1. **[5 marks]**

$\mathbf{a} = \begin{pmatrix} 5 \\ -2 \end{pmatrix}$ $\mathbf{b} = \begin{pmatrix} 1 \\ 7 \end{pmatrix}$ $\mathbf{c} = \begin{pmatrix} -7 \\ 0 \end{pmatrix}$

(a) Write, as a column vector, $2\mathbf{a}$

$\begin{pmatrix} \\ \\ \end{pmatrix}$
....
(1)

(b) Write, as a column vector, $3\mathbf{b} - \mathbf{c}$

$\begin{pmatrix} \\ \\ \end{pmatrix}$
....
(2)

(c) Work out the magnitude of **a**
Give your answer as a surd.

....
(2)

2. **[2 marks]**

ABCD is a parallelogram.

$\overrightarrow{BC} = \begin{pmatrix} 5 \\ -1 \end{pmatrix}$ $\overrightarrow{DC} = \begin{pmatrix} -2 \\ 3 \end{pmatrix}$

Find $\overrightarrow{BD}$ as a column vector.

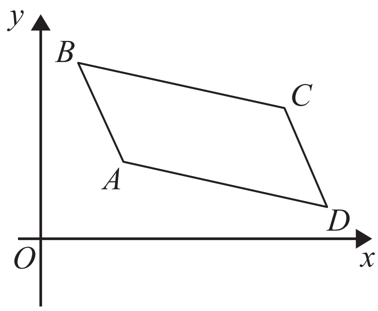


Diagram **NOT** accurately drawn

$\begin{pmatrix} \\ \\ \end{pmatrix}$

3. **[2 marks]**

A is the point with coordinates (2, 3).

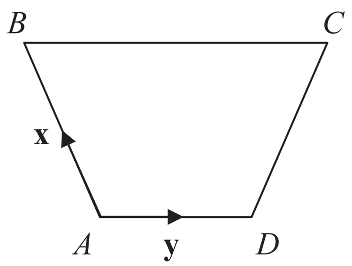
$\overrightarrow{AB} = \begin{pmatrix} 5 \\ -4 \end{pmatrix}$.

Find the coordinates of B.

(............., ...)

4. **[4 marks]**

The diagram shows a trapezium $ABCD$.



$\overrightarrow{BC} = 2\overrightarrow{AD}$.

$\overrightarrow{AB} = \mathbf{x}$. $\overrightarrow{AD} = \mathbf{y}$.

(a) Find, in terms of **x** and **y**,

(i) $\overrightarrow{AC}$

....

(ii) $\overrightarrow{DC}$

....

(2)

(b) The point E is such that $\overrightarrow{AE} = \mathbf{x} + \mathbf{y}$.
Use your answer to part (a)(ii) to explain why $AECD$ is a parallelogram.

....

....

(2)

5. **[3 marks]**

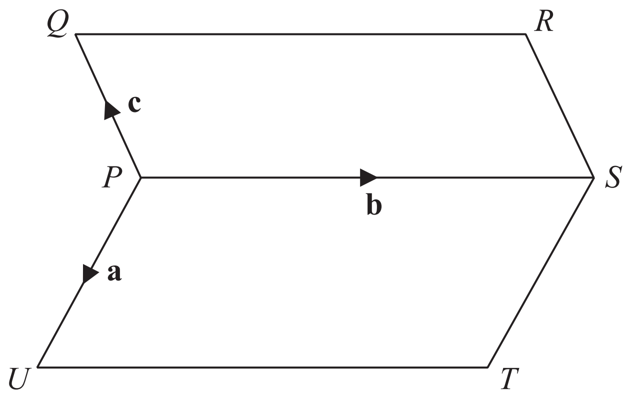


Diagram **NOT** accurately drawn

PQRS and *PSTU* are parallelograms.

$\overrightarrow{PU} = \mathbf{a}$ $\quad \overrightarrow{PS} = \mathbf{b}$ $\quad \overrightarrow{PQ} = \mathbf{c}$

Find, in terms of **a**, **b** and **c**

(i) $\overrightarrow{TQ}$

....

(ii) $\overrightarrow{PX}$ where *X* is the midpoint of *TQ*.

Simplify your answer as much as possible.

....

6. **[3 marks]**

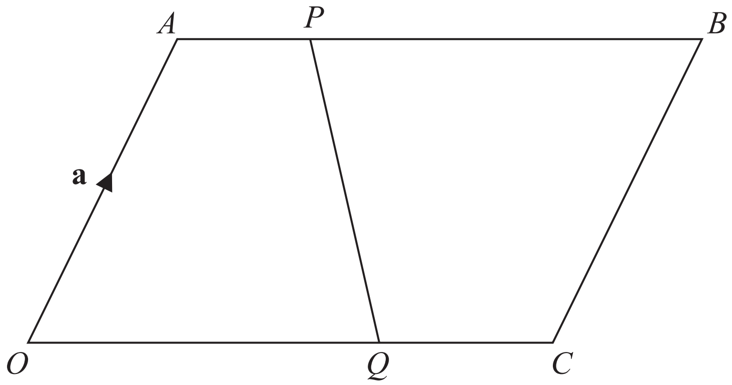


Diagram **NOT** accurately drawn

OABC is a parallelogram.

$\overrightarrow{OA} = \mathbf{a}$ and $\overrightarrow{OC} = \mathbf{c}$

P is the point on *AB* such that $AP = \frac{1}{4}AB$.

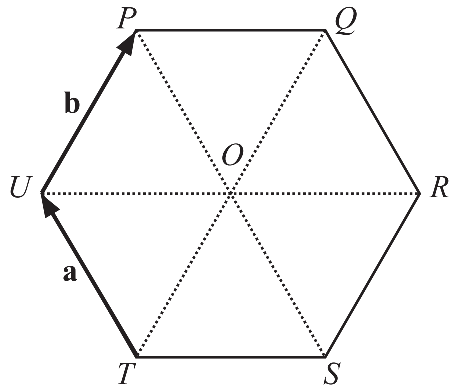
Q is the point on *OC* such that $OQ = \frac{2}{3}OC$.

Find, in terms of **a** and **c**, $\overrightarrow{PQ}$.
Give your answer in its simplest form.

....

7. **[4 marks]**

PQRSTU is a regular hexagon, centre *O*.
The hexagon is made from six equilateral triangles of side 2.5 cm.



$\overrightarrow{TU} = \mathbf{a}$. $\overrightarrow{UP} = \mathbf{b}$.

(a) Find, in terms of **a** and/or **b**, the vectors

(i) $\overrightarrow{TP}$

....
(1)

(ii) $\overrightarrow{PO}$

....
(1)

(iii) $\overrightarrow{UO}$

....
(1)

(b) Find the modulus (magnitude) of $\overrightarrow{UR}$.

.... cm
(1)

8. **[4 marks]**

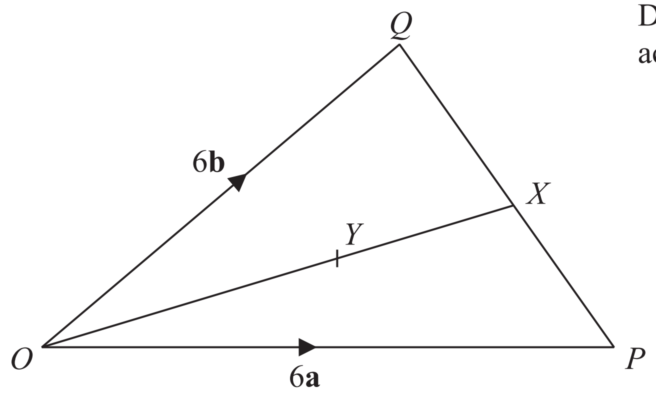


Diagram **NOT** accurately drawn

In triangle OPQ, $\overrightarrow{OP} = 6\mathbf{a}$ and $\overrightarrow{OQ} = 6\mathbf{b}$

X is the midpoint of PQ.

(a) Find, in terms of **a** and **b**, the vector $\overrightarrow{OX}$
Give your answer in its simplest form.

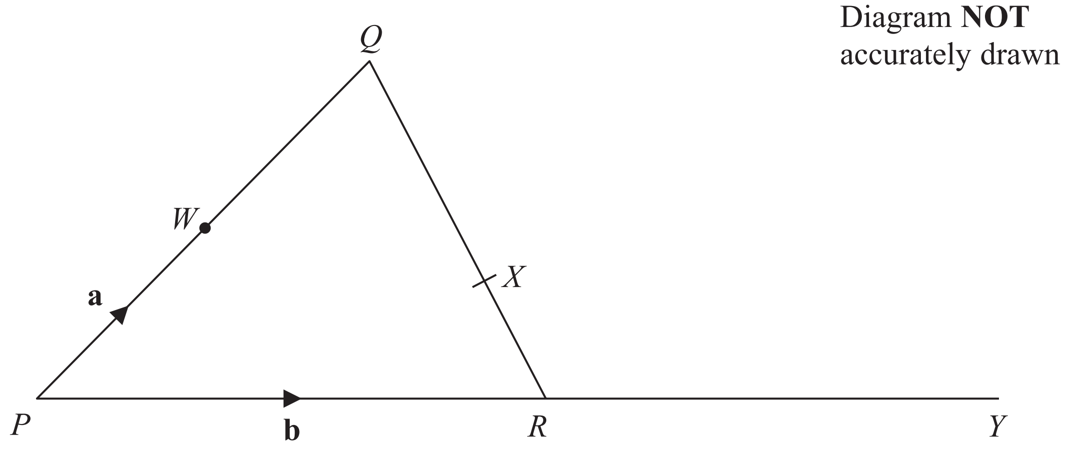
....
(2)

Y is the point on OX such that $OY : YX = 2 : 1$

(b) Find, in terms of **a** and **b**, the vector $\overrightarrow{QY}$
Give your answer in its simplest form.

....
(2)

9. **[5 marks]**



PQR is a triangle.
The midpoint of *PQ* is *W*.
X is the point on *QR* such that *QX* : *XR* = 2 : 1
PRY is a straight line.

$\overrightarrow{PW} = \mathbf{a}$ $\overrightarrow{PR} = \mathbf{b}$

(a) Find, in terms of **a** and **b**,

(i) $\overrightarrow{QR}$

....

(ii) $\overrightarrow{QX}$

....

(iii) $\overrightarrow{WX}$

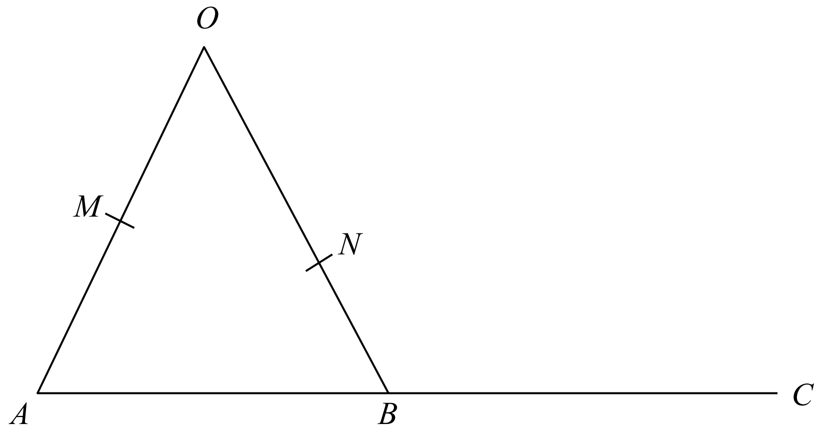
....
(3)

R is the midpoint of the straight line *PRY*.

(b) Use a vector method to show that *WXY* is a straight line.

(2)

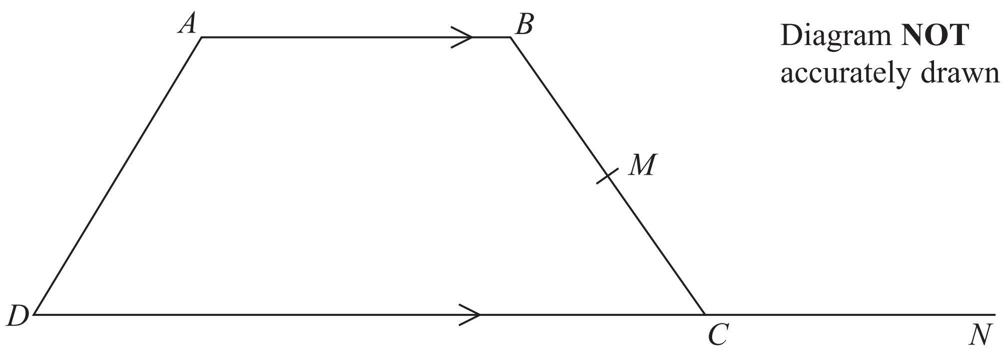
10. **[5 marks]**



OMA, ONB and *ABC* are straight lines.
M is the midpoint of *OA*.
B is the midpoint of *AC*.
$\overrightarrow{OA} = 6\mathbf{a}$ $\overrightarrow{OB} = 6\mathbf{b}$ $\overrightarrow{ON} = k\mathbf{b}$ where k is a scalar quantity.

Given that *MNC* is a straight line, find the value of k.

11. **[4 marks]**



AB is parallel to *DC*
$DC = 2AB$
M is the midpoint of *BC*
$\overrightarrow{AD} = 2\mathbf{b}$
$\overrightarrow{AB} = 4\mathbf{a}$

(a) Find $\overrightarrow{BM}$ in terms of **a** and **b**.
Give your answer in its simplest form.

....
(2)

N is the point such that *DCN* is a straight line and $DC : CN = 2 : 1$
(b) Show that *AMN* is a straight line.

(2)

12. **[4 marks]**

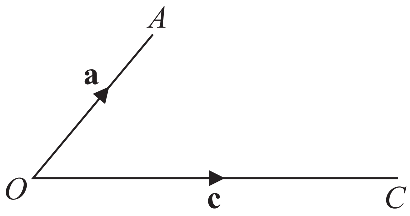


Diagram **NOT** accurately drawn

In the diagram $\overrightarrow{OA} = \mathbf{a}$ and $\overrightarrow{OC} = \mathbf{c}$.

(a) Find $\overrightarrow{CA}$ in terms of **a** and **c**.

....

(1)

(b) The point B is such that $\overrightarrow{AB} = \frac{1}{2}\,\mathbf{c}$.

Give the mathematical name for the quadrilateral $OABC$.

....

(1)

(c) The point P is such that $\overrightarrow{OP} = \mathbf{a} + k\mathbf{c}$, where $k \geqslant 0$

State the two conditions relating to $\mathbf{a} + k\mathbf{c}$ that must be true for $OAPC$ to be a rhombus.

(2)

13. **[4 marks]**

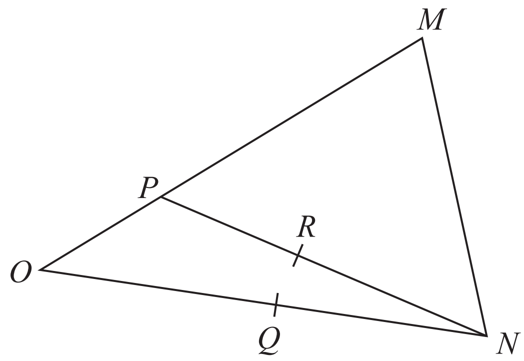


Diagram **NOT** accurately drawn

OMN is a triangle.

P is the point on *OM* such that $OP = \frac{1}{4} OM$

Q is the midpoint of *ON*

R is the midpoint of *PN*

$\overrightarrow{OP} = \mathbf{p}$ $\overrightarrow{OQ} = \mathbf{q}$

(a) Find, in terms of **p** and **q**,

(i) $\overrightarrow{MN}$

....

(ii) $\overrightarrow{PR}$

....

(2)

(b) Use a vector method to prove that *QR* is parallel to *OP*

(2)

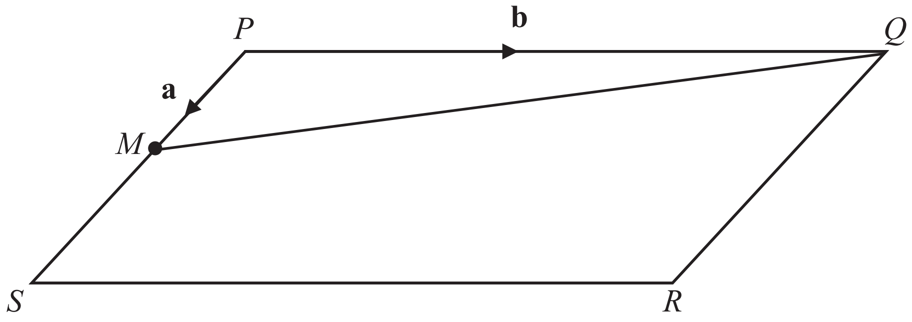
14. **[5 marks]**

The diagram shows a parallelogram, *PQRS*.

M is the midpoint of *PS*.

$\overrightarrow{PM} = \mathbf{a}$ $\quad \overrightarrow{PQ} = \mathbf{b}$

Diagram **NOT** accurately drawn



(a) Find, in terms of **a** and/or **b**,

(i) $\overrightarrow{PS}$

....

(ii) $\overrightarrow{PR}$

....

(iii) $\overrightarrow{MQ}$

....

(3)

N is the point on *MQ* such that $MN = \frac{1}{3}MQ$

(b) Use a vector method to prove that *PNR* is a straight line.

(2)

15. **[4 marks]**

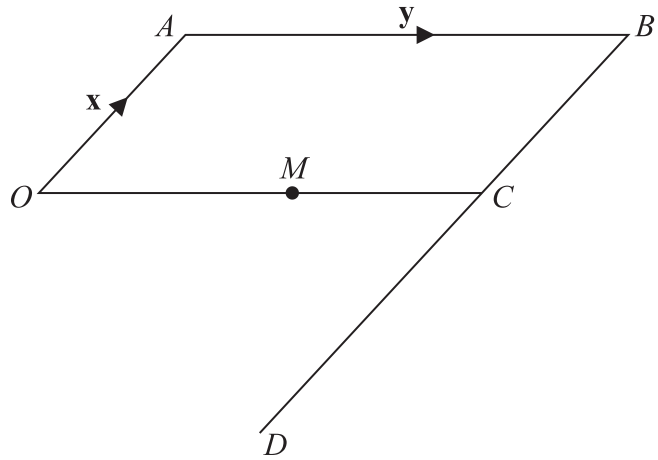


Diagram **NOT** accurately drawn

OABC is a parallelogram.

BCD is a straight line.

BD = 3*BC*.

M is the midpoint of *OC*.

$\overrightarrow{OA} = \mathbf{x}$ $\quad \overrightarrow{AB} = \mathbf{y}$

(a) Find, in terms of **x** and **y**,

(i) $\overrightarrow{AM}$

....

(ii) $\overrightarrow{OD}$

....

(2)

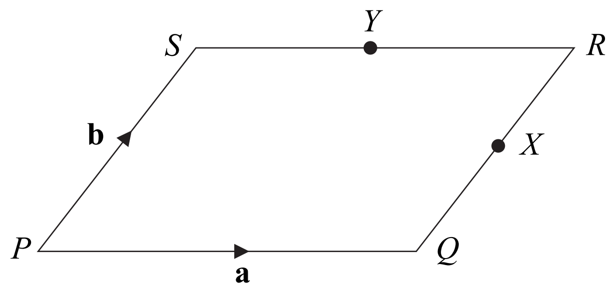
(b) Use your answers to (a)(i) and (ii) to write down two different geometric facts about the lines *AM* and *OD*.

....

....

(2)

16. **[5 marks]**



PQRS is a parallelogram.
X is the midpoint of *QR* and *Y* is the midpoint of *SR*.
$\overrightarrow{PQ} = \mathbf{a}$ and $\overrightarrow{PS} = \mathbf{b}$.

(a) Write down, in terms of **a** and **b**, expressions for

(i) $\overrightarrow{PX}$

....

(ii) $\overrightarrow{PY}$

....

(iii) $\overrightarrow{QS}$

....
(3)

(b) Use a vector method to show that *XY* is parallel to *QS* and that $XY = \frac{1}{2}QS$.

(2)

17. **[5 marks]**

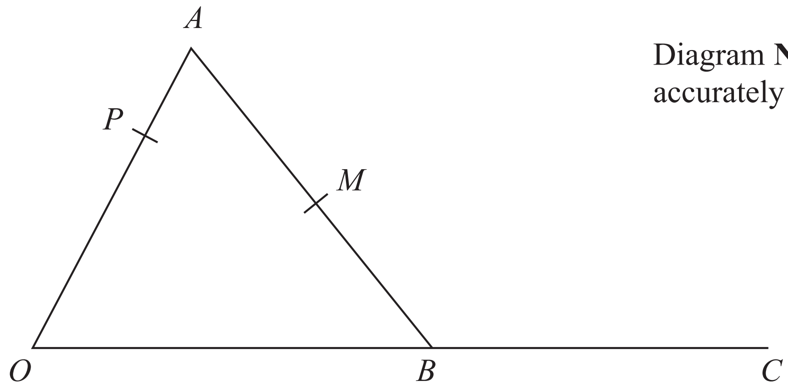


Diagram **NOT** accurately drawn

OAB is a triangle.
P is the point on *OA* such that $OP : PA = 2 : 1$

C is the point such that *B* is the midpoint of *OC*.
M is the midpoint of *AB*.

$\overrightarrow{OA} = 6\mathbf{a}$ $\qquad$ $\overrightarrow{OB} = 4\mathbf{b}$

Show that *PMC* is a straight line.

18. **[8 marks]**

OABC is a parallelogram.

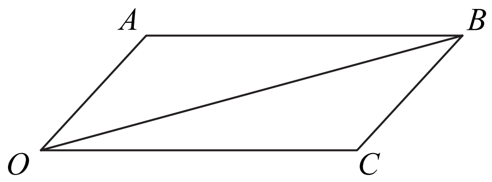


Diagram **NOT** accurately drawn

$\overrightarrow{OA} = \begin{pmatrix} 1 \\ 2 \end{pmatrix}$, $\overrightarrow{OC} = \begin{pmatrix} 4 \\ 0 \end{pmatrix}$.

(a) Find the vector $\overrightarrow{OB}$ as a column vector.

$\begin{pmatrix} \quad \\ \quad \end{pmatrix}$

....

(1)

X is the point on *OB* such that $OX = kOB$, where $0 < k < 1$

(b) Find, in terms of *k*, the vectors

(i) $\overrightarrow{OX}$,

....

(ii) $\overrightarrow{AX}$,

....

(iii) $\overrightarrow{XC}$.

....

(3)

(c) Find the value of *k* for which $\overrightarrow{AX} = \overrightarrow{XC}$.

....

(2)

(d) Use your answer to part (c) to show that the diagonals of the parallelogram *OABC* bisect one another.

....

....

....

(2)