Question Number	Answer	Marks
8		
(a)	$AB = 2OA \Rightarrow OC = 3OA$	
	$\overrightarrow{OC} = 3(\mathbf{a}+\mathbf{e}) \Rightarrow \overrightarrow{AB} = 2(\mathbf{a}+\mathbf{e})$	M1A1 (2)
(b)	$\overrightarrow{BE} = \overrightarrow{BA} + \overrightarrow{AO} + \overrightarrow{OE} = -2(\mathbf{a}+\mathbf{e}) - \mathbf{a} + \mathbf{e} = -(3\mathbf{a}+\mathbf{e})$	M1,A1 (2)
(c)	$\overrightarrow{PC} = \overrightarrow{PB} + \overrightarrow{BC} = \frac{3}{5} \times 2(\mathbf{a}+\mathbf{e}) + \mathbf{e}, = \frac{6}{5}\mathbf{a} + \frac{11}{5}\mathbf{e}$	M1A1,A1 (3)
(d)	$\overrightarrow{PQ} = k\overrightarrow{PC} = \frac{k}{5}(6\mathbf{a}+11\mathbf{e})$	
	$\overrightarrow{OQ} = \overrightarrow{OP} + \overrightarrow{PQ} = \mathbf{a} + \frac{2}{5} \times 2(\mathbf{a}+\mathbf{e}) + \frac{k}{5}(6\mathbf{a}+11\mathbf{e})$	M1A1
	$\overrightarrow{OQ} = \overrightarrow{OE} + \overrightarrow{EQ} = \mathbf{e} + p(\mathbf{a}+\mathbf{e})$	B1
	$\therefore \frac{1}{5}(9+6k)\mathbf{a} + \frac{1}{5}(4+11k)\mathbf{e} = (1+p)\mathbf{e} + p\mathbf{a}$	
	$\frac{1}{5}(9+6k) = p \qquad \frac{1}{5}(4+11k) = 1+p$	M1
	Eliminate p to obtain $k = 2$ or eliminate k to obtain $p = \frac{21}{5}$	A1
	$\therefore \overrightarrow{OQ} = \frac{21}{5}\mathbf{a} + \frac{26}{5}\mathbf{e} \qquad \lambda = \frac{21}{5},\ \mu = \frac{26}{5}$	A1 (6)
		[13]

Notes

a, e need not be bold or written $\underset{\sim}{a}$ in students' work but $\overrightarrow{AB}$ etc must have the vector arrows when referring to the vector

(a)

M1 for any complete, valid method for obtaining $\overrightarrow{AB}$ in terms of **a** and **e**

A1 for $\overrightarrow{AB} = 2(\mathbf{a}+\mathbf{e})$ oe **must** be simplified.

(b)

M1 for any complete, valid method for obtaining $\overrightarrow{BE}$ in terms of **a** and **e**

A1 for $\overrightarrow{BE} = -(3\mathbf{a} + \mathbf{e})$ oe **must** be simplified.

(c)

M1 for any complete, valid method for obtaining $\overrightarrow{PC}$ in terms of **a** and **e.** Must include the correct use of the ratio.

A1 for a correct unsimplified expression for $\overrightarrow{PC}$ in terms of **a** and **e**

A1 for $\overrightarrow{PC} = \frac{6}{5}\mathbf{a} + \frac{11}{5}\mathbf{e}$ oe

(d)

M1 for obtaining $\overrightarrow{OQ}$ in terms of **a** and **e,** using the collinearity of *P*, *Q* and *C*

A1 for an unsimplified correct expression for $\overrightarrow{OQ}$ in terms of **a** and **e**

B1 for a second correct expression for $\overrightarrow{OQ}$ in terms of **a** and **e** using *O*, *E* and *Q*

M1 for equating components in the two expressions

A1 for a correct value for either of the 2 unknowns that were introduced

A1cao for deducing that $\lambda = \frac{21}{5}$, $\mu = \frac{26}{5}$ need not be shown explicitly

Alternative:

$\overrightarrow{PQ} = 2\overrightarrow{PC} = \frac{2}{5}(6\mathbf{a} + 11\mathbf{e})$	B1Award when $\frac{2}{5}(6\mathbf{a} + 11\mathbf{e})$ seen
$\overrightarrow{OQ} = \overrightarrow{OP} + \overrightarrow{PQ} = \mathbf{a} + \frac{4}{5}(\mathbf{a} + \mathbf{e}) + \frac{2}{5}(6\mathbf{a} + 11\mathbf{e})$	M1A1
$= \mathbf{a}\left(1 + \frac{4}{5} + \frac{12}{5}\right) + \mathbf{e}\left(\frac{4}{5} + \frac{22}{5}\right)$	M1
$\therefore \overrightarrow{OQ} = \frac{21}{5}\mathbf{a} + \frac{26}{5}\mathbf{e}$ $\lambda = \frac{21}{5}$, $\mu = \frac{26}{5}$	A1A1