Vectors and Matrices

1) June 2010 V2

2 **(a)** $\mathbf{p} = \begin{pmatrix} 3 \\ 2 \end{pmatrix}$ and $\mathbf{q} = \begin{pmatrix} 6 \\ 3 \end{pmatrix}$.

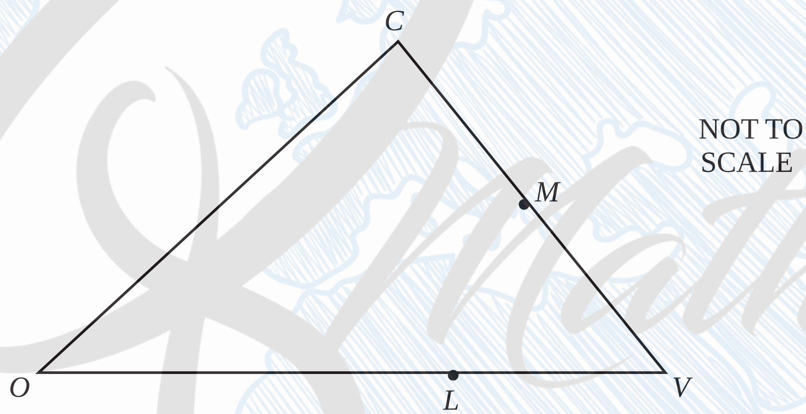
(i) Find, as a single column vector, $\mathbf{p} + 2\mathbf{q}$.

Answer(a)(i) $\begin{pmatrix} \quad \\ \quad \end{pmatrix}$ [2]

(ii) Calculate the value of $|\mathbf{p} + 2\mathbf{q}|$.

Answer(a)(ii) .... [2]

(b)



In the diagram, $CM = MV$ and $OL = 2LV$.
O is the origin. $\overrightarrow{OC} = \mathbf{c}$ and $\overrightarrow{OV} = \mathbf{v}$

Find, in terms of **c** and **v**, in their simplest forms

(i) $\overrightarrow{CM}$,

Answer(b)(i) .... [2]

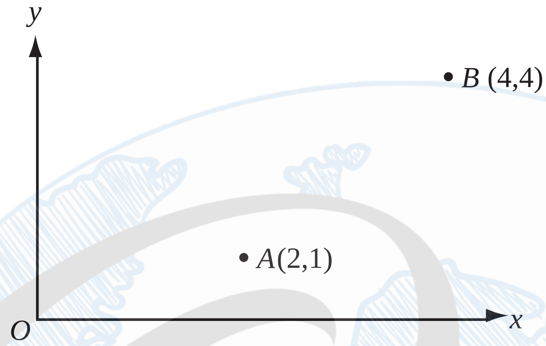
(ii) the position vector of M,

Answer(b)(ii) .... [2]

(iii) $\overrightarrow{ML}$.

Answer(b)(iii) .... [2]

7 **(b)**



(i) Write down $\overrightarrow{AB}$ as a column vector.

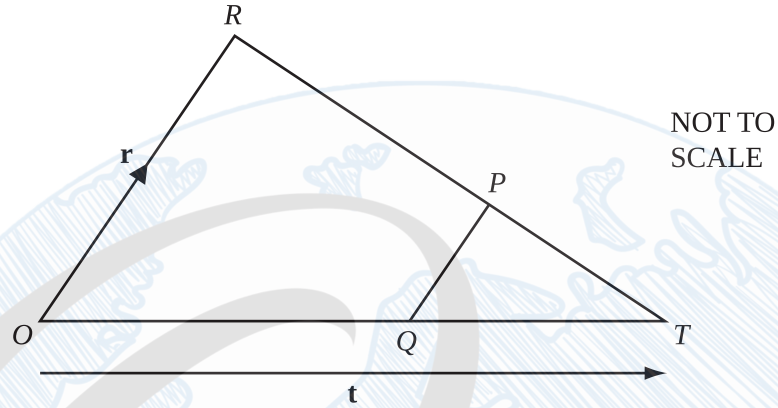
Answer(b)(i) $\overrightarrow{AB} = \begin{pmatrix} \\ \end{pmatrix}$ [1]

(ii) $\overrightarrow{AC} = \begin{pmatrix} 0 \\ 7 \end{pmatrix}$.

Work out $\overrightarrow{BC}$ as a column vector.

Answer(b)(ii) $\overrightarrow{BC} = \begin{pmatrix} \\ \end{pmatrix}$ [2]

(c)



$\overrightarrow{OR} = \mathbf{r}$ and $\overrightarrow{OT} = \mathbf{t}$.
P is on RT such that $RP : PT = 2 : 1$.
Q is on OT such that $OQ = \frac{2}{3}OT$.

Write the following in terms of **r** and/or **t**.
Simplify your answers where possible.

(i) $\overrightarrow{QT}$

Answer(c)(i) $\overrightarrow{QT}$ = ... [1]

(ii) $\overrightarrow{TP}$

Answer(c)(ii) $\overrightarrow{TP}$ = ... [2]

(iii) $\overrightarrow{QP}$

Answer(c)(iii) $\overrightarrow{QP}$ = ... [2]

(iv) Write down two conclusions you can make about the line segment QP.

Answer(c)(iv) ....

.... [2]

4 **(a)**

$$\mathbf{A} = \begin{pmatrix} 2 & 3 \\ 4 & 5 \end{pmatrix} \qquad \mathbf{B} = \begin{pmatrix} 2 \\ 7 \end{pmatrix} \qquad \mathbf{C} = \begin{pmatrix} 1 & 2 \end{pmatrix}$$

Find the following matrices.

(i) **AB**

Answer(a)(i) [2]

(ii) **CB**

Answer(a)(ii) [2]

(iii) $\mathbf{A}^{-1}$, the inverse of **A**

Answer(a)(iii) [2]

(b) Describe fully the **single** transformation represented by the matrix $\begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$.

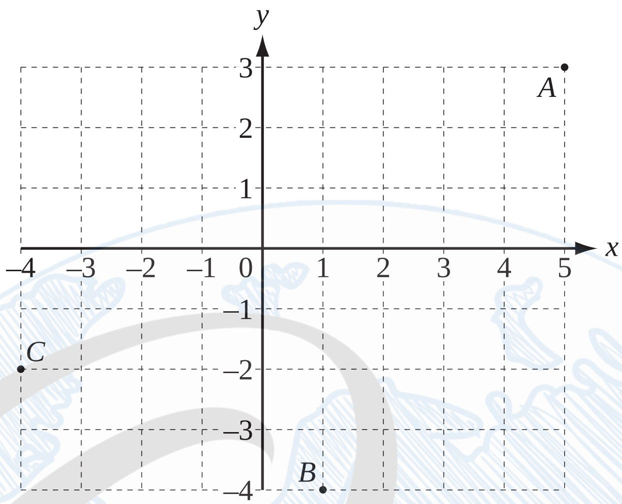
Answer(b) .... [2]

(c) Find the 2 by 2 matrix that represents an anticlockwise rotation of 90° about the origin.

Answer(c) $\begin{pmatrix} & \\ & \end{pmatrix}$ [2]

4) November 2010 V3

9 **(a)**



The points A (5, 3), B (1, –4) and C (–4, –2) are shown in the diagram.

(i) Write $\overrightarrow{CA}$ as a column vector.

Answer(a)(i) $\overrightarrow{CA} = \begin{pmatrix} \\ \end{pmatrix}$ [1]

(ii) Find $\overrightarrow{CA} - \overrightarrow{CB}$ as a single column vector.

Answer(a)(ii) $\begin{pmatrix} \\ \end{pmatrix}$ [2]

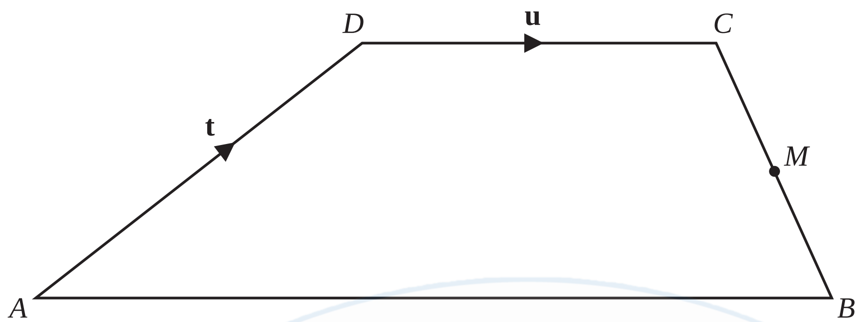
(iii) Complete the following statement.

$\overrightarrow{CA} - \overrightarrow{CB} =$ .... [1]

(iv) Calculate $|\overrightarrow{CA}|$.

Answer(a)(iv) .... [2]

(b)



$ABCD$ is a trapezium with DC parallel to AB and $DC = \frac{1}{2}AB$.

M is the midpoint of BC.

$\overrightarrow{AD} = \mathbf{t}$ and $\overrightarrow{DC} = \mathbf{u}$.

Find the following vectors in terms of **t** and / or **u**.

Give each answer in its simplest form.

(i) $\overrightarrow{AB}$

Answer(b)(i) $\overrightarrow{AB}$ = ... [1]

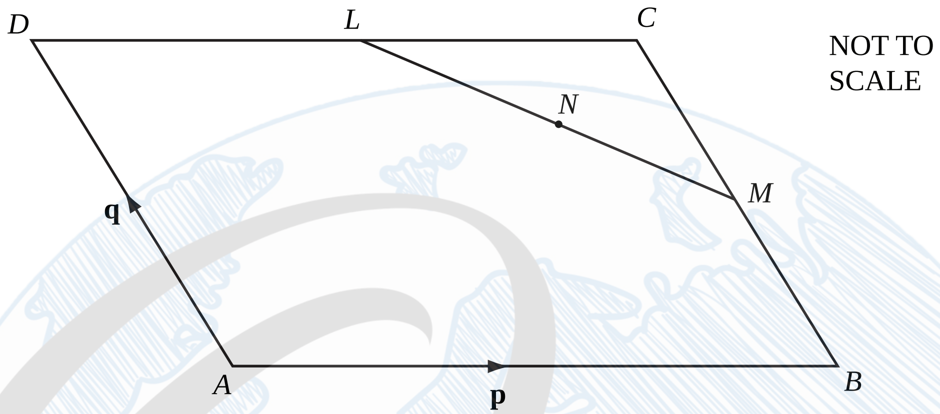
(ii) $\overrightarrow{BM}$

Answer(b)(ii) $\overrightarrow{BM}$ = ... [2]

(iii) $\overrightarrow{AM}$

Answer(b)(iii) $\overrightarrow{AM}$ = ... [2]

10 (a)



ABCD is a parallelogram.
L is the midpoint of *DC*, *M* is the midpoint of *BC* and *N* is the midpoint of *LM*.
$\overrightarrow{AB} = \mathbf{p}$ and $\overrightarrow{AD} = \mathbf{q}$.

(i) Find the following in terms of **p** and **q**, in their simplest form.

(a) $\overrightarrow{AC}$

Answer(a)(i)(a) $\overrightarrow{AC}$ = ... [1]

(b) $\overrightarrow{LM}$

Answer(a)(i)(b) $\overrightarrow{LM}$= .... [2]

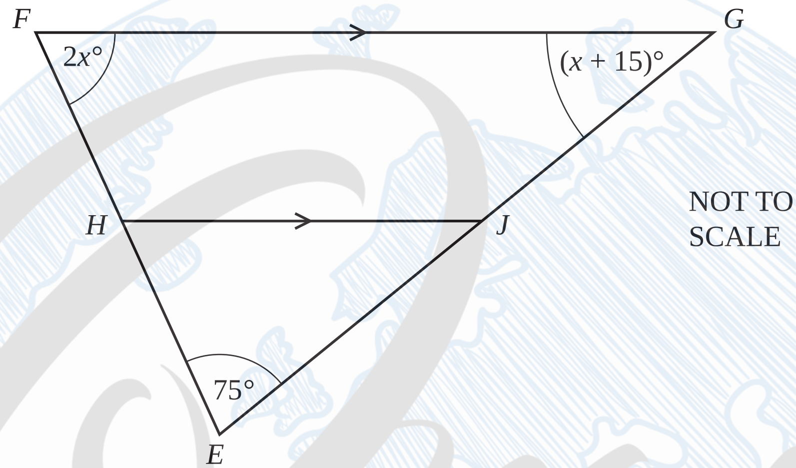
(c) $\overrightarrow{AN}$

Answer(a)(i)(c) $\overrightarrow{AN}$= .... [2]

(ii) Explain why your answer for $\overrightarrow{AN}$ shows that the point *N* lies on the line *AC*.

Answer(a)(ii) .... [1]

(b)



EFG is a triangle.
HJ is parallel to *FG*.
Angle *FEG* = 75°.
Angle *EFG* = $2x°$ and angle *FGE* = $(x + 15)°$.

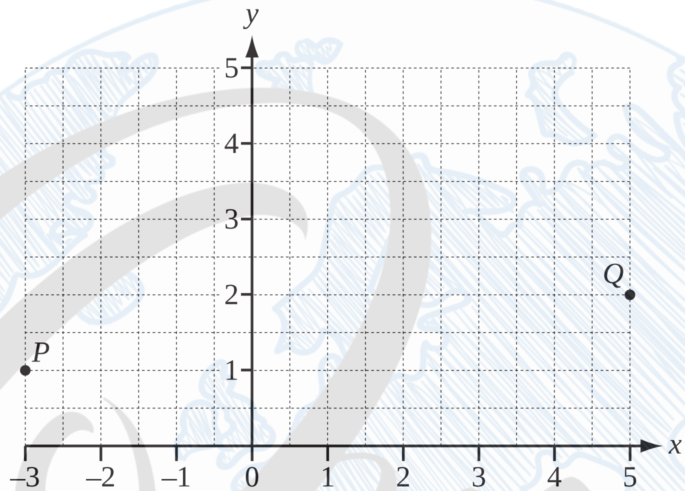
(i) Find the value of x.

Answer(b)(i) x = ... [2]

(ii) Find angle *HJG*.

Answer(b)(ii) Angle *HJG* = ... [1]

11 (a)



The points P and Q have co-ordinates (–3, 1) and (5, 2).

(i) Write $\overrightarrow{PQ}$ as a column vector.

Answer(a)(i) $\overrightarrow{PQ} = \begin{pmatrix} \\ \end{pmatrix}$ [1]

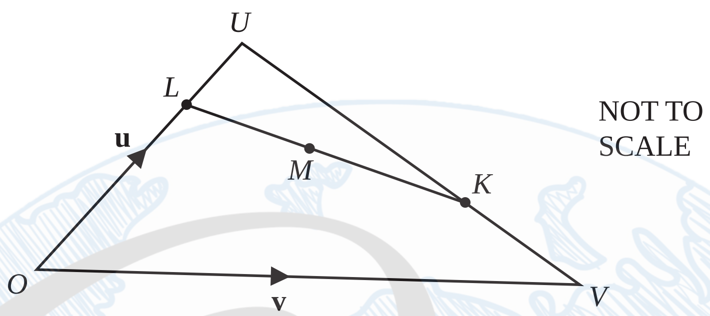
(ii) $\overrightarrow{QR} = 2\begin{pmatrix} -1 \\ 1 \end{pmatrix}$

Mark the point R on the grid. [1]

(iii) Write down the position vector of the point P.

Answer(a)(iii) $\begin{pmatrix} \\ \end{pmatrix}$ [1]

(b)



In the diagram, $\overrightarrow{OU} = \mathbf{u}$ and $\overrightarrow{OV} = \mathbf{v}$.

K is on UV so that $\overrightarrow{UK} = \frac{2}{3}\overrightarrow{UV}$ and L is on OU so that $\overrightarrow{OL} = \frac{3}{4}\overrightarrow{OU}$.

M is the midpoint of KL.

Find the following in terms of **u** and **v**, giving your answers in their simplest form.

(i) $\overrightarrow{LK}$

Answer(b)(i) $\overrightarrow{LK}$ = ... [4]

(ii) $\overrightarrow{OM}$

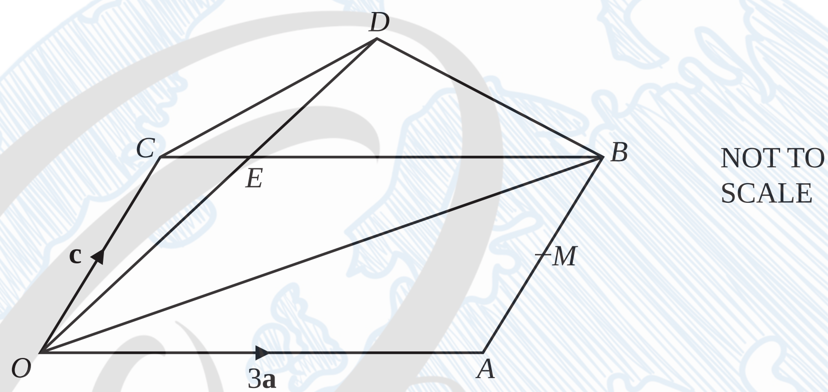
Answer(b)(ii) $\overrightarrow{OM}$ = ... [2]

7 **(a)** P is the point (2, 5) and $\overrightarrow{PQ} = \begin{pmatrix} 3 \\ -2 \end{pmatrix}$.

Write down the co-ordinates of Q.

Answer(a) (.......... , ...) [1]

(b)



O is the origin and $OABC$ is a parallelogram.
M is the midpoint of AB.

$\overrightarrow{OC} = \mathbf{c}$, $\overrightarrow{OA} = 3\mathbf{a}$ and $CE = \frac{1}{3}CB$.

OED is a straight line with $OE : ED = 2 : 1$.

Find in terms of **a** and **c**, in their simplest forms

(i) $\overrightarrow{OB}$,

Answer(b)(i) $\overrightarrow{OB}$ = ... [1]

(ii) the position vector of M,

Answer(b)(ii) .... [2]

(iii) $\overrightarrow{OE}$,

Answer(b)(iii) $\overrightarrow{OE}$ = ... [1]

(iv) $\overrightarrow{CD}$.

Answer(b)(iv) $\overrightarrow{CD}$ = ... [2]

(c) Write down two facts about the lines CD and OB.

Answer (c) ....

[2]

6 **(a)** $\mathbf{a} = \begin{pmatrix} -2 \\ 3 \end{pmatrix}$ $\mathbf{b} = \begin{pmatrix} 2 \\ -7 \end{pmatrix}$ $\mathbf{c} = \begin{pmatrix} -10 \\ 21 \end{pmatrix}$

(i) Find 2**a** + **b**.

Answer(a)(i) $\begin{pmatrix} \quad \\ \quad \end{pmatrix}$ [1]

(ii) Find | **b** |.

Answer(a)(ii) .... [2]

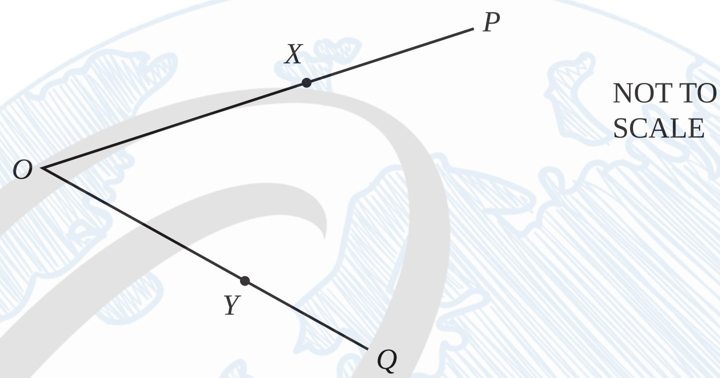
(iii) $m\mathbf{a} + n\mathbf{b} = \mathbf{c}$

Find the values of m and n.
Show all your working.

Answer(a)(iii) m = ...

n = ... [6]

(b)



In the diagram, $OX : XP = 3 : 2$ and $OY : YQ = 3 : 2$.
$\overrightarrow{OP} = \mathbf{p}$ and $\overrightarrow{OQ} = \mathbf{q}$.

(i) Write $\overrightarrow{PQ}$ in terms of **p** and **q**.

Answer(b)(i) $\overrightarrow{PQ}$ = ... [1]

(ii) Write $\overrightarrow{XY}$ in terms of **p** and **q**.

Answer(b)(ii) $\overrightarrow{XY}$ = ... [1]

(iii) Complete the following sentences.

The lines *XY* and *PQ* are ....

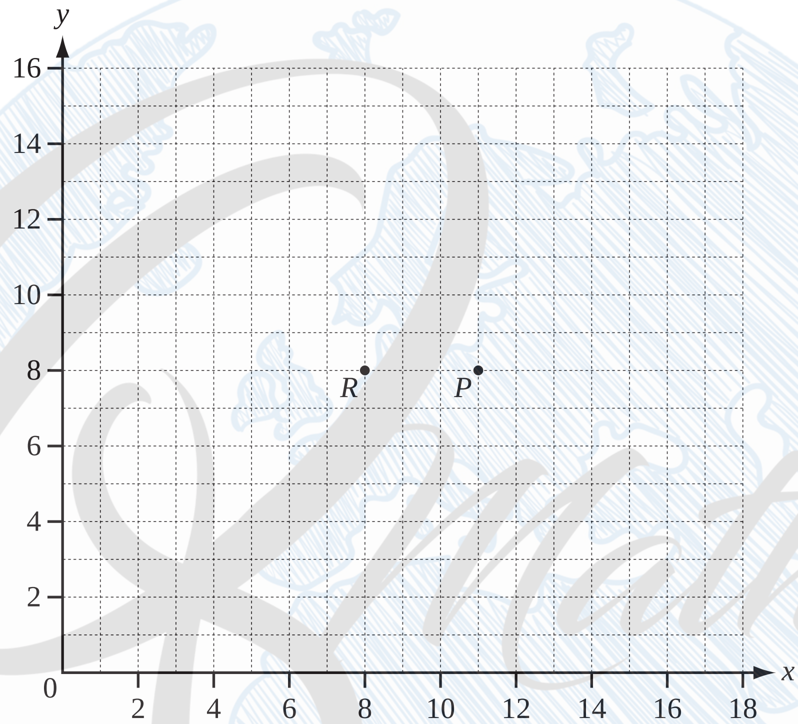
The triangles *OXY* and *OPQ* are ....

The ratio of the area of triangle *OXY* to the area of triangle *OPQ* is .... : .... [3]

6 **(a)** Calculate the magnitude of the vector $\begin{pmatrix} 3 \\ -5 \end{pmatrix}$.

Answer(a) .... [2]

(b)



(i) The points P and R are marked on the grid above.

$\overrightarrow{PQ} = \begin{pmatrix} 3 \\ -5 \end{pmatrix}$. Draw the vector $\overrightarrow{PQ}$ on the grid above. [1]

(ii) Draw the image of vector $\overrightarrow{PQ}$ after rotation by 90° anticlockwise about R. [2]

(c) $\overrightarrow{DE} = 2\mathbf{a} + \mathbf{b}$ and $\overrightarrow{DC} = 3\mathbf{b} - \mathbf{a}$.

Find $\overrightarrow{CE}$ in terms of **a** and **b**. Write your answer in its simplest form.

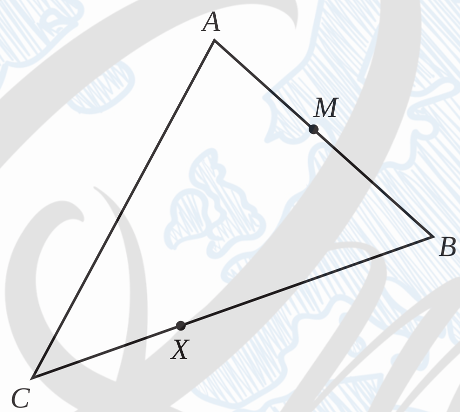
Answer(c) $\overrightarrow{CE}$ = ... [2]

(d) $\overrightarrow{OT} = \begin{pmatrix} -2 \\ 5 \end{pmatrix}$ and $\overrightarrow{OV} = \begin{pmatrix} 5 \\ -1 \end{pmatrix}$.

Write $\overrightarrow{TV}$ as a column vector.

Answer(d) $\overrightarrow{TV} = \begin{pmatrix} \quad \\ \quad \end{pmatrix}$ [2]

(e)



$\overrightarrow{AB} = \mathbf{b}$ and $\overrightarrow{AC} = \mathbf{c}$.

(i) Find $\overrightarrow{CB}$ in terms of **b** and **c**.

Answer(e)(i) $\overrightarrow{CB} =$ .... [1]

(ii) X divides CB in the ratio $1:3$.
M is the midpoint of AB.

Find $\overrightarrow{MX}$ in terms of **b** and **c**.
Show all your working and write your answer in its simplest form.

Answer(e)(ii) $\overrightarrow{MX} =$ .... [4]

10) June 2013 V2

7 $\mathbf{A} = \begin{pmatrix} 5 \\ 7 \end{pmatrix}$ $\mathbf{B} = (6 \quad -4)$ $\mathbf{C} = \begin{pmatrix} 2 & 4 \\ 1 & 3 \end{pmatrix}$ $\mathbf{D} = \begin{pmatrix} 2 & 9 \\ -1 & -3 \end{pmatrix}$

(a) Calculate the result of each of the following, if possible.

If a calculation is not possible, write "not possible" in the answer space.

(i) 3**A**

Answer(a)(i) [1]

(ii) **AC**

Answer(a)(ii) [1]

(iii) **BA**

Answer(a)(iii) [2]

(iv) **C** + **D**

Answer(a)(iv) [1]

(v) $\mathbf{D}^2$

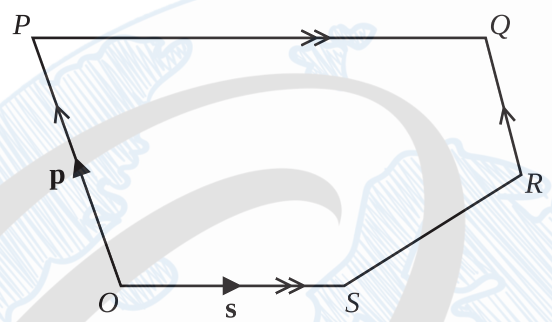
Answer(a)(v) [2]

(b) Calculate $\mathbf{C}^{-1}$, the inverse of **C**.

Answer(b) [2]

5

(b)



In the pentagon *OPQRS*, *OP* is parallel to *RQ* and *OS* is parallel to *PQ*.
PQ = 2*OS* and *OP* = 2*RQ*.
O is the origin, $\overrightarrow{OP} = \mathbf{p}$ and $\overrightarrow{OS} = \mathbf{s}$.

Find, in terms of **p** and **s**, in their simplest form,

(i) the position vector of *Q*,

Answer(b)(i) .... [2]

(ii) $\overrightarrow{SR}$.

Answer(b)(ii) $\overrightarrow{SR}$ = ... [2]

(c) Explain what your answers in **part (b)** tell you about the lines *OQ* and *SR*.

Answer(c) .... [1]

7 **(a)** The co-ordinates of P are (–4, –4) and the co-ordinates of Q are (8, 14).

(i) Find the gradient of the line PQ.

Answer(a)(i) .... [2]

(ii) Find the equation of the line PQ.

Answer(a)(ii) .... [2]

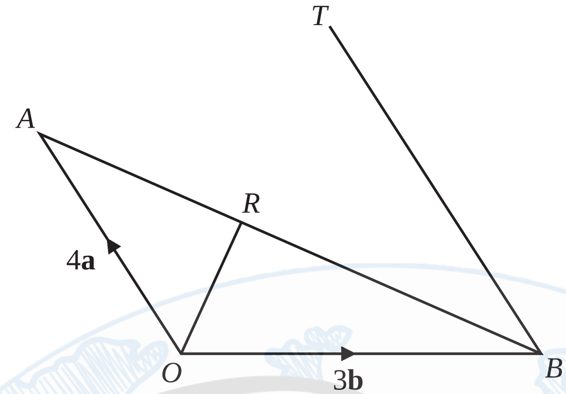
(iii) Write $\overrightarrow{PQ}$ as a column vector.

Answer(a)(iii) $\overrightarrow{PQ} = \begin{pmatrix} \\ \end{pmatrix}$ [1]

(iv) Find the magnitude of $\overrightarrow{PQ}$.

Answer(a)(iv) .... [2]

(b)



In the diagram, $\overrightarrow{OA} = 4\mathbf{a}$ and $\overrightarrow{OB} = 3\mathbf{b}$.

R lies on AB such that $\overrightarrow{OR} = \frac{1}{5}(12\mathbf{a} + 6\mathbf{b})$.

T is the point such that $\overrightarrow{BT} = \frac{3}{2}\overrightarrow{OA}$.

(i) Find the following in terms of **a** and **b**, giving each answer in its simplest form.

(a) $\overrightarrow{AB}$

Answer(b)(i)(a) $\overrightarrow{AB}$ = ... [1]

(b) $\overrightarrow{AR}$

Answer(b)(i)(b) $\overrightarrow{AR}$ = ... [2]

(c) $\overrightarrow{OT}$

Answer(b)(i)(c) $\overrightarrow{OT}$ = ... [1]

(ii) Complete the following statement.

The points O, R and T are in a straight line because ....

.... [1]

(iii) Triangle OAR and triangle TBR are similar.

Find the value of $\dfrac{\text{area of triangle } TBR}{\text{area of triangle } OAR}$.

Answer(b)(iii) .... [2]

13) June 2014 V1

1 $\mathbf{A} = \begin{pmatrix} 3 & 2 \\ -1 & 1 \end{pmatrix}$ $\mathbf{B} = \begin{pmatrix} -2 & 5 \end{pmatrix}$ $\mathbf{C} = \begin{pmatrix} -2 \\ 5 \end{pmatrix}$ $\mathbf{D} = \begin{pmatrix} 2 & 0 \\ 0 & 2 \end{pmatrix}$

(a) Work out, when possible, each of the following.
If it is not possible, write 'not possible' in the answer space.

(i) 2**A**

Answer(a)(i) [1]

(ii) **B** + **C**

Answer(a)(ii) [1]

(iii) **AD**

Answer(a)(iii) [2]

(iv) $\mathbf{A}^{-1}$, the inverse of **A**

Answer(a)(iv) [2]

(b) Explain why it is not possible to work out **CD**.

Answer(b) .... [1]

(c) Describe fully the **single** transformation represented by the matrix **D**.

Answer(c) ....

.... [3]

14) June 2014 V1

11 **(a)** $\overrightarrow{PQ} = \begin{pmatrix} -3 \\ 4 \end{pmatrix}$

(i) P is the point (–2, 3).

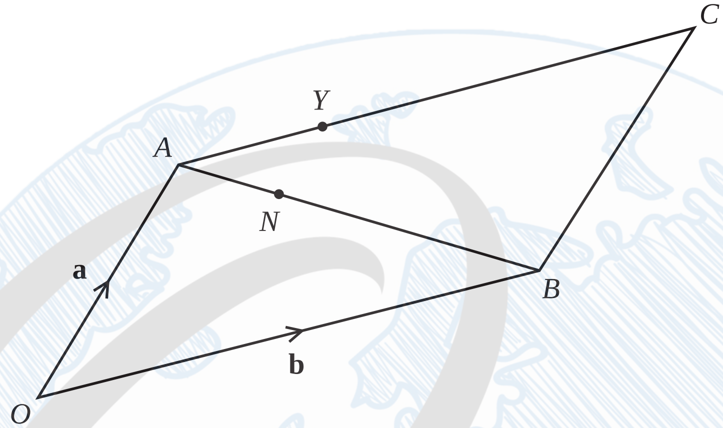
Work out the co-ordinates of Q.

Answer(a)(i) (............ , ...) [1]

(ii) Work out $\left|\overrightarrow{PQ}\right|$, the magnitude of $\overrightarrow{PQ}$.

Answer(a)(ii) .... [2]

(b)



OACB is a parallelogram.
$\overrightarrow{OA} = \mathbf{a}$ and $\overrightarrow{OB} = \mathbf{b}$.
$AN : NB = 2 : 3$ and $AY = \frac{2}{5}AC$.

(i) Write each of the following in terms of **a** and/or **b**.
Give your answers in their simplest form.

(a) $\overrightarrow{ON}$

Answer(b)(i)(a) $\overrightarrow{ON}$ = ... [2]

(b) $\overrightarrow{NY}$

Answer(b)(i)(b) $\overrightarrow{NY}$ = ... [2]

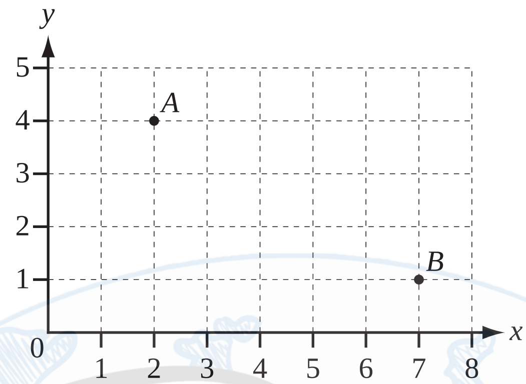
(ii) Write down two conclusions you can make about the line segments *NY* and *BC*.

Answer(b)(ii) ....

.... [2]

15) June 2014 V3

5 **(a)**



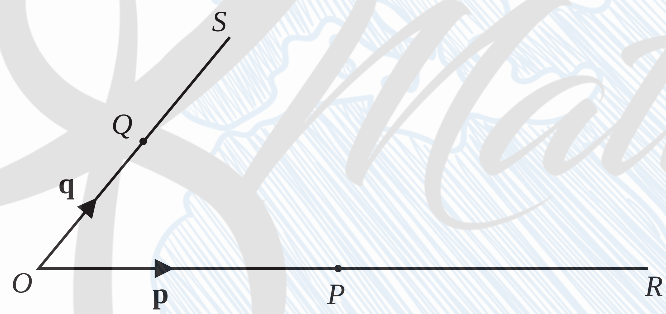
(i) Write down the position vector of *A*.

Answer(a)(i) $\begin{pmatrix} \quad \\ \quad \end{pmatrix}$ [1]

(ii) Find $|\overrightarrow{AB}|$, the magnitude of $\overrightarrow{AB}$.

Answer(a)(ii) .... [2]

(b)



O is the origin, $\overrightarrow{OP} = \mathbf{p}$ and $\overrightarrow{OQ} = \mathbf{q}$.
OP is extended to *R* so that *OP* = *PR*.
OQ is extended to *S* so that *OQ* = *QS*.

(i) Write down $\overrightarrow{RQ}$ in terms of **p** and **q**.

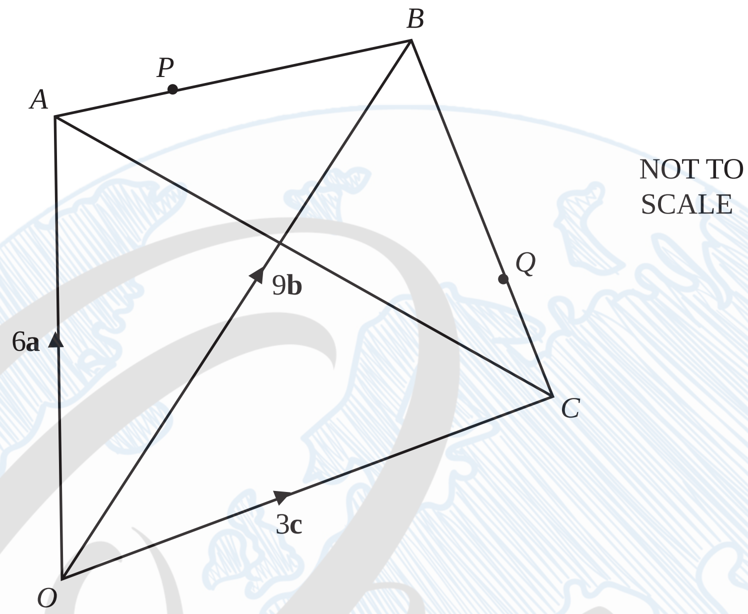
Answer(b)(i) $\overrightarrow{RQ}$ = ... [1]

(ii) *PS* and *RQ* intersect at *M* and *RM* = 2*MQ*.

Use vectors to find the ratio *PM* : *PS*, showing all your working.

Answer(b)(ii) *PM* : *PS* = ... : .... [4]

8



In the diagram, O is the origin and $\overrightarrow{OA} = 6\mathbf{a}$, $\overrightarrow{OB} = 9\mathbf{b}$ and $\overrightarrow{OC} = 3\mathbf{c}$.
The point P lies on AB such that $\overrightarrow{AP} = 3\mathbf{b} - 2\mathbf{a}$.
The point Q lies on BC such that $\overrightarrow{BQ} = 2\mathbf{c} - 6\mathbf{b}$

(a) Find, in terms of $\mathbf{b}$ and $\mathbf{c}$, the position vector of Q
Give your answer in its simplest form.

Answer(a) .... [2]

(b) Find, in terms of **a** and **c**, in its simplest form

(i) $\overrightarrow{AC}$,

Answer(b)(i) $\overrightarrow{AC}$ = ... [1]

(ii) $\overrightarrow{PQ}$.

Answer(b)(ii) $\overrightarrow{PQ}$ = ... [2]

(c) Explain what your answers in **part (b)** tell you about PQ and AC.

Answer(c) ....

.... [2]

17) November 2014 V3

5 $\mathbf{P} = \begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix}$ $\mathbf{Q} = \begin{pmatrix} 1 & -2 \\ 0 & 1 \end{pmatrix}$ $\mathbf{R} = \begin{pmatrix} -3 \\ 5 \end{pmatrix}$

(a) Work out

(i) 4**P**,

Answer(a)(i) [1]

(ii) **P** – **Q**,

Answer(a)(ii) [1]

(iii) $\mathbf{P}^2$,

Answer(a)(iii) [2]

(iv) **QR**.

Answer(a)(iv) [2]

(b) Find the matrix **S**, so that $\mathbf{QS} = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$.

Answer(b) [3]

18) June 2015 V2

10 **(a)** $\overrightarrow{PQ} = \begin{pmatrix} 5 \\ -8 \end{pmatrix}$

(i) Find the value of $|\overrightarrow{PQ}|$.

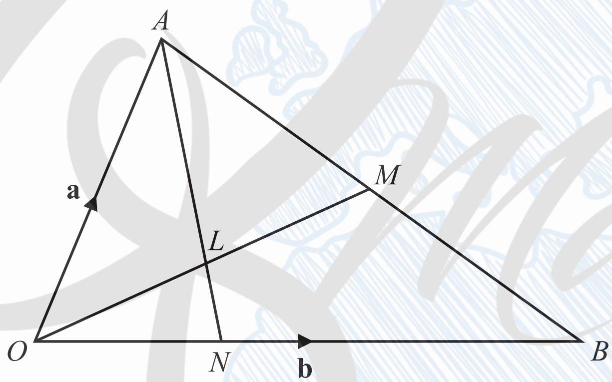
Answer(a)(i) $|\overrightarrow{PQ}|$ = ... [2]

(ii) Q is the point (2, –3).

Find the co-ordinates of the point P.

Answer(a)(ii) (..................... , ...) [1]

(b)



NOT TO SCALE

In the diagram, M is the midpoint of AB and L is the midpoint of OM.
The lines OM and AN intersect at L and $ON = \frac{1}{3}OB$.
$\overrightarrow{OA} = \mathbf{a}$ and $\overrightarrow{OB} = \mathbf{b}$.

(i) Find, in terms of **a** and **b**, in its simplest form,

(a) $\overrightarrow{OM}$,

Answer(b)(i)(a) $\overrightarrow{OM}$ = ... [2]

(b) $\overrightarrow{OL}$,

Answer(b)(i)(b) $\overrightarrow{OL}$ = ... [1]

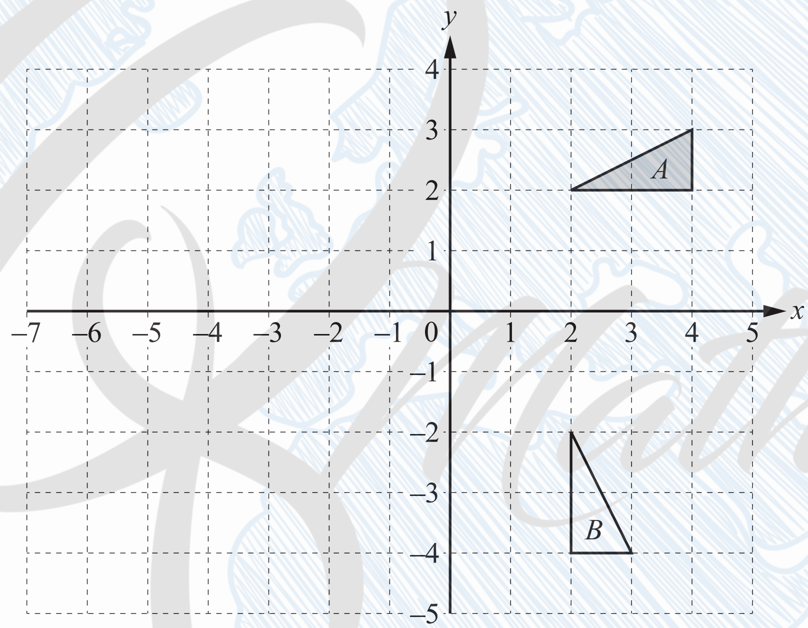
(c) $\overrightarrow{AL}$.

Answer(b)(i)(c) $\overrightarrow{AL}$ = ... [2]

(ii) Find the ratio $AL : AN$ in its simplest form.

Answer(b)(ii) .... : .... [3]

(c)



(i) On the grid, draw the image of triangle A after the transformation represented by the matrix $\begin{pmatrix} -1.5 & 0 \\ 0 & -1.5 \end{pmatrix}$. [3]

(ii) Find the 2 × 2 matrix which represents the transformation that maps triangle A onto triangle B.

Answer(c)(ii) $\begin{pmatrix} & \\ & \end{pmatrix}$ [2]

19) June 2015 V3

9 $\mathbf{P} = \begin{pmatrix} 2 & 3 \\ 1 & 4 \end{pmatrix}$ $\mathbf{Q} = \begin{pmatrix} 1 & 2 \\ 0 & 3 \end{pmatrix}$ $\mathbf{R} = \begin{pmatrix} 0 & u \\ 1 & v \end{pmatrix}$ $\mathbf{S} = \begin{pmatrix} w & 3 \\ 8 & 2 \end{pmatrix}$

(a) Work out **PQ**.

Answer(a) $\begin{pmatrix} \quad & \quad \\ \quad & \quad \end{pmatrix}$ [2]

(b) Find $\mathbf{Q}^{-1}$.

Answer(b) $\begin{pmatrix} \quad & \quad \\ \quad & \quad \end{pmatrix}$ [2]

(c) **PR** = **RP**

Find the value of u and the value of v.

Answer(c) u = ...

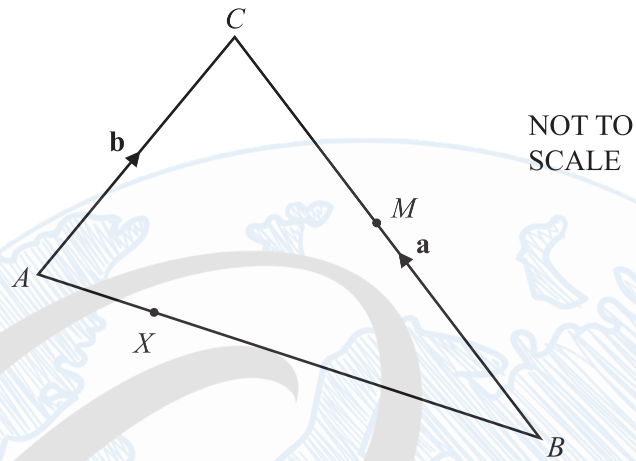
v = ... [3]

(d) The determinant of **S** is 0.

Find the value of w.

Answer(d) w = ... [2]

10



$\overrightarrow{BC} = \mathbf{a}$ and $\overrightarrow{AC} = \mathbf{b}$.

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

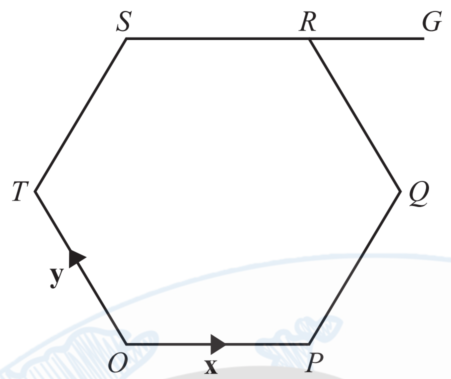
Answer(a) $\overrightarrow{AB}$ = ... [1]

(b) M is the midpoint of BC.
X divides AB in the ratio $1 : 4$.

Find $\overrightarrow{XM}$ in terms of **a** and **b**.
Show all your working and write your answer in its simplest form.

Answer(b) $\overrightarrow{XM}$ = ... [4]

9



NOT TO SCALE

O is the origin and $OPQRST$ is a regular hexagon.

$\overrightarrow{OP} = \mathbf{x}$ and $\overrightarrow{OT} = \mathbf{y}$.

(a) Write down, in terms of **x** and/or **y**, in its simplest form,

(i) $\overrightarrow{QR}$,

$\overrightarrow{QR}$ = ... [1]

(ii) $\overrightarrow{PQ}$,

$\overrightarrow{PQ}$ = ... [1]

(iii) the position vector of S.

.... [2]

(b) The line SR is extended to G so that $SR : RG = 2 : 1$.

Find $\overrightarrow{GQ}$, in terms of **x** and **y**, in its simplest form.

$\overrightarrow{GQ}$ = ... [2]

(c) M is the midpoint of OP.

(i) Find $\overrightarrow{MG}$, in terms of **x** and **y**, in its simplest form.

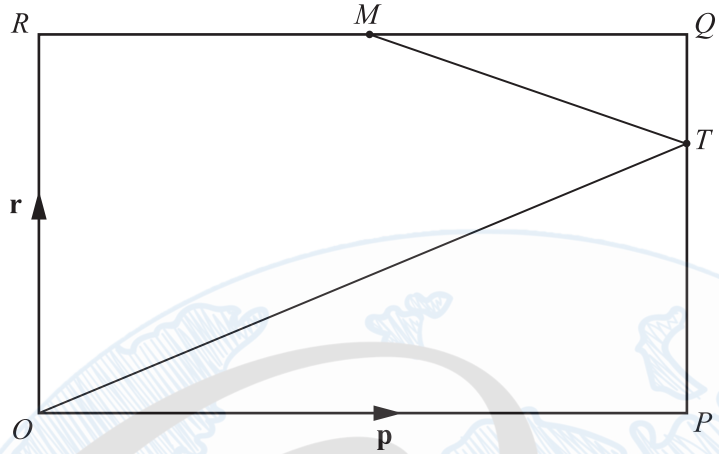
$\overrightarrow{MG}$ = ... [2]

(ii) H is a point on TQ such that $TH : HQ = 3 : 1$.

Use vectors to show that H lies on MG.

[2]

7



NOT TO SCALE

$OPQR$ is a rectangle and O is the origin.
M is the midpoint of RQ and $PT : TQ = 2 : 1$.
$\overrightarrow{OP} = \mathbf{p}$ and $\overrightarrow{OR} = \mathbf{r}$.

(a) Find, in terms of **p** and/or **r**, in its simplest form

(i) $\overrightarrow{MQ}$,

$\overrightarrow{MQ} =$ .... [1]

(ii) $\overrightarrow{MT}$,

$\overrightarrow{MT} =$ .... [1]

(iii) $\overrightarrow{OT}$.

$\overrightarrow{OT} =$ .... [1]

(b) RQ and OT are extended to meet at U.

Find the position vector of U in terms of **p** and **r**.
Give your answer in its simplest form.

.... [2]

(c) $\overrightarrow{MT} = \begin{pmatrix} 2k \\ -k \end{pmatrix}$ and $|\overrightarrow{MT}| = \sqrt{180}$.

Find the positive value of k.

$k =$ .... [3]

8 $\mathbf{A} = \begin{pmatrix} 2 & 0 \\ -1 & 5 \\ 3 & -4 \end{pmatrix}$ $\mathbf{B} = \begin{pmatrix} 1 & 3 \\ -1 & 5 \end{pmatrix}$ $\mathbf{C} = \begin{pmatrix} 7 \\ -4 \end{pmatrix}$ $\mathbf{D} = \begin{pmatrix} 2 & 5 \end{pmatrix}$

(a) Work out each of the following if the answer is possible.
If a calculation is not possible, write "not possible" in the answer space.

(i) **BA**

[1]

(ii) 2**A**

[1]

(iii) **CD**

[2]

(iv) **DC**

[2]

(v) $\mathbf{B}^2$

[2]

(b) Find $\mathbf{B}^{-1}$, the inverse of **B**.

$\begin{pmatrix} & \\ & \end{pmatrix}$ [2]

11 (a) $\mathbf{A} = \begin{pmatrix} 2 & -3 \\ 1 & 4 \end{pmatrix}$

Find

(i) $\mathbf{A}^2$,

$\begin{pmatrix} & \\ & \end{pmatrix}$ [2]

(ii) $\mathbf{A}^{-1}$, the inverse of **A**.

$\begin{pmatrix} & \\ & \end{pmatrix}$ [2]

(b) Describe fully the **single** transformation represented by the matrix $\begin{pmatrix} -1 & 0 \\ 0 & 1 \end{pmatrix}$.

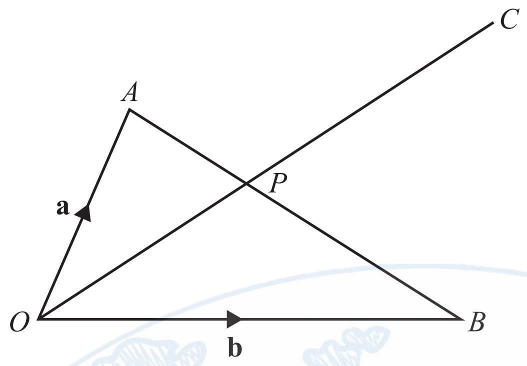
....

.... [2]

(c) Find the matrix that represents a clockwise rotation of 90º about the origin.

$\begin{pmatrix} & \\ & \end{pmatrix}$ [2]

(d)



NOT TO SCALE

In the diagram, O is the origin and P lies on AB such that $AP : PB = 3 : 4$.
$\overrightarrow{OA} = \mathbf{a}$ and $\overrightarrow{OB} = \mathbf{b}$.

(i) Find $\overrightarrow{OP}$, in terms of **a** and **b**, in its simplest form.

$\overrightarrow{OP}$ = ... [3]

(ii) The line OP is extended to C such that $\overrightarrow{OC} = m\overrightarrow{OP}$ and $\overrightarrow{BC} = k\mathbf{a}$.

Find the value of m and the value of k.

m = ...

k = ... [2]

11 **(a)** $\overrightarrow{OA} = \begin{pmatrix} 4 \\ 3 \end{pmatrix}$ $\overrightarrow{AB} = \begin{pmatrix} 8 \\ -7 \end{pmatrix}$ $\overrightarrow{AC} = \begin{pmatrix} -3 \\ 6 \end{pmatrix}$

Find

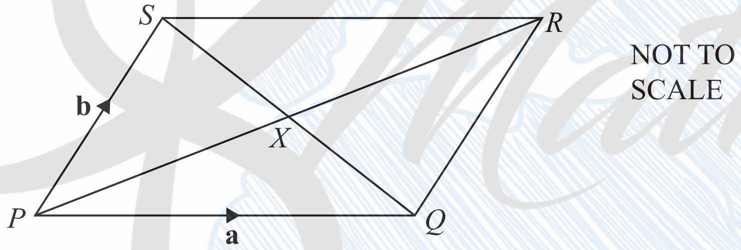
(i) $|\overrightarrow{OB}|$,

$|\overrightarrow{OB}|$ = ... [3]

(ii) $\overrightarrow{BC}$.

$\overrightarrow{BC} = \begin{pmatrix} \quad \\ \quad \end{pmatrix}$ [2]

(b)



PQRS is a parallelogram with diagonals *PR* and *SQ* intersecting at *X*.
$\overrightarrow{PQ} = \mathbf{a}$ and $\overrightarrow{PS} = \mathbf{b}$.

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

$\overrightarrow{QX}$ = ... [2]

(c) $\mathbf{M} = \begin{pmatrix} 2 & 5 \\ 1 & 8 \end{pmatrix}$

Calculate

(i) $\mathbf{M}^2$,

$\mathbf{M}^2 = \begin{pmatrix} & \\ & \end{pmatrix}$ [2]

(ii) $\mathbf{M}^{-1}$.

$\mathbf{M}^{-1} = \begin{pmatrix} & \\ & \end{pmatrix}$ [2]

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2 **(a)** $\mathbf{p} = \begin{pmatrix} 4 \\ 5 \end{pmatrix}$ $\mathbf{q} = \begin{pmatrix} -2 \\ 7 \end{pmatrix}$

(i) Find $2\mathbf{p} + \mathbf{q}$.

$\begin{pmatrix} \quad \\ \quad \end{pmatrix}$ [2]

(ii) Find $|\mathbf{p}|$.

.... [2]

(b) A is the point (4, 1) and $\overrightarrow{AB} = \begin{pmatrix} -3 \\ 1 \end{pmatrix}$.

Find the coordinates of B.

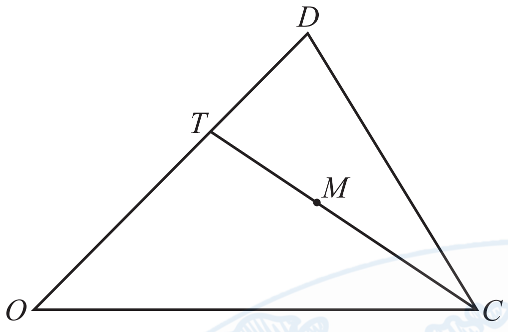
(...................... , ...) [1]

(c) The line $y = 3x - 2$ crosses the y-axis at G.

Write down the coordinates of G.

(...................... , ...) [1]

(d)



NOT TO SCALE

In the diagram, O is the origin, $OT = 2TD$ and M is the midpoint of TC.
$\overrightarrow{OC} = \mathbf{c}$ and $\overrightarrow{OD} = \mathbf{d}$.

Find the position vector of M.
Give your answer in terms of **c** and **d** in its simplest form.

.... [3]