Edexcel - Pure Year 2 exam questions

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Ch. 12: Vectors

June 2023 Question 6 Paper 2

6. Relative to a fixed origin O,

- A is the point with position vector $12\mathbf{i}$
- B is the point with position vector $16\mathbf{j}$
- C is the point with position vector $(50\mathbf{i} + 136\mathbf{j})$
- D is the point with position vector $(22\mathbf{i} + 24\mathbf{j})$

(a) Show that AD is parallel to BC.

(2)

Points A, B, C and D are used to model the vertices of a running track in the shape of a quadrilateral.

Runners complete one lap by running along all four sides of the track.

The lengths of the sides are measured in metres.

Given that a particular runner takes exactly 5 minutes to complete 2 laps,

(b) calculate the average speed of this runner, giving the answer in kilometres per hour.

(4)

ANSWER

Question	Scheme	Marks	AOs
6(a)	$\overrightarrow{AD} = 10\mathbf{i} + 24\mathbf{j}$ and $\overrightarrow{BC} = 50\mathbf{i} + 120\mathbf{j}$	**M1**	1.1b
	$\overrightarrow{AD} = \frac{1}{5}\overrightarrow{BC}$ therefore AD is parallel to BC *	**A1*cso**	2.2a
		(2)	
(b)	Attempt to find at least two lengths between AB, BC, CD and AD $\lvert\overrightarrow{BC}\rvert = \sqrt{50^2 + 120^2} = 130$, $\lvert\overrightarrow{DA}\rvert = \sqrt{10^2 + 24^2} = 26$	**M1**	1.1b
	$\lvert\overrightarrow{AB}\rvert = \sqrt{12^2 + 16^2} = 20$, $\lvert\overrightarrow{CD}\rvert = \sqrt{28^2 + 112^2} = 28\sqrt{17}$ (awrt 115 m)	**A1**	1.1b
	Average speed $= \dfrac{2\left(26+130+20+28\sqrt{17}\right)/1000}{5/60}$	**dM1**	3.1b
	awrt $= 6.99$ (km/h)	**A1**	3.2a
		(4)	
			(6 marks)

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June 2023 Question 3 Paper 1

3. Relative to a fixed origin O

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

where a is a positive integer.

(a) Show that $|\overrightarrow{OA}| = \sqrt{38}$

(1)

(b) Find the smallest value of a for which

$$|\overrightarrow{OB}| > |\overrightarrow{OA}|$$

(2)

ANSWER

Question	Scheme	Marks	AOs
3(a)	$\left(\lvert OA\rvert =\right)\sqrt{5^2+3^2+2^2} = \sqrt{38}$ *	B1*	1.1b
		(1)	
(b)	$\lvert OB\rvert = \sqrt{2^2+4^2+a^2} = \sqrt{20+a^2}$ so when $a=5$ $\lvert OB\rvert = \sqrt{20+25} = \sqrt{45}$	M1	1.1b
	$=5$	A1cso	2.3
		(2)	
			(3 marks)

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June 2022 Question 13 Paper 2

13. Relative to a fixed origin O

- the point A has position vector $4\mathbf{i} - 3\mathbf{j} + 5\mathbf{k}$
- the point B has position vector $4\mathbf{j} + 6\mathbf{k}$
- the point C has position vector $-16\mathbf{i} + p\mathbf{j} + 10\mathbf{k}$

where p is a constant.

Given that A, B and C lie on a straight line,

(a) find the value of p.

(3)

The line segment OB is extended to a point D so that $\overrightarrow{CD}$ is parallel to $\overrightarrow{OA}$

(b) Find $\left|\overrightarrow{OD}\right|$, writing your answer as a fully simplified surd.

(3)

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ANSWER

Question	Scheme	Marks	AOs
13(a)	Attempts two of the relevant vectors $\pm\overrightarrow{AB} = \pm(-4\mathbf{i}+7\mathbf{j}+\mathbf{k})$ $\pm\overrightarrow{AC} = \pm(-20\mathbf{i}+(p+3)\mathbf{j}+5\mathbf{k})$ $\pm\overrightarrow{BC} = \pm(-16\mathbf{i}+(p-4)\mathbf{j}+4\mathbf{k})$	M1	3.1a
	Uses two of the three vectors in such a way as to find the value of p. E.g. $p+3=5\times 7$	dM1	2.1
	$p=32$	A1	1.1b
		(3)	

Question	Scheme	Marks	AOs
(b)	Deduces that $\overrightarrow{OD} = \lambda\overrightarrow{OB} = 4\lambda\mathbf{j}+6\lambda\mathbf{k}$ and attempts $\overrightarrow{CD} = 16\mathbf{i}+(4\lambda-\text{"}32\text{"})\mathbf{j}+(6\lambda-10)\mathbf{k}$	M1	3.1a
	Correct attempt at λ using the fact that $\overrightarrow{CD}$ is parallel to $\overrightarrow{OA}$ $\overrightarrow{CD} = 16\mathbf{i}+(4\lambda-\text{"}32\text{"})\mathbf{j}+(6\lambda-10)\mathbf{k}$ $\overrightarrow{OA} = 4\mathbf{i}-3\mathbf{j}+5\mathbf{k}$ $4\lambda-32=-12 \Rightarrow \lambda = \ldots$ OR $6\lambda-10=20 \Rightarrow \lambda=\ldots$	dM1	1.1b
	$\lvert\overrightarrow{OD}\rvert = 5\times\sqrt{4^2+6^2} = 10\sqrt{13}$	A1	1.1b
		(3)	

Video solution:

https://youtu.be/8uADn2CLsVs

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June 2022 Question 9 Paper 1

9.

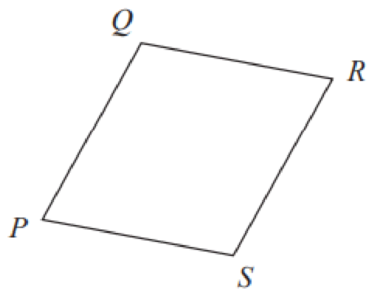

Figure 3

Figure 3 shows a sketch of a parallelogram *PQRS*.

Given that

- $\overrightarrow{PQ} = 2\mathbf{i} + 3\mathbf{j} - 4\mathbf{k}$
- $\overrightarrow{QR} = 5\mathbf{i} - 2\mathbf{k}$

(a) show that parallelogram *PQRS* is a rhombus.

(2)

(b) Find the exact area of the rhombus *PQRS*.

(4)

ANSWER

Question	Scheme	Marks	AOs
9(a)	Attempts both $\left\|\overrightarrow{PQ}\right\| = \sqrt{2^2+3^2+(-4)^2}$ and $\left\|\overrightarrow{QR}\right\| = \sqrt{5^2+(-2)^2}$	M1	3.1a
	States that $\left\|\overrightarrow{PQ}\right\| = \left\|\overrightarrow{QR}\right\| = \sqrt{29}$ so *PQRS* is a rhombus	A1	2.4
		(2)	
(b)	Attempts BOTH $\overrightarrow{PR} = \overrightarrow{PQ} + \overrightarrow{QR} = 7\mathbf{i} + 3\mathbf{j} - 6\mathbf{k}$ AND $\overrightarrow{QS} = -\overrightarrow{PQ} + \overrightarrow{PS} = 3\mathbf{i} - 3\mathbf{j} + 2\mathbf{k}$	M1	3.1a
	Correct $\overrightarrow{PR} = 7\mathbf{i} + 3\mathbf{j} - 6\mathbf{k}$ and $\overrightarrow{QS} = 3\mathbf{i} - 3\mathbf{j} + 2\mathbf{k}$	A1	1.1b
	Correct method for area *PQRS*. E.g. $\frac{1}{2} \times \left\|\overrightarrow{PR}\right\| \times \left\|\overrightarrow{QS}\right\|$	dM1	2.1
	$= \sqrt{517}$	A1	1.1b
		(4)	
			(6 marks)

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November 2021 Question 6 Paper 1

6.

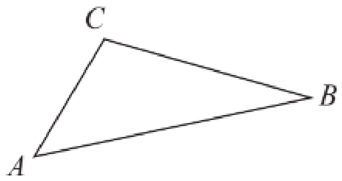

Figure 1

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)

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ANSWER

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 $\left(AC^2\right)="2^2+3^2+1^2",\left(AB^2\right)=3^2+4^2+5^2,\ \left(BC^2\right)=1^2+1^2+4^2$	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
	$14=50+18-2\sqrt{50}\sqrt{18}\cos ABC$ $\Rightarrow \cos ABC=\dfrac{50+18-14}{2\sqrt{50}\sqrt{18}}=\dfrac{9}{10}*$	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
	$27=\sqrt{50}\sqrt{18}\cos ABC\Rightarrow\cos ABC=\dfrac{27}{\sqrt{50}\sqrt{18}}=\dfrac{9}{10}*$	A1*	2.1
			(5 marks)

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June 2018 Question 2 Paper 2

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)

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ANSWER

Question	Scheme	Marks	AOs
2	$\overrightarrow{OA} = 2\mathbf{i}+3\mathbf{j}-4\mathbf{k},\ \overrightarrow{OB} = 4\mathbf{i}-2\mathbf{j}+3\mathbf{k},\ \overrightarrow{OC} = a\mathbf{i}+5\mathbf{j}-2\mathbf{k},\ a<0$ $\overrightarrow{AB} = \overrightarrow{BD},\ \left\|\overrightarrow{AB}\right\| = 4$		
(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
	$\left\{\left\|\overrightarrow{AC}\right\| = 4 \Rightarrow\right\}\ (a-2)^2+(5-3)^2+(-2--4)^2 = (4)^2$ $\Rightarrow (a-2)^2 = 8 \Rightarrow a = \ldots$ **or** $\Rightarrow a^2-4a-4=0 \Rightarrow a = \ldots$	dM1	2.1
	(as $a<0 \Rightarrow$) $a = 2-2\sqrt{2}$ (or $a = 2-\sqrt{8}$)	A1	1.1b
		(3)	
			(5 marks)

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