
MATHEMATICS

9709/22

Paper 2

October/November 2017

MARK SCHEME

Maximum Mark: 50

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

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

Cambridge International will not enter into discussions about these mark schemes.

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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.

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.

Question	Answer	Marks	Guidance
1	Introduce logarithms to both sides and use power law	*M1	
	Obtain $(3x-1)\log 5 = 4x\log 2$ or equivalent	A1	Allow A1 for poor use of brackets if recovered later
	Solve linear equation for x	DM1	dep *M
	Obtain 0.783	A1	Allow 3 sf or better
		4	

Question	Answer	Marks	Guidance
2	Solve 3-term quadratic equation or a pair of linear equations	M1	For M1 , must square both sides when attempting a quadratic equation
	Obtain $x = -5$ and $x = 3$	A1	
	Substitute (at least) one value of x (less than 4) into $ x+4 - x-4 $, showing correct evaluation of modulus and producing only one answer in each case	M1	
	Obtain -8 and 6 and no others	A1	
		4	

Question	Answer	Marks	Guidance
3	Differentiate to obtain form $k_1 \sec^2 \frac{1}{2}x + k_2 \cos \frac{1}{2}x$	M1	If a factor of 0.5 is missed, can still get 5/6, penalise at first A1
	Obtain $\frac{1}{2}\sec^2 \frac{1}{2}x + \frac{3}{2}\cos \frac{1}{2}x$	A1	
	Equate first derivative to zero and produce $\cos^3 \frac{1}{2}x = k_3$	*M1	
	Use correct process to find one value of x	DM1	Dep on *M, allow for obtaining 1.609....., 92.2° or 268°
	Obtain $x = 4.67$	A1	Allow $x = 4.67$ or better for A1
	Obtain $y = 1.12$	A1	Allow $y = 1.12$ from $x = 4.66$ but nothing else
		6	

Question	Answer	Marks	Guidance
4(i)	Substitute $x = -3$ into either $p(x)$ or $q(x)$ and equate to zero (may be implied)	M1	Allow long division, but the remainder needs to be independent of x
	Obtain $a = -11$	A1	
	Obtain $b = -8$	A1	
		3	
4(ii)	Divide $x + 3$ into expression for $q(x) - p(x)$ (may be a four term cubic equation), or Obtain a 3 term cubic equation by subtraction	*M1	Allow *M1 for their $x^3 + 3x + 36$, but must have integer values for a and b
	Obtain $x^2 - 3x + 12$ or $x^2 - 2x - 5$ and $2x^2 - 5x + 7$	A1	
	Apply discriminant to quadratic factor of $q(x) - p(x)$ or equivalent	DM1	dep on *M
	Obtain -39 or equivalent and conclude appropriately	A1	
		4	

Question	Answer	Marks	Guidance
5(i)	Obtain derivative of the form ke^{-2x}	*M1	Condone $k = 4$ for M1
	State or imply gradient of curve at P is -8	A1	
	Form equation of straight line through $(0, 9)$ with negative gradient	*DM1	dep on *M
	Obtain $y = -8x + 9$ or equivalent	A1	
	Equate equation of curve and equation of straight line	DM1	dep on both *M
	Rearrange to confirm $x = \frac{9}{8} - \frac{1}{2}e^{-2x}$	A1	
		6	

Question	Answer	Marks	Guidance
5(ii)	Use iterative process correctly at least once	M1	
	Obtain final answer 1.07	A1	
	Show sufficient iterations to 5 sf to justify answer or show sign change in interval (1.065, 1.075)	A1	
		6	

Question	Answer	Marks	Guidance
6(a)	Obtain $2 - 2\cos 2x$ as part of integrand	B1	
	Obtain $3\sin 2x$ as part of integrand	B1	Allow second B1 for writing
	Integrate to obtain form $k_1x + k_2\sin 2x + k_3\cos 2x$	M1	$\int 6\sin x \cos x \, dx = 6\left(\frac{1}{2}\sin^2 x\right)$, M1 may then be implied by subsequent work
	Obtain $2x - \sin 2x - \frac{3}{2}\cos 2x$ or $2x - \sin 2x + 3\sin^2 x$	A1	
	Apply limits to obtain $\frac{1}{2}\pi + \frac{1}{2}$	A1	
		5	
6(b)	Integrate to obtain $2\ln(3x + 2)$	B1	Allow $\frac{6}{3}\ln(3x + 2)$ for B1
	Use at least one relevant logarithm property	*M1	
	Obtain $\frac{3a + 2}{2} = 7$ or $\frac{(3a + 2)^2}{4} = 49$ or equivalent without \ln	A1	
	Solve relevant equation to find a	DM1	Dep on *M1 , allow for $49 = (3a + 2)^2$ OE or correct working involving $(3a + 2)$
	Obtain $a = 4$ only	A1	
		5	

Question	Answer	Marks	Guidance
7(i)	Obtain $4y + 4x \frac{dy}{dx}$ as derivative of $4xy$	B1	
	Obtain $4y \frac{dy}{dx}$ as derivative of $2y^2$	B1	
	State $2x + 4y + 4x \frac{dy}{dx} + 4y \frac{dy}{dx} = 0$	B1	3rd B1 may be implied by later work
	Substitute $x = -1$, $y = 3$ to find gradient of line	*M1	dep at least one B1
	Form equation of tangent through $(-1, 3)$ with numerical gradient	DM1	dep *M
	Obtain $5x + 4y - 7 = 0$ or equivalent of required form	A1	Allow any 3 term integer form for A1
		6	
7(ii)	Substitute $\frac{dy}{dx} = \frac{1}{2}$ to find relation between x and y	*M1	dep at least one B1 in part (i), must be linear
	Obtain $4x + 6y = 0$ or equivalent	A1	
	Substitute for x or y in equation of curve	DM1	dep on *M
	Obtain $-\frac{7}{4}y^2 = 7$ or $-\frac{7}{9}x^2 = 7$ or equivalent and conclude appropriately	A1	
		4	