

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.

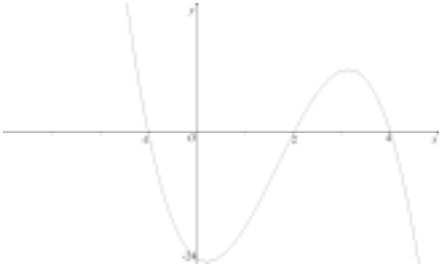
Types of mark

- 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 minimum point in the fourth quadrant and the maximum point in the first quadrant. Ends of the curve must be in the 2nd and 4th quadrants B1 for correct x - intercepts $(-1, 0)$, $(2, 0)$, $(4, 0)$ B1 for correct y -intercept $(0, -24)$
1(b)	$x < -1$	B1	
	$2 < x < 4$	B1	

Question	Answer	Marks	Guidance
2	$2x^2 + 4x + k - 1 = kx + 3$ $2x^2 + (4 - k)x + (k - 4) = 0$	2	M1 for attempt to equate the line and curve and simplify to a 3 term quadratic equation = 0 A1 for a correct equation, allow equivalent form
	$(4 - k)^2 = 4 \times 2 \times (k - 4)$	M1	Use of discriminant in any form
	$k^2 - 16k + 48 = 0$ $k = 12, k = 4$ Do not isw	2	Dep M1 on previous M mark, for attempt to solve a quadratic equation in k A1 for both
	Alternative 1		
	$2x^2 + 4x + k - 1 = kx + 3$ $2x^2 + (4 - k)x + (k - 4) = 0$	(2)	M1 for attempt to equate the line and curve and simplify A1 for a correct equation, allow equivalent form
	$k = 4x + 4$ $2\left(\frac{k - 4}{4}\right)^2 + (4 - k)\left(\frac{k - 4}{4}\right) + (k - 4) = 0$	M1	Equating gradients and substitution to obtain a quadratic equation in terms of k
	$k^2 - 16k + 48 = 0$ $k = 12$ and $k = 4$ Do not isw	2)	Dep M1 on previous M mark, for attempt to solve a quadratic equation in k A1 for both
	Alternative 2		
	$2x^2 + 4x + k - 1 = kx + 3$ $2x^2 + (4 - k)x + (k - 4) = 0$	(2)	M1 for attempt to equate the line and curve and simplify A1 for a correct equation, allow equivalent form
	$k = 4x + 4$ $2x^2 - 4x = 0$ $x = 0, 2$	M1	Equating gradients and substitution to obtain a quadratic equation in terms of x and solution of this equation to obtain 2 x values
$k = 4x + 4$ $k = 12$ and $k = 4$ Do not isw	2)	Dep M1 on previous M mark, for substitution of their x values to obtain k values A1 for both	

Question	Answer	Marks	Guidance
3	$b = 243$	B1	Must be evaluated
	${}^5C_1 \times 3^4 \times (-a) = -81$	M1	Allow equivalent with no negative signs, allow sign error
	$a = \frac{1}{5}$ oe	A1	
	${}^5C_2 \times 3^3 \times (-a)^2$	M1	Allow with <i>their</i> a^2
	$c = \frac{54}{5}$ or 10.8 oe	A1	Must be from correct working
4	$\frac{dy}{dx} = \frac{6x}{3x^2 - 4} - \frac{x^2}{2}$	2	M1 for attempt to differentiate, must have at least one term correct A1 All correct
	When $x = 2$, $\frac{dy}{dx} = -\frac{1}{2}$	B1	
	When $x = 2$, $y = \ln 8 - \frac{4}{3}$, or exact equivalent	B1	Allow $\ln 8 - \frac{8}{6}$
	Equation of tangent $y - \left(\ln 8 - \frac{4}{3}\right) = -\frac{1}{2}(x - 2)$ oe	M1	Dep on first M mark, allow unsimplified, allow use of decimals
	$\left(0, \ln 8 - \frac{1}{3}\right)$, or exact equivalent	A1	Allow $x = 0, y = \ln 8 - \frac{1}{3}$
5(a)	$\frac{1}{2}(5 - \sqrt{3})(2 + 4\sqrt{3})$ $\frac{1}{2}(10 - 2\sqrt{3} + 20\sqrt{3} - 12)$	M1	Need to see $\frac{1}{2}(10 - 18\sqrt{3} - 12)$ or $(5 - 9\sqrt{3} - 6)$ minimum for M1
	$9\sqrt{3} - 1$	A1	
5(b)	$\tan ABC = \frac{5 - \sqrt{3}}{1 + 2\sqrt{3}} \times \frac{1 - 2\sqrt{3}}{1 - 2\sqrt{3}}$ $= \frac{5 - \sqrt{3} - 10\sqrt{3} + 6}{1 - 12}$	M1	Attempt at trig ratio and attempt to rationalise. Need to see $5 - 11\sqrt{3} + 6$ in the numerator as a minimum for M1 Allow one error only
	$= \sqrt{3} - 1$	2	A1 for $\sqrt{3}$, A1 for -1

Question	Answer	Marks	Guidance
5(c)	$\sec^2 ABC = \tan^2 ABC + 1$ $= (\sqrt{3} - 1)^2 + 1$ oe	M1	Allow use of correct identity with <i>their</i> (b)
	$= 5 - 2\sqrt{3}$	A1	
	Alternative		
	$\sec^2 ABC = \left(\frac{\sqrt{(5-\sqrt{3})^2 + (1+2\sqrt{3})^2}}{1+2\sqrt{3}} \right)^2$ leads to $\frac{41-6\sqrt{3}}{13+4\sqrt{3}}$ leads to $\frac{533+72-242\sqrt{3}}{121}$	(M1	For a complete method using triangle <i>ABD</i> , with sufficient detail in the expansions and rationalisation
	$= 5 - 2\sqrt{3}$	A1)	
6(a)	Midpoint = (2,7)	B1	
	Gradient of <i>AB</i> = $\frac{6}{8}$ oe	B1	
	Perp bisector: $y - 7 = -\frac{4}{3}(x - 2)$	M1	Must be using a perp gradient and a mid-point
	$4x + 3y - 29 = 0$	A1	Allow in any order but must be equated to zero.
6(b)	3	B1	FT on <i>their</i> (a)
6(c)	Displacement vector $\overline{CM} = \begin{pmatrix} -3 \\ 4 \end{pmatrix}$	M1	Allow equivalent vectors or other methods. May be implied by one correct coordinate.
	(-1,11)	A1	Allow $x = -1, y = 11$

Question	Answer	Marks	Guidance
7(a)	$p\left(-\frac{1}{2}\right): -\frac{a}{8} + \frac{3}{4} - \frac{b}{2} - 12 = 0$ $p(3): 27a + 27 + 3b - 12 = 105$	M1	For attempt at an equation using either $p\left(-\frac{1}{2}\right)$ or $p(3)$
	$a + 4b = -90$	A1	Allow equivalent with constants collected
	$9a + b = 30$	A1	Allow equivalent with constants collected
	$a = 6, b = -24$	2	M1 for attempt to solve <i>their</i> equations, dep on first M mark A1 for both
7(b)	$(2x+1)(3x^2 - 12)$	2	B1 for $3x^2$ B1 for -12 and no extra term in x
7(c)	$x = -\frac{1}{2}$	B1	
	$x = \pm 2$	B1	Dep on both B marks in part (b)
8(a)	$\begin{pmatrix} -20 \\ 48 \end{pmatrix}$	B1	
8(b)	$\begin{pmatrix} -20 \\ 48 \end{pmatrix}^t$	B1	Follow through on <i>their</i> (a)
8(c)	$\begin{pmatrix} 12 \\ 8 \end{pmatrix} + \begin{pmatrix} -25 \\ 45 \end{pmatrix}^t$ oe	B1	
8(d)	$\begin{pmatrix} 12 \\ 8 \end{pmatrix} + \begin{pmatrix} -5 \\ -3 \end{pmatrix}^t$ oe	B1	
8(e)	$ \overrightarrow{PQ} ^2 = (12 - 5t)^2 + (8 - 3t)^2$	M1	Attempt to find modulus of <i>their</i> (d) which must contain terms in t
	$ \overrightarrow{PQ} = \sqrt{144 - 120t + 25t^2 + 64 - 48t + 9t^2}$ $PQ = \sqrt{34t^2 - 168t + 208}$	A1	Must see correct expansion leading to given answer.

Question	Answer	Marks	Guidance
8(f)	$34t^2 - 168t + 204 = 0$	M1	For dealing with square root correctly and attempt to solve a 3 term quadratic equation
	2.15 only	A1	
9(a)(i)	360	B1	
9(a)(ii)	60	B1	FT on <i>their</i> (b)(i) divided by 6
9(a)(iii)	A complete plan for dealing with odd numbers and numbers greater than 7000, see below	M1	Must be considering each case
	Starts with 8 and ends with odd = 48	B1	
	Starts with 7 or 9 and ends with odd = 72	B1	
	120	A1	
	Alternative		
	Their answer to (a)(i) – odd numbers starting with 2 – odd number starting with 3 or 5 – all even numbers	(M1)	Must be considering each case
	All even numbers = 120 Odd and starting with 2 = 48 Odd and starting with 3 or 5 = 72	2	B1 for 1 correct
120	A1)		
9(b)	$\frac{n!}{(n-3)!3!} = 92n$	B1	
	$n(n-1)(n-2) = 552n$	M1	Attempt to simplify factorials
	$n(n^2 - 3n - 550) = 0$ $n(n-25)(n+22) = 0$	M1	Dep on previous M mark for expansion and simplification to a cubic or quadratic in n and attempt to solve
	$n = 25$	A1	For $n = 25$ only
10(a)	$\alpha + 45^\circ = 144.7^\circ, 324.7^\circ$ $\alpha = 99.7^\circ, 279.7^\circ$	3	M1 for attempt to solve using a correct order of operations, may be implied by one correct solution A1 for 1 correct solution A1 for a second correct solution and no extras

Question	Answer	Marks	Guidance
10(b)(i)	$\frac{(\sin \theta + 1) - (\sin \theta - 1)}{\sin^2 \theta - 1}$	M1	For dealing with fractions
	$\frac{2}{-\cos^2 \theta}$	M1	For simplification of numerator and use of the correct identity
	$-2\sec^2 \theta$ $a = -2$	A1	Must see previous line for A1
10(b)(ii)	$-2\sec^2 3\phi = -8$ oe $\sec 3\phi = \pm 2$	M1	For making use of (i) and attempt to simplify in terms of 3ϕ
	$\cos 3\phi = \pm \frac{1}{2}$	A1	
	$3\phi = -\frac{2\pi}{3}, -\frac{\pi}{3}, \frac{\pi}{3}, \frac{2\pi}{3}$ $\phi = -\frac{2\pi}{9}, -\frac{\pi}{9}, \frac{\pi}{9}, \frac{2\pi}{9}$ or $\pm 0.349, \pm 0.698,$	3	Dep M1 for attempt to solve, may be implied by one correct solution A1 for each pair of correct solutions
11	$[\ln(2x+3) + \ln(3x-1) - \ln x]_1^a$	2	B1 for 1 term correct B1 all correct
	$(\ln(2a+3) + \ln(3a-1) - \ln a)$ $-(\ln 5 + \ln 2)$	M1	Correct substitution of limits, dep on first B1, ignore equality Must have 3 terms involving x
	$\ln \frac{(2a+3)(3a-1)}{10a} = \ln 2.4$	M1	For use of both addition and subtraction rules, ignore equality Or for use of addition rule on each side of an equation.
	$6a^2 - 17a - 3 = 0$	A1	
	$a = 3$	2	M1 for solution of their quadratic A1 for $a = 3$ only