Pearson Edexcel

Topic Test
Summer 2022

Pearson Edexcel GCE Mathematics (9MA0)

Paper 1 and Paper 2

Topic 10: Vectors

Contents

Questions

Question T10_Q1

2. Relative to a fixed origin O,

the point A has position vector $(2\mathbf{i} + 3\mathbf{j} - 4\mathbf{k})$,

the point B has position vector $(4\mathbf{i} - 2\mathbf{j} + 3\mathbf{k})$,

and the point C has position vector $(a\mathbf{i} + 5\mathbf{j} - 2\mathbf{k})$, where a is a constant and $a < 0$

D is the point such that $\overrightarrow{AB} = \overrightarrow{BD}$.

(a) Find the position vector of D.

(2)

Given $|\overrightarrow{AC}| = 4$

(b) find the value of a.

(3)

Question T10_Q2

10.

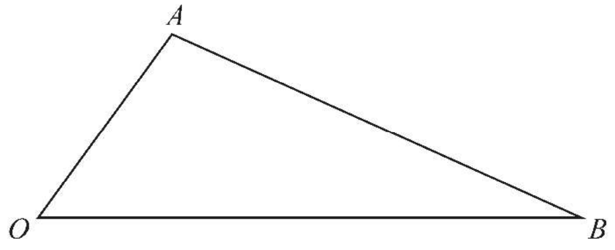


Figure 7

Figure 7 shows a sketch of triangle OAB.

The point C is such that $\overrightarrow{OC} = 2\overrightarrow{OA}$.

The point M is the midpoint of AB.

The straight line through C and M cuts OB at the point N.

Given $\overrightarrow{OA} = \mathbf{a}$ and $\overrightarrow{OB} = \mathbf{b}$

(a) Find $\overrightarrow{CM}$ in terms of **a** and **b**

(2)

(b) Show that $\overrightarrow{ON} = \left(2 - \frac{3}{2}\lambda\right)\mathbf{a} + \frac{1}{2}\lambda\mathbf{b}$, where λ is a scalar constant.

(2)

(c) Hence prove that $ON : NB = 2 : 1$

(2)

Question T10_Q3

3. Relative to a fixed origin O

- point A has position vector $2\mathbf{i} + 5\mathbf{j} - 6\mathbf{k}$
- point B has position vector $3\mathbf{i} - 3\mathbf{j} - 4\mathbf{k}$
- point C has position vector $2\mathbf{i} - 16\mathbf{j} + 4\mathbf{k}$

(a) Find $\overrightarrow{AB}$

(2)

(b) Show that quadrilateral $OABC$ is a trapezium, giving reasons for your answer.

(2)

Question 6 continued

Question T10_Q5

6.

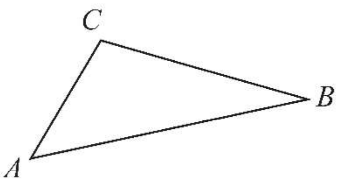


Figure 1

Figure 1 shows a sketch of triangle ABC.

Given that

- $\overrightarrow{AB} = -3\mathbf{i} - 4\mathbf{j} - 5\mathbf{k}$
- $\overrightarrow{BC} = \mathbf{i} + \mathbf{j} + 4\mathbf{k}$

(a) find $\overrightarrow{AC}$

(2)

(b) show that $\cos ABC = \dfrac{9}{10}$

(3)

Mark Scheme

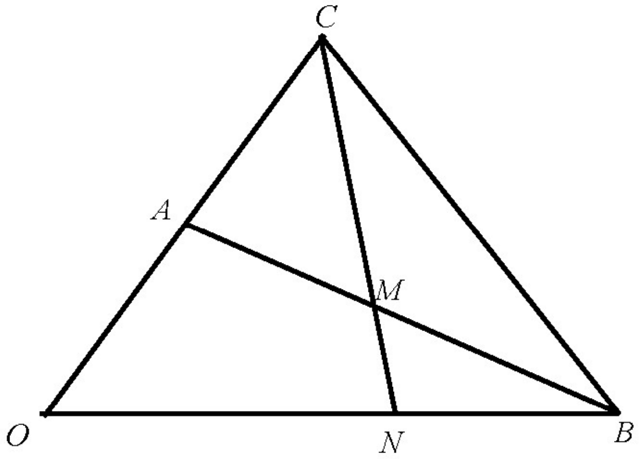
Question T10_Q1

Question	Scheme	Marks	AOs
2	$\overrightarrow{OA} = 2\mathbf{i} + 3\mathbf{j} - 4\mathbf{k},\ \overrightarrow{OB} = 4\mathbf{i} - 2\mathbf{j} + 3\mathbf{k},\ \overrightarrow{OC} = a\mathbf{i} + 5\mathbf{j} - 2\mathbf{k},\ a < 0$ $\overrightarrow{AB} = \overrightarrow{BD},\ \lvert\overrightarrow{AB}\rvert = 4$		
(a)	E.g. $\overrightarrow{OD} = \overrightarrow{OB} + \overrightarrow{BD} = \overrightarrow{OB} + \overrightarrow{AB}$ **or** $\overrightarrow{OD} = \overrightarrow{OB} + \overrightarrow{BD} = \overrightarrow{OB} + \overrightarrow{AB} = \overrightarrow{OB} + \overrightarrow{OB} - \overrightarrow{OA} = 2\overrightarrow{OB} - \overrightarrow{OA}$ **or** $\overrightarrow{OD} = \overrightarrow{OB} + \overrightarrow{BD} = \overrightarrow{OB} + \overrightarrow{AB} = \overrightarrow{OA} + \overrightarrow{AB} + \overrightarrow{AB} = \overrightarrow{OA} + 2\overrightarrow{AB}$		
	$= \begin{pmatrix}4\\-2\\3\end{pmatrix} + \begin{pmatrix}4\\-2\\3\end{pmatrix} - \begin{pmatrix}2\\3\\-4\end{pmatrix} \left\{ = \begin{pmatrix}4\\-2\\3\end{pmatrix} + \begin{pmatrix}2\\-5\\7\end{pmatrix} \right\}$ **or** $= \begin{pmatrix}2\\3\\-4\end{pmatrix} + 2\left(\begin{pmatrix}4\\-2\\3\end{pmatrix} - \begin{pmatrix}2\\3\\-4\end{pmatrix}\right) \left\{ = \begin{pmatrix}2\\3\\-4\end{pmatrix} + 2\begin{pmatrix}2\\-5\\7\end{pmatrix} \right\}$	M1	3.1a
	$= \begin{pmatrix}6\\-7\\10\end{pmatrix}$ or $6\mathbf{i} - 7\mathbf{j} + 10\mathbf{k}$	A1	1.1b
		(2)	
(b)	$(a-2)^2 + (5-3)^2 + (-2--4)^2$	M1	1.1b
	$\left\{\lvert\overrightarrow{AC}\rvert = 4 \Rightarrow\right\} (a-2)^2 + (5-3)^2 + (-2--4)^2 = (4)^2$ $\Rightarrow (a-2)^2 = 8 \Rightarrow a = ...$ **or** $\Rightarrow a^2 - 4a - 4 = 0 \Rightarrow a = ...$	dM1	2.1
	(as $a < 0 \Rightarrow$) $a = 2 - 2\sqrt{2}$ (or $a = 2 - \sqrt{8}$)	A1	1.1b
		(3)	
			(5 marks)

Notes for Question 2

(a)	
M1:	Complete ***applied*** strategy to find a vector expression for $\overrightarrow{OD}$
A1:	See scheme
Note:	Give M0 for subtracting the wrong way wrong to give e.g. $(4\mathbf{i} - 2\mathbf{j} + 3\mathbf{k}) + (2\mathbf{i} + 3\mathbf{j} - 4\mathbf{k}) - (4\mathbf{i} - 2\mathbf{j} + 3\mathbf{k}) = (4\mathbf{i} - 2\mathbf{j} + 3\mathbf{k}) + (-2\mathbf{i} + 5\mathbf{j} - 7\mathbf{k}) = (2\mathbf{i} + 3\mathbf{j} - 4\mathbf{k})$
Note:	Writing e.g. $\overrightarrow{OD} = \overrightarrow{OB} + \overrightarrow{AB}$ or $\overrightarrow{OD} = 2\overrightarrow{OB} - \overrightarrow{OA}$ with no other work is M0
Note:	Finding ***coordinates***, i.e. $(6, -7, 10)$ without reference to the correct position vectors is A0
Note:	Allow M1A1 for writing down $6\mathbf{i} - 7\mathbf{j} + 10\mathbf{k}$ with no working
Note:	M1 can be implied for at least two correct components in their position vector of D
(b)	
M1:	Finds the difference between $\overrightarrow{OA}$ and $\overrightarrow{OC}$, then squares and adds each of the 3 components Note: Ignore labelling
dM1:	Complete method of ***correctly*** applying Pythagoras' Theorem on $\lvert\overrightarrow{AC}\rvert = 4$ and using a correct method of solving their resulting quadratic equation to find at least one of $a = ...$
Note:	Condone at least one of either awrt 4.8 or awrt -0.83 for the dM mark
A1:	Obtains **only one** exact value, $a = 2 - 2\sqrt{2}$
Note:	Writing $a = 2 \pm 2\sqrt{2}$, without evidence of rejecting $a = 2 + 2\sqrt{2}$ is A0
Note:	Allow exact alternatives such as $2 - \sqrt{8}$ or $\frac{4 - \sqrt{32}}{2}$ for A1, and isw can be applied
Note:	Writing $a = -0.828...$, without reference to a correct exact value is A0

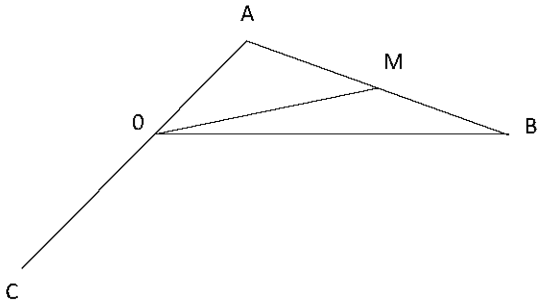
Question T10_Q2

Question	Scheme	Marks	AOs
10			
	$\overrightarrow{OA} = \mathbf{a},\ \overrightarrow{OB} = \mathbf{b}$		
(a)	$\left\{\overrightarrow{CM} = \overrightarrow{CA} + \overrightarrow{AM} = \overrightarrow{CA} + \frac{1}{2}\overrightarrow{AB} \Rightarrow\right\}\ \overrightarrow{CM} = -\mathbf{a} + \frac{1}{2}(\mathbf{b} - \mathbf{a})$	M1	3.1a
	$\left\{\overrightarrow{CM} = \overrightarrow{CB} + \overrightarrow{BM} = \overrightarrow{CB} + \frac{1}{2}\overrightarrow{BA} \Rightarrow\right\}\ \overrightarrow{CM} = (-2\mathbf{a} + \mathbf{b}) + \frac{1}{2}(\mathbf{a} - \mathbf{b})$		
	$\Rightarrow \overrightarrow{CM} = -\frac{3}{2}\mathbf{a} + \frac{1}{2}\mathbf{b}$ ***(needs to be simplified and seen in (a) only)***	A1	1.1b
		(2)	
(b)	$\dot{ON} = \dot{OC} + \dot{CN} \Rightarrow\ \dot{ON} = \dot{OC} + \lambda \dot{CM}$	M1	1.1b
	$\dot{ON} = 2\mathbf{a} + \lambda\left(-\frac{3}{2}\mathbf{a} + \frac{1}{2}\mathbf{b}\right) \Rightarrow\ \dot{ON} = \left(2 - \frac{3}{2}\lambda\right)\mathbf{a} + \frac{1}{2}\lambda\mathbf{b}$ *	A1*	2.1
		(2)	
(c) **Way 1**	$\left(2 - \frac{3}{2}\lambda\right) = 0 \Rightarrow \lambda = \ldots$	M1	2.2a
	$\lambda = \frac{4}{3} \Rightarrow \overrightarrow{ON} = \frac{2}{3}\mathbf{b}\ \left\{\Rightarrow \overrightarrow{NB} = \frac{1}{3}\mathbf{b}\right\} \Rightarrow ON : NB = 2:1$ *	A1*	2.1
		(2)	
(c) **Way 2**	$\overrightarrow{ON} = \mu\mathbf{b} \Rightarrow\ \left(2 - \frac{3}{2}\lambda\right)\mathbf{a} + \frac{1}{2}\lambda\mathbf{b} = \mu\mathbf{b}$		
	$\mathbf{a}:\ \left(2 - \frac{3}{2}\lambda\right) = 0 \Rightarrow \lambda = \ldots\ \left\{\mathbf{b}:\ \frac{1}{2}\lambda = \mu\ \&\ \lambda = \frac{4}{3} \Rightarrow \mu = \frac{2}{3}\right\}$	M1	2.2a
	$\lambda = \frac{4}{3}$ or $\mu = \frac{2}{3} \Rightarrow \dot{ON} = \frac{2}{3}\mathbf{b}\ \left\{\Rightarrow \dot{NB} = \frac{1}{3}\mathbf{b}\right\} \Rightarrow ON : NB = 2:1$ *	A1*	2.1
		(2)	
			(6 marks)

Question	Scheme	Marks	AOs
10 (c) Way 3	$\overrightarrow{OB}=\overrightarrow{ON}+\overrightarrow{NB} \Rightarrow \mathbf{b}=\left(2-\frac{3}{2}\lambda\right)\mathbf{a}+\frac{1}{2}\lambda\mathbf{b}+K\mathbf{b}$		
	$\mathbf{a}:\ \left(2-\frac{3}{2}\lambda\right)=0 \Rightarrow \lambda=...\ \left\{\mathbf{b}:\ 1=\frac{1}{2}\lambda+K\ \ \&\ \lambda=\frac{4}{3}\ \Rightarrow K=\frac{1}{3}\right\}$	M1	2.2a
	$\lambda=\frac{4}{3}$ or $K=\frac{1}{3} \Rightarrow \overrightarrow{ON}=\frac{2}{3}\mathbf{b}$ or $\overrightarrow{NB}=\frac{1}{3}\mathbf{b} \Rightarrow ON:NB=2:1$ *	A1	2.1
		(2)	
10 (c) Way 4	$\overrightarrow{ON}=\mu\mathbf{b}\ \&\ \overrightarrow{CN}=k\overrightarrow{CM} \Rightarrow \overrightarrow{CO}+\overrightarrow{ON}=k\overrightarrow{CM}$		
	$-2\mathbf{a}+\mu\mathbf{b}=k\left(-\frac{3}{2}\mathbf{a}+\frac{1}{2}\mathbf{b}\right)$		
	$\mathbf{a}:-2=-\frac{3}{2}k \Rightarrow k=\frac{4}{3},\ \ \mathbf{b}:\ \mu=\frac{1}{2}k \Rightarrow \mu=\frac{1}{2}\left(\frac{4}{3}\right)=...$	M1	2.2a
	$\mu=\frac{2}{3} \Rightarrow \overrightarrow{ON}=\frac{2}{3}\mathbf{b}\ \left\{\Rightarrow \overrightarrow{NB}=\frac{1}{3}\mathbf{b}\right\} \Rightarrow ON:NB=2:1$ *	A1	2.1
		(2)	

Notes for Question 10

(a)	
M1:	Valid attempt to find $\overrightarrow{CM}$ using a combination of known vectors **a** and **b**
A1:	A simplified correct answer for $\overrightarrow{CM}$
Note:	Give M1 for $\overrightarrow{CM}=-\mathbf{a}+\frac{1}{2}(\mathbf{b}-\mathbf{a})$ or $\overrightarrow{CM}=(-2\mathbf{a}+\mathbf{b})+\frac{1}{2}(\mathbf{a}-\mathbf{b})$ or for $\left\{\overrightarrow{CM}=\overrightarrow{OM}-\overrightarrow{OC} \Rightarrow\right\}\ \overrightarrow{CM}=\frac{1}{2}(\mathbf{a}+\mathbf{b})-2\mathbf{a}$ **only o.e.**
(b)	
M1:	Uses $\overrightarrow{ON}=\overrightarrow{OC}+\lambda\overrightarrow{CM}$
A1*:	Correct proof
Note:	<u>**Special Case**</u>
	Give SC M1 A0 for the solution $\overrightarrow{ON}=\overrightarrow{OA}+\overrightarrow{AM}+\overrightarrow{MN} \Rightarrow \overrightarrow{ON}=\overrightarrow{OA}+\overrightarrow{AM}+\lambda\overrightarrow{CM}$
	$\overrightarrow{ON}=\mathbf{a}+\frac{1}{2}(\mathbf{b}-\mathbf{a})+\lambda\left(-\frac{3}{2}\mathbf{a}+\frac{1}{2}\mathbf{b}\right)\ \left\{=\left(\frac{1}{2}-\frac{3}{2}\lambda\right)\mathbf{a}+\left(\frac{1}{2}+\frac{1}{2}\lambda\right)\mathbf{b}\right\}$
Note:	<u>**Alternative 1:**</u> Give M1 A1 for the following alternative solution: $\overrightarrow{ON}=\overrightarrow{OA}+\overrightarrow{AM}+\overrightarrow{MN} \Rightarrow \overrightarrow{ON}=\overrightarrow{OA}+\overrightarrow{AM}+\mu\overrightarrow{CM}$ $\overrightarrow{ON}=\mathbf{a}+\frac{1}{2}(\mathbf{b}-\mathbf{a})+\mu\left(-\frac{3}{2}\mathbf{a}+\frac{1}{2}\mathbf{b}\right)=\left(\frac{1}{2}-\frac{3}{2}\mu\right)\mathbf{a}+\left(\frac{1}{2}+\frac{1}{2}\mu\right)\mathbf{b}$ $\mu=\lambda-1 \Rightarrow\ \overrightarrow{ON}=\left(\frac{1}{2}-\frac{3}{2}(\lambda-1)\right)\mathbf{a}+\left(\frac{1}{2}+\frac{1}{2}(\lambda-1)\right)\mathbf{b} \Rightarrow \overrightarrow{ON}=\left(2-\frac{3}{2}\lambda\right)\mathbf{a}+\frac{1}{2}\lambda\mathbf{b}$
(c)	**Way 1, Way 2 and Way 3**
M1:	Deduces that $\left(2-\frac{3}{2}\lambda\right)=0$ and attempts to find the value of λ
A1*:	Correct proof
(c)	**Way 4**
M1:	Complete attempt to find the value of μ
A1*:	Correct proof

Notes for Question 10 Continued	
Note:	Part (b) and part (c) can be marked together.
(a) Special Case	**<u>Special Case where the point C is believed to be below the origin O</u>** 
	Give Special Case M1 A0 in part (a) for $\left\{\overrightarrow{CM} = \overrightarrow{CA} + \overrightarrow{AM} \Rightarrow\right\}$ $\overrightarrow{CM} = 3\mathbf{a} + \frac{1}{2}(\mathbf{b} - \mathbf{a})$
	$\left\{\text{which leads to } \overrightarrow{CM} = \frac{5}{2}\mathbf{a} + \frac{1}{2}\mathbf{b}\right\}$

Question T10_Q3

Question	Scheme	Marks	AOs
3 (a)	$\overrightarrow{AB} = (3\mathbf{i}-3\mathbf{j}-4\mathbf{k})-(2\mathbf{i}+5\mathbf{j}-6\mathbf{k})$	M1	1.1b
	$= \mathbf{i}-8\mathbf{j}+2\mathbf{k}$	A1	1.1b
		(2)	
(b)	States $\overrightarrow{OC} = 2\times\overrightarrow{AB}$	M1	1.1b
	Explains that as OC is parallel to AB, so $OABC$ is a trapezium.	A1	2.4
		(2)	
			(4 marks)
Notes:			

(a)

M1: Attempts to subtract either way around. If no method is seen it is implied by two of $\pm 1\mathbf{i}\pm 8\mathbf{j}\pm 2\mathbf{k}$.

A1: $\mathbf{i}-8\mathbf{j}+2\mathbf{k}$ or $\begin{pmatrix}1\\-8\\2\end{pmatrix}$ but not $(1,-8,2)$

(b)

M1: Compares their $\mathbf{i}-8\mathbf{j}+2\mathbf{k}$ with $2\mathbf{i}-16\mathbf{j}+4\mathbf{k}$ by stating **any one of**

- $\overrightarrow{OC} = 2\times\overrightarrow{AB}$
- $\begin{pmatrix}2\\-16\\4\end{pmatrix} = 2\times\begin{pmatrix}1\\-8\\2\end{pmatrix}$
- $\overrightarrow{OC} = \lambda\times\overrightarrow{AB}$ or vice versa

This may be awarded if AB was subtracted "the wrong way around" or if there was one numerical slip

A1: A full explanation as to why $OABC$ is a trapezium.

Requires fully correct calculations, so part (a) must be $\overrightarrow{AB} = (\mathbf{i}-8\mathbf{j}+2\mathbf{k})$

It requires a reason and minimal conclusion.

Example 1:

$\overrightarrow{OC} = 2\times\overrightarrow{AB}$, therefore OC is parallel to AB so $OABC$ is a trapezium

Example 2:

A trapezium has one pair of parallel sides. As $\overrightarrow{OC} = 2\times\overrightarrow{AB}$, they are parallel, so ✓.

Example 3

As $\begin{pmatrix}2\\-16\\4\end{pmatrix} = 2\times\begin{pmatrix}1\\-8\\2\end{pmatrix}$, OC and AB are parallel, so proven

Example 4

Accept as $\overrightarrow{OC} = \lambda\times\overrightarrow{AB}$, they are parallel so true

Note: There are two definitions for a trapezium. One stating that it is a shape with one pair of parallel sides, the other with **only one** pair of parallel sides. Any calculations to do with sides OA and CB in this question may be ignored, even if incorrect.

Question T10_Q4

Question Number	Scheme	Marks	AO's
2	Attempts any one of $\left(\pm\overrightarrow{PQ}=\right)\pm(\mathbf{q}-\mathbf{p}),\ \left(\pm\overrightarrow{PR}=\right)\pm(\mathbf{r}-\mathbf{p}),\ \left(\pm\overrightarrow{QR}=\right)\pm(\mathbf{r}-\mathbf{q})$ Or e.g. $\left(\pm\overrightarrow{PQ}=\right)\pm\left(\overrightarrow{OQ}-\overrightarrow{OP}\right),\ \left(\pm\overrightarrow{PR}=\right)\pm\left(\overrightarrow{OR}-\overrightarrow{OP}\right),\ \left(\pm\overrightarrow{QR}=\right)\pm\left(\overrightarrow{OR}-\overrightarrow{OQ}\right)$	M1	1.1b
	Attempts e.g. $\mathbf{r}-\mathbf{q}=2(\mathbf{q}-\mathbf{p})$ $\mathbf{r}-\mathbf{p}=3(\mathbf{q}-\mathbf{p})$ $\frac{2}{3}(\mathbf{q}-\mathbf{p})=\frac{1}{3}(\mathbf{r}-\mathbf{q})$ $\mathbf{q}=\mathbf{p}+\frac{1}{3}(\mathbf{r}-\mathbf{p})$ $\mathbf{q}=\mathbf{r}+\frac{2}{3}(\mathbf{p}-\mathbf{r})$	dM1	3.1a
	E.g. $\Rightarrow \mathbf{r}-\mathbf{q}=2\mathbf{q}-2\mathbf{p}\Rightarrow 2\mathbf{p}+\mathbf{r}=3\mathbf{q}\Rightarrow \mathbf{q}=\frac{1}{3}(\mathbf{r}+2\mathbf{p})$*	A1*	2.1
		(3)	
			(3 marks)

Notes:

M1: Attempts any of the relevant vectors by subtracting either way around. This may be implied by sight of any one of $\pm(\mathbf{q}-\mathbf{p}),\ \pm(\mathbf{r}-\mathbf{p}),\ \pm(\mathbf{r}-\mathbf{q})$ ignoring how they are labelled

dM1: Uses the given information and writes it correctly in vector form that if rearranged would give the printed answer

A1*: Fully correct work leading to the given answer. Allow OQ = … as long as OQ has been defined as **q** earlier.

In the working allow use of P instead of **p** and Q instead of **q** as long as the intention is clear.

Question T10_Q5

Question	Scheme	Marks	AOs
6(a)	$\overrightarrow{AC} = \overrightarrow{AB} + \overrightarrow{BC} = -3\mathbf{i} - 4\mathbf{j} - 5\mathbf{k} + \mathbf{i} + \mathbf{j} + 4\mathbf{k} = ...$	M1	1.1b
	$= -2\mathbf{i} - 3\mathbf{j} - \mathbf{k}$	A1	1.1b
		(2)	
(b)	At least 2 of $(AC^2) = "2^2 + 3^2 + 1^2", (AB^2) = 3^2 + 4^2 + 5^2, (BC^2) = 1^2 + 1^2 + 4^2$	M1	1.1b
	$2^2 + 3^2 + 1^2 = 3^2 + 4^2 + 5^2 + 1^2 + 1^2 + 4^2 - 2\sqrt{3^2 + 4^2 + 5^2}\sqrt{1^2 + 1^2 + 4^2}\cos ABC$	M1	3.1a
	$14 = 50 + 18 - 2\sqrt{50}\sqrt{18}\cos ABC$ $\Rightarrow \cos ABC = \frac{50 + 18 - 14}{2\sqrt{50}\sqrt{18}} = \frac{9}{10}$*	A1*	2.1
		(3)	
	(b) Alternative		
	$AB^2 = 3^2 + 4^2 + 5^2,\ BC^2 = 1^2 + 1^2 + 4^2$	M1	1.1b
	$\overrightarrow{BA}.\overrightarrow{BC} = (3\mathbf{i} + 4\mathbf{j} + 5\mathbf{k})\cdot(\mathbf{i} + \mathbf{j} + 4\mathbf{k}) = 27 = \sqrt{3^2 + 4^2 + 5^2}\sqrt{1^2 + 1^2 + 4^2}\cos ABC$	M1	3.1a
	$27 = \sqrt{50}\sqrt{18}\cos ABC \Rightarrow \cos ABC = \frac{27}{\sqrt{50}\sqrt{18}} = \frac{9}{10}$*	A1*	2.1
		(5 marks)	
Notes			

(a)

M1: Attempts $\overrightarrow{AC} = \overrightarrow{AB} + \overrightarrow{BC}$

There must be attempt to add not subtract.

If no method shown it may be implied by **two** correct components

A1: Correct vector. Allow $-2\mathbf{i} - 3\mathbf{j} - \mathbf{k}$ and $\begin{pmatrix} -2 \\ -3 \\ -1 \end{pmatrix}$ but not $\begin{pmatrix} -2\mathbf{i} \\ -3\mathbf{j} \\ -1\mathbf{k} \end{pmatrix}$

(b)

M1: Attempts to "square and add" for at least 2 of the 3 sides. Follow through on their $\overrightarrow{AC}$

Look for an attempt at either $a^2 + b^2 + c^2$ or $\sqrt{a^2 + b^2 + c^2}$

M1: A correct attempt to apply a correct cosine rule to the given problem; Condone **slips** on the lengths of the sides but the sides must be in the correct position to find angle ABC

A1*: Correct completion with sufficient intermediate work to establish the printed result.

Condone different labelling, e.g. $ABC \leftrightarrow \theta$ as long as it is clear what is meant

It is OK to move from a correct cosine rule $14 = 50 + 18 - 2\sqrt{50}\sqrt{18}\cos ABC$

via $\cos ABC = \frac{54}{2\sqrt{50}\sqrt{18}}$ o.e. such as $\cos ABC = \frac{(5\sqrt{2})^2 + (3\sqrt{2})^2 - (\sqrt{14})^2}{2 \times 5\sqrt{2} \times 3\sqrt{2}}$ to $\cos ABC = \frac{9}{10}$

Alternative:

M1: Correct application of Pythagoras for sides AB and BC or their squares

M1: Recognises the requirement for and applies the scalar product

A1*: Correct completion with sufficient intermediate work to establish the printed result