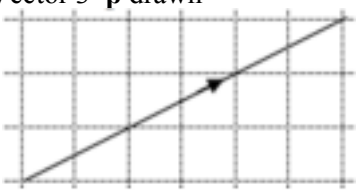
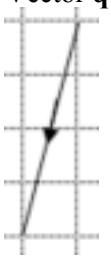
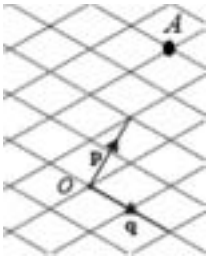
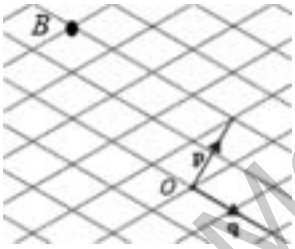
1 (a)	$\frac{5}{3}\mathbf{b}-\frac{2}{3}\mathbf{a}$ final answer	**3**	**B2** for $\left[\overrightarrow{AC}=\right]\ \frac{5}{3}(\mathbf{b}-\mathbf{a})$ or $\frac{5}{3}\mathbf{b}-\frac{5}{3}\mathbf{a}$ or $\left[\overrightarrow{BC}=\right]\ \frac{2}{3}(\mathbf{b}-\mathbf{a})$ or $\frac{2}{3}\mathbf{b}-\frac{2}{3}\mathbf{a}$ or **M1** for a correct vector route for $\overrightarrow{OC}$ or $\left[\overrightarrow{AB}=\right]\ \mathbf{b}-\mathbf{a}$ If 0 scored, **SC1** for answer $-\frac{5}{3}\mathbf{b}+\frac{2}{3}\mathbf{a}$ oe
1(b)	$\overrightarrow{DB}=\frac{2}{5}\mathbf{a}$ or $\overrightarrow{BD}=-\frac{2}{5}\mathbf{a}$	**M1**	
	$\overrightarrow{DB}$ is a multiple of $\overrightarrow{OA}$, hence parallel oe	**A1**	Or $BD=\frac{2}{5}AO$, hence parallel
2(a)	$\frac{5}{2}\mathbf{c}$ oe final answer	**1**	
2(b)	$4\mathbf{a}+\frac{3}{2}\mathbf{c}$ or $\frac{8\mathbf{a}+3\mathbf{c}}{2}$ final answer	**2**	**B1** for final answer $4\mathbf{a}+k\mathbf{c}$ oe or $k\mathbf{a}+1.5\mathbf{c}$ oe, $k\neq 0$ or $\overrightarrow{AP}=3\mathbf{a}$ soi or **M1** for a correct route along the lines of the diagram using the given vertex letters
2(c)	1 : 10 oe	**1**	
3(a)(i)	(–1, 4.5)	**1**	
3(a)(ii)	(–1, 13)	**1**	
3(a)(iii)	7.21[1...]	**2**	**M1** for $(-4)^2 + 6^2$ oe
3(b)(i)	**b** – **a**	**1**	

3(b)(ii)	$\frac{1}{4}\mathbf{a}+\frac{1}{4}\mathbf{b}$ or $\frac{1}{4}(\mathbf{a}+\mathbf{b})$	**3**	**M1** for correct vector route along the lines of the diagram **B1** for $\overrightarrow{BC}=\frac{\mathbf{a}}{2}$ soi or for $\overrightarrow{NB}=\frac{1}{4}their(\mathbf{b}-\mathbf{a})$ soi or $\overrightarrow{NA}=\frac{3}{4}their(\mathbf{a}-\mathbf{b})$ soi
4(a)(i)	$\begin{pmatrix}1\\-8\end{pmatrix}$	**2**	**B1** for answer $\begin{pmatrix}1\\p\end{pmatrix}$ or $\begin{pmatrix}p\\-8\end{pmatrix}$ After 0 scored, **SC1** for answer $\begin{pmatrix}-1\\8\end{pmatrix}$
4(a)(ii)	(–1, –2)	**1**	
4(a)(iii)	10 and –4	**3**	**B2** for answer 10 or –4 nfww or $n-3=\pm7$ oe or $n^2-6n-40$ [=0] or **M1** for $\sqrt{74}=\sqrt{(-3-2)^2+(n-3)^2}$ oe
4(b)	2 : 3 nfww	**3**	**B2** for $\overrightarrow{PL}=\frac{2}{5}\mathbf{q}$ oe or $\overrightarrow{RL}=-\frac{3}{5}\mathrm{q}$ oe or **M1** for correct vector route for $\overrightarrow{KL}$ along the lines of the diagram or $\overrightarrow{PL}=\frac{1}{2}\mathrm{q}-\frac{1}{10}\mathrm{q}$ oe or $\overrightarrow{RL}=-\frac{1}{2}\mathrm{q}-\frac{1}{10}\mathrm{q}$ oe
5(a)(i)	11.7 or 11.66...	**2**	**M1** for $10^2+(-6)^2$ oe
5(a)(ii)	(23, –14)	**2**	**B1** for one coordinate correct or for $\begin{pmatrix}30\\-18\end{pmatrix}$ seen After 0 scored, **SC1** for (–14, 23)
5(b)(i)	$4\mathbf{p}+\mathbf{q}$	**1**	
5(b)(ii)	$3\mathbf{p}+\frac{3}{5}\mathbf{q}$ oe simplified vector final answer	**2**	**B1** for $\overrightarrow{BX}=\frac{3}{5}\mathbf{q}$ or $\overrightarrow{XB}=-\frac{3}{5}\mathrm{q}$ or **M1** for a correct route along the lines of the diagram
5(b)(iii)	$4\mathbf{p}-\frac{2}{5}\mathbf{q}$ oe simplified vector final answer	**2**	**B1** for $\overrightarrow{CX}=-\frac{2}{5}\mathbf{q}$ or $\overrightarrow{XC}=\frac{2}{5}\mathrm{q}$ or **M1** for a correct route along the lines of the diagram

6(a)	Vector 3 **p** drawn 	**1**	
6(b)	Vector **q** – **p** drawn 	**1**	If 0 scored in (a) and (b), award **SC1** for two correct lines with no/incorrect arrows
7(a)	*A* positioned correctly 	**1**	
7(b)	*B* positioned correctly 	**1**	
7(c)	2 **q** – **p** oe	**2**	**B1** for 2**q** oe or for – **p** oe If 0 scored, **SC1** for answer **p** – 2**q**
8(a)(i)	$\begin{pmatrix}-7\\1\end{pmatrix}$ final answer	**1**	
8(a)(ii)	$4^2 + (\pm 3)^2$	**M1**	
	$1^2 + (\pm 5)^2$	**M1**	
	Correct concluding statement eg $\sqrt{25} < \sqrt{26}$ or 5 > 5.1[0] wrong or $\lvert f \rvert = 5$ $\lvert g \rvert = 5.099$ so $\lvert f \rvert$ is not greater than $\lvert g \rvert$	**A1**	

8(b)(i)	$-\frac{1}{3}\mathbf{a}+\mathbf{b}$ or $\frac{1}{3}(-\mathbf{a}+3\mathbf{b})$	**1**	
8(b)(ii)	$\frac{1}{6}\mathbf{a}+\frac{1}{2}\mathbf{b}$ or $\frac{1}{6}(\mathbf{a}+3\mathbf{b})$	**2**	**M1FT** for a correct vector route for $\overrightarrow{OQ}$
8(b)(iii)	$\left[\overrightarrow{AR}=\right]-\frac{1}{2}\mathbf{a}+\frac{3}{2}\mathbf{b}$ or $\frac{1}{2}(-\mathbf{a}+3\mathbf{b})$ or $-\frac{1}{2}(\mathbf{a}-3\mathbf{b})$	**B2**	**M1** for $-\mathbf{a}+3\times$ *their* **(b)(ii)** or $-\frac{2}{3}\mathbf{a}+\frac{1}{2}$ *their*(b)(i)+2×*their* **(b)(ii)**
	$OQ=\frac{1}{3}OR$, $OP=\frac{1}{3}OA$ and $P\hat{O}R=A\hat{O}R$		**M1** for <u>two</u> of $OQ=\frac{1}{3}OR$, $OP=\frac{1}{3}OA$ or $P\hat{O}R=A\hat{O}R$
	$\overrightarrow{AR}=\frac{3}{2}\overrightarrow{PB}$ oe	**B1**	Dep on B2
	Similar triangles $O\hat{P}Q=O\hat{A}R$ or Similar triangles $O\hat{Q}P=O\hat{R}A$		Dep on B2
9(a)	3 **p**	**1**	
9(b)	$\frac{1}{2}(3\mathbf{p}+5\mathbf{q})$ oe	**1**	
9(c)	$\frac{1}{2}(3\mathbf{p}+9\mathbf{q})$ oe	**1**	**FT** 2**q** oe + *their* **(b)** isw
9(d)	1.5 oe	**2**	**B1** for [$\overrightarrow{DE}$ =] **p** + 3**q** **;** or for k(**p** + 3**q**)
10(a)	$\angle BAX=\angle OCX$, alternate [angles] $\angle ABX=\angle COX$, alternate [angles] $\angle AXB=\angle CXO$, [vertically] opposite	**3**	**B1** for two correct pairs of angles **B1** for correct reason for one pair of angles
10(b)(i)	**4**	**1**	
10(b)(ii)	**9a** – 6**c** or 3(3**a** – 2**c**)	**2**	**B1** for answer 9**a** + k**c** or k**a** – 6**c** ($k \neq 0$)
10(c)(i)	3 : 2	**2**	**B1** for 3k : 2k, where k is an integer
10(c)(ii)	9 : 4	**1**	**FT** *their* 3^2 : *their* 2^2
10(c)(iii)	4 : 5	**1**	
11(a)	7	**3**	**M1** for $\left\lvert\overrightarrow{OP}\right\rvert=\sqrt{(-3)^2+(4)^2}$ **B1** for $\left\lvert\overrightarrow{PQ}\right\rvert=2$
11(b)(i)	$\begin{pmatrix}-3+2k\\4\end{pmatrix}$ oe	**1**	
11(b)(ii)	$4\frac{1}{2}$ oe	**2**	**B1** for expressing $\overrightarrow{OM}$ as a multiple (by 4) of $\overrightarrow{OT}$ or **B1** for T is (6, 4); or for $\overrightarrow{OT}=\begin{pmatrix}6\\4\end{pmatrix}$

12(a)(i)	$\frac{1}{3}\mathbf{a} + \frac{1}{3}\mathbf{b}$ or $\frac{1}{3}(\mathbf{a}+\mathbf{b})$ or $\frac{\mathbf{a}+\mathbf{b}}{3}$ final answer	**1**	
12(a)(ii)	$\frac{1}{3}\mathbf{a} - \frac{2}{3}\mathbf{b}$ or $\frac{1}{3}(\mathbf{a}-2\mathbf{b})$ or $\frac{\mathbf{a}-2\mathbf{b}}{3}$ final answer	**1**	
12(b)	Any two pairs of vectors from $\overrightarrow{OA} = \overrightarrow{BC}$ oe $\overrightarrow{OQ} = \overrightarrow{PC}$ oe $\overrightarrow{QA} = \overrightarrow{BP}$ oe **Alternative method:** $OA = BC$ $OQ = PC$ $\angle AOQ = \angle BCP$	**2**	**B1** for any one pair of vectors stated **B1** for two of these pairs of sides stated or one of these pairs of sides and this pair of angles stated
13 (a) (i)	$6\mathbf{b} - 3\mathbf{a}$ oe isw	**1**	
(ii)	$2\mathbf{b} - \mathbf{a}$ oe isw	**1ft**	
(iii)	2 : 3 cao **NB www**	**4**	M1+ M1 for two of $\overrightarrow{OC} = \overrightarrow{OA} + \overrightarrow{AC}$ $\overrightarrow{CD} = \overrightarrow{CB} + \overrightarrow{BD}$ $\overrightarrow{OD} = \overrightarrow{OB} + \overrightarrow{BD}$ A1 for $\overrightarrow{OC} = 2\mathbf{a} + 2\mathbf{b}$ ft or $\overrightarrow{CD} = 3\mathbf{a} + 3\mathbf{b}$ ft or $\overrightarrow{OD} = 5\mathbf{a} + 5\mathbf{b}$
14 (a) (i)	$\begin{pmatrix}5\\6\end{pmatrix}$	**1**	
(ii)	4.47 – 4.473 or 4.5 or $\sqrt{20}$ or $2\sqrt{5}$	**2**	**M1** for $\sqrt{((\pm4)^2 + (\pm2)^2)}$
(b) (i)	(a) $\frac{1}{2}\mathbf{b} - \mathbf{a}$ or $\frac{1}{2}(\mathbf{b} - 2\mathbf{a})$ or equivalent two term answers final answer	**1**	
	(b) $\frac{3}{2}\mathbf{b} - 3\mathbf{a}$ or $3(\frac{1}{2}\mathbf{b} - \mathbf{a})$ or $\frac{3\mathbf{b}-6\mathbf{a}}{2}$ or equivalent two term answers final answer	**1**	
(ii)	3 : 1 cao	**1**	Dependent on correct (b)(i)(a) and (b)(i)(b)

15 (a) (i)	6.08	**1**	
(ii)	$\begin{pmatrix}1\\4\end{pmatrix}$	**2**	**M1** for $\overrightarrow{AF} = \overrightarrow{AH} + \overrightarrow{HF}$ oe or **B1** for $\frac{1}{2}\begin{pmatrix}6\\1\end{pmatrix}$
(iii) (a)	$\begin{pmatrix}4\\-7\end{pmatrix}$	**1**	
(b)	$\overrightarrow{GD} = 2\overrightarrow{FH}$ stated or appropriate numerical vector statement	**1**	dep
(iv)	(9.5, 3)	**1ft**	

16 (a) (i)	**b** – **a**	1	
(ii)	3**b** – 2**a**	1	
(b) (i)	$\frac{4}{3}$**a**	2FT	**M1** for such as $\overrightarrow{BO} + \overrightarrow{OC} + \overrightarrow{CE}$ Or $BD - ED$ or –b + a + AE Or **B1** for $(\overrightarrow{CE}) = \pm\frac{1}{3}$ their **(a)(ii)** Or $(\overrightarrow{DE}) = \pm\frac{2}{3}$ their **(a)(ii)**
(ii)	trapezium	1	

17 (a) (i)	Convincing argument	**3**	www e.g. need to see **b** – **a** and $\frac{5}{3}$(**b** – **a**) **B1** for $\overrightarrow{DE}$ = **b** – **a** oe **B1** for $\overrightarrow{DB} = \frac{2}{3}$**a** or $\overrightarrow{EC} = \frac{2}{3}$**b** oe soi
(ii)	9 : 25 oe	**2**	**B1** for at least 3 : 5 oe seen

18(a)	$\begin{pmatrix}-4\\-3\end{pmatrix}$	**1**	
(b)	$\begin{pmatrix}-3\\-4\end{pmatrix}$	**1**	
(c)	5 cao	**1**	

19 (a) (i)	$\begin{pmatrix}4\\-5\end{pmatrix}$	1	
(ii)	6.4(0) to 6.41 or $\sqrt{41}$ cao	1	

(b)	**(i)**	**(a)** **b** – **a**	1	
		(b) 3**a** cao	1	
		(c) 4(**b** – **a**)	2	**B1** for correct unsimplified $\overrightarrow{CD}$ or for 3(**b** – **a**)
	(ii)	**(a)** 1 : 4	1	
		(b) 1 : 15	1	
20	**(a)**	**(i)** 6.08	1	
		(ii) $\begin{pmatrix} 2 \\ -1.5 \end{pmatrix}$	2	**B1** for $\begin{pmatrix} -1 \\ -2 \end{pmatrix}$ or $\frac{1}{2}\begin{pmatrix} 6 \\ 1 \end{pmatrix}$ oe or **M1** for $\left(\overrightarrow{EH} =\right)\overrightarrow{EA} + \overrightarrow{AH}$
		(iii) $\begin{pmatrix} 2 \\ -1.5 \end{pmatrix}$	1	
		(iv) Equal and parallel	1	Dependent on **(ii)** and **(iii)** correct.
		(v) Shows *G* is midpoint of *CD*	2	**M1** for $\begin{pmatrix} -3 \\ 0 \end{pmatrix} + \begin{pmatrix} -2 \\ -4 \end{pmatrix} + \begin{pmatrix} 6 \\ 1 \end{pmatrix}$ oe seen or **B1** for $\left(\overrightarrow{CD} =\right) 2\overrightarrow{CG} = \begin{pmatrix} 1 \\ -3 \end{pmatrix}$