GradeMax

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MATHEMATICS **9709/11**

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MARK SCHEME

Maximum Mark: 75

Published

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Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

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Mark Scheme Notes

Marks are of the following three types:

M Method mark, awarded for a valid method applied to the problem. Method marks are not 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. Correct application of a formula without the formula being quoted obviously earns the M mark and in some cases an M mark can be implied from a correct answer.

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).

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

- When a part of a question has two or more "method" steps, the M marks are generally independent unless the scheme specifically says otherwise; and similarly when there are several B marks allocated. The notation DM or DB (or dep*) is used to indicate that a particular M or B mark is dependent on an earlier M or B (asterisked) mark in the scheme. When two or more steps are run together by the candidate, the earlier marks are implied and full credit is given.

- The symbol FT implies that the A or B mark indicated is allowed for work correctly following on from previously incorrect results. Otherwise, A or B marks are given for correct work only. A and B marks are not given for fortuitously "correct" answers or results obtained from incorrect working.

  - Note: B2 or A2 means that the candidate can earn 2 or 0.
    B2/1/0 means that the candidate can earn anything from 0 to 2.

  The marks indicated in the scheme may not be subdivided. If there is genuine doubt whether a candidate has earned a mark, allow the candidate the benefit of the doubt. Unless otherwise indicated, marks once gained cannot subsequently be lost, e.g. wrong working following a correct form of answer is ignored.

- Wrong or missing units in an answer should not lead to the loss of a mark unless the scheme specifically indicates otherwise.

- For a numerical answer, allow the A or B mark if a value is obtained which is correct to 3 s.f., or which would be correct to 3 s.f. if rounded (1 d.p. in the case of an angle). As stated above, an A or B mark is not given if a correct numerical answer arises fortuitously from incorrect working. For Mechanics questions, allow A or B marks for correct answers which arise from taking *g* equal to 9.8 or 9.81 instead of 10.

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The following abbreviations may be used in a mark scheme or used on the scripts:

AEF/OE Any Equivalent Form (of answer is equally acceptable) / Or Equivalent

AG Answer Given on the question paper (so extra checking is needed to ensure that the detailed working leading to the result is valid)

CAO Correct Answer Only (emphasising that no "follow through" from a previous error is allowed)

CWO Correct Working Only – often written by a 'fortuitous' answer

ISW Ignore Subsequent Working

SOI Seen or implied

SR Special Ruling (detailing the mark to be given for a specific wrong solution, or a case where some standard marking practice is to be varied in the light of a particular circumstance)

Penalties

MR –1 A penalty of MR –1 is deducted from A or B marks when the data of a question or part question are genuinely misread and the object and difficulty of the question remain unaltered. In this case all A and B marks then become "follow through" marks. MR is not applied when the candidate misreads his own figures – this is regarded as an error in accuracy. An MR –2 penalty may be applied in particular cases if agreed at the coordination meeting.

PA –1 This is deducted from A or B marks in the case of premature approximation. The PA –1 penalty is usually discussed at the meeting.

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Question	Answer	Marks	Guidance
1	$\frac{dy}{dx} = 3x^{1/2} - 3 - 2x^{-1/2}$	**B2,1,0**	
	at $x = 4$, $\frac{dy}{dx} = 6 - 3 - 1 = 2$	**M1**	
	Equation of tangent is $y = 2(x-4)$ OE	**A1FT**	Equation through (4, 0) with *their* gradient
		4	

Question	Answer	Marks	Guidance
2	$f'(x) = 3x^2 - 2x - 8$	**M1**	Attempt differentiation
	$-\frac{4}{3}$, 2 SOI	**A1**	
	$f'(x) > 0 \Rightarrow x < -\frac{4}{3}$ SOI	**M1**	Accept $x > 2$ in addition. FT *their* solutions
	Largest value of a is $-\frac{4}{3}$	**A1**	Statement in terms of a. Accept $a \leqslant -\frac{4}{3}$ or $a < -\frac{4}{3}$. Penalise extra solutions
		4	

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Question	Answer	Marks	Guidance
3(i)	$\frac{3a}{1-r}=\frac{a}{1+2r}$	**M1**	Attempt to equate 2 sums to infinity. At least one correct
	$3+6r=1-r$	**DM1**	Elimination of 1 variable (a) at any stage and multiplication
	$r=-\frac{2}{7}$	**A1**	
		3	
3(ii)	$½n\left[2\times15+\left(n-1\right)4\right]=½n\left[2\times420+\left(n-1\right)\left(-5\right)\right]$	**M1A1**	Attempt to equate 2 sum to n terms, at least one correct (**M1**). Both correct (**A1**)
	$n=91$	**A1**	
		3	

Question	Answer	Marks	Guidance
4(i)	$V = \frac{1}{3}\pi r^2(18 - r) = 6\pi r^2 - \frac{1}{3}\pi r^3$	**B1**	AG
		1	
4(ii)	$\frac{dV}{dr} = 12\pi r - \pi r^2 = 0$	**M1**	Differentiate and set = 0
	$\pi r(12 - r) = 0 \rightarrow r = 12$	**A1**	
	$\frac{d^2V}{dr^2} = 12\pi - 2\pi r$	**M1**	
	Sub $r = 12 \rightarrow 12\pi - 24\pi = -12\pi \rightarrow$ MAX	**A1**	AG
		4	
4(iii)	Sub $r = 12$, $h = 6 \rightarrow \text{Max } V = 288\pi$ or 905	**B1**	
		1	

Question	Answer	Marks	Guidance
5(i)	$\cos A = 8/10 \rightarrow A = 0.6435$	**B1**	AG Allow other valid methods e.g. $\sin A = 6/10$
		1	
5(ii)	*EITHER:* Area $\Delta ABC = ½ \times 16 \times 6$ or $½ \times 10 \times 16 \sin 0.6435 = 48$	**(M1A1**	
	Area 1 sector $½ \times 10^2 \times 0.6435$	**M1**	
	Shaded area $= 2 \times$ *their* sector $-$ *their* ΔABC	**M1)**	
	OR: $\Delta BDE = 12$, $\Delta BDC = 30$	**(B1 B1**	
	Sector = 32.18	**M1**	
	2×segment + ΔBDE	**M1)**	
	=16.4	**A1**	
		5	

Question	Answer	Marks	Guidance
6(i)	Mid-point of AB = (3, 5)	**B1**	Answers may be derived from simultaneous equations
	Gradient of $AB = 2$	**B1**	
	Eqn of perp. bisector is $y-5=-½(x-3) \rightarrow 2y=13-x$	**M1A1**	AG For **M1** FT from mid-point and gradient of AB
		4	
6(ii)	$-3x+39=5x^2-18x+19 \rightarrow (5)(x^2-3x-4)(=0)$	**M1**	Equate equations and form 3-term quadratic
	$x = 4$ or -1	**A1**	
	$y = 4½$ or 7	**A1**	
	$CD^2 = 5^2 + 2½^2 \rightarrow CD = \sqrt{\frac{125}{4}}$	**M1A1**	Or equivalent integer fractions ISW
		5	

Question	Answer	Marks	Guidance
7(a)	$a = -2, \quad b = 3$	**B1B1**	
		2	
7(b)(i)	$s + s^2 - sc + 2c + 2sc - 2c^2 = s + sc \rightarrow s^2 - 2c^2 + 2c = 0$	**B1**	Expansion of brackets must be correct
	$1 - \cos^2\theta - 2\cos^2\theta + 2\cos\theta = 0$	**M1**	Uses $s^2 = 1 - c^2$
	$3\cos^2\theta - 2\cos\theta - 1 = 0$	**A1**	AG
		3	
7(b)(ii)	$\cos\theta = 1$ or $-\frac{1}{3}$	**B1**	
	$\theta = 0°$ or $109.5°$ or $-109.5°$	**B1B1B1 FT**	FT for – *their* 109.5°
		4	

Question	Answer	Marks	Guidance
8(a)	*EITHER:* $\overrightarrow{PR} = 2\overrightarrow{PQ} = 2(\mathbf{q}-\mathbf{p})$	**(B1**	
	$\overrightarrow{OR} = \mathbf{p}+2\mathbf{q}-2\mathbf{p} = 2\mathbf{q}-\mathbf{p}$	**M1A1)**	
	OR: $\overrightarrow{QR} = \overrightarrow{PQ} = \mathbf{q}-\mathbf{p}$	**(B1**	
	$\overrightarrow{OR} = \overrightarrow{OQ} + \overrightarrow{QR} = \mathbf{q}+\mathbf{q}-\mathbf{p} = 2\mathbf{q}-\mathbf{p}$	**M1A1)**	Or other valid method
		3	
8(b)	$6^2 + a^2 + b^2 = 21^2$ SOI	**B1**	
	$18 + 2a + 2b = 0$	**B1**	
	$a^2 + (-a-9)^2 = 405$	**M1**	Correct method for elimination of a variable. (Or same equation in b)
	$(2)(a^2 + 9a - 162)(=0)$	**A1**	Or same equation in b
	$a = 9$ or -18	**A1**	
	$b = -18$ or 9	**A1**	
		6	

Question	Answer	Marks	Guidance
9(i)	$gg(x) = g(2x-3) = 2(2x-3)-3 = 4x-9$	**M1A1**	
		2	
9(ii)	$y = \frac{1}{x^2-9} \rightarrow x^2 = \frac{1}{y}+9$ OE	**M1**	Invert; add 9 to both sides or with *x*/*y* interchanged
	$f^{-1}(x) = \sqrt{\frac{1}{x}+9}$	**A1**	
	Attempt soln of $\sqrt{\frac{1}{x}+9} > 3$ or attempt to find range of f. $(y > 0)$	**M1**	
	Domain is $x > 0$ CAO	**A1**	May simply be stated for **B2**
		4	

Question	Answer	Marks	Guidance
9(iii)	*EITHER:* $\frac{1}{(2x-3)^2-9}=\frac{1}{7}$	**(M1**	
	$(2x-3)^2=16$ or $4x^2-12x-7=0$	**A1**	
	$x = 7/2$ or $-1/2$	**A1**	
	$x = 7/2$ only	**A1)**	
	OR: $g(x) = f^{-1}\left(\frac{1}{7}\right)$	**(M1**	
	$g(x) = 4$	**A1**	
	$2x - 3 = 4$	**A1**	
	$x = 7/2$	**A1)**	
		4	

Question	Answer	Marks	Guidance
10(i)	Area $= \int ½\left(x^4 - 1\right)\mathrm{d}x = ½\left[\frac{x^5}{5} - x\right]$	***B1**	
	$½\left[\frac{1}{5} - 1\right] - 0 \quad = \quad (-)\frac{2}{5}$	**DM1A1**	Apply limits 0→1
		3	
10(ii)	Vol $= \pi \int y^2 \mathrm{d}x \quad = \quad ¼(\pi)\int\left(x^8 - 2x^4 + 1\right)\mathrm{d}x$	**M1**	(If middle term missed out can only gain the M marks)
	$¼(\pi)\left[\frac{x^9}{9} - \frac{2x^5}{5} + x\right]$	***A1**	
	$¼(\pi)[\left(\frac{1}{9} - \frac{2}{5} + 1\right] - 0$	**DM1**	
	$\frac{8\pi}{45}$ or 0.559	**A1**	
		4	

Question	Answer	Marks	Guidance
10(iii)	$\text{Vol} = \pi\int x^2 \text{d}y = (\pi)\int(2y+1)^{1/2}\,\text{d}y$	**M1**	Condone use of x if integral is correct
	$(\pi)\left[\frac{(2y+1)^{3/2}}{3/2}\right][\div 2]$	***A1A1**	Expect $(\pi)\left[\frac{(2y+1)^{3/2}}{3}\right]$
	$(\pi)\left[\frac{1}{3}-0\right]$	**DM1**	
	$\frac{\pi}{3}$ or 1.05	**A1**	Apply $-\frac{1}{2}\rightarrow 0$
		5	