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.

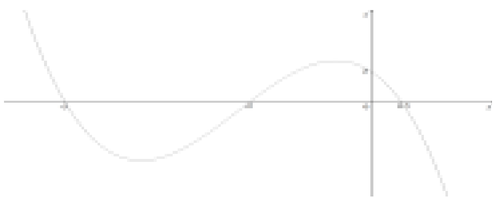
A Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. For accuracy marks to be given, the associated Method mark must be earned or implied.

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)		3	**B1** for correct shape with max and min in the correct quadrant. Ignore labelling of their maximum point if incorrect coordinates. **B1** for $-5,\ -2,\ \frac{1}{2}$ marked on x-axis. Must have a cubic shape **B1** for 2 marked on the y-axis. Must have a cubic shape
1(b)	$x \leqslant -5, \quad -2 \leqslant x \leqslant \frac{1}{2}$	2	**B1** for each If **B0** then **SC1** for $x < -5, \quad -2 < x < \frac{1}{2}$

Question	Answer	Marks	Guidance
2(a)	$\mathrm{q}(x)=3x^2-10x-8$ $r=5$	3	**M1** for a valid attempt to obtain the quotient by algebraic long division, synthetic division, factorising $(2x-5)$ or by forming an identity **A1** for each
2(b)	$[\mathrm{p}(x)-5=](3x^2-10x-8)(2x-5)$	**M1**	For a correct attempt to factorise
	$(3x+2)(x-4)(2x-5)$	**A1**	Must see $\mathrm{p}(x)-5$ as a product of linear factors
2(c)	$x=-\frac{2}{3},\ 4,\ \frac{5}{2}$	**B1**	**FT** on *their* 3 terms quadratic q(x)
3(a)	$1=\lg 10$ soi	**B1**	
	$\lg\frac{10(x^2-1)}{(x-1)^2}$ oe	**M1**	For correct use of logs power rule **or** multiplication **or** division rule. i.e.: Award **M1** for example: $2\log(x-1)=\log(x-1)^2$ $\log(x^2-1)=\log(x-1)+\log(x+1)$ $\log 10+\log(x^2-1)=\log 10(x^2-1)$ $\log(x^2-1)-\log(x-1)^2=\log\frac{(x^2-1)}{(x-1)^2}$
	$\lg\frac{10(x-1)(x+1)}{(x-1)^2}$	**DM1**	**Dep** on previous **M1** for a correct attempt to factorise and an attempt to simplify
	$\lg\frac{10(x+1)}{x-1}$	**A1**	
3(b)	$\left[4\log_5(x+1)=\right]\frac{9}{\log_5(x+1)}$ or $\frac{4}{\log_{(x+1)}5}\left[=9\log_{(x+1)}5\right]$	**B1**	For change of base
	$(\log_5(x+1))^2=\frac{9}{4}$ or $(\log_{(x+1)}5)^2=\frac{4}{9}$	2	**M1** for a correct method in forming a quadratic equation Dep on previous **B1**
	$x+1=5^{(\pm)\frac{3}{2}}$	**M1**	**Dep** on dealing with logarithms correctly Allow if ± is missing
	$x=-1+5\sqrt{5},\quad -1+\frac{1}{25}\sqrt{5}$	**A1**	

Question	Answer	Marks	Guidance
4(a)	$n = 5$	**B1**	
	$5 \times 3^4 p = 810$	**M1**	For considering the second term. Allow for use of *their n*
	$p = 2$	**A1**	
	$10 \times 3^3 \times p^2 = q$	**M1**	For considering the third term. Allow for use of *their n* and p^2
	$q = 1080$	**A1**	
4(b)	${}^6C_2 (2y)^4 \left((-)\frac{1}{3y^2}\right)^2$	**M1**	For identifying the correct term. Condone errors with brackets and coefficients. Could be implied by a correct answer
	$\frac{80}{3}$ oe	**A1**	Must be exact. Allow $\frac{240}{9}$ or $26\frac{2}{3}$
5(a)	$a = 5$, $b = \frac{3}{4}$ (oe), $c = -4$	**3**	**B1** for each
5(b)	[$p =$]1, [$p =$]5	**2**	**B1** for each Do not allow if written as inequalities
6	$\ln(2x-3)$	**B1**	Allow unsimplified
	$\frac{1}{3x-5}$ oe	**B1**	
	$\ln 5 + \frac{1}{7} - 1$	**M1**	For correct application of limits in *their* integral, Must be in the correct form $a\ln(2x-3) \pm \frac{b}{3x-5}$
	$\ln 5 - \frac{6}{7}$ cao	**A1**	

Question	Answer	Marks	Guidance
7	Use of $\cot^2\theta + 1 = \text{cosec}^2\theta$ and $\text{cosec}\,\theta = \dfrac{1}{\sin\theta}$	**B1**	$4 + \cot^2\theta = 9x^2$ gets **B0 M0 A0** unless recovered
	$(3x-2)^2 + 1 = \left(\dfrac{1}{y}\right)$ oe	**M1**	
	$y = \dfrac{1}{(3x-2)^2+1}$ oe	**A1**	
	Alternative Method: Use of $\cot\theta = \dfrac{\cos\theta}{\sin\theta}$ leading to $y = \dfrac{\cos^2\theta}{(3x-2)^2}$ oe	**M1**	For use of the identity to substitute $\cot\theta$ to get $2 + \dfrac{\cos\theta}{\sqrt{y}} = 3x$ **and** rearranging to get $y = \dfrac{\cos^2\theta}{(3x-2)^2}$
	Use $\sin^2\theta + \cos^2\theta = 1$ to get $y = \dfrac{1-y}{(3x-2)^2}$ oe	**M1**	For use of the identity to substitute $\cos^2\theta$ to get $y = \dfrac{1-\sin^2\theta}{(3x-2)^2}$ **and** use of $\sin^2\theta = y$
	$y = \dfrac{1}{(3x-2)^2+1}$ oe	**A1**	
8	$\sin\left(2\alpha - \dfrac{\pi}{3}\right) = (\pm)\dfrac{1}{2}$	**B1**	Condone if ± is missing for this mark
	$\alpha = -\dfrac{5\pi}{12}, -\dfrac{\pi}{4}, \dfrac{\pi}{12}, \dfrac{\pi}{4}$ oe in terms of π	**4**	**M1** for correct attempt to obtain one solution using correct order of operations **A3** for 4 correct solutions and no extras in the range, or **A2** for 3 correct solutions or **A1** for 2 correct solutions
9(a)	For use of $e^0 = 1$ or $\ln 1 = 0$	**B1**	
	$4x - y(=0)$	**B1**	For simplifying powers of e leading to a linear equation in x and y
	$4x^3 = 256$ or $\dfrac{y^3}{16} = 256$	**M1**	For attempt to obtain a cubic equation in one variable using *their* linear $4x - y = 0$ with an attempt to solve
	$x = 4,\ y = 16$	**2**	**A1** for each **A0** for $y = \pm 16$

Question	Answer	Marks	Guidance
9(b)	$\mathrm{e}^{1-2x} = \dfrac{1}{\mathrm{e}^{2x-1}}$	**B1**	Correct use of the reciprocal
	$10\left(\mathrm{e}^{2x-1}\right)^2 - 11\mathrm{e}^{2x-1} - 6 = 0$ or $6\left(\mathrm{e}^{1-2x}\right)^2 + 11\mathrm{e}^{1-2x} - 10 = 0$	**M1**	For a correct attempt to form a quadratic equation in e^{2x-1} or in e^{1-2x}
	$\mathrm{e}^{2x-1} = \dfrac{3}{2}$ $\left(\mathrm{e}^{2x-1} = -\dfrac{2}{5}\right)$ or $\mathrm{e}^{1-2x} = \dfrac{2}{3}$ $\left(\mathrm{e}^{1-2x} = -\dfrac{5}{2}\right)$	**M1**	**Dep** on attempt to solve *their* quadratic equation
	$x = \dfrac{1}{2} + \dfrac{1}{2}\ln\dfrac{3}{2}$ or exact equivalent only	**A1**	Allow $x = \dfrac{1+\ln\frac{3}{2}}{2}$ and $x = \dfrac{1}{2}\ln(\dfrac{3}{2}e)$ for **A1** **A0** if negative root not discounted
	Alternative Method: $\dfrac{10e^{2x}}{e} - 11 = \dfrac{6e}{e^{2x}}$	**B1**	Correct use of the reciprocal
	$10(e^{2x})^2 - 11e(e^{2x}) - 6e^2 = 0$	**M1**	For correct attempt to form a quadratic equation
	$e^{2x} = \dfrac{11e \pm 19e}{20}$	**M1**	**Dep** on attempt to solve *their* quadratic equation
	$x = \dfrac{1}{2}\ln(\dfrac{3}{2}e)\left[= \dfrac{1}{2}\ln\dfrac{3}{2} + \dfrac{1}{2}\right]$	**A1**	Allow $x = \dfrac{1+\ln\frac{3}{2}}{2}$ and $x = \dfrac{1}{2}\ln(\dfrac{3}{2}e)$ for **A1** **A0** if negative root not discounted
10(a)	$t = \dfrac{\pi}{2}$	**2**	**M1** for attempt at solution of $3\sin 2t = 0$ implied by 90 or $\dfrac{\pi}{2}$ **A0** for $t = 90$
10(b)	$-\dfrac{3}{2}\cos 2t$	**2**	**M1** for $k\cos 2t,\ k \neq 6$
	When $t = 0$, $s = 0$ so $c = \dfrac{3}{2}$	**M1**	**Dep** on attempt to find c using *their* s
	$s = \dfrac{3}{2} - \dfrac{3}{2}\cos 2t$	**A1**	Must be an expression for s

Question	Answer	Marks	Guidance
10(c)	Distance travelled = $2\times\left[\frac{3}{2}-\frac{3}{2}\cos 2t\right]_0^{\frac{\pi}{2}}$ using symmetry or $2\times\left(\frac{3}{2}-\frac{3}{2}\cos\left(2\frac{\pi}{2}\right)\right)$ using symmetry $\left[\frac{3}{2}-\frac{3}{2}\cos 2t\right]_0^{\frac{\pi}{2}}+\left\|\left[\frac{3}{2}-\frac{3}{2}\cos 2t\right]_{\frac{\pi}{2}}^{\pi}\right\|$ oe	2	**M1 dep** on *their s* from (b) unless restarted. Must be in the form of $k\cos 2t$ (+c) Condone the use of 0 to π as limits. Limits must be the correct way round and subtracted. **M1dep** for correct substitution of limits at least once **and** correct use of symmetry
	6	A1	
11	When $x=3,\ y=2$	B1	
	$\frac{dy}{dx}=(3x-1)^{-\frac{2}{3}}$	M1	Allow for $k(3x-1)^{-\frac{2}{3}}$
	When $x=3,\ \frac{dy}{dx}=\frac{1}{4}$	A1	
	Tangent equation: $y-2=\frac{1}{4}(x-3)$	M1	Allow using *their y* and *their* $\frac{dy}{dx}$
	Intercepts on the axes: $x=-5,\ y=\frac{5}{4}$	A1	For both
	Midpoint of *AB*: $\left(-\frac{5}{2},\frac{5}{8}\right)$	M1	**Dep** on **M** mark for equation of tangent **FT** on *their* intercepts
	Grad of perp bisector = –4	M1	**FT** on *their* $\frac{dy}{dx}$ or from their *x* and *y* intercept
	Perp bisector equation: $y-\frac{5}{8}=-4\left(x+\frac{5}{2}\right)$	M1	Allow using *their* – 4 and *their* midpoint
	$a-\frac{5}{8}=-4\left(a+\frac{5}{2}\right)$	M1	**Dep** on previous **M** mark for use of $(a,\ a)$ in *their* perp bisector equation
	$a=-\frac{15}{8}$, –1.875	A1	

Question	Answer	Marks	Guidance
12(a)	$\frac{dy}{dx} = \frac{x^2\left(\frac{1}{x}\right) - 2x\ln 3x}{x^4}$ oe $\frac{dy}{dx} = x^{-2} \times \frac{3}{3x} + \frac{-2}{x^3} \times \ln 3x$	3	**B1** for $\frac{1}{x}$ or $\frac{3}{3x}$ **M1** for a correct attempt at a quotient or a product **A1** for all terms apart from log derivative correct.
	$\frac{1-2\ln 3x}{x^3}$	**A1**	
12(b)	$\frac{\ln 3x}{x^2} = \int \frac{1-2\ln 3x}{x^3}\,dx$ $2\int \frac{\ln 3x}{x^3}\,dx = \int \frac{1}{x^3}\,dx - \frac{\ln 3x}{x^2}$ oe	**M1**	For using integration as a reverse of differentiation (reverse of part **(a)**) Allow using *their A* and *B* but do not allow any extra terms added or subtracted from *their* part **(a)**
	$\left(\int \frac{1}{x^3}\,dx = \right) \ -\frac{1}{2x^2}$ oe nfww	**B1**	**FT** on their *A*
	$-\frac{1}{4x^2} - \frac{\ln 3x}{2x^2} + c$ oe	**2**	**M1** dep for rearranging simplification **and** an attempt to integrate ax^{-3}. Allow if $+c$ is missing **A1** must include +c