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.

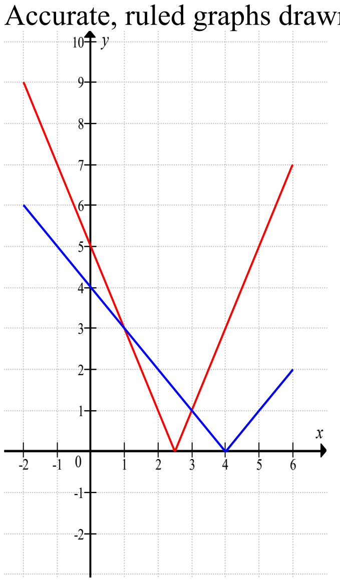
B Mark for a correct result or statement independent of Method marks.

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	$y-5=-2(x-3)$ oe	**3**	**M1** for midpoint $\left(\frac{5+1}{2},\frac{6+4}{2}\right)$ or $(3, 5)$ **M1** for $m_{\perp}=\frac{-1}{\frac{1}{2}}$ oe or -2
	$\frac{121}{4}$ or 30.25 oe cao	**2**	**B1 FT** for *x*-intercept (5.5, 0) and *y*-intercept (0, 11) soi; **FT** *their* perpendicular bisector providing **M1 M1** awarded

Question	Answer	Marks	Partial Marks
2	Uses $b^2 - 4ac$ correctly: $(2k-1)^2 - 4(k)(k+1)$ [*0 where * is any inequality sign or =]	**M1**	
	Simplifies to $-8k + 1$[*0]	**A1**	
	Critical Value: $k = \frac{1}{8}$ soi	**M1**	**FT** *their* $ak + b$ where a and b are constants
	$k > \frac{1}{8}$ mark final answer	**A1**	
3(a)	Accurate, ruled graphs drawn 	4	**M1** for $y = \lvert 4 - x \rvert$: $\vee$ shape with vertex at (4, 0) **A1** Correct graph with y-intercept at (0, 4) **M1** for $y = \lvert 2x - 5 \rvert$: $\vee$ shape with vertex at (2.5, 0) **A1** Correct graph with y-intercept at (0, 5)
3(b)	$x \le 1, x \ge 3$ final answer	2	**FT** *their* **(a)** providing at least **M1** awarded and a pair of V-shaped graphs attempted **B1** for exactly two correct critical values or **B1 FT** for exactly two correct FT critical values soi, **FT** *their* **(a)** providing at least **M1** awarded and a pair of V-shaped graphs attempted
4(a)	$\frac{105}{8}$ isw or 13.125 oe	2	**B1** for ${}^{10}C_4 (x^2)^6 \left(-\frac{1}{2x^3}\right)^4$ oe

Question	Answer	Marks	Partial Marks
4(b)(i)	$1+4(2\sqrt{2})+6(2\sqrt{2})^2+4(2\sqrt{2})^3+(2\sqrt{2})^4$ soi or $1+4(-2\sqrt{2})+6(-2\sqrt{2})^2+4(-2\sqrt{2})^3+(-2\sqrt{2})^4$ soi	**M1**	
	$1+8\sqrt{2}+48+64\sqrt{2}+64$ or $1-8\sqrt{2}+48-64\sqrt{2}+64$	**A1**	
	Correct difference stated or clearly implied $1+8\sqrt{2}+48+64\sqrt{2}+64-$ $(1-8\sqrt{2}+48-64\sqrt{2}+64)$	**M1**	**dep** on sight of correct expansions with numerical coefficients
	$144\sqrt{2}$ nfww	**A1**	
4(b)(ii)	$\frac{(\textit{their } k)\sqrt{2}}{1+\sqrt{2}}\times\frac{1-\sqrt{2}}{1-\sqrt{2}}=$ $\frac{(\textit{their } k)\sqrt{2}-2\textit{their } k}{-1}$ oe simplified to $2(\textit{their } k)-(\textit{their } k)\sqrt{2}$ mark final answer	**2**	**STRICT FT** of *their* integer value of *k* **B1 STRICT FT** of *their* integer value of *k* for $\frac{\textit{their } k\sqrt{2}}{1+\sqrt{2}}\times\frac{1-\sqrt{2}}{1-\sqrt{2}}$
5(a)(i)	$\sec^2 x+2\tan^2 x$ oe and correct completion to $3\tan^2 x+1$ nfww	**2**	**M1** for use of a relationship to form a convincing correct statement from which the answer can be easily determined e.g. $\sec^2 x+\frac{2\sin^2 x}{\cos^2 x}$ or $\frac{1}{\cos^2 x}+2\tan^2 x$
5(a)(ii)	$\tan x=[\pm]1$ soi	**M1**	**FT** $\tan x=[\pm]\sqrt{\frac{4-\textit{their}1}{\textit{their}3}}$ providing $\frac{4-\textit{their}1}{\textit{their}3}>0$
	$[x=]\ \frac{\pi}{4},-\frac{\pi}{4}$ or ±0.785[39…] nfww and no other solutions	**A2**	**A1** for each, ignoring extra solutions

Question	Answer	Marks	Partial Marks
5(a)(iii)	$f'(x) = 6\tan x \sec^2 x$ oe	**M2**	**FT** $2(\textit{their}3)\tan x \sec^2 x$ **M1** for $f'(x) = k\tan x \sec^2 x$ where $k \neq 2\textit{their}\ 3$
	$\left[f'\left(\frac{\pi}{4}\right)=\right]$ 12; $\left[f'\left(-\frac{\pi}{4}\right)=\right]$ – 12 nfww	**A2**	**A1** for each nfww
5(b)	Correct use of $\sin^2\theta + \cos^2\theta = 1$ to form a 3-term quadratic in $\sin\theta$ in solvable form $50\sin^2\theta + 5\sin\theta - 3\,[=0]$ oe	**M1**	Condone one sign or arithmetic error in rearrangement
	Solves or factorises *their* 3-term quadratic in $\sin\theta$ e.g. $(10\sin\theta + 3)(5\sin\theta - 1)$ [= 0]	**M1**	**FT** *their* 3-term quadratic in $\sin\theta$
	$\sin\theta = -0.3$ $\sin\theta = 0.2$ soi	**A1**	
	11.5 or 11.53[69...] 168.5 or 168.46[30...] 197.5 or 197.45[76...] 342.5 or 342.54[23...]	**A2**	with no extras in range **A1** for any two correct angles, ignoring extras
6(a)	$(2x + 1)(x - 3)(x + 1)$ nfww	**M1**	
	Correct method leading to $x = -\frac{1}{2}$, $x = 3$, $x = -1$	**A1**	
6(b)(i)	$[p'(x) =]\ 3x^2 + 2ax + b\,[= 0]$	**B1**	
	$3\left(\frac{4}{3}\right)^2 + 2a\left(\frac{4}{3}\right) + b = 0$	**B1**	OR forms the product $(3x - 4)(x - 2) = 0$
	$3(2)^2 + 2a(2) + b = 0$	**B1**	OR multiplies out to find $3x^2 - 10x + 8 = 0$
	Solves to find the value of one unknown	**M1**	**FT** *their* linear equations in *a* and *b* oe OR compares coefficients to state a value of *a* or *b*
	$a = -5$, $b = 8$	**A1**	
	[p(1)=] $1 + a + b + c = -5$ oe, soi	**M1**	
	$[1 - 5 + 8 + c = -5]$ $c = -9$	**A1**	

Question	Answer	Marks	Partial Marks
6(b)(ii)	$[p''(x) =]\ 6x + 2(\textit{their } a)$ soi	**M1**	**FT** *their a*
	6(2) – 10 = 2 > 0 [therefore minimum]	**A1**	
7(a)	$\frac{1}{2} \times 9^2 \times \theta - \frac{1}{2} \times 5^2 \times \theta = 4\pi$ oe, soi	**M2**	**M1** for $\frac{1}{2} \times 9^2 \times \theta$ or $\frac{1}{2} \times 5^2 \times \theta$ oe, soi
	$\theta = \frac{\pi}{7}$ oe or 0.449 or 0.4487 to 0.4488	**A1**	
7(b)	[Arc AD =] $\frac{5\pi}{7}$	**2**	**M1** for [Arc AD =] $5 \times \textit{their} \frac{\pi}{7}$ **FT** any stated value of θ from **(a)**
	[AC =] 4.991[27...] rot to 4 or more sf	**2**	**M1** for [AC^2 =] $9^2 + 5^2 - 2(9)(5)\cos\left(\textit{their} \frac{\pi}{7}\right)$ **FT** *their* θ providing $0 < \theta < \frac{\pi}{2}$
	11.2 or 11.23[526...] rot to 4 or more sf	**A1**	
8	$\int \cos\left(4x - \frac{\pi}{4}\right) dx = \frac{1}{4}\sin\left(4x - \frac{\pi}{4}\right)(+c)$	**B2**	**B1** for $k\sin\left(4x - \frac{\pi}{4}\right)$ where $k > 0$ or $k = -\frac{1}{4}$
	$\frac{3}{4} = \frac{1}{4}\sin\left(4\left(\frac{3\pi}{16}\right) - \frac{\pi}{4}\right) + c$	**M1**	**FT** *their k* providing **B1** awarded
	$-\frac{1}{16}\cos\left(4x - \frac{\pi}{4}\right) + \frac{1}{2}x \quad (+A)$	**2**	**M1 FT** for $m\cos\left(4x - \frac{\pi}{4}\right) + \left(\textit{their} \frac{1}{2}\right)x \quad (+A)$ **FT** $\textit{their } k\sin\left(4x - \frac{\pi}{4}\right) + \textit{their } c$ providing at least **B1 M1** awarded
	$y = -\frac{1}{16}\cos\left(4x - \frac{\pi}{4}\right) + \frac{1}{2}x + \frac{5\pi}{32}$ oe, cao	**2**	**M1 FT** for $\frac{\pi}{4} = -\frac{1}{16}\cos\left(\frac{3\pi}{4} - \frac{\pi}{4}\right) + \frac{1}{2}\left(\frac{3\pi}{16}\right) + A$ **FT** $(\textit{their } m)\cos\left(4x - \frac{\pi}{4}\right) + \left(\textit{their} \frac{1}{2}\right)x + A$ providing previous **M1** awarded

Question	Answer	Marks	Partial Marks
9	$\frac{dy}{dx} = -(3x-1)^{-2} \times 3$	**M2**	**M1** for $\frac{dy}{dx} = -k(3x-1)^{-2}$ where $k > 0$
	[When $x = 1$] $\frac{dy}{dx} = -\frac{3}{4}$ and $y = \frac{9}{2}$	**A1**	**FT** *their* $\frac{dy}{dx}$ providing **M1** has been awarded
	Equation of tangent: $y - \frac{9}{2} = -\frac{3}{4}(x-1)$ oe isw	**M1**	**FT** the value of *their* $\frac{dy}{dx}$ at $x = 1$ and *their* y
	$B(7, 0)$ oe	**A1**	
	Area of triangle: $\frac{1}{2} \times \frac{9}{2} \times ((\textit{their}\,7) - 1)$ or $\frac{27}{2}$ nfww or $-\frac{3}{8}(49) + \frac{21}{4}(7) - \left(-\frac{3}{8} + \frac{21}{4}\right)$	**M1**	**FT** *their* 7 and *their* $-0.75x + 5.25$ of the form $mx + c$ if needed
	[Area under curve = F(x) =] $\left[4x + \frac{1}{3}\ln(3x-1)\right]_1^9$ oe	**B2**	**B1** for $\int \frac{1}{3x-1}\,dx = k\ln(3x-1)$ or $\frac{1}{3}\ln 3x - 1$
	Correct and actioned plan e.g. F(9) – F(1) – *their* $\frac{27}{2}$	**M1**	**dep** on at least previous **B1** and correct plan or correct **FT** area of triangle oe
	$18\frac{1}{2} + \frac{1}{3}\ln 13$ or 19.4 or 19.35[49...]	**A1**	
10	$\overrightarrow{OP} = \lambda(\mathbf{a} + \mathbf{c})$ oe	**B1**	
	$\overrightarrow{OP} = \mathbf{a} + \mu\left(-\mathbf{a} + \frac{2}{5}\mathbf{c}\right)$ oe	**B2**	**B1** for $\overrightarrow{OP} = \mathbf{a} + \mu\left(-\mathbf{a} + \left(\textit{their}\,\frac{2}{5}\right)\mathbf{c}\right)$
	Equates components at least once: $\lambda = 1 - \mu$ or $\lambda = \frac{2}{5}\mu$	**M1**	**FT** providing at least **B1** awarded
	Equates components: $\lambda = 1 - \mu$ and $\lambda = \frac{2}{5}\mu$	**A1**	
	$\mu = \frac{5}{7}$ $\lambda = \frac{2}{7}$ and $DP : PA = 2 : 5 = OP : PB$ oe	**A2**	**A1** for $\mu = \frac{5}{7}$ or $\lambda = \frac{2}{7}$