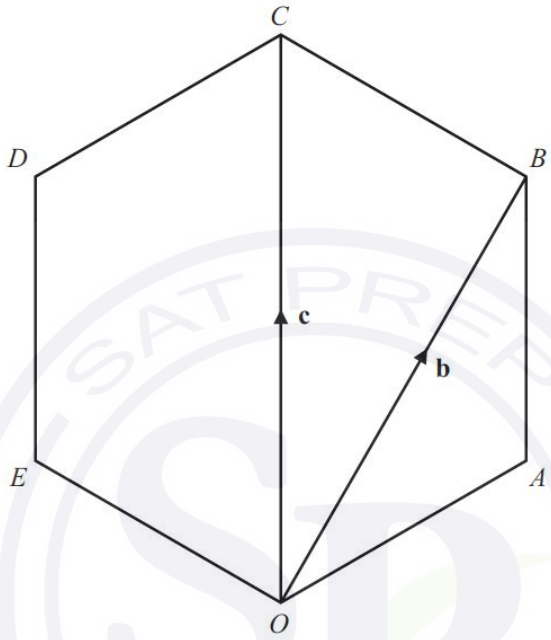
Extended Mathematics
Topic : Vector-Function-Transformation
Year :May 2013 -May 2024
Paper - 2
Question Booklet

Question 1



OABCDE is a regular polygon.

(a) Write down the geometrical name for this polygon.

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

(b) *O* is the origin. $\overrightarrow{OB} = \mathbf{b}$ and $\overrightarrow{OC} = \mathbf{c}$.

Find, in terms of **b** and **c**, in their simplest form,

(i) $\overrightarrow{BC}$,

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

(ii) $\overrightarrow{OA}$,

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

(iii) the position vector of *E*.

Answer(b)(iii) ..... [1]

Question 2

$$f(x) = x + \frac{2}{x} - 3, \quad x \neq 0 \qquad g(x) = \frac{x}{2} - 5$$

Find

(a) fg(18),

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

(b) $g^{-1}(x)$.

Answer(b) $g^{-1}(x) =$ ..... [2]

Question 3

$$f(x) = 5x + 4 \qquad g(x) = \frac{1}{2x}, \quad x \neq 0 \qquad h(x) = \left(\frac{1}{2}\right)^x$$

Find

(a) fg(5) ,

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

(b) gg(x) in its simplest form,

Answer(b) $gg(x) =$ ..... [2]

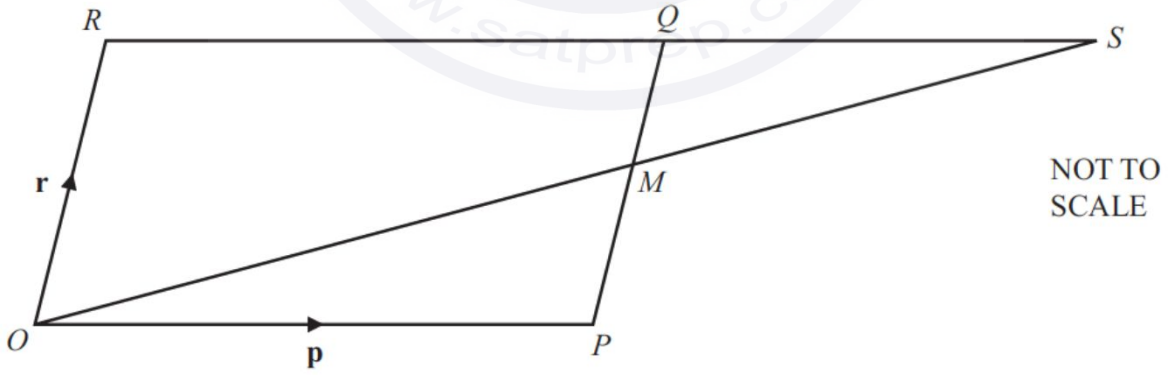
(c) $f^{-1}(x)$,

Answer(c) $f^{-1}(x) =$ ..... [2]

(d) the value of x when $h(x) = 8$.

Answer(d) $x =$ ..... [2]

Question 4



$OPQR$ is a parallelogram, with O the origin.
M is the midpoint of PQ.
OM and RQ are extended to meet at S.
$\overrightarrow{OP} = \mathbf{p}$ and $\overrightarrow{OR} = \mathbf{r}$.

Continue on the next page..

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

(i) $\overrightarrow{OM}$,

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

(ii) the position vector of S.

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

(b) When $\overrightarrow{PT} = -\frac{1}{2}\mathbf{p} + \mathbf{r}$, what can you write down about the position of T?

Answer(b) ..... [1]

Question 5

$f(x) = 2x + 3$ $g(x) = x^2$

(a) Find $fg(6)$.

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

(b) Solve the equation $gf(x) = 100$.

Answer(b) x = ... or x = ... [3]

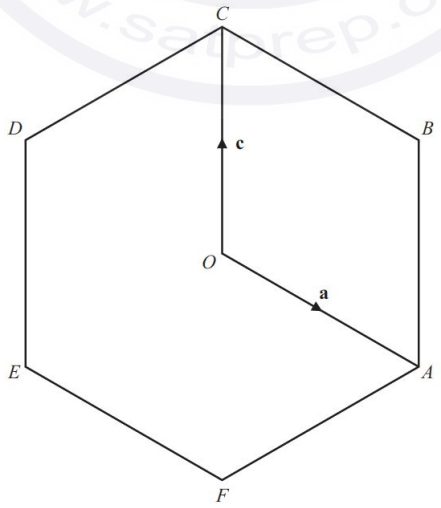
(c) Find $f^{-1}(x)$.

Answer(c) $f^{-1}(x)$ = ... [2]

(d) Find $ff^{-1}(5)$.

Answer(d) ..... [1]

Question 6



Continue on the next page..

O is the origin.
$ABCDEF$ is a regular hexagon and O is the midpoint of AD.

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

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

(a) $\overrightarrow{BE}$,

Answer(a) $\overrightarrow{BE}$ = ... [2]

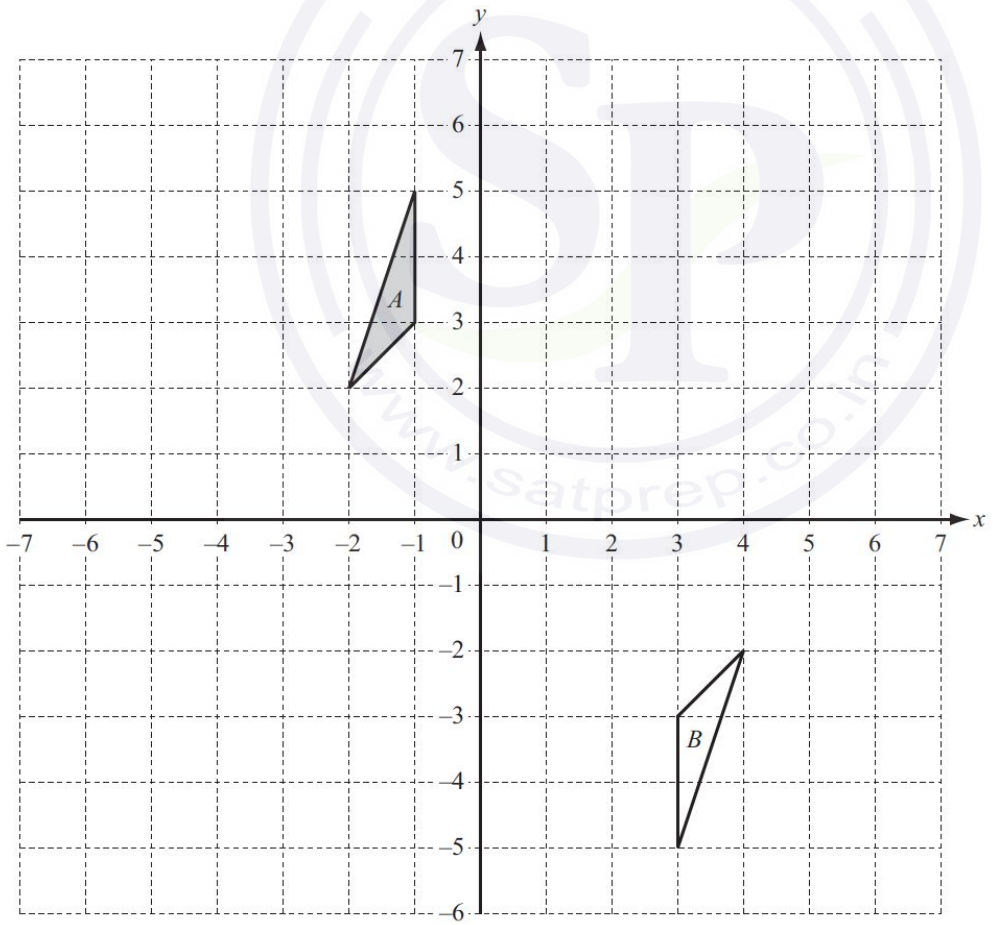
(b) $\overrightarrow{DB}$,

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

(c) the position vector of E.

Answer(c) ..... [2]

Question 7



Continue on the next page..

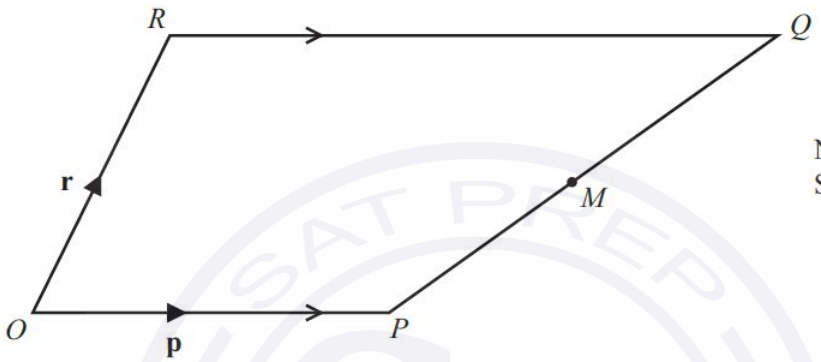
(a) Draw the image of triangle A after a translation by the vector $\begin{pmatrix} 3 \\ -4 \end{pmatrix}$. [2]

(b) Describe fully the **single** transformation which maps triangle A onto triangle B.

Answer(b) .....

..... [3]

Question 8



NOT TO SCALE

$OPQR$ is a trapezium with RQ parallel to OP and $RQ = 2OP$.
O is the origin, $\overrightarrow{OP} = \mathbf{p}$ and $\overrightarrow{OR} = \mathbf{r}$.
M is the midpoint of PQ.

Find, in terms of **p** and **r**, in its simplest form

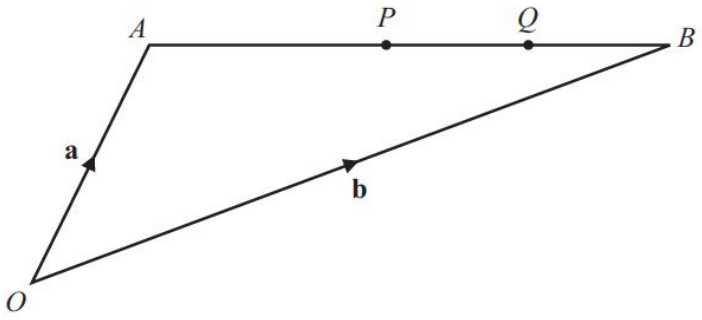
(a) $\overrightarrow{PQ}$,

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

(b) $\overrightarrow{OM}$, the position vector of M.

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

Question 9



NOT TO SCALE

The diagram shows two points, P and Q, on a straight line AB.
P is the midpoint of AB and Q is the midpoint of PB.
O is the origin, $\overrightarrow{OA} = \mathbf{a}$ and $\overrightarrow{OB} = \mathbf{b}$.

Write down, in terms of **a** and **b**, in its simplest form

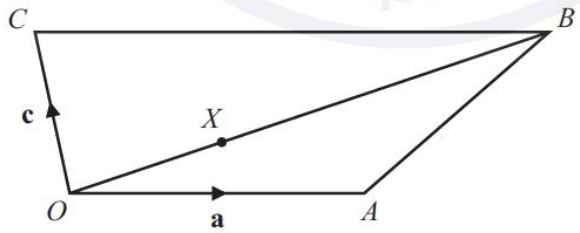
(a) $\overrightarrow{AP}$,

Answer(a) $\overrightarrow{AP}$ = ... [2]

(b) the position vector of Q.

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

Question 10



NOT TO SCALE

The diagram shows a quadrilateral $OABC$.
$\overrightarrow{OA} = \mathbf{a}$, $\overrightarrow{OC} = \mathbf{c}$ and $\overrightarrow{CB} = 2\mathbf{a}$.
X is a point on OB such that $OX:XB = 1:2$.

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

Continue on the next page..

(i) $\overrightarrow{AC}$,

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

(ii) $\overrightarrow{AX}$.

Answer(a)(ii) $\overrightarrow{AX}$ = ... [3]

(b) Explain why the vectors $\overrightarrow{AC}$ and $\overrightarrow{AX}$ show that C, X and A lie on a straight line.

Answer(b) .....

..... [2]

Question 11

$f(x) = 5x - 3$ $g(x) = x^2$

(a) Find $fg(-2)$.

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

(b) Find $gf(x)$, in terms of x, in its simplest form.

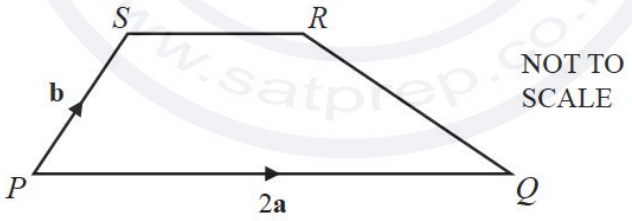
Answer(b) ..... [2]

(c) Find $f^{-1}(x)$.

Answer(c) $f^{-1}(x)$ = ... [2]

Question 12

(a)



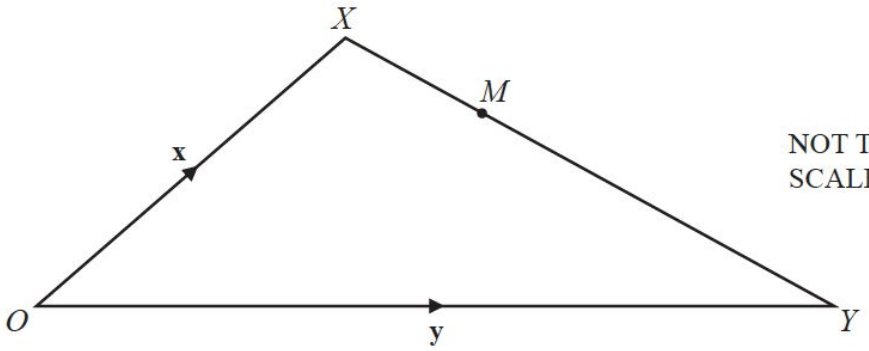
$PQRS$ is a trapezium with $PQ = 2SR$.
$\overrightarrow{PQ} = 2\mathbf{a}$ and $\overrightarrow{PS} = \mathbf{b}$.

Find $\overrightarrow{QR}$ in terms of **a** and **b** in its simplest form.

Answer(a) $\overrightarrow{QR}$ = ... [2]

Continue on the next page..

(b)



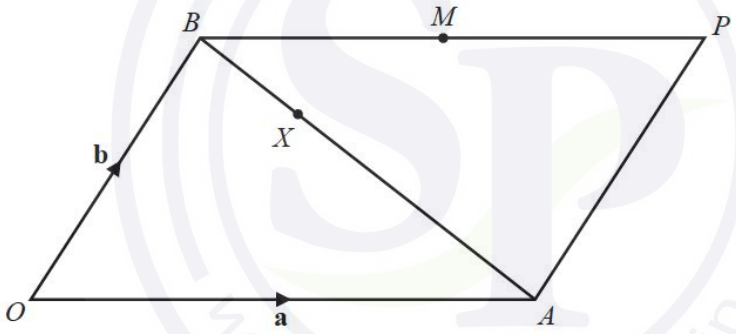
NOT TO SCALE

$\overrightarrow{OX} = \mathbf{x}$ and $\overrightarrow{OY} = \mathbf{y}$.
M is a point on XY such that $XM : MY = 3 : 5$.

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

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

Question 13



NOT TO SCALE

$OAPB$ is a parallelogram.
O is the origin, $\overrightarrow{OA} = \mathbf{a}$ and $\overrightarrow{OB} = \mathbf{b}$.
M is the midpoint of BP.

(a) Find, in terms of **a** and **b**, giving your answer in its simplest form,

(i) $\overrightarrow{BA}$,

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

(ii) the position vector of M.

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

(b) X is on BA so that $BX:XA = 1:2$.

Show that X lies on OM.

Answer(b)

[4]

Question 14

$f(x) = 3x + 5$ $\quad$ $g(x) = x^2$

(a) Find $g(3x)$.

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

(b) Find $f^{-1}(x)$, the inverse function.

Answer(b) $f^{-1}(x) =$ ..... [2]

(c) Find $ff(x)$.
Give your answer in its simplest form.

Answer(c) ..... [2]

Question 15

$f(x) = 5 - 3x$

(a) Find $f(6)$.

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

(b) Find $f(x + 2)$.

Answer(b) ..... [1]

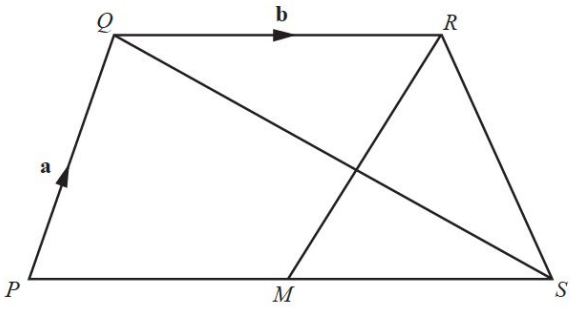
(c) Find $ff(x)$, in its simplest form.

Answer(c) ..... [2]

(d) Find $f^{-1}(x)$, the inverse of $f(x)$.

Answer(d) $f^{-1}(x) =$ ..... [2]

Question 16



NOT TO SCALE

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$PQRS$ is a quadrilateral and M is the midpoint of PS.
$\overrightarrow{PQ} = \mathbf{a}$, $\overrightarrow{QR} = \mathbf{b}$ and $\overrightarrow{SQ} = \mathbf{a} - 2\mathbf{b}$.

(a) Show that $\overrightarrow{PS} = 2\mathbf{b}$.

Answer(a)

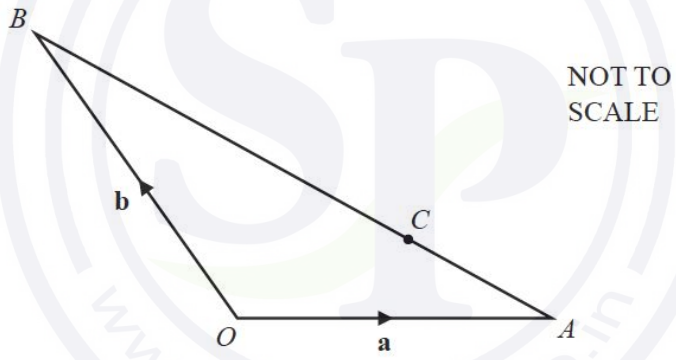
[1]

(b) Write down the mathematical name for the quadrilateral $PQRM$, giving reasons for your answer.

Answer(b) ..... because .....

..... [2]

Question 17



In the diagram, O is the origin, $\overrightarrow{OA} = \mathbf{a}$ and $\overrightarrow{OB} = \mathbf{b}$.
C is on the line AB so that $AC : CB = 1 : 2$.

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

(a) $\overrightarrow{AC}$,

Answer(a) $\overrightarrow{AC}$ = ... [2]

(b) the position vector of C.

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

Continue on the next page..

Question 18

$f(x) = x^3$ $g(x) = 3x - 5$ $h(x) = 2x + 1$

Work out

(a) ff(2),

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

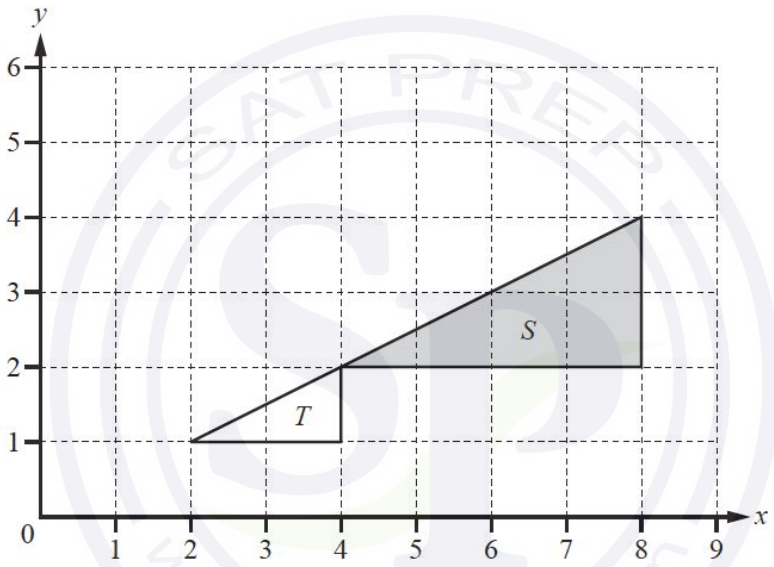
(b) gh(x) and simplify your answer,

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

(c) $h^{-1}(x)$, the inverse of h(x).

Answer(c) $h^{-1}(x) =$ ..... [2]

Question 19



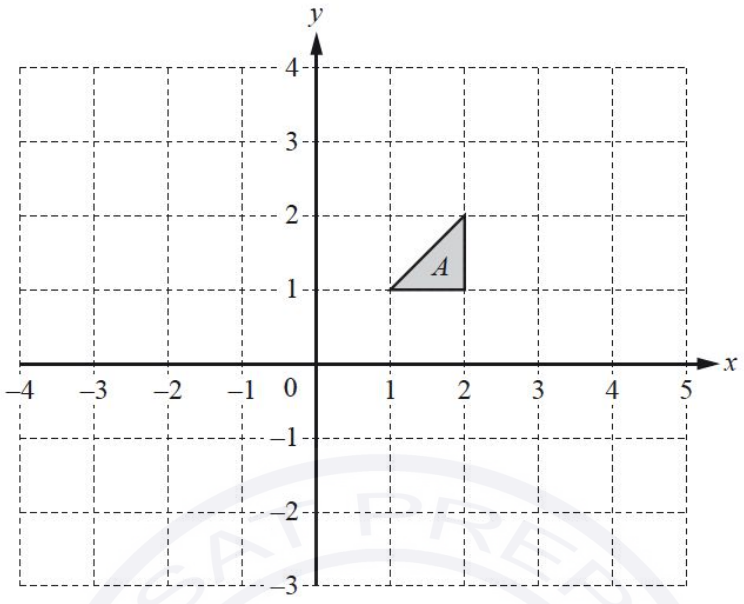
Describe fully the **single** transformation that maps triangle S onto triangle T.

Answer(a) .....

..... [3]

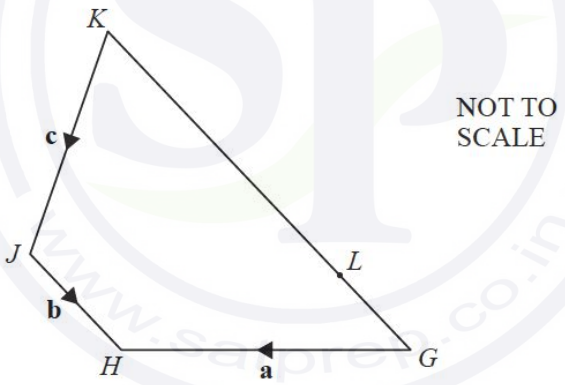
Continue on the next page..

Question 20



Draw the image of shape A after a translation by the vector $\begin{pmatrix} 2 \\ -3 \end{pmatrix}$. [2]

Question 21

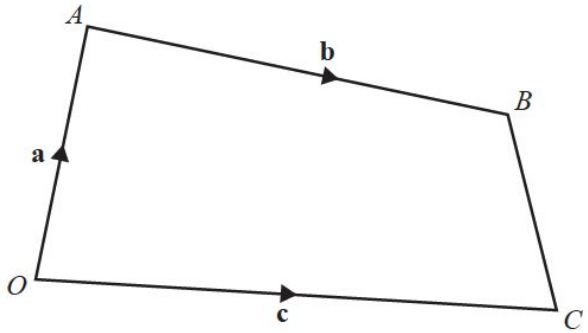


$GHJK$ is a quadrilateral.
$\overrightarrow{GH} = \mathbf{a}$, $\overrightarrow{JH} = \mathbf{b}$ and $\overrightarrow{KJ} = \mathbf{c}$.
L lies on GK so that $LK = 3GL$.

Find an expression, in terms of $\mathbf{a}$, $\mathbf{b}$ and $\mathbf{c}$, for $\overrightarrow{GL}$.

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

Question 22



NOT TO SCALE

In the diagram, O is the origin, $\overrightarrow{OA} = \mathbf{a}$, $\overrightarrow{OC} = \mathbf{c}$ and $\overrightarrow{AB} = \mathbf{b}$.
P is on the line AB so that $AP : PB = 2 : 1$.
Q is the midpoint of BC.

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

(a) $\overrightarrow{CB}$,

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

(b) the position vector of Q,

..... [2]

(c) $\overrightarrow{PQ}$.

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

Question 23

$\overrightarrow{BC} = \begin{pmatrix} 2 \\ 3 \end{pmatrix}$ $\overrightarrow{BA} = \begin{pmatrix} -5 \\ 6 \end{pmatrix}$

(a) Find $\overrightarrow{CA}$.

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

(b) Work out $|\overrightarrow{BA}|$.

..... [2]

Question 24

$f(x) = \frac{x}{4} - 3$ $\quad$ $g(x) = 6x - 7$ $\quad$ $h(x) = 2^x$

(a) Work out the value of x when $f(x) = -0.5$.

$x =$ ..... [2]

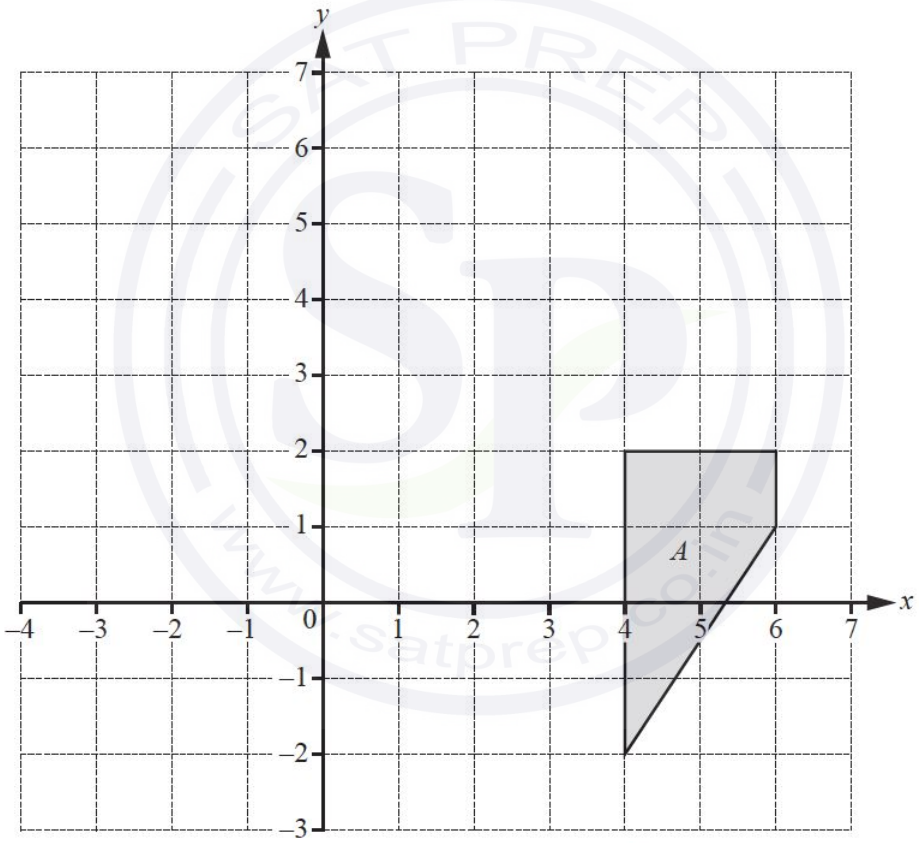
(b) Find $g^{-1}(x)$.

$g^{-1}(x) =$ ..... [2]

(c) Work out the value of x when $h(x) = f(13)$.

$x =$ ..... [2]

Question 25

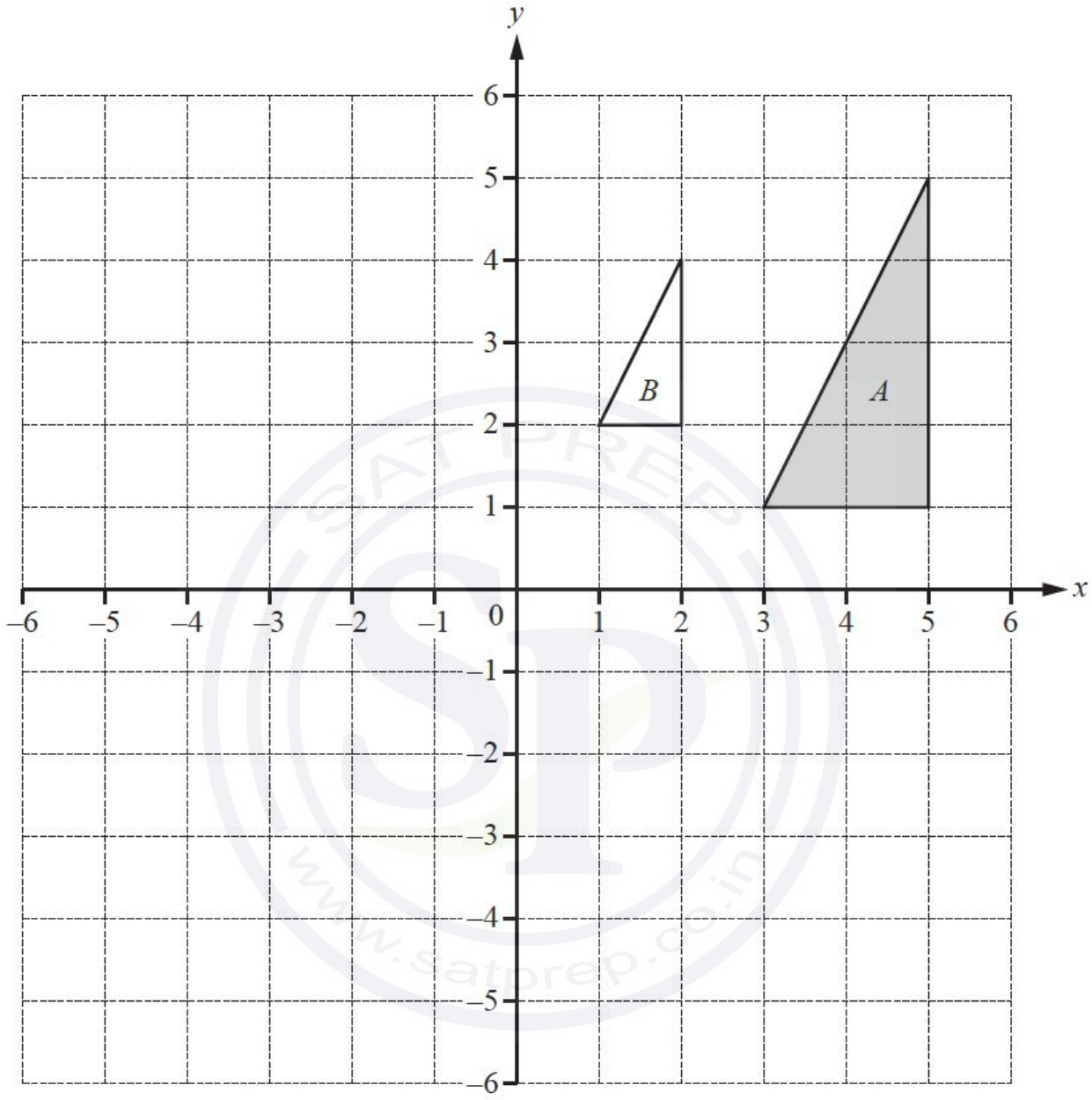


T(X) is the image of the shape X after translation by the vector $\begin{pmatrix} -1 \\ 3 \end{pmatrix}$.

M(Y) is the image of the shape Y after reflection in the line $x = 2$.

On the grid, draw MT(A), the image of shape A after the transformation MT. [3]

Question 26

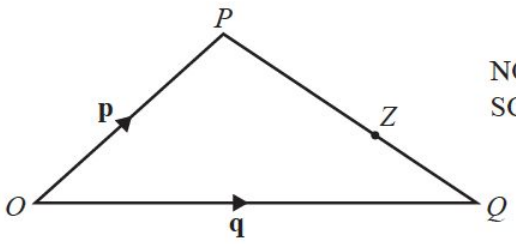


Describe fully the **single** transformation that maps triangle *A* onto triangle *B*.

.....

..... [3]

Question 27



NOT TO SCALE

O is the origin, $\overrightarrow{OP} = \mathbf{p}$ and $\overrightarrow{OQ} = \mathbf{q}$.
Z is a point on PQ such that $PZ : ZQ = 5 : 2$.

Work out, in terms of $\mathbf{p}$ and $\mathbf{q}$, the position vector of Z.
Give your answer in its simplest form.

..... [3]

Question 28

$f(x) = 3 + 4x$ $g(x) = 6x + 7$

Find, in its simplest form,

(a) $f(3x)$,

..... [1]

(b) $fg(x)$.

..... [2]

Question 29

(a) $\overrightarrow{GH} = \begin{pmatrix} 6 \\ -4 \end{pmatrix}$

Find

(i) $5\overrightarrow{GH}$,

$\begin{pmatrix} \quad \\ \quad \end{pmatrix}$ [1]

(ii) $\overrightarrow{HG}$.

$\begin{pmatrix} \quad \\ \quad \end{pmatrix}$ [1]

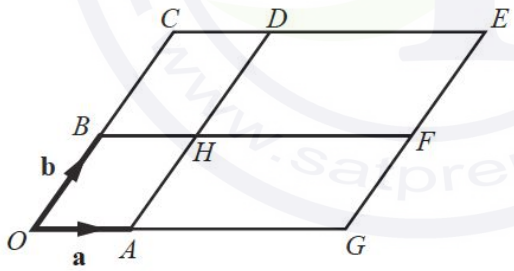
(b) $\begin{pmatrix} 6 \\ 7 \end{pmatrix} + \begin{pmatrix} 2 \\ y \end{pmatrix} = \begin{pmatrix} 8 \\ 3 \end{pmatrix}$

Find the value of y.

$y =$ ..... [1]

Question 30

The diagram shows a parallelogram $OCEG$.



NOT TO SCALE

O is the origin, $\overrightarrow{OA} = \mathbf{a}$ and $\overrightarrow{OB} = \mathbf{b}$.
BHF and AHD are straight lines parallel to the sides of the parallelogram.
$\overrightarrow{OG} = 3\overrightarrow{OA}$ and $\overrightarrow{OC} = 2\overrightarrow{OB}$.

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

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

Continue on the next page..

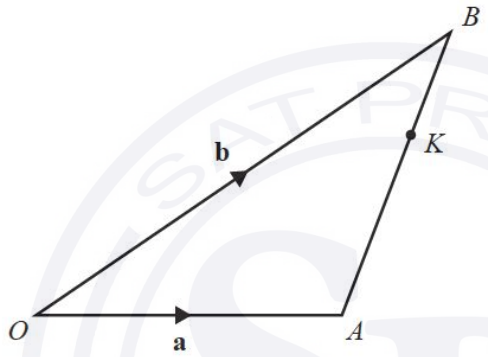
(b) Complete this statement.

$\mathbf{a} + 2\mathbf{b}$ is the position vector of point ..... [1]

(c) Write down two vectors that can be written as $3\mathbf{a} - \mathbf{b}$.

..... and ..... [2]

Question 31



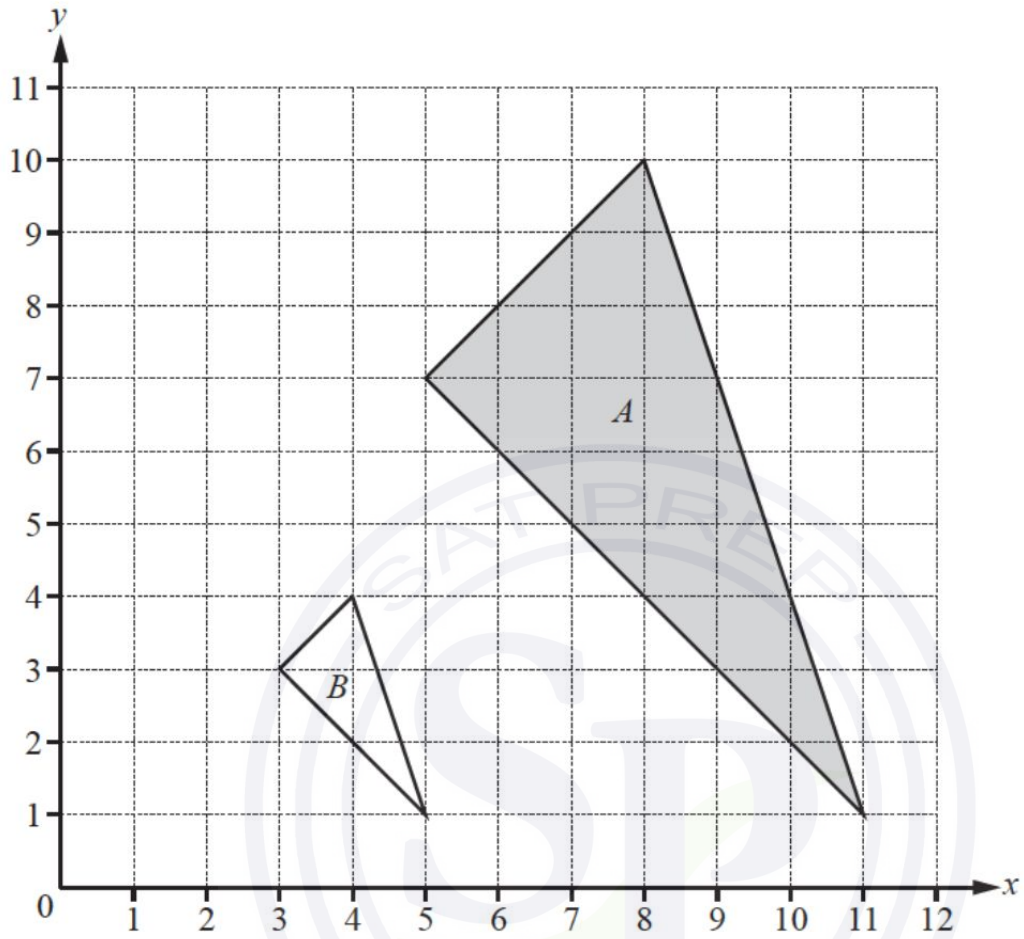
NOT TO SCALE

O is the origin and K is the point on AB so that $AK : KB = 2 : 1$.
$\overrightarrow{OA} = \mathbf{a}$ and $\overrightarrow{OB} = \mathbf{b}$.

Find the position vector of K.
Give your answer in terms of $\mathbf{a}$ and $\mathbf{b}$ in its simplest form.

..... [3]

Question 32



Describe fully the **single** transformation that maps triangle A onto triangle B.

.....

..... [3]

Question 33

$f(x) = 7 - x$ $g(x) = 4x + 2$ $h(x) = 15 - x^2$

(a) Find $ff(2)$.

..... [2]

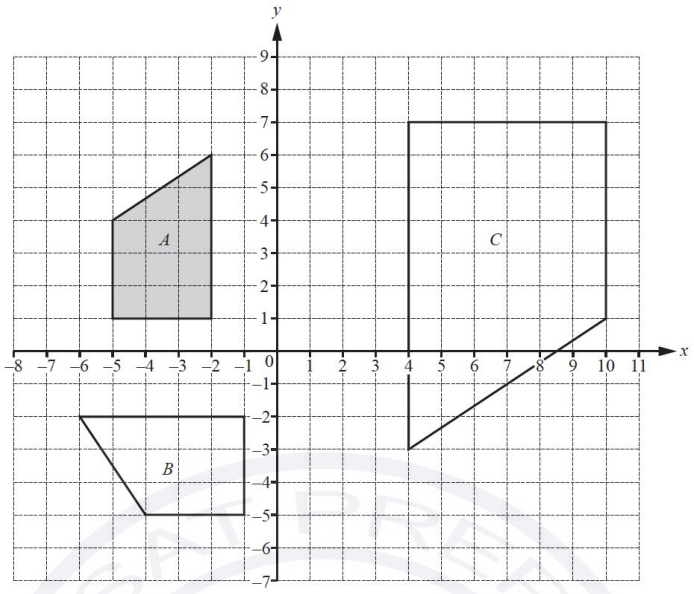
(b) Find $gf(x)$ in its simplest form.

..... [2]

(c) Find $h(2x)$ in its simplest form.

..... [2]

Question 34



Describe fully the **single** transformation that maps

(a) shape A onto shape B,

.....

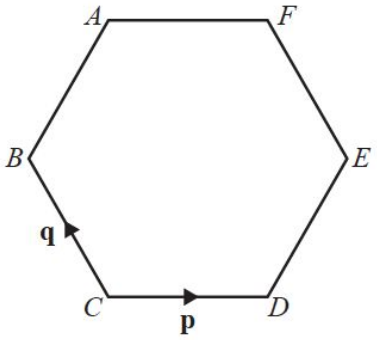
..... [3]

(b) shape A onto shape C.

.....

..... [3]

Question 35

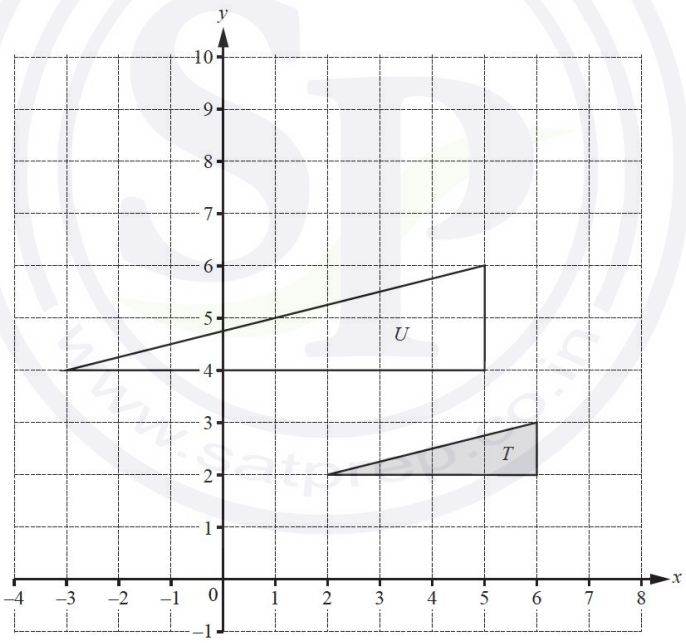


The diagram shows a regular hexagon $ABCDEF$.
$\overrightarrow{CD} = \mathbf{p}$ and $\overrightarrow{CB} = \mathbf{q}$.

Find $\overrightarrow{CA}$, in terms of $\mathbf{p}$ and $\mathbf{q}$, giving your answer in its simplest form.

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

Question 36



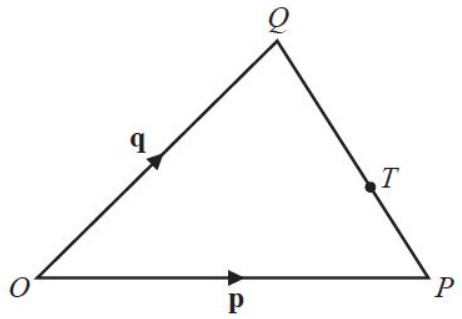
(a) Describe fully the **single** transformation that maps triangle T onto triangle U.

.....

..... [3]

(b) On the grid, draw the image of triangle T after a rotation through 90° clockwise about the point (7, 3). [3]

Question 37



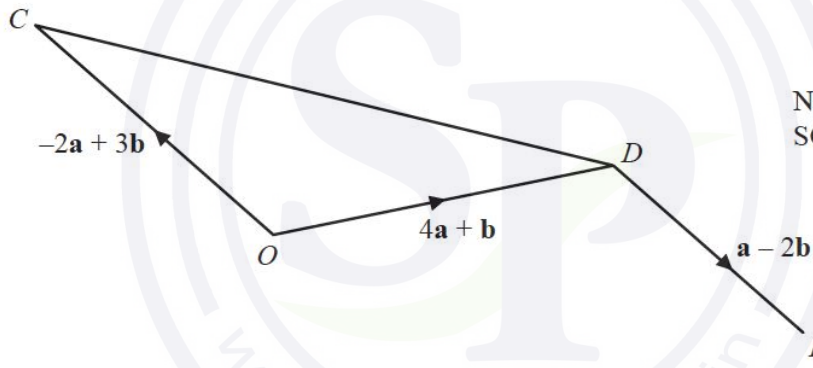
NOT TO SCALE

O is the origin, $\overrightarrow{OP} = \mathbf{p}$ and $\overrightarrow{OQ} = \mathbf{q}$.
$QT : TP = 2 : 1$

Find the position vector of T.
Give your answer in terms of $\mathbf{p}$ and $\mathbf{q}$, in its simplest form.

..... [2]

Question 38



NOT TO SCALE

In the diagram, O is the origin, $\overrightarrow{OC} = -2\mathbf{a} + 3\mathbf{b}$ and $\overrightarrow{OD} = 4\mathbf{a} + \mathbf{b}$.

(a) Find $\overrightarrow{CD}$, in terms of $\mathbf{a}$ and $\mathbf{b}$, in its simplest form.

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

(b) $\overrightarrow{DE} = \mathbf{a} - 2\mathbf{b}$

Find the position vector of E, in terms of $\mathbf{a}$ and $\mathbf{b}$, in its simplest form.

..... [2]

Question 39

$f(x) = 5 - 2x$ $\quad$ $g(x) = x^2 + 8$

(a) Calculate $ff(-3)$.

..... [2]

Continue on the next page..

(b) Find

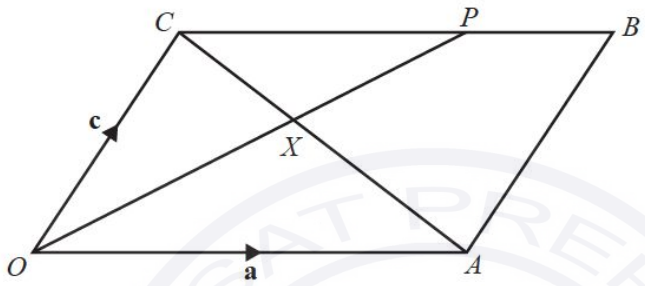
(i) $g(2x)$,

..... [1]

(ii) $f^{-1}(x)$.

$f^{-1}(x) =$ ..... [2]

Question 40



NOT TO SCALE

In the diagram, $OABC$ is a parallelogram.
OP and CA intersect at X and $CP : PB = 2 : 1$.
$\overrightarrow{OA} = \mathbf{a}$ and $\overrightarrow{OC} = \mathbf{c}$.

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

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

(b) $CX : XA = 2 : 3$

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

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

(ii) Find $OX : XP$.

$OX : XP =$ ..... : ..... [2]

Question 41

(a) $f(x) = x^3$ $\quad$ $g(x) = 5x + 2$

(i) Find $gf(x)$.

..... [1]

(ii) Find $g^{-1}(x)$.

$g^{-1}(x) =$ ..... [2]

Continue on the next page..

(b) $h(x) = ax^2 + 1$

Find the value of a when $h(-2) = 21$.

$a =$ ..... [2]

Question 42

$f(x) = 7 + 3x$ $\quad$ $g(x) = x^4$ $\quad$ $h(x) = 3^x$

(a) $h(3x) = k^x$

Find the value of k.

$k =$ ..... [2]

(b) Find the value of x when $f(x) = g(2)$.

$x =$ ..... [2]

(c) Find $f^{-1}(x)$.

$f^{-1}(x) =$ ..... [2]

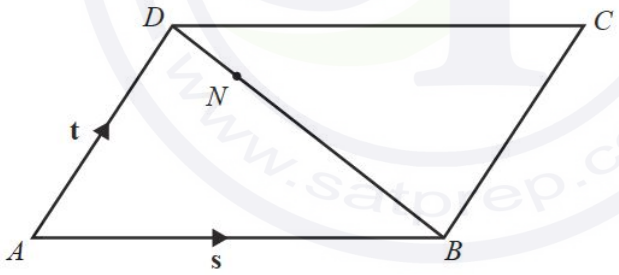
Question 43

O is the origin, $\overrightarrow{OA} = 2\mathbf{x} + 3\mathbf{y}$ and $\overrightarrow{BA} = \mathbf{x} - 4\mathbf{y}$.

Find the position vector of B, in terms of $\mathbf{x}$ and $\mathbf{y}$, in its simplest form.

..... [2]

Question 44



NOT TO SCALE

$ABCD$ is a parallelogram.
N is the point on BD such that $BN : ND = 4 : 1$.
$\overrightarrow{AB} = \mathbf{s}$ and $\overrightarrow{AD} = \mathbf{t}$.

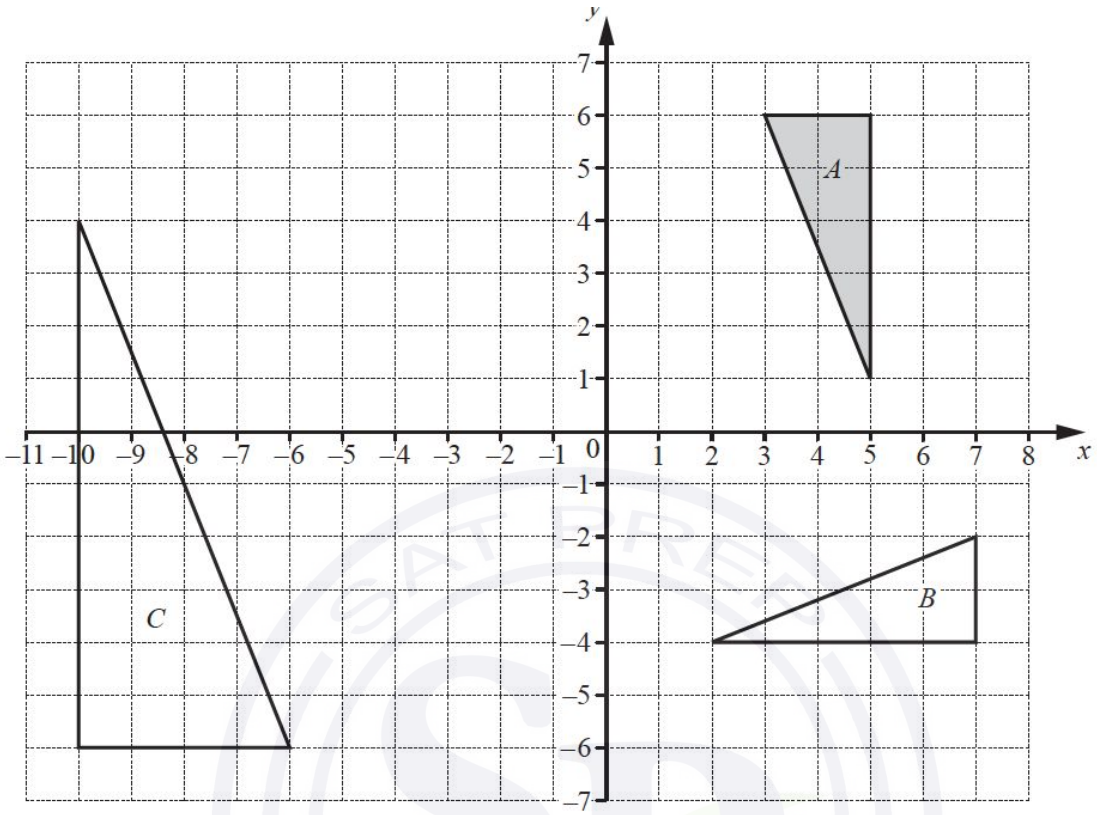
Find, in terms of $\mathbf{s}$ and $\mathbf{t}$, an expression in its simplest form for

(a) $\overrightarrow{BD}$,

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

(b) $\overrightarrow{CN}$.

Question 45



Describe fully the **single** transformation that maps

(a) triangle A onto triangle B,

.....

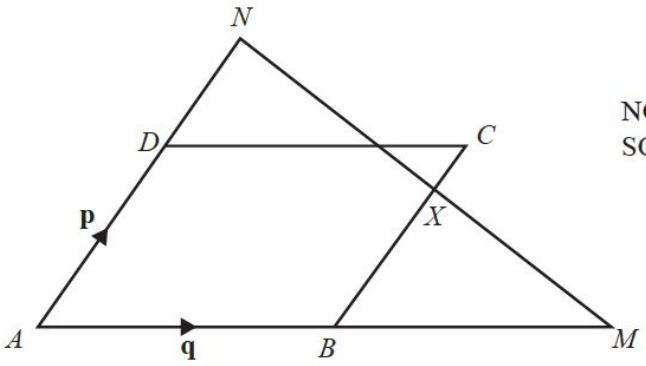
..... [3]

(b) triangle A onto triangle C.

.....

..... [3]

Question 46



NOT TO SCALE

$ABCD$ is a parallelogram with $\overrightarrow{AB} = \mathbf{q}$ and $\overrightarrow{AD} = \mathbf{p}$.
ABM is a straight line with $AB : BM = 1 : 1$.
ADN is a straight line with $AD : DN = 3 : 2$.

(a) Write $\overrightarrow{MN}$, in terms of **p** and **q**, in its simplest form.

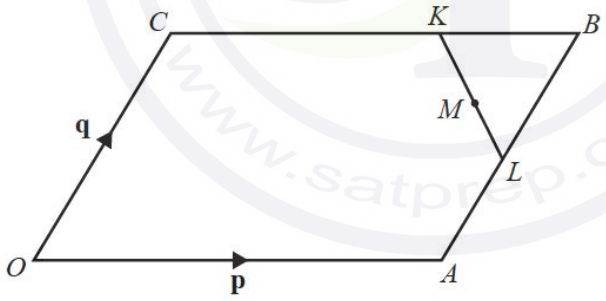
$\overrightarrow{MN}$ = ... [2]

(b) The straight line NM cuts BC at X.
X is the midpoint of MN.
$\overrightarrow{BX} = k\mathbf{p}$

Find the value of k.

k = ... [2]

Question 47



NOT TO SCALE

$OABC$ is a parallelogram and O is the origin.
$CK = 2KB$ and $AL = LB$.
M is the midpoint of KL.
$\overrightarrow{OA} = \mathbf{p}$ and $\overrightarrow{OC} = \mathbf{q}$.

Find, in terms of **p** and **q**, giving your answer in its simplest form

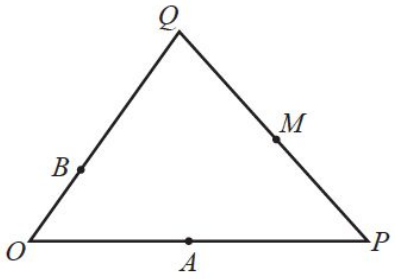
(a) $\overrightarrow{KL}$,

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

(b) the position vector of M.

..... [2]

Question 48



NOT TO SCALE

O is the origin, $\overrightarrow{OP} = 2\overrightarrow{OA}$, $\overrightarrow{OQ} = 3\overrightarrow{OB}$ and $\overrightarrow{PM} = \overrightarrow{MQ}$.

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

Find, in terms of $\mathbf{p}$ and $\mathbf{q}$, in its simplest form

(a) $\overrightarrow{BA}$,

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

(b) the position vector of M.

..... [2]

Question 49

$f(x) = 3x - 5$ $g(x) = 2^x$

(a) Find $fg(3)$.

..... [2]

(b) Find $f^{-1}(x)$.

$f^{-1}(x) =$ ..... [2]

Question 50

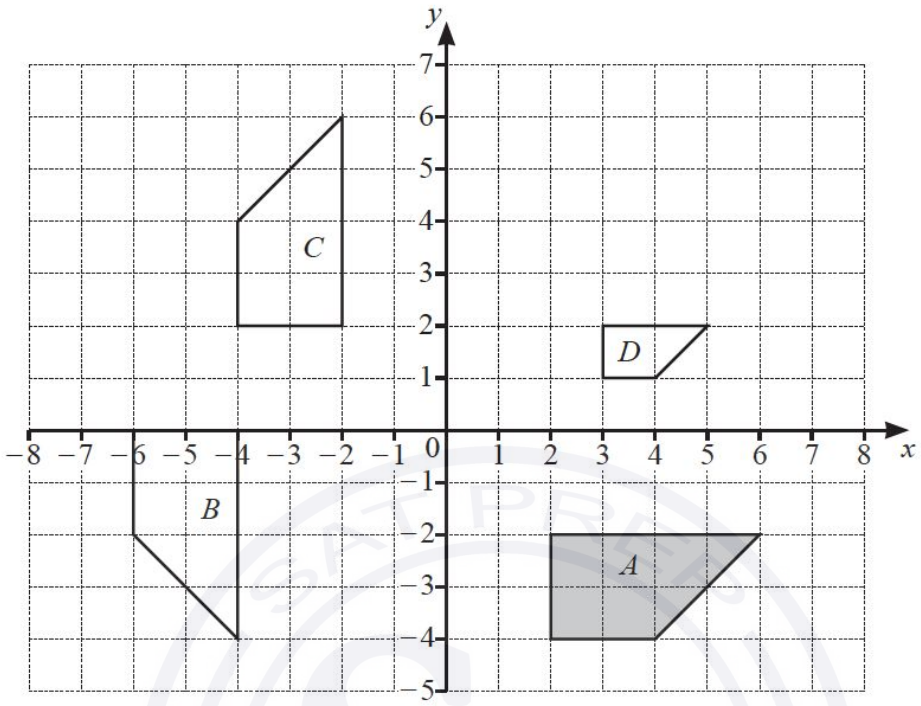
$\overrightarrow{XY} = 3\mathbf{a} + 2\mathbf{b}$ and $\overrightarrow{ZY} = 6\mathbf{a} + 4\mathbf{b}$.

Write down two statements about the relationship between the points X, Y and Z.

1 .....

2 ..... [2]

Question51



Describe fully the **single** transformation that maps

(a) shape *A* onto shape *B*,

.....

..... [3]

(b) shape *A* onto shape *C*,

.....

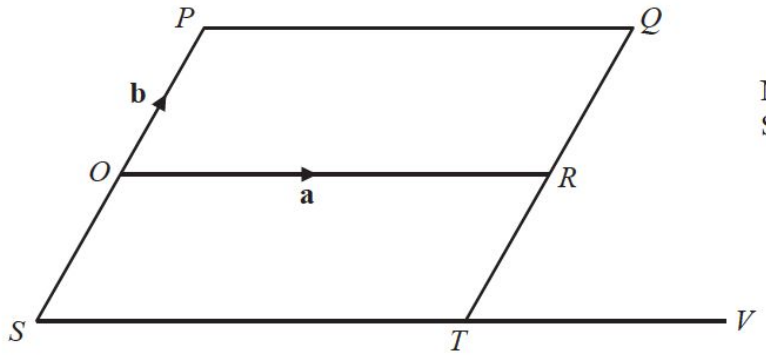
..... [2]

(c) shape *A* onto shape *D*.

.....

..... [3]

Question 52



NOT TO SCALE

O is the origin and $OPQR$ is a parallelogram.
SOP is a straight line with $SO = OP$.
TRQ is a straight line with $TR = RQ$.
STV is a straight line and $ST : TV = 2 : 1$.
$\overrightarrow{OR} = \mathbf{a}$ and $\overrightarrow{OP} = \mathbf{b}$.

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

(i) the position vector of T,

..... [2]

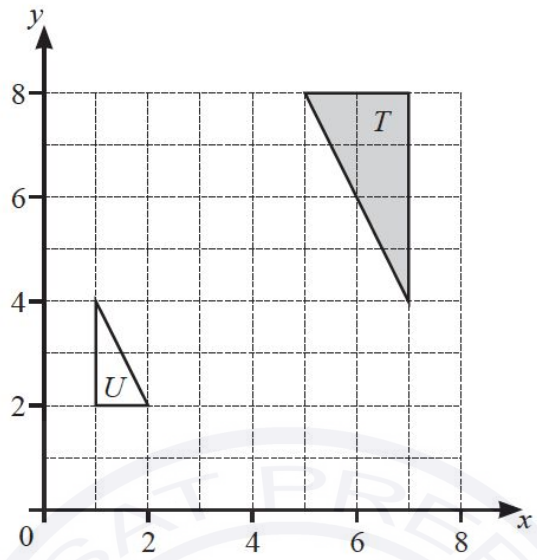
(ii) $\overrightarrow{RV}$.

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

(b) Show that PT is parallel to RV.

[2]

Question 53



Describe fully the **single** transformation that maps triangle T onto triangle U.

.....

..... [3]

Question 54

(a) (i) $\mathbf{m} = \begin{pmatrix} 5 \\ 7 \end{pmatrix}$

Find $3\mathbf{m}$.

( ) [1]

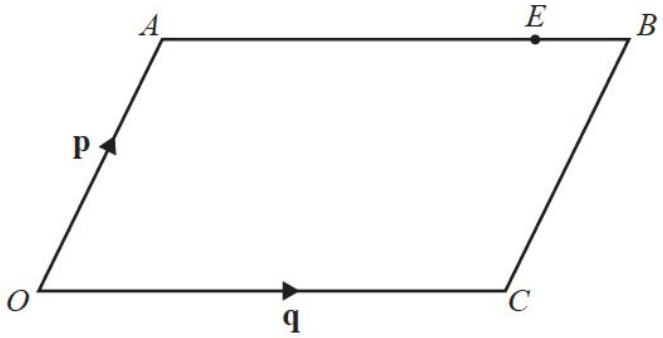
(ii) $\overrightarrow{VW} = \begin{pmatrix} 10 \\ -24 \end{pmatrix}$

Find $\left|\overrightarrow{VW}\right|$.

..... [2]

Continue on the next page..

(b)



NOT TO SCALE

$OABC$ is a parallelogram.
$\overrightarrow{OA} = \mathbf{p}$ and $\overrightarrow{OC} = \mathbf{q}$.
E is the point on AB such that $AE : EB = 3 : 1$.

Find $\overrightarrow{OE}$, in terms of $\mathbf{p}$ and $\mathbf{q}$, in its simplest form.

Question 55

(a) $f(x) = 4x + 3$ $\quad$ $g(x) = 5x - 4$

$fg(x) = 20x + p$

Find the value of p.

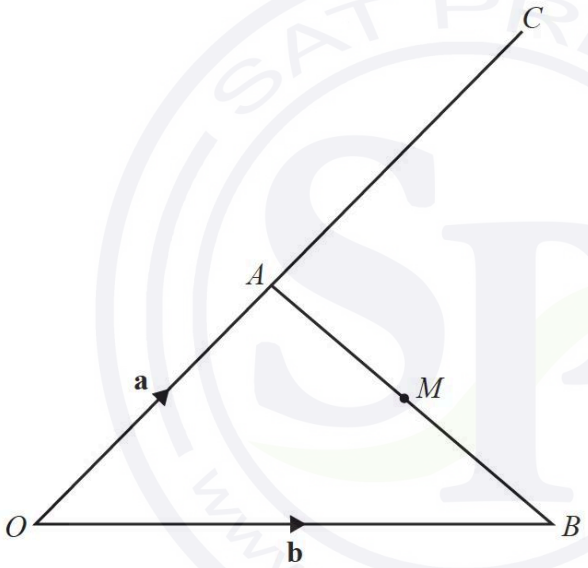
$p =$ ..... [2]

(b) $h(x) = \dfrac{5x - 1}{3}$

Find $h^{-1}(x)$.

$h^{-1}(x) =$ ..... [3]

Question 56



NOT TO SCALE

The diagram shows a triangle OAB and a straight line OAC.
$OA : OC = 2 : 5$ and M is the midpoint of AB.
$\overrightarrow{OA} = \mathbf{a}$ and $\overrightarrow{OB} = \mathbf{b}$.

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

(a) $\overrightarrow{AB}$,

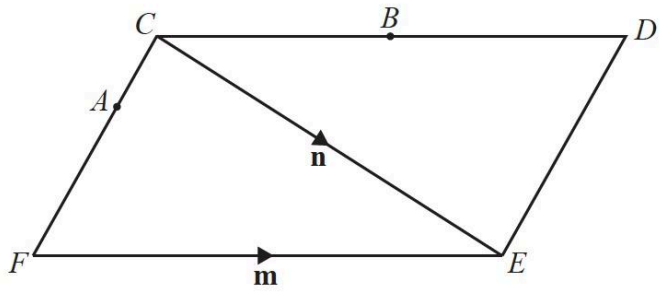
$\overrightarrow{AB} =$ ..... [1]

(b) $\overrightarrow{MC}$.

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

Question 57

(a)



NOT TO SCALE

The diagram shows a parallelogram $CDEF$.
$\overrightarrow{FE} = \mathbf{m}$ and $\overrightarrow{CE} = \mathbf{n}$.
B is the midpoint of CD.
$FA = 2AC$

Find an expression, in terms of **m** and **n**, for $\overrightarrow{AB}$.
Give your answer in its simplest form.

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

(b) $\overrightarrow{GH} = \frac{5}{6}(2\mathbf{p} + \mathbf{q})$ $\overrightarrow{JK} = \frac{5}{18}(2\mathbf{p} + \mathbf{q})$

Write down **two** facts about vectors $\overrightarrow{GH}$ and $\overrightarrow{JK}$.

.....

..... [2]

Question 58

(a) $f(x) = 3x^2 + a$ where a is an integer.
$f(-2) = 19$

Find the value of a.

$a =$ ..... [2]

(b) $g(x) = 2x + 7$ $h(x) = 3x - 8$

(i) Find $gh(x)$ in its simplest form.

..... [2]

(ii) Find $g^{-1}(x)$.

$g^{-1}(x) =$ ..... [2]

Question 59

Ahmed finds the magnitude of the vector $\begin{pmatrix} 2 \\ -3 \end{pmatrix}$.

From this list, put a ring around the correct calculation.

$\sqrt{2^2 + -3^2}$ $\quad 2^2 - 3^2$ $\quad \sqrt{2^2 - 3^2}$ $\quad 2^2 + (-3)^2$ $\quad \sqrt{2^2 + (-3)^2}$

[1]

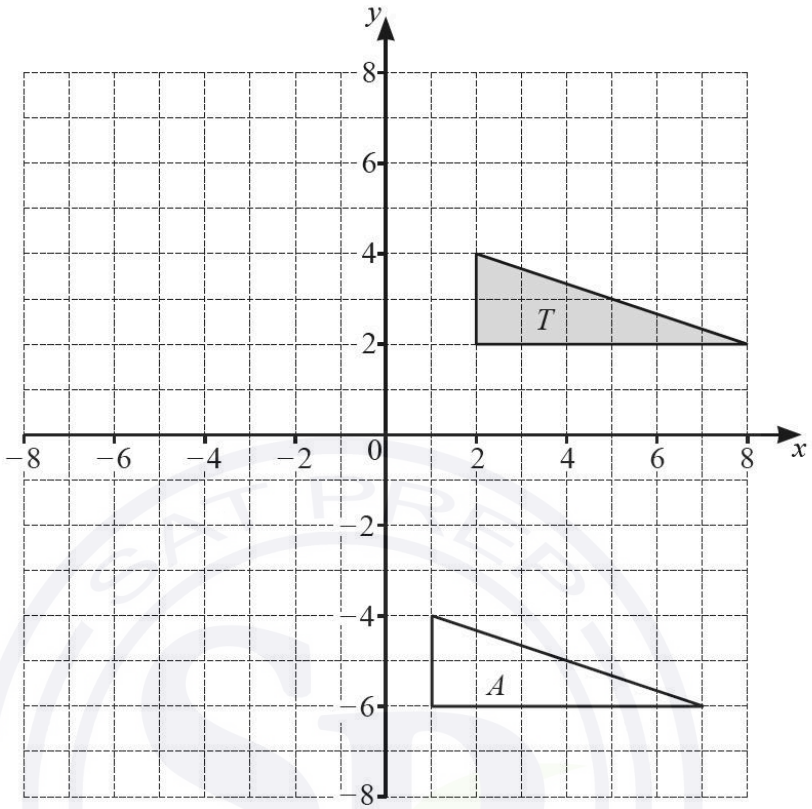
Question 60

The magnitude of the vector $\begin{pmatrix} 20 \\ k \end{pmatrix}$ is 29.

Find the value of k.

$k =$ ..... [3]

Question 61



(a) Describe fully the **single** transformation that maps triangle T onto triangle A.

.....

..... [2]

(b) Draw the image of triangle T after an enlargement, scale factor $-\frac{1}{2}$, centre (0, 0). [2]

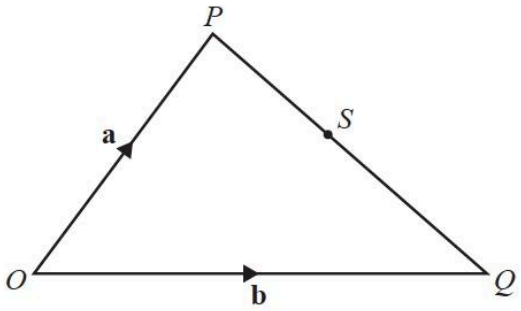
Question 62

$f(x) = x^2 - 25$ $g(x) = x + 4$

Solve $fg(x+1) = gf(x)$.

$x =$ ..... [4]

Question 63



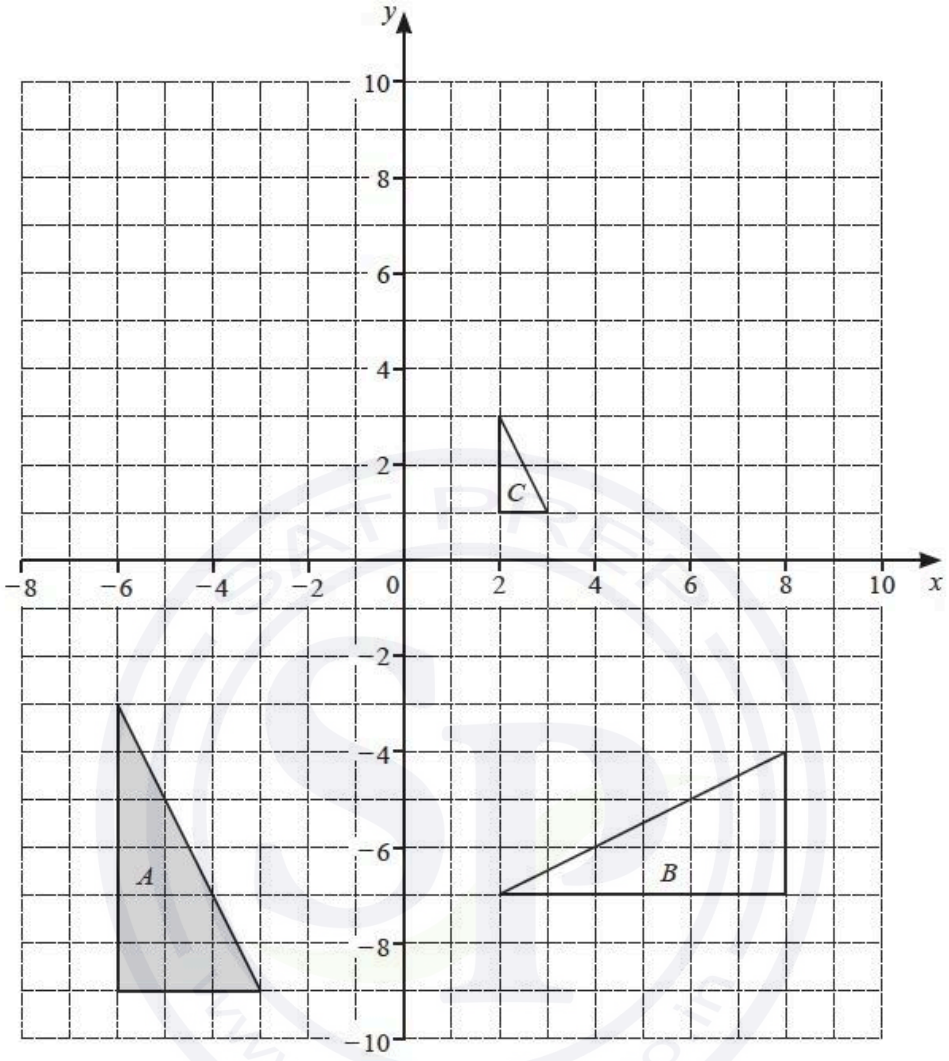
NOT TO SCALE

S is a point on PQ such that $PS : SQ = 4 : 5$.

Find $\overrightarrow{OS}$, in terms of **a** and **b**, in its simplest form.

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

Question 64



(a) Describe fully the **single** transformation that maps

(i) triangle A onto triangle B,

.....

..... [3]

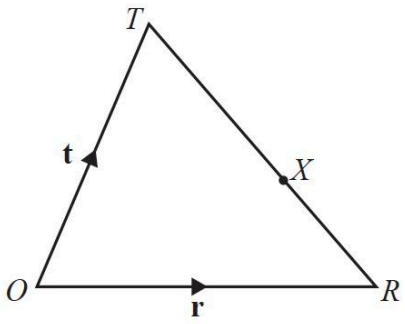
(ii) triangle A onto triangle C.

.....

..... [3]

(b) Draw the image of triangle A after a translation by the vector $\begin{pmatrix} 2 \\ 10 \end{pmatrix}$. [2]

Question 65



NOT TO SCALE

ORT is a triangle.
X is a point on TR so that $TX : XR = 3 : 2$.
O is the origin, $\overrightarrow{OR} = \mathbf{r}$ and $\overrightarrow{OT} = \mathbf{t}$.

Find the position vector of X.
Give your answer in terms of $\mathbf{r}$ and $\mathbf{t}$ in its simplest form.

..... [3]

Question 66

$$f(x) = 2^{x-3} \qquad g(x) = 2x - 1 \qquad h(x) = \frac{5}{x-4}$$

(a) Find ff(6).

..... [2]

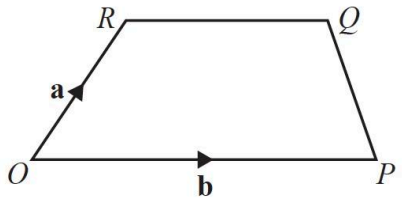
(b) Find $g^{-1}g(x+21)$.

..... [1]

(c) Find x when $f(x) = h(84)$.

$x =$ ..... [2]

Question 67



NOT TO SCALE

The diagram shows a trapezium $OPQR$.
O is the origin, $\overrightarrow{OR} = \mathbf{a}$ and $\overrightarrow{OP} = \mathbf{b}$.

$|\overrightarrow{RQ}| = \frac{3}{5}|\overrightarrow{OP}|$

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

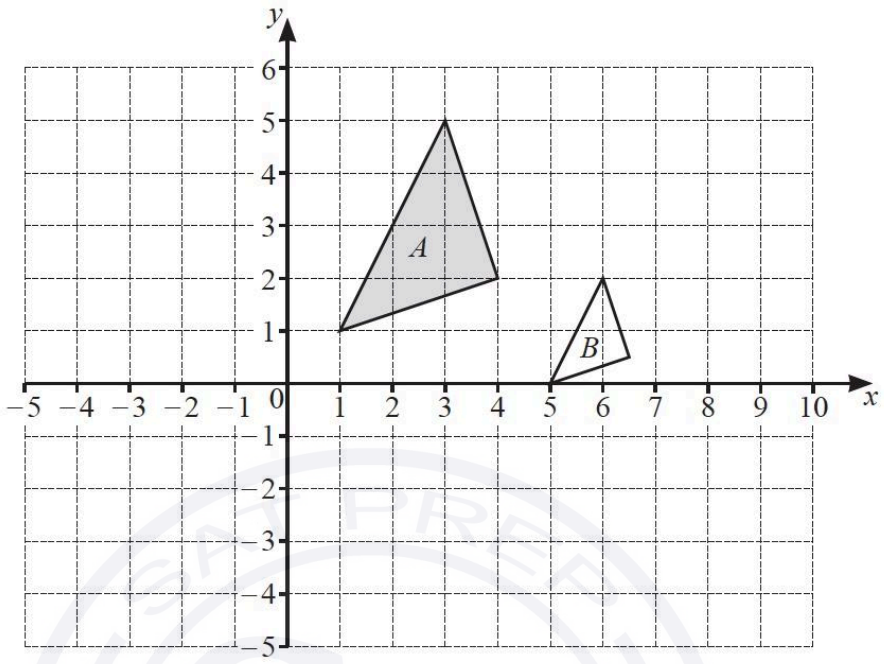
$\overrightarrow{PQ}$ = ... [2]

(b) When PQ and OR are extended, they intersect at W.

Find the position vector of W.

..... [2]

Question 68



(a) On the grid, draw the image of

(i) triangle A after a reflection in the y-axis, [1]

(ii) triangle A after a translation by the vector $\begin{pmatrix} -3 \\ -4 \end{pmatrix}$. [2]

(b) Describe fully the **single** transformation that maps triangle A onto triangle B.

.....

..... [3]

Question 69

$f(x) = kx^2$ $\quad$ $g(x) = \frac{1}{x}$ $\quad$ $h(x) = \frac{7x-2}{5}$ $\quad$ $j(x) = \frac{3-10x}{14}$

(a) $f(-5k) = 675$

Find the value of k.

$k =$ ..... [2]

(b) Find $gh(x)$.

..... [1]

(c) Find $h^{-1}(x) + j(x)$.
Give your answer in its simplest form.

..... [4]

Question 70

$f(x) = 7x - 8$ $\quad$ $g(x) = \frac{4}{x} + 5$ $\quad$ $h(x) = 2^x + 1$

(a) Find $f^{-1}(x)$.

$f^{-1}(x) =$ ..... [2]

(b) Find the value of x when $h(x) = g\left(\frac{1}{3}\right)$.

$x =$ ..... [2]

Question 71

$$\mathbf{p} = \begin{pmatrix} 2 \\ 8 \end{pmatrix} \qquad \mathbf{q} = \begin{pmatrix} -1 \\ 4 \end{pmatrix}$$

(a) Find

(i) $\mathbf{p} - \mathbf{q}$,

$\begin{pmatrix} \quad \\ \quad \end{pmatrix}$ [1]

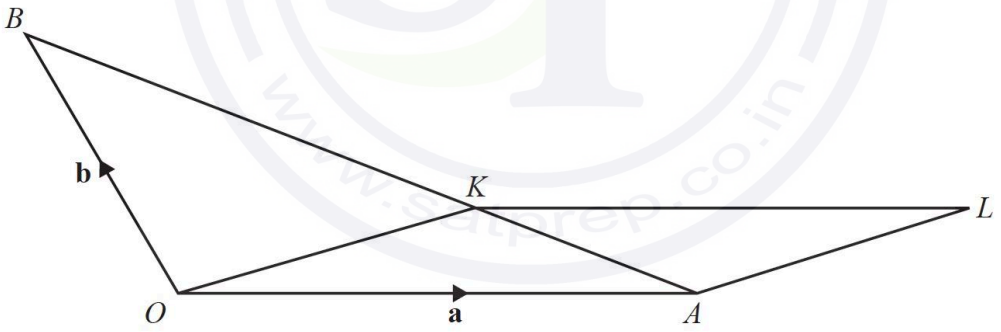
(ii) $6\mathbf{p}$.

$\begin{pmatrix} \quad \\ \quad \end{pmatrix}$ [1]

(b) Find $|\mathbf{p} - \mathbf{q}|$.

..... [2]

Question 72



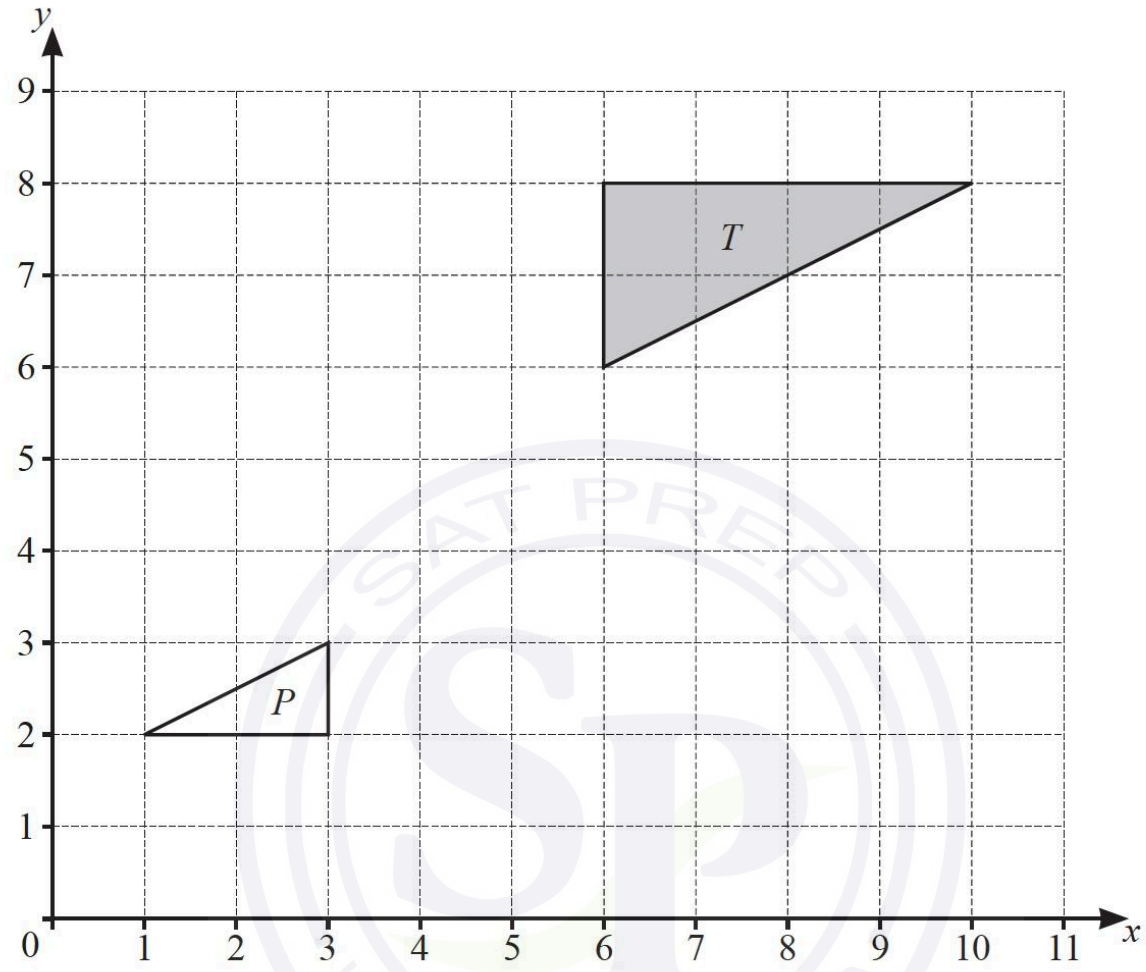
NOT TO SCALE

The diagram shows a triangle OAB and a parallelogram $OALK$.
The position vector of A is $\mathbf{a}$ and the position vector of B is $\mathbf{b}$.
K is a point on AB so that $AK : KB = 1 : 2$.

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

..... [4]

Question 73



Describe fully the **single** transformation that maps triangle T onto triangle P.

.....

..... [3]

Question 74

$$f(x) = 5x - 3,\ x > 1$$

$$g(x) = \frac{10}{x-2},\ x \neq 2$$

(a) Find $gf(x)$.
Give your answer in its simplest form.

..... [2]

(b) Find $g^{-1}(x)$.

$g^{-1}(x) =$ ..... [3]

(c) Find $ff^{-1}(x-1)$.

..... [1]

Question 75

$$f(x) = x^2 \qquad g(x) = \frac{x+5}{2} \qquad h(x) = 7x - 3$$

(a) Find $f(-3)$.

..... [1]

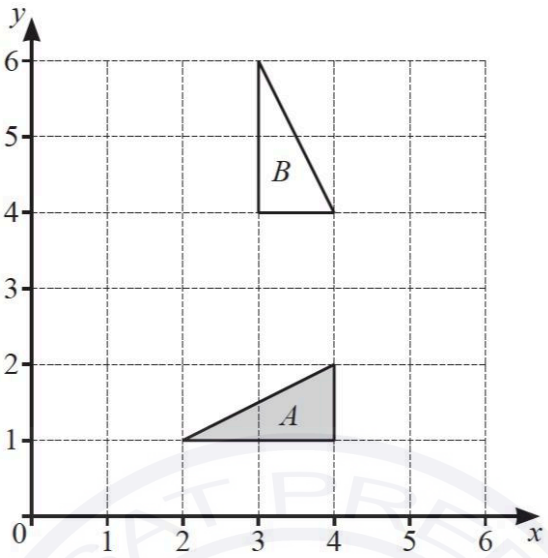
(b) Find $g^{-1}(x)$.

$g^{-1}(x) =$ ..... [2]

(c) Solve $gf(x) = hh^{-1}(63)$ where $x > 0$.

$x =$ ..... [3]

Question 76



Describe fully the **single** transformation that maps triangle A onto triangle B.

.....

..... [3]

Question 77

$$f(x) = x^3 + 1$$

Find $f^{-1}(x)$.

$f^{-1}(x) =$ ..... [2]

Question 78

$$\mathbf{v} = \begin{pmatrix} -1 \\ 3 \end{pmatrix} \qquad \mathbf{y} = \begin{pmatrix} 2 \\ 5 \end{pmatrix}$$

Find

(a) $\mathbf{v} - \mathbf{y}$

$\begin{pmatrix} \quad \\ \quad \end{pmatrix}$ [1]

(b) $2\mathbf{v}$.

$\begin{pmatrix} \quad \\ \quad \end{pmatrix}$ [1]

Question 79

$f(x) = 6x - 7$ $\quad\quad$ $g(x) = x^{-3}$

(a) Find $f(x+2)$.
Give your answer in its simplest form.

..... [2]

(b) Find $f^{-1}(x)$.

$f^{-1}(x) =$ ..... [2]

(c) Find x when $g(x) = f(22)$.

$x =$ ..... [2]

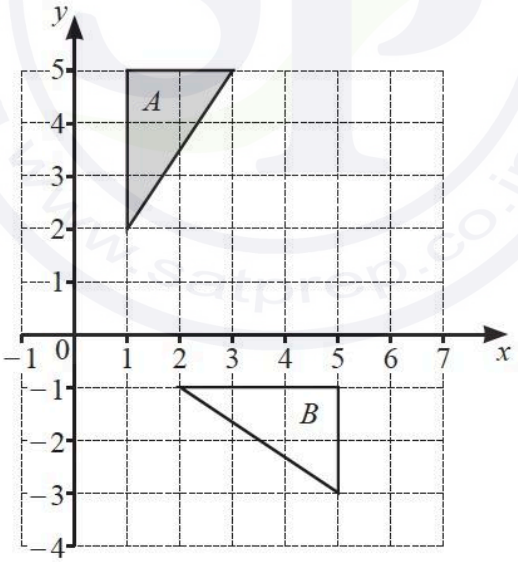
Question 80

The position vector of A is $\begin{pmatrix} 5 \\ 3 \end{pmatrix}$ and $\overrightarrow{BA} = \begin{pmatrix} 4 \\ 8 \end{pmatrix}$.

Show that $|\overrightarrow{OB}| = 5.1$, correct to 1 decimal place.

[3]

Question 81



Describe fully the single transformation that maps triangle A onto triangle B.

..... [3]

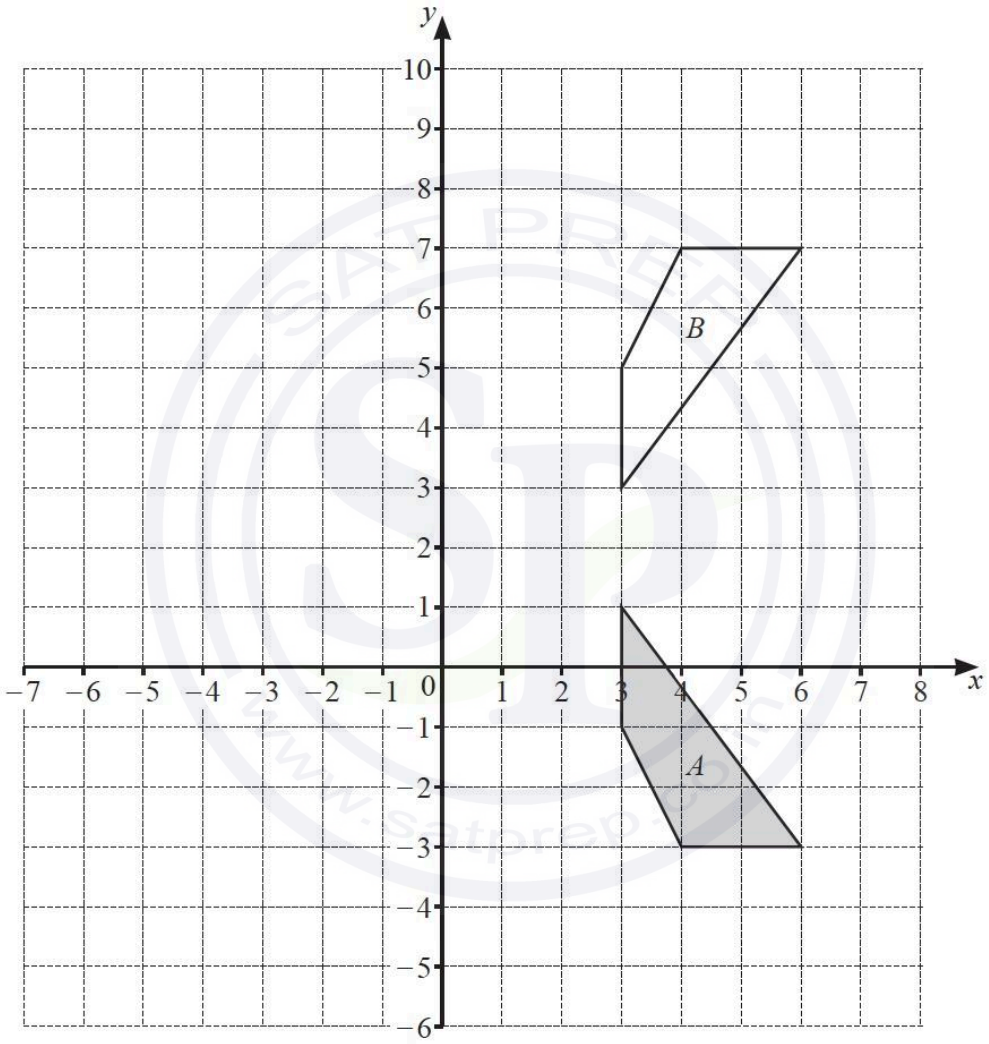
Question 82

$f(x) = 5x + 2$

Find $f^{-1}(x)$.

$f^{-1}(x) =$ ..... [2]

Question 83



(a) Describe fully the **single** transformation that maps shape A onto shape B.

.....

..... [2]

(b) Rotate shape A 90° clockwise about the point $(-1, 2)$. [2]

(c) Enlarge shape A by scale factor -2, centre $(2, 0)$. [2]

Question 84

F is the point $(1, -4)$, $\overrightarrow{FG} = \begin{pmatrix} 8 \\ -3 \end{pmatrix}$ and $\overrightarrow{GH} = \begin{pmatrix} -12 \\ 35 \end{pmatrix}$.

Find

(a) $3\overrightarrow{FG}$

$\begin{pmatrix} \quad \\ \quad \end{pmatrix}$ [1]

(b) $\overrightarrow{FG} + \overrightarrow{GH}$

$\begin{pmatrix} \quad \\ \quad \end{pmatrix}$ [1]

(c) the coordinates of the point G

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

(d) the magnitude of vector $\overrightarrow{GH}$.

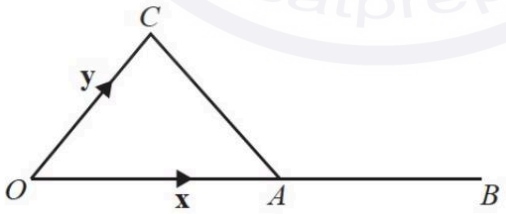
..... [2]

Question 85

(a) Find the magnitude of the vector $\begin{pmatrix} -4 \\ 5 \end{pmatrix}$.

..... [2]

(b)



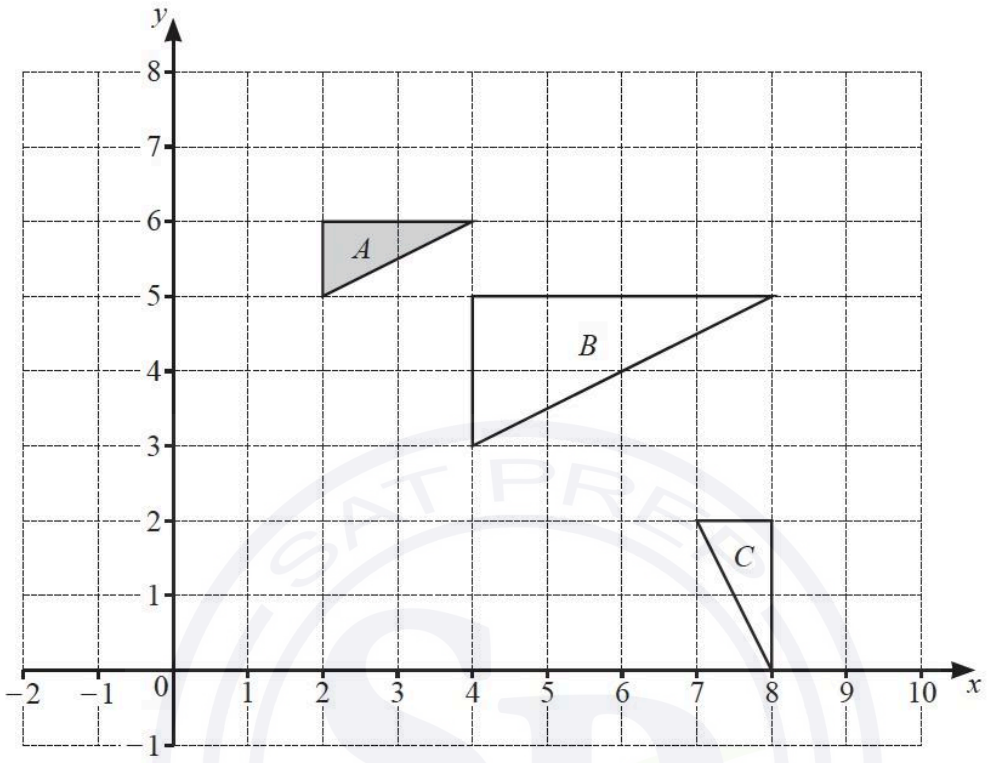
NOT TO SCALE

The diagram shows a triangle OAC.
A is the midpoint of the straight line OB.
$\overrightarrow{OA} = \mathbf{x}$ and $\overrightarrow{OC} = \mathbf{y}$.

Find $\overrightarrow{CB}$ in terms of $\mathbf{x}$ and $\mathbf{y}$.

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

Question 86



Describe the **single** transformation that maps

(a) triangle A onto triangle B

.....

..... [3]

(b) triangle A onto triangle C.

.....

..... [3]

Question 87

$\overrightarrow{AB} = \begin{pmatrix} 7 \\ -3 \end{pmatrix}$

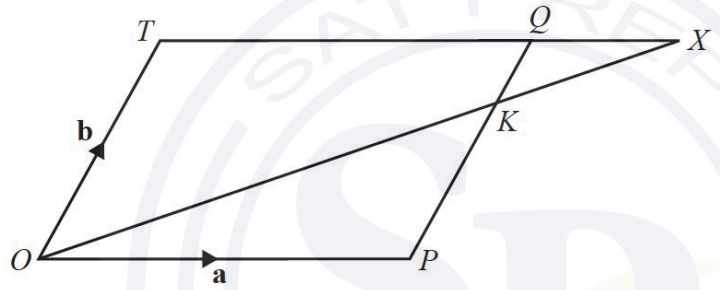
(a) Find $3\overrightarrow{AB}$.

$\begin{pmatrix} \quad \\ \quad \end{pmatrix}$ [1]

(b) Find $\left|\overrightarrow{AB}\right|$.

$\left|\overrightarrow{AB}\right| =$ ..... [2]

Question 88



NOT TO SCALE

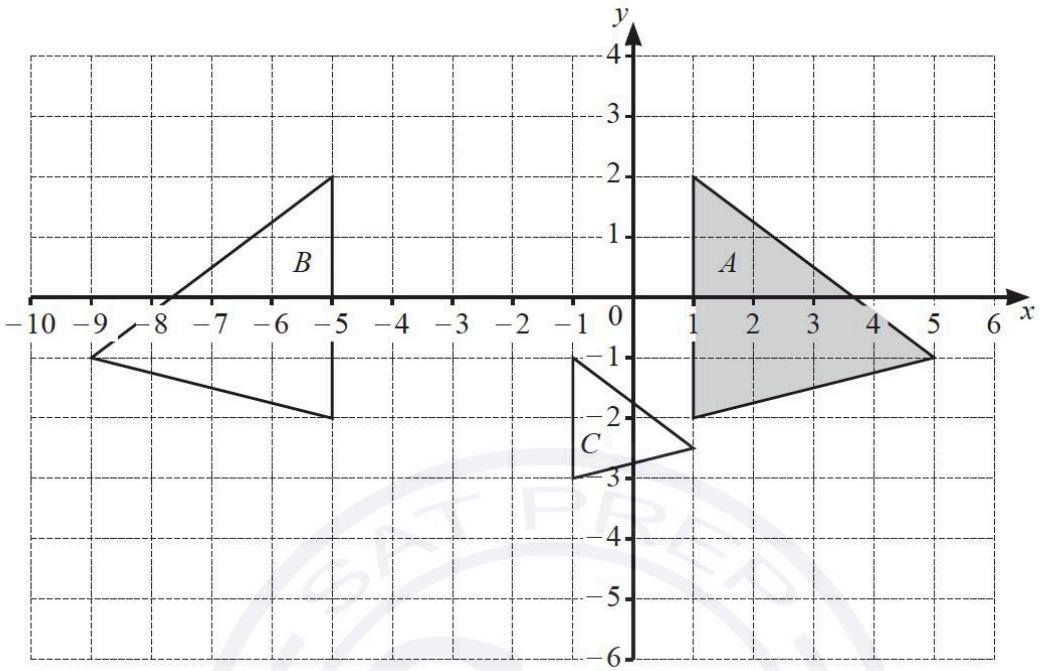
The diagram shows a parallelogram $OPQT$.
The position vector of P is **a** and the position vector of T is **b**.

K is on PQ so that $PK : KQ = 3 : 1$.
The lines OK and TQ are extended to meet at X.

Find the position vector of X in terms of **a** and **b**.
Give your answer in its simplest form.

..... [3]

Question 89



(a) Describe fully the **single** transformation that maps

(i) triangle A onto triangle B

.....

..... [2]

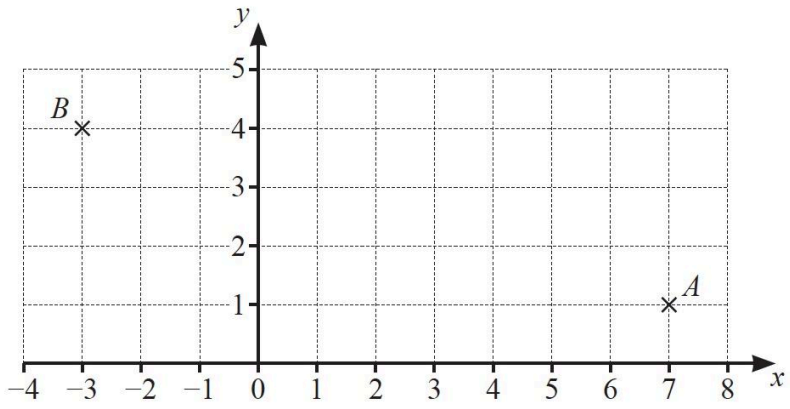
(ii) triangle A onto triangle C.

.....

..... [3]

(b) Draw the image of triangle A after a rotation, 90° clockwise, about $(1, 3)$. [2]

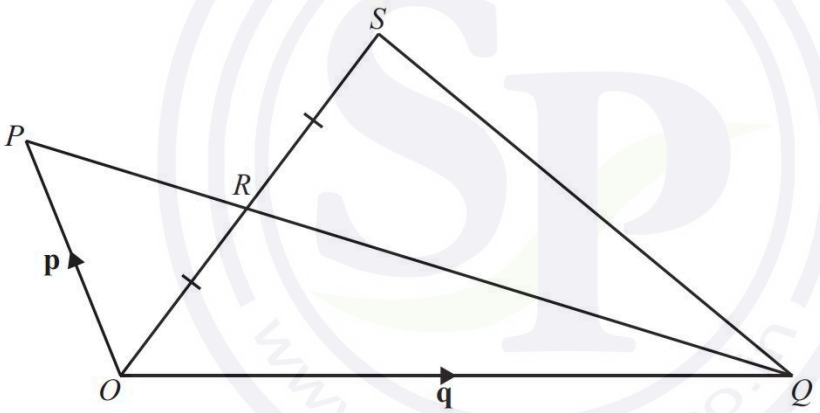
Question 90



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

$\overrightarrow{AB} = \begin{pmatrix} \quad \\ \quad \end{pmatrix}$ [1]

Question 91



NOT TO SCALE

In the diagram, O is the origin.
$\overrightarrow{OP} = \mathbf{p}$ and $\overrightarrow{OQ} = \mathbf{q}$.
R is the point of intersection of PQ and OS, with $PR : RQ = 1 : 2$ and $OR = RS$.

Find the position vector of S in terms of $\mathbf{p}$ and $\mathbf{q}$.
Give your answer in its simplest form.

.....[4]

Question 92

$f(x) = 3^x + 2$

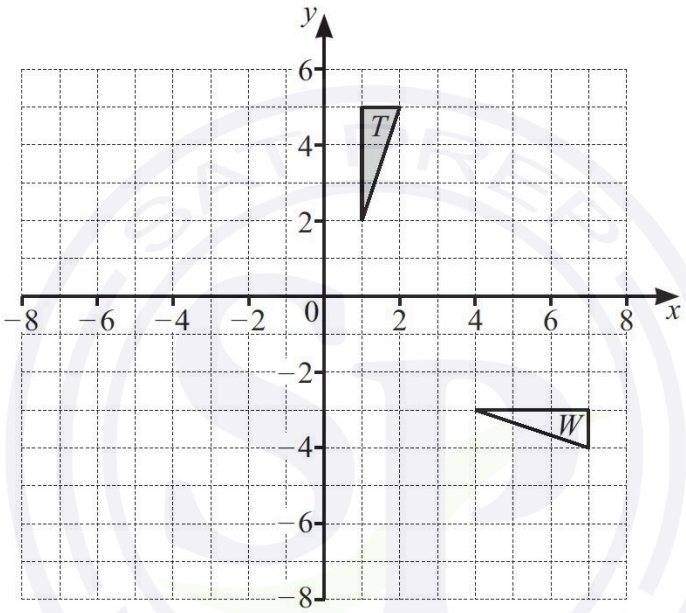
(a) Find x when $f(x) = 245$.

$x =$ ..... [2]

(b) Find x when $f^{-1}(x) = 7$.

$x =$ ..... [2]

Question 93



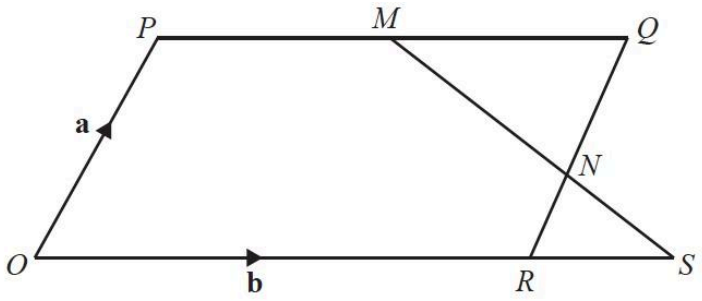
(a) Describe fully the **single** transformation that maps triangle T onto triangle W.

.....

..... [3]

(b) Draw the enlargement of triangle T with scale factor -2 and centre of enlargement $(-1, 1)$. [2]

Question 94



NOT TO SCALE

O is the origin and $OPQR$ is a parallelogram.
M is the midpoint of PQ and N divides QR in the ratio 2 : 1.
$\overrightarrow{OP} = \mathbf{a}$ and $\overrightarrow{OR} = \mathbf{b}$.

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

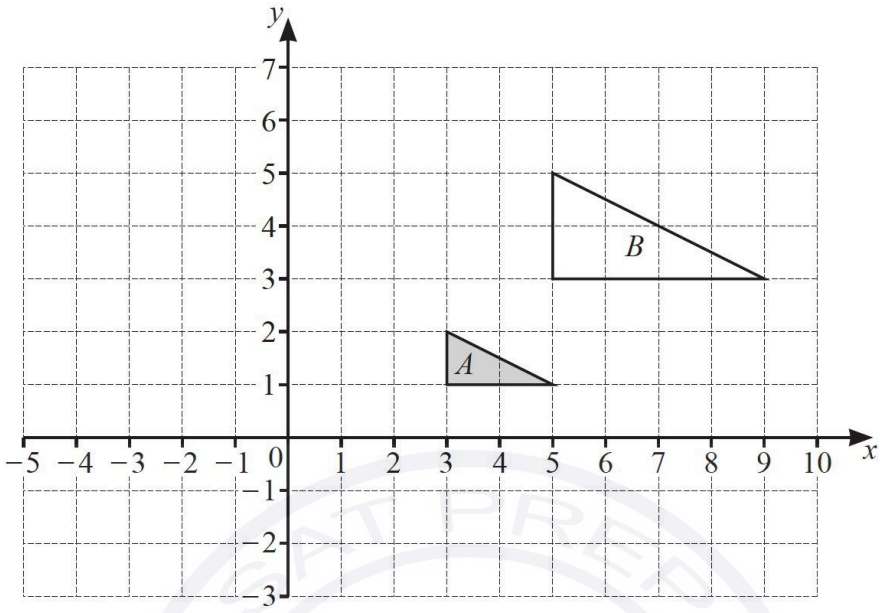
$\overrightarrow{MN} =$ ..... [2]

(b) The lines MN and OR are extended to meet at S.

Find the position vector of S.
Give your answer in terms of **a** and/or **b** and in its simplest form.

..... [3]

Question 95



(a) Describe fully the **single** transformation that maps triangle A onto triangle B.

.....

..... [3]

(b) On the grid, draw the image of triangle A after a translation by the vector $\begin{pmatrix} -4 \\ 3 \end{pmatrix}$. [2]