$\frac{6x^2-16}{(x+1)(2x-3)}=\frac{B}{x+1}+\frac{C}{2x-3}$ and via substitution will get "a correct" $\frac{2}{x+1}-\frac{1}{2x-3}$

$\int\frac{6x^2-16}{(x+1)(2x-3)}\,dx=\int\frac{"B"}{x+1}+\frac{"C"}{2x-3}\,dx="B"\ln(x+1)+\frac{"C"}{2}\ln(2x-3)$

Scores SC B0 M0 A0 M1 A1ft A0 for 2 out of 6 if ft integration is correct

Question Number	Scheme	Marks
8 (a)	$\begin{pmatrix}4\\-3\\2\end{pmatrix}+\lambda\begin{pmatrix}3\\-2\\-1\end{pmatrix}=\begin{pmatrix}2\\0\\-9\end{pmatrix}+\mu\begin{pmatrix}2\\-1\\-3\end{pmatrix}\Rightarrow\begin{matrix}4+3\lambda=2+2\mu\\-3-2\lambda=0-1\mu\\2-1\lambda=-9-3\mu\end{matrix}$ **any two** of these	M1
	Full method to find either λ **or** μ eg $(1)+3(3)\Rightarrow\mu=...$	M1
	Either $\lambda=-4$ or $\mu=-5$	A1
	Position vector of intersection is $\begin{pmatrix}4\\-3\\2\end{pmatrix}-4\begin{pmatrix}3\\-2\\-1\end{pmatrix}=$ OR $\begin{pmatrix}2\\0\\-9\end{pmatrix}-5\begin{pmatrix}2\\-1\\-3\end{pmatrix}=$	dM1
	$=\begin{pmatrix}-8\\5\\6\end{pmatrix}$	A1 **(5)**
(b)	Co-ordinates or position vector of point $Q=\begin{pmatrix}2+2\mu\\0-1\mu\\-9-3\mu\end{pmatrix}$	
	$\overrightarrow{PQ}=\begin{pmatrix}2+2\mu\\0-1\mu\\-9-3\mu\end{pmatrix}-\begin{pmatrix}10\\-7\\0\end{pmatrix}=\begin{pmatrix}2\mu-8\\7-1\mu\\-9-3\mu\end{pmatrix}$	M1
	Uses $\overrightarrow{PQ}.\begin{pmatrix}2\\-1\\-3\end{pmatrix}=0\Rightarrow4\mu-16-7+\mu+27+9\mu=0\Rightarrow\mu=-\frac{2}{7}$	dM1 A1
	Substitutes their μ into $\begin{pmatrix}2+2\mu\\0-1\mu\\-9-3\mu\end{pmatrix}\Rightarrow Q=\left(\frac{10}{7},\frac{2}{7},-\frac{57}{7}\right)$	ddM1 A1 **(5)** **(10 marks)**

(a)

M1: For writing down **any two equations** that give the coordinates of the point of intersection.

Accept two of $4+3\lambda=2+2\mu$, $-3-2\lambda=0-1\mu$, $2-1\lambda=-9-3\mu$

There must be an attempt to set the coordinates equal but condone one slip.

Setting the vectors equal to each other is insufficient for this but correct calculations will imply this.

M1: A full method to find **either** λ **or** μ. There are a few answers with limited or no working.

In such cases this M mark can be implied only if **either** λ **or** μ are correct for their equations.

A1: Either value correct $\mu=-5$ or $\lambda=-4$. Correct value(s) following correct equations implies M1 A1

dM1: Substitutes their value of λ into l_1 to find the coordinates or position vector of the point of intersection.

It is dependent upon having scored second method mark. Alternatively substitutes their value of μ into l_2 to find the coordinates or position vector of the point of intersection. It can be implied in cases where there is limited working by two correct coordinates for their λ **or** μ.

A1: Either $\begin{pmatrix}-8\\5\\6\end{pmatrix}$ or $-8\mathbf{i}+5\mathbf{j}+6\mathbf{k}$ but not the coordinate $(-8, 5, 6)$

However ISW after sight of the correct **vector****

(b)

M1: States or uses a general point on $l_2=\begin{pmatrix}2+2\mu\\0-1\mu\\-9-3\mu\end{pmatrix}$ and attempt $\overrightarrow{PQ}=\begin{pmatrix}2+2\mu\\0-1\mu\\-9-3\mu\end{pmatrix}-\begin{pmatrix}10\\-7\\0\end{pmatrix}=\begin{pmatrix}2\mu-8\\7-1\mu\\-9-3\mu\end{pmatrix}$ either way around with their general point. Condone slips

dM1: Uses the scalar product with fact that $\overrightarrow{PQ}$ and $\begin{pmatrix}2\\-1\\-3\end{pmatrix}$ are perpendicular vectors to find μ

See scheme but again condone slips.

Alternatively uses the scalar product with fact that $\overrightarrow{PQ}$ and $\overrightarrow{XQ}$ are perpendicular vectors to find μ

$\overrightarrow{PQ}.\overrightarrow{XQ}=0\Rightarrow(2\mu-8)(2\mu+10)+(7-\mu)(-\mu-5)+(-9-3\mu)(-15-3\mu)=0\Rightarrow\mu=\left(-\frac{2}{7}\right)$

A1: $\mu=-\frac{2}{7}$

ddM1: Uses their μ to find the coordinates of Q.

If no method is seen imply by two correct coordinates for their μ

A1: $Q=\left(\frac{10}{7},\frac{2}{7},-\frac{57}{7}\right)$ but not (**) $\frac{10}{7}\mathbf{i}+\frac{2}{7}\mathbf{j}-\frac{57}{7}\mathbf{k}$ o.e

** Only penalise incorrect notation once, the first time that it occurs. **

Alt using distances

(b)	Co-ordinates or position vector of point $Q = \begin{pmatrix} 2+2\mu \\ 0-1\mu \\ -9-3\mu \end{pmatrix}$	
	$\overrightarrow{PQ} = \begin{pmatrix} 2+2\mu \\ 0-1\mu \\ -9-3\mu \end{pmatrix} - \begin{pmatrix} 10 \\ -7 \\ 0 \end{pmatrix} = \begin{pmatrix} 2\mu-8 \\ 7-1\mu \\ -9-3\mu \end{pmatrix}$	M1
	Uses Pythagoras with $PQ^2 + QX^2 = PX^2 \Rightarrow 28\mu^2 + 148\mu + 544 = 504 \Rightarrow \mu = \cancel{-5}, -\frac{2}{7}$	dM1 A1
	Substitutes their μ into $\begin{pmatrix} 2+2\mu \\ 0-1\mu \\ -9-3\mu \end{pmatrix} \Rightarrow Q = \left(\frac{10}{7}, \frac{2}{7}, -\frac{57}{7}\right)$	ddM1 A1

Alt using minimum distance and differentiation

(b)	Co-ordinates or position vector of point $Q = \begin{pmatrix} 2+2\mu \\ 0-1\mu \\ -9-3\mu \end{pmatrix}$	
	$\overrightarrow{PQ} = \begin{pmatrix} 2+2\mu \\ 0-1\mu \\ -9-3\mu \end{pmatrix} - \begin{pmatrix} 10 \\ -7 \\ 0 \end{pmatrix} = \begin{pmatrix} 2\mu-8 \\ 7-1\mu \\ -9-3\mu \end{pmatrix}$	M1
	Uses Pythagoras with $PQ^2 = (2\mu-8)^2 + (7-\mu)^2 + (-9-3\mu)^2$ $\frac{\mathrm{d}}{\mathrm{d}\mu} PQ^2 = 0 \Rightarrow 4(2\mu-8) - 2(7-\mu) - 6(-9-3\mu) = 0 \Rightarrow \mu = -\frac{2}{7}$	dM1 A1
	Substitutes their μ into $\begin{pmatrix} 2+2\mu \\ 0-1\mu \\ -9-3\mu \end{pmatrix} \Rightarrow Q = \left(\frac{10}{7}, \frac{2}{7}, -\frac{57}{7}\right)$	ddM1 A1

Question Number	Scheme	Marks
9 (a)	$\frac{\mathrm{d}A}{\mathrm{d}t}=\frac{A^{\frac{3}{2}}}{5t^2}\Rightarrow\int\frac{\mathrm{d}A}{A^{\frac{3}{2}}}=\int\frac{\mathrm{d}t}{5t^2}$ oe	M1
	$-2A^{-\frac{1}{2}}=-\frac{1}{5}t^{-1}(+c)$	M1 M1 A1
	Substitutes $t=3, A=2.25\Rightarrow c=...\left(-\frac{19}{15}\right)$	M1
	Uses their $\frac{2}{\sqrt{A}}=\frac{1}{5t}+\frac{19}{15}\Rightarrow A=\left(\frac{30t}{19t+3}\right)^2$	M1, A1
		(7)
(b)	As $t\to\infty, A\to\left(\frac{30}{19}\right)^2=\frac{900}{361}$ or awrt 2.49 cm^2	M1 A1
		(2)
		(9 marks)

(a)

M1: Attempts to separate the variables either $\int\frac{\mathrm{d}A}{A^{\frac{3}{2}}}=\int...\frac{\mathrm{d}t}{t^2}$ oe such as $\int...\frac{\mathrm{d}A}{A^{\frac{3}{2}}}=\int\frac{\mathrm{d}t}{t^2}$

Condone without the integral signs but the $A^{\frac{3}{2}}$, $\mathrm{d}A$, t^2 and $\mathrm{d}t$ must be in the correct positions.
Don't be too concerned on the position of the "5"

M1: Integrates one side correctly. Look for $pA^{-\frac{1}{2}}$ or qt^{-1}

dM1: Integrates both sides correctly. Look for $pA^{-\frac{1}{2}}$ and qt^{-1}

A1: Correct intermediate stage (without $+c$).

Either $-2A^{-\frac{1}{2}}=-\frac{1}{5}t^{-1}(+c)$ or $-10A^{-\frac{1}{2}}=-t^{-1}(+c)$ or equivalent such as $-\frac{A^{-0.5}}{0.5}=-\frac{1}{5}t^{-1}(+c)$

M1: Must have a "$+c$ " now. It is for using $t=3, A=2.25\Rightarrow c=...$.

There must be some evidence for this award which may be implied by their value for c if no working is seen.
One index must have started out correct
This may be awarded after an incorrect change of subject has occurred.

M1: It is for proceeding to $A=\left(\frac{pt}{qt+r}\right)^2$ from an equation of the form $\frac{p}{\sqrt{A}}=\frac{q}{t}+r$ with correct operations.

Candidates do not need to have found a **value** for r (their constant) to score this mark
The attempt must involve

- using a common factor on the rhs of $\frac{p}{\sqrt{A}}=\frac{q}{t}+r$
- "inverting" both sides not each term
- an attempt to square both sides and not each term to reach A = ...

A1: $A=\left(\frac{30t}{19t+3}\right)^2$ cso. This mark can be awarded independent of the first M1