Question Number	Scheme	Marks
8(a)	$\pm\left(-6\mathbf{i}+4\mathbf{j}-\mathbf{k}-\left(-10\mathbf{i}+5\mathbf{j}-4\mathbf{k}\right)\right)$	M1
	e.g. $\mathbf{r}=-10\mathbf{i}+5\mathbf{j}-4\mathbf{k}\pm\lambda\left(4\mathbf{i}-\mathbf{j}+3\mathbf{k}\right)$ e.g. $\mathbf{r}=-6\mathbf{i}+4\mathbf{j}-\mathbf{k}\pm\lambda\left(4\mathbf{i}-\mathbf{j}+3\mathbf{k}\right)$	A1
		(2)
(b)	$3+3\mu=-6\Rightarrow\mu=-3$	M1
	$p+12=4\Rightarrow p=\ldots$ or $q-3=-1\Rightarrow q=\ldots$	dM1
	$p=-8,\quad q=2$	A1
		(3)
(c)	$\left(4\mathbf{i}-\mathbf{j}+3\mathbf{k}\right)\left(3\mathbf{i}-4\mathbf{j}+\mathbf{k}\right)=12+4+3$	M1
	$\left(4\mathbf{i}-\mathbf{j}+3\mathbf{k}\right)\left(3\mathbf{i}-4\mathbf{j}+\mathbf{k}\right)=\sqrt{26}\sqrt{26}\cos\theta=19\Rightarrow\cos\theta=\ldots$	M1
	$\left(\cos\theta=\right)\ \frac{19}{26}$	A1
		(3)
(d)	$AC=AB\sin\theta=\sqrt{26}\sqrt{1-\left(\frac{19}{26}\right)^2}$	M1
	$\frac{3\sqrt{910}}{26}$ o.e.	A1
		(2)
		Total 10

(a)

M1: Attempts the direction of l_1. The expression is sufficient condoning one sign slip or may be implied by 2 correct components of $\pm\left(4\mathbf{i}-\mathbf{j}+3\mathbf{k}\right)$

A1: Any correct equation including '$\mathbf{r}=$'. Allow any parameter to be used including μ.

Allow $\mathbf{r}=-10\mathbf{i}+5\mathbf{j}-4\mathbf{k}\pm\lambda\left(4\mathbf{i}-\mathbf{j}+3\mathbf{k}\right)$, $\mathbf{r}=\begin{pmatrix}-10\\5\\-4\end{pmatrix}\pm\lambda\begin{pmatrix}4\\-1\\3\end{pmatrix}$, $\mathbf{r}=\begin{pmatrix}-6\\4\\-1\end{pmatrix}\pm\lambda\begin{pmatrix}-4\\1\\-3\end{pmatrix}$

Do not accept i, j, k notation in either bracket using column vector notation

e.g. $\mathbf{r}=\begin{pmatrix}-10\\5\\-4\end{pmatrix}\pm\lambda\begin{pmatrix}4\mathbf{i}\\-1\mathbf{j}\\3\mathbf{k}\end{pmatrix}$

(b)

M1: Equates the *x* component of l_2 to -6 and proceeds to find a value for μ.

dM1: Uses the value of μ to find *p* or *q*. It is dependent on the previous method mark.

Alternatively,

- forms a correct equation for the *x* component using their l_1 and l_2
- proceeds to find λ
- uses this value of λ with the value of μ correctly to find *p* or *q* by forming an equation for the *y* or *z* component.

Do not be concerned by the mechanics of the rearrangement in solving.

A1: Correct values

Alt (b)

M1: Forms three correct equations $3+3\mu=-6,\ p-4\mu=4,\ q+\mu=-1$

dM1: Solves simultaneously to find a value for *p* or *q*. Do not be concerned by the mechanics of the rearrangement.

A1: Correct values

(c)

M1: Attempts the scalar product using their direction vectors or may find another direction vector which should be a multiple of the one for l_1 or l_2 (condoning slips e.g. if they restart using another point on l_2 to find a direction vector). Look for at least two correct products using their l_1. May be implied by "±19". May find the obtuse angle which can still score this mark.

M1: Completes the scalar product method using their direction vectors to find cos θ (acute or obtuse). Attempts the magnitude of both of their direction vectors and uses these values in the correct positions in the equation for cos θ

A1: $\frac{19}{26}$ or exact equivalent. Do not accept fractions where the numerator or denominator is not an integer (square roots must be evaluated). Isw if they proceed to find θ

Alt (c) There will be many alternatives such as the one below. Send to review if unsure.

M1: The first mark should be for finding the required components to use in the cosine rule e.g. attempts to find another point *P* on l_2 and attempts to find the lengths of *AB*, *BP* and *PA*

M1: The second mark should be using all the components required in the cosine rule. E.g.uses their lengths for *AB*, *BP* and *PA* in the correct positions in the cosine rule.

A1: As above in the main scheme notes.

(d)

M1: Fully correct method to find the exact value for the length of *AC*.

May alternatively attempt e.g.

$$\begin{pmatrix}3\\-4\\1\end{pmatrix}\bullet\begin{pmatrix}13+3\mu\\-13-4\mu\\6+\mu\end{pmatrix}=0\Rightarrow\mu=-\frac{97}{26}\Rightarrow\overrightarrow{AC}=\begin{pmatrix}\frac{47}{26}\\\frac{25}{13}\\\frac{59}{26}\end{pmatrix}\Rightarrow AC=\sqrt{\left(\frac{47}{26}\right)^2+\left(\frac{25}{13}\right)^2+\left(\frac{59}{26}\right)^2}$$

Note the coordinates for *C* are $\left(-\frac{213}{26},\frac{90}{13},-\frac{45}{26}\right)$ and they may use their coordinates for *C* with point *A* to find the distance *AC*. Condone one sign slip in the distance formula. i.e. there must be sufficient evidence that they were attempting the differences between appropriate coordinates.

Look out for other fully correct methods to find the exact value for the length of *AC*.

e.g. attempts to find $|BC|$ and uses either trigonometry or Pythagoras' Theorem.

A1: Correct value. Allow $\sqrt{\frac{315}{26}}$ or $3\sqrt{\frac{35}{26}}$

Question Number	Scheme	Marks
9(a)	$\dfrac{1}{x(2x-1)} \equiv \dfrac{A}{x} + \dfrac{B}{2x-1} \Rightarrow 1 \equiv A(2x-1) + Bx \Rightarrow A = ... \text{or } B = ...$	M1
	$\dfrac{1}{x(2x-1)} \equiv \dfrac{2}{2x-1} - \dfrac{1}{x}$	A1
		(2)
(b)	$\dfrac{\mathrm{d}h}{\mathrm{d}t} = \dfrac{1}{50}h(2h-1)\cos\left(\dfrac{t}{10}\right) \Rightarrow \displaystyle\int \dfrac{1}{h(2h-1)}\mathrm{d}h = \int \dfrac{1}{50}\cos\left(\dfrac{t}{10}\right)\mathrm{d}t$	M1
	$\displaystyle\int \dfrac{1}{h(2h-1)}\mathrm{d}h = \int \left(\dfrac{2}{2h-1} - \dfrac{1}{h}\right)\mathrm{d}h = \ln(2h-1) - \ln h$	M1
	$\displaystyle\int \left(\dfrac{2}{2h-1} - \dfrac{1}{h}\right)\mathrm{d}h = \int \dfrac{1}{50}\cos\left(\dfrac{t}{10}\right)\mathrm{d}t \Rightarrow \ln(2h-1) - \ln h = \dfrac{1}{5}\sin\left(\dfrac{t}{10}\right)\ (+c)$	A1ft
	e.g. $t = 0, h = 2.5 \Rightarrow \ln(2\times 2.5 - 1) - \ln 2.5 = c$ or e.g. $\ln\dfrac{2h-1}{h} = \dfrac{1}{5}\sin\left(\dfrac{t}{10}\right) + c \Rightarrow \dfrac{2h-1}{h} = X\mathrm{e}^{\frac{1}{5}\sin\left(\frac{t}{10}\right)}$ $\quad t = 0, h = 2.5 \Rightarrow X = 1.6$	M1
	$\ln(2h-1) - \ln h = \dfrac{1}{5}\sin\left(\dfrac{t}{10}\right) + \ln 1.6 \Rightarrow \dfrac{2h-1}{h} = 1.6\mathrm{e}^{\frac{1}{5}\sin\left(\frac{t}{10}\right)}$ $\Rightarrow 2h - 1.6h\mathrm{e}^{\frac{1}{5}\sin\left(\frac{t}{10}\right)} = 1 \Rightarrow h = ...$	M1
	$h = \dfrac{5}{10 - 8\mathrm{e}^{\frac{1}{5}\sin\left(\frac{t}{10}\right)}}$	A1
		(6)
(c)	$\sin\left(\dfrac{t}{10}\right) = 1 \Rightarrow \dfrac{t}{10} = \dfrac{\pi}{2}, \dfrac{5\pi}{2}, \dfrac{9\pi}{2}, ... \Rightarrow t = ...$	M1
	$t = 45\pi = 141$ (s)	A1
		(2)
		Total 10

(a)

M1: Correct attempt at partial fractions. Sets $\dfrac{1}{x(2x-1)} = \dfrac{A}{x} + \dfrac{B}{2x-1}$ and uses a correct method to identify at least one constant. Incorrect work e.g. $\dfrac{A}{x} + \dfrac{B}{2x-1} \Rightarrow 1 = Ax + B(2x-1)$ etc. is M0.

A1: Correct partial fractions. Note that this mark is not just for the correct constants, it is for the correct written fractions but allow this mark to be scored if it is seen in part (b) (in terms of h or x).

Condone $\dfrac{2}{2x-1} + \dfrac{-1}{x}$ or written as e.g. $2(2x-1)^{-1} - x^{-1}$