



GCE

Mathematics

Unit **4724**: Core Mathematics 4

Advanced GCE

Mark Scheme for June 2014

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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.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

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1. Annotations and abbreviations

Annotation in scoris	Meaning
BP	Blank Page – this annotation must be used on all blank pages within an answer booklet (structured or unstructured) and on each page of an additional object where there is no candidate response.
✓ 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

2. Subject-specific Marking Instructions for GCE Mathematics (OCR) Pure 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 Wrong or missing units in an answer should not lead to the loss of a mark unless the scheme specifically indicates otherwise. Candidates are expected to give numerical answers to an appropriate degree of accuracy, with 3 significant figures often being the norm. Small variations in the degree of accuracy to which an answer is given (e.g. 2 or 4 significant figures where 3 is expected) should not normally be penalised, while answers which are grossly over- or under-specified should normally result in the loss of a mark. The situation regarding any particular cases where the accuracy of the answer may be a marking issue should be detailed in the mark scheme rationale. If in doubt, contact your Team Leader.

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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.

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

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Question	Answer	Marks	Guidance	
1	$x(1-x^2) + (1+x) + 2(1-x)$ oe $1-x^2$ oe $\frac{3-x^3}{1-x^2}$ oe cao	M1 B1 A1 [3]	condone one sign error any correct denominator common to all three fractions must be fully simplified; mark the final answer	if M0B0, SC1 for any pair of terms correctly combined into a single fraction, may be unsimplified eg $\frac{x(3-x^3)}{x(1-x^2)}$ oe may score a maximum of M1B1A0
2	$\pm ((3-2)\mathbf{i} + (-3-8)\mathbf{j} + (6-2)\mathbf{k})$ soi their $\pm (\mathbf{i} - 11\mathbf{j} + 4\mathbf{k}), \pm(5\mathbf{i} + 5\mathbf{j} + 8\mathbf{k})$ both diagonals used ; evaluation not essential $\pm (1 \times 5 + (-11) \times 5 + 4 \times 8)$ $= \sqrt{1^2 + 11^2 + 4^2} \times \sqrt{5^2 + 5^2 + 8^2} \cos \theta$ oe $\theta = \cos^{-1} \frac{\pm 18}{\sqrt{138} \times \sqrt{114}}$ 81.7 to 82°	B1 M1 A1 A1 A1 [5]	NB $\mathbf{i} - 11\mathbf{j} + 4\mathbf{k}$ if M0 SC2 for 84° (or 84.5°), or 52(.3°) or 39° or (38.5° or 43(.2°) or 46(.0°) found from scalar product or SC1 for the equivalent obtuse angle must be fully correct 1.4 to 1.43 rad	or B3 for correct use of Cosine Rule (using the midpoint of the diagonals of the parallelogram) $[\cos \theta] = \frac{34.5 + 28.5 - 72}{2\sqrt{34.5}\sqrt{28.5}}$ oe B2 for 81.7 to 82° unsupported or B3 + B2 possible for Cosine Rule

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Question		Answer	Marks	Guidance
3	(i)	$1 + \left(-\frac{1}{2}\right)(-2x) + \left(-\frac{1}{2}\right)\left(\frac{-3}{2}\right)\frac{(\pm 2x)^2}{2!} [+...]$ $1 + x + \frac{3}{2}x^2 \text{ oe}$	B1 B1 B1 [3]	first two terms third term allow recovery from omission of brackets do not allow $2x^2$ unless fully recovered in answer
	(ii)	use of $(x + 3) \times \text{their}(1 + x + \frac{3}{2}x^2)$ coefficient is 5.5 oe	M1 A1 [2]	or B2 www in either part may be embedded (eg $5.5x^2$ alone or in expansion)
4		$\int \frac{\cos 2x}{1 + \sin 2x} (dx)$ $F[x] = k \ln(1 + \sin 2x) \text{ soi}$ $k = \frac{1}{2}$ $\frac{1}{2} \ln(1 + \sin(\pi/2)) - \frac{1}{2} \ln(1 + 0)$ $= \frac{1}{2} \ln 2$	B1* B1* M1dep* A1 A1 AG [5]	$\cos 2x = 1 - 2\sin^2 x$ or $(1 + \sin 2x) = (1 + \sin x)\cos x$ seen numerator and denominator both correct in the integral soi or $k \ln(1 + u)$ or $k \ln(u)$ following their substitution www correct k for their substitution correct use of limits www if B0B0M0A0, SC4 for $F[x] = \frac{1}{2} \ln(1 + 2\sin x \cos x)$ or $\frac{1}{2} \ln(1 + \sin 2x)$ final mark may still be awarded minimum working: $\frac{1}{2} \ln 2 - \frac{1}{2} \ln 1$ or $\frac{1}{2} \ln(1 + 1)$ oe

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Question		Answer	Marks	Guidance	
5	(i)	$1 - s = 2 + t$ $4 + 2s = 8 + 3t$ $1 + 2s = 2 + 5t$	B1	for all three equations NB third equation may appear later, or with values already substituted	or M1 for one value (of s or t) found from one pair of equations A1 for substitution of this value (of s or t) in third equation and obtaining the other parameter (ie of t or s); NB $(0.2, -0.12)$ or $(^{-4}/7, ^{-12}/7)$ or $(4.25, -5.25)$ if s found first and $(-2.5, -1.2)$ or $(^{19}/14, ^{-3}/7)$ or $(-2.5, 1.5)$ if t found first or find same parameter from second pair of equations A1 for correct demonstration of inconsistency NB clear statement needed if two different values of same parameter found
		value of either s or t obtained from valid method	M1	eqns (i) and (ii): $s = 0.2, t = -1.2$	
		correct pair of values	A1	eqns (i) and (iii): $s = ^{-4}/7, t = ^{-3}/7$	
		eg $1 + 2 \times 0.2 \neq 2 + 5 \times -1.2$ oe isw NB A0 for $1 + 2 \times 0.2 = 2 + 5 \times -1.2$ unless clarified by suitable comment	A1	eqns (ii) and (iii) $s = 4.25, t = 1.5$ correct substitution of correct values in correct equation	
			[4]		
5	(ii)	$2\mathbf{i} - 4\mathbf{j} - 4\mathbf{k} = -2(-\mathbf{i} + 2\mathbf{j} + 2\mathbf{k})$ oe eg line A goes through $(1, 4, 1)$ but line C goes through $(1, 15, 11)$, so they do not coincide so the lines are parallel eg demonstration of different y or z values on each line for (say) $x = 1$, so lines are parallel	B1	allow equivalent in words, but scale factors must be correct	eg direction of A is $^{-1}/2 \times$ direction of C
			B1		
			[2]		

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6	$3y^2 \frac{dy}{dx}$ $2x - 12 \frac{dy}{dx} - 8$ <p>their $3y^2 \frac{dy}{dx} - 12 \frac{dy}{dx} = 8 - 2x$ soi</p> <p>must be two terms on each side and must follow from RHS = 0</p> $\frac{dy}{dx} = \frac{8 - 2x}{3y^2 - 12} \text{ oe}$ <p>their $3y^2 - 12 = 0$</p> $y = (\pm) 2$ <p>substitution of their positive y value in original equation</p> <p>$x = 10, x = -2$ and no others cao</p>	<p>B1</p> <p>B1</p> <p>M1</p> <p>A1</p> <p>M1*</p> <p>A1</p> <p>M1dep*</p> <p>A1</p> <p>[8]</p>	<p>or $2x \frac{dx}{dy}$</p> $3y^2 - 8 \frac{dx}{dy} - 12$ <p>their $2x \frac{dx}{dy} - 8 \frac{dx}{dy} = -3y^2 + 12$</p> <p>must be two terms on each side must follow from RHS = 0</p> <p>This mark may be implied if $\frac{dx}{dy} = 0$ is substituted and there is no evidence for an incorrect expression for $\frac{dx}{dy}$</p> <p>A0 if $\frac{dy}{dx}$ incorrect</p> <p>A0 if $\frac{dy}{dx}$ incorrect</p> <p>ignore substitution of - 2</p> <p>condone omission of formal statement of coordinates (10, 2) and (-2, 2)</p> <p>if BOB0 M0</p> <p>SC2 for $\frac{dy}{dx} =$</p> $\frac{1}{3}(-x^2 + 8x + 12y + 4)^{\frac{-2}{3}} \times (-2x + 8 + 12 \frac{dy}{dx})$ <p>M1 may be earned for setting correct denominator equal to 0</p> <p>$x \neq 4$ not required</p>

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Question	Answer	Marks	Guidance	
7 (i)	$\frac{dy}{dt} = -2 \sin 2t + 2 \cos t \text{ soi}$ $\frac{dy}{dx} = \text{their } \frac{\frac{dy}{dt}}{\frac{dx}{dt}} \text{ oe}$ $\frac{-2 \sin 2t + 2 \cos t}{2 \cos t} \text{ soi}$ $\frac{-4 \sin t \cos t + 2 \cos t}{2 \cos t} \text{ or } \frac{2 \cos t(-2 \sin t + 1)}{2 \cos t} \text{ and}$ completion to $1 - 2 \sin t$ www (1, 1½)	B1 M1 A1 A1 B1 [5]	NB $\frac{dx}{dt} = 2 \cos t$ or equivalent intermediate step NB $t = \frac{\pi}{6}$	if B0M0A0 SC3 for $\frac{dy}{dx} = 1 - x$ from correct Cartesian equation seen in part (i) or part (ii) B1 for substitution of $x = 2 \sin t$ from $1 - 2 \sin t = 0$
7 (ii)	$(y =) 1 - 2 \sin^2 t + 2 \sin t$ substitution of $\sin t = \frac{1}{2}x$ to eliminate t $y = 1 + x - \frac{1}{2}x^2$ oe isw	B1 M1 A1 [3]	may be awarded after correct substitution for x eg $(y =) 1 - \frac{x^2}{4} - \sin^2 t + 2 \sin t$ or B3 www	or $(y =) x + \cos 2t$ substitution of $t = \sin^{-1}(\frac{x}{2})$ to eliminate t $y = x + \cos 2(\sin^{-1}(\frac{x}{2}))$ oe isw

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7 (iii)	<p>$-2 \leq x \leq 2$ or $x \geq -2$ (and) $x \leq 2$ or $x \leq 2$</p> <p>sketch of negative quadratic with endpoints in 1st and 3rd quadrants</p> <p>positive y-intercept and one distinguishing feature isw</p>	<p>B1</p> <p>M1</p> <p>A1</p> <p>[3]</p>	<p>cao</p> <p>RH point must be to the right of the maximum</p> <p>one from: endpoints $(-2, -3)$ and $(2, 1)$, vertex at $(1, 1\frac{1}{2})$, y-intercept is $(0, 1)$, x-intercept is $(1 - \sqrt{3}, 0)$</p>	
8 (i)	<p>t^2 in quotient and $t^3 + 2t^2$ seen</p> <p>$-2t$ in quotient and $-2t^2 - (-2t^2 - 4t) = 4t$ seen</p> <p>completion to obtain correct quotient and remainder identified www</p>	<p>B1</p> <p>B1</p> <p>B1</p> <p>[3]</p>	<p>or $\frac{t(t^2 - 4) + 4t}{(t + 2)}$</p> <p>$\frac{t(t + 2)(t - 2)}{(t + 2)} + \frac{4t}{t + 2}$</p> <p>$t(t - 2) + \frac{4(t + 2) - 8}{t + 2}$</p> <p>or $\frac{(t + 2)^3 - 6t^2 - 12t - 8}{(t + 2)}$</p> <p>$\frac{(t + 2)^3}{(t + 2)} - \frac{6((t + 2)^2 - 4t - 4) + 12t + 8}{(t + 2)}$ oe</p> <p>$(t + 2)^2 - 6(t + 2) + \frac{12t + 16}{t + 2}$ oe</p> <p>$= t^2 + 4t + 4 - 6t - 12 + \frac{12(t + 2) - 8}{t + 2}$ oe</p> <p>both steps needed for final B1</p>	
8 (i)	<p>alternatively $\frac{t^3}{t + 2} \equiv At^2 + Bt + C + \frac{D}{(t + 2)}$</p> <p>equate coefficients to obtain correctly $A = 1, 0 = 2A + B$ and $B = -2$ www</p> <p>$0 = 2B + C$ and $0 = 2C + D$ obtained and solved correctly www</p>	<p>B1</p> <p>B1</p> <p>B1</p> <p>[3]</p>	<p>or $t^3 \equiv (At^2 + Bt + C)(t + 2) + D$</p> <p>or B1 for $\frac{t^2(t + 2) - 2t^2}{(t + 2)}$</p> <p>B1 for $t^2 + \frac{-2t(t + 2) + 4t}{(t + 2)}$</p> <p>B1 for $t^2 - 2t + \frac{4(t + 2) - 8}{(t + 2)}$</p>	

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<p>8 (ii)</p>	<p>integration by parts with $u = \ln(t + 2)$ and $dv = 6t^2$ to obtain $f(t) \pm \int g(t)(dt)$</p> $2t^3 \ln(t + 2) - \int \frac{2t^3}{t + 2} (dt) \text{ cao}$ <p>result from part (i) seen in integrand; must follow award of at least first M1</p> $F[t] = 2t^3 \ln(t + 2) \pm \frac{2t^3}{3} \pm 2t^2 \pm 8t \pm 16 \ln(t + 2)$ <p>their $F[2] - F[1]$</p> $-6\frac{2}{3} - 18 \ln 3 + 32 \ln 4 \text{ oe cao}$	<p>M1*</p> <p>A1</p> <p>M1*</p> <p>A1</p> <p>M1dep*</p> <p>A1</p> <p>[6]</p>	<p>$f(t)$ must include t^3 and $g(t)$ must not include a logarithm</p> <p>ignore spurious dx etc</p> <p>alternatively, following $u = t + 2$</p> $\int 2(u^2 - 6u + 12 - \frac{8}{u}) du \text{ oe}$ $\frac{2u^3}{3} - 6u^2 + 24u - 16 \ln u \text{ and}$ $2t^3 \ln(t + 2)$ <p>NB limits following substitution are $u = 4$ and $u = 3$</p> <p>no integration required for this mark</p> $2t^3 \ln(t + 2) - \frac{2t^3}{3} + 2t^2 - 8t + 16 \ln(t + 2)$ <p>at least one of their terms correctly integrated</p>
<p>9</p>	$\frac{A}{1 + 2x} + \frac{B}{1 - x} + \frac{C}{(1 - x)^2}$ <p>may be seen in later work</p> $2 + x^2 \equiv A(1 - x)^2 + B(1 + 2x)(1 - x) + C(1 + 2x)$ <p>$A = 1, B = 0$ and $C = 1$ www</p> $\int \left(\frac{1}{1 + 2x} + \frac{1}{(1 - x)^2} \right) dx =$ $a \ln(1 + 2x) + b(1 - x)^{-1}$ $F(x) = \frac{1}{2} \ln(1 + 2x) + (1 - x)^{-1}$ <p>their $\frac{1}{2} \ln(\frac{3}{2}) + \frac{4}{3} - (\frac{1}{2} \ln 1 + 1)$</p>	<p>B1</p> <p>M1</p> <p>A1A1A1</p> <p>M1*</p> <p>A1</p> <p>M1dep*</p>	<p>or $\frac{A}{1 + 2x} + \frac{Bx + C}{(1 - x)^2}$</p> <p>may be seen later in later work</p> <p>or $A(1 - x)^2 + (Bx + C)(1 + 2x)$</p> <p>$a$ and b are non-zero constants</p> <p>if B0M0, SC1 for $\frac{1}{1 + 2x}$ seen</p> <p>allow only sign errors , not algebraic errors</p> <p>ignore extra terms</p>

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Question		Answer	Marks	Guidance
		$\frac{1}{2} \ln\left(\frac{3}{2}\right) + \frac{4}{3} - 0 - 1$	A1 [9]	and completion to given result www NB $\frac{1}{2} \ln\left(\frac{3}{2}\right) + \frac{1}{3}$
10	(i)	$\frac{dV}{dt} = \pm 0.01$ by similar triangles, $\frac{h}{4.5} = \frac{r}{3}$ $\frac{dV}{dh} = \frac{4}{9} \pi h^2$ oe $\frac{dh}{dt} = \pm 0.01 \times \text{their } \frac{dh}{dV}$ oe $-0.01 = \left(\frac{4}{9} \pi h^2\right) \times \frac{dh}{dt}$	B1 B1 B1 M1 A1 [5]	may be implied by $r = \frac{2h}{3}$ oe use of Chain rule completion to given result www may follow from incorrect differentiation: expressions must be a function of either r or h or both $h^2 \frac{dh}{dt} = \frac{-0.09}{4\pi} = \frac{-9}{400\pi}$
10	(ii)	$\int h^2 dh = \int \frac{-9}{400\pi} dt$ oe soi $\frac{h^3}{3} = \frac{-9}{400\pi} t(+c)$ substitution of $t = 0$ and $h = 4.5$ in their expression following integration $h = \sqrt[3]{\frac{729}{8} - \frac{27t}{400\pi}}$ oe isw	M1 A1 M1 A1 [4]	if no subsequent work, integral signs needed, but allow omission of dh or dt , but must be correctly placed if present; expression must include c and powers must be correct on each side allow -0.0215 or $-0.02148591\dots$ r.o.t to 4 sf or more and similarly 91.125 $91.125 = \frac{729}{8}$
10	(iii)	set $h = 0$ and solve to obtain positive t 71 minutes cao	M1 A1 [2]	or $(t =) \frac{1}{3} \pi \times 3^2 \times 4.5 \div 0.01 (= 1350\pi)$ NB $1350\pi = 4241.150082\dots$

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OCR (Oxford Cambridge and RSA Examinations)
1 Hills Road
Cambridge
CB1 2EU

OCR Customer Contact Centre

Education and Learning

Telephone: 01223 553998

Facsimile: 01223 552627

Email: general.qualifications@ocr.org.uk

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Facsimile: 01223 552553

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