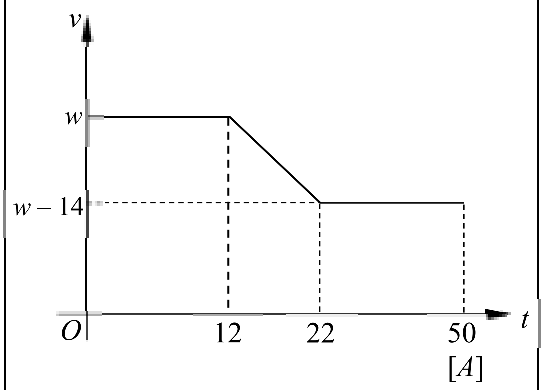
Question	Answer	Marks	Partial Marks
1	Mid-point: $\left(-\frac{5}{2}, 8\right)$ soi	**B1**	
	Gradient: $-\frac{4}{5}$ soi or substitution of mid-point into e.g. $4x+5y=k$	**B1**	
	$y-8=-\frac{4}{5}\left(x+\frac{5}{2}\right)$ or $4x+5y=30$ oe, isw	**B1**	
2	$\log_5\left(\frac{8x+7}{2x}\right)=2$ or $\log_5\left(\frac{8x+7}{2x}\right)=\log_5 25$	**M1**	
	$\frac{8x+7}{2x}=5^2$ oe	**M1**	
	correct completion to $x=\frac{1}{6}$ oe, isw	**A1**	
3(a)	[7! =] 5040	**B1**	
3(b)	3! × 5! oe	**M1**	
	720	**A1**	
3(c)	5040 – (2! × 6!) oe	**M1**	
	3600	**A1**	
4	Eliminates one unknown e.g. $\frac{x^2}{4}+\frac{1}{9}\left(\frac{3}{2x}\right)^2=1$	**M1**	
	Rearranges to solvable form e.g. $x^4-4x^2+1=0$	**A1**	
	Solves : $\frac{-(-4)\pm\sqrt{(-4)^2-4(1)(1)}}{2}$	**M1**	**dep** on attempt to eliminate one unknown and having a 3-term quadratic in x^2
	$x^2=2\pm\sqrt{3}$ oe isw or 3.7320[5...] and 0.2679[4...]	**A1**	
	$x=\pm 1.932$ or $x=\pm 0.518$	**A1**	

Question	Answer	Marks	Partial Marks
5(a)	$f(x)=(x-1)(x-4)$ oe and $f(x)=-(x-1)(x-4)$ oe	**B2**	**B1** for either correct
5(b)	Factorised form: $(5x-1)(x-n)(x-(n+1))$ oe	**B1**	
	their $-1\times(-n)\times(-(n+1))=-2$	**M1**	
	$n=-2$ as the only valid solution	**A1**	
	Multiplies out $(5x-1)(x+2)(x+1)$	**M1**	
	$5x^3+14x^2+7x-2$ or a = 14 and b = 7 following $n=-2$	**A1**	
	Alternative method 1:		
	Factorised form: $(5x-1)(x-n)(x-(n+1))$ oe	**(B1)**	
	Multiplies out $5x^3+(-10n-6)x^2+(5n^2+7n+1)x$ $-(n^2+n)$	**(M1)**	
	their $(n^2+n)=2$ oe	**(M1)**	
	$n=-2$ as the only valid solution	**(A1)**	
	$5x^3+14x^2+7x-2$ or a = 14 and b = 7 following $n=-2$	**(A1)**	

Question	Answer	Marks	Partial Marks
5(b)	**Alternative method 2:**		
	Using product of roots: $\frac{1}{5}n(n+1) = -\left(\frac{-2}{5}\right)$ oe	**(M1)**	
	$n = -2$ as the only valid solution	**(A1)**	
	Using sum of roots and/or sum of products of pairs of roots, solves to find *a* or *b*: $\frac{1}{5} + n + n + 1 = -\frac{a}{5}$ oe and/or $\frac{1}{5}(n) + n(n+1) + \frac{1}{5}(n+1) = \frac{b}{5}$	**(M1)**	
	$a = 14$ or $b = 7$	**(A1)**	
	$5x^3 + 14x^2 + 7x - 2$ or $a = 14$ and $b = 7$ following $n = -2$	**(A1)**	
			If 0 scored for any method, **SC3** for $5\left(\frac{1}{5}\right)^3 + a\left(\frac{1}{5}\right)^2 + b\left(\frac{1}{5}\right) - 2 = 0$ oe **and** $5n^3 + an^2 + bn - 2 = 0$ oe or $5(n+1)^3 + a(n+1)^2 + b(n+1) - 2 = 0$ oe leading to $a = 14$, $b = 7$ with $n = -1$ or n not stated or **SC1** for $5\left(\frac{1}{5}\right)^3 + a\left(\frac{1}{5}\right)^2 + b\left(\frac{1}{5}\right) - 2 = 0$ oe or $5n^3 + an^2 + bn - 2 = 0$ oe or or $5(n+1)^3 + a(n+1)^2 + b(n+1) - 2 = 0$ oe
6(a)(i)	$1 + 21x + 189x^2 + 945x^3$	**B2**	**B1** for three out of the four terms correct or for a correct answer seen then spoilt If 0 scored then **SC1** for $1, 21x, 189x^2, 945x^3$ seen but not summed
6(a)(ii)	$1 + 21(0.01) + 189(0.01)^2 + 945(0.01)^3$ or 1 + 0.21 + 0.0189 + 0.000945 oe leading to 1.229[845 = 1.23] cao	**B2**	**M1** for use of $x = 0.01$ oe in *their* expansion seen or implied by e.g. $1 + 21(0.01) + 189(0.01)^2 + 945(0.01)^3$ or 1 + 0.21 + 0.0189 + 0.000945 OR 1.229845 without working or from working that is not fully correct

Question	Answer	Marks	Partial Marks
6(b)	${}^{15}C_{12} \times \left(\frac{x^4}{2}\right)^3 \times \left(\frac{2}{x}\right)^{12}$ oe	**M1**	
	232960	**A1**	
7(a)	Uses a valid Pythagorean identity to write in terms of a single trig ratio e.g. $1+\tan^2\theta = \tan\theta + 3$	**B1**	
	Rearranges and factorises/solves e.g. $\tan^2\theta - \tan\theta - 2 = 0$ $(\tan\theta - 2)(\tan\theta + 1) = 0$	**M1**	
	$\tan\theta = 2 \quad \tan\theta = -1$ soi	**A1**	
	1.11, –2.03, $-\frac{\pi}{4}$, $\frac{3\pi}{4}$ and no extras in range cao	**A2**	**A1** for any 3 correct, ignoring extras
7(b)	Use of $\tan\phi = \frac{\sin\phi}{\cos\phi}$ in a correct expression or correct working	**M1**	
	Use of $1-\cos^2\phi = \sin^2\phi$ in a correct expression or correct working	**M1**	
	Completion with $\frac{1}{\cos\phi} = \sec\phi$	**A1**	nfww
7(c)	$\cot x = [-]\sqrt{\text{cosec}^2 x - 1}$ soi or $\sin x = -\frac{8}{17}$ and $\tan x = -\frac{8}{15}$ soi or $\sin x = -\frac{8}{17}$ and $\cos x = \frac{15}{17}$ soi or $\frac{1}{\tan\left(\sin^{-1}\left(-\frac{8}{17}\right)\right)}$	**M1**	
	$-\frac{15}{8}$ or –1.875 cao, isw	**A1**	

Question	Answer	Marks	Partial Marks
8(a)	[Area of sector =] $\frac{1}{2}(15)^2\left(\frac{\pi}{6}\right)$ soi	**B1**	
	[Area of triangle =] $\frac{1}{2}(15)(15-a)\sin\left(\frac{\pi}{6}\right)$ soi	**B1**	
	Forms correct equation and attempts to solve for *a* or 15 – *a* or *OC* e.g. $\frac{1}{2}(15)^2\left(\frac{\pi}{6}\right)-\frac{15(15-a)}{4}=\frac{15(15-a)}{4}$ or $\frac{75\pi}{8}=\frac{15}{4}OC$ and solves as far as *a* = ... or 15 – *a* = ... or *OC* = ...	**M1**	
	$15-\frac{5}{2}\pi$ (cm) or exact equivalent	**A1**	
8(b)	[*CA* + arc *AB* + *BC* =] $\sqrt{15^2+\left(\frac{5}{2}\pi\right)^2-2\times15\times\frac{5}{2}\pi\times\cos\frac{\pi}{6}}$ $+\left(15\times\frac{\pi}{6}\right)+\left(15-\frac{5}{2}\pi\right)$ oe, soi	**M2**	**FT** *their*$(15-\frac{5}{2}\pi)$ and $\frac{5}{2}\pi$ **M1** for $15\times\frac{\pi}{6}$ oe seen or $\sqrt{15^2+\left(\frac{5}{2}\pi\right)^2-2\times15\times\frac{5}{2}\pi\times\cos\frac{\pi}{6}}+\left(15-\frac{5}{2}\pi\right)$ oe seen
	24.1 (cm)	**A1**	

Question	Answer	Marks	Partial Marks
9(a)	Correct *v*-*t* graph soi e.g. 	**B1**	
	Equates ‘area’ and distance e.g. $12w+\frac{1}{2}\times10\times(w+w-14)+28(w-14)=458$	**M2**	implies **B1** **M1** for $12w + ... + 28(w – 14) = 458$ soi or $12w + 70 + 10(w – 14) + ... = 458$ soi or $... + 70 + 10(w – 14) + 28(w – 14) = 458$
	18.4 (m s^{-1})	**A1**	
9(b)(i)	$v=t^2-9t+20$, $a = 2t – 9$ or $a = t – 5 + t – 4$ from product rule	**M1**	
	$t = 4.5$	**A1**	
9(b)(ii)	Critical values 4, 5	**M1**	
	$4 < t < 5$	**A1**	
9(b)(iii)	$\int_0^4(t^2-9t+20)\,dt+\left\|\int_4^5(t^2-9t+20)\,dt\right\|$ oe, soi	**M1**	**FT** *their* $t^2-9t+20$ providing 3 terms
	$\left[\frac{t^3}{3}-\frac{9t^2}{2}+20t\right]_0^4+\left\|\left[\frac{t^3}{3}-\frac{9t^2}{2}+20t\right]_4^5\right\|$	**B1**	
	$\frac{64}{3}-72+80+\left\|\frac{125}{3}-\frac{225}{2}+100-\left(\frac{64}{3}-72+80\right)\right\|$	**M1**	**dep** on an attempt to integrate
	$\frac{59}{2}$ oe or 29.5	**A1**	

Question	Answer	Marks	Partial Marks
10(a)	$\overrightarrow{PQ} = 5\mathbf{i} + 15\mathbf{j}$ or $\overrightarrow{OQ} - \overrightarrow{OP} = 5\left(\overrightarrow{OR} - \overrightarrow{OP}\right)$	**B1**	
	$\overrightarrow{OR} = 3\mathbf{i} - 2\mathbf{j} + \frac{1}{5}(their(5\mathbf{i} + 15\mathbf{j}))$ or $\overrightarrow{OR} = x\mathbf{i} + y\mathbf{j}$ $\overrightarrow{PR} = \mathbf{i} + 3\mathbf{j}$ and $\overrightarrow{PR} = (x-3)\mathbf{i} + (y+2)\mathbf{j}$ $x - 3 = 1$ and $y + 2 = 3$ oe or $5\overrightarrow{OR} = \overrightarrow{OQ} + 4\overrightarrow{OP} = 8\mathbf{i} + 13\mathbf{j} + 4(3\mathbf{i} - 2\mathbf{j})$ oe	**M1**	**FT** $\overrightarrow{PR} = \frac{1}{5}(their(5\mathbf{i} + 15\mathbf{j}))$
	$\overrightarrow{OR} = 4\mathbf{i} + \mathbf{j}$	**A1**	
	$\left\|their\ \overrightarrow{OR}\right\| = \sqrt{their(4^2) + their(1^2)}$	**M1**	**FT** *their* $a\mathbf{i} + b\mathbf{j}$
	$\frac{4\mathbf{i} + \mathbf{j}}{\sqrt{17}}$ oe	**A1**	
10(b)	$\overrightarrow{RS} = \lambda\mathbf{j} - their(4\mathbf{i} + \mathbf{j}) = -4\mathbf{i} + (\lambda - 1)\mathbf{j}$ soi or finds [equation *RS* is] $y = 3x + c$	**M1**	
	Correct method to find λ: $\frac{-4}{5} = \frac{\lambda - 1}{15}$ oe or [for some scalar t, $t(\lambda - 1) = 15$ and $-4t = 5$, therefore] $-\frac{5}{4}(\lambda - 1) = 15$ oe or finds e.g. $-2 = 3(3) + c$ oe	**M1**	**dep** on prev **M1** **FT** *their* $\overrightarrow{PQ}$
	$\lambda = -11$ cao	**A1**	

Question	Answer	Marks	Partial Marks
11	Length of rectangle: $6 + e^3$ or $\left[(6+e^3)x\right]_0^2$	M1	
	Area of rectangle: $2(6 + e^3)$ soi	A1	
	Area between curve and *x*-axis: $\int_0^2 (6+e^{4x-5})\,dx = \left[6x+\frac{1}{4}e^{4x-5}\right]_0^2$	M2	**M1** for $\frac{1}{4}e^{4x-5}$
	Correct use of limits in *their* $6x+\frac{1}{4}e^{4x-5}$: F(2) – F(0)	M1	dep on an attempt to integrate that results in $ax + be^{4x-5}$
	their area of rectangle – *their* area between curve and *x*-axis	M1	dep on an attempt to integrate using correct limits
	$\frac{7}{4}e^3+\frac{1}{4e^5}$ or 35.2 or 35.15.... isw	A1	nfww
11	**Alternative method**		
	Length of rectangle: $6 + e^3$ soi	(M1)	
	$\int_0^2 \left(their(6+e^3)-(6+e^{4x-5})\right)dx$	(M1)	
	$\int_0^2 \left((6+e^3)-(6+e^{4x-5})\right)dx$ oe	(A1)	
	$\int_0^2 (e^3-e^{4x-5})\,dx = \left[e^3x-\frac{1}{4}e^{4x-5}\right]_0^2$ oe	(M2)	**M1** for $\frac{1}{4}e^{4x-5}$
	Correct use of limits in *their* $e^3x-\frac{1}{4}e^{4x-5}$ F(2) – F(0)	(M1)	dep on an attempt to integrate that results in $ax + be^{4x-5}$; may be unsimplified
	$\frac{7}{4}e^3+\frac{1}{4e^5}$ or 35.2 or 35.151374.... rot to 4 or more sf	(A1)	nfww

Question	Answer	Marks	Partial Marks
12(a)	$\frac{PQ}{8}=\frac{12-h}{12}$ oe or $\left(\frac{12-h}{12}\right)^2=\frac{\text{Area }\Delta PQR}{16\sqrt{3}}$ oe	M1	
	$PQ=\frac{8(12-h)}{12}$ oe or Area $\Delta PQR=16\sqrt{3}\left(\frac{12-h}{12}\right)^2$ oe	A1	
	$V=\frac{1}{2}\times\left(\frac{8(12-h)}{12}\right)^2\times\sin\frac{\pi}{3}\times h$ oe or $16\sqrt{3}\left(\frac{12-h}{12}\right)^2\times h$	M1	**FT** *their PQ* or Area ΔPQR providing of correct structure
	$V=\frac{\sqrt{3}}{9}\left(h^3-24h^2+144h\right)$	A1	
12(b)	$\frac{\mathrm{d}V}{\mathrm{d}h}=\frac{\sqrt{3}}{9}\left(3h^2-48h+144\right)$	B1	**FT** *their* $V=\frac{\sqrt{3}}{9}\left(h^3-24h^2+144h\right)$ if of the same structure
	their $\frac{\sqrt{3}}{9}\left(3h^2-48h+144\right)=0$ and factorises/solves	M1	must be a 3-term quadratic; must be an attempt at a derivative
	4 oe identified as the only solution; cao	A1	