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$$(a) \quad \vec{AB} = \begin{pmatrix} 4 \\ -1 \\ 0 \end{pmatrix} - \begin{pmatrix} 1 \\ 5 \\ -3 \end{pmatrix} = \begin{pmatrix} 3 \\ -6 \\ 3 \end{pmatrix}$$

$$\vec{BC} = \begin{pmatrix} 8 \\ -9 \\ 4 \end{pmatrix} - \begin{pmatrix} 4 \\ -1 \\ 0 \end{pmatrix} = \begin{pmatrix} 4 \\ -8 \\ 4 \end{pmatrix}$$

$\vec{AB}$ is parallel to $\vec{BC}$ since $\vec{AB} = \frac{3}{4} \vec{BC}$

and since B is a common point, A, B and C are collinear.

$$(b) \quad 3:4$$

Question			Generic scheme	Illustrative scheme	Max mark
5.	(a)		•¹ find an appropriate vector eg $\overrightarrow{AB}$ •² find a second vector eg $\overrightarrow{BC}$ and compare •³ appropriate conclusion	•¹ eg $\overrightarrow{AB} = \begin{pmatrix} 3 \\ -6 \\ 3 \end{pmatrix}$ •² eg $\overrightarrow{BC} = \begin{pmatrix} 4 \\ -8 \\ 4 \end{pmatrix} \therefore \overrightarrow{AB} = \frac{3}{4}\overrightarrow{BC}$ •³ ... $\Rightarrow$ AB is parallel to BC (common direction) and B is a common point $\Rightarrow$ A, B and C are collinear.	3

Notes:

1. Do not penalise inconsistent vector notation (eg lack of arrows or brackets).
2. Where •² is not awarded, if a candidate states that $\overrightarrow{AB} = \overrightarrow{BC}$, only •¹ is available.
3. •³ can only be awarded if a candidate has stated 'parallel', 'common point' and 'collinear'.
4. Candidates who state that 'points are parallel' or 'vectors are collinear' or 'parallel and share common point $\Rightarrow$ collinear' do not gain •³. There must be reference to points A, B and C.
5. Do not accept 'a, b and c are collinear' at •³.

Commonly Observed Responses:

Candidate A - missing labels

$$\begin{pmatrix} 3 \\ -6 \\ 3 \end{pmatrix} \quad \bullet^1 \text{ } \wedge$$

$$\begin{pmatrix} 4 \\ -8 \\ 4 \end{pmatrix} \therefore \overrightarrow{AB} = \frac{3}{4}\overrightarrow{BC} \quad \bullet^2 \text{ } \boxed{\checkmark 1}$$

Missing labels at •2 is a repeated error

$\Rightarrow$ AB is parallel to BC and B is a common point

$\Rightarrow$ A, B and C are collinear $\bullet^3 \text{ } \boxed{\checkmark 1}$

Candidate B

$$\overrightarrow{AB} = \begin{pmatrix} 3 \\ -6 \\ 3 \end{pmatrix} \quad \bullet^1 \text{ } \checkmark$$

$$\overrightarrow{BC} = \begin{pmatrix} 4 \\ -8 \\ 4 \end{pmatrix}$$

$$\begin{pmatrix} 3 \\ -6 \\ 3 \end{pmatrix} = 3 \begin{pmatrix} 1 \\ -2 \\ 1 \end{pmatrix} \text{ and } \begin{pmatrix} 4 \\ -8 \\ 4 \end{pmatrix} = 4 \begin{pmatrix} 1 \\ -2 \\ 1 \end{pmatrix} \quad \bullet^2 \text{ } \checkmark$$

$$\therefore \overrightarrow{AB} = \frac{4}{3}\overrightarrow{BC}$$

Ignore working subsequent to correct statement made on previous line.

$\Rightarrow$ AB is parallel to BC and B is a common point

$\Rightarrow$ A, B and C are collinear $\bullet^3 \text{ } \checkmark$

Question			Generic scheme	Illustrative scheme	Max mark
	(b)		• ⁴ state ratio	• ⁴ 3:4	1
Notes:					
6. Answers in (b) must be consistent with the components of the vectors in (a) or the comparison of the vectors in (a). See Candidates C and D. 7. In this case, the answer for •⁴ must be stated explicitly in part (b). 8. The only acceptable variations for •⁴ must be related explicitly to AB and BC. For $\frac{BC}{AB} = \frac{4}{3}$, $\frac{AB}{BC} = \frac{3}{4}$ or $BC : AB = 4 : 3$ stated in part (b) award •⁴. See Candidate E. 9. Accept unitary ratios for •⁴, eg $\frac{3}{4} : 1$ or $1 : \frac{4}{3}$. 10. Where a candidate states multiple ratios which are not equivalent, award 0/1.					
Commonly Observed Responses:					
Candidate C - using components of vectors			Candidate D - using comparison of vectors		
(a) $\overrightarrow{AB} = \begin{pmatrix} 3 \\ -6 \\ 3 \end{pmatrix}$ • ¹ ✓ $\overrightarrow{BC} = \begin{pmatrix} 4 \\ -8 \\ 4 \end{pmatrix}$ $\overrightarrow{BC} = \frac{3}{4} \overrightarrow{AB}$ • ² ✗ (b) 3:4 • ⁴ ✓			(a) $\overrightarrow{AB} = \begin{pmatrix} 3 \\ -6 \\ 3 \end{pmatrix}$ • ¹ ✓ $\overrightarrow{BC} = \begin{pmatrix} 4 \\ -8 \\ 4 \end{pmatrix}$ $\overrightarrow{BC} = \frac{3}{4} \overrightarrow{AB}$ • ² ✗ (b) 4:3 • ⁴ ✓ 1		
Candidate E - acceptable variation $\frac{AB}{BC} = \frac{3}{4}$ • ⁴ ✓ Ratio = 4 : 3			Candidate F - trivial ratio Ratio is 1:1 • ⁴ ✓ 2		
			Ignore working subsequent to correct statement made on previous line.		