

Question	Answer	Marks	Partial Marks
1(a)	$P + Q = 500$ and $P + Qe^2 = 600$	B1	
	$Q = \frac{100}{(e^2 - 1)} = 15.7$ or 15.6	2	M1 for attempt to solve by removing P from two equations both containing 3 terms A1 awrt
	$P = 484$ or 485	A1	awrt
	$b = 484.3 + 15.65e^4 = 1339$	B1	
1(b)	$e^{2t} = \frac{2\,000\,000 - 484.3}{15.65}$	M1	Make e^{2t} the subject
	$2t = \ln\left(\frac{2\,000\,000 - 484.3}{15.65}\right)$	M1	Take logs correctly where $e^{2t} > 0$ or $e^n > 0$
	$t = 5.88$ or 5.878 to 5.879	A1	nfww; no trial and improvement
2	$x^5 + 10x^3 + 40x + \dots$	3	M1 for attempt to expand $\left(x + \frac{2}{x}\right)^5$, with at least 2 correct terms oe A1 for $10x^3$ A1 for $40x$
	Term in x^2 : $(1 \times 40) - (3 \times 10)$	M1	For $(1 \times \textit{their } 40) \pm (3 \times \textit{their } 10)$
	10	A1	
3	$\left[F(x) = \int \left(\sec^2 \frac{x}{2} + e^x \right) dx = \right] 2 \tan \frac{x}{2} + e^x$	B3	B2 for $2 \tan \frac{x}{2}$ or $k \tan \frac{x}{2} + e^x$ or B1 for $k \tan \frac{x}{2}$ where k is a constant
	$F\left(\frac{\pi}{2}\right) - F\left(\frac{\pi}{4}\right)$	M1	FT providing at least B1 awarded; necessary working
	3.79 cao	A1	3.78877... If zero scored, award SC1 for an unsupported answer of 3.79
4(a)(i)	$176 + 9d = 149$	M1	
	$d = -3$	A1	

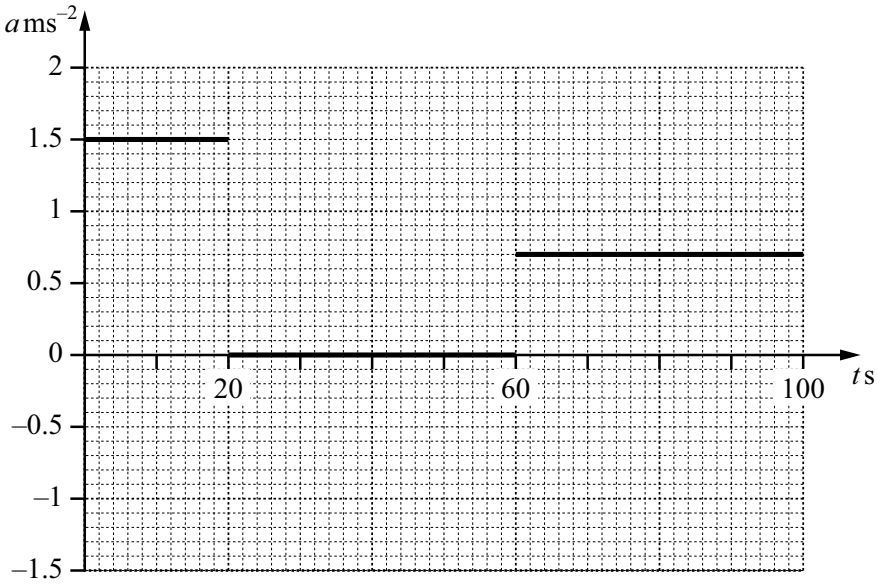
Question	Answer	Marks	Partial Marks
4(a)(ii)	$\frac{n}{2}(352 + (n-1)(-3)) (< 0)$	M1	FT <i>their d</i>
	$\frac{355}{3}$ or 118.3 oe	A1	
	119	A1	
4(b)(i)	$a = 3 \quad r = \frac{2.4}{3} = 0.8$	B1	
	$S_8 = \frac{3(1-0.8^8)}{(1-0.8)}$	M1	FT <i>their r</i>
	12.5 or awrt 12.48	A1	
4(b)(ii)	15	B1	
4(b)(iii)	3(<i>their</i> 0.8 ⁹) and use of S_{50}	M1	FT <i>their r</i>
	$\frac{3(\textit{their } 0.8^9)(1 - \textit{their } 0.8^{50})}{1 - \textit{their } 0.8}$	M1	FT <i>their r</i>
	Correct sum	A1	
	2.01 or 2.013[23...]	A1	
	Alternative		
	$S_{59} = \frac{3(1 - \textit{their } 0.8^{59})}{1 - \textit{their } 0.8}$ or $S_9 = \frac{3(1 - \textit{their } 0.8^9)}{1 - \textit{their } 0.8}$	(M1)	FT <i>their r</i>
	$S_{59} = \frac{3(1 - 0.8^{59})}{1 - 0.8}$ and $S_9 = \frac{3(1 - 0.8^9)}{1 - 0.8}$	(A1)	
	Correct plan: $S_{59} - S_9$ oe attempted	(M1)	FT <i>their r</i>
2.01 or 2.013[23...]	(A1)		
5(a)(i)	120	B1	
5(a)(ii)	48	B1	

Question	Answer	Marks	Partial Marks
5(a)(iii)	Starts with 7 or 9 24	B1	May be implied by 12 and 12
	Starts with 8 18	B1	
	42	B1	
	Alternative		
	Ends with 3 18	(B1)	
	Ends with 7 or 9 24	(B1)	May be implied by 12 and 12
	42	(B1)	
5(b)	${}^{12}C_3 \times {}^9C_4 = 220 \times 126$ or ${}^{12}C_5 \times {}^7C_4 = 792 \times 35$ or ${}^{12}C_4 \times {}^8C_5 = 495 \times 56$ or other equivalents	M2	M1 for one correct combination or value in a product of two or three combinations Must be numeric
	27720	A1	

Question	Answer	Marks	Partial Marks
6(a)	$\frac{dy}{dx} = \frac{(2x+1)\frac{6x}{3x^2-5} - 2\ln(3x^2-5)}{(2x+1)^2}$ or $\frac{dy}{dx} = (2x+1)^{-1}\frac{6x}{3x^2-5} - 2(2x+1)^{-2}\ln(3x^2-5)$	3	B1 for $\frac{6x}{3x^2-5}$ M1 for attempt at a quotient or equivalent product A1 for all terms other than $\frac{6x}{3x^2-5}$ correct
	When $x = \sqrt{2}, y = 0$	B1	May be implied
	When $x = \sqrt{2}, \frac{dy}{dx} = \frac{6\sqrt{2}}{2\sqrt{2}+1}$ or $\frac{24-6\sqrt{2}}{7}$ or 2.22 oe Normal: $y = -\frac{(2\sqrt{2}+1)}{6\sqrt{2}}(x-\sqrt{2})$ oe or $y = -\frac{7}{24-6\sqrt{2}}(x-\sqrt{2})$ oe or $y = -\frac{1}{2.22}(x-\sqrt{2})$ oe or $y = -\frac{4+\sqrt{2}}{12}(x-\sqrt{2})$ oe or $y = -0.451(x-\sqrt{2})$ oe or $y = -\frac{9+4\sqrt{2}}{24+6\sqrt{2}}(x-\sqrt{2})$ oe or $y = -0.451x + 0.638$	2	M1 for attempt at normal using <i>their y</i> and <i>their perpendicular gradient</i> A1 Allow equivalent surd forms
6(b)	$\frac{6\sqrt{2}}{2\sqrt{2}+1}h$ or $\frac{24-6\sqrt{2}}{7}h$ or other equivalent surd forms or 2.22h	B1	FT <i>their</i> $\left.\frac{dy}{dx}\right _{x=\sqrt{2}}$ from (a)

Question	Answer	Marks	Partial Marks
7	$5 \frac{\sin x}{\cos x} - 3 \frac{\cos x}{\sin x} = \frac{2}{\cos x}$	B1	Change $\tan x$, $\cot x$ and $\sec x$ into $\sin x$ and $\cos x$ correctly
	$5 \sin^2 x - 3(1 - \sin^2 x) = 2 \sin x$	M1	Multiply correctly by $\sin x \cos x$ oe and use $\cos^2 x + \sin^2 x = 1$
	$8 \sin^2 x - 2 \sin x - 3 = 0$	A1	Correct 3-term quadratic
	$(2 \sin x + 1)(4 \sin x - 3) = 0$	M1	Factorise or use formula correctly on <i>their</i> quadratic
	$\sin x = -\frac{1}{2} \rightarrow x = 210^\circ, 330^\circ$	A1	
	$\sin x = \frac{3}{4} \rightarrow x = 48.6^\circ, 131.4^\circ$	A1	
8(a)	$\frac{dy}{dx} = (2x - 1) \times \frac{1}{2} \times 4(4x + 3)^{-\frac{1}{2}} + 2(4x + 3)^{\frac{1}{2}}$	3	B1 for $\frac{1}{2} \times 4(4x + 3)^{-\frac{1}{2}}$ oe M1 for a correct attempt at a product A1 for all other terms correct
	$\frac{dy}{dx} = 2(4x + 3)^{-\frac{1}{2}}(2x - 1 + 4x + 3)$ or equivalent	M1	For attempt to simplify to the given form
	$\frac{dy}{dx} = \frac{4(3x + 1)}{(4x + 3)^{\frac{1}{2}}}$	A1	
8(b)	$-\frac{1}{3}$	B1	

Question	Answer	Marks	Partial Marks																
8(c)	For a complete method using 2nd derivative: $\frac{d^2y}{dx^2} = 4 \left(\frac{3(4x+3)^{-\frac{1}{2}} - 2(3x+1)(4x+3)^{-\frac{1}{2}}}{4x+3} \right)$ OR gradient or y values either side or one side of <i>their</i> stationary point, e.g. <table border="1" data-bbox="304 440 909 624"> <tr> <td>x</td> <td>$< -\frac{1}{3}$</td> <td>$-\frac{1}{3}$</td> <td>$> -\frac{1}{3}$</td> </tr> <tr> <td>$\frac{dy}{dx}$</td> <td>-</td> <td>0</td> <td>+</td> </tr> </table> <table border="1" data-bbox="304 659 909 802"> <tr> <td>x</td> <td>$< -\frac{1}{3}$</td> <td>$-\frac{1}{3}$</td> <td>$> -\frac{1}{3}$</td> </tr> <tr> <td>y</td> <td>< -2.15</td> <td>-2.15</td> <td>> -2.15</td> </tr> </table>	x	$< -\frac{1}{3}$	$-\frac{1}{3}$	$> -\frac{1}{3}$	$\frac{dy}{dx}$	-	0	+	x	$< -\frac{1}{3}$	$-\frac{1}{3}$	$> -\frac{1}{3}$	y	< -2.15	-2.15	> -2.15	M1	Must be using values of $x > -\frac{3}{4}$
x	$< -\frac{1}{3}$	$-\frac{1}{3}$	$> -\frac{1}{3}$																
$\frac{dy}{dx}$	-	0	+																
x	$< -\frac{1}{3}$	$-\frac{1}{3}$	$> -\frac{1}{3}$																
y	< -2.15	-2.15	> -2.15																
	Minimum	A1	Must be from correct work																
9(a)(i)	Finds total area under graph: $\frac{1}{2}(60+40) \times 30 + \frac{1}{2}(30+V) \times 40$ or $\frac{1}{2}(20 \times 30) + (40 \times 30) + \frac{1}{2}(30+V) \times 40$ Equates area to 3260 and finds V or $V - 30$	M1	Allow one error in an area but not a missing area; allow if areas are seen separately																
	58	A1	dep previous M1																

Question	Answer	Marks	Partial Marks
9(a)(ii)	Correct $a-t$ graph: 	2	B1 for any two correct sections
9(b)(i)	$v = 3 \sin 2t (+ c)$	M1	Must have $\pm 3 \sin 2t$
	$10 = c$	M1	dep previous M1 ; attempts to find constant
	$v = 3 \sin 2t + 10$	A1	
9(b)(ii)	$s = -\frac{3}{2} \cos 2t + 10t + d$	M1	attempts to integrate <i>their</i> v ; must have $\pm \frac{3}{2} \cos 2t$
	$d = \frac{3}{2}$	M1	dep previous M1 ; attempts to find constant
	$s = -\frac{3}{2} \cos 2t + 10t + \frac{3}{2}$ nfw	A1	

Question	Answer	Marks	Partial Marks
10(a)	$\angle BOC = 1.5 \text{ rad}$	B1	Check diagram
	$\sin 0.75 = \frac{BC/2}{r}$	M1	For a complete attempt to find BC – must be using a right-angled triangle to get required result – answer given
	$BC = 2r \sin 0.75$	A1	
	Perimeter = $2r + 2r \sin 0.75 + 4r + 1.5r$	M1	dep previous M1 attempt at perimeter
	Correct completion to given answer: $r(7.5 + 2 \sin 0.75)$	A1	
10(b)	Correct plan, e.g. Rectangle – segment Rectangle – sector + triangle	M1	
	rectangle: $(2r + 2r \sin 0.75)r$	M1	FT <i>their</i> $2r \sin 0.75$
	segment: $\frac{1}{2}r^2(1.5 - \sin 1.5)$ [= $0.251r^2$]	B1	
	Area = $3.11r^2$	A1	