Question Number	Scheme	Marks
2 (a)	States that $\begin{pmatrix}4\\-3\\10\end{pmatrix}$ is not a scalar multiple of $\begin{pmatrix}2\\-1\\5\end{pmatrix}$	B1 **(1)**
(b)	Assume that there exists a λ and a μ such that $\begin{pmatrix}-2\\5\\3\end{pmatrix}+\lambda\begin{pmatrix}2\\-1\\5\end{pmatrix}=\begin{pmatrix}6\\12\\-5\end{pmatrix}+\mu\begin{pmatrix}4\\-3\\10\end{pmatrix}$	B1
	Attempts to solve two of the equations and find either λ or μ .	M1
	Correct values for either λ or μ for the appropriate equation E.g. (1) and (2) $-2+2\lambda=6+4\mu \quad 5-1\lambda=12-3\mu \quad \Rightarrow \lambda=26$ or $\mu=11$	A1
	E.g Uses $\lambda=26, \mu=11$ in equation (3) LHS = $3+5\lambda=133$ RHS = $-5+10\mu=105$	dM1
	$133 \neq 105$, so lines don't intersect	A1 **(5)** **(6 marks)**

(a)

B1: Explains that $\begin{pmatrix}4\\-3\\10\end{pmatrix}$ is not a (scalar) multiple of $\begin{pmatrix}2\\-1\\5\end{pmatrix}$. E.g States that $\begin{pmatrix}4\\-3\\10\end{pmatrix}\neq k\begin{pmatrix}2\\-1\\5\end{pmatrix}$

Allow attempts via use of ratios such as $4=\underline{\underline{2}}\times 2$, $10=\underline{\underline{2}}\times 5$ but $-3=\underline{\underline{3}}\times -1$ so cannot be parallel.

Condone for this mark a statement that 'the direction vectors are not multiples of each other'

(b)

B1: Sets up the contradiction

There must be some words and a reference to what it would mean for the equations

E.g.I Assume that l_1 and l_2 intersect so

$-2+2\lambda=6+4\mu$, $5-1\lambda=12-3\mu$ and $3+5\lambda=-5+10\mu$

E.g.II Assume the lines meet so

$-2+2\lambda=6+4\mu$, $5-1\lambda=12-3\mu$ and $3+5\lambda=-5+10\mu$

The equations may appear some way after the assumption

Note that B0, M1, A1, dM1, A1 is possible

Standard/usual method:

M1: Attempts to solve two of the equations to find the value of λ OR μ

E.g. (1) and (2) $-2+2\lambda=6+4\mu \quad 5-1\lambda=12-3\mu \quad \Rightarrow \lambda=...$or $\mu=...$

E.g. (2) and (3) $3+5\lambda=-5+10\mu \quad 5-\lambda=12-3\mu \quad \Rightarrow \lambda=...,$or $\mu=...$

Condone slips in the coefficients of the initial equations but it must lead to a value for either λ or μ

A1: Find the correct value of λ or μ for the equations they choose.

E.g. Equations (1) and (2) $\lambda = 26$ or $\mu = 11$ or Equations (2) and (3) $\lambda = 9.2$ or $\mu = 5.4$

dM1: Dependent upon the previous M. This mark is scored for substituting their values of λ and μ into both sides of the third equation and comparing values/equating values. Alternatively, they may substitute their value of λ or μ into their third equation and find a contradictory value for μ or λ. Again, condone slips, but the intention must be clear.

A1: Requires all of the following

- accurate calculations and values for the approach they use
- a reason e.g. '$133 \neq 105$'
- a minimal conclusion such as 'lines don't intersect' 'contradiction', 'hence proven' or ✓.

So, using equations **(2) and (3)** expect to see:

$3+5\lambda = -5+10\mu \quad 5-\lambda = 12-3\mu \quad \Rightarrow \lambda = 9.2, \mu = 5.4$

which when substituted into (1) gives LHS = $-2+2\lambda = 16.4$ RHS = $6+4\mu = 27.6$

Other correct methods exist. You should look very carefully at what the candidates are doing.

Three alternative methods that have been seen are:

Alt I: Uses two of the equations to find one unknown.

Uses two different equations to find the same unknown and compares

E.g. (1) and (2) $-2+2\lambda = 6+4\mu \quad 5-1\lambda = 12-3\mu \quad \Rightarrow \mu = 11$

(2) and (3) $3+5\lambda = -5+10\mu \quad 5-\lambda = 12-3\mu \quad \Rightarrow \mu = 5.4$

As these are different, lines don't meet and are skew

Score M1: For attempting to solve two equations and find one unknown

A1: For correctly finding one correct value for their equations

dM1: For attempting to solve two different equations and find the same unknown

A1: For correct values, valid statement and suitable conclusion

Alt II: Uses two equations to find one unknown

Uses two different equations to find the other unknown.

Substitutes in one of the equations and compares

E.g. (1) and (2) $-2+2\lambda = 6+4\mu \quad 5-1\lambda = 12-3\mu \quad \Rightarrow \mu = 11$

(2) and (3) $3+5\lambda = -5+10\mu \quad 5-\lambda = 12-3\mu \quad \Rightarrow \lambda = 9.2$

Then substitute into (1) $-2+2\lambda = 16.4, \quad 6+4\mu = 50$

As these are different, lines don't meet and are skew

Score M1: For attempting to solve two equations and find one unknown

A1: For finding one correct value for their equations

dM1: For attempting to solve two different equations and find the other unknown AND

substitute both values into one of the equations

A1: For correct values, valid statement and suitable conclusion

Alt III

Note that if equations **(1) and (3) are attempted they cannot be solved but the method is valid**:

Expect to see something like $-2+2\lambda=6+4\mu \quad 3+5\lambda=-5+10\mu \quad \Rightarrow 5\lambda-10\mu=20$ and $5\lambda-10\mu=-8$ and $20\neq-8$.

Score M1, A1 for considering both equations and finding two equations that can be compared, e.g $\lambda-2\mu=4$ and $\lambda-2\mu=-1.6$

Then dM1: For an attempt at the comparison with A1 scored for accurate calculations, reason and conclusion

Question Number	Scheme	Marks
3 (a)	Coordinates of $P = (1, 2)$	B1
	Attempts $\frac{dx}{dt} = \frac{-4}{(t+2)^2}$ and $\frac{dy}{dt} = \frac{(t+4)\times 6 - 6t}{(t+4)^2}$	M1
	Attempts gradient of the tangent using $m = \frac{dy/dt}{dx/dt} = \left(\frac{-6(t+2)^2}{(t+4)^2}\right)$ at $t = 2$	M1
	Equation of tangent $y - 2 = -\frac{8}{3}(x-1) \Rightarrow y = -\frac{8}{3}x + \frac{14}{3}$	ddM1, A1
		(5)
(b)	Attempts to get t in terms of x or y. E.g. $x = \frac{4}{t+2} \Rightarrow t = \frac{4}{x} - 2$	M1
	Achieves a Cartesian Equation E.g. $y = \frac{6t}{t+4} \Rightarrow y = \frac{6\left(\frac{4}{x} - 2\right)}{\frac{4}{x} - 2 + 4}$	dM1
	$\Rightarrow y = \frac{-6x+12}{x+2}, \quad 0 < x < 4$	A1, B1
		(4)
(c)	Range $-2 < f < 6$	M1, A1
		(2)
		(11 marks)

(a)

B1: Coordinates of $P = (1, 2)$ but this may be implied within the tangent equation via use of $x = 1,\ y = 2$

M1: Attempts both $\frac{dx}{dt}$ and $\frac{dy}{dt}$ and reaching a correct form for each.

Look for $\frac{dx}{dt} = \pm\frac{\beta}{(t+2)^2}$ and $\frac{dy}{dt} = \frac{\lambda(t+4) - \delta t}{(t+4)^2}$ $\lambda, \delta > 0$ o.e. condoning missing brackets

For the differentiation of y with respect to t. You may see either chain rule or product rule used.

E.g. Chain rule; $y = \frac{6t}{t+4} = 6 - \frac{24}{t+4} \Rightarrow \frac{dy}{dt} = \frac{24}{(t+4)^2}$. Look for $\frac{dy}{dt} = \frac{\pm p}{(t+4)^2}$ following division.