1	$\overrightarrow{AB} = 2\mathbf{b} - 2\mathbf{a}$ or $\overrightarrow{BA} = 2\mathbf{a} - 2\mathbf{b}$ $\overrightarrow{MN} = 10\mathbf{a} - \mathbf{b}$ or $\overrightarrow{NM} = -10\mathbf{a} + \mathbf{b}$		5	M1	for finding $\overrightarrow{AB}$ or $\overrightarrow{BA}$ or $\overrightarrow{MN}$ or $\overrightarrow{NM}$
	eg $\overrightarrow{MP} = -\mathbf{b} + 2\mathbf{a} + k(2\mathbf{b} - 2\mathbf{a})$ and $\overrightarrow{MP} = l(10\mathbf{a} - \mathbf{b})$ or eg $\overrightarrow{MP} = \mathbf{b} + k(2\mathbf{a} - 2\mathbf{b})$ and $\overrightarrow{MP} = l(10\mathbf{a} - \mathbf{b})$ or eg $\overrightarrow{PN} = 8\mathbf{a} + k(2\mathbf{a} - 2\mathbf{b})$ and $\overrightarrow{PN} = l(10\mathbf{a} - \mathbf{b})$ or eg $\overrightarrow{AP} = 8\mathbf{a} + k(\mathbf{b} - 10\mathbf{a})$ and $\overrightarrow{AP} = l(2\mathbf{b} - 2\mathbf{a})$ or eg $\overrightarrow{AP} = -2\mathbf{a} + \mathbf{b} + k(10\mathbf{a} - \mathbf{b})$ and $\overrightarrow{AP} = l(2\mathbf{b} - 2\mathbf{a})$ or eg $\overrightarrow{AM} = k(2\mathbf{b} - 2\mathbf{a}) + l(\mathbf{b} - 10\mathbf{a})$ and $\overrightarrow{AM} = -2\mathbf{a} + \mathbf{b}$			M2	for writing eg $\overrightarrow{MP}$ or $\overrightarrow{PN}$ or $\overrightarrow{AP}$ or $\overrightarrow{AM}$ in two different ways in terms of **a** and **b** (M1 for writing eg $\overrightarrow{MP}$ or $\overrightarrow{PN}$ or $\overrightarrow{AP}$ or $\overrightarrow{AM}$ in one way) These may be written as eg $\overrightarrow{PM}$ in place of $\overrightarrow{MP}$
	eg $2-2k=10\lambda$ and $-1+k=-\lambda$ (from $\overrightarrow{MP}$ 1st) or eg $2k=10\lambda$ and $1-2k=-\lambda$ (from $\overrightarrow{MP}$ 2nd) or eg $8+2k=10\lambda$ and $-2k=-\lambda$ (from $\overrightarrow{PN}$) or eg $8-10k=-2\lambda$ and $k=2\lambda$ (from $\overrightarrow{AP}$ 1st) or eg $-2+10k=-2\lambda$ and $1-k=2\lambda$ (from $\overrightarrow{AP}$ 2nd) or eg $-2k-10\lambda=-2$ and $2k+\lambda=1$ (from $\overrightarrow{AM}$)			M1	dep M3 for writing a pair of equations using their variables. $\overrightarrow{MP}$ (1st) leads to $\lambda=\frac{1}{9}, k=\frac{4}{9}$ $\overrightarrow{MP}$ (2nd) leads to $\lambda=\frac{1}{9}, k=\frac{5}{9}$ $\overrightarrow{PN}$ leads to $\lambda=\frac{8}{9}, k=\frac{4}{9}$ $\overrightarrow{AP}$ (1st) leads to $\lambda=\frac{4}{9}, k=\frac{8}{9}$ $\overrightarrow{AP}$ (2nd) leads to $\lambda=\frac{4}{9}, k=\frac{1}{9}$ $\overrightarrow{AM}$ leads to $\lambda=\frac{1}{9}, k=\frac{4}{9}$
		4 : 5		A1	cao
					Total 5 marks

2	$OC = 3\mathbf{a} + 4\mathbf{b}$		5	B1	Correct expression for OC
	$ON = t(3\mathbf{a} + 4\mathbf{b})$			M1	Correct expressions for ON
	$ON = 3\mathbf{a} + s(-3\mathbf{a} + 6\mathbf{b})$			M1	
	$t(3\mathbf{a} + 4\mathbf{b}) = 3\mathbf{a} + s(-3\mathbf{a} + 6\mathbf{b})$ $\rightarrow t = 0.6,\ s = 0.4$			A1	t or s value correct
		$ON = 1.8\mathbf{a} + 2.4\mathbf{b}$ oe		A1	e.g. $ON = \frac{3}{5}(3\mathbf{a} + 4\mathbf{b})$
	Alt:				
	$AB = -3\mathbf{a} + 6\mathbf{b}$			B1	Correct expression for AB
	$AN = s(-3\mathbf{a} + 6\mathbf{b})$			M1	Correct expressions for AN
	$AN = -3\mathbf{a} + t(3\mathbf{a} + 4\mathbf{b})$			M1	
	$-3\mathbf{a} + t(3\mathbf{a} + 4\mathbf{b}) = s(-3\mathbf{a} + 6\mathbf{b})$ $\rightarrow t = 0.6,\ s = 0.4 \rightarrow AN = -1.2\mathbf{a} + 2.4\mathbf{b}$ $ON = 3\mathbf{a} + AN$			A1	t or s value correct
		$ON = 1.8\mathbf{a} + 2.4\mathbf{b}$ oe		A1	e.g. $ON = \frac{3}{5}(3\mathbf{a} + 4\mathbf{b})$
	Alt:				
	$OC = 3\mathbf{a} + 4\mathbf{b}$			B1	Correct expression for OC
	$ON : NC = 6 : 4$ (i.e 3:2)			M1	
	$ON = \frac{3}{5} OC$			M2	
		$ON = 1.8\mathbf{a} + 2.4\mathbf{b}$ oe		A1	e.g. $ON = \frac{3}{5}(3\mathbf{a} + 4\mathbf{b})$
					Total 5 marks

3	$\overrightarrow{PM} = -\frac{3}{2}\mathbf{a} - \frac{3}{4}\mathbf{b} + 4\mathbf{a} + \frac{1}{2}(2\mathbf{b} - 4\mathbf{a}) \left(= \frac{1}{2}\mathbf{a} + \frac{1}{4}\mathbf{b}\right)$ $\overrightarrow{AM} = 4\mathbf{a} + \frac{1}{2}(2\mathbf{b} - 4\mathbf{a}) (= 2\mathbf{a} + \mathbf{b})$ $\overrightarrow{AM} = 2\mathbf{b} + \frac{1}{2}(4\mathbf{a} - 2\mathbf{b}) (= 2\mathbf{a} + \mathbf{b})$ $\overrightarrow{MA} = \frac{1}{2}(2\mathbf{b} - 4\mathbf{a}) - 2\mathbf{b} (= -2\mathbf{a} - \mathbf{b})$ $\overrightarrow{MA} = \frac{1}{2}(4\mathbf{a} - 2\mathbf{b}) - 4\mathbf{a} (= -2\mathbf{a} - \mathbf{b})$		3	M1	for finding $\overrightarrow{PM}$ or $\overrightarrow{AM}$ or $\overrightarrow{MA}$
	$(AP : PM =) \left\lvert\frac{3}{2}\mathbf{a} + \frac{3}{4}\mathbf{b}\right\rvert : \left\lvert\frac{1}{2}\mathbf{a} + \frac{1}{4}\mathbf{b}\right\rvert$ oe $(AP : AM =) \left\lvert\frac{3}{2}\mathbf{a} + \frac{3}{4}\mathbf{b}\right\rvert : \lvert 2\mathbf{a} + \mathbf{b}\rvert (= 3 : 4)$ oe $(AM : PM =) \lvert 2\mathbf{a} + \mathbf{b}\rvert : \left\lvert\frac{1}{2}\mathbf{a} + \frac{1}{4}\mathbf{b}\right\rvert (= 4 : 1)$ oe $AP = 3PM$ oe eg $\frac{3}{2}\mathbf{a} + \frac{3}{4}\mathbf{b} = 3(\frac{1}{2}\mathbf{a} + \frac{1}{4}\mathbf{b})$ oe $AM = \frac{4}{3}AP$ oe $AM = 4PM$ oe			M1	For use of a correct ratio or fraction linking AP and PM **or** AP and AM **or** AM and PM (in either order) vectors must be in form $p\mathbf{a} + q\mathbf{b}$
		3 : 1		A1	
					Total 3 marks

4		eg $\overrightarrow{OP} = n(2\mathbf{a} + 3\mathbf{b})$ **or** $\overrightarrow{OP} = 2\mathbf{a} + m(5\mathbf{b} - 2\mathbf{a})$ **or** $\overrightarrow{OP} = 5\mathbf{b} + x(2\mathbf{a} - 5\mathbf{b})$		5	M1	for a vector equation for $\overrightarrow{OP}$
		eg $\overrightarrow{OP} = n(2\mathbf{a} + 3\mathbf{b})$ **and** $\overrightarrow{OP} = 2\mathbf{a} + m(5\mathbf{b} - 2\mathbf{a})$ **or** eg $\overrightarrow{OP} = n(2\mathbf{a} + 3\mathbf{b})$ **and** $\overrightarrow{OP} = 5\mathbf{b} + x(2\mathbf{a} - 5\mathbf{b})$ oe			M1	2 vector equations for $\overrightarrow{OP}$ that can be used to find $\overrightarrow{OP}$ - must be in terms of **a** and **b** and a scalar
		eg $5m = 3n$ or $m = \frac{3}{5}n$ or $2n = 2 - 2m$ or $n = 1 - m$ oe **and** $2 - 2 \times \frac{3}{5}n = 2n$ or $2 \times \frac{5}{3}m = 2 - 2m$ oe **or** eg $2n = 2x$ or $n = x$ or $3n = 5 - 5x$ oe **and** $3x = 5 - 5x$ or $3n = 5 - 5n$ oe			M1	Writing one equation in terms of only one scalar eg one of n or m or x etc
		eg $m = \frac{3}{8}$ or $n = \frac{5}{8}$ or $x = \frac{5}{8}$ oe			M1	for a correct value for one scalar
		Working is required	$\frac{5}{4}\mathbf{a} + \frac{15}{8}\mathbf{b}$		A1	oe (dep on M1) but terms in **a** and terms in **b** should be simplified. eg $\frac{1}{8}(10\mathbf{a} + 15\mathbf{b})$ or $\frac{5}{8}(2\mathbf{a} + 3\mathbf{b})$ etc
						Total 5 marks
		Alternative method as a vector method not requested				
		eg $\overrightarrow{OP} = n(2\mathbf{a} + 3\mathbf{b})$		5	M1	for a vector equation for $\overrightarrow{OP}$

		eg $CP : OP = 3 : 5$ or $CP : CO = 3 : 8$ or $\frac{CP}{OP} = \frac{3}{5}$ or $\frac{CP}{CO} = \frac{3}{8}$ oe		M2	for a correct ratio for two sides in triangle ACP and triangle BOP that help to find $\overrightarrow{OP}$ as a fraction of $\overrightarrow{OC}$ (could be seen on the diagram)
		$\overrightarrow{OP} = \frac{5}{8}\overrightarrow{OC}$ or $n = \frac{5}{8}$		M1	
		Working is required	$\frac{5}{4}\mathbf{a} + \frac{15}{8}\mathbf{b}$	A1	oe (dep on M1) but terms in **a** and terms in **b** should be simplified. eg $\frac{1}{8}(10\mathbf{a} + 15\mathbf{b})$ or $\frac{5}{8}(2\mathbf{a} + 3\mathbf{b})$ etc
					Total 5 marks

5	e.g. $\begin{pmatrix}5\\3\end{pmatrix} - \begin{pmatrix}-2\\4\end{pmatrix}$ **or** $\begin{pmatrix}5\\3\end{pmatrix} + \begin{pmatrix}2\\-4\end{pmatrix}$		2	M1	**or** for $\begin{pmatrix}7\\a\end{pmatrix}$ where $a \neq -1$ **or** $\begin{pmatrix}b\\-1\end{pmatrix}$ where $b \neq 7$
		$\begin{pmatrix}7\\-1\end{pmatrix}$		A1	
					Total 2 marks

6	$\overrightarrow{AB}=2\mathbf{b}-2\mathbf{a}$ oe **or** $\overrightarrow{BA}=2\mathbf{a}-2\mathbf{b}$ oe **or** $\overrightarrow{AM}=\mathbf{b}-\mathbf{a}$ oe **or** $\overrightarrow{MA}=\mathbf{a}-\mathbf{b}$ oe **or** $\overrightarrow{BM}=\mathbf{b}-\mathbf{a}$ oe **or** $\overrightarrow{MB}=\mathbf{a}-\mathbf{b}$ oe		6	M1	for finding $\overrightarrow{AB}$ **or** $\overrightarrow{BA}$ **or** $\overrightarrow{AM}$ **or** $\overrightarrow{MA}$ **or** $\overrightarrow{BM}$ **or** $\overrightarrow{MB}$
	e.g. $\overrightarrow{OM}=2\mathbf{a}+(\mathbf{b}-\mathbf{a})\,(=\mathbf{a}+\mathbf{b})$ oe **or** $\overrightarrow{MO}=(\mathbf{b}-\mathbf{a})-2\mathbf{b}\,(=-\mathbf{a}-\mathbf{b})$ oe **or** $\overrightarrow{AN}=\frac{4}{3}\mathbf{b}-2\mathbf{a}$ oe **or** $\overrightarrow{NA}=2\mathbf{a}-\frac{4}{3}\mathbf{b}$ oe			M1	for finding $\overrightarrow{OM}$ **or** $\overrightarrow{MO}$ **or** $\overrightarrow{AN}$ **or** $\overrightarrow{NA}$
	e.g. $\overrightarrow{OP}=2\mathbf{a}+\lambda\left(\frac{4}{3}\mathbf{b}-2\mathbf{a}\right)$ oe **or** $\overrightarrow{OP}=\frac{4}{3}\mathbf{b}+\lambda\left(2\mathbf{a}-\frac{4}{3}\mathbf{b}\right)$ oe **or** $\overrightarrow{OP}=\mu(\mathbf{a}+\mathbf{b})$ oe **OR** $\overrightarrow{MP}=\mathbf{a}-\mathbf{b}+k\left(\frac{4}{3}\mathbf{b}-2\mathbf{a}\right)$ oe **or** $\overrightarrow{MP}=\mathbf{b}-\mathbf{a}-\frac{2}{3}\mathbf{b}+k\left(2\mathbf{a}-\frac{4}{3}\mathbf{b}\right)$ oe **or** $\overrightarrow{MP}=t(-\mathbf{a}-\mathbf{b})$ oe			M1	for finding $\overrightarrow{OP}$ **or** $\overrightarrow{PO}$ **or** $\overrightarrow{MP}$ **or** $\overrightarrow{PM}$
	e.g. $2\mathbf{a}+\lambda\left(\frac{4}{3}\mathbf{b}-2\mathbf{a}\right)=\mu(\mathbf{a}+\mathbf{b})$ oe **or** $\frac{4}{3}\mathbf{b}+\lambda\left(2\mathbf{a}-\frac{4}{3}\mathbf{b}\right)=\mu(\mathbf{a}+\mathbf{b})$ oe **or** $\mathbf{a}-\mathbf{b}+k\left(\frac{4}{3}\mathbf{b}-2\mathbf{a}\right)=t(-\mathbf{a}-\mathbf{b})$ oe **or** $\mathbf{b}-\mathbf{a}-\frac{2}{3}\mathbf{b}+k\left(2\mathbf{a}-\frac{4}{3}\mathbf{b}\right)=t(-\mathbf{a}-\mathbf{b})$ oe			M1	for setting up an equation for $\overrightarrow{OP}$ **or** $\overrightarrow{MP}$
	$\mu=\frac{4}{5}$ **or** $t=\frac{1}{5}$			M1	for finding μ or t for either $\overrightarrow{OP}=\mu\overrightarrow{OM}$ **or** $\overrightarrow{MP}=t\overrightarrow{MO}$
		4 : 1		A1	cao (dep on M3)
					Total 6 marks

7	eg $\overrightarrow{AK}=\lambda\mathbf{a}$ $\overrightarrow{KB}=(1-\lambda)\mathbf{a}$ $\overrightarrow{CL}=-\mu\mathbf{a}$ $\overrightarrow{DL}=(1-\mu)\mathbf{a}$	eg $\overrightarrow{AK}=\frac{1}{2}\mu\mathbf{a}$ $\overrightarrow{KB}=(1-\frac{1}{2}\mu)\mathbf{a}$ $\overrightarrow{CL}=-2\lambda\mathbf{a}$ $\overrightarrow{DL}=(1-2\lambda)\mathbf{a}$	**SEE NEXT PAGE FOR MISREAD**	5	M1	for correctly using the ratio to form an expression for a vector passing through K or L could be in terms of λ or μ $\overrightarrow{AK}$ or $\overrightarrow{KA}$, $\overrightarrow{KB}$ or $\overrightarrow{BK}$, $\overrightarrow{CL}$ or $\overrightarrow{LC}$, $\overrightarrow{DL}$ or $\overrightarrow{LD}$ (may be seen as part of another expression)
	eg $\overrightarrow{KL}=-\lambda\mathbf{a}+\mathbf{b}+(1-\mu)\mathbf{a}$ or $=(1-\lambda-\mu)\mathbf{a}+\mathbf{b}$ $\overrightarrow{LM}=(\mu-1)\mathbf{a}+0.5\mathbf{b}$ $\overrightarrow{KM}=-\lambda\mathbf{a}+\mathbf{b}+0.5\mathbf{b}\,(=-\lambda\mathbf{a}+1.5\mathbf{b})$	eg $\overrightarrow{KL}=\mathbf{b}+(1-\frac{3}{2}\mu)\mathbf{a}$ or $\overrightarrow{KL}=\mathbf{b}+(1-3\lambda)\mathbf{a}$ $\overrightarrow{LM}=(2\lambda-1)\mathbf{a}+\frac{1}{2}\mathbf{b}$ or $\overrightarrow{KM}=-\lambda\mathbf{a}+\frac{3}{2}\mathbf{b}$ or			M1	for finding an expression in λ and/or μ for **one of** $\overrightarrow{KL}$ (or $\overrightarrow{LK}$), $\overrightarrow{LM}$ (or $\overrightarrow{ML}$), $\overrightarrow{KM}$ (or $\overrightarrow{MK}$) [If this mark is awarded it assumes the first M1]
	Two of the above – may have used $2\lambda=\mu$ to write all in one of λ or μ May be simplified or not – so may have brackets or not				M1	for finding an expression in λ or μ for **two of** the following: $\overrightarrow{KL}$ (or $\overrightarrow{LK}$), $\overrightarrow{LM}$ (or $\overrightarrow{ML}$), or $\overrightarrow{KM}$ (or $\overrightarrow{MK}$)
	eg using $\overrightarrow{KM}=-\lambda\mathbf{a}+1.5\mathbf{b}$ and $\overrightarrow{LM}=(2\lambda-1)\mathbf{a}+\frac{1}{2}\mathbf{b}$ $\overrightarrow{LM}=x\overrightarrow{KM}$ gives $\frac{-\lambda x}{2\lambda-1}=\frac{1.5x}{0.5}\Rightarrow 3.5\lambda=1.5\Rightarrow\lambda=\frac{3}{7}$ oe		$\lambda=\frac{3}{7}$ or $\mu=\frac{6}{7}$		A1	dep on M2 for one value correct or both values but written the wrong way round $(\mu=\frac{3}{7}\ \lambda=\frac{6}{7})$
			$\lambda=\frac{3}{7}$ & $\mu=\frac{6}{7}$		A1	dep on M2 for both values
						Total 5 marks

7	eg $\overrightarrow{AK}=\left(\frac{\lambda}{\lambda+1}\right)\mathbf{a}$ $\overrightarrow{KB}=\left(\frac{1}{\lambda+1}\right)\mathbf{a}$ $\overrightarrow{CL}=\left(\frac{-\mu}{1+\mu}\right)\mathbf{a}$ $\overrightarrow{DL}=\left(\frac{1}{1+\mu}\right)\mathbf{a}$	eg $\overrightarrow{AK}=\left(\frac{\frac{1}{2}\mu}{\frac{1}{2}\mu+1}\right)\mathbf{a}\ \left(=\left(\frac{\mu}{\mu+2}\right)\mathbf{a}\right)$ $\overrightarrow{KB}=\left(\frac{1}{\frac{1}{2}\mu+1}\right)\mathbf{a}\ \left(=\left(\frac{2}{\mu+2}\right)\mathbf{a}\right)$ $\overrightarrow{CL}=\left(\frac{-2\lambda}{1+2\lambda}\right)\mathbf{a}$ $\overrightarrow{DL}=\left(\frac{1}{1+2\lambda}\right)\mathbf{a}$	**MISREAD** $\overrightarrow{AK}:\overrightarrow{KB}=\lambda:1$ and $\overrightarrow{CL}:\overrightarrow{LD}=\mu:1$	M1	For using the ratio to form an expression for a vector passing through K or L could be in terms of λ or μ $\overrightarrow{AK}$ or $\overrightarrow{KA}$, $\overrightarrow{KB}$ or $\overrightarrow{BK}$, $\overrightarrow{CL}$ or $\overrightarrow{LC}$, $\overrightarrow{DL}$ or $\overrightarrow{LD}$ (may be seen as part of another expression)
	eg $\overrightarrow{KL}=\left(\frac{-\lambda}{\lambda+1}\right)\mathbf{a}+\mathbf{b}+\left(\frac{1}{1+\mu}\right)\mathbf{a}$ or $\overrightarrow{LM}=\left(\frac{-1}{1+\mu}\right)\mathbf{a}+0.5\mathbf{b}$ $\overrightarrow{KM}=\left(\frac{-\lambda}{1+\lambda}\right)\mathbf{a}+\frac{3}{2}\mathbf{b}$ oe	eg $\overrightarrow{KL}=\left(\frac{-\frac{1}{2}\mu}{\frac{1}{2}\mu+1}\right)\mathbf{a}+\mathbf{b}+\left(\frac{1}{1+\mu}\right)\mathbf{a}$ $\overrightarrow{LM}=\left(\frac{-1}{1+2\lambda}\right)\mathbf{a}+\frac{1}{2}\mathbf{b}$ or $\overrightarrow{KM}=\left(\frac{-\frac{1}{2}\mu}{\frac{1}{2}\mu+1}\right)\mathbf{a}+\frac{3}{2}\mathbf{b}$ oe		M1	for finding an expression in λ and/or μ using the above misread for **one of** $\overrightarrow{KL}$ (or $\overrightarrow{LK}$), $\overrightarrow{LM}$ (or $\overrightarrow{ML}$), $\overrightarrow{KM}$ (or $\overrightarrow{MK}$) [If this mark is awarded it assumes the first M1]
	Two of the above – may have used $2\lambda=\mu$ to write all in one of λ or μ May be simplified or not – so may have brackets or not			M1	for finding an expression in λ or μ for **two of** $\overrightarrow{KL}$ (or $\overrightarrow{LK}$), $\overrightarrow{LM}$ (or $\overrightarrow{ML}$), $\overrightarrow{KM}$ (or $\overrightarrow{MK}$)
	(Giving answers of $\lambda=0.5(1+\sqrt{7})$, $\mu=1+\sqrt{7}$)				***A MAXIMUM OF 3 MARKS CAN BE AWARDED FOR THIS MISREAD***

8	$\overrightarrow{OP}=4\mathbf{a}+2\mathbf{a}+8\mathbf{b}(=6\mathbf{a}+8\mathbf{b})$ oe OR $\overrightarrow{PO}=-6\mathbf{a}-8\mathbf{b}$ oe or $\overrightarrow{AB}=6\mathbf{b}-4\mathbf{a}$ oe OR $\overrightarrow{BA}=4\mathbf{a}-6\mathbf{b}$ oe or $\overrightarrow{BP}=6\mathbf{a}+2\mathbf{b}$ oe OR $\overrightarrow{PB}=-6\mathbf{a}-2\mathbf{b}$ oe		5	M1 oe for one of $\overrightarrow{OP}$ or $\overrightarrow{PO}$ or $\overrightarrow{AB}$ or $\overrightarrow{BA}$ or $\overrightarrow{BP}$ or $\overrightarrow{PB}$ (may be seen as part of another vector calculation)
	$\overrightarrow{OQ}=4\mathbf{a}+\lambda(6\mathbf{b}-4\mathbf{a})$ oe OR $6\mathbf{b}+\mu(4\mathbf{a}-6\mathbf{b})$ oe OR $x(6\mathbf{a}+8\mathbf{b})$ oe or $\overrightarrow{BQ}=\mu(4\mathbf{a}-6\mathbf{b})$ oe OR $-6\mathbf{b}+\lambda(6\mathbf{a}+8\mathbf{b})$ oe OR $4\mathbf{a}-6\mathbf{b}+x(6\mathbf{b}-4\mathbf{a})$ oe or $\overrightarrow{AQ}=y(6\mathbf{b}-4\mathbf{a})$ oe OR $-4\mathbf{a}+x(6\mathbf{a}+8\mathbf{b})$ oe OR $6\mathbf{b}-4\mathbf{a}+\mu(4\mathbf{a}-6\mathbf{b})$ oe OR $2\mathbf{a}+8\mathbf{b}+m(6\mathbf{a}+8\mathbf{b})$ oe or $\overrightarrow{QP}=\lambda(6\mathbf{a}+8\mathbf{b})$ oe OR $\mu(4\mathbf{a}-6\mathbf{b})+2\mathbf{a}+8\mathbf{b}$ oe			M1 for a second correct expression for the same vector OR for two correct expressions for parallel vectors eg 2 of $\overrightarrow{OQ}$, $\overrightarrow{OP}$, $\overrightarrow{QP}$ oe AND using ratios to form an equation in one variable that can lead to a solution eg $\overrightarrow{OQ}=4\mathbf{a}+k(6\mathbf{b}-4\mathbf{a})$ and $\overrightarrow{QP}=2\mathbf{a}+8\mathbf{b}-k(6\mathbf{b}-4\mathbf{a})$ and $\frac{4-4k}{2+4k}=\frac{6k}{8-6k}$
	eg $\lambda=\frac{8}{17}$ or $\mu=\frac{9}{17}$ or $AQ:QB=\frac{4x}{3}:\frac{3x}{2}$ oe			A1 oe
		8 : 9		A1 oe

9	$(\overrightarrow{ON}=)\lambda(\mathbf{a}+\mathbf{b})(=\lambda\mathbf{a}+\lambda\mathbf{b})$ **or** $(\overrightarrow{NY}=)(1-\lambda)(\mathbf{a}+\mathbf{b})(=(1-\lambda)\mathbf{a}+(1-\lambda)\mathbf{b})$		5	M1 for finding a vector for $\overrightarrow{ON}$ **or** $\overrightarrow{NY}$ **or** $\overrightarrow{NO}$ **or** $\overrightarrow{YN}$ in terms **a** and **b** and using λ oe (can be embedded)
	$(\overrightarrow{MN}=\overrightarrow{MO}+\overrightarrow{ON}=)-0.5\mathbf{a}+\lambda\mathbf{a}+\lambda\mathbf{b}(=(\lambda-0.5)\mathbf{a}+\lambda\mathbf{b})$ **or** $(\overrightarrow{MZ}=\overrightarrow{MO}+\overrightarrow{OZ}=)-0.5\mathbf{a}+3\mathbf{b}$ **or** $(\overrightarrow{MN}=\overrightarrow{MX}+\overrightarrow{XY}+\overrightarrow{YN}=)0.5\mathbf{a}+\mathbf{b}+(\lambda-1)(\mathbf{a}+\mathbf{b})(=(\lambda-0.5)\mathbf{a}+\lambda\mathbf{b})$			M1 for finding a vector for $\overrightarrow{MN}$ **or** $\overrightarrow{NM}$ **or** $\overrightarrow{MZ}$ **or** $\overrightarrow{ZM}$
	$(\overrightarrow{MN}=\mu\overrightarrow{MZ}=)\mu(-0.5\mathbf{a}+3\mathbf{b})(=-0.5\mu\mathbf{a}+3\mu\mathbf{b})$ **or** $(\overrightarrow{ON}=\overrightarrow{OM}+\overrightarrow{MN}=)0.5\mathbf{a}+\mu(-0.5\mathbf{a}+3\mathbf{b})(=(0.5-0.5\mu)\mathbf{a}+3\mu\mathbf{b})$ **or** $(\overrightarrow{NY}=\overrightarrow{NM}+\overrightarrow{MX}+\overrightarrow{XY}=)-\mu(-0.5\mathbf{a}+3\mathbf{b})+0.5\mathbf{a}+\mathbf{b}(=(0.5+0.5\mu)\mathbf{a}+(1-3\mu)\mathbf{b})$			M1 for finding a vector for $\overrightarrow{MN}$ or $\overrightarrow{ON}$ or $\overrightarrow{NY}$ or $\overrightarrow{NM}$ or $\overrightarrow{NO}$ or $\overrightarrow{YN}$ using another variable e.g. μ oe
	$-0.5\mu=-0.5+\lambda$ oe $3\mu=\lambda$ oe $1-\lambda=0.5\mu+0.5$ oe $1-\lambda=1-3\mu$ oe			M1 for setting up **two** simultaneous equations using the components of **a** and **b** for $\overrightarrow{MN}$ or $\overrightarrow{ON}$ or $\overrightarrow{NY}$ oe
		$\frac{3}{7}$		A1 (allow $\frac{3}{7}=0.42(8571\ldots)$ to 2 sf truncated or rounded)
				Total 5 marks

9 ALT	$(\overrightarrow{ON} =)\lambda(\mathbf{a}+\mathbf{b})(=\lambda\mathbf{a}+\lambda\mathbf{b})$ **or** $(\overrightarrow{NY} =)(1-\lambda)(\mathbf{a}+\mathbf{b})(=(1-\lambda)\mathbf{a}+(1-\lambda)\mathbf{b})$		5	M1 for finding a vector for $\overrightarrow{ON}$ **or** $\overrightarrow{NY}$ **or** $\overrightarrow{NO}$ **or** $\overrightarrow{YN}$ in terms **a** and **b** and using λ oe
	$(\overrightarrow{MN} = \overrightarrow{MO} + \overrightarrow{ON} =) -0.5\mathbf{a} + \lambda\mathbf{a} + \lambda\mathbf{b} (= (\lambda - 0.5)\mathbf{a} + \lambda\mathbf{b})$ **or** $(\overrightarrow{MN} = \overrightarrow{MX} + \overrightarrow{XY} + \overrightarrow{YN} =) 0.5\mathbf{a} + \mathbf{b} + (\lambda - 1)(\mathbf{a} + \mathbf{b}) (= (\lambda - 0.5)\mathbf{a} + \lambda\mathbf{b})$			M1 for finding a vector for $\overrightarrow{MN}$ **or** $\overrightarrow{NM}$ in terms **a** and **b** and using λ oe
	$(\overrightarrow{NZ} = \overrightarrow{NO} + \overrightarrow{OZ} =) -\lambda(\mathbf{a} + \mathbf{b}) + 3\mathbf{b} (= -\lambda\mathbf{a} + (3 - \lambda)\mathbf{b})$ **or** $(\overrightarrow{NZ} = \overrightarrow{NY} + \overrightarrow{YZ} =) (1 - \lambda)(\mathbf{a} + \mathbf{b}) - \mathbf{b} - \mathbf{a} + 3\mathbf{b} (= -\lambda\mathbf{a} + (3 - \lambda)\mathbf{b})$			M1 for finding a vector for $\overrightarrow{NZ}$ or $\overrightarrow{ZN}$ in terms **a** and **b** and using λ oe
	$\frac{\lambda - 0.5}{-\lambda} = \frac{\lambda}{3 - \lambda}$ oe			M1 for setting up an equation using the components of $\overrightarrow{MN}$ and $\overrightarrow{NZ}$ oe
		$\frac{3}{7}$		A1 (allow $\frac{3}{7} = 0.42(8571\ldots)$ to 2 sf truncated or rounded)
				Total 5 marks

10	eg $\overrightarrow{ON} = 8\mathbf{a} + \frac{1}{2}(6\mathbf{b} - 8\mathbf{a}) (= 3\mathbf{b} + 4\mathbf{a})$ **or** $\overrightarrow{ON} = 6\mathbf{b} + \frac{1}{2}(-6\mathbf{b} + 8\mathbf{a}) (= 3\mathbf{b} + 4\mathbf{a})$ **or** $\overrightarrow{NO} = \frac{1}{2}(8\mathbf{a} - 6\mathbf{b}) - 8\mathbf{a} (= -4\mathbf{a} - 3\mathbf{b})$ **or** $\overrightarrow{NO} = -6\mathbf{b} + \frac{1}{2}(6\mathbf{b} - 8\mathbf{a}) (= -3\mathbf{b} - 4\mathbf{a})$ **or** $\overrightarrow{AM} = -8\mathbf{a} + \frac{1}{3}(6\mathbf{b}) (= 2\mathbf{b} - 8\mathbf{a})$ **or** $\overrightarrow{AM} = -8\mathbf{a} + 6\mathbf{b} - \frac{2}{3}(6\mathbf{b}) (= 2\mathbf{b} - 8\mathbf{a})$ **or** $\overrightarrow{MA} = 8\mathbf{a} - \frac{1}{3}(6\mathbf{b}) (= 8\mathbf{a} - 2\mathbf{b})$ **or** $\overrightarrow{MA} = \frac{2}{3}(6\mathbf{b}) + 8\mathbf{a} - 6\mathbf{b} (= 8\mathbf{a} - 2\mathbf{b})$		5	M1 a correct expression for $\overrightarrow{ON}$ **or** $\overrightarrow{NO}$ **or** $\overrightarrow{AM}$ **or** $\overrightarrow{MA}$
	$\overrightarrow{OP} = \mu(3\mathbf{b} + 4\mathbf{a})$ and one of eg $\overrightarrow{OP} = 8\mathbf{a} + x(2\mathbf{b} - 8\mathbf{a})$ $(= (8 - 8x)\mathbf{a} + 2x\mathbf{b})$ or $\overrightarrow{OP} = 2\mathbf{b} + y(8\mathbf{a} - 2\mathbf{b}) (= (2 - 2y)\mathbf{b} + 8y\mathbf{a})$			M2 oe (M1 for one correct expression for $\overrightarrow{OP}$) (where μ, x, y are scalars)
	eg $\frac{4}{3} = \frac{8y}{2 - 2y}$ **or** $\frac{4}{3} = \frac{8 - 8x}{2x}$ oe **or** $3\mu = 2x$ **and** $4\mu = 8 - 8x$ **or** $3\mu = 2 - 2y$ **and** $4\mu = 8y$			M1 A correct expression to find the position of P along ON **or** two correct simultaneous equations coming from the expressions for $\overrightarrow{OP}$
		$2\mathbf{a} + \frac{3}{2}\mathbf{b}$		A1 dep on M3, oe eg $2\mathbf{a} + 1.5\mathbf{b}$
				Total 5 marks

11	(a)	$\overrightarrow{ON} = \mathbf{b} + \frac{2}{5}(\mathbf{a} - \mathbf{b})$ oe or $\overrightarrow{ON} = \mathbf{a} + \frac{3}{5}(\mathbf{b} - \mathbf{a})$ oe		2	M1
		Correct answer scores full marks (unless from obvious incorrect working)	$\frac{2}{5}\mathbf{a} + \frac{3}{5}\mathbf{b}$		A1 oe eg $\frac{1}{5}(2\mathbf{a} + 3\mathbf{b})$ but must be one term in **a** and one in **b**

12	eg $-\begin{pmatrix}-5\\4\end{pmatrix} + \begin{pmatrix}9\\1\end{pmatrix}$ **or** $\begin{pmatrix}5\\-4\end{pmatrix} + \begin{pmatrix}9\\1\end{pmatrix}$ **or** $\begin{pmatrix}14\\a\end{pmatrix}$ $a \neq -3$ **or** $\begin{pmatrix}b\\-3\end{pmatrix}$ $b \neq 14$		2	M1 or an answer of $\begin{pmatrix}-14\\3\end{pmatrix}$
	Correct answer scores full marks (unless from obvious incorrect working)	$\begin{pmatrix}14\\-3\end{pmatrix}$		A1
				Total 2 marks

13	e.g. $(\overrightarrow{AB} =) 2\mathbf{b} - 2\mathbf{a}$ oe or $(\overrightarrow{BA} =) 2\mathbf{a} - 2\mathbf{b}$ oe or $(\overrightarrow{BD} =) 2(2\mathbf{b} - 2\mathbf{a}) (= 4\mathbf{b} - 4\mathbf{a})$ oe or $(\overrightarrow{AD} =) 3(2\mathbf{b} - 2\mathbf{a}) (= 6\mathbf{b} - 6\mathbf{a})$ oe		5	M1
	e.g. $(\overrightarrow{OE} =) 2\mathbf{b} + 2(2\mathbf{b} - 2\mathbf{a}) + 7\mathbf{a} + 3\mathbf{b}$ $(= 3\mathbf{a} + 9\mathbf{b})$ oe or $(\overrightarrow{OC} =) 2\mathbf{a} + \lambda(2\mathbf{b} - 2\mathbf{a}) = (2 - 2\lambda)\mathbf{a} + 2\lambda\mathbf{b}$ oe **or** $2\mathbf{b} + \lambda(2\mathbf{a} - 2\mathbf{b})$ or $(\overrightarrow{CE} =) (2\mathbf{b} - 2\mathbf{a}) - \lambda(2\mathbf{b} - 2\mathbf{a}) + 2(2\mathbf{b} - 2\mathbf{a}) + 7\mathbf{a} + 3\mathbf{b} = (1 + 2\lambda)\mathbf{a} + (9 - 2\lambda)\mathbf{b}$			M2 for 2 correct paths seen M1 for 1 correct path seen Any correct path for OC passing through A or B involving a variable
	e.g. $\frac{2 - 2\lambda}{2\lambda} = \frac{1 + 2\lambda}{9 - 2\lambda}$ oe or $\frac{2 - 2\lambda}{2\lambda} = \frac{3}{9}$ oe or $\frac{(1 + 2\lambda)}{(9 - 2\lambda)} = \frac{1}{3}$ oe or $\lambda = \frac{3}{4}$ or $(2 - 2\lambda)\mathbf{a} + 2\lambda\mathbf{b} = \mu(3\mathbf{a} + 9\mathbf{b})$ or $\lambda = \frac{3}{4}$ or $\mu = \frac{1}{6}$ or $2\mathbf{b} + \lambda(2\mathbf{a} - 2\mathbf{b}) = \mu(3\mathbf{a} + 9\mathbf{b})$ or $\lambda = \frac{1}{4}$ or $\mu = \frac{5}{6}$			M1 for comparing coefficients of **a** and **b** for (OC and CE) **or** (OC and OE) **or** (CE and OE) OC is a multiple of OE Two different paths for OC
		1 : 5		A1 dep M2 oe e.g 2 : 10
	Working required			**Total 5 marks**

13 ALT	e.g. $\left(\overrightarrow{AB}=\right)2\mathbf{b}-2\mathbf{a}$ oe or $\left(\overrightarrow{BA}=\right)2\mathbf{a}-2\mathbf{b}$ oe or $\left(\overrightarrow{BD}=\right)2(2\mathbf{b}-2\mathbf{a})(=4\mathbf{b}-4\mathbf{a})$ oe or $\left(\overrightarrow{AD}=\right)3(2\mathbf{b}-2\mathbf{a})(=6\mathbf{b}-6\mathbf{a})$ oe		5	M1
	e.g. $\left(\overrightarrow{OE}=\right)2\mathbf{b}+2(2\mathbf{b}-2\mathbf{a})+7\mathbf{a}+3\mathbf{b}\ (=3\mathbf{a}+9\mathbf{b})$ oe			M1
	e.g. $\left(\overrightarrow{AE}=\right)2\mathbf{b}-2\mathbf{a}+2(2\mathbf{b}-2\mathbf{a})+7\mathbf{a}+3\mathbf{b}(=\mathbf{a}+9\mathbf{b})$ oe			M1
	$\left[\overrightarrow{AE}=\lambda\overrightarrow{AD}+\mu\overrightarrow{OE}\right]$ $\mathbf{a}+9\mathbf{b}=\lambda(6\mathbf{b}-6\mathbf{a})+\mu(3\mathbf{a}+9\mathbf{b})$ oe or $1=-6\lambda+3\mu$ oe and $9=6\lambda+9\mu$ oe or or $\lambda=\frac{1}{4}$ or $\mu=\frac{5}{6}$			M1
		1 : 5		A1 dep on M2 oe e.g 2 : 10
	Working required			**Total 5 marks**

14	(a)		$-2\mathbf{a}+\mathbf{b}$	1	B1	oe
	(b)	eg $\overrightarrow{OP}=\mathbf{a}+y(-\mathbf{a}+6\mathbf{b})$ and $\overrightarrow{OP}=2\mathbf{a}+x("-2\mathbf{a}+\mathbf{b}")$ $\overrightarrow{AP}=-\mathbf{a}+y(-\mathbf{a}+6\mathbf{b})$ and $\overrightarrow{AP}=x("-2\mathbf{a}+\mathbf{b}")$ $\overrightarrow{AB}=x("-2\mathbf{a}+\mathbf{b}")+y(-\mathbf{a}+6\mathbf{b})$ and $\overrightarrow{AB}=-2\mathbf{a}+6\mathbf{b}$ $\overrightarrow{NP}=-\mathbf{b}+\mathbf{a}+y(-\mathbf{a}+6\mathbf{b})$ and $\overrightarrow{NP}=x("2\mathbf{a}-\mathbf{b}")$ $\overrightarrow{MP}=x(-\mathbf{a}+6\mathbf{b})$ and $\overrightarrow{MP}=\mathbf{a}+y("-2\mathbf{a}+\mathbf{b}")$		4	M2	ft from (a), for writing eg $\overrightarrow{OP}$ or $\overrightarrow{AP}$ or $\overrightarrow{AB}$ or $\overrightarrow{NP}$ or $\overrightarrow{MP}$ or similar in two different ways in terms of **a** and **b** (M1 for writing eg $\overrightarrow{OP}$ or $\overrightarrow{AP}$ or $\overrightarrow{AB}$ or $\overrightarrow{NP}$ or $\overrightarrow{MP}$ or similar in one way in terms of **a** and **b**) These may be written as eg $\overrightarrow{PO}$ in place of $\overrightarrow{OP}$
		eg $x=6y$ and $2-2x=1-y$ (from $\overrightarrow{OP}$) $x=6y$ and $-2x=-1-y$ (from $\overrightarrow{AP}$) $6=x+6y$ and $-2=-2x-y$ (from $\overrightarrow{AB}$) $2x=1-y$ and $-x=-1+6y$ (from $\overrightarrow{NP}$) $-x=1-2y$ and $6x=y$ (from $\overrightarrow{MP}$)			M1	dep M2 for writing a pair of equations using their variables $\overrightarrow{OP}$ leads to $x=\frac{6}{11}, y=\frac{1}{11}$ $\overrightarrow{AP}$ leads to $x=\frac{6}{11}, y=\frac{1}{11}$ $\overrightarrow{AB}$ leads to $x=\frac{6}{11}, y=\frac{10}{11}$ $\overrightarrow{NP}$ leads to $x=\frac{5}{11}, y=\frac{1}{11}$ $\overrightarrow{MP}$ leads to $x=\frac{1}{11}, y=\frac{6}{11}$
		Vector method required	6 : 5		A1	dep on M2, oe eg $\frac{6}{11}:\frac{5}{11}$
						Total 5 marks