UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

General Certificate of Education Ordinary Level

MARK SCHEME for the November 2004 question paper

4024 MATHEMATICS

4024/02   **Paper 2, maximum raw mark 100**

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 Examiners were initially instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began. Any substantial changes to the mark scheme that arose from these discussions will be recorded in the published *Report on the Examination*.

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 must be read in conjunction with the question papers and the *Report on the Examination*.

•   CIE will not enter into discussion or correspondence in connection with these mark schemes.

CIE is publishing the mark schemes for the November 2004 question papers for most IGCSE and GCE Advanced Level syllabuses.

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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 √ 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.

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

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

BOD   Benefit of Doubt (allowed when the validity of a solution may not be absolutely clear)

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

MR   Misread

PA   Premature Approximation (resulting in basically correct work that is insufficiently accurate)

SOS   See Other Solution (the candidate makes a better attempt at the same question)

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.

OW -1,2   This is deducted from A or B marks when essential working is omitted.

PA -1   This is deducted from A or B marks in the case of premature approximation.

S -1   Occasionally used for persistent slackness – usually discussed at a meeting.

EX -1   Applied to A or B marks when extra solutions are offered to a particular equation. Again, this is usually discussed at the meeting.

November 2004

GCE O LEVEL

MARK SCHEME

MAXIMUM MARK: 100

SYLLABUS/COMPONENT: 4024/02

MATHEMATICS
PAPER 2

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1	Incorrect work in any one part may be used to earn M marks in any other part of the question. Throughout, accept equivalent complete methods and decimal angles without degree sign, but degree sign essential if answer is given in degrees and minutes.		
(a)	(AD =) 8sin35 4.585 to 4.595 (m)	**M1** **A1**	**2**
(b)	(CE =) $\dfrac{8}{\cos 35}$ 9.76(0) to 9.77(0) (m)	**M1** **A1**	**2**
(c)	(A$\hat{\text{B}}$C =) 47(°) and (A$\hat{\text{C}}$B =) 55(°) soi	**B1**	
	(AB =) $\dfrac{8\sin(\text{their}55)}{\sin(\text{their}47)}$ (= 8.96…)	**M1**	
	8.955 to 8.965 (m)	**A1**	**3**
	OR Complete alternative method: M2 A1		
			7
2 (a)(i)	$-\dfrac{4}{3}$ seen, isw or –1.33 or better	**B1**	**1**
(ii)	$y = -\dfrac{4}{3}x + \dfrac{10}{3}$ or 4x + 3y = 10 **OR** 3 term equivalent **OR** $y = -\dfrac{4}{3}x + c$ and $c = \dfrac{10}{3}$ seen isw.	**B2**	**2**
	After B0, allow B1 for straight line with gradient $-\dfrac{4}{3}$ or their **(i)** **OR** B1 for 3 term straight line through (4, –2). y = –1.33x + 3.32 scores B1 B0 but allow B2 for y = –1.33x + 3.33		
(b)(i)	(AB =) 5 (units)	**B1**	
(ii)	(BC =) 10 (units)	**B1**	**2**
(c)	AC^2 = 5^2 + 10^2 = AB^2 + BC^2 seen o.e. **OR** Gradient of BC = $\dfrac{6}{8}$ <u>and</u> $\dfrac{6}{8} \times \left(-\dfrac{4}{3}\right) = -1$ o.e.	**B1** **(B1)**	**1**
(d)	25 (units^2) or $\dfrac{1}{2}$ (their **(b)(i)**) × (their **(b)(ii)**) √	**B1√**	**1**
			7

3 (a)	$\dfrac{4}{4+5+7}\times 80\,000\,000$ **OR** $\dfrac{5}{4+5+7}\times 80\,000\,000$	**M1**	
	OR $\dfrac{7}{4+5+7}\times 80\,000\,000$		
	20 000 <u>and</u> 25 000 000 <u>and</u> 35 000 000	**A1**	**2**
(b)	9 600 000 isw	**B1**	**1**
(c)(i)	5 000 000 **OR** $\dfrac{25}{100}\times$ their 20 000 000 $\sqrt{}$	**B1$\sqrt{}$**	**1**
(ii)	(Loss on Beta =) $\dfrac{10}{100}\times$ their 25 000 000 (= 2 500 000)	**M1**	
	If selling price used, allow M1 for $\dfrac{90}{100}\times 25\,000\,000$ (= 22 500 000)		
	$\left\{\begin{array}{l}\text{(Profit on Gamma =) }\textit{their}\text{ 9 600 000 – [}\textit{their}\text{ 5 000 000 –}\\ \textit{their}\text{ 2 500 000]}\\ \text{(= 7 100 000)}\\ \text{and (Percentage =) }\dfrac{\textit{Their}\,7\,100\,000}{\textit{Their}\,35\,000\,000}\times 100\text{ o.e.}\end{array}\right.$	**M1**	
	$20\dfrac{2}{7}$ **OR** 20.25 to 20.35 (%) cao	**A1**	**3**
(d)	$\dfrac{100}{160}\times 80\,000\,000$	**M1**	
	50 000 000	**A1**	**2**
	Accept such as 20 m for 20 000 000 throughout.		
	Accept in standard form or equivalents (such as 20×10^6).		
			9
4 (a)(i)	States AB = BC **OR** sides of square (ABCD) are equal	**M1**	
	Correctly deduces PB = QC (must mention AP = BQ)	**A1**	**2**
(ii)	BQ = CR seen	**M1**	
	$P\hat{B}Q = Q\hat{C}R$ seen	**M1**	
	Deduces triangles BPQ and CQR congruent, dep on no extra facts	**A1**	**3**
(iii)	$R\hat{Q}C = Q\hat{P}B$ **OR** $P\hat{Q}B = Q\hat{R}C$ stated or implied	**M1**	
	Correctly deduces $P\hat{Q}R = 90°$ with no errors seen	**A1**	**2**
	(e.g. $\hat{P}+\hat{Q}+\hat{B}=180°$ or $\hat{P}+\hat{Q}=90° \Rightarrow R\hat{Q}C + P\hat{Q}B = 90°$)		
(b)	PQ = QR (= RS)(= SP) stated	**B1**	
	$P\hat{Q}R = Q\hat{R}S$ ($= R\hat{S}P$)($= S\hat{P}Q$) stated etc.	**B1**	**2**
	OR $P\hat{Q}R = 90°$		
	Two <u>different</u> reasons required, but proof not needed.		
	[Condone use of numerical or literal values throughout.]		
			9

5 (a)(i)	120	**B1**	**1**
(ii)	$(l =)\ \dfrac{25}{n} - a$ or $\dfrac{2s - an}{n}$ (Mark <u>Final Answer</u>)	**B2**	**2**
	After B0, allow B1 for $25 = an + ln$ **OR** $\dfrac{2s}{n} = a + l$ seen.		
(b)(i)	$(t =)\ 0$	**B1**	
	$\dfrac{12}{5},\ 2\dfrac{2}{5}$ or 2.4 isw	**B1**	**2**
(ii)	$(y - 1)^2 = 16$ or 2×8 o.e. soi **OR** $y - 1 = 4, -4$ or ± 4	**M1**	
	$(y =)\ 5$ and -3	**A1+A1**	**3**
(c)	<u>Formula</u> For numerical $\dfrac{p \pm (or + or -)\sqrt{q}}{r}$ seen or used, allow B1 for	**B1**	
	$p = -9$ and $r = 6$ and B1 for $q = 21$ or $\sqrt{q} = 4.58\ldots$	**B1**	
	OR <u>Completing Square</u> Allow B1 for $\left(x + \dfrac{3}{2}\right)^{(2)}$ or equivalent		
	and B1 for $\dfrac{7}{12}$ or square roots, such as $\pm 0.763\ldots$		
	$(x =)$ $-(0).74$	**B1**	
	(Final answer) -2.26 nww	**B1**	**4**
	After B0 + B0, allow B1 for both $-0.736\ldots$ and $-2.263\ldots$ seen		
	OR for both -0.74 and -2.26 seen somewhere.		
			12
6 (a)(i)	$(EC =)\ 5$ cm	**B1**	**1**
(ii)	$\sin C\hat{A}D = \dfrac{5\ \text{or their }(\mathbf{a})(\mathbf{i})}{13\ \text{or }[8 + \text{their }(\mathbf{a})(\mathbf{i})]}$ $(= 0.3846\ldots)$	**M1**	
	$(C\hat{A}D =)\ 22.55(^\circ)$ to $22.65(^\circ)$	**A1**	**2**
(b)(i)	$(Q\hat{P}R =)\ 70(^\circ)$	**B1**	**1**
(ii)	$(Q\hat{Z}X =)\ \dfrac{1}{2}(180 - 52)$ **OR** $Q\hat{Z}X = Q\hat{X}Z$ stated	**M1**	
	$(Q\hat{Z}X =)\ 64(^\circ)$	**A1**	**2**
(iii)	$(Z\hat{X}Y =)\ 55^\circ$	**B2**	
	After B0, allow B1 for $R\hat{X}Y = 61^\circ$ or $Z\hat{O}Y = 110^\circ$		**2**
			8

7	Incorrect work in any one part may be used to earn M marks in any other part of the question.		
	Throughout, accept equivalent complete methods and decimal angles without degree sign, but degree sign essential if answer is given in degrees and minutes.		
(a)	$51^2 + 72^2 \pm 2 \times 51 \times 72 \cos 81$ o.e. soi	**M1**	
	Correct formula, simplification and square root intended soi by subsequent values dep	**M1**	
	$(AB =)$ 81.4(0) to 81.5(0) (m)	**A2**	**4**
	After A0, allow A1 for 6636… or 8933… or 94.5… seen		
	(dep on first M1)		
(b)	(Area of ABC =) $\frac{1}{2} 72 \times 51 \sin 81$	**M1**	
	1810 to 1820 (m^2)	**A1**	**2**
(c)	$\dfrac{\text{Their (\textbf{b})}}{\frac{1}{2}\text{their (\textbf{a})}}$ or better	**M1**	
	44.45 to 44.55 (m)	**A1**	**2**
(d)	$(CT =)$ 72 tan15	**M1**	
	19.25 to 19.35 (m)	**A1**	**2**
(e)	$\tan\alpha = \dfrac{\text{Their (\textbf{d})}}{\text{their (\textbf{c})}}$ $(= 0.433\ldots)$	**M1**	
	(Angle =) 23.4(0)(°) to 23.5(0) (°)	**A1**	**2**
			12
8 (a)	States or implies points of contact and centres collinear	**B1**	
	[e.g. (Diameter =) $2x + 2y$ or $2(x + y)$ seen]		
	Justifies radius = $x + y$ A.G.	**B1**	**2**
	Accept correct expressions without explanation.		
(b)(i)	$\pi (x + y)^2 - \pi (2x)^2$ seen isw or better	**B1**	
(ii)	$\pi (2y)^2 - \pi (x + y)^2$ seen isw or better	**B1**	**2**
	OR $\pi (2y)^2 - $ their **(i)** $- \pi (2x)^2$		
(c)	Their **(b)(ii)** = $2 \times$ their **(b)(i)** o.e. (possibly without π)	**M1**	
	$(\pi) [4y^2 - x^2 - 2xy - y^2] = 2 (\pi) [x^2 + 2xy + y^2 - 4x^2]$ or better	**A1**	
	OR $(\pi) (y - x) (3y + x) = 2 (\pi) (y - x)(y + 3x)$		
	Correctly deduces $y^2 - 6xy + 5x^2 = 0$ www A.G.	**A1**	**3**
(d)(i)	$(y - x)(y + 5x)$ o.e. seen	**B1**	
(ii)	$y - x$ seen (but may be cancelled)	**B1**	
	$y - 5x$ seen	**B1**	**3**
	Extra answers –1 each		
(e)	(Fraction =) $\dfrac{(\pi)\{(6x)^2 - (2x)^2\}}{\pi\{(10x)^2\}}$ or $\dfrac{\text{their (\textbf{b})(i)}}{\pi(2y)^2}$ with $y = 5x$	**M1**	
	$\dfrac{8k}{25k}$ isw unless condensed, 0.32 or 32%	**A1**	**2**
			12

9 (a)	$25^2 - 24^2 = 1 \times 49 = 7^2$ o.e. (so 7, 24, 25 is Pythagoras Triple) Expect to see some justification A.G.	**B1**	**1**
(b)(i)	9 soi www	**B1**	
(ii)	60, 61 soi www	**B1**	**2**
(c)(i)	$2n + 1$ or $n + n + 1$	**B1**	**1**
(ii)	Equates their **(i)** = 101^2 or better Obtains 5100, 5101 soi www	**M1** **A1**	**2**
(d)(i)	$(12)......(37 - 35)(37 + 35) = 2 \times 72 = 144 = 12^2$ (Expect to see some justification) 63, 65 soi www 2×128 soi or better indep	**B1** **B1** **B1**	**1** **2**
(ii)	$\{(4n^2 + 1) + (4n^2 - 1)\}\{(4n^2 + 1) - (4n^2 - 1)\}$ or better **OR** $16n^4 + 8n^2 + 1 - (16n^4 - 8n^2 + 1)$ or better $(4n)^2$ **OR** 4^2n^2 Condone $4n$ if seen after $16n^2$, but www	 **B1** **B1**	 **2**
(iii)	39 999, 40 001 soi www	**B1**	**1**
			12
	Throughout, allow correct answers implied www Terms in correct order in equations (e.g. <u>not</u> $24^2 - 25^2 = 7^2$)		
10 (a)(i)	$100\pi = \pi r^2 h$ seen, leading to $h = \dfrac{100}{r^2}$ A.G.	**B1**	**1**
(ii)	$\pi y = 2\pi rh + 2\pi r^2$ soi Convincingly leading to $y = 2r^2 + \dfrac{200}{r}$ A.G.	**B1**	**1**
(b)(i)	$(p =)$ 105 $(105.3...$ or $105\frac{1}{3}$ acceptable$)$	**B1**	**1**
(ii)	All 7 points plotted √ (P1 for at least 5 plotted √) Smooth curve, not grossly thick, through all plotted points, of which at least 5 correct √	**P2** **C1**	**3**
(c)	2.2(0) to 2.27 5.65 to 5.75	**Y2**	**2**
(d)	Drawing a tangent at $r = 2$ and estimating $\dfrac{\text{change in } y}{\text{change in } r}$, ignoring sign (Check working is valid) –35 to –48 (Ignore support from Calculus)	**M1** **A1**	 **2**
(e)(i)	3.6 to 3.8	**R1**	
(ii)	Value of A in the range $80\pi \le A < 82\pi$ or $251 \le A \le 257$ seen <u>Note</u> Not $A = 82\pi$ or $80 \le A < 82$ Ignore any unit stated	**L1**	**2**
			12

11 (a)	(0) (4) 30 80 136 (140)	**B1**	
	(0) 10 30 60 15 140	**B1**	2
(b)	Ignore plots at $x = 0$ [Accept two separate graphs] All 10 other points plotted $\sqrt{}$ (P1 for at least 6 plotted $\sqrt{}$) [Some points may represent 2 plots] 2 smooth curves, with at least one label, not grossly thick, through all appropriate plots of which at least 6 correct Curves must be ogive shape (no negative gradients)	**P2** **C1**	 3
(c)(i)	64 to 68	**V1**	
(ii)	Their **(i)** – (42 to 44) evaluated $\sqrt{}$	**Q1**	
(iii)	English 56 to 58 <u>and</u> Maths 63 to 65	**N1**	3
(d)	Maths easier $\sqrt{}$, with sensible reason (e.g. greater median, or U.Q. L.Q. etc.) (Follow through from their curves if labelled) (There must be two curves)	**R1**	1
(e)(i)	$\frac{12}{49}$ cao	**B1**	1
(ii)	$\frac{4}{140} \times \frac{115}{140} + \frac{25}{140} \times \frac{136}{140}$	**M1**	
	$\frac{193k}{980k}$ isw (e.g. $\frac{3860}{19600}$) **OR** 0.1965 to 0.1975 **OR** 19.65 to 19.75%	**A2**	2
	After M0 allow SCB1 for $\frac{3860}{140 \times 139} = \frac{3860}{19460} = \frac{193k}{973k}$ or 0.1980 to 0.1990 isw		
			12