RECOGNISING ACHIEVEMENT

GCE

Mathematics

Advanced Subsidiary GCE

Unit **4721:** Core Mathematics 1

Mark Scheme for June 2012

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
✓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 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.

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.

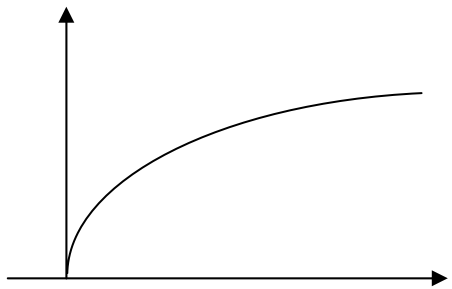
If there are two or more attempts at a question which have not been crossed out, examiners should mark what appears to be the last (complete) attempt and ignore the others.

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 or B mark in the question.

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

Question			Answer	Marks	Guidance	
1			$x^3-5x^2+3x-15-(x^2+4x-x-4)$	M1	Attempt to expand both pairs of brackets	No more than one "missing term"
				A1	Expansion with at most one incorrect term (no missing terms)	**Do not allow** "invisible brackets" unless final answer correct Allow one simplified incorrect term e.g. (x^2+5x-4)
			$=x^3-6x^2-11$	A1 **[3]**	cao	
2	(i)		$\sqrt[4]{7}=7^{\frac{1}{4}}$	B1 **[1]**	Allow $7^{0.25}$, $k = 0.25$ etc.	
2	(ii)		$\frac{1}{7\sqrt{7}}=7^{-\frac{3}{2}}$	M1	**Clear evidence** of **correct use** of $7^a\times7^b=7^{a+b}$ or a single term $\frac{1}{7^d}=7^{-d}$	Allow $\frac{1}{7^d7^e}=(7^d7^e)^{-1}$ [not $=7^d7^{-e}$]
				A1 **[2]**	Allow -1.5, k = -1.5 etc.	
2	(iii)		$7^4\times7^{20}$ $=7^{24}$	M1 A1 **[2]**	7^{20} or 49^2 seen (or 49^{12}) Allow $k = 24$	$(7^2)^{10}$ is **not** good enough for M1
3	(i)		$\frac{3}{5}$	B1 **[1]**	Allow 0.6 or any equivalent fraction	Do not allow $\frac{3}{5}x$ as final answer
3	(ii)		$P\left(\frac{20}{3},0\right)$	B1	May be implied by subsequent working	Allow $x=\frac{20}{3}$ for P
			$Q\ (0, -4)$	B1	May be implied	Allow y = - 4 for Q
			$\left(\frac{\frac{20}{3}+0}{2},\frac{0+^-4}{2}\right)$	M1	Correct method to find midpoint of line	Check formula, or if formula not seen, the use of formula is correct (including correct signs) for both x and y, Can be implied by correct final answers
			$\left(\frac{10}{3},-2\right)$	A1 **[4]**	Allow exact equivalent forms, decimals must be correct to at least 2dp	**SC** If P and Q given the wrong way round but then used correctly to obtain correct final answer **B2**

Question			Answer	Marks	Guidance	
4	(i)		$2(x^2-10x)+49$ $=2(x-5)^2-50+49$ $=2(x-5)^2-1$	B1 B1 M1 A1 **[4]**	$p=2$ $(x-5)^2$ $49-2q^2$ or $\frac{49}{2}-q^2$	If p, q, r found correctly, then **ISW** slips in format. $2(x-5)^2+1$ **B1 B1 M0 A0** $2(x-5)-1$ **B1 B1 M1 A1 (BOD)** $2(x-5x)^2-1$ **B1 B0 M1 A0** $2(x^2-5)^2-1$ **B1 B0 M1 A0** $2(x+5)^2-1$ **B1 B0 M1 A1 (BOD)** $2x(x-5)^2-1$ **B0 B1M1A1**
4	(ii)		(5, –1)	B1 FT B1 FT **[2]**	ft their q (Do not allow "5x") ft their r (Do not allow "-1y")	If restarted then **B1 B1** for each **B0** if more than one answer given
5	(i)			M1 A1 **[2]**	Correct shape of graph in Q1 Ignore reflection in the x axis Correct graph in Q1 only	Ignore "feathering" Finite "plot" scores **M0** Need not meet origin for **M** mark Allow slight curve downwards for **M** mark but not for **A** Allow tending to horizontal
5	(ii)		Translate(d) or Translation Parallel to x-axis, (+)4 units	B1 B1 **[2]**	**Do not accept** "shift", "move" etc. without the word translation/translate(d) For "parallel to the x axis" allow "horizontally", "across", "to the right", "in the (positive) x direction". **Do not accept** "in/on/across/up/along/to/towards the x axis"	Allow e.g. "4 units across in the positive x direction parallel to the x axis" but do not award second B1 if statements are contradictory. "Factor 4" not acceptable
5	(iii)		$y=\sqrt{\left(\frac{x}{5}\right)}$	M1 A1 **[2]**	$\sqrt{5x}$ or $\sqrt{\frac{x}{5}}$ seen **Must have** "$y=$ " to earn A mark (do not allow "$f(x)=$")	**SC** If doubt over whether use of square root/solidus is totally correct **B1** (Must still have "$y=$ ") Allow $\sqrt{5}y=\sqrt{x}$ or equivalent

Question			Answer	Marks	Guidance	
6			$\frac{dy}{dx} = -12x^{-3}$	M1 A1	Attempt to differentiate (i.e. kx^{-3} seen) Correct derivative	"+ C" is A0
			When $x = 2$, $\frac{dy}{dx} = -\frac{3}{2}$	A1	Correct value of $\frac{dy}{dx}$. Allow equivalent fractions.	
			Gradient of normal = $\frac{2}{3}$	B1 FT	Follow through their **evaluated** $\frac{dy}{dx}$	Must be processed correctly
			When $x = 2$, $y = -\frac{7}{2}$	B1	Correct y coordinate, accept equivalent forms	
			$y + \frac{7}{2} = \frac{2}{3}(x-2)$	M1	Correct equation of straight line through (2, their evaluated y), any non-zero gradient	
			$4x - 6y - 29 = 0$	A1 **[7]**	Correct equation in required form i.e. $k(4x - 6y - 29) = 0$ for integer k. **Must have** "=0".	
7			$k = x^{\frac{1}{2}}$ $k^2 - 6k + 2 = 0$	M1*	Use a substitution to obtain a quadratic with k^2, $6k$ and 2(may be implied by squaring or rooting later)	**Any sight of 4 or 36x from "squaring" original equation scores 0/6.** Alternative solution: $6\sqrt{x} = x + 2$ $36x = x^2 + 4x + 4$ Rearrange and square both sides **M1*** Correct simplified quadratic $x^2 - 32x + 4 = 0$ **A1** Method to solve quadratic **M1dep** Correct unsimplified expression **A1** Correct discriminant **A1** $16 \pm 6\sqrt{7}$ o.e. **A1** **SC** If no evidence of substitution at start and no squaring/rooting at end: Correct method for solving quadratic with $a = 1$, $b = -6$, $c = 2$ and solution simplified to $3 \pm \sqrt{7}$ **B1**
			$(k-3)^2 - 7 = 0$	M1 dep	Correct method to solve resulting quadratic	
			$k = 3 \pm \sqrt{7}$	A1	$k = \mathbf{3 \pm \sqrt{7}}$ **or** $k = \frac{6 \pm \sqrt{28}}{2}$ **or** $k = 3 \pm \frac{\sqrt{28}}{2}$	
			$x = (3 \pm \sqrt{7})^2$	M1 M1	Recognise the need to square to obtain x Correct method for squaring $a + \sqrt{b}$ (3 or 4 term expansion)	
			$x = 16 + 6\sqrt{7}$ or $x = 16 - 6\sqrt{7}$	A1 **[6]**	Allow $16 \pm 3\sqrt{28}$ or $16 \pm 2\sqrt{63}$	

Question			Answer	Marks	Guidance	
8	(i)		$\frac{dy}{dx} = 4x^3 + 32$	M1 A1	Attempt to differentiate (one term correct) Completely correct	"+ C" is A0
			$4x^3 + 32 = 0$	M1	Sets their $\frac{dy}{dx} = 0$ (can be implied)	
			$x = -2$	A1	Correct value for x (**not** ±2) **www**	
			$y = -48$	A1 FT **[5]**	Correct value of y for *their* single non-zero value of x	e.g. (2, 80), (4, 384), (− 4, 128), (8, 4352), (− 8, 3840)
8	(ii)		$\frac{d^2y}{dx^2} = 12x^2$	M1	Correct method for determining nature of a stationary point – see right hand column	e.g. evaluating second derivate at x = "−2" and stating a conclusion
			When $x = -2$, $\frac{d^2y}{dx^2} > 0$ so minimum pt	A1 **[2]**	Fully correct for $x = -2$ only	Evaluating $\frac{dy}{dx}$ either side of x = "−2" Evaluating y either side of x = "−2"
8	(iii)		$x > -2$	B1 **FT** **[1]**	ft from single x value in **(i)** consistent with **(ii)**	**Do not accept** $x \geq -2$
9	(i)		Area of tile = $4x(x + 3)$	B1	Correct expression for area of rectangle (may be unsimplified)	
			$4x(x + 3) < 112$ $4x^2 + 12x - 112 < 0$	B1 √	Correct inequality for their expression	Correct alternative forms for factorised inequality include:
			$4(x + 7)(x - 4) < 0$	M1 M1	Correct method to solve a three term quadratic Chooses correct region for the quadratic inequality i.e. lower root < x < higher root	$(x + 7)(4x - 16) < 0$ $(4x + 28)(x - 4) < 0$ $(2x + 14)(2x - 8) < 0$ etc.
			$-7 < x < 4$	A1	(May be implied by correct final answer)	
			$\therefore\ 0 < x < 4$	A1 **[6]**	Restricts range to positive values of x **CWO**	**Do not allow ≤ for final A mark**
9	(ii)		Perimeter = $4y + (y + 3) + 2y + y + 2y + 3$	M1 A1	**Clear** attempt to add lengths of all **6** edges Correct perimeter simplified to $10y + 6$ seen	**Allow < or ≤ throughout part (ii)**
			$20 < 10y + 6 < 54$	B1 FT M1	Correct inequalities for their expression Solving 2 linear equations or inequalities dealing with all 3 terms	Can still be unsimplified here
			$1.4 < y < 4.8$	A1 **[5]**	Accept "$1.4 < y, y < 4.8$", "$1.4 < y$ ***and*** $y < 4.8$" but **NOT** "$1.4 < y$ ***or*** $y < 4.8$".	**Do not ISW** if contradictory incorrect form follows correct answer

Question			Answer	Marks	Guidance	
10	(i)		Centre (5, –2) Radius = 5 Diameter = 10	B1 M1 A1 **[3]**	 5 or $\sqrt{25}$ soi	
10	(ii)		Gradient of line = $\frac{2-^-2}{7-5}(=2)$ $y-2=2(x-7)$ or y–⁻2 = 2 (*x*–5) $y=2x-12$	M1 A1 M1 A1 **[4]**	uses $\frac{y_2-y_1}{x_2-x_1}$ with their centre correct equation of straight line through (7, 2) or their centre, any non-zero gradient o.e. 3 term equation	3/4 substitutions correct Allow other points on the line e.g. mid-point is (6,0)
10	(iii)		$\sqrt{(7-5)^2+(2-^-2)^2}$ $=\sqrt{20}$ $\sqrt{20}<5$ so *P* lies inside the circle	M1 A1 B1 FT **[3]**	Use of $\sqrt{(x_2-x_1)^2+(y_2-y_1)^2}$ with their centre Compares their length *CP* with their radius and states consistent conclusion. **Both lengths must be mentioned.**	3/4 substitutions correct**. Must have** square root as length specifically asked for. **SC** If **M0**, award for **B1** for finding $CP^2=20$ and stating 20 < 25 and concluding inside **www**
10	(iv)		$(x-5)^2+(2x+2)^2(=25)$ $(x-5)^2+(2x+2)^2=25$ $x^2-10x+25+4x^2+8x+4=25$ $5x^2-2x+4=0$ $b^2-4ac=4-(4\times5\times4)$ $b^2-4ac<0$ so no real roots	M1* A1 A1 M1dep A1 **[5]**	Substitute for *x*/*y* or attempt to eliminate one of the variables Correct unsimplified equation (= 0 can be implied) Obtain correct 3 term quadratic Attempt to determine whether equation has real roots with consistent conclusion regarding roots/intersection Fully justified statement that line and circle do not meet **www**	 If *x* eliminated, $5y^2-4y+16=0$ If the discriminant is evaluated, this must be –76 (from the quadratic in *x*) or –304 (from the quadratic in *y*) for full marks.

Allocation of method mark for solving a quadratic

e.g. $2x^2 - 5x - 18 = 0$

1) If the candidate attempts to solve by factorisation, their attempt when expanded must produce the **correct quadratic term** and **one other correct term** (with correct sign):

$(2x+2)(x-9)=0$	**M1**	$2x^2$ and -18 obtained from expansion
$(2x+3)(x-4)=0$	**M1**	$2x^2$ and $-5x$ obtained from expansion
$(2x-9)(x-2)=0$	**M0**	only $2x^2$ term correct

2) If the candidate attempts to solve by using the formula

a) If the formula is quoted incorrectly then **M0**.

b) If the formula is quoted correctly then one **sign** slip is permitted. Substituting the wrong numerical value for a or b or c scores **M0**

$\dfrac{-5 \pm \sqrt{(-5)^2 - 4\times 2 \times -18}}{2\times 2}$ earns **M1** (minus sign incorrect at start of formula)

$\dfrac{5 \pm \sqrt{(-5)^2 - 4\times 2 \times 18}}{2\times 2}$ earns **M1** (18 for *c* instead of −18)

$\dfrac{-5 \pm \sqrt{(-5)^2 - 4\times 2 \times 18}}{2\times 2}$ **M0** (2 sign errors: initial sign and *c* incorrect)

$\dfrac{5 \pm \sqrt{(-5)^2 - 4\times 2 \times -18}}{2\times -5}$ **M0** (2*b* on the denominator)

Notes – for equations such as $2x^2 - 5x - 18 = 0$, then $b^2 = 5^2$ would be condoned in the discriminant and would not be counted as a sign error. Repeating the sign error for *a* in both occurrences in the formula would be two sign errors and score **M0**.

c) If the formula is not quoted at all, substitution must be completely correct to earn the **M1**

3) If the candidate attempts to complete the square, they must get to the "square root stage" involving ±; we are looking for evidence that the candidate knows a quadratic has two solutions!

$$2x^2 - 5x - 18 = 0$$

$$2\left(x^2 - \frac{5}{2}x\right) - 18 = 0$$

$$2\left[\left(x - \frac{5}{4}\right)^2 - \frac{25}{16}\right] - 18 = 0$$

$$\left(x - \frac{5}{4}\right)^2 = \frac{169}{16}$$

$$x - \frac{5}{4} = \pm\sqrt{\frac{169}{16}}$$

← This is where the **M1** is awarded – arithmetical errors may be condoned provided $x - \frac{5}{4}$ seen or implied

If a candidate makes repeated attempts (e.g. fails to factorise and then tries the formula), mark only what you consider to be their last full attempt.

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