Write your name, centre number and candidate number in the boxes below.

Surname	Other names

Centre number | | | | | |

Candidate number | | | | |

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Vectors

Time allowed: 1 hour 50 minutes

Subject code **0606**

Additional Mathematics

Questions from Paper 1 and Paper 2

You must have: a ruler marked in centimetres and millimetres, a protractor, compasses, a pen, an HB pencil and an eraser.
Questions 1-2, 6, 10 (Paper 1): no calculator.
Questions 3-5, 7-9 (Paper 2): calculator allowed.

Total marks

/ 71

Instructions

- Answer every question in the space provided on this paper.
- Write in black or dark blue ink. Pencil may be used for diagrams and graphs.
- Fill in your name, centre number and candidate number above.
- Show your working: a correct method can earn marks even if the answer is wrong.
- Unless a question says otherwise, give answers that are not exact to 3 significant figures, and angles in degrees to 1 decimal place.

Information

- This paper has 10 questions worth 71 marks in total.
- The marks for each question or part are shown in brackets, for example [3].

Advice

- Read every question through once before you write anything.
- Use the marks in brackets to judge how long to spend on each part.
- If you finish early, go back and check your working.

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Print at 100% (Actual size) so diagrams keep their real measurements.

1 The point A has position vector $\begin{pmatrix} 2 \\ -6 \end{pmatrix}$. The point B has position vector $\begin{pmatrix} -3 \\ 6 \end{pmatrix}$.

(a) Find, in vector form, the displacement of B from A. [2]

(b) Find the distance AB. [1]

The point X is such that $3\overrightarrow{AB} = 2\overrightarrow{AX}$.

(c) Find the position vector of X. [2]

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2 **(a)** The vector **v** has a magnitude of 39 units and is in the same direction as $\begin{pmatrix} -12 \\ 5 \end{pmatrix}$. Write **v** in the form $\begin{pmatrix} a \\ b \end{pmatrix}$, where a and b are constants. [2]

(b) Vectors **p** and **q** are such that $\mathbf{p} = \begin{pmatrix} r+s \\ r+6 \end{pmatrix}$ and $\mathbf{q} = \begin{pmatrix} 5r+1 \\ 2s-1 \end{pmatrix}$, where r and s are constants. Given that $2\mathbf{p}+3\mathbf{q} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}$, find the value of r and of s. [4]

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3 Vectors **i** and **j** are vectors parallel to the x-axis and y-axis respectively.

Given that $\mathbf{a} = 2\mathbf{i} + 3\mathbf{j}$, $\mathbf{b} = \mathbf{i} - 5\mathbf{j}$ and $\mathbf{c} = 3\mathbf{i} + 11\mathbf{j}$, find

(i) the exact value of $|\mathbf{a} + \mathbf{c}|$, [2]

(ii) the value of the constant m such that $\mathbf{a} + m\mathbf{b}$ is parallel to **j**, [2]

(iii) the value of the constant n such that $n\mathbf{a} - \mathbf{b} = \mathbf{c}$. [2]

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4 A plane, which can travel at a speed of $300\,\text{km}\,\text{h}^{-1}$ in still air, heads due north. The plane is blown off course by a wind so that it travels on a bearing of 010° at a speed of $280\,\text{km}\,\text{h}^{-1}$.

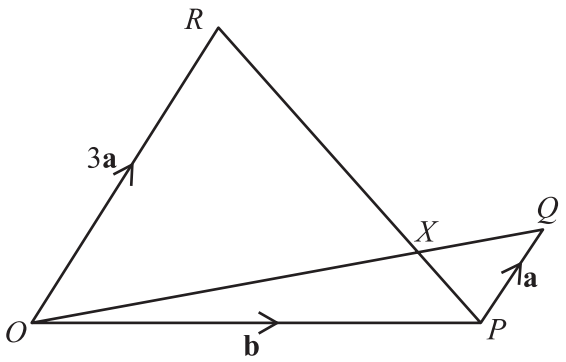
(i) Find the speed of the wind. [3]

(ii) Find the direction of the wind as a bearing correct to the nearest degree. [3]

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Velocity vectors and relative motion Click for more variations

5



In the diagram $\overrightarrow{OP} = \mathbf{b}$, $\overrightarrow{PQ} = \mathbf{a}$ and $\overrightarrow{OR} = 3\mathbf{a}$. The lines OQ and PR intersect at X.

(i) Given that $\overrightarrow{OX} = \mu\overrightarrow{OQ}$, express $\overrightarrow{OX}$ in terms of μ, $\mathbf{a}$ and $\mathbf{b}$. [1]

(ii) Given that $\overrightarrow{RX} = \lambda\overrightarrow{RP}$, express $\overrightarrow{OX}$ in terms of λ, $\mathbf{a}$ and $\mathbf{b}$. [2]

(iii) Hence find the value of μ and of λ and state the value of the ratio $\frac{RX}{XP}$. [3]

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6 A particle P is moving with a velocity of $20\,\text{ms}^{-1}$ in the same direction as $\begin{pmatrix}3\\4\end{pmatrix}$.

(i) Find the velocity vector of P. [2]

At time $t = 0\,\text{s}$, P has position vector $\begin{pmatrix}1\\2\end{pmatrix}$ relative to a fixed point O.

(ii) Write down the position vector of P after t s. [2]

A particle Q has position vector $\begin{pmatrix}17\\18\end{pmatrix}$ relative to O at time $t = 0\,\text{s}$ and has a velocity vector $\begin{pmatrix}8\\12\end{pmatrix}\,\text{ms}^{-1}$.

(iii) Given that P and Q collide, find the value of t when they collide and the position vector of the point of collision. [3]

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7 Relative to an origin O, the position vectors of the points A, B, C and D are

$$\overrightarrow{OA} = \begin{pmatrix} 6 \\ -5 \end{pmatrix}, \quad \overrightarrow{OB} = \begin{pmatrix} 10 \\ 3 \end{pmatrix}, \quad \overrightarrow{OC} = \begin{pmatrix} x \\ y \end{pmatrix} \text{ and } \overrightarrow{OD} = \begin{pmatrix} 12 \\ 7 \end{pmatrix}.$$

(a) Find the unit vector in the direction of $\overrightarrow{AB}$. [3]

(b) The point A is the mid-point of BC. Find the value of x and of y. [2]

(c) The point E lies on OD such that $OE : OD$ is $1 : 1 + \lambda$. Find the value of λ such that $\overrightarrow{BE}$ is parallel to the x-axis. [3]

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8 **(a)** The four points O, A, B and C are such that

$$\overrightarrow{OA} = 5\mathbf{a}, \qquad \overrightarrow{OB} = 15\mathbf{b}, \qquad \overrightarrow{OC} = 24\mathbf{b} - 3\mathbf{a}.$$

Show that B lies on the line AC. [3]

(b) Relative to an origin O, the position vector of the point P is $\mathbf{i} - 4\mathbf{j}$ and the position vector of the point Q is $3\mathbf{i} + 7\mathbf{j}$. Find

(i) $|\overrightarrow{PQ}|$, [2]

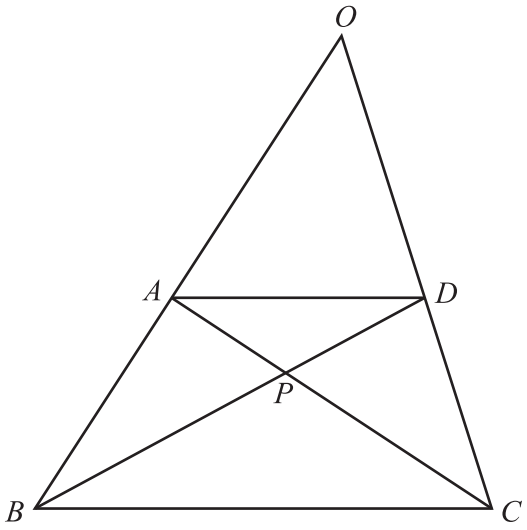
(ii) the unit vector in the direction $\overrightarrow{PQ}$, [1]

(iii) the position vector of M, the mid-point of PQ. [2]

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9



The diagram shows a triangle OBC.
$OA : OB = 4 : 7$ and $OD : OC = 4 : 7$.

$$\overrightarrow{OB} = \mathbf{b} \text{ and } \overrightarrow{OC} = \mathbf{c}$$

The point P is the point of intersection of AC and BD such that $\overrightarrow{AP} = \lambda\overrightarrow{AC}$ and $\overrightarrow{BP} = \mu\overrightarrow{BD}$ where λ and μ are scalars.

(a) Find two expressions for $\overrightarrow{OP}$, each in terms of **b**, **c** and a scalar, and hence show that P divides both AC and DB in the ratio 4 : 7. [7]

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(b) The point Q is such that $\overrightarrow{OQ} = \frac{2}{7}\mathbf{b} + \frac{2}{7}\mathbf{c}$.

Use a vector method to show that O, Q and P are collinear. Justify your answer. [2]

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10 In this question, all distances are in metres and time, t, is in seconds.

A particle P moves with a speed of 14.5 parallel to the vector $\begin{pmatrix} -20 \\ 21 \end{pmatrix}$.

(a) Find the velocity vector of P. [2]

Initially, P has position vector $\begin{pmatrix} 3 \\ 5 \end{pmatrix}$.

(b) Write down the position vector of P at time t. [2]

A second particle Q has position vector $\begin{pmatrix} -1 \\ 3 \end{pmatrix} + \begin{pmatrix} -5 \\ 7.5 \end{pmatrix} t$ at time t.

(c) Find, in terms of t, the distance between P and Q at time t. Simplify your answer. [4]

(d) Hence show that P and Q never collide. [2]

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