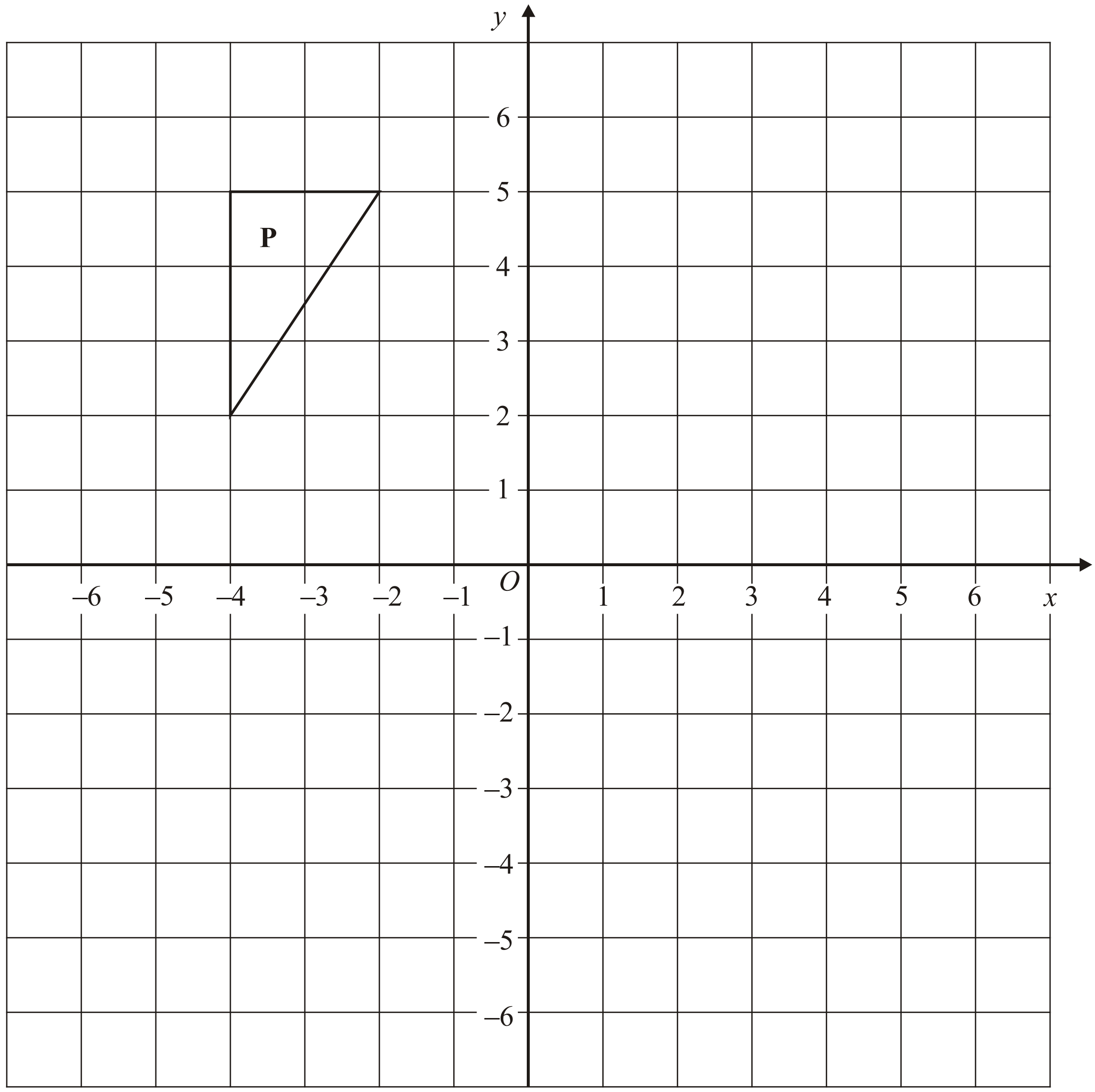
1.



(a) Rotate triangle **P** 90° clockwise about the point (0, 2)
Label the new triangle **Q**.

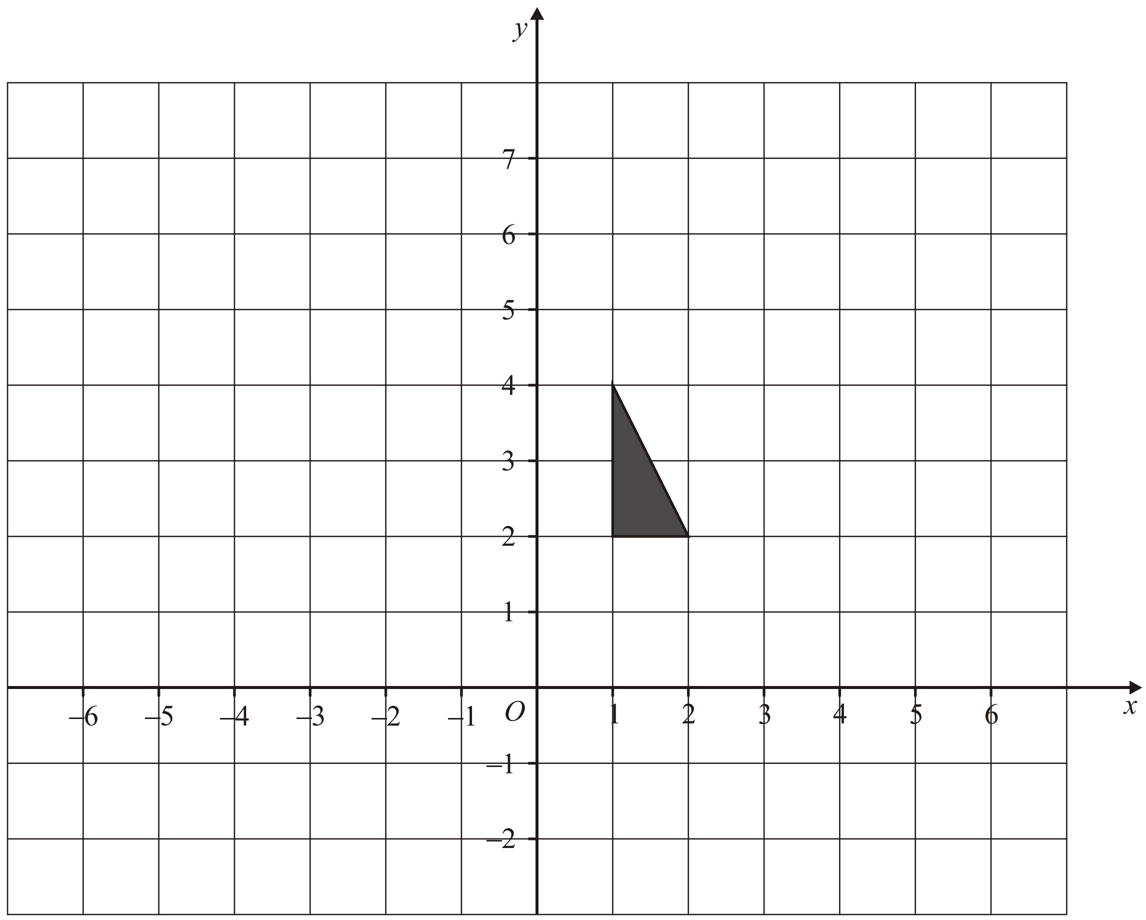
(2)

(b) Translate triangle **P** by the vector $\begin{pmatrix} 5 \\ -6 \end{pmatrix}$

Label the new triangle **R.**

(1)
(Total 3 marks)

2.



Translate the triangle by the vector

$$\begin{pmatrix} 4 \\ -3 \end{pmatrix}$$

(Total 1 mark)

3.

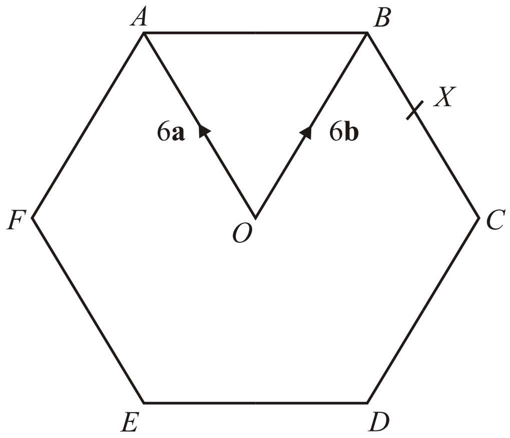


Diagram **NOT** accurately drawn

The diagram shows a regular hexagon *ABCDEF* with centre *O*.

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

(a) Express in terms of **a** and/or **b**

(i) $\overrightarrow{AB}$,

....

(ii) $\overrightarrow{EF}$.

....

(2)

X is the midpoint of *BC*.

(b) Express $\overrightarrow{EX}$ in terms of **a** and/or **b**

....

(2)

Y is the point on AB extended, such that $AB : BY = 3:2$

(c) Prove that E, X and Y lie on the same straight line.

(3)
(Total 7 marks)

4.

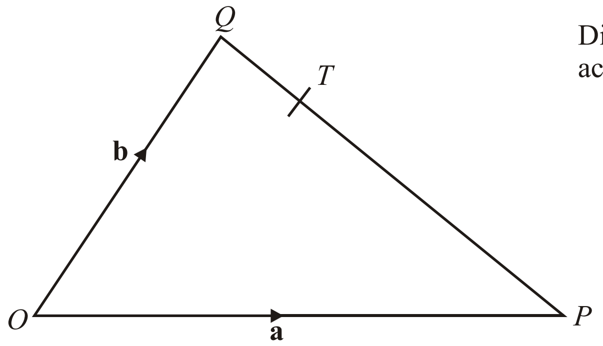


Diagram **NOT** accurately drawn

OPQ is a triangle.
T is the point on PQ for which $PT : TQ = 2 : 1$.
$\overrightarrow{OP} = \mathbf{a}$ and $\overrightarrow{OQ} = \mathbf{b}$.

(a) Write down, in terms of **a** and **b**, an expression for $\overrightarrow{PQ}$.

$\overrightarrow{PQ}$ = ……………………

(1)

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

$\overrightarrow{OT}$ = ……………………

(2)
(Total 3 marks)

5.

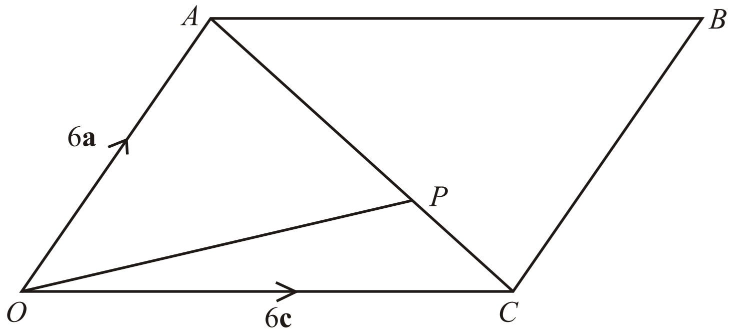


Diagram **NOT** accurately drawn

OABC is a parallelogram.

P is the point on *AC* such that $AP = \frac{2}{3}AC$.

$\overrightarrow{OA} = 6\mathbf{a}$. $\overrightarrow{OC} = 6\mathbf{c}$.

(a) Find the vector $\overrightarrow{OP}$.
Give your answer in terms of **a** and **c**.

....

(3)

The midpoint of CB is M.

(b) Prove that OPM is a straight line.

(2)
(Total 5 marks)

6.

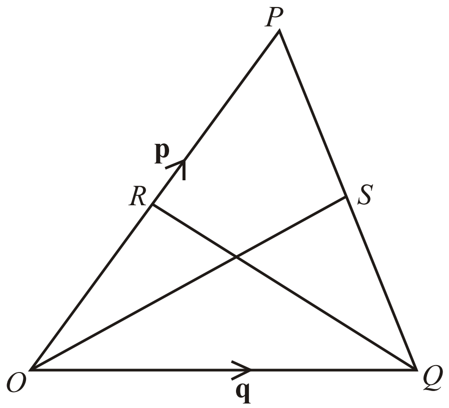


Diagram **NOT** accurately drawn

OPQ is a triangle.
R is the midpoint of OP.
S is the midpoint of PQ.
$\overrightarrow{OP} = \mathbf{p}$ and $\overrightarrow{OQ} = \mathbf{q}$

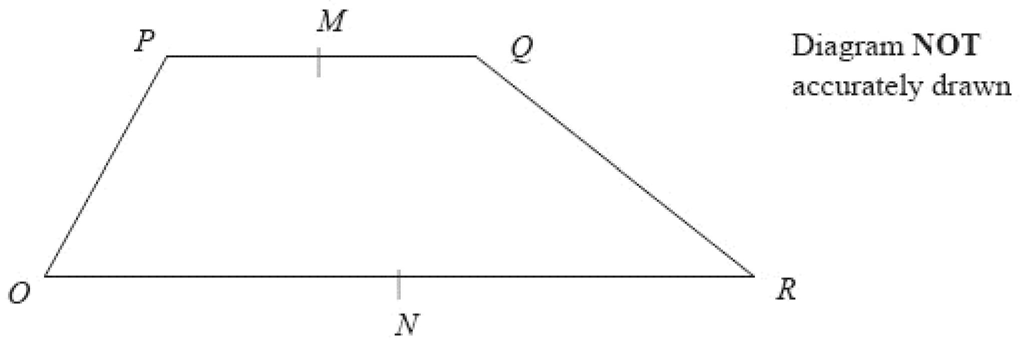
(i) Find $\overrightarrow{OS}$ in terms of $\mathbf{p}$ and $\mathbf{q}$.

$\overrightarrow{OS}$ = ...

(ii) Show that *RS* is parallel to *OQ*.

(Total 5 marks)

7.



OPQR is a trapezium with *PQ* parallel to *OR*.

$\overrightarrow{OP} = 2\mathbf{b}$ $\overrightarrow{PQ} = 2\mathbf{a}$ $\overrightarrow{OR} = 6\mathbf{a}$

M is the midpoint of *PQ* and *N* is the midpoint of *OR*.

(a) Find the vector $\overrightarrow{MN}$ in terms of **a** and **b**.

$\overrightarrow{MN}$ = ...

(2)

X is the midpoint of *MN* and *Y* is the midpoint of *QR*.

(b) Prove that *XY* is parallel to *OR*.

(2)
(Total 4 marks)

8. *ABCD* is a straight line.

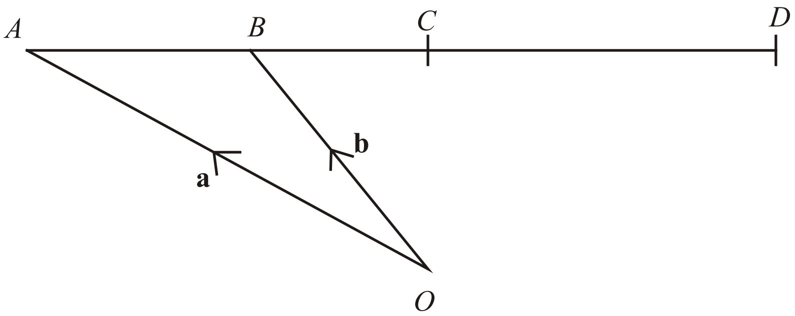


Diagram **NOT** accurately drawn

O is a point so that $\overrightarrow{OA} = \mathbf{a}$ and $\overrightarrow{OB} = \mathbf{b}$.

B is the midpoint of *AC*.
C is the midpoint of *AD*.

Express, in terms of **a** and **b**, the vectors

(i) $\overrightarrow{AC}$

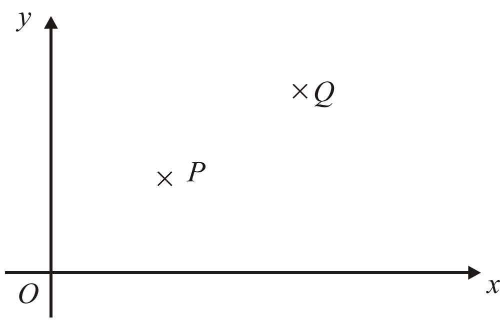
....

(ii) $\underrightarrow{OD}$

....

(Total 3 marks)

9. Diagram **NOT** accurately drawn



The diagram is a sketch.

P is the point (2, 3)
Q is the point (6, 6)

(a) Write down the vector $\overrightarrow{PQ}$

Write your answer as a column vector $\begin{pmatrix} x \\ y \end{pmatrix}$

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

(2)

PQRS is a parallelogram.

$\overrightarrow{PR} = \begin{pmatrix} 4 \\ 7 \end{pmatrix}$

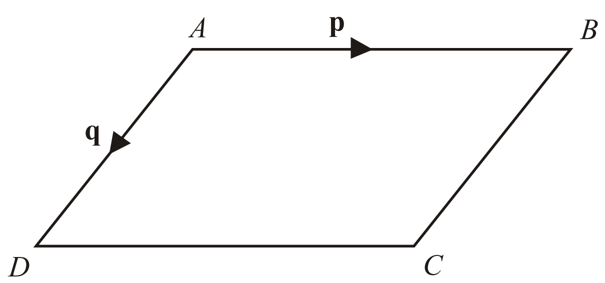
(b) Find the vector $\overrightarrow{QS}$

Write your answer as a column vector $\begin{pmatrix} x \\ y \end{pmatrix}$

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

(2)
(Total 4 marks)

10. Diagram **NOT** accurately drawn



ABCD is a parallelogram.
AB is parallel to *DC*.
AD is parallel to *BC*.

$\overrightarrow{AB} = \mathbf{p}$
$\overrightarrow{AD} = \mathbf{q}$

(a) Express, in terms of p and q

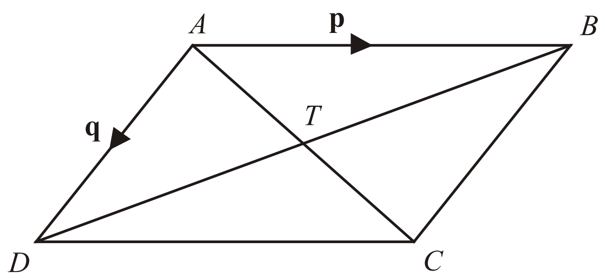
(i) $\overrightarrow{AC}$

(i)....................................

(ii) $\overrightarrow{BD}$

(ii)....................................
(2)

Diagram **NOT** accurately drawn



AC and *BD* are diagonals of parallelogram *ABCD*.
AC and *BD* intersect at *T*.

(b) Express $\overrightarrow{AT}$ in terms of **p** and **q.**

....
(1)
(Total 3 marks)

11.

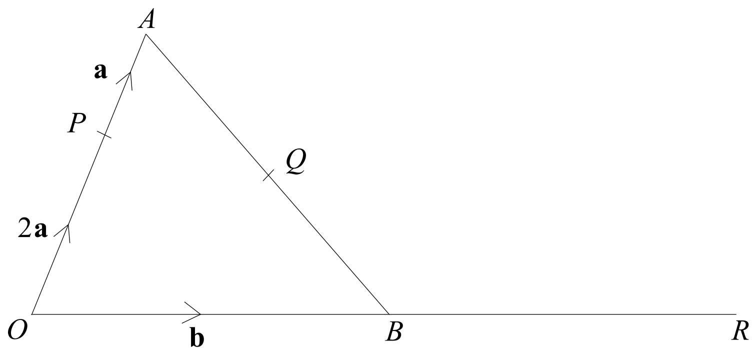


Diagram **NOT** accurately drawn

OAB is a triangle.
B is the midpoint of *OR*.
Q is the midpoint of *AB*.

$\overrightarrow{OP} = 2\mathbf{a}$ $\overrightarrow{PA} = \mathbf{a}$ $\overrightarrow{OB} = \mathbf{b}$

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

(i) $\overrightarrow{AB}$,

....

(ii) $\overrightarrow{PR}$,

....

(iii) $\overrightarrow{PQ}$.

....

(4)

(b) Hence explain why PQR is a straight line.

(2)

The length of PQ is 3 cm.

(c) Find the length of PR.

.... cm

(1)

(Total 7 marks)

12.

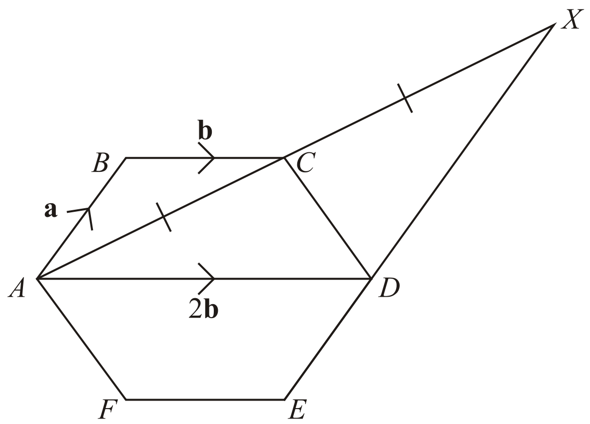


Diagram **NOT** accurately drawn

ABCDEF is a regular hexagon.

$\overrightarrow{AB} = \mathbf{a}$ $\overrightarrow{BC} = \mathbf{b}$ $\overrightarrow{AD} = 2\mathbf{b}$

(a) Find the vector $\overrightarrow{AC}$ in terms of **a** and **b**.

$\overrightarrow{AC}$ = ...

(1)

$\overrightarrow{AC} = \overrightarrow{CX}$

(b) Prove that *AB* is parallel to *DX*.

(3)
(Total 4 marks)

13.

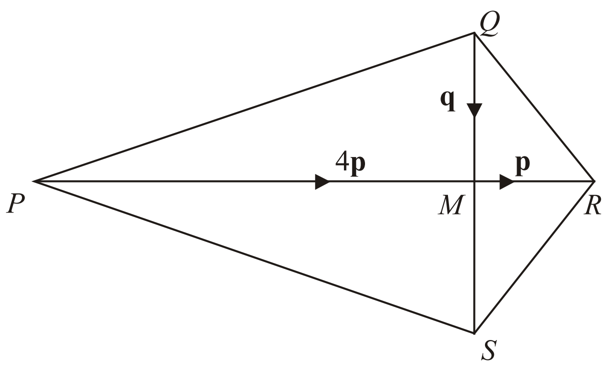


Diagram **NOT** accurately drawn

PQRS is a kite.

The diagonals *PR* and *QS* intersect at *M*.

$\overrightarrow{MP} = 4\mathbf{p}$

$\overrightarrow{QM} = \mathbf{q}$

$\overrightarrow{MR} = \mathbf{p}$

$\overrightarrow{QM} =$

(a) Find expressions, in terms of **p** and/or **q** for

(i) $\overrightarrow{PR}$ $\overrightarrow{PR}$ ....

(ii) $\overrightarrow{QS}$ $\overrightarrow{QS}$ ....

(iii) $\overrightarrow{PQ}$ $\overrightarrow{PQ}$ ....

(4)

SR and *PQ* are extended to meet at point *T*.
Q is the midpoint of *PT*.

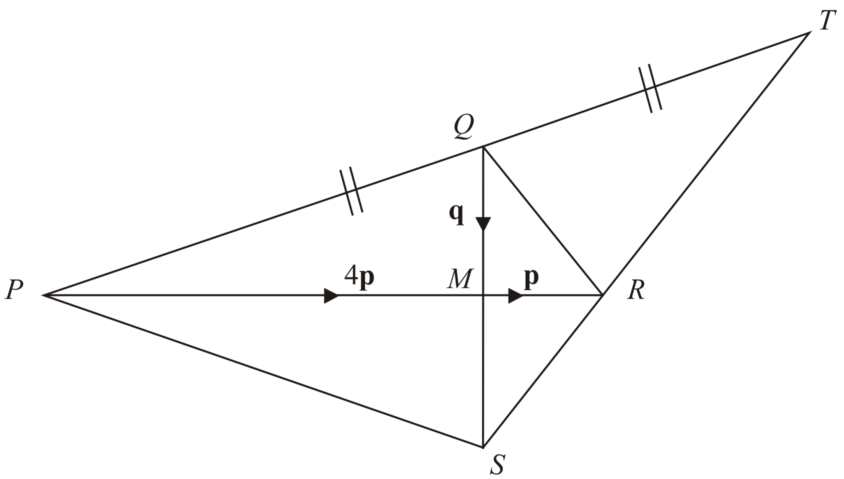


Diagram **NOT** accurately drawn

(b) Find $\overrightarrow{RT}$ in terms of **p** and **q**.

$\overrightarrow{RT}$ ....

(4)
(Total 8 marks)

14.

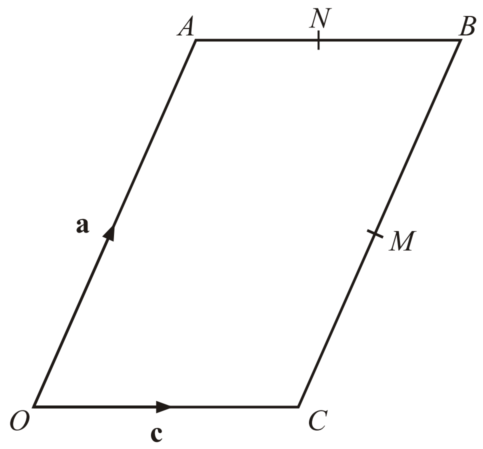


Diagram **NOT** accurately drawn

OABC is a parallelogram.
M is the midpoint of *CB*.
N is the midpoint of *AB*.

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

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

(i) $\overrightarrow{MB}$

....

(ii) $\overrightarrow{MN}$

....

(2)

(b) Show that *CA* is parallel to *MN*.

(2)

(Total 4 marks)

15.

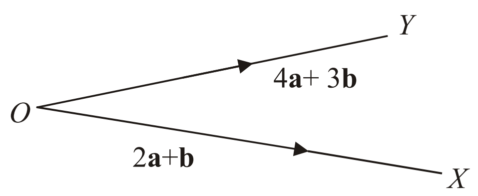


Diagram **NOT** accurately drawn

$\overrightarrow{OX} = 2\mathbf{a} + \mathbf{b}$

$\overrightarrow{OY} = 4\mathbf{a} + 3\mathbf{b}$

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

....

(2)

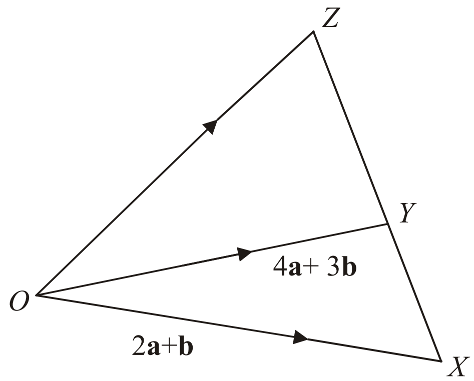


Diagram **NOT** accurately drawn

XYZ is a straight line.
XY : *YZ* = 2 : 3

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

....
(3)
(Total 5 marks)

16.

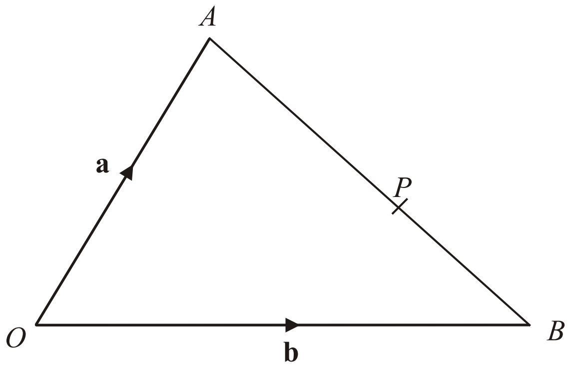


Diagram **NOT** accurately drawn

OAB is a triangle.

$\overrightarrow{OA} = \mathbf{a}$

$\overrightarrow{OB} = \mathbf{b}$

(a) Find the vector $\overrightarrow{AB}$ in terms of **a** and **b**.

$\overrightarrow{AB} =$ ....

(1)

P is the point on *AB* such that *AP* : *PB* = 3 : 2

(b) Show that $\overrightarrow{OP} = \frac{1}{5}(2\mathbf{a} + 3\mathbf{b})$

(3)
(Total 4 marks)

17.

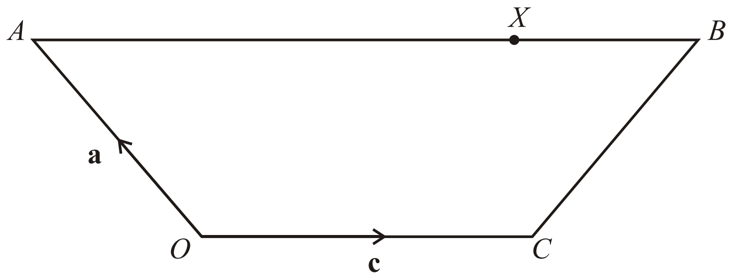


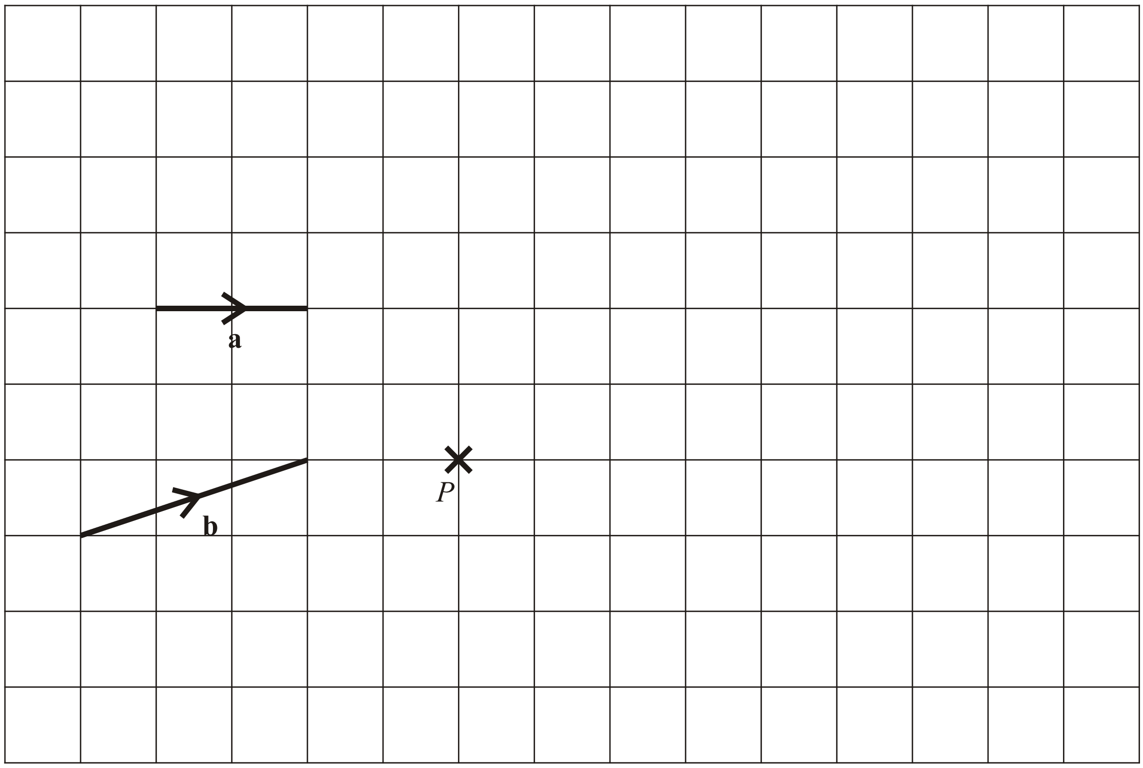
Diagram **NOT** accurately drawn

OABC is a trapezium.
OC is parallel to *AB*.
$\overrightarrow{OA} = \mathbf{a}$, $\overrightarrow{OC} = \mathbf{c}$
$AB = 2OC$.
X is the point on *AB* such that $AX:XB = 3:1$.

Express $\overrightarrow{XC}$ in terms of **a** and **c**.

$\overrightarrow{XC}$ = …………………………
(Total 3 marks)

18.



The diagram shows two vectors **a** and **b.**

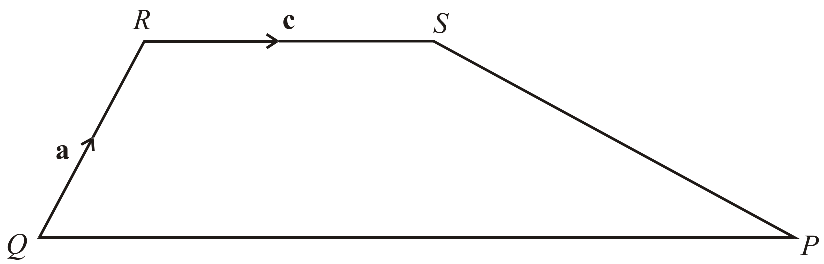
$\overrightarrow{PQ} = \mathbf{a} + 2\mathbf{b}$

On the grid above draw the vector $\overrightarrow{PQ}$.

(Total 2 marks)

19.

Diagram **NOT** accurately drawn



PQRS is a trapezium.
is parallel to *RS*.
= 3*RS*.
$\overrightarrow{QR} = \boldsymbol{a}$, $\overrightarrow{RS} = \boldsymbol{c}$

Express in terms of **a** and/or **c**

(i)

= ....

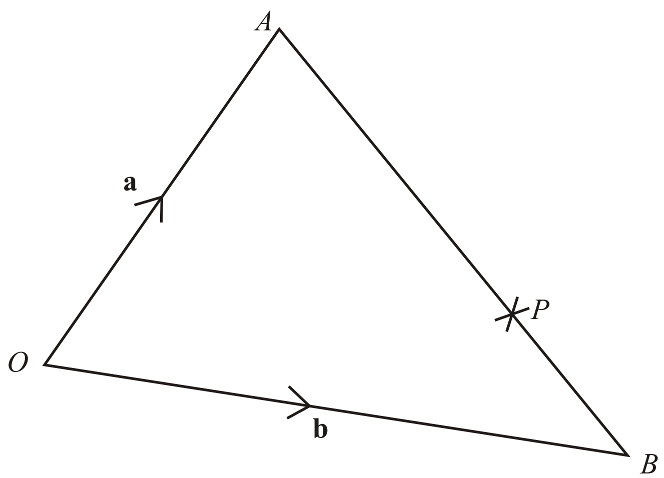
(ii) $\overrightarrow{SP}$

$\overrightarrow{SP}$ = ...

(Total 3 marks)

20.

Diagram **NOT** accurately drawn



OAB is a triangle.

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

P is the point on *AB* such that $AP : PB = 2 : 1$

Write $\overrightarrow{OP}$ in terms of **a** and **b**

$\overrightarrow{OP}$ = ...

(Total 3 marks)

21.

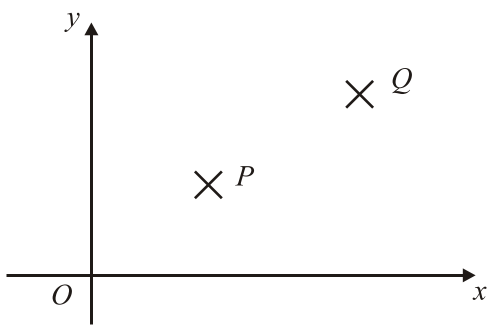


Diagram **NOT** accurately drawn

The diagram is a sketch.

P is the point (2, 3)
Q is the point (6, 6)

Write down the vector $\overrightarrow{PQ}$

Write your answer as a column vector $\begin{pmatrix} x \\ y \end{pmatrix}$

……… $\begin{pmatrix} - \end{pmatrix}$ ……………

(Total 2 marks)

1. (a) Triangle at (0, 6) (3, 6) and (3, 4) — 2

B2 for correct rotation
(B1 for 90° clockwise rotation about any centre or 90°anticlockwise rotation about (0, 2))

(b) Triangle (3, –1), (1, –1) and (1, –4) — 1

B1 for correct translation

[3]

2. (5, 1), (5, -1), (6, -1) — 1

B1 cao

[1]

3. (a) (i) 6**b** – 6**a** — 2

*B1 for 6**b** – 6**a** oe*

(ii) 6**a**

*B1 for 6**a** oe*

(b) 12**b** – 3**a** — 2

$\overrightarrow{EX} = \overrightarrow{EB} + \overrightarrow{BX} = 12\mathbf{b} + \frac{1}{2}\overrightarrow{BC}$

M1 for $\overrightarrow{EX} = \overrightarrow{EB} + \overrightarrow{BX}$ *oe vector journey in a form ready for straightforward substitution*
*A1 for 12**b** – 3**a** oe*

(c) Printer Answer 3

$\overrightarrow{AY} = \frac{5}{3}\overrightarrow{AB}$ or $\overrightarrow{AY} = \frac{5}{3}\overrightarrow{AB}$

$\overrightarrow{EY} = 16\mathbf{b} - 4\mathbf{a}$ or $\overrightarrow{XY} = 4\mathbf{b} - \mathbf{a}$

$\overrightarrow{EY} = 4\overrightarrow{XY}$ or $\overrightarrow{EX} = 3\overrightarrow{XY}$ or $\overrightarrow{EY} = \frac{4}{3}\overrightarrow{XY}$

B1 for either $\overrightarrow{AY} = \frac{5}{3}\overrightarrow{AB}$ *or* $\overrightarrow{BY} = \frac{2}{3}\overrightarrow{AB}$ *oe*

B1 ft for either $\overrightarrow{EY} = 16\boldsymbol{b} - 4\boldsymbol{a}$ *or* $\overrightarrow{XY} = 4\boldsymbol{b} - \boldsymbol{a}$
ft only on parts (a) and (b)

B1 for either $\overrightarrow{EY} = 4\overrightarrow{XY}$ *or* $\overrightarrow{EX} = 3\overrightarrow{XY}$ *or* $\overrightarrow{EY} = \frac{4}{3}\overrightarrow{EX}$

oe ***plus*** *conclusion of E, X, Y on the same straight line*

[7]

4. (a) **b – a** 1

B1 for ***b – a*** *cao*

(b) $\frac{1}{3}\mathbf{a} + \frac{2}{3}\mathbf{b}$ 2

Eg $\overrightarrow{OT} = \mathbf{a} + \frac{2}{3}\overrightarrow{PQ}$

or $\overrightarrow{OT} = \mathbf{b} - \frac{1}{3}\overrightarrow{PQ}$ oe

M1 for $\overrightarrow{OT} = \mathbf{a} + \frac{2}{3}\overrightarrow{PQ}$ *oe*

A1 for $\frac{1}{3}\boldsymbol{a} + \frac{2}{3}\boldsymbol{b}$ *oe simplified*

[3]

5. (a) 2**a** + 4**c** 3

$\overrightarrow{OP} = \overrightarrow{OA} + \overrightarrow{AP}$

$= \overrightarrow{OA} + \frac{2}{3}(6\mathbf{c} - 6\mathbf{a})$

$= 6\mathbf{a} + 4\mathbf{c} - 4\mathbf{a}$

M1 for $\overrightarrow{OP} = \overrightarrow{OA} + \overrightarrow{AP}$ or any correct vector journey involving $\overrightarrow{OP}$

M1 for $\overrightarrow{AP} = \frac{2}{3}(6\mathbf{c} - 6\mathbf{a})$ oe or $\overrightarrow{CP} = \frac{1}{3}(-6\mathbf{c} + 6\mathbf{a})$ oe or reverse vectors

*A1 for 2**a** + 4**c** oe (accept unsimplified)*

(b) $\overrightarrow{OM} = 1.5\overrightarrow{OP}$ so *OPM* is a straight line 2

Eg $\overrightarrow{OM} = \overrightarrow{OC} + \overrightarrow{CM} = 6\mathbf{c} + 3\mathbf{a}$

$\overrightarrow{OM} = 1.5\overrightarrow{OP}$

B1 for $\overrightarrow{OM} = 6\mathbf{c} + \frac{1}{2}(6\mathbf{a})$ or $\overrightarrow{PM} = 2\mathbf{c} + \mathbf{a}$ unsimplified or reverse vectors

B1 for a fully correct proof.

[5]

6. (i) ½ (**p** + **q**) 3

$\overrightarrow{PS} = \frac{1}{2}(\mathbf{q} - \mathbf{p})$

$\overrightarrow{OS} = \mathbf{p} + \frac{1}{2}(\mathbf{q} - \mathbf{p})$

M1 for realising that $\overrightarrow{OS} = \overrightarrow{OP} + \overrightarrow{PS}$

or $\overrightarrow{OS} = \overrightarrow{OQ} + \overrightarrow{QS}$

or $\overrightarrow{OS} = \overrightarrow{OR} + \overrightarrow{RS}$

M1 for $\overrightarrow{PS} = \frac{1}{2}(\boldsymbol{q} - \boldsymbol{p})$

or $\overrightarrow{QS} = \frac{1}{2}(\boldsymbol{p} - \boldsymbol{q})$

A1 for $\frac{1}{2}(\boldsymbol{p} + \boldsymbol{q})$ *or unsimplified correct answer*

(ii) $\overrightarrow{RS} = \overrightarrow{RP} + \overrightarrow{PS}$

$\overrightarrow{RS} = \frac{1}{2}\mathbf{p} + \frac{1}{2}(\mathbf{q} - \mathbf{p})$

$\overrightarrow{RS} = \frac{1}{2}\mathbf{q}$

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

Therefore RS is parallel to *OQ* 2

B1 for $\overrightarrow{RS} = \frac{1}{2}\boldsymbol{q}$

B1(dep) for RS parallel to OQ

or compares ***q*** *and ½* ***q***

[5]

7. (a) $2\boldsymbol{a} - 2\boldsymbol{b}$ 2

$(\overline{OM} =)\ \boldsymbol{a} + 2\boldsymbol{b}\ \ (\overline{ON} =) 3\boldsymbol{a}$ or $\frac{6}{2}\boldsymbol{a}$

$(\overline{MN} =)\ -\boldsymbol{a} - 2\boldsymbol{b} + 3\boldsymbol{a}$

B2

(B1 for either $\overline{OM}$ *or* $\overline{ON}$ *or* $-\boldsymbol{a} - 2\boldsymbol{b} + 3\boldsymbol{a}$

SC: B1 for $2\boldsymbol{b} - 2\boldsymbol{a}$

(b) $\overline{XY} = 2\boldsymbol{a}$
(hence parallel) 2

$\left(\overline{OX} =\right)$ $2\boldsymbol{a} + \boldsymbol{b}$ $\left(\overline{OY} =\right)$ $\boldsymbol{b} + 4\boldsymbol{a}$

(½ $\overline{QR}$ =) 2a – $\boldsymbol{b}$ or (½ $\overline{RQ}$ =) $\boldsymbol{b} - 2\boldsymbol{a}$

B1 for either $\overline{OX}$ or $\overline{OY}$ or (½ $\overline{QR}$)

B1 for $\overline{XY}$ = $2\boldsymbol{a}$ or $\overline{YX}$ $\overline{YX} = -2\boldsymbol{a}$

[4]

8. (i) 2(**b** – **a**) 3

*B1 for 2(**b** – **a**) oe*

(ii) *OD* = OA + 4*AB* = **a** + 4(**b** – **a**)
4**b** – 3**a**

M1 for OA + 4AB or OA + 2 'AC' oe
*A1 cao for 4**b** – 3**a***

[3]

9. (a) $\begin{pmatrix} 4 \\ 3 \end{pmatrix}$ 2

M1 subtraction of coordinates or position vectors or $\begin{pmatrix} 4 \\ y \end{pmatrix}$ *or*
$\begin{pmatrix} x \\ 3 \end{pmatrix}$*, where x and y are integers*
A1 cao
SC: B1 for $\begin{pmatrix} -4 \\ -3 \end{pmatrix}$ *or* $\begin{pmatrix} 3 \\ 4 \end{pmatrix}$

(b) $R = (6, 10)$, $S = (2, 7)$ 2

$\vec{QS} = \begin{pmatrix}2\\7\end{pmatrix} - \begin{pmatrix}6\\6\end{pmatrix}$

$\begin{pmatrix}-4\\1\end{pmatrix}$

B2 for $\begin{pmatrix}-4\\1\end{pmatrix}$

B1 for $\begin{pmatrix}-4\\y\end{pmatrix}$ *or* $\begin{pmatrix}x\\1\end{pmatrix}$*, where x and y are integers*

[4]

10. (a) (i) **p** + **q** 2

B1 cao ***p*** + ***q***

(ii) **q** – **p**

B1 ***q*** – ***p*** *oe*

(b) $\frac{1}{2}$(**p** + **q**) 1

B1 $\frac{1}{2}$ ***(p*** + ***q)*** *oe*

[3]

11. (a) (i) –3***a*** + ***b*** 4

*B1 for –3**a** + **b** accept –2**a** – **a** + **b** oe*

*B1 for –2**a** + 2**b** accept –2**a** + **b** + **b** oe*

(ii) –2***a*** + 2***b***

(iii) $\vec{PQ} = \vec{PA} + \frac{1}{2}\vec{AB}$ or $\vec{PQ} = \vec{PO} + \vec{OB} + \frac{1}{2}\vec{BA}$

$= \boldsymbol{a} + \frac{1}{2}(-3\boldsymbol{a} + \boldsymbol{b})$ $= -2\boldsymbol{a} + \boldsymbol{b} + \frac{1}{2}(3\boldsymbol{a} - \boldsymbol{b})$

$= -\frac{1}{2}\boldsymbol{a} + \frac{1}{2}\boldsymbol{b}$

M1 for $((\vec{PQ} =)\vec{PA} + \frac{1}{2}"\vec{AB}"$ or

$(\vec{PQ} =)\vec{PQ} + \vec{OB} \pm \frac{1}{2}"\vec{AB}"$

A1 for $-\frac{1}{2}\boldsymbol{a} + \frac{1}{2}\boldsymbol{b}$, accept $\boldsymbol{a} + \frac{b-3a}{2}$ oe

(b) $\vec{PR} = 4\vec{PQ}$ so PR is 'parallel' to *PQ* so *PQR* is a straight line 2

*M1 for PR = 4PQ oe or comparing 2(–**a** + **b**) with ½(–**a** + **b**)*

A1 for a fully correct proof

(c) 12 1

B1 cao

[7]

12. (a) **a** + **b** 1

*B1 **a** + **b** oe*

(b) *ED* = **a**

DX = −2**b** + 2 *AC* = 2**a**

(So, *DX* = 2*ED*)

= 2**a** 3

M1 for (DX =) DA + AX

*A1 for (DX =) −2**b** + 2 ("**a** + **b**")*

*A1 2**a** from fully correct proof*

[4]

13. (a) (i) 5**p** 4

*B1 for 5**p** or* $\begin{pmatrix} 5p \\ 0 \end{pmatrix}$ *or* $\begin{pmatrix} 0 \\ 5p \end{pmatrix}$

(ii) 2**q**

*B1 for 2**q** or* $\begin{pmatrix} 0 \\ 2q \end{pmatrix}$ *or* $\begin{pmatrix} 2q \\ 0 \end{pmatrix}$

(iii) 4**p** – **q**

*B2 for 4**p** – **q** or* $\begin{pmatrix} 4p \\ -q \end{pmatrix}$ *or* $\begin{pmatrix} -q \\ 4p \end{pmatrix}$

*(B1 for 4**p** + **q** or – 4**p** – **q** or PM + MQ or PM – QM)*

(b) $\overrightarrow{RT} = \overrightarrow{RP} + \overrightarrow{PT}$ 4

3**p** – 2**q**

$= -5\mathbf{p} + 2\,(\overrightarrow{PQ})$

= –5**p** + 2(4**p** – **q**)

= –5**p** + 8**p** – 2**q**

B1 for PT = 2PQ or PQ = QT seen or implied
M1 for a valid vector journey, e.g.
RP + PT or RM + MQ + QT seen or implied
*M1 for – 5**p** + 2 × '4**p** – **q**' or –**p** – **q** + '4**p** – **q**'*
*A1 for – 5**p** + 2 × 4**p** – **q** or –**p** – **q**+4**p** – **q** or better*

[8]

14. (a) (i) $\frac{1}{2}\mathbf{a}$ 2

B1 for $\frac{1}{2}\mathbf{a}$ *oe*

(ii) $\frac{1}{2}\mathbf{a} - \frac{1}{2}\mathbf{c}$

B1 for $\frac{1}{2}\mathbf{a} - \frac{1}{2}\mathbf{c}$ *oe*

(b) $\overrightarrow{CA} = \mathbf{a} - \mathbf{c}$

$\overrightarrow{MN} = \frac{1}{2}(\mathbf{a} - \mathbf{c})$

$\overrightarrow{MN} = \frac{1}{2}\overrightarrow{CA}$ 2

B1 for ($\overrightarrow{CA}$) $\boldsymbol{a} - \boldsymbol{c}$ or $\overrightarrow{CB} + \overrightarrow{BA}$ oe

B1 (dep) for correct proof, e.g. '$\overrightarrow{CA} = 2\overrightarrow{MN}$' or '$\overrightarrow{CA}$ is a multiple of $\overrightarrow{MN}$'

(NB: condone absence/misuse of vector notation)

[4]

15. (a) $4\mathbf{a} + 3\mathbf{b} - (2\mathbf{a} + \mathbf{b})$

$2\mathbf{a} + 2\mathbf{b}$ 2

*M1 ($\overrightarrow{OX} + \overrightarrow{XY} = \overrightarrow{OY}$) or $4\boldsymbol{a} + 3\boldsymbol{b} - (2\boldsymbol{a} + \boldsymbol{b})$ oe **or** an intention to do $\overrightarrow{XO} + \overrightarrow{OY}$ eg. $-2\boldsymbol{a} + \boldsymbol{b} + 4\boldsymbol{a} + 3\boldsymbol{b}$*

A1 cao

(b) $\overrightarrow{YZ} = 3\mathbf{a} + 3\mathbf{b}$ or $\overrightarrow{XZ} = 5\mathbf{a} + 5\mathbf{b}$

$\overrightarrow{OZ} = \overrightarrow{OX} + \overrightarrow{XZ} = 2\mathbf{a} + \mathbf{b} + 5\mathbf{a} + 5\mathbf{b}$

$7\mathbf{a} + 6\mathbf{b}$ 3

*M1 for $\overrightarrow{OZ} = \overrightarrow{OX} + \overrightarrow{XZ}$ oe **or** $\overrightarrow{OZ} = \overrightarrow{OY} + \overrightarrow{YZ}$ oe (may be given in terms of **a** and **b**)*

*M1 (indep) for (YZ =) $\frac{3}{2}$("$2\boldsymbol{a} + 2\boldsymbol{b}$")(= $3\boldsymbol{a} + 3\boldsymbol{b}$) **or***

($\vec{XZ}$ =) $\frac{5}{2}$("$2\boldsymbol{a} + 2\boldsymbol{b}$") (= $5\boldsymbol{a} + 5\boldsymbol{b}$)

A1 cao

SC : B2 for $7\boldsymbol{a} + 9\boldsymbol{b}$ or $7\boldsymbol{a} + 11\boldsymbol{b}$

[5]

16. (a) $\mathbf{b} - \mathbf{a}$ 1

B1 for $\boldsymbol{b} - \boldsymbol{a}$ or $-\boldsymbol{a} + \boldsymbol{b}$ oe

(b) $\overrightarrow{OP} = \overrightarrow{OA} + \overrightarrow{AP}$

$\overrightarrow{OP} = a + \frac{3}{5}(\mathbf{b} - \mathbf{a})$

$\overrightarrow{OP} = \frac{1}{5}(2\mathbf{a} + 3\mathbf{b})$

proof 3

M1 for $\overrightarrow{OP} = \overrightarrow{OA} + \overrightarrow{AP}$ oe or $\overrightarrow{OP} = \overrightarrow{OB} + \overrightarrow{BP}$ oe

M1 for $\overrightarrow{AP} = \frac{3}{5}$ × "($\mathbf{b} - \mathbf{a}$)" oe or $\overrightarrow{BP} = \frac{2}{5}$ × "($\mathbf{a} - \mathbf{b}$)" oe

A1 for $\mathbf{a} + \frac{3}{5} \times (\mathbf{b} - \mathbf{a})$ oe or $\mathbf{b} + \frac{2}{5} \times (\mathbf{a} - \mathbf{b})$ oe leading to given answer with correct expansion of brackets seen

[4]

17. $-\frac{3}{2}\mathbf{c} - \mathbf{a} + \mathbf{c}$ oe 3

$\overrightarrow{AB} = 2\mathbf{c}$

$\overrightarrow{XA} = \frac{3}{4}2\,\mathbf{c}\left(= \frac{3}{2}\mathbf{c}\right)$

$\overrightarrow{XC} = \overrightarrow{XA} + \overrightarrow{AO} + \overrightarrow{OC}$

$\overrightarrow{XC} = \frac{-3}{2}\mathbf{c} - \mathbf{a} + \mathbf{c}$

B1 for $\frac{3}{4}(2\mathbf{c})$ or $-\frac{3}{4}(2\mathbf{c})$ or $\frac{1}{4}(2\mathbf{c})$ or $-\frac{1}{4}(2\mathbf{c})$ or better

*M1 for ($\overrightarrow{XC}$) = $\overrightarrow{XA} + \overrightarrow{AO} + \overrightarrow{OC}$ **or** $\overrightarrow{XB} + \overrightarrow{BC}$ with $\overrightarrow{BA} + \overrightarrow{AO} + \overrightarrow{OC}$*

A1 for $-\frac{3}{2}\mathbf{c} - \mathbf{a} + \mathbf{c}$ oe

[3]

18. A vector of $\begin{pmatrix} 8 \\ 2 \end{pmatrix}$ drawn on the grid 2

M1 for $\mathbf{a} + 2\mathbf{b}$ drawn

A1 for correct vector $\overrightarrow{PQ}$ drawn

[2]

19. (i) 3**c** 1

B1 cao

(ii) $\overrightarrow{SR} + \overrightarrow{RQ} + \overrightarrow{QP}$

$= -\mathbf{c} - \mathbf{a} + 3\mathbf{c}$

$2\mathbf{c} - \mathbf{a}$ oe 2

M1 for $\overrightarrow{SR} + \overrightarrow{RQ} + \overrightarrow{QP}$

A1 for $2\mathbf{c} - \boldsymbol{a}$ *oe*

[3]

20. $\overrightarrow{OP} = \overrightarrow{OA} + \overrightarrow{AP}$

$\overrightarrow{AB} = \mathbf{b} - \mathbf{a}$

$\overrightarrow{AP} = \frac{2}{3}(\mathbf{b} - \mathbf{a})$

$\frac{2}{3}\mathbf{b} + \frac{1}{3}\mathbf{a}$ 3

M1 for correct vector equation for $\overrightarrow{OP}$

M1 for $\overrightarrow{AB} = \boldsymbol{b} - \boldsymbol{a}$

A1 for $\boldsymbol{a} + \frac{2}{3}(\boldsymbol{b} - \boldsymbol{a})$ *oe*

[3]

21. $\begin{pmatrix} 4 \\ 3 \end{pmatrix}$ 2

M1 subtraction of coordinates or position vectors or $\begin{pmatrix} 4 \\ y \end{pmatrix}$ *or*

$\begin{pmatrix} x \\ 3 \end{pmatrix}$ *where x and y are intergers*

A1 cao

SC:B1 for $\begin{pmatrix} -4 \\ -3 \end{pmatrix}$ *or* $\begin{pmatrix} 3 \\ 4 \end{pmatrix}$

[2]

1. The vast majority of candidates were able to gain some credit for the rotation. A significant number of candidates, however, did not use the correct centre and so failed to gain full credit. A minority of candidates used the correct centre but rotated anticlockwise rather than clockwise. Success with the translation was very varied; approximately 60% of candidates were able to carry this out correctly.

2. This question was answered correctly by the majority of candidates. A common error was to translate the shape by a vector of rather than as specified in the question.

3. Many candidates gained credit for a correct vector in part (a) but a common error with the below average candidate was to assume that since all the sides of the hexagon were of equal length, each side could be represented by the same vector. Those candidates who wrote down a relevant vector journey normally gained credit in part (b). Part (c) was generally only completed correctly by the A* candidates although many other candidates gained some credit for correctly writing, for example, vector BY in terms of a and b.

4. Part (a) normally proved to be straightforward for those candidates who displayed any knowledge of vectors. In part (b) many of these candidates correctly dealt with the ratio of the two lengths but in some cases used $\mathbf{b} + \frac{1}{3}(-\mathbf{a} + \mathbf{b})$ for the vector OT rather than $\mathbf{b} - \frac{1}{3}(-\mathbf{a} + \mathbf{b})$. Those who used the 'journey' $O \rightarrow P \rightarrow T$ for the vector OT were generally more successful, although a significant number of candidates failed to simplify their answer.

5. Candidates' responses to this vector question were mixed with some not making any attempt (or just stating that vectors was a topic that they 'never did'). For those who made a realistic attempt there were many sign errors in part (b). Those candidates who started by writing down a basic 'vector journey', for example "OP = OA + AP" then "=6**a** + 2/3AC" gained more credit than those who normally just wrote down an answer. In part (b) many grade A and above candidates correctly found vector OM in terms of **a** and **b** but only the better candidates could finish off the proof convincingly.

6. Few candidates understood the concepts of working out the vectors required for this question. They took scant notice of the direction of the vectors arrows and their length. Only about 40% of candidates scored any marks at all and only 15% of candidates showed a fully correct solution.

7. Virtually all the candidates used the 'nose to tail' method for working out these vectors, and there were some very encouraging attempts.
In part (a), many of those candidates working at grades A and A* were able to achieve full marks, and some lower grade candidates managed to score a mark for identifying the vector 3a.
Although few of the candidates were able to achieve full marks in part (b), there were many correct methods that involved $\frac{1}{2}\overline{QR}$.

8. Many candidates gained at least one mark for this question. Part (i) was generally done well with adequate use of notation. In part (ii), many knew that the vector journey involved $2\overline{AC}$ (oe) but some forgot to add a (oe). Candidates should be encouraged to write down vector journeys (e.g. $\overline{OD} = \overline{OA} + 4\overline{AB}$) before substitution of vectors (e.g. $\overline{OD} = a + 4(b - a)$)

9. Part (a) was done correctly by about three-quarters of the candidates.
Common errors were to add or multiply the vectors.
Locating the parallelogram was a problem for many in part (b). Most of the successful attempts at this question involved finding the vector by considering displacements in the diagram.
Correct horizontal displacements were seen more often than correct vertical displacements.

10. This was a straightforward vector question. Competent candidates had little difficulty in getting full marks for the question. Other candidates tried to give answers as column vectors or gave an incorrect combination of signs, for example $\frac{1}{2}(p - q)$ for part (b).

11. Only the best candidates were able to make much progress with this question. In part (a), candidates were often able to give a correct answer for (i) and (ii), but (iii) was found to be a more challenging. A common error here was $a - \frac{b - 3a}{2}$. In part (b), explanations for why PQR is a straight line were often incomplete. Either the common point was not identified when the vectors were shown to be parallel, or the lines were not shown to be parallel when the common point was identified. Some candidates stated that the lines were multiples of each other without supporting evidence in either the correct work in part (a), or in explicitly comparing the vectors $2(b - a)$ and $\frac{1}{2}(b - a)$.
A common incorrect answer in part (c) was 9.

12. Part (a) was done well by many candidates. The most common incorrect answers were ab, $a - b$, $a^2 + b^2$, $2b - a$, $(a + b)/2$, $AB + BC$

Few candidates were able to achieve full marks in part (b). Common incorrect answer involved:

- assuming CD was either a or b
- stating that $DX = 2a$ without supporting evidence
- using geometry of hexagons, isosceles triangles and parallelograms, but making unsupported assumptions such as "*EDX* is a straight line" and "*ADX* is an isosceles triangle".

13. Most candidates were able to score some marks in part (a), usually for (i) and (ii). Some left their final answer in an unsimplified form, i.e. 4**p** + **p** and **q** + **q**, but were not penalised. A common misunderstanding in (iii) was to find the length of PQ as $\sqrt{4p^2 + q^2}$ (common) or $4p^2 + q^2$.

Only the best candidates were able to make much progress in part (b). Candidates should be encouraged to write down their vector journey before substituting in term of **p** and **q**. A significant number of candidates were confused about the relationship between the direction of the vector and its sign. It was not uncommon to see ***RT*** expressed as **p** + **q** + (4**p** − **q**) or as **p** + 4**p** + 2(4**p** – **q**). Many candidates were able to gain a mark for showing **PQ** = **QT**. A common misconception was to use **RT** = **QT**.

14. The use of vector notation in this question was generally poor. In part (a)(i), about half the candidates were able to score 1 mark for $\frac{1}{2}\mathbf{a}$. A common incorrect answer in part (a)(ii) was $\frac{1}{2}\mathbf{a} + \frac{1}{2}\mathbf{c}$. In part (b), about a quarter of the candidates were able to write down a correct vector for $\overrightarrow{CA}$ and show that CA is parallel to MN. Common correct answers here were and $\overrightarrow{CA} = 2\overrightarrow{MN}$ and $\overrightarrow{MN} = \frac{1}{2}(\mathbf{a} - \mathbf{c})$.

15. Over 70% of candidates failed to gain any marks for this question. Fully correct solutions were seen from only 5% of candidates. Of those who made some attempt, most added the vectors, and those who attempted subtraction often did $4a + 3b - 2a + b$ omitting the brackets, they gained the method mark but not the accuracy mark. In part (b) most just ignored the 3/2 and just added or subtracted the vectors given.
It was rare to see a vector equation written down. A few realised the significance of XZ:YZ = 3 : 2 but applied it to OY or OX.

16. **Specification A**

Part (a) was correctly answered by about half the candidates, but incorrect responses included (ab)/2, $a + b$, $a – b$, and p. It appeared that candidates were confused by part b, and it was noticeable that a lot of those who correctly responded to part (a) did not even attempt part (b). There were some very neat logical arguments but on the whole the responses were messy with lots of crossing out and arrows directing you to the next line of their answer. Of those who gained some credit the most common mistake was using PB instead of BP, (there was little appreciation that the opposite direction results in a negative vector), followed by those who missed out brackets and hence only multiplied part of the vector. Some candidates tried to draw a scale drawing as the proof. A few candidates tried to give a justification in words.

Specification B

Some candidates where able to write down a correct expression for the vector AB in terms of **a** and **b**. Part (b) proved to be a challenge, even for those who scored in part (a). The key ideas were to understand that $OP = OA + AP$ by the triangle law and that $AP = \frac{3}{5} AB$. Those that did usually were able to expand the brackets correctly and achieve the correct given answer.

17. It was clear that some candidates had not covered this topic. Pythagoras' theorem was often incorrectly used. Those who made a realistic attempt generally dealt correctly with the given ratio but had problems with the required 'vector journey'. A common wrong approach assumed that the vector **BC** was **a**. Candidates should be encouraged to initially write the vector journey in terms of the points given in the diagram e.g. **XC** = **XA** + **XO** + **OC** before further substitution.

18. The majority of candidates were able to gain some credit on this question. Candidates should be reminded that vectors need to show direction.

19. About 70% of candidates were able to answer part (i) correctly. In part (ii) few candidates showed any method. Candidates should be advised to start this type of question by writing down an appropriate vector equation.

20. Only a very few candidates were able to give a fully correct solution to this question. Some candidates were able to write down a correct vector equation for $\overrightarrow{OP}$ and thus gain some credit.

21. Just over 75% of candidates were able to give the correct vector. Common errors seen were to reverse the correct values or to add, rather than subtract, the coordinates.