for a resource?

There is now a quick and easy search tool to help find **free** resources for your qualification:

www.ocr.org.uk/i-want-to/find-resources/

www.ocr.org.uk

OCR Customer Contact Centre

General qualifications

Telephone 01223 553998
Facsimile 01223 552627
Email general.qualifications@ocr.org.uk

Qualification and notional component raw mark grade boundaries June 2018 series

The following qualifications are linear and therefore do not use UMS. For an explanation of how the new linear qualifications work, check out our blog: www.ocr.org.uk/blog/view/how-linear-qualifications-and-grade-boundaries-work

New AS Levels

AS GCE Mathematics B (MEI)

				Max Mark	a	b	c	d	e	u
H630	01	Pure Mathematics and Mechanics	Raw	70	44	38	33	28	23	0
H630	02	Pure Mathematics and Statistics	Raw	70	50	45	39	33	28	0
			Overall	140	94	83	72	61	51	0

AS GCE Further Mathematics B (MEI) (H635)

				Max Mark	a	b	c	d	e	u
Y410	01	Core Pure	Raw	60	46	41	36	32	28	0
Y411	01	Mechanics a	Raw	60	37	32	27	22	18	0
Y412	01	Statistics a	Raw	60	42	38	34	30	26	0
Y413	01	Modelling with Algorithms	Raw	60	37	33	29	25	22	0
Y414	01	Numerical Methods	Raw	60	35	29	24	19	14	0
Y415	01	Mechanics b	Raw	No entry in June 2018						
Y416	01	Statistics b	Raw	60	43	38	33	28	24	0
H635		*Option Y410+Y411+Y412*	Overall	180	125	111	98	85	72	0
H635		*Option Y410+Y411+Y413*	Overall	180	120	107	94	81	68	0
H635		*Option Y410+Y411+Y414*	Overall	180	118	103	88	74	60	0
H635		*Option Y410+Y412+Y413*	Overall	180	125	112	100	88	76	0
H635		*Option Y410+Y412+Y414*	Overall	180	123	109	95	81	68	0
H635		*Option Y410+Y412+Y416*	Overall	180	131	117	104	91	78	0
H635		*Option Y410+Y413+Y414*	Overall	180	118	104	90	77	64	0

OCR
Oxford Cambridge and RSA

Qualification and notional component raw mark grade boundaries June 2018 series

The following qualifications are linear and therefore do not use UMS. For an explanation of how the new linear qualifications work, check out our blog:
www.ocr.org.uk/blog/view/how-linear-qualifications-and-grade-boundaries-work

New A Levels

A Level Mathematics B (MEI)												
				Max Mark	a*	a	b	c	d	e	u
H640	01	Pure Mathematics and Mechanics	Raw	100	81	74	67	59	52	45	0
H640	02	Pure Mathematics and Statistics	Raw	100	75	68	61	54	47	40	0
H640	03	Pure Mathematics and Comprehension	Raw	75	62	55	48	42	36	30	0
			Overall	275	218	197	176	155	135	115	0