1		$\frac{d}{dx}(xy) = x\frac{dy}{dx} + y$	**B1**		s.o.i. e.g. $2x\frac{dy}{dx} + y$
		$\frac{d}{dx}(y^2) = 2y\frac{dy}{dx}$	**B1**		
		Substitute (1,2) into their differentiated equation and attempt to solve for $\frac{dy}{dx}$. [Allow subst of (2,1)]	**M1** dep at least 1 x **B1**		Or attempt to solve their diff equation for $\frac{dy}{dx}$ and then substitute (1,2)
		$\frac{dy}{dx} = -2$	**A1**	**4**	
2	**(i)**	$1 + (-2)(-3x) + \frac{(-2)(-3)}{1.2}(-3x)^2$ (+ … ignore)	**M1**		State or imply; accept $-3x^2$ & $-9x^2$
		$= 1 + 6x$	**B1**		Correct first 2 terms
		… $+ 27x^2$	**A1**	**3**	Correct third term
	(ii)	$(1+2x)^2(1-3x)^{-2}$	**M1**		For changing into suitable form, seen/implied
		Attempt to expand $(1+2x)^2$ & select (at least) 2 relevant products and add	**M1**		Selection may be after multiplying out
		55 (Accept $55x^2$)	**A2√**	**4**	If (i) is $a + bx + cx^2$, f.t. $4(a+b)+c$
		<u>SR 1</u> For expansion of $(1+2x)^2$ with 1 error, A1√			
		<u>SR 2</u> For expansion of $(1+2x)^2$ & > 1 error, A0			
		<u>Alternative Method</u>			
		For correct method idea of long division	**M1**		
		1 ….. $+10x$ ….. $+55x^2$	**A1,A1,A1(4)**		
3	**(i)**	$\frac{A}{x} + \frac{B}{3-x}$ & c-u rule or $A(3-x) + Bx \equiv 3 - 2x$	**M1**		Correct format + suitable method
		$\frac{1}{x}$	**A1**		seen in (i) or (ii)
		$-\frac{1}{3-x}$	**A1**	**3**	ditto; $\frac{1}{x} - \frac{1}{3-x}$ scores 3 immediately
	(ii)	$\int \frac{1}{x}(dx) = \ln x$ or $\ln\|x\|$	**B1**		
		$\int \frac{1}{3-x}(dx) = -\ln(3-x)$ or $-\ln\|3-x\|$	**B1**		Check sign carefully; do not allow $\ln(x-3)$
		Correct method idea of substitution of limits	**M1**		Dep on an attempt at integrating
		ln 2 (+ ln 1 − ln 1) − ln 2 = 0	**A1**	**4**	Clearly seen; WWW **AG**
		<u>Alternative Method</u>			
		If ignoring PFs, ln x(3 − x) immediately	**B2**		$\ln x(x-3) \to 0$
		As before	**M1,A1**	**(4)**	
	(iii)	Suitable statement or clear implication e.g. Equal amounts (of area) above and below (axis) or graph crosses axis or there's a root (Be lenient)	**B1**	**1**	

Q		Answer	Marks		Guidance
4	(i)	Working out **b** – **a** or **a** – **b** or **c** – **a** or **a** – **c**	M1	)	Irrespective of label
		= ± (– 3**i** – **j** – **k**) or ± (– 2**i** + **j** – 2**k**)	A1	)	If not scored ,these 1st 3 marks can be
		Method for finding magnitude of <u>any</u> vector	M1	)	awarded in part (ii)
		Method for finding scalar product of <u>any</u> 2 vectors	M1		
		Using $\cos\theta = \frac{a.b}{\lvert a\rvert\lvert b\rvert}$ AEF for <u>any</u> 2 vectors	M1		
		<u>[Alternative cosine rule method</u> $\lvert\overrightarrow{BC}\rvert = \sqrt{6}$	B1		
		Cosine rule used	M1		'Recognisable' form
		$45.3°, 0.79(0), \frac{\pi}{3.97}$ (45.289378, 0.7904487)	A1	6	Do not accept supplement (134.7 etc)
	(ii)	Use of $\frac{1}{2}\lvert\overrightarrow{AB}\rvert\lvert\overrightarrow{AC}\rvert\sin\theta$	M1		Accept $\left\lvert\frac{1}{2}\overrightarrow{AB} \times \overrightarrow{AC}\right\rvert$
		3.54 (3.5355) or $\frac{5\sqrt{2}}{2}$	A1	2	Accept from correct supp (134.7 etc)
5	(i)	$\frac{dA}{dt}$ or kA^2 seen	M1		
		$\frac{dA}{dt} = kA^2$	A1	2	
	(ii)	Separate variables + attempt to integrate	*M1		Accept if based on $\frac{dA}{dt} = kA^2$ or A^2
		$-\frac{1}{A} = kt + c$ or $-\frac{1}{kA} = t + c$ or $-\frac{1}{A} = t + c$	A1		
		Subst one of (0,0),(1,1000) or (2,2000) into eqn.	dep*M1		Equation must contain k and/or c
		Subst another of (0,),(1,1000) or (2,2000) into eqn	dep*M1		This equation must contain k <u>and</u> c
		Substitute $A = 3000$ into eqn with k and c subst	dep*M1		
		$t = \frac{7}{3}$ ISW	A1	6	Accept 2.33, 2h 20 m
6	(i)	Attempt to connect du and dx e.g. $\frac{du}{dx} = e^x$	M1		But not $du = dx$
		Use of $e^{2x} = (e^x)^2$ or $(u-1)^2$ s.o.i.	A1		
		Simplification to $\int \frac{u-1}{u}(du)$ WWW	A1	3	**AG**
	(ii)	Change $\frac{u-1}{u}$ to $1 - \frac{1}{u}$ or use parts	M1		If parts, may be twice if $\int \ln x \, dx$ is involved
		$\int \frac{1}{u} du = \ln u$	A1		Seen anywhere in this part
		<u>Either</u> attempt to change limits <u>or</u> resubstitute	M1 (indep)		Expect new limits e+1 & 2
		Show as $e + 1 - \ln(e+1) - \{2 \text{ or } (1+1)\} + \ln 2$	A1		
		WWW show final result as $e - 1 - \ln\left(\frac{e+1}{2}\right)$	A1	5	**AG**

7	(i)	Produce at least 2 of the 3 relevant eqns in λ and μ	M1		e.g. $1 + 3\lambda = -8 + \mu,\ -2 + \lambda = 2 - 2\mu$
		Solve the 2 eqns in λ & μ as far as λ = … or μ = …	M1		
		1st solution: $\lambda = -2$ or $\mu = 3$	A1		
		2nd solution: $\mu = 3$ or $\lambda = -2$ f.t.	A1√		
		Substitute their λ and μ into 3rd eqn and find 'a'	M1		
		Obtain $a = 2$ <u>& clearly state that a cannot be 2</u>	A1	6	
	(ii)	Subst their λ or μ (& poss a) into either line eqn	M1		
		Point of intersection is $-5\mathbf{i} - 4\mathbf{j}$	A1	2	Accept any format <u>No f.t. here</u>
		N.B. In this question, award marks irrespective of labelling of parts			
8	(i)	<u>Integration method</u>			
		Attempt to change $\cos^2 6x$ into $f(\cos 12x)$	M1		
		$\cos^2 6x = \frac{1}{2}(1 + \cos 12x)$	A1		with $\cos^2 6x$ as the subject of the formula
		$\int = \frac{1}{2}x + \frac{1}{24}\sin 12x + c$	A1		**AG** Accept $\frac{1}{2}\left(x + \frac{1}{12}\sin 12x\right)$
		<u>Differentiation method</u>			
		Differentiate RHS producing $\frac{1}{2} + \frac{1}{2}\cos 12x$ ---(E)	B1		
		Attempt to change $\cos 12x$ into $f(\cos 6x)$	M1		Accept $+/-2\cos^2 6x +/-1$
		Simplify (E) WWW to $\cos^2 6x$ + satis finish	A1	3	
	(ii)	Parts with $u = x, \mathrm{d}v = \cos^2 6x$	*M1		
		$x\left(\frac{1}{2}x + \frac{1}{24}\sin 12x\right) - \int\left(\frac{1}{2}x + \frac{1}{24}\sin 12x\right)\mathrm{d}x$	A1		Correct expression only
		$\int \sin 12x\,\mathrm{d}x = -\frac{1}{12}\cos 12x$	B1		Clear indication somewhere in this part
		Correct use of limits to <u>whole</u> integral	dep*M1		Accept ( ) (−0)
		$\frac{\pi^2}{288} - \frac{\pi^2}{576} - \frac{1}{288} - \frac{1}{288}$	A1		AE unsimp exp. Accept 12x24,sin π here
		$\frac{\pi^2}{576} - \frac{1}{144}$	+A1	6	Tolerate e.g. $\frac{2}{288}$ here
		S.R. If final marks are A0 + A0, allow SR A1 for			0.01/0.010/0.0101/0.0102/0.0101902

9	**(i)**	$\frac{dy}{dx} = \frac{\frac{dy}{dt}}{\frac{dx}{dt}}$	**M1**		Used, not just quoted
		$\frac{dx}{dt} = -4\sin t$ or $\frac{dy}{dt} = 3\cos t$	***B1**		
		$\frac{dy}{dx} = -\frac{3\cos t}{4\sin t}$ or $\frac{3\cos t}{-4\sin t}$ ISW	**dep*A1**	**3**	Also $\frac{-3\cos t}{4\sin t}$ provided B0 not awarded
		SR: M1 for Cartesian eqn attempt + B1 for $\frac{d}{dx}\left(y^2\right) = 2y\frac{dy}{dx}$ + **A1** as before(must be in terms of t)			
	(ii)	$y - 3\sin p = \left(\text{their } \frac{dy}{dx}\right)(x - 4\cos p)$	**M1**		Accept p or t here
		or $y = \left(\text{their } \frac{dy}{dx}\right)x + c$ & subst cords to find c			Ditto
		$4y\sin p - 12\sin^2 p = -3x\cos p + 12\cos^2 p$	**A1**		Correct equation cleared of fractions
		or c = $\frac{12\sin^2 p + 12\cos^2 p}{4\sin p}$			
		$3x\cos p + 4y\sin p = 12$ WWW	**A1**	**3**	**AG** Only p here. Mixture earlier $\to$ A0
	(iii)	Subst $x = 0$ and $y = 0$ separately in tangent eqn	**M1**		to find R & S
		Produce $\frac{3}{\sin p}$ and $\frac{4}{\cos p}$	**A1**		Accept $\frac{12}{4\sin p}$ and/or $\frac{12}{3\cos p}$
		Use $\Delta = \frac{1}{2}\left(\frac{3}{\sin p}.\frac{4}{\cos p}\right) = \frac{12}{\sin 2p}$ WWW	**A1**	**3**	**AG**
	(iv)	Least area = 12	**B1**		
		$p = \frac{1}{4}\pi$ as final or only answer	**B2**	**3**	These B marks are independent.
		S.R. $45° \to$ B1 ;			S.R. [-12 and e.g. $-\pi/4 \to$ B1]