## 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.

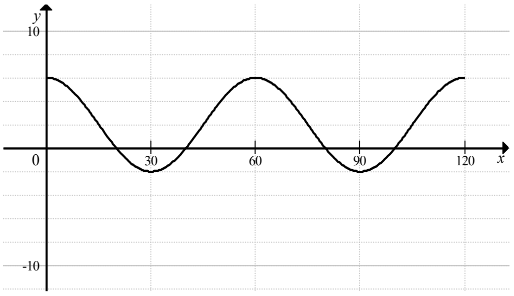
B Mark for a correct result or statement independent of Method marks.

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

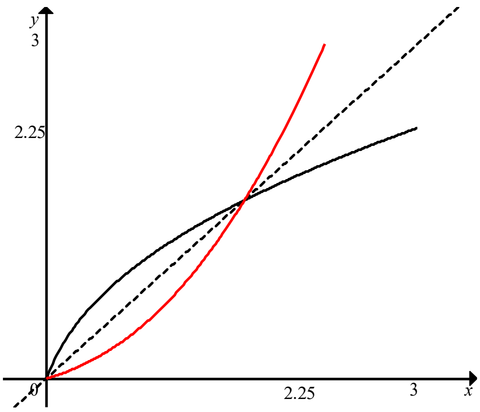
| Question | Answer | Marks | Partial Marks |
|---|---|---|---|
| 1 | $\lg y = 2\sqrt{x} + 3$<br>OR<br>$\lg b = 2$ and $\lg A = 3$ | **B2** | **B1** for $\lg y = \left(\frac{8-5}{2.5-1}\right)\sqrt{x} + c$ soi or<br>$\lg y = m\sqrt{x} + 3$ soi<br>OR<br>$\lg b = \frac{8-5}{2.5-1}$ or $\lg A = 3$ soi |
| | $y = 10^{2\sqrt{x}+3}$ or $\lg \frac{y}{10^3} = 2\sqrt{x}$ OR<br>$b = 100$ and $A = 1000$ | **M1** | **FT** *their m* and *c* |
| | $y = 10^3 \times 100^{\sqrt{x}}$ oe mark final answer | **A1** | |

| Question | Answer | Marks | Partial Marks |
|---|---|---|---|
| 2(a) | Correct curve  | 3 | **B2** for correct cosine shape over 2 cycles with midline at $y = 2$ and consistent amplitude<br>or **B1** for attempt at cosine shape over 2 cycles **with** consistent amplitude<br><br>**B1** for a consistent amplitude of 2; must have attempted correct shape<br><br>**Maximum of 2 marks if not fully correct** |
| 2(b) | 4 | 1 | |
| 2(c) | 60° | 1 | |
| 3(a) | $a = 2$, $b = 3$, $c = -2$ | 2 | **B1** for any two correct |
| 3(b) | $-3 \leqslant x \leqslant -0.5$ or $x \geqslant 1$ | 3 | **B1** for the critical values –3, –0.5, 1<br><br>**B1** for $-3 \leqslant x \leqslant -0.5$<br><br>**B1** for $x \geqslant 1$ |
| 4(a) | $(2y-1)\log 5 = \log 6 + y\log 3$ oe<br>or<br>$2y\log 5 = \log 30 + y\log 3$ oe<br><br>OR<br>[rearranges $\frac{5^{2y}}{5} = 6\times 3^y$ and collects powers to a single power in $y$]<br>$\left(\frac{5^2}{3}\right)^y = 30$ oe | M1 | |
| | Collects terms and factorises:<br>$y(2\log 5 - \log 3) = \log 6 + \log 5$ oe<br>or<br>$y(2\log 5 - \log 3) = \log 30$ oe<br><br>OR<br>takes logs<br>$y = \log_{\frac{25}{3}} 30$ oe or $y\log\left(\frac{5^2}{3}\right) = \log 30$ oe | M1 | **FT** if of equivalent difficulty |
| | 1.604 | A1 | cao |

| Question | Answer | Marks | Partial Marks |
|---|---|---|---|
| 4(b) | $e^{4x} - 4e^{2x} + 3 = 0$ or $(e^{2x})^2 - 4e^{2x} + 3 = 0$ oe | **M1** | condone one error |
| | Factorises: $(e^{2x} - 1)(e^{2x} - 3)$ oe or solves $e^{4x} - 4e^{2x} + 3 = 0$ oe | **M1** | **FT** $a(e^{2x})^2 + be^{2x} + c[= 0]$ |
| | $e^{2x} = 1, \quad e^{2x} = 3$ | **A1** | |
| | $x = 0$, $x = \frac{1}{2}\ln 3$ or exact equivalent | **A1** | |
| 5 | $\frac{dV}{dr} = 4\pi r^2$ **oe and** $\left.\frac{dV}{dr}\right\|_{r=6} = 144\pi$ | **B1** | |
| | $\frac{dr}{dt} = \frac{dV}{dt} \times \frac{dr}{dV}$ **soi** | **B1** | Not if chain rule for $\frac{dt}{dr}$ unless answer is inverted |
| | $\frac{24}{\text{their } 144\pi}$ | **M1** | *their* 144π must come from an attempt at differentiation |
| | 0.0531 or 0.05305[16….] rot to 4 or more sig figs | **A1** | |
| 6(a) | $3\begin{pmatrix} x-8 \\ y-5 \end{pmatrix} = 2\begin{pmatrix} x-4 \\ y-7 \end{pmatrix}$ oe<br><br>OR<br>$\overrightarrow{QR} = \begin{pmatrix} x-8 \\ y-5 \end{pmatrix}$ and $\overrightarrow{PR} = \begin{pmatrix} x-4 \\ y-7 \end{pmatrix}$<br>and<br>$3x - 24 = 2x - 8$<br>and<br>$3y - 15 = 2y - 14$ | **M1** | |
| | $x = 16$ | **A1** | **dep** on vector method |
| | $y = 1$ | **A1** | **dep** on vector method |

| Question | Answer | Marks | Partial Marks |
|---|---|---|---|
| 6(b)(i) | $\mathbf{a} = -2.5\mathbf{i} - \frac{5\sqrt{3}}{2}\mathbf{j}$ isw | **B1** | |
| | $\mathbf{c} = -5\mathbf{i} + 5\sqrt{3}\,\mathbf{j}$ isw | **B1** | |
| 6(b)(ii) | $\mathbf{b} = (-5 + 2.5)\mathbf{i} + \left(5\sqrt{3} + 2.5\sqrt{3}\right)\mathbf{j}$ oe soi | **B1** | |
| | $r = \sqrt{(-2.5)^2 + \left(7.5\sqrt{3}\right)^2}$ | **M1** | **FT** *their* **b** of the form $x\mathbf{i} + y\mathbf{j}$ providing neither component is zero |
| | [$r$ = ] 13.2 or 13.22875… rot to 4 or more sf | **A1** | **dep** on **B1** |
| | $\tan\alpha = \left(\frac{7.5\sqrt{3}}{2.5}\right)$ oe or awrt 79.1 or $\tan\beta = \left(\frac{2.5}{7.5\sqrt{3}}\right)$ oe or awrt 10.9 | **M1** | **FT** *their* **b** of the form $x\mathbf{i} + y\mathbf{j}$ |
| | 349[.106…] rot to 3 or more sf | **A1** | **dep** on **B1** |
| | **Alternative method** | | |
| | $[r^2 =] 10^2 + 5^2 - 2 \times 10 \times 5 \times \cos 120°$ | **(M1)** | |
| | [$r$ = ] 13.2 or 13.22875… rot to 4 or more sf | **(A1)** | |
| | $\frac{\sin\theta}{10} = \frac{\sin their 120}{their 5\sqrt{7}}$ or $\frac{\sin\phi}{5} = \frac{\sin their 120}{their 5\sqrt{7}}$ | **(M1)** | **FT** consistent use of *their* 120 and *their* $r$ |
| | $[\theta =]$ awrt 40.9 or $[\phi =]$ awrt 19.1 | **(A1)** | |
| | 349[.106…] rot to 3 or more sf | **(A1)** | |

| Question | Answer | Marks | Partial Marks |
|---|---|---|---|
| 7(a) | $\left[\frac{6x^2}{2}-\frac{x^3}{3}\right]_0^5$ | B1 | |
| | Area under line: $0.5\times5\times5$ oe | B1 | |
| | Fully actioned correct plan: $3(25)-\frac{5^3}{3}-\left(3(0)-\frac{0^3}{3}\right)-0.5\times5\times5$ oe | M1 | |
| | $\frac{125}{6}$ oe isw | A1 | **dep** on all previous marks |
| | **Alternative method** | | |
| | $\int_0^5(5x-x^2)\mathrm{d}x$ | (B1) | |
| | $\left[\frac{5x^2}{2}-\frac{x^3}{3}\right]_0^5$ | (B1) | |
| | Correct use of correct limits $2.5(25)-\frac{5^3}{3}-\left(2.5(0)-\frac{0^3}{3}\right)$ | (M1) | |
| | $\frac{125}{6}$ oe isw | (A1) | **dep** on all previous marks |
| 7(b)(i) | $\frac{(2x-6)^{-2}}{-2\times2}+\sin x$ $(+c)$ oe, isw | 3 | **B1** for $\sin x$<br>**B2** for $\frac{(2x-6)^{-2}}{-2\times2}$<br>or **B1** for $\frac{(2x-6)^{-2}}{-2}$ soi |
| 7(b)(ii) | $\frac{x^7}{2}+x^3+\frac{1}{2x}$ oe | B1 | |
| | $\frac{x^8}{16}+\frac{x^4}{4}+\frac{1}{2}\ln x(+c)$ oe or<br>$\frac{x^8}{16}+\frac{x^4}{4}+\frac{1}{2}\ln 2x(+c)$ oe | B2 | **B1** for any two correct |

| Question | Answer | Marks | Partial Marks |
|---|---|---|---|
| 8(a)(i) | [Domain $f^{-1}$] $0 \leqslant x \leqslant 2.25$ oe | **B2** | **B1** for either end correct or for 0 and 2.25 in an incorrect inequality |
| | [Range $f^{-1}$ ] $0 \leqslant f^{-1} \leqslant 3$ | **B1** | |
| 8(a)(ii) | $x = 1.6$ oe or $x = 0$ | **2** | **B1** for each |
| 8(a)(iii) |  | **2** | **B1** for attempt at correct graph of inverse function drawn over correct domain soi<br><br>**B1** for correct shape with intersection in approximately correct location |
| 8(b)(i) | For a complete method to find the inverse, including changing the subject and swapping the variables | **M1** | |
| | $\left[g^{-1}(x) =\right] \sqrt[3]{\dfrac{x^3 - 3}{8}}$ oe mark final answer | **A1** | |
| 8(b)(ii) | $[\,k =]\ 0$ | **1** | |
| 8(b)(iii) | $\sqrt[3]{8e^{12x} + 3}$ mark final answer | **1** | |

| Question | Answer | Marks | Partial Marks |
|---|---|---|---|
| 9(a) | $\frac{1}{2}\times 24^2\times\theta = 432$ | M1 | |
| | $\theta = \frac{3}{2}$ rads soi | A1 | |
| | 24 × *their* $\theta$ | M1 | |
| | 36 cao | A1 | |
| | **Alternative method** | | |
| | $s = r\theta$ soi and<br>$\frac{1}{2}\times r\times s = 432$ | (B1) | |
| | $\frac{1}{2}\times 24\times s = 432$ | (M1) | |
| | $s = \frac{432\times 2}{24}$ oe | (M1) | |
| | [$s$ =] 36 | (A1) | |
| 9(b)(i) | [$OB$ =] $2y\cos\alpha$ oe | B1 | |
| 9(b)(ii) | $\frac{(their\ 2y\cos\alpha)\times y\sin\alpha}{2}$<br>$-\frac{1}{2}\times(their\ y\cos\alpha)^2\times\alpha$ oe | M2 | **M1** for either area |
| | correct completion to<br>$\frac{y^2}{2}\cos\alpha(2\sin\alpha-\alpha\cos\alpha)$ | A1 | |

| Question | Answer | Marks | Partial Marks |
|---|---|---|---|
| 10 | [Term independent of $x$:]<br>${}^9C_3 \times a^6 \times b^3$ or $84 \times a^6 \times b^3$ | **B1** | |
| | $a^6b^3 = \dfrac{-145152}{84}$ | **M1** | **dep** on **B1** |
| | $\left(a^2b\right)^3 = -1728$ leading to $a^2b = -12$<br>or $a^2b = \sqrt[3]{-1728} = -12$ | **A1** | |
| | ${}^9C_1 \times a^8 \times b$ or $9 \times a^8 \times b$ | **B1** | |
| | Correctly solves correct equations simultaneously<br>$9 \times a^8 \times b = -6912$<br>and<br>$a^2b = -12$<br>as far as $a^6 =\ldots$ or $b^3 =\ldots.$. | **M1** | Must be solving correct equations |
| | $a = 2$, $b = -3$ and no other values nfww | **B2** | **B1** for each nfww<br>**dep** on previous B1B1 |
| 11 | Eliminates one variable<br>$(k-3y)^2 + y^2 + 2y - 9 = 0$ | **M1** | |
| | $10y^2 + (2-6k)y + (k^2 - 9) = 0$ soi | **A1** | |
| | Uses $b^2 - 4ac * 0$ with *their* 3-term quadratic:<br>$(2-6k)^2 - 4(10)(k^2 - 9) \quad [*0]$ | **M1** | * can be = or any inequality sign |
| | $-4k^2 - 24k + 364 \quad [*0]$ | **A1** | |
| | Factorises $-4k^2 - 24k + 364$ or solves *their* $-4k^2 - 24k + 364 = 0$ | **M1** | |
| | $k = 7$ only | **A1** | |
| | Uses *their* $k$ in<br>$10y^2 + (2-6k)y + (k^2 - 9) = 0$ oe | **M1** | |
| | $y = 2$ only | **A1** | |
| | $x = 1$ only | **A1** | |