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**Cambridge Assessment International Education**
Cambridge International General Certificate of Secondary Education

**ADDITIONAL MATHEMATICS** **0606/11**

Paper 1 **October/November 2018**

MARK SCHEME

Maximum Mark: 80

**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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## Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

GENERIC MARKING PRINCIPLE 5:

Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).

GENERIC MARKING PRINCIPLE 6:

Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

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## MARK SCHEME NOTES

The following notes are intended to aid interpretation of mark schemes in general, but individual mark schemes may include marks awarded for specific reasons outside the scope of these notes.

### Types of mark

M Method marks, awarded for a valid method applied to the problem.

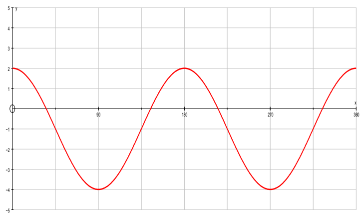
A Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. For accuracy marks to be given, the associated Method mark must be earned or implied.

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 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 M or B mark is dependent on an earlier mark in the scheme.

### Abbreviations

| | |
|---|---|
| awrt | answers which round to |
| cao | correct answer only |
| dep | dependent |
| FT | follow through after error |
| isw | ignore subsequent working |
| nfww | not from wrong working |
| oe | or equivalent |
| rot | rounded or truncated |
| SC | Special Case |
| soi | seen or implied |

| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 1(a) |  | B3 | **B1** for 2 cycles, one max and 2 min points in the correct places and up to a max at each end<br>**B1** for going between 2 and –4<br>**B1** for starting at $(0, 2)$ and finishing at $(360, 2)$ |
| 1(b)(i) | 4 | B1 | |
| 1(b)(ii) | $60^{\circ}$ or $\frac{\pi}{3}$ | B1 | |
| 2(i) | $\left(p\left(-\frac{1}{2}\right)=\right)$ $-\frac{1}{4}+\frac{5}{4}-2+a=2$<br>$\left(q(-2)=\right)$ $16-6a+b=0$ | M1 | For either $p\left(-\frac{1}{2}\right)=2$ or $q(-2)=0$ |
| | $a=3$ | A1 | |
| | $b=2$ | A1 | |
| 2(ii) | $r(x)=2x^3+x^2-5x+1$ | M1 | For $r(x)$ using *their* $p(x)$ and $q(x)$ |
| | $r\left(\frac{2}{3}\right)=\frac{16}{27}+\frac{4}{9}-\frac{10}{3}+1$ | M1 | For $r\left(\frac{2}{3}\right)$ |
| | $=-\frac{35}{27}$ | A1 | Must be exact |

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| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 3 | $(3+kx)^6 =$<br>$729+1458kx+1215k^2x^2$ | **B2** | **B1** for $1458kx$ or $1215k^2x^2$ |
| | Terms in $x^2$ for $(2-x)(3+kx)^6$<br>$= -1458k+2430k^2$<br>$2430k^2-1458k=972$ | **M1** | For attempt at further expansion to obtain 2 terms in $x^2$ and equating to 972 |
| | $5k^2-3k-2=0$<br>$(5k+2)(k-1)=0$ | **M1** | **Dep** for solution of resulting 3 term quadratic |
| | $k=-\frac{2}{5}$ | **A1** | |
| | $k=1$ | **A1** | |
| 4(i) | $\left(x-\frac{9}{2}\right)^2-\frac{49}{4}$ | **B2** | **B1** for $\frac{9}{2}$ or $\frac{49}{4}$ |
| 4(ii) | $\left(\frac{9}{2}, -\frac{49}{4}\right)$ | **B1** | **FT** *their p* and *q* |
| 4(iii) |  | **B3** | **B1** for shape<br>**B1** for cusps at $(1, 0)$ and $(8, 0)$<br>**B1** for all correct, passing through $(0, 8)$ with maximum in correct position |
| 4(iv) | $\frac{49}{4}$ | **B1** | **FT** *their q* |
| 5(i) | $\frac{1}{2}r^2\theta=48$ | **B1** | |
| | $\theta=\frac{96}{r^2}$ | **B1** | **Dep**<br>Must have previous B1 |
| 5(ii) | $r\theta=12$ | **B1** | For statement of arc length |
| | $r\times\frac{96}{r^2}=12$ | **M1** | For attempt to use part **(i)** to find either $r$ or $\theta$ |
| | $r=8$ and $\theta=1.5$ | **A1** | For both |

| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 5(iii) | Area $= 48-\left(\frac{1}{2}r^2\sin\theta\right)$ | M1 | For a complete method including a correct attempt for the area of the triangle using their $r$ and $\theta$ |
| | $=16.1$ | A1 | |
| 6(i) | For $\frac{4x}{2x^2+3}$ | B1 | |
| | | M1 | For attempt to differentiate a quotient or appropriate product |
| | $\frac{dy}{dx}=$ $\frac{(5x+2)\frac{4x}{2x^2+3}-5\ln(2x^2+3)}{(5x+2)^2}$ | A1 | All other terms correct |
| | When $x=0$ $\frac{dy}{dx}=\frac{-5\ln 3}{4}$ | A1 | For **given answer** |
| 6(ii) | $y=\frac{1}{2}\ln 3$ or 0.549 | B1 | May be implied by tangent equation, allow 0.55 |
| | Equation of tangent $y=\left(-\frac{5}{4}\ln 3\right)x+\frac{1}{2}\ln 3$ or $y=-1.37x+0.549$ | B1 | |
| 7(a) | $\lg 100=2$ | B1 | |
| | $3\lg x=\lg x^3$ | B1 | |
| | $\lg\frac{100x^3}{y}$ | B1 | |
| 7(b)(i) | $6x^2+7x-3=0$ $(2x+3)(3x-1)=0$ | M1 | For obtaining in suitable quadratic form and attempt to solve |
| | $x=-\frac{3}{2}$ $x=\frac{1}{3}$ | A1 | For both |

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| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 7(b)(ii) | $x = \log_a 3$<br>$\frac{1}{3} = \log_a 3$ | M1 | For realising connection with part **(i)** and attempt to solve $\frac{1}{3} = \log_a 3$ or $-\frac{3}{2} = \log_a 3$ |
| | $a = 27$ | A1 | |
| | $-\frac{3}{2} = \log_a 3$ | M1 | For realising connection with part **(i)** and attempt to solve $-\frac{3}{2} = \log_a 3$ or $\frac{1}{3} = \log_a 3$ |
| | $a = \left(\frac{1}{3}\right)^{\frac{2}{3}}$ or 0.481or $\left(\frac{1}{9}\right)^{\frac{1}{3}}$ oe | A1 | |
| 8(i) | | M1 | For attempt to use chain rule to obtain $kx\left(5x^2+4\right)^{\frac{1}{2}}$ where $k$ is a constant |
| | $\frac{3}{2}(10x)\left(5x^2+4\right)^{\frac{1}{2}}$ | A1 | Allow unsimplified |
| 8(ii) | | M1 | For attempt to use part **(i)** if in correct form of $m\left(5x^2+4\right)^{\frac{3}{2}}$ |
| | $\frac{1}{15}\left(5x^2+4\right)^{\frac{3}{2}}$ $(+c)$ | A1 | **FT** on *their* $\frac{1}{k}\left(5x^2+4\right)^{\frac{3}{2}}$ |
| 8(iii) | | M1 | For use of limits if *their* **(ii)**<br>Must be in the form $m\left(5x^2+4\right)^{\frac{3}{2}}$ |
| | $\frac{1}{15}\left(\left(5a^2+4\right)^{\frac{3}{2}} - 4^{\frac{3}{2}}\right)$ $\left[=\frac{19}{15}\right]$ | A1 | |
| | $\left(5a^2+4\right)^{\frac{3}{2}} = 27$ | M1 | **Dep**<br>For complete and correct method to deal with the power of $\frac{3}{2}$ |
| | leading to $a = 1$ | A1 | |
| 9(i) | 3 | B1 | |

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| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 9(ii) | | M1 | For attempt to differentiate to obtain $a+be^{-t}$ |
| | $\frac{ds}{dt}=4-3e^{-t}$ | A1 | All correct |
| | $2=4-3e^{-t}$ | M1 | **Dep** for correct attempt to solve equation involving exponential where $e^{-t}>0$ |
| | leading to $t=\ln\frac{3}{2}$ or $-\ln\frac{2}{3}$ | A1 | Must be an exact form |
| 9(iii) | When $t=\ln 5$, $\frac{ds}{dt}=\frac{17}{5}$ | M1 | For attempt to find value of $\frac{ds}{dt}$ when $t=\ln 2$ |
| | | M1 | **Dep** for attempt to use method of small changes |
| | $\partial s=\frac{17h}{5}$ | A1 | |
| 10(i) | Velocity of $A$ $\begin{pmatrix}6\\8\end{pmatrix}$ | B1 | For velocity, may be implied by later work |
| | When $t=6$, $\mathbf{r}_A=\begin{pmatrix}2\\-5\end{pmatrix}+6\begin{pmatrix}6\\8\end{pmatrix}$ | M1 | For a complete and correct method |
| | $=\begin{pmatrix}38\\43\end{pmatrix}$ | A1 | For 43 |
| 10(ii) | $\mathbf{r}_B=\begin{pmatrix}16\\37\end{pmatrix}+\begin{pmatrix}4\\2\end{pmatrix}t$ | B1 | |
| 10(iii) | $\begin{pmatrix}16\\37\end{pmatrix}+\begin{pmatrix}4\\2\end{pmatrix}t=\begin{pmatrix}2\\-5\end{pmatrix}+\begin{pmatrix}6\\8\end{pmatrix}t$ | M1 | For equating position vectors at a time $t$ |
| | $16+4t=2+6t$ or<br>$37+2t=-5+8t$ | M1 | **Dep** for equating like vectors at least once |
| | $t=7$ | A1 | Allow from one correct equation |
| | Both equations lead to $t=7$ | B1 | For showing that $t=7$ satisfies both equations thus verifying collision, or equivalent |
| 10(iv) | $\begin{pmatrix}44\\51\end{pmatrix}$ | B1 | |

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| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 11(a)(i) | | B1 | For critical values |
| | $2 \leqslant f \leqslant 4$ | B1 | **Dep**<br>For correct inequality and notation |
| 11(a)(ii) | $x = 3\cos y$<br>$\cos 2y = 0.5$ | M1 | For attempt to find $f^{-1}$ and equate to 0.5 |
| | $2y = \frac{\pi}{3}$ | M1 | **Dep**<br>For correct attempt to solve, dealing with the double angle |
| | $y = \frac{\pi}{6}$ | A1 | |
| 11(b) | $g^2(x) = g(3 - x^2)$<br>$= 3 - (3 - x^2)^2$ | M1 | For correct attempt at $g^2$, allow unsimplified |
| | $-6 + 6x^2 - x^4 = -6$<br>$6x^2 - x^4 = 0$ | M1 | **Dep** for equating to –6 and attempt to solve to obtain a non-zero root |
| | $x = 0$ | B1 | |
| | $x = \pm\sqrt{6}$ | A1 | |