



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

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**ADDITIONAL MATHEMATICS**

**0606/21**

Paper 2

**October/November 2017**

MARK SCHEME

Maximum Mark: 80

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**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.

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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  |
| nfwf | not from wrong working     |
| oe   | or equivalent              |
| rot  | rounded or truncated       |
| SC   | Special Case               |
| soi  | seen or implied            |

| Question | Answer   | Marks     | Guidance  |
|----------|--|-----------|---|
| 1        | $x^2 - 6x - 7 (> 0)$   | <b>B1</b> |   |
|          | $(x - 7)(x + 1) (> 0)$   | <b>M1</b> |   |
|          | Critical values 7 and -1   | <b>A1</b> |   |
|          | $x > 7$ or $x < -1$  | <b>A1</b> |   |
| 2        | $\frac{(1 + \sin\theta) - (1 - \sin\theta)}{(1 - \sin\theta)(1 + \sin\theta)}$ | <b>M1</b> | Dealing with fractions  |
|          | $= \frac{2\sin\theta}{(1 - \sin^2\theta)}$                                     | <b>A1</b> | Simplification  |
|          | $= \frac{2\sin\theta}{\cos^2\theta}$   | <b>M1</b> | Use of identity (seen anywhere)   |
|          | $= 2\tan\theta\sec\theta$  | <b>M1</b> | Use of $\tan\theta = \frac{\sin\theta}{\cos\theta}$ and $\sec\theta = \frac{1}{\cos\theta}$ (seen anywhere) |
| 3        | $2 = \log_5 25$  | <b>B1</b> |   |
|          | $\log_5 25 + \log_5 (x - 7) = \log_5 25(x - 7)$<br>$10x + 5 = 25(x - 7)$       | <b>M1</b> |   |
|          | $180 = 15x$  | <b>M1</b> | Equate, clear brackets and collect terms.   |
|          | $12 = x$   | <b>A1</b> |   |

| Question | Answer  | Marks | Guidance                                     |
|----------|---|-------|--|
| 4        | $x - 2(4 - \sqrt{3}x) = 5\sqrt{3}$  | M1    | Eliminate y                                  |
|          | $x = \frac{5\sqrt{3} + 8}{2\sqrt{3} + 1}$                                   | A1    |  |
|          | $x = \frac{(5\sqrt{3} + 8)(2\sqrt{3} - 1)}{(2\sqrt{3} + 1)(2\sqrt{3} - 1)}$ | M1    | Multiply by $(a\sqrt{b} + c)$ as appropriate |
|          | $x = 2 + \sqrt{3}$  | A1    |  |
|          | $y = 1 - 2\sqrt{3}$   | A1    |  |
|          | <u>Alternative method</u>   |       |  |
|          | $\sqrt{3}(5\sqrt{3} + 2y) + y = 4$  | M1    | Eliminate x                                  |
|          | $y = \frac{-11}{2\sqrt{3} + 1}$   | A1    |  |
|          | $y = \frac{-11(2\sqrt{3} - 1)}{(2\sqrt{3} + 1)(2\sqrt{3} - 1)}$             | M1    | Multiply by $(a\sqrt{b} + c)$ as appropriate |
|          | $y = 1 - 2\sqrt{3}$   | A1    |  |
| 5(i)     | $\frac{d}{dx}\left(\frac{5}{3x+2}\right) = -5(3x+2)^{-2} \times 3$          | M1    | $-5(3x+2)^{-2}$                              |
|          |   | A1    | $\times 3$                                   |
| 5(ii)    | $\int \frac{30}{(3x+2)^2} dx = \left[ \frac{-10}{(3x+2)} \right]$           | M1    | $\frac{1}{(3x+2)}$                           |
|          |   | A1    | $\times -10$                                 |
| 5(iii)   | $\left[ \frac{-10}{(3x+2)} \right]_1^2 = -\frac{10}{8} + \frac{10}{5}$      | M1    | Insert limits and subtract                   |
|          | $= \frac{3}{4}$   | A1    |  |
| 6(i)     | $2q + 3p = 13$  | B1    |  |

| Question | Answer  | Marks     | Guidance   |
|----------|---|-----------|--|
| 6(ii)    | Multiply matrices correctly   | <b>M1</b> |  |
|          | $2p + pq = 12$  | <b>A1</b> |  |
| 6(iii)   | $4p + p(13 - 3p) = 24$  | <b>M1</b> | Eliminate $q$  |
|          | $3p^2 - 17p + 24 = 0$   | <b>A1</b> |  |
|          | $(3p - 8)(p - 3) = 0$   | <b>M1</b> | Solve  |
|          | $p = 3, q = 2$  | <b>A1</b> |  |
| 7        | $\frac{dy}{dx} = 3x^2 - \frac{1}{x^2} (+C)$                         | <b>B2</b> | <b>B1</b> for $3x^2$<br><b>B1</b> for $-\frac{1}{x^2}$ . |
|          | $x = 1, \frac{dy}{dx} = 1 \rightarrow C = -1$                       | <b>B1</b> |  |
|          | $y = x^3 + \frac{1}{x} - x + D$<br>$x = 1, y = 3 \rightarrow D = 2$ | <b>B2</b> | <b>B1</b> for two correct terms in $x$                   |
|          | $y = x^3 + \frac{1}{x} - x + 2$                                     | <b>B1</b> |  |
| 8        | $z^2 = a^2 + 3(a + 3)^2 + 2a(a + 3)\sqrt{3}$<br>$= 79 + b\sqrt{3}$  | <b>M1</b> |  |
|          | $a^2 + 3(a + 3)^2 = 79$ and $2a(a + 3) = b$                         | <b>A1</b> | <b>FT</b><br>Equate correctly to obtain both eqns        |
|          | $a^2 + 3a^2 + 18a + 27 = 79$<br>$4a^2 + 18a - 52 = 0$               | <b>M1</b> | Expand and simplify to obtain 3 term quadratic           |
|          | $(a - 2)(4a + 26) = 0$  | <b>M1</b> |  |
|          | $a = 2, b = 20$   | <b>A2</b> | <b>A1</b> for each                                       |
| 9(i)     | $1 + 4x + 6x^2 + 4x^3 + x^4$  | <b>B1</b> |  |
| 9(ii)    | $1296 - 864x + 216x^2 - 24x^3 + x^4$                                | <b>B2</b> | Minus 1 each error.                                      |
| 9(iii)   | $1295 - 868x + 210x^2 - 28x^3 = 175$                                | <b>M1</b> | Subtract and equate to 1                                 |
|          | $28x^3 - 210x^2 + 868x - 1120 = 0$                                  | <b>A1</b> |  |

| Question | Answer   | Marks       | Guidance   |
|----------|--|-------------|--|
| 9(iv)    | $28(2)^3 - 210(2)^2 + 868(2) - 1120$   | <b>M1</b>   | Inserts $x = 2$  |
|          | $= 224 - 840 + 1736 - 1120 = 0$<br>$(x - 2)$ is a factor                                     | <b>A1</b>   |  |
|          | $(x - 2)(28x^2 - 154x + 560)$  | <b>M1A1</b> | <b>M1</b> for 28 and 560 seen oe<br><b>A1</b> for -154     |
|          | $b^2 - 4ac < 0$ shown  | <b>B1</b>   |  |
| 10(i)    | $\mathbf{r}_A = (2\mathbf{i} + 4\mathbf{j}) + t(\mathbf{i} + \mathbf{j})$                    | <b>B1</b>   |  |
| 10(ii)   | $\mathbf{r}_B = (10\mathbf{i} + 14\mathbf{j}) + t(-2\mathbf{i} - 3\mathbf{j})$               | <b>B1</b>   |  |
| 10(iii)  | $\mathbf{r}_B - \mathbf{r}_A = (8\mathbf{i} + 10\mathbf{j}) + t(-3\mathbf{i} - 4\mathbf{j})$ | <b>M1</b>   |  |
|          | $X^2 = (8 - 3t)^2 + (10 - 4t)^2$   | <b>M1A1</b> |  |
| 10(iv)   | Differentiate  | <b>M1</b>   |  |
|          | $\frac{dX^2}{dt} = 2(8 - 3t)(-3) + 2(10 - 4t)(-4)$<br>oe                                     | <b>A1</b>   |  |
|          | $\frac{dX^2}{dt} = 0 \rightarrow t = 2.56$<br>$\rightarrow X = 0.4$                          | <b>B2</b>   | <b>B1</b> for value of $t$<br><b>B1</b> for value of $X$ . |
| 11(i)    | $x^2 - 2x + (kx + 3)^2 = 8$  | <b>M1</b>   | Eliminate $y$  |
|          | $(1 + k^2)x^2 + (6k - 2)x + 1 = 0$   | <b>A1</b>   |  |
|          | $b^2 - 4ac = 0 \rightarrow (6k - 2)^2 - 4(1 + k^2) = 0$                                      | <b>M1</b>   |  |
|          | $k = \frac{3}{4}$  | <b>A1</b>   | Answer given   |
| 11(ii)   | $x = \frac{-b}{2a} \rightarrow x = \frac{-2.5}{2 \times 1.5625}$                             | <b>M1</b>   |  |
|          | $= -0.8$   | <b>A1</b>   |  |
|          | $y = 0.75 \times -0.8 + 3 = 2.4$   | <b>A1</b>   | <b>FT</b>  |

| Question | Answer   | Marks     | Guidance  |
|----------|--|-----------|---|
| 11(iii)  | Eqn of $PQ$ $\frac{y-2.4}{x+0.8} = \frac{-4}{3}$                         | <b>M1</b> |   |
|          | $\rightarrow 3y = 4 - 4x$  | <b>A1</b> |   |
| 12(i)    | $\frac{d(\cos x)^{-1}}{dx} = \frac{1}{\cos^2 x} \times \sin x$           | <b>M1</b> | $\frac{1}{\cos^2 x}$                                    |
|          |  | <b>A1</b> | $\times \sin x$   |
| 12(ii)   | $\frac{dy}{dx} = \sec^2 x + \frac{4\sin x}{\cos^2 x}$                    | <b>B1</b> | $\sec^2 x$  |
|          |  | <b>B1</b> | $\frac{4\sin x}{\cos^2 x}$                              |
| 12(iii)  | $\frac{1}{\cos^2 x} + \frac{4}{\cos x} \times \frac{\sin x}{\cos x} = 4$ | <b>M1</b> | Equate <i>their</i> (i) to 4 and multiply by $\cos^2 x$ |
|          | $\rightarrow 1 + 4\sin x = 4\cos^2 x$                                    | <b>M1</b> | Use of identity and simplify                            |
|          | $4\sin^2 x + 4\sin x - 3 = 0$  | <b>A1</b> |   |
|          | $(2\sin x - 1)(2\sin x + 3) = 0$   | <b>M1</b> | Solve   |
|          | $x = \frac{\pi}{6}, \frac{5\pi}{6}$                                      | <b>A2</b> | <b>A1</b> for each                                      |