Pure Year 1 exam questions Edexcel

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Ch. 11: Vectors

June 2023 Question 13

13. Relative to a fixed origin O

- point A has position vector $10\mathbf{i} - 3\mathbf{j}$
- point B has position vector $-8\mathbf{i} + 9\mathbf{j}$
- point C has position vector $-2\mathbf{i} + p\mathbf{j}$ where p is a constant

(a) Find $\overrightarrow{AB}$

(2)

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

(2)

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

(c) (i) find the value of p,

(ii) state the ratio of the area of triangle AOC to the area of triangle AOB.

(3)

ANSWER

Question	Scheme	Marks	AOs
13 (a)	$\overrightarrow{AB}=\overrightarrow{OB}-\overrightarrow{OA}=(-8\mathbf{i}+9\mathbf{j})-(10\mathbf{i}-3\mathbf{j})$	M1	1.1b
	$=-18\mathbf{i}+12\mathbf{j}$	A1	1.1b
		(2)	
(b)	$\lvert\overrightarrow{AB}\rvert=\sqrt{"18"^2+"12"^2}\ \{=\sqrt{468}\}$	M1	1.1b
	$=6\sqrt{13}$	A1	1.1b
		(2)	
(c)	For the key step in using the fact that BCA forms a straight line in an attempt to find "p" $\overrightarrow{AB}=\lambda\overrightarrow{BC}\Rightarrow -18\mathbf{i}+12\mathbf{j}=6\lambda\mathbf{i}+\lambda(p-9)\mathbf{j}$ with components equated leading to a value for λ and to $p=\ldots$	M1	2.1
	(i) $p=5$	A1	1.1b
	(ii) ratio = 2: 3	B1 (A1 on EPEN)	2.2a
		(3)	
			(7 marks)

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)

June 2022 Question 3

3. The triangle PQR is such that $\overrightarrow{PQ} = 3\mathbf{i} + 5\mathbf{j}$ and $\overrightarrow{PR} = 13\mathbf{i} - 15\mathbf{j}$

(a) Find $\overrightarrow{QR}$

(2)

(b) Hence find $|\overrightarrow{QR}|$ giving your answer as a simplified surd.

(2)

The point S lies on the line segment QR so that $QS:SR = 3:2$

(c) Find $\overrightarrow{PS}$

(2)

ANSWER

Question	Scheme	Marks	AOs
3(a)	$\overrightarrow{QR} = \overrightarrow{PR} - \overrightarrow{PQ} = 13\mathbf{i} - 15\mathbf{j} - (3\mathbf{i} + 5\mathbf{j})$	M1	1.1a
	$= 10\mathbf{i} - 20\mathbf{j}$	A1	1.1b
		(2)	
(b)	$\lvert\overrightarrow{QR}\rvert = \sqrt{"10"^2 + "(-20)"^2}$	M1	2.5
	$= 10\sqrt{5}$	A1ft	1.1b
		(2)	
(c)	$\overrightarrow{PS} = \overrightarrow{PQ} + \frac{3}{5}\overrightarrow{QR} = 3\mathbf{i} + 5\mathbf{j} + \frac{3}{5}("10\mathbf{i} - 20\mathbf{j}") = \ldots$ or $\overrightarrow{PS} = \overrightarrow{PR} + \frac{2}{5}\overrightarrow{RQ} = 13\mathbf{i} - 15\mathbf{j} + \frac{2}{5}("-10\mathbf{i} + 20\mathbf{j}") = \ldots$	M1	3.1a
	$= 9\mathbf{i} - 7\mathbf{j}$	A1	1.1b
		(2)	
		(6 marks)	

Video solution:
https://youtu.be/eQHKB8Vrz-c

November 2021 Question 4

4. [*In this question the unit vectors* **i** *and* **j** *are due east and due north respectively*.]

A stone slides horizontally across ice.

Initially the stone is at the point $A(-24\mathbf{i} - 10\mathbf{j})$ m relative to a fixed point O.

After 4 seconds the stone is at the point $B(12\mathbf{i} + 5\mathbf{j})$ m relative to the fixed point O.

The motion of the stone is modelled as that of a particle moving in a straight line at constant speed.

Using the model,

(a) prove that the stone passes through O,

(2)

(b) calculate the speed of the stone.

(3)

ANSWER

Question	Scheme	Marks	AOs
4(a)	Attempts to compare the two position vectors. Allow an attempt using two of $\overrightarrow{AO}, \overrightarrow{OB}$ or $\overrightarrow{AB}$ E.g. $(-24\mathbf{i}-10\mathbf{j}) = -2\times(12\mathbf{i}+5\mathbf{j})$	M1	1.1b
	Explains that as $\overrightarrow{AO}$ is parallel to $\overrightarrow{OB}$ (and the stone is travelling in a straight line) the stone passes through the point O.	A1	2.4
		(2)	
(b)	Attempts distance $AB = \sqrt{(12+24)^2+(10+5)^2}$	M1	1.1b
	Attempts speed = $\dfrac{\sqrt{(12+24)^2+(10+5)^2}}{4}$	dM1	3.1a
	Speed = 9.75 ms^{-1}	A1	3.2a
		(3)	
			(5 marks)

November 2020 Question 2

2. [*In this question the unit vectors* **i** *and* **j** *are due east and due north respectively*.]

A coastguard station O monitors the movements of a small boat.

At 10:00 the boat is at the point $(4\mathbf{i} - 2\mathbf{j})$ km relative to O.

At 12:45 the boat is at the point $(-3\mathbf{i} - 5\mathbf{j})$ km relative to O.

The motion of the boat is modelled as that of a particle moving in a straight line at constant speed.

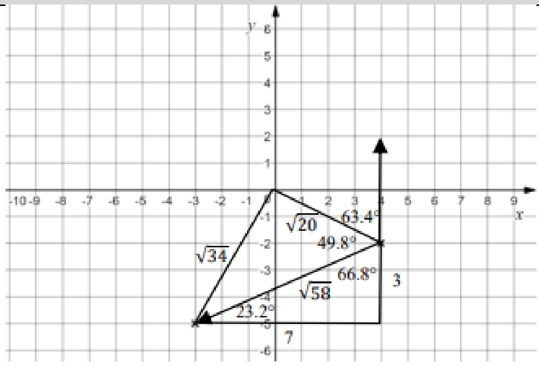
(a) Calculate the bearing on which the boat is moving, giving your answer in degrees to one decimal place.

(3)

(b) Calculate the speed of the boat, giving your answer in km h^{-1}

(3)

ANSWER

Question	Scheme	Marks	AOs
2(a)			
	Attempts to find an "allowable" angle Eg $\tan\theta = \frac{7}{3}$	M1	1.1b
	A full attempt to find the bearing Eg $180° + "67°"$	dM1	3.1b
	Bearing = awrt $246.8°$	A1	1.1b
		(3)	
(b)	Attempts to find the distance travelled = $\sqrt{(4--3)^2+(-2+5)^2} = \left(\sqrt{58}\right)$	M1	1.1b
	Attempts to find the speed = $\frac{\sqrt{58}}{2.75}$	dM1	3.1b
	= awrt 2.77 km h^{-1}	A1	1.1b
		(3)	
			(6 marks)

November 2020 Question 3 Paper 1

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)

ANSWER

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)

November 2020 Question 2 Paper 2 (A-Level)

2. Relative to a fixed origin, points P, Q and R have position vectors $\mathbf{p}$, $\mathbf{q}$ and $\mathbf{r}$ respectively.

Given that

- P, Q and R lie on a straight line
- Q lies one third of the way from P to R

show that

$$\mathbf{q} = \frac{1}{3}(\mathbf{r} + 2\mathbf{p})$$

(3)

ANSWER

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)

June 2019 Question 10 Paper 2 (A-Level)

10.

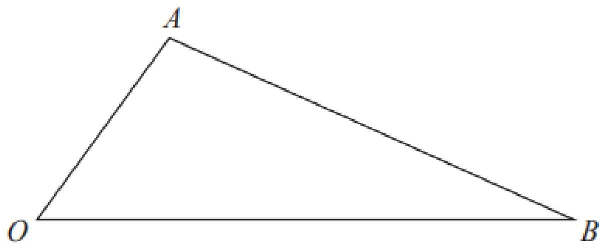


Figure 7

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)

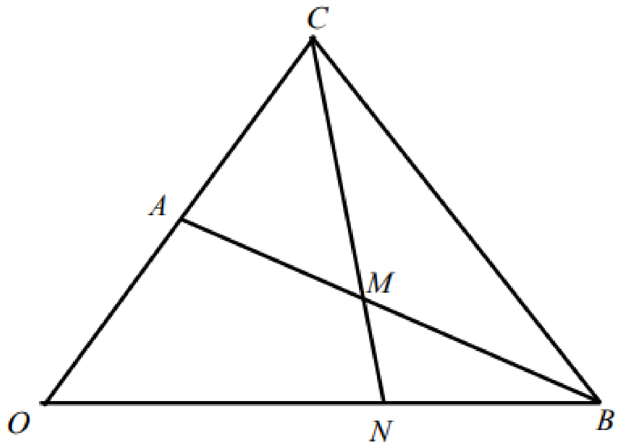
(b) Show that $\overrightarrow{ON} = \left(2 - \frac{3}{2}\lambda\right)\mathbf{a} + \frac{1}{2}\lambda\mathbf{b}$, where λ is a scalar constant.

(2)

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

(2)

ANSWER

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)	$\overrightarrow{ON}=\overrightarrow{OC}+\overrightarrow{CN}\Rightarrow\overrightarrow{ON}=\overrightarrow{OC}+\lambda\overrightarrow{CM}$	M1	1.1b
	$\overrightarrow{ON}=2\mathbf{a}+\lambda\left(-\frac{3}{2}\mathbf{a}+\frac{1}{2}\mathbf{b}\right)\Rightarrow\overrightarrow{ON}=\left(2-\frac{3}{2}\lambda\right)\mathbf{a}+\frac{1}{2}\lambda\mathbf{b}$ *	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 $\mu=\frac{2}{3}\Rightarrow\overrightarrow{ON}=\frac{2}{3}\mathbf{b}\ \left\{\Rightarrow\overrightarrow{NB}=\frac{1}{3}\mathbf{b}\right\}\Rightarrow ON:NB=2:1$ *	A1*	2.1
		(2)	
			(6 marks)

June 2018 Question 3

3. Given that the point A has position vector $4\mathbf{i} - 5\mathbf{j}$ and the point B has position vector $-5\mathbf{i} - 2\mathbf{j}$,

(a) find the vector $\overrightarrow{AB}$,

(2)

(b) find $|\overrightarrow{AB}|$.

Give your answer as a simplified surd.

(2)

ANSWER

Question	Scheme	Marks	AOs
3(a)	Attempts $\overrightarrow{AB} = \overrightarrow{OB} - \overrightarrow{OA}$ or similar	M1	1.1b
	$\overrightarrow{AB} = -9\mathbf{i} + 3\mathbf{j}$	A1	1.1b
		(2)	
(b)	Finds length using 'Pythagoras' $\lvert AB \rvert = \sqrt{(-9)^2 + (3)^2}$	M1	1.1b
	$\lvert AB \rvert = 3\sqrt{10}$	A1ft	1.1b
		(2)	
			(4 marks)