

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

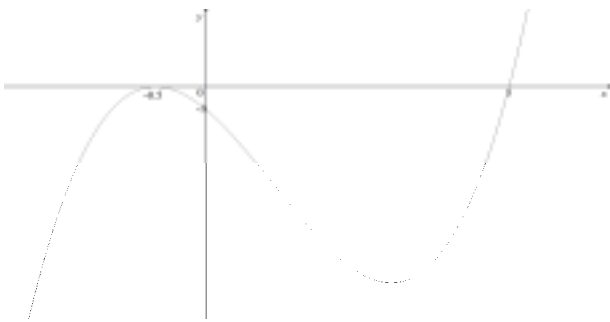
- M Method marks, awarded for a valid method applied to the problem.
- A Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. For accuracy marks to be given, the associated Method mark must be earned or implied.
- B Mark for a correct result or statement independent of 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.

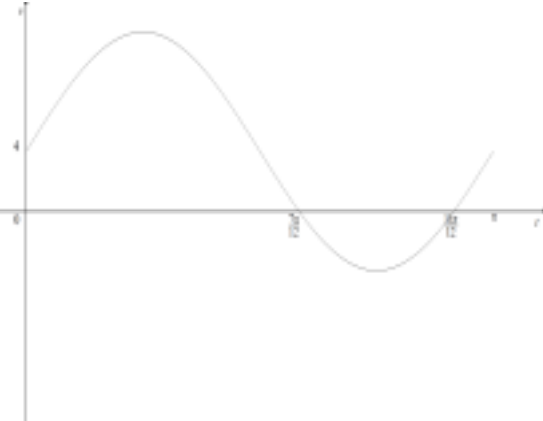
Abbreviations

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

Question	Answer	Marks	Guidance
1	$a = 4$	B1	
	$b = \frac{3}{8}$ or 0.375 oe	B1	
	$c = 2$	B1	
2	$6(2^{2x}) - 11(2^x) + 3 = 0$ soi	B1	
	$2^x = \frac{1}{3}, 2^x = \frac{3}{2}$	2	M1 for solution of <i>their</i> quadratic equation in 2^x or appropriate substitution to obtain $2^x = \dots$
	-1.58, 0.58	A1	For both

Question	Answer	Marks	Guidance
3(a)	$\frac{dy}{dx} = (2x+1)^2 + 4(2x+1)(x-3)$ or $\frac{dy}{dx} = 12x^2 - 16x - 11$	M1	For correct attempt to differentiate a product or expansion and then differentiate.
	$x = -\frac{1}{2}, \frac{11}{6}$	2	M1 for setting <i>their</i> quadratic $\frac{dy}{dx}$ to zero and attempting to solve to obtain two x values.
	$y = 0, -\frac{686}{27}$ or -25.4	A1	For both Must be separate inequalities
3(b)		3	B1 for correct shape with max on the negative x -axis and a min in the 4 th quadrant B1 for correct x intercepts $-\frac{1}{2}$ and 3. Must have a cubic curve B1 for correct y intercept -3 . Must have a cubic curve
3(c)	$k > 0$	B1	
	$k < -\frac{686}{27}$ or $k < -25.4$	B1	FT on <i>their</i> $-\frac{686}{27}$ or -25.4 from part (a)
4	$1 + 2e^{2x} + e^{4x}$	B1	For correct integrand
	$x + e^{2x} + \frac{e^{4x}}{4}$	B2	B1 for 2 correct terms in integral
	$\left(2 + e^4 + \frac{e^8}{4}\right) - \left(1 + \frac{1}{4}\right)$	M1	For correct application of limits. Must be in the form $me^{4x} + ne^{2x} + x$
	$\frac{3}{4} + e^4 + \frac{e^8}{4}$	A1	

Question	Answer	Marks	Guidance
5(a)	$e^{2y} = mx^3 + c$ soi	B1	May be seen later
	Either $7.2 = 6.4m + c$ or $5 = 2m + c$ Or gradient = $m = \frac{1}{2}$	M1	For correct use of coordinates at least once or for finding the gradient and equating it to m
	$m = \frac{1}{2}, c = 4$	A1	For both
	$y = \frac{1}{2} \ln \left(\frac{x^3}{2} + 4 \right)$ oe	A1	
5(b)	$\frac{x^3}{2} + 4 > 0$	M1	Allow <i>their</i> $\frac{x^3}{2} + 4 > 0$
	$x > -2$	A1	
6(a)	$\frac{(x+2) \frac{4x}{(2x^2+1)} - \ln(2x^2+1)}{(x+2)^2}$	3	B1 for $\frac{4x}{(2x^2+1)}$ M1 for correct attempt at a quotient or equivalent product A1 for all other terms correct
6(b)	When $x = 1, \frac{dy}{dx} = \frac{4 - \ln 3}{9}$ or 0.322	B1	
	$\frac{4 - \ln 3}{9}h$ or $0.322h$	B1	FT on <i>their</i> $\frac{4 - \ln 3}{9}$ or 0.322
6(c)	$\frac{dx}{dt} = \frac{3}{\text{their } 0.322}$	M1	
	9.31 or 9.32	A1	
7(a)	Ending in 0: 15120 or 9P_5 or $9 \times 8 \times 7 \times 6 \times 5$ oe	B1	
	Ending in 5: 13440 or ${}^8P_1 \times {}^8P_4$ or $8 \times 8 \times 7 \times 6 \times 5$ oe	B1	
	Total: 28560	B1	

Question	Answer	Marks	Guidance
7(b)	$\frac{(n+1)!}{(n-12)!13!} = \frac{16n!}{(n-12)!12!}$ soi	B1	
	$n+1=13 \times 16$ oe	B1	Dep on previous B mark for either $n+1$ or 13×16
	$n=207$	B1	Dep on previous 2 B marks
8	When $x=2$, $y=12$	B1	
	$\frac{dy}{dx} = \frac{15}{2}(5x+6)^{-\frac{1}{2}}$	2	M1 for $k(5x+6)^{-\frac{1}{2}}$, $k \neq \frac{15}{2}$
	When $x=2$, $\frac{dy}{dx} = \frac{15}{8}$,	A1	
	perp gradient = $-\frac{8}{15}$	M1	Dep on previous M mark. Allow for use of <i>their</i> gradient to obtain perp gradient
	Normal equation: $y-12 = -\frac{8}{15}(x-2)$	M1	Allow for using <i>their</i> perp gradient and <i>their</i> y
	When $x=-2$ $k = \frac{212}{15}$ or $14\frac{2}{15}$	A1	
9(a)	$v = 4 + 8 \sin 2t$	2	M1 for $v = 4 + k \sin 2t$, $k \neq 8$
9(b)		5	B1 for a complete correct cycle between $t=0$ and $t=\pi$ B1 for $v=4$, must have a sine curve M1 for correct attempt to find one t -intercept using their v , must be in the form $4 + k \sin 2t$ and $0 < t < \pi$ Allow M1 for 105° or 165° seen A1 for $t = \frac{7\pi}{12}$ A1 for $t = \frac{11\pi}{12}$
9(c)	$a = 16 \cos 2t$	B1	FT on <i>their</i> v which must be in the form $4 + k \sin 2t$
9(d)	$t = \frac{\pi}{4}, \frac{3\pi}{4}$	2	B1 for each Must be from $\cos 2t = 0$

Question	Answer	Marks	Guidance
10(a)(i)	$a + d = 14$ soi	B1	
	$a(a + d)(a + 2d) = -6720$	B1	
	$a \times 14 \times (a + 2d) = -6720$, leading to $a(a + 2d) = -480$	B1	Dep on both previous B marks AG , needs sufficient detail
10(a)(ii)	$(14 - d)(14 + d) = -480$ or $a(28 - a) = -480$	M1	For attempt to obtain a quadratic equation in one variable
	$d^2 = 676$ or $a^2 - 28a - 480 = 0$	A1	
	$a = 40, d = -26$	A2	A1 for each
10(b)	$ar^2 = \frac{e^{4x}}{4}$	B1	
	$ar^9 = \frac{e^{11x}}{512}$	B1	
	$r^7 = \frac{e^{7x}}{128}$ oe	M1	For a correct attempt to solve <i>their</i> 2 equations. Must be the same structure to obtain $r^7 = \dots$
	$r = \frac{e^x}{2}$	A1	
	$a = e^{2x}$	A1	

Question	Answer	Marks	Guidance
11	$12 \log_{81} y = 3 \log_3 y$ oe or $4 \log_9 x = 2 \log_3 x$ oe	B1	For either
	$8 \log_3 x + 3 \log_3 y = 5$ oe	B1	
	$2 \log_3 x + 3 \log_3 y = 2$ oe	B1	
	$y = 3^{\frac{1}{3}}, x = \sqrt{3}$	3	M1 for attempt to solve <i>their</i> equations. Must have at least 2 B marks and obtain 2 solutions A1 for each
	Alternative		
	$12 \log_{81} y = \frac{\log_3 y^{12}}{4}$ oe or $4 \log_9 x = \frac{\log_3 x^4}{2}$ oe	B1	
	$x^{32} y^{12} = 3^{20}$ or $x^8 y^3 = 3^5$ oe	B1	
	$x^4 y^6 = 3^4$ or $x^2 y^3 = 3^2$ oe	B1	
12	$y = 3^{\frac{1}{3}}, x = \sqrt{3}$	3	M1 for attempt to solve <i>their</i> equations, which must both be in the correct form. Must have at least 2 B marks and obtain 2 solutions A1 for each
12	$\cos\left(3\theta - \frac{\pi}{2}\right) = \frac{1}{2}$ oe soi	B1	
	$\theta = -\frac{7\pi}{18}, \frac{\pi}{18}, \frac{5\pi}{18}$	4	M1 dep on previous B mark, for one of the following $3\theta - \frac{\pi}{2} = -\frac{5\pi}{3}, -\frac{\pi}{3}, \frac{\pi}{3}, \frac{5\pi}{3}$ A1 for one correct solution A1 for a second correct solution A1 for a third correct solution and no extra solutions in the range.