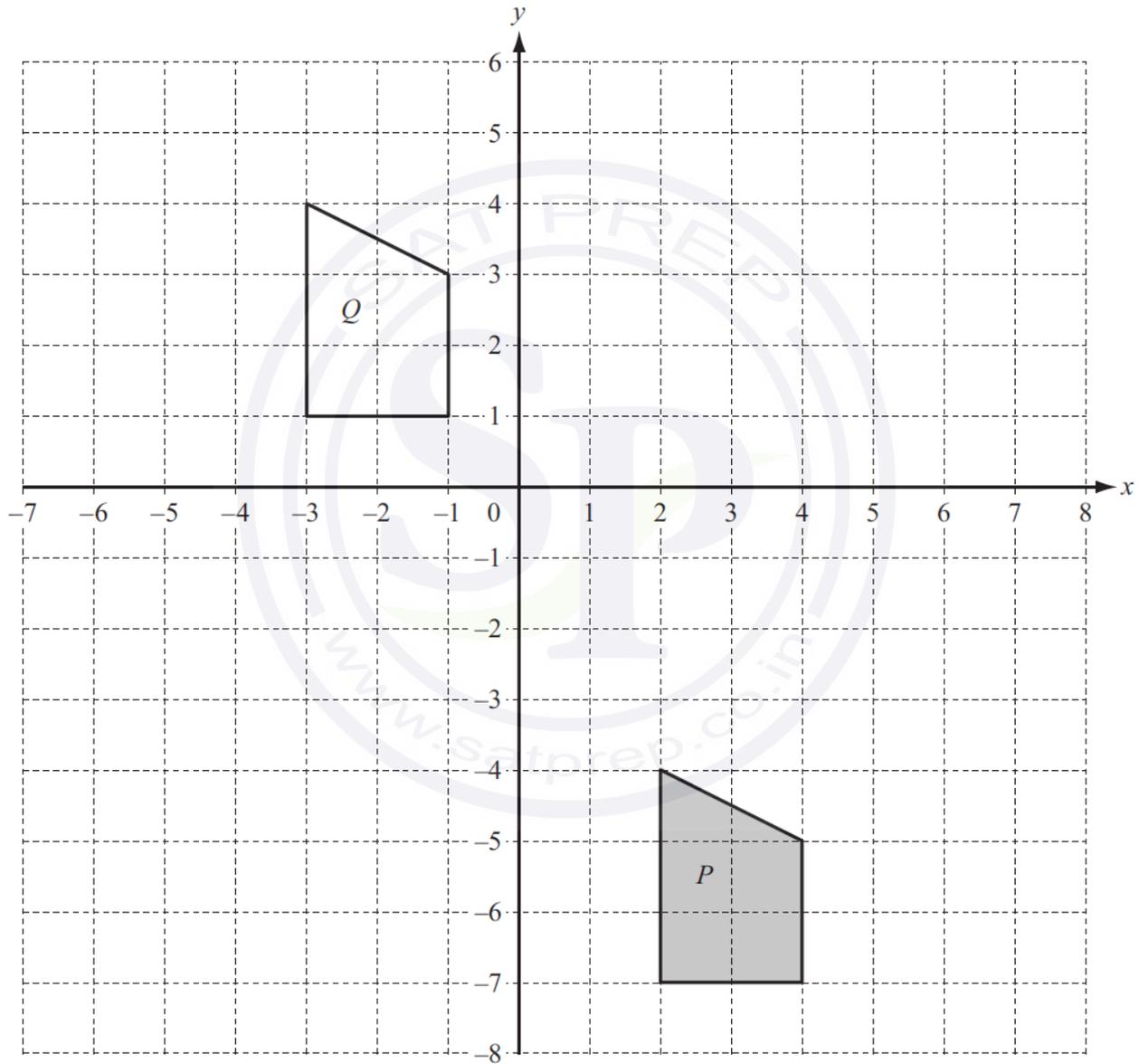


Extended Mathematics
Topic : Vector-Function-Transformation
Year : May 2013 - May 2024
Paper -4
Questions Booklet

Question 1



Continue on the next page...

(i) Describe fully the **single** transformation which maps shape P onto shape Q .

Answer(a)(i) [2]

(ii) On the grid above, draw the image of shape P after reflection in the line $y = -1$. [2]

Question 2

$$f(x) = x^2 + x - 3 \quad g(x) = 2x + 7 \quad h(x) = 2^x$$

(a) Solve the equation $f(x) = 0$.
Show all your working and give your answers correct to 2 decimal places.

Answer(a) $x = \dots\dots\dots$ or $x = \dots\dots\dots$ [4]

(b) $fg(x) = px^2 + qx + r$

Find the values of p , q and r .

Answer(b) $p = \dots\dots\dots$

$q = \dots\dots\dots$

$r = \dots\dots\dots$ [3]

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

Answer(c) $g^{-1}(x) = \dots\dots\dots$ [2]

(d) Find x when $h(x) = 0.25$.

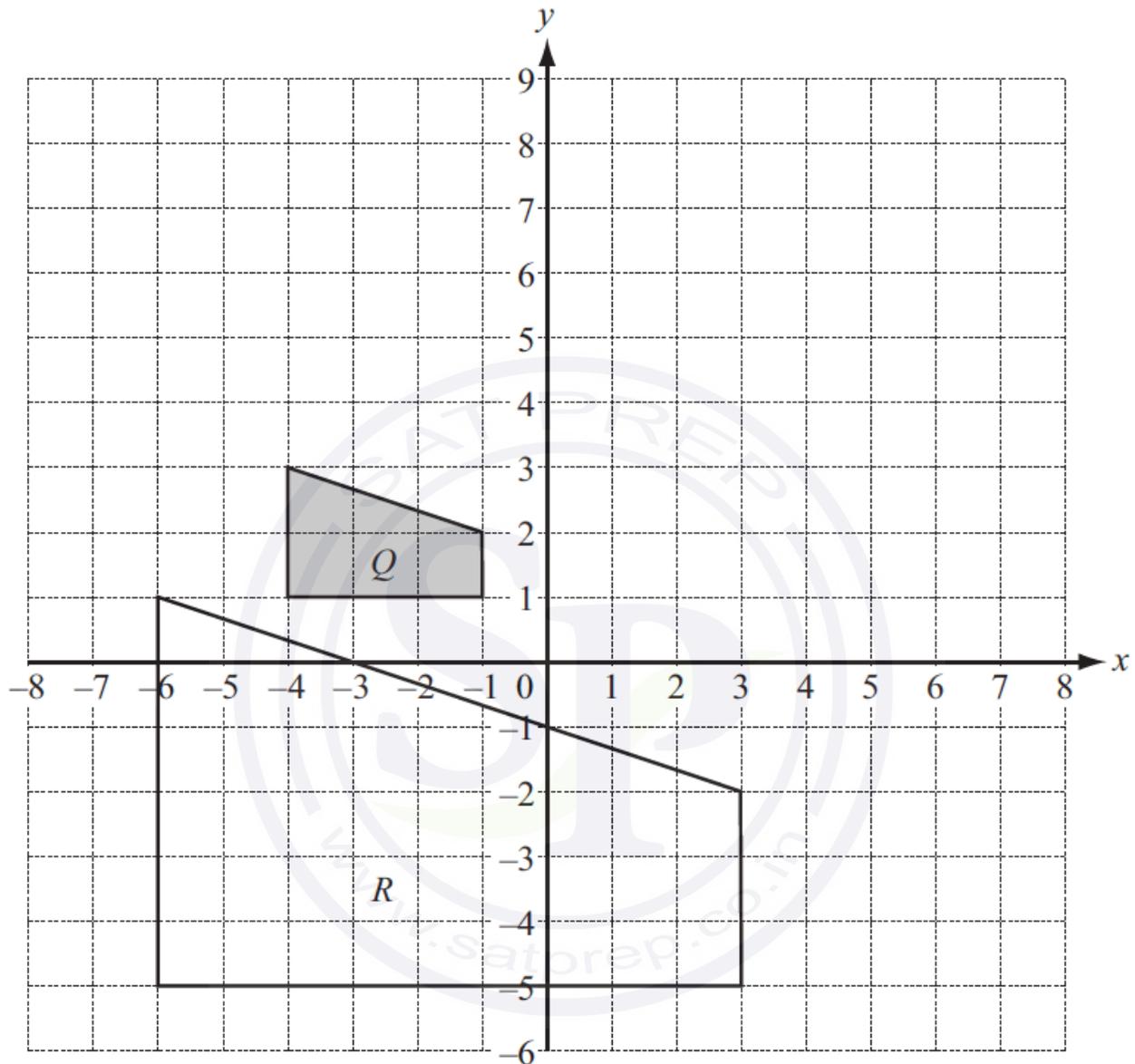
Answer(d) $x = \dots\dots\dots$ [1]

(e) Find $hhh(3)$.

Give your answer in standard form, correct to 4 significant figures.

Answer(e) [4]

Question 3



(a) Describe fully the **single** transformation that maps shape Q onto shape R .

Answer(a) [3]

(b) (i) Draw the image when shape Q is translated by the vector $\begin{pmatrix} 5 \\ 4 \end{pmatrix}$. [2]

(ii) Draw the image when shape Q is reflected in the line $x = 2$. [2]

(iii) Draw the image when shape Q is stretched, factor 3, x -axis invariant. [2]

Questions 4

(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 \vec{PQ} as a column vector.

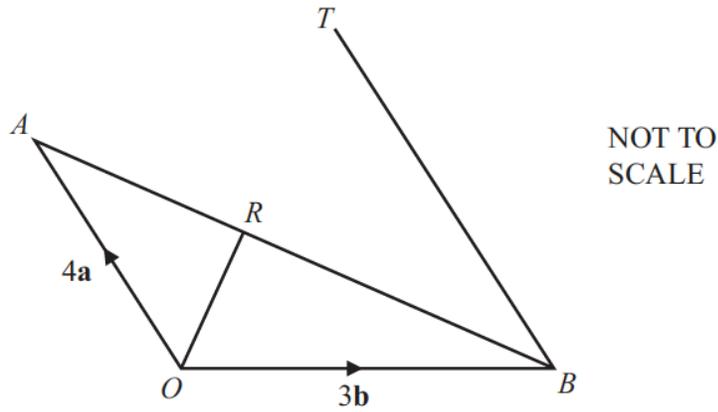
Answer(a)(iii) $\vec{PQ} = \begin{pmatrix} \\ \end{pmatrix}$ [1]

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

Answer(a)(iv) [2]

Continue on the next page...

(b)



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

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

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

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

(a) \vec{AB}

Answer(b)(i)(a) $\vec{AB} = \dots\dots\dots$ [1]

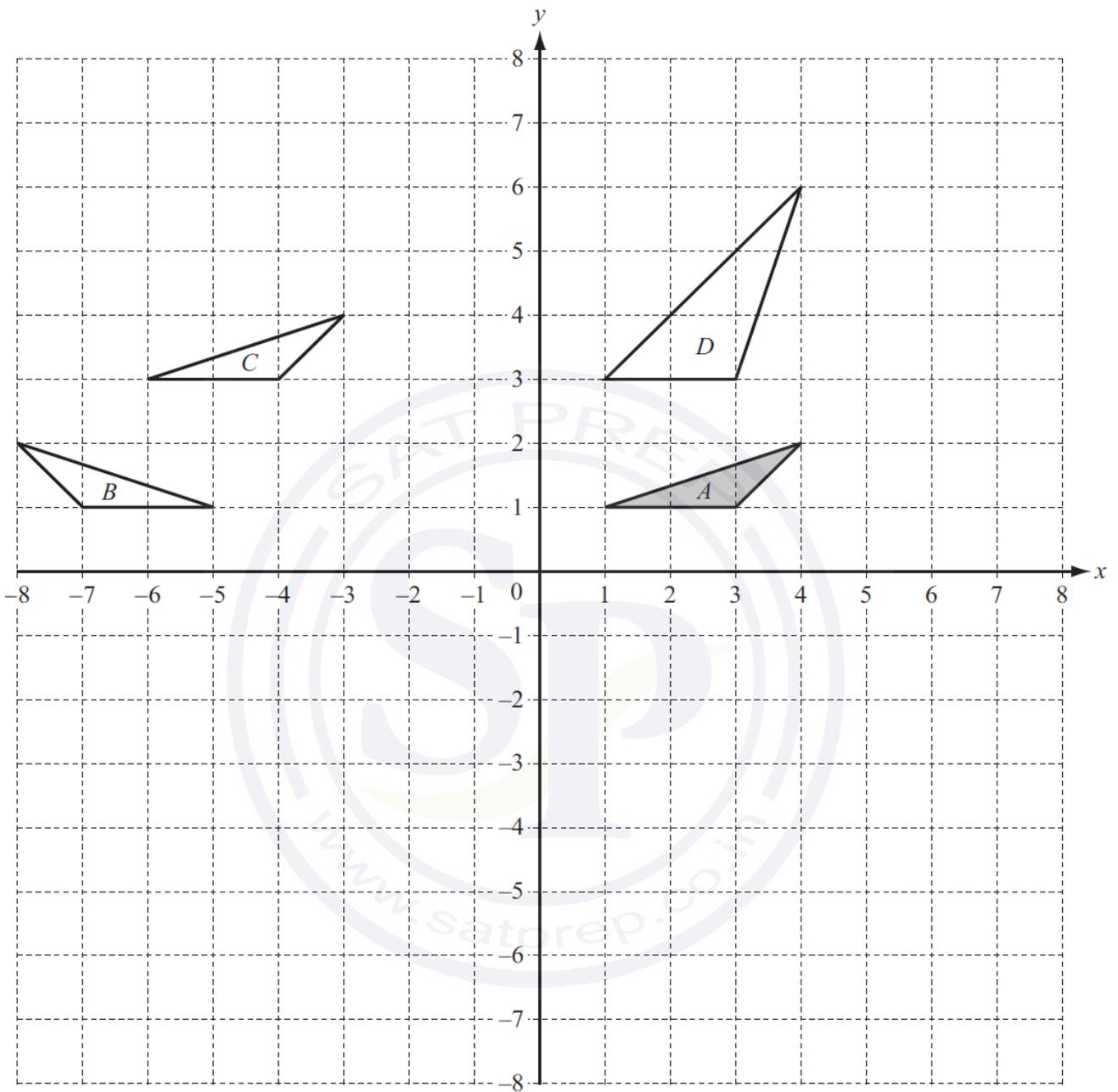
(b) \vec{AR}

Answer(b)(i)(b) $\vec{AR} = \dots\dots\dots$ [2]

(c) \vec{OT}

Answer(b)(i)(c) $\vec{OT} = \dots\dots\dots$ [1]

Question 5



Continue on the next page...

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

(i) triangle B ,

Answer(a)(i) [2]

(ii) triangle C ,

Answer(a)(ii) [2]

(iii) triangle D .

Answer(a)(iii) [3]

(b) On the grid, draw

(i) the rotation of triangle A about $(6, 0)$ through 90° clockwise, [2]

(ii) the enlargement of triangle A by scale factor -2 with centre $(0, -1)$, [2]

Question 6

$f(x) = 4x + 3$ $g(x) = \frac{7}{x+1} (x, -1)$ $h(x) = x^2 + 5x$

(a) Work out

(i) $h(-3)$,

Answer(a)(i) [1]

(ii) $hg(13)$.

Answer(a)(ii) [2]

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

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

(c) (i) Solve the equation $f(x) = 23$.

Answer(c)(i) $x =$ [2]

(ii) Solve the equation $h(x) = 7$.

Show all your working and give your answers correct to 2 decimal places.

Answer(c)(ii) $x =$ or $x =$ [5]

Question 7

$$g(x) = 1 - 2x \quad h(x) = x^2 - 1$$

(i) Find $gh(3)$.

Answer (i)[2]

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

Answer (ii)[2]

(iii) Solve the equation $h(x) = 3$.

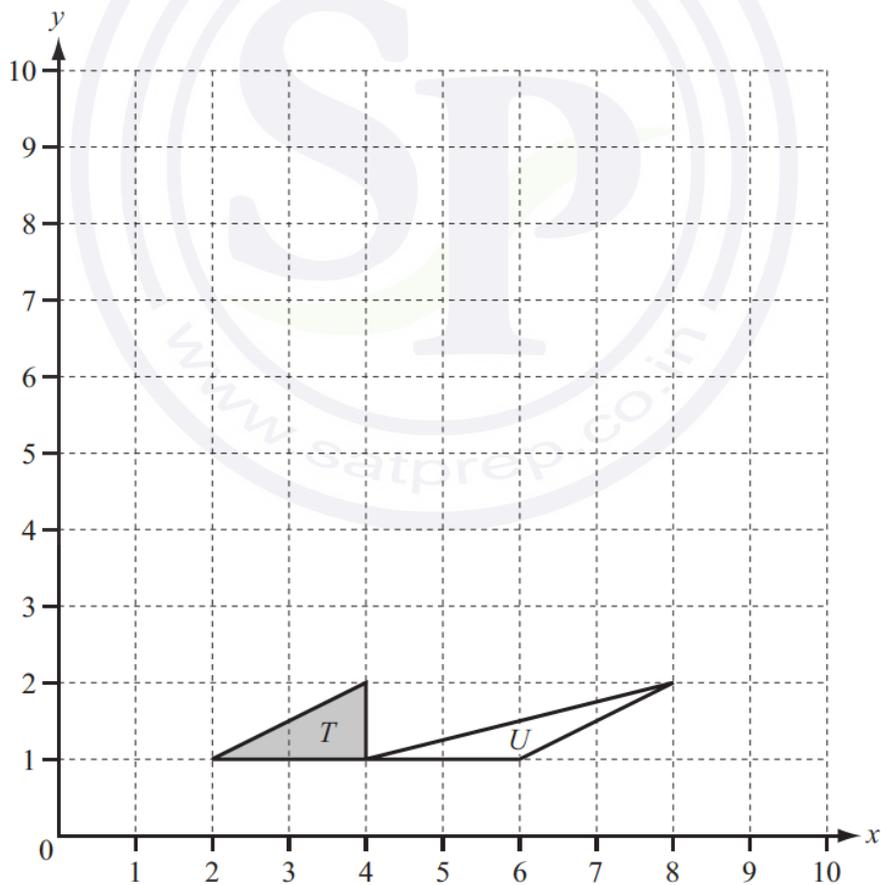
Answer (iii) $x = \dots\dots\dots$ or $x = \dots\dots\dots$ [2]

(iv) Solve the equation $g(3x) = 2x$.

Answer (iv) $x = \dots\dots\dots$ [3]

Question 8

(a)

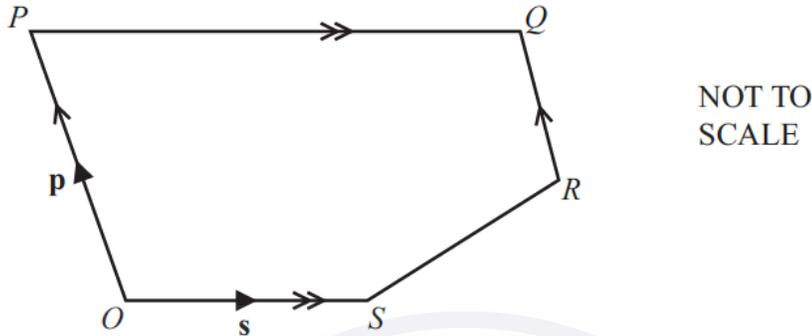


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(i) Draw the reflection of triangle T in the line $y = 5$. [2]

(ii) Draw the rotation of triangle T about the point $(4, 2)$ through 180° . [2]

(b)



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

Find, in terms of \mathbf{p} and \mathbf{s} , in their simplest form,

(i) the position vector of Q ,

Answer(b)(i) [2]

(ii) \vec{SR} .

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

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

Answer(c) [1]

Question 9

$f(x) = 4 - 3x$ $g(x) = 3^{-x}$

(a) Find $f(2x)$ in terms of x .

Answer(a) $f(2x) =$ [1]

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

Answer(b) $ff(x) =$ [2]

(c) Work out $gg(-1)$.
 Give your answer as a fraction.

Answer(c) [3]

Continue on the next page...

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

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

(e) Solve the equation $gf(x) = 1$.

Answer(e) $x = \dots\dots\dots$ [3]

Question 10

$f(x) = 4 - 3x$ $g(x) = 3^{-x}$

(a) Find $f(2x)$ in terms of x .

Answer(a) $f(2x) = \dots\dots\dots$ [1]

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

Answer(b) $ff(x) = \dots\dots\dots$ [2]

(c) Work out $gg(-1)$.
Give your answer as a fraction.

Answer(c) $\dots\dots\dots$ [3]

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

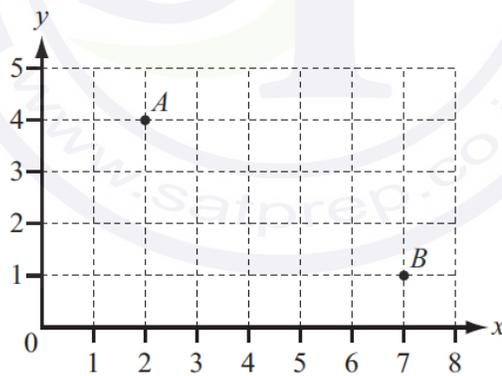
Answer(d) $f^{-1}(x) = \dots\dots\dots$ [2]

(e) Solve the equation $gf(x) = 1$.

Answer(e) $x = \dots\dots\dots$ [3]

Question 11

(a)



(i) Write down the position vector of A .

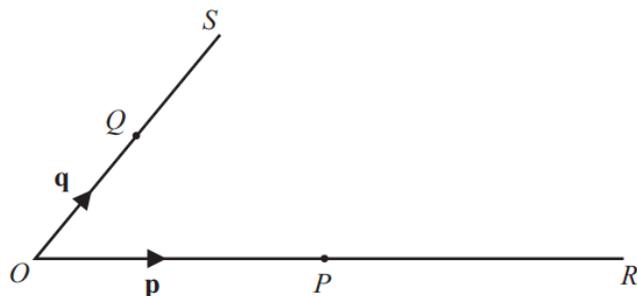
Answer(a)(i) $\left(\begin{array}{c} \\ \end{array} \right)$ [1]

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

Answer(a)(ii) $\dots\dots\dots$ [2]

Continue on the next page...

(b)



NOT TO SCALE

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

(i) Write down \vec{RQ} in terms of \mathbf{p} and \mathbf{q} .

Answer(b)(i) $\vec{RQ} = \dots\dots\dots$ [1]

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

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

Answer(b)(ii) $PM : PS = \dots\dots\dots : \dots\dots\dots$ [4]

Question 12

$f(x) = \frac{1}{x}, x \neq 0$

$g(x) = 1 - x$

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

(a) Find $fg\left(\frac{1}{2}\right)$.

Answer(a) $\dots\dots\dots$ [2]

(b) Find $g^{-1}(x)$, the inverse of $g(x)$.

Answer(b) $g^{-1}(x) = \dots\dots\dots$ [1]

(c) Find $hg(x)$, giving your answer in its simplest form.

Answer(c) $hg(x) = \dots\dots\dots$ [3]

(d) Find the value of x when $g(x) = 7$.

Answer(d) $x = \dots\dots\dots$ [1]

(e) Solve the equation $h(x) = 3x$.

Show your working and give your answers correct to 2 decimal places.

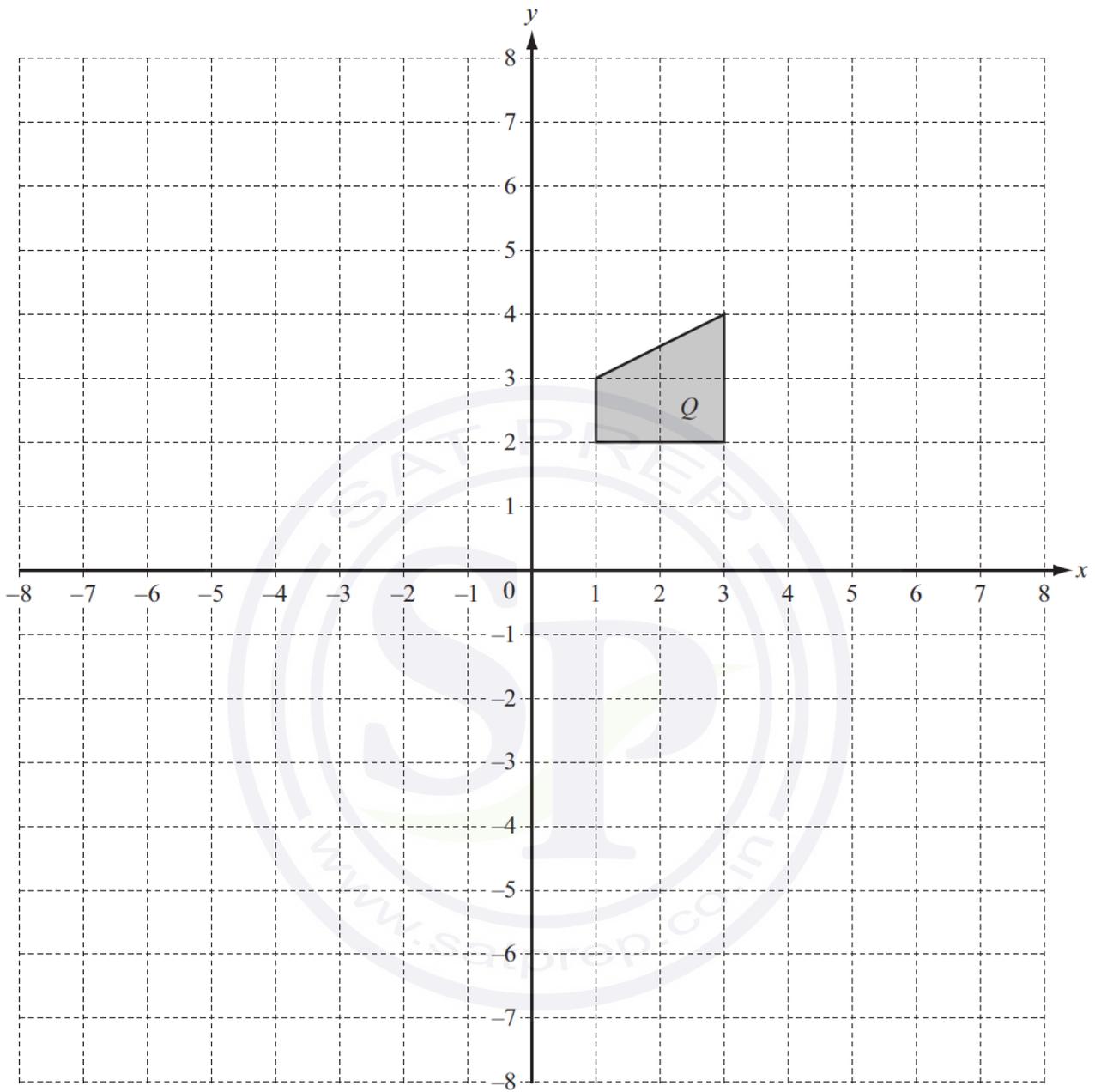
Answer(e) $x = \dots\dots\dots$ or $x = \dots\dots\dots$ [4]

(f) A function $k(x)$ is its own inverse when $k^{-1}(x) = k(x)$.

For which of the functions $f(x)$, $g(x)$ and $h(x)$ is this true?

Answer(f) $\dots\dots\dots$ [1]

Question 13



Draw the reflection of shape Q in the line $x = -1$. [2]

Draw the enlargement of shape Q , centre $(0, 0)$, scale factor -2 . [2]

Question 14

(a) $\vec{PQ} = \begin{pmatrix} -3 \\ 4 \end{pmatrix}$

(i) P is the point $(-2, 3)$.

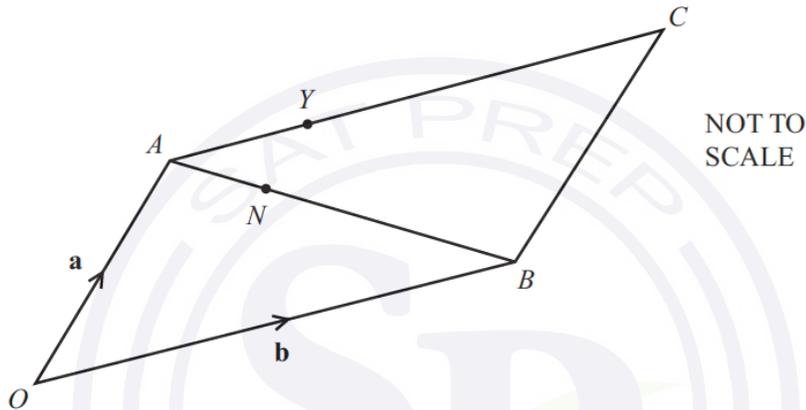
Work out the co-ordinates of Q .

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

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

Answer(a)(ii) [2]

(b)



$OACB$ is a parallelogram.

$\vec{OA} = \mathbf{a}$ and $\vec{OB} = \mathbf{b}$.

$AN:NB = 2:3$ and $AY = \frac{2}{5}AC$.

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

(a) \vec{ON}

Answer(b)(i)(a) $\vec{ON} = \dots\dots\dots$ [2]

(b) \vec{NY}

Answer(b)(i)(b) $\vec{NY} = \dots\dots\dots$ [2]

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

Answer(b)(ii)

..... [2]

Question 15

$$f(x) = 2x - 3$$

$$g(x) = \frac{1}{x+1} + 2$$

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

(i) Work out $f(4)$.

Answer (i) [1]

(ii) Work out $fh(-1)$.

Answer (ii) [2]

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

Answer (iii) [2]

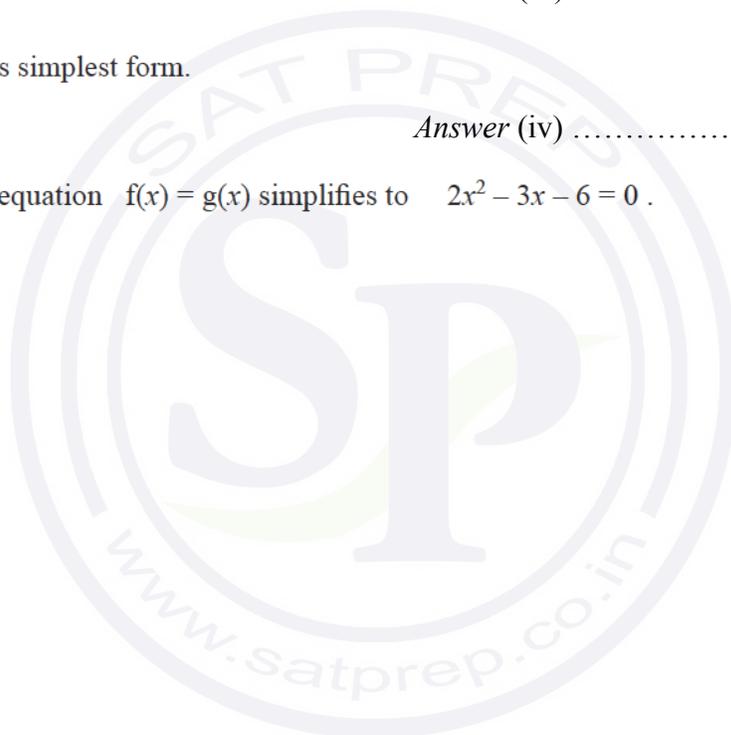
(iv) Find $ff(x)$ in its simplest form.

Answer (iv) [2]

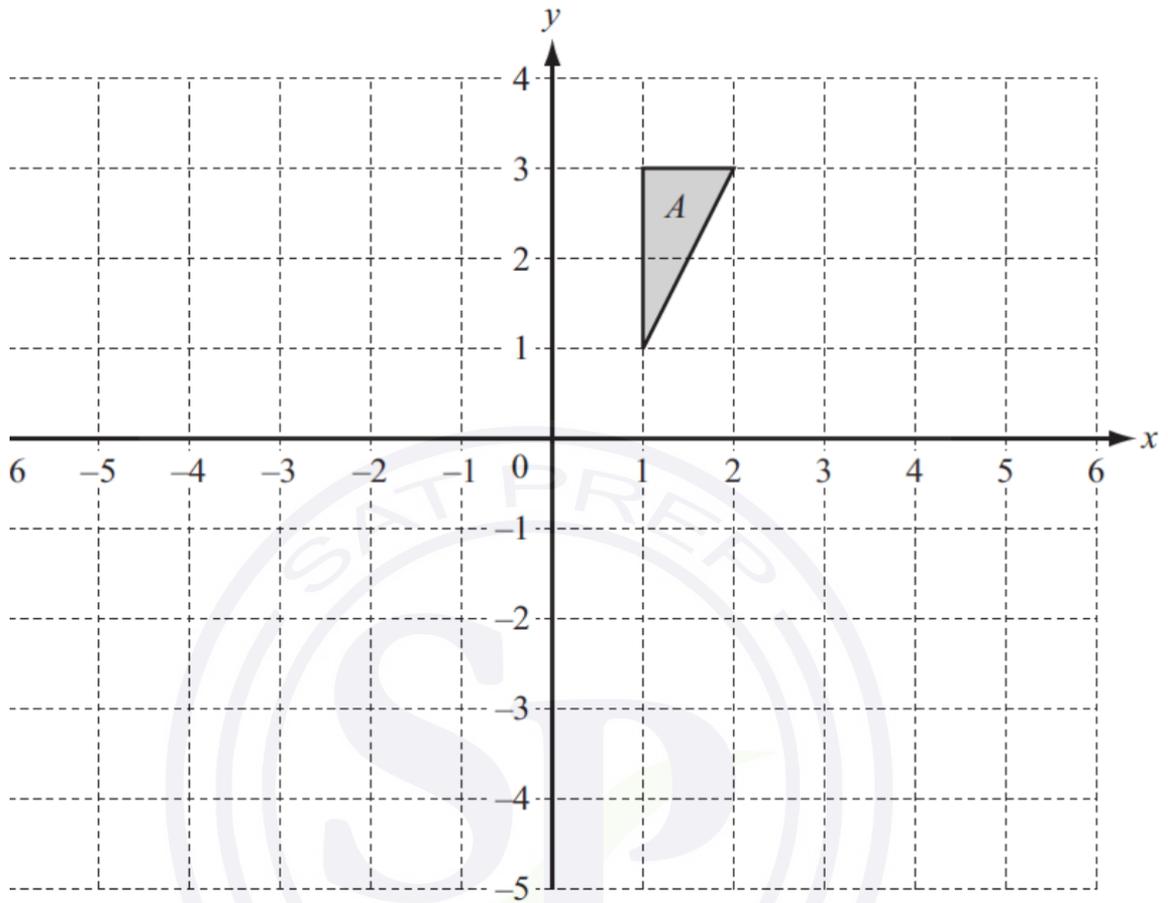
(v) Show that the equation $f(x) = g(x)$ simplifies to $2x^2 - 3x - 6 = 0$.

Answer(a)(v)

[3]



Question 16



On the grid,

- (i) draw the image of shape A after a translation by the vector $\begin{pmatrix} -5 \\ -4 \end{pmatrix}$, [2]
- (ii) draw the image of shape A after a rotation through 90° clockwise about the origin. [2]

Question 17

$$f(x) = 5x - 2$$

$$g(x) = \frac{7}{x-3}, \quad x \neq 3$$

$$h(x) = 2x^2 + 7x$$

(a) Work out

(i) $f(2)$,

Answer(a)(i) [1]

(ii) $hg(17)$.

Answer(a)(ii) [2]

(b) Solve $g(x) = x + 3$.

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

(c) Solve $h(x) = 11$, showing all your working and giving your answers correct to 2 decimal places.

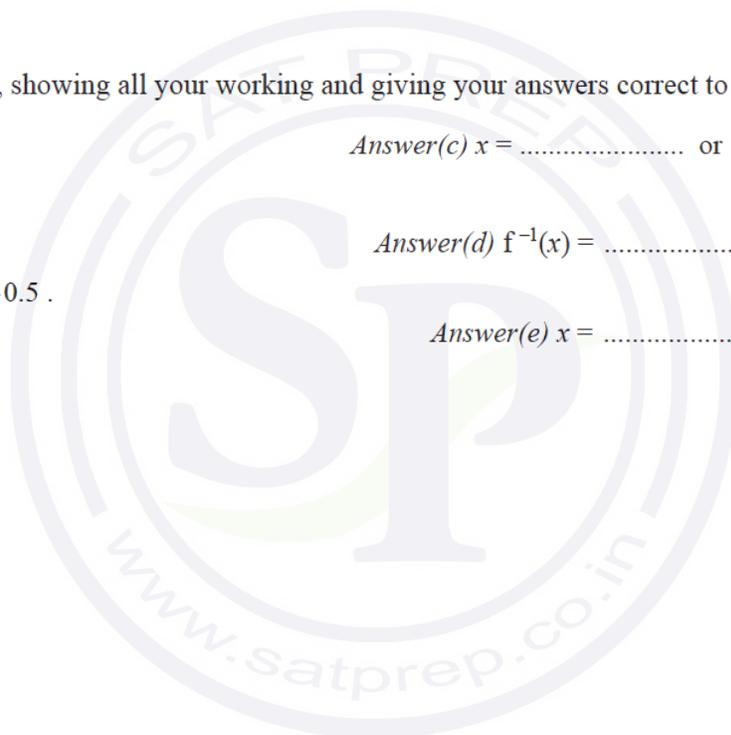
Answer(c) $x =$ or $x =$ [5]

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

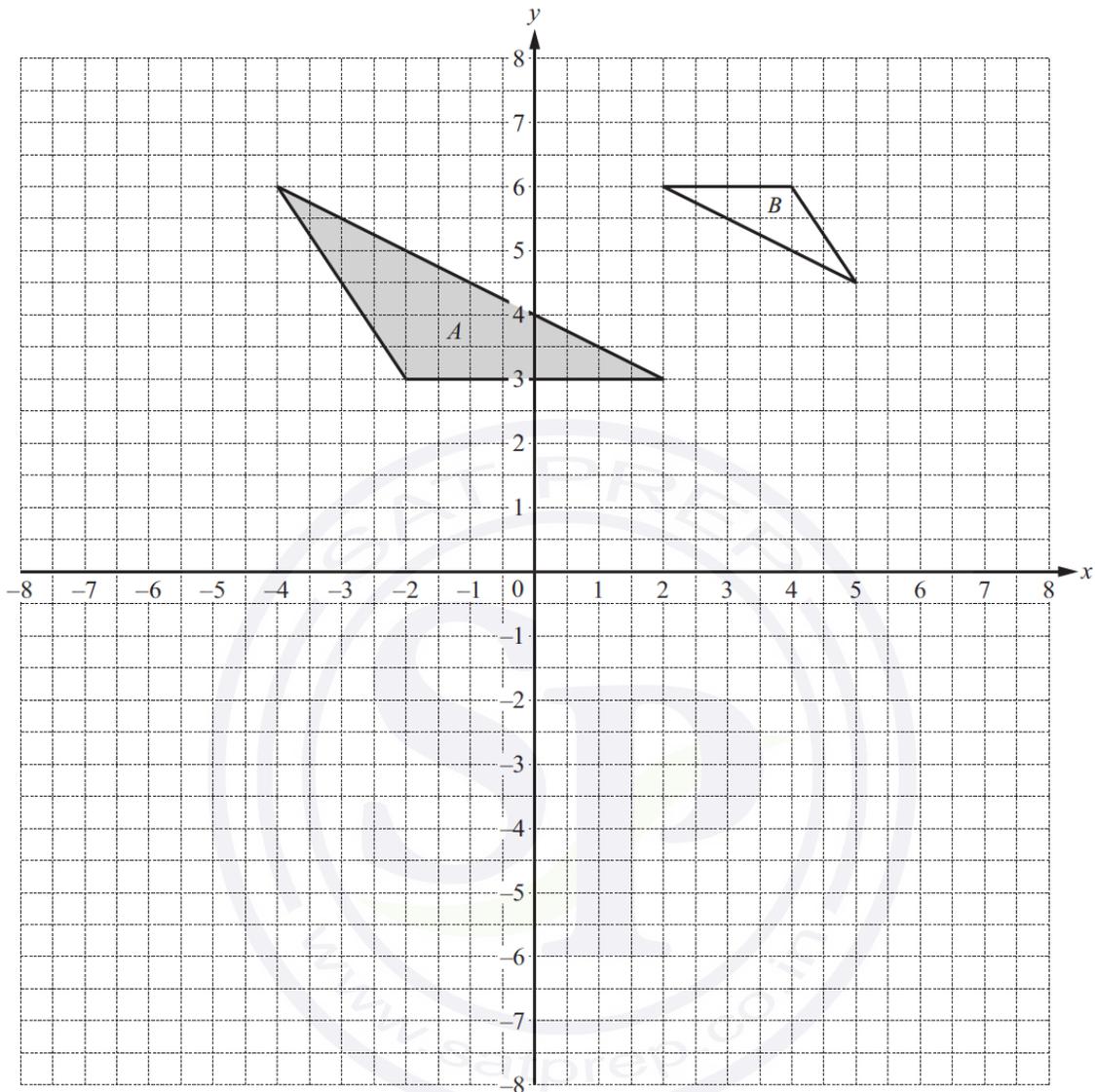
Answer(d) $f^{-1}(x) =$ [2]

(e) Solve $g^{-1}(x) = -0.5$.

Answer(e) $x =$ [1]



Question 18



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

Answer(a)

..... [3]

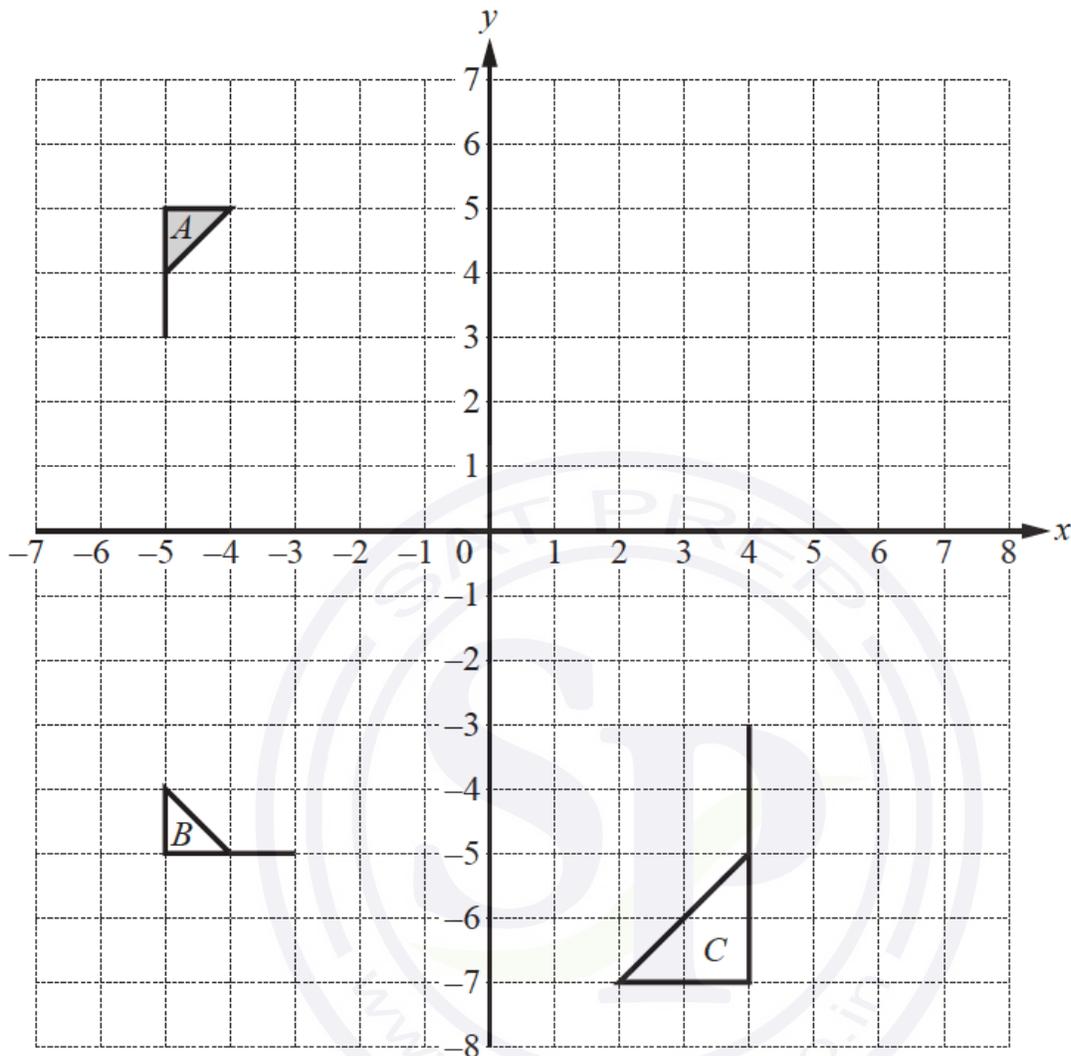
(b) On the grid, draw the image of

(i) triangle *A* after a reflection in the line $x = -3$, [2]

(ii) triangle *A* after a rotation about the origin through 270° anticlockwise, [2]

(iii) triangle *A* after a translation by the vector $\begin{pmatrix} -1 \\ -5 \end{pmatrix}$. [2]

Question 19



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

(i) flag *A* onto flag *B*,

Answer(a)(i)
 [3]

(ii) flag *A* onto flag *C*.

Answer(a)(ii)
 [3]

(b) Draw the image of flag *A* after a translation by the vector $\begin{pmatrix} 2 \\ 1 \end{pmatrix}$. [2]

(c) Draw the image of flag *A* after a reflection in the line $x = 1$. [2]

Question 20

$$f(x) = 2x - 1$$

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

$$h(x) = \frac{2}{x}, x \neq 0$$

(a) Find $ff(3)$.

Answer(a) [2]

(b) Find $gf(x)$, giving your answer in its simplest form.

Answer(b) [3]

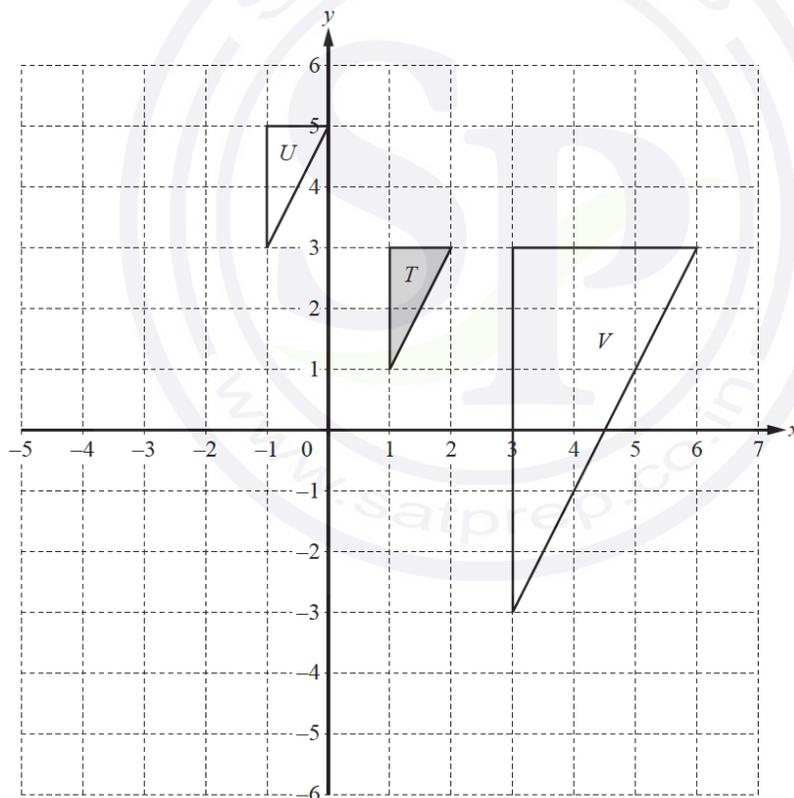
(c) Find $f^{-1}(x)$.

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

(d) Find $h(x) + h(x + 2)$, giving your answer as a single fraction.

Answer(d) [4]

Question 21



(a) On the grid, draw the image of

(i) triangle T after a reflection in the line $x = -1$, [2]

(ii) triangle T after a rotation through 180° about $(0, 0)$. [2]

Continue on the next page...

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

(i) triangle T onto triangle U ,

Answer(b)(i)
 [2]

(ii) triangle T onto triangle V .

Answer(b)(ii)
 [3]

Question 22

(a) $\vec{PQ} = \begin{pmatrix} 5 \\ -8 \end{pmatrix}$

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

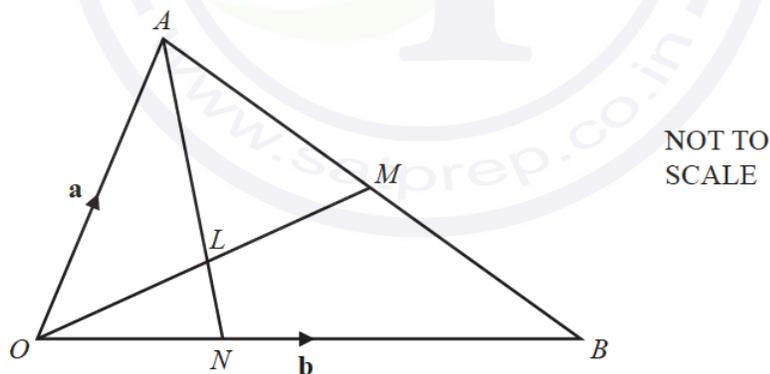
Answer(a)(i) $|\vec{PQ}| = \dots\dots\dots$ [2]

(ii) Q is the point $(2, -3)$.

Find the co-ordinates of the point P .

Answer(a)(ii) $(\dots\dots\dots, \dots\dots\dots)$ [1]

(b)



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 $ON = \frac{1}{3}OB$.

$\vec{OA} = \mathbf{a}$ and $\vec{OB} = \mathbf{b}$.

(i) Find, in terms of \mathbf{a} and \mathbf{b} , in its simplest form,

(a) \vec{OM} ,

Continue on the next page...

Answer(b)(i)(a) $\vec{OM} = \dots\dots\dots$ [2]

(b) \vec{OL} ,

Answer(b)(i)(b) $\vec{OL} = \dots\dots\dots$ [1]

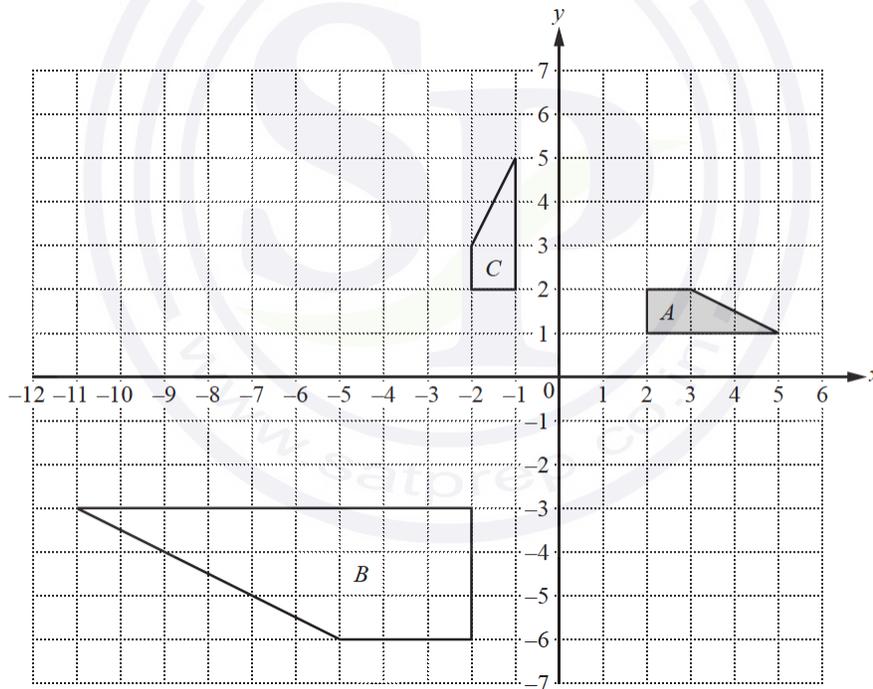
(c) \vec{AL} .

Answer(b)(i)(c) $\vec{AL} = \dots\dots\dots$ [2]

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

Answer(b)(ii) $\dots\dots\dots : \dots\dots\dots$ [3]

Question 23



(a) Draw the image of

(i) shape A after a translation by $\begin{pmatrix} -1 \\ 3 \end{pmatrix}$, [2]

(ii) shape A after a rotation through 180° about the point $(0, 0)$, [2]

Continue on the next page...

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

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

Question 26

$$f(x) = 2x - 1 \qquad g(x) = \frac{1}{x}, \quad x \neq 0 \qquad h(x) = 2^x$$

(a) Find $h(3)$.

Answer(a) [1]

(b) Find $fg(0.5)$.

Answer(b) [2]

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

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

(d) Find $ff(x)$, giving your answer in its simplest form.

Answer(d) [2]

(e) Find $(f(x))^2 + 6$, giving your answer in its simplest form.

Answer(e) [2]

(f) Simplify $hh^{-1}(x)$.

Answer(f) [1]

(g) Which of the following statements is true?

$$f^{-1}(x) = f(x)$$

$$g^{-1}(x) = g(x)$$

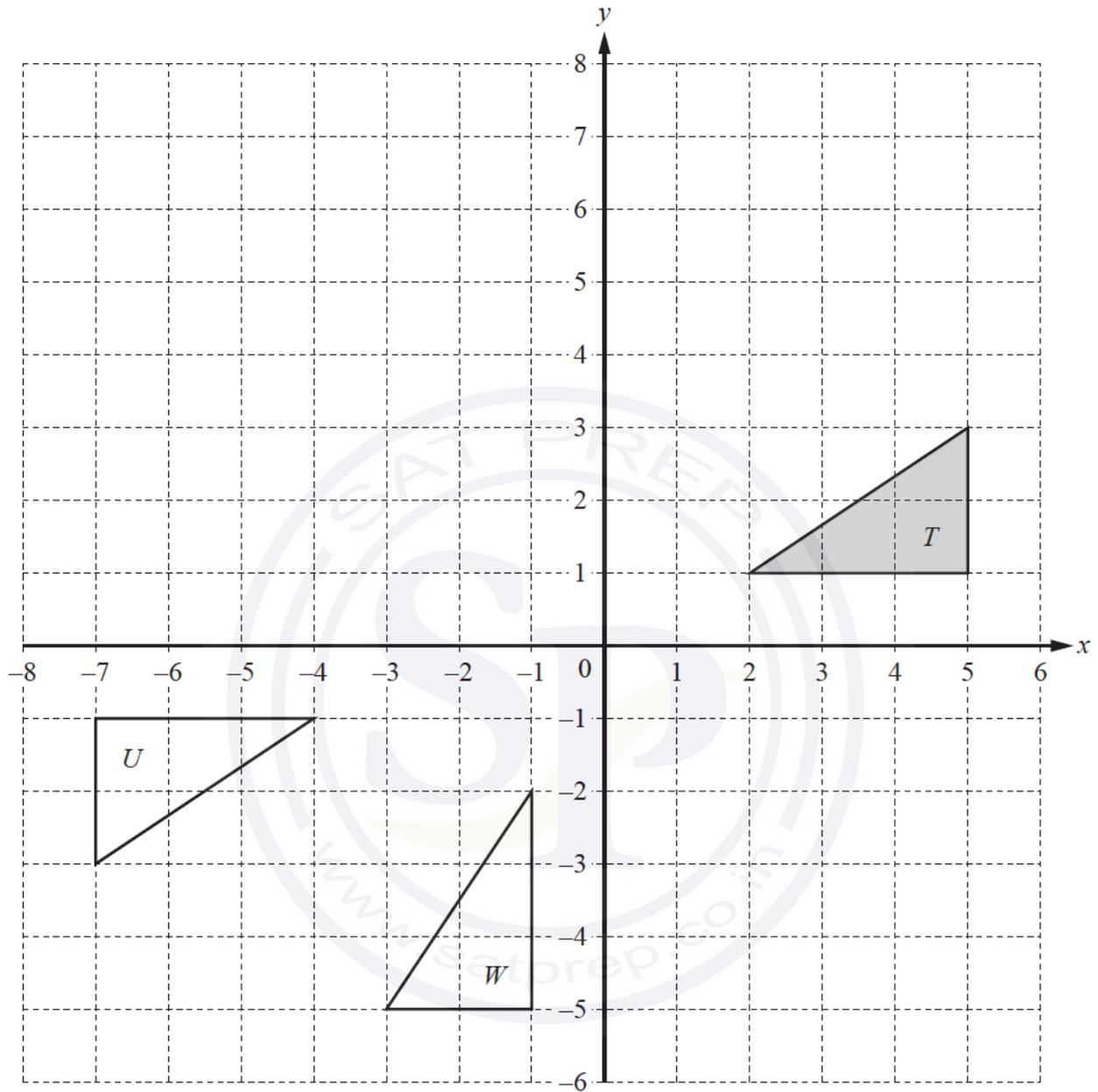
$$h^{-1}(x) = h(x)$$

Answer(g) [1]

(h) Use two of the functions $f(x)$, $g(x)$ and $h(x)$ to find the composite function which is equal to $2^{x+1} - 1$.

Answer(h) [1]

Question 25



(a) On the grid, draw the image of

(i) triangle T after a translation by the vector $\begin{pmatrix} -4 \\ 4 \end{pmatrix}$, [2]

(ii) triangle T after a reflection in the line $y = -1$. [2]

Continue on the next page...

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

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

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

..... [2]

Question 26

$$f(x) = 2x + 5$$

$$g(x) = 2^x$$

$$h(x) = 7 - 3x$$

(a) Find

(i) $f(3)$,

Answer(a)(i) [1]

(ii) $gg(3)$.

Answer(a)(ii) [2]

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

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

(c) Find $fh(x)$, giving your answer in its simplest form.

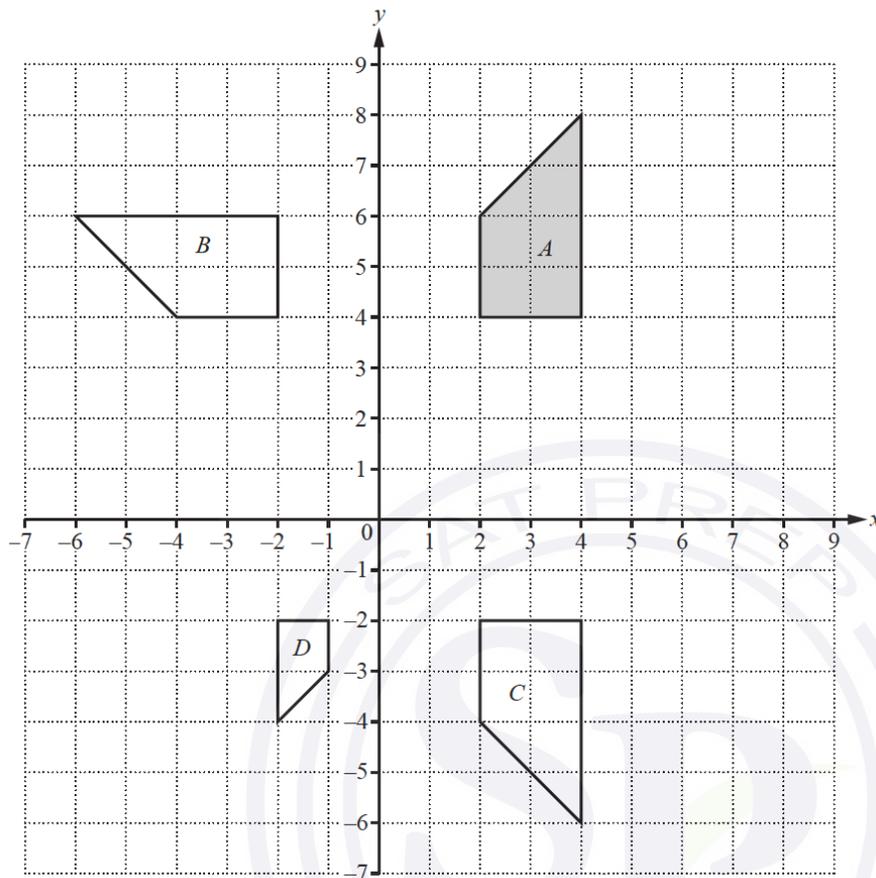
Answer(c) [2]

(d) Find the integer values of x which satisfy this inequality.

$$1 < f(x) \leq 9$$

Answer(d) [3]

Question 27



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

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

Answer(a)(i) [3]

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

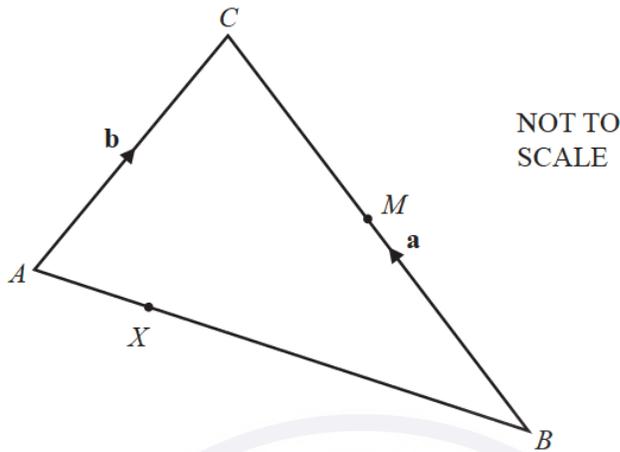
Answer(a)(ii) [2]

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

Answer(a)(iii) [3]

On the grid, draw the image of shape *A* after a translation by the vector $\begin{pmatrix} 2 \\ -3 \end{pmatrix}$. [2]

Question 28



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

(a) Find \vec{AB} in terms of \mathbf{a} and \mathbf{b} .

Answer(a) $\vec{AB} = \dots\dots\dots$ [1]

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

Find \vec{XM} in terms of \mathbf{a} and \mathbf{b} .

Show all your working and write your answer in its simplest form.

Answer(b) $\vec{XM} = \dots\dots\dots$ [4]

Question 29

$f(x) = 2 - 3x$

$g(x) = 7x + 3$

(a) Find

(i) $f(-3)$,

$\dots\dots\dots$ [1]

(ii) $g(2x)$.

$\dots\dots\dots$ [1]

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

$\dots\dots\dots$ [2]

(c) Find x when $3f(x) = 7$.

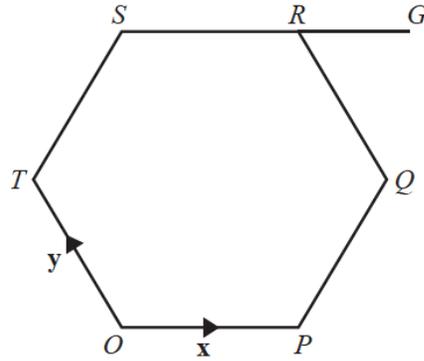
$x = \dots\dots\dots$ [3]

(d) Solve the equation.

$f(x + 4) - g(x) = 0$

$x = \dots\dots\dots$ [3]

Question 30



NOT TO SCALE

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

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

(a) Write down, in terms of \mathbf{x} and/or \mathbf{y} , in its simplest form,

(i) \vec{QR} ,

$\vec{QR} = \dots\dots\dots$ [1]

(ii) \vec{PQ} ,

$\vec{PQ} = \dots\dots\dots$ [1]

(iii) the position vector of S .

$\dots\dots\dots$ [2]

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

Find \vec{GQ} , in terms of \mathbf{x} and \mathbf{y} , in its simplest form.

$\vec{GQ} = \dots\dots\dots$ [2]

(c) M is the midpoint of OP .

(i) Find \vec{MG} , in terms of \mathbf{x} and \mathbf{y} , in its simplest form.

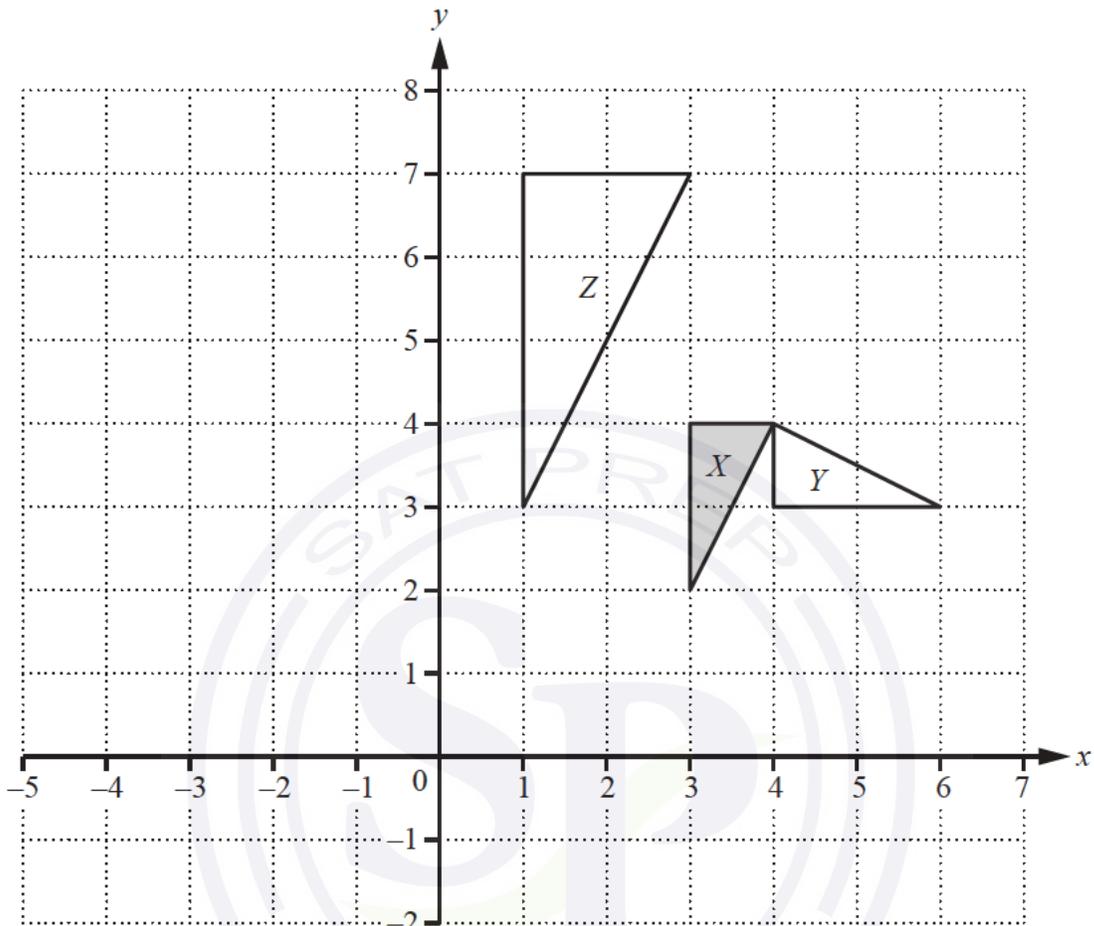
$\vec{MG} = \dots\dots\dots$ [2]

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

Use vectors to show that H lies on MG .

[2]

Question 31



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

(i) triangle X onto triangle Y ,

.....
 [3]

(ii) triangle X onto triangle Z .

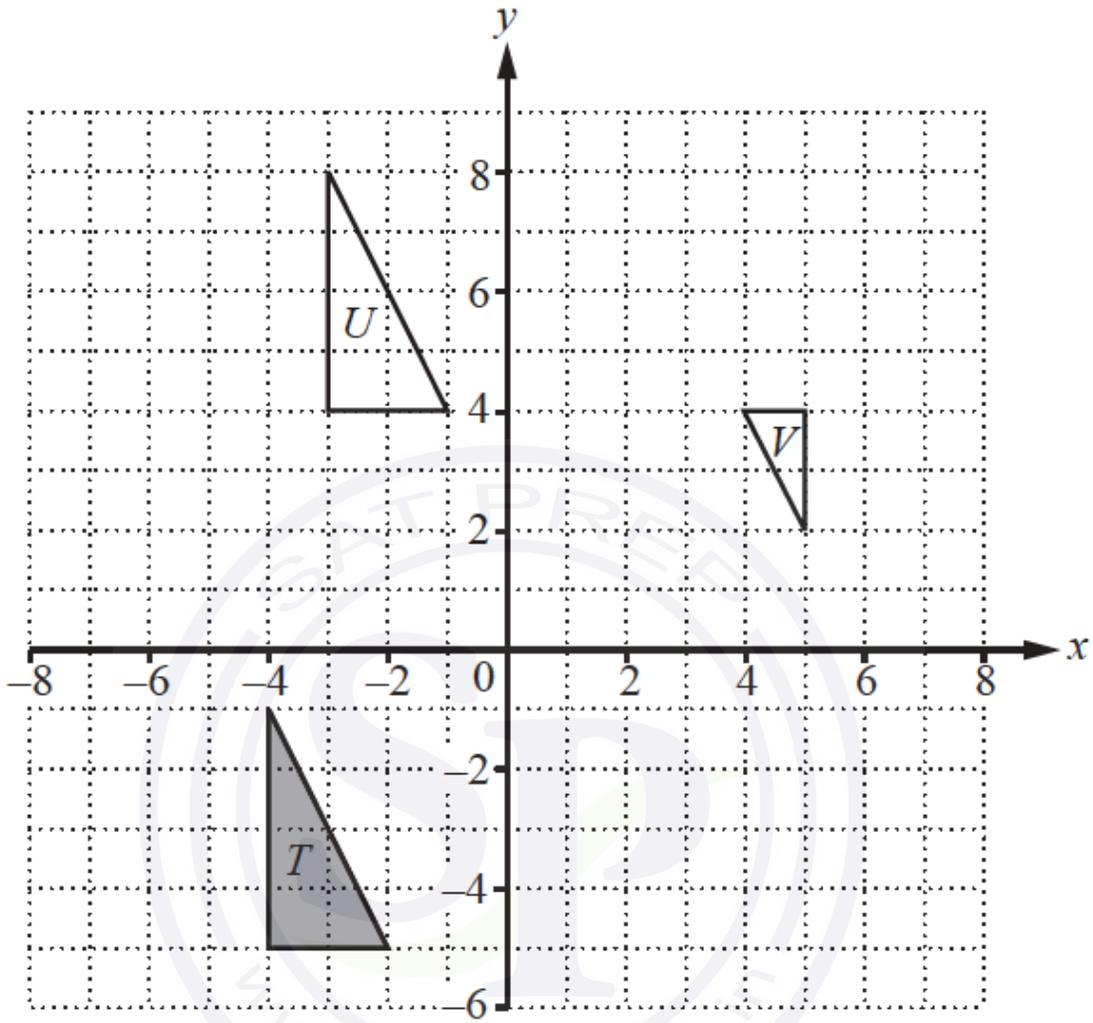
.....
 [3]

(b) (i) Draw the image of triangle X after a translation by the vector $\begin{pmatrix} -5 \\ 3 \end{pmatrix}$.

Label this triangle P . [2]

(ii) Draw the reflection of triangle P in the line $y = 3$. [2]

Question 32



- (i) Draw the image of triangle T after a reflection in the line $x = 0$. [2]
- (ii) Draw the image of triangle T after a rotation through 90° clockwise about $(-2, -1)$. [2]
- (iii) Describe fully the **single** transformation that maps triangle T onto triangle U .

 [2]
- (iv) Describe fully the **single** transformation that maps triangle T onto triangle V .

 [3]

Question 33

$$f(x) = 5x + 7 \qquad g(x) = \frac{4}{x-3}, \quad x \neq 3$$

(a) Find

(i) $fg(1)$,

..... [2]

(ii) $gf(x)$,

..... [2]

(iii) $g^{-1}(x)$,

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

(iv) $f^{-1}f(2)$.

..... [1]

[3]

(ii) Solve $5x^2 - 8x - 25 = 0$.

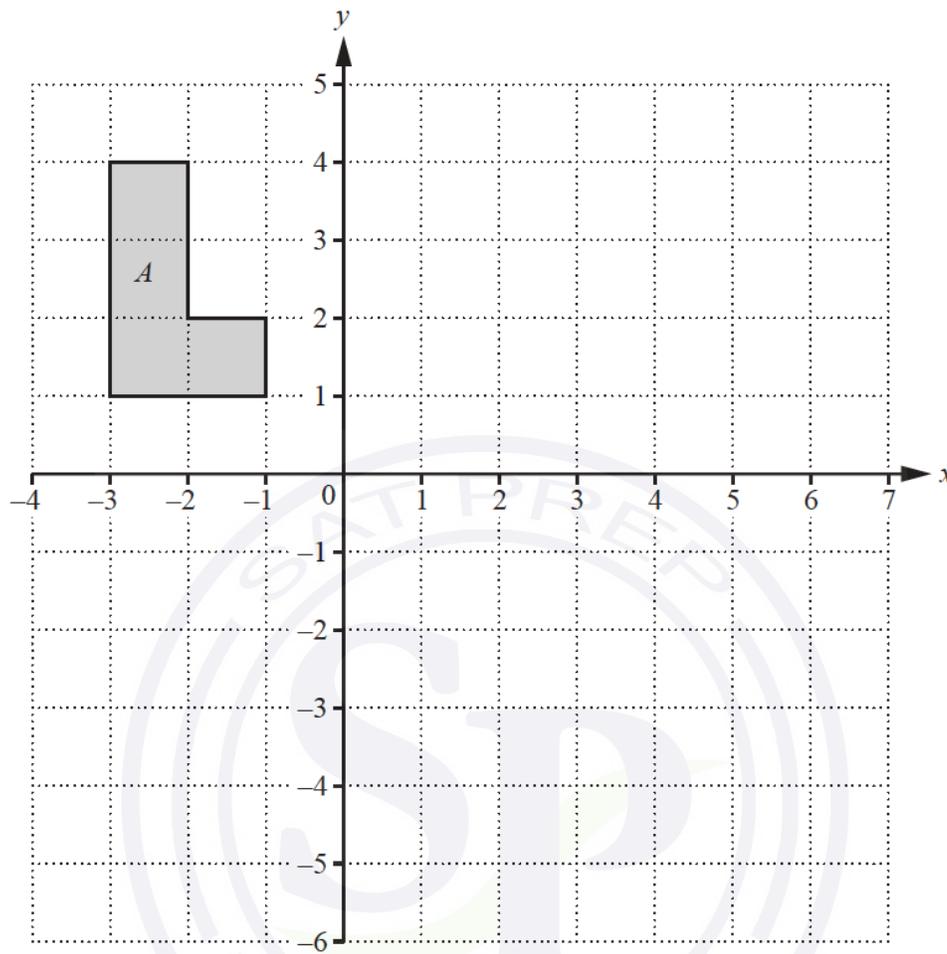
Show all your working and give your answers correct to 2 decimal places.

(b) $f(x) = g(x)$

(i) Show that $5x^2 - 8x - 25 = 0$.

$x =$ Or $x =$ [4]

Question 34



On the grid, draw the image of

- (i) shape A after a reflection in the line $x = 1$, [2]
- (ii) shape A after an enlargement with scale factor -2 , centre $(0, 1)$, [2]

Question 35

$$f(x) = 2x + 1$$

$$g(x) = x^2 + 4$$

$$h(x) = 2^x$$

- (a) Solve the equation $f(x) = g(1)$.

$$x = \dots\dots\dots [2]$$

- (b) Find the value of $fh(3)$.

$$\dots\dots\dots [2]$$

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

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

- (d) Find $gf(x)$ in its simplest form.

$$\dots\dots\dots [3]$$

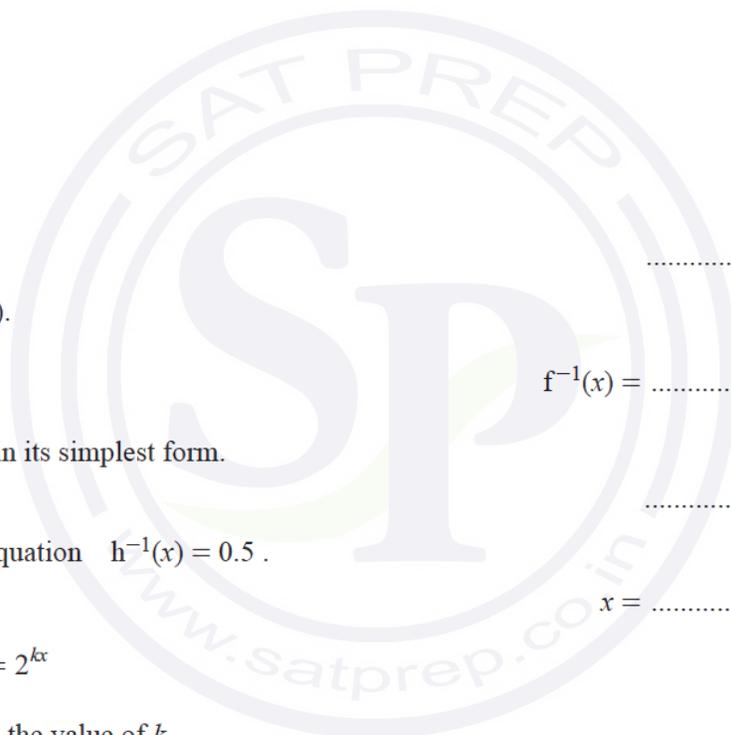
- (e) Solve the equation $h^{-1}(x) = 0.5$.

$$x = \dots\dots\dots [1]$$

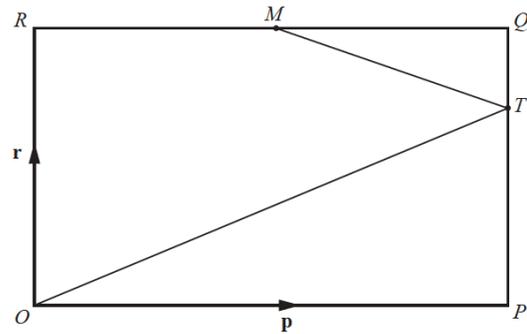
- (f) $\frac{1}{h(x)} = 2^{kx}$

Write down the value of k .

$$k = \dots\dots\dots [1]$$



Question 36



NOT TO SCALE

(a) Find, in terms of \mathbf{p} and/or \mathbf{r} , in its simplest form

(i) \vec{MQ} ,

$\vec{MQ} = \dots\dots\dots [1]$

(ii) \vec{MT} ,

$\vec{MT} = \dots\dots\dots [1]$

(iii) \vec{OT} .

$\vec{OT} = \dots\dots\dots [1]$

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

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

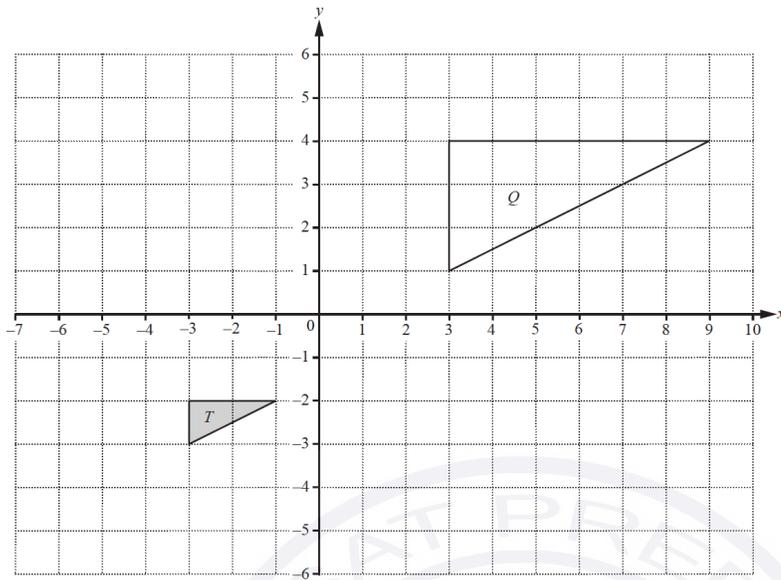
$\dots\dots\dots [2]$

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

Find the positive value of k .

$k = \dots\dots\dots [3]$

Question 37



(a) $\mathbf{m} = \begin{pmatrix} 3 \\ 2 \end{pmatrix}$ $\mathbf{n} = \begin{pmatrix} -2 \\ 3 \end{pmatrix}$

(i) Work out $2\mathbf{m} - 3\mathbf{n}$.

(i) Draw the image of triangle T after a translation by the vector $\begin{pmatrix} 5 \\ -2 \end{pmatrix}$. [2]

(ii) Draw the image of triangle T after a reflection in the line $y = 1$. [2]

(iii) Describe fully the **single** transformation that maps triangle T onto triangle Q .

.....
 [3]

Question 38

(a) $\mathbf{m} = \begin{pmatrix} 3 \\ 2 \end{pmatrix}$ $\mathbf{n} = \begin{pmatrix} -2 \\ 3 \end{pmatrix}$

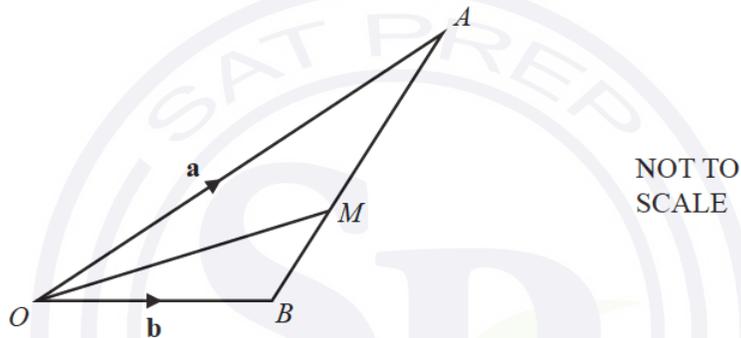
(i) Work out $2\mathbf{m} - 3\mathbf{n}$.

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

(ii) Calculate $|2\mathbf{m} - 3\mathbf{n}|$.

..... [2]

(b) (i)



In the diagram, O is the origin, $\vec{OA} = \mathbf{a}$ and $\vec{OB} = \mathbf{b}$.
The point M lies on AB such that $AM : MB = 3 : 2$.

Find, in terms of \mathbf{a} and \mathbf{b} , in its simplest form

(a) \vec{AB} ,

$\vec{AB} = \dots\dots\dots$ [1]

(b) \vec{AM} ,

$\vec{AM} = \dots\dots\dots$ [1]

(c) the position vector of M .

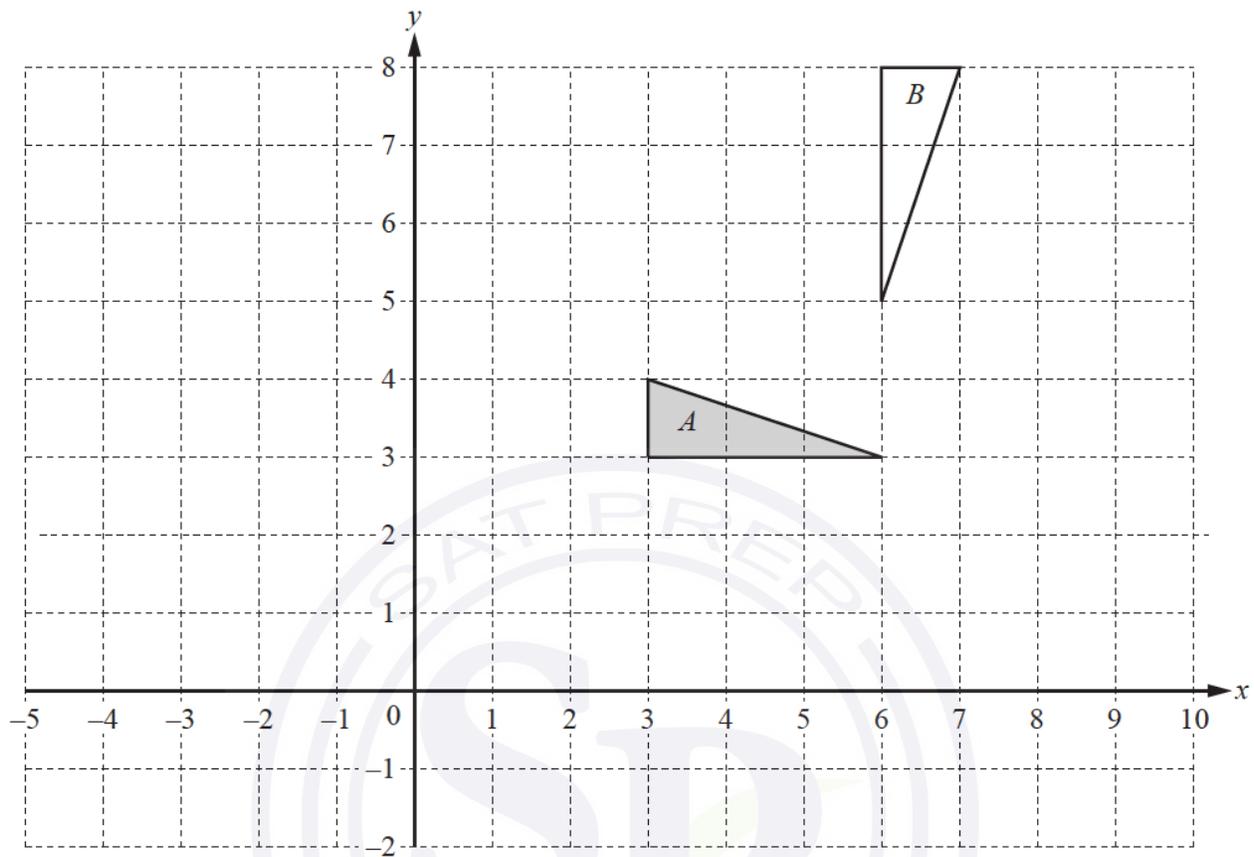
..... [2]

(ii) OM is extended to the point C .
The position vector of C is $\mathbf{a} + k\mathbf{b}$.

Find the value of k .

$k = \dots\dots\dots$ [1]

Question 39



(a) Draw the image when triangle A is reflected in the line $x = 1$. [2]

(b) Draw the image when triangle A is translated by the vector $\begin{pmatrix} -2 \\ 3 \end{pmatrix}$. [2]

(c) Draw the image when triangle A is enlarged by scale factor 2 with centre (4, 5). [2]

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

.....
 [3]

Question 40

(a) $y = \frac{3}{x} + 2, \quad x \neq 0$

(i) Find the value of y when $x = -6$.

$y = \dots\dots\dots [1]$

(ii) Find x in terms of y .

$x = \dots\dots\dots [3]$

(b) $g(x) = 2 - x \qquad h(x) = 2^x$

(i) Find $g(5)$.

$\dots\dots\dots [1]$

(ii) Find $h(2)$.

(iii) Find x when $g(x) = h(3)$.

$x = \dots\dots\dots [2]$

(iv) Find x when $g^{-1}(x) = -1$.

$x = \dots\dots\dots [1]$

Question 41

$f(x) = 2x + 1$

$g(x) = 3x - 2$

$h(x) = 3^x$

(a) Find $hf(2) - fh(1)$.

$\dots\dots\dots [3]$

(b) Find $gf(x)$, giving your answer in its simplest form.

$\dots\dots\dots [2]$

(c) Solve the inequality $f(x) > g(x)$.

$\dots\dots\dots [2]$

(d) Solve the equation $h(x) = \frac{1}{9}$.

$x = \dots\dots\dots [1]$

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

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

(f) Find $\frac{5}{f(x)} + g(x)$.

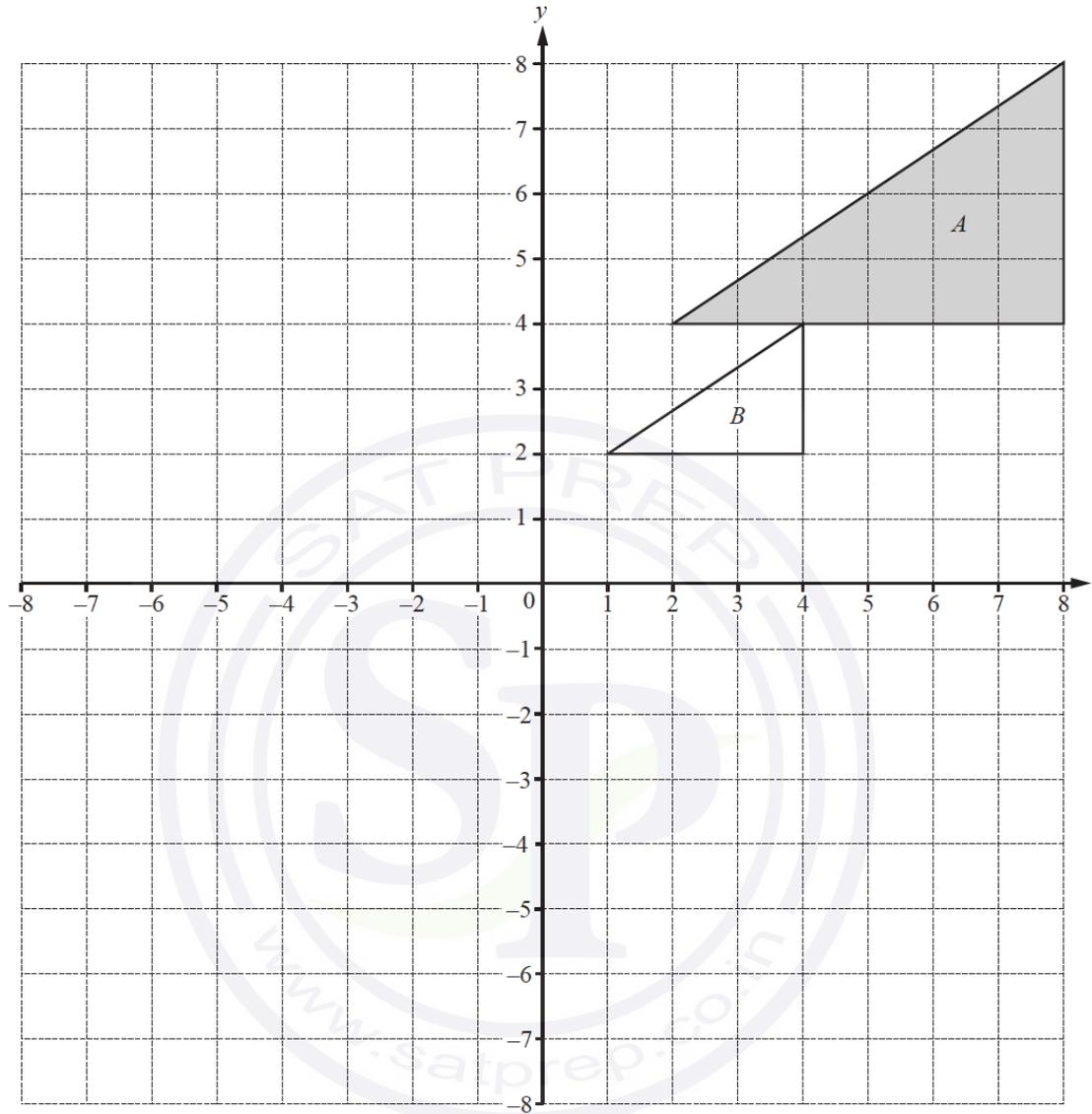
Give your answer as a single fraction.

$\dots\dots\dots [3]$

(g) Solve the equation $f^{-1}(x) = 4$.

$x = \dots\dots\dots [1]$

Question 41



(a) $\mathbf{v} = \begin{pmatrix} -4 \\ -8 \end{pmatrix}$

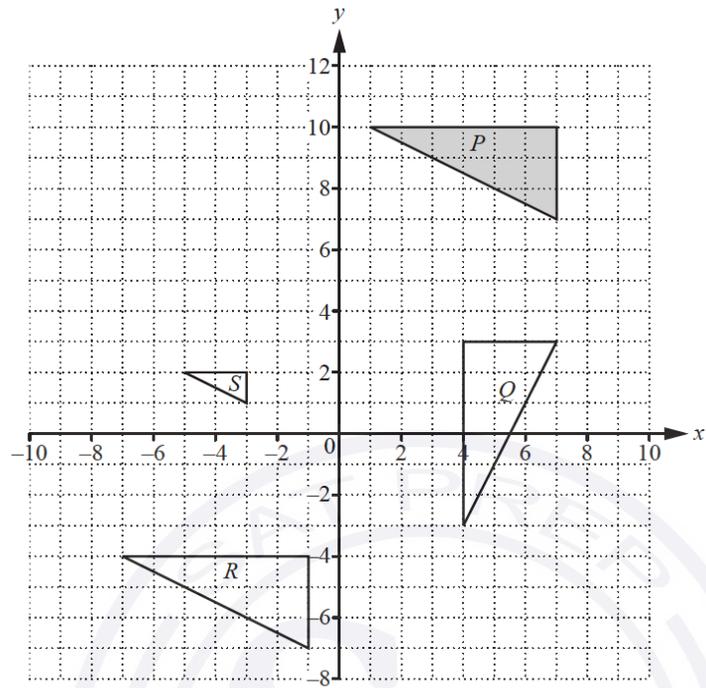
(i) Draw the image of triangle A after the translation by vector \mathbf{v} . [2]

(ii) Calculate $|\mathbf{v}|$.
 [2]

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

.....
 [3]

Question 43



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

(i) shape *P* onto shape *Q*,

.....
 [3]

(ii) shape *P* onto shape *R*,

.....
 [2]

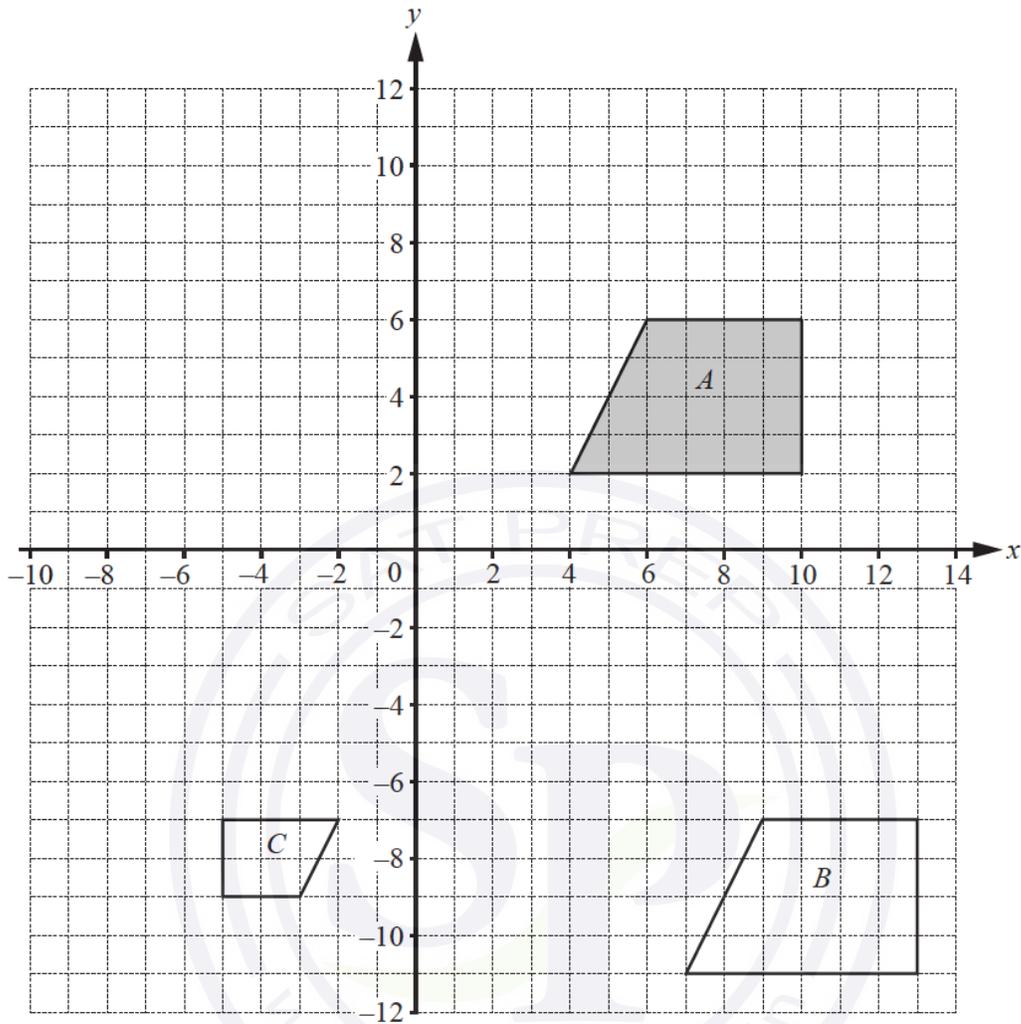
(iii) shape *P* onto shape *S*.

.....
 [3]

(b) (i) Draw the reflection of **shape S** in the line $y = x$.

[2]

Question 44



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

(i) shape *B*,

.....
 [2]

(ii) shape *C*.

.....
 [3]

(b) Draw the image of shape *A* after rotation through 90° anticlockwise about the point $(3, -1)$. [2]

(c) Draw the image of shape *A* after reflection in $y = 1$. [2]

Question 45

$$f(x) = 3x - 2$$

$$g(x) = x^2$$

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

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

..... [1]

(b) Find the value of x when $f(x) = 19$.

$x =$ [2]

(c) Find $fh(2)$.

..... [2]

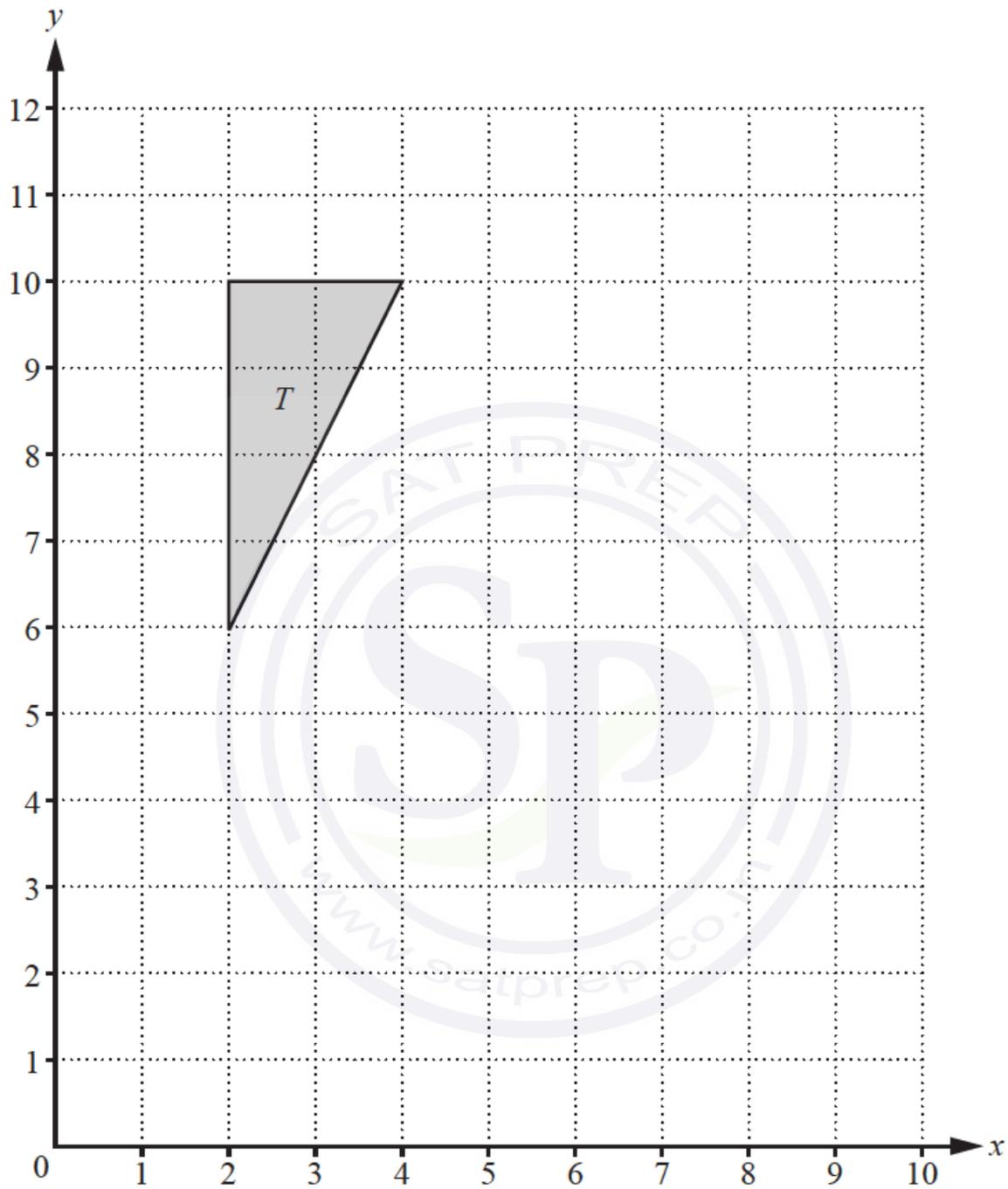
(d) Find $gf(x) + f(x) + x$.
Give your answer in its simplest form.

..... [3]

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

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

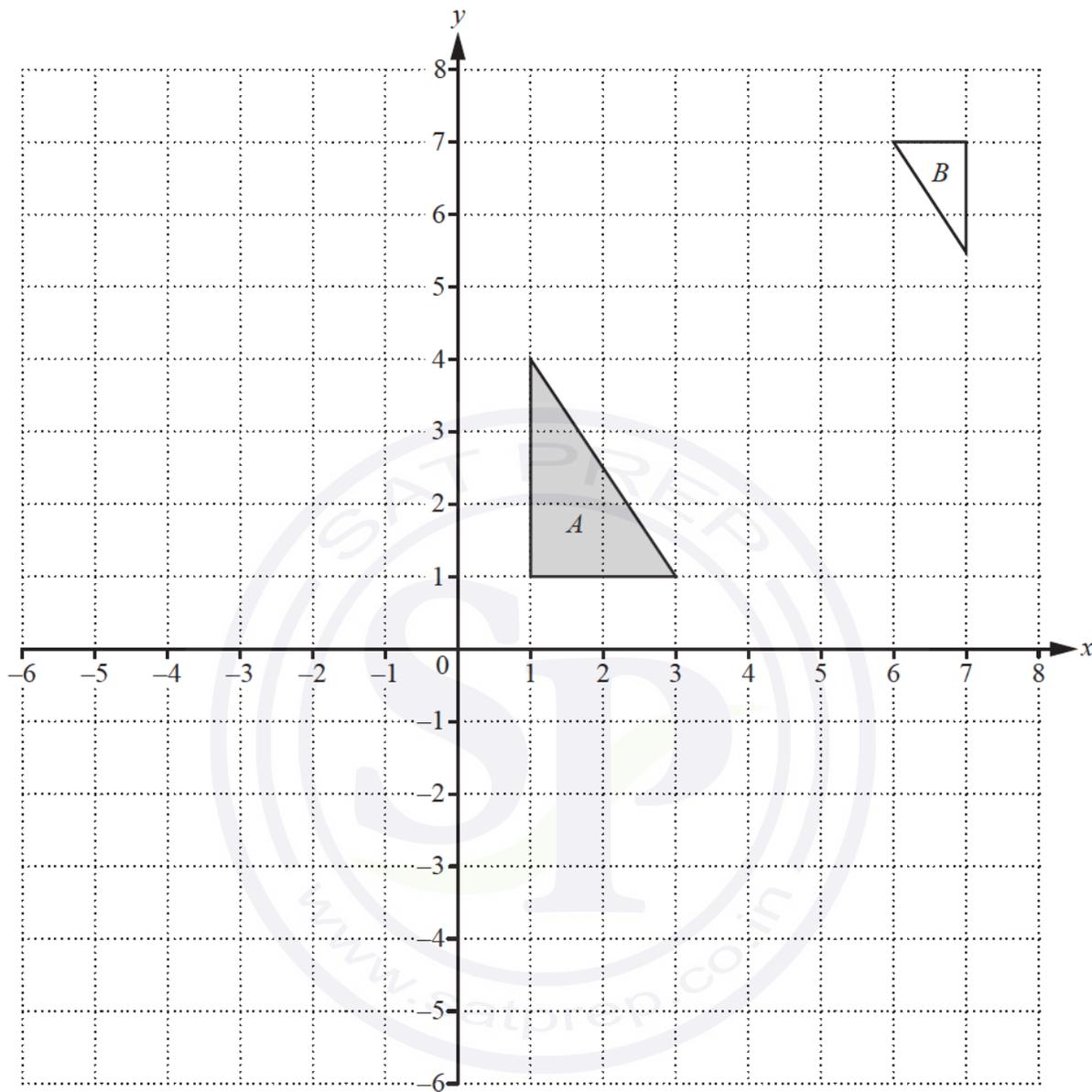
Question 46



On the grid, draw the image of

- (i) triangle T after translation by the vector $\begin{pmatrix} 6 \\ -5 \end{pmatrix}$, [2]
- (ii) triangle T after rotation through 90° anticlockwise with centre $(4, 10)$, [2]
- (iii) triangle T after enlargement with scale factor $\frac{1}{2}$, centre $(10, 0)$. [2]

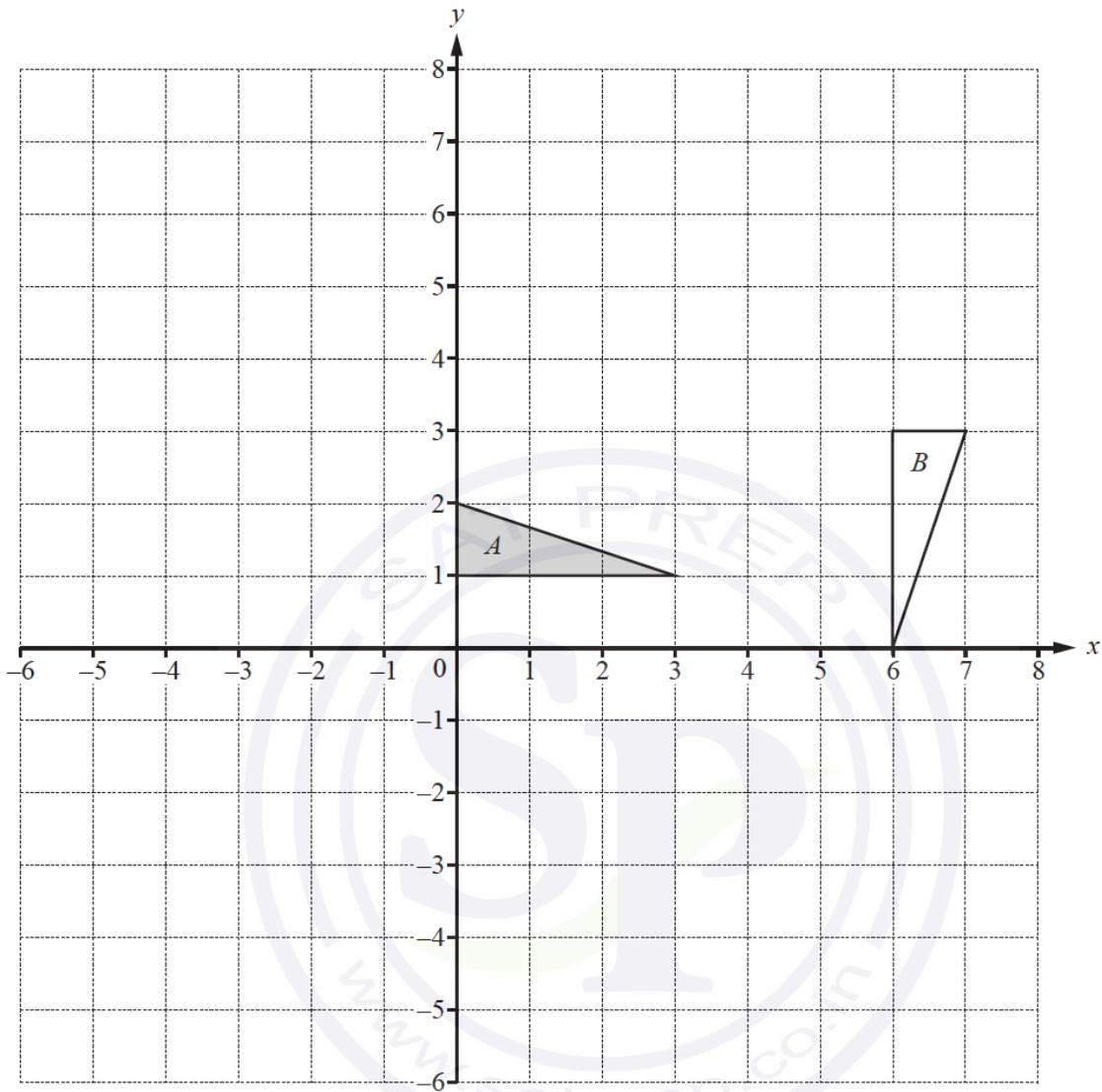
Question 47



- (a) (i) Draw the image of triangle A after reflection in the line $x = 4$. [2]
- (ii) Draw the image of triangle A after rotation of 90° anticlockwise about $(0, 0)$. [2]
- (iii) Draw the image of triangle A after translation by the vector $\begin{pmatrix} 1 \\ -5 \end{pmatrix}$. [2]
- (b) Describe fully the **single** transformation that maps triangle A onto triangle B .

.....
 [3]

Question 48



(a) Draw the image of

(i) triangle A after a reflection in the line $x = 0$, [2]

(ii) triangle A after an enlargement, scale factor 2, centre $(0, 4)$, [2]

(iii) triangle A after a translation by the vector $\begin{pmatrix} -5 \\ 3 \end{pmatrix}$. [2]

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

.....
 [3]

Question 49

$$f(x) = 1 - 2x \qquad g(x) = x + 4 \qquad h(x) = x^2 + 1$$

(a) Find $f(-1)$.

..... [1]

(b) Solve the equation.

$$2f(x) = g(x)$$

$x =$ [2]

(c) Find $fg(x)$.

Give your answer in its simplest form.

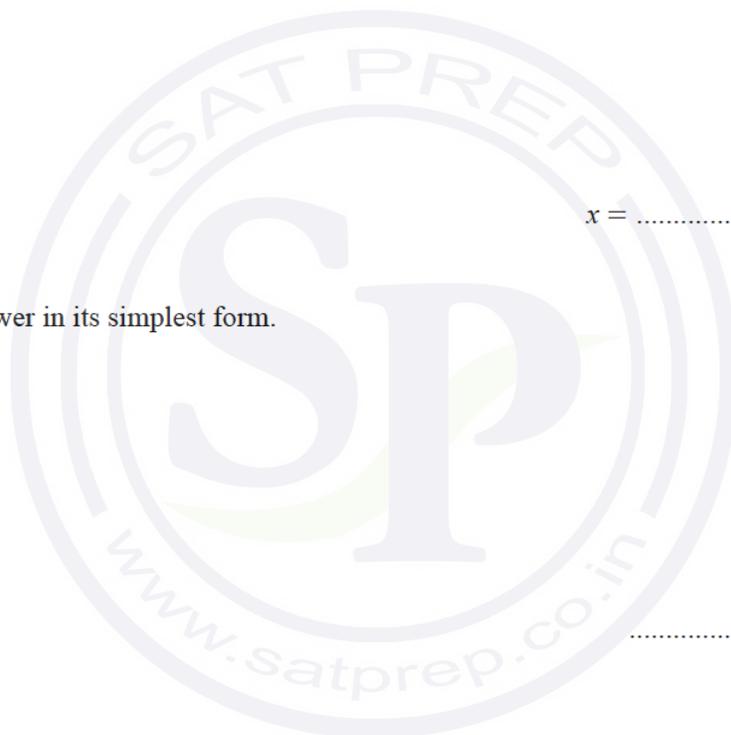
..... [2]

(d) Find $hh(2)$.

..... [2]

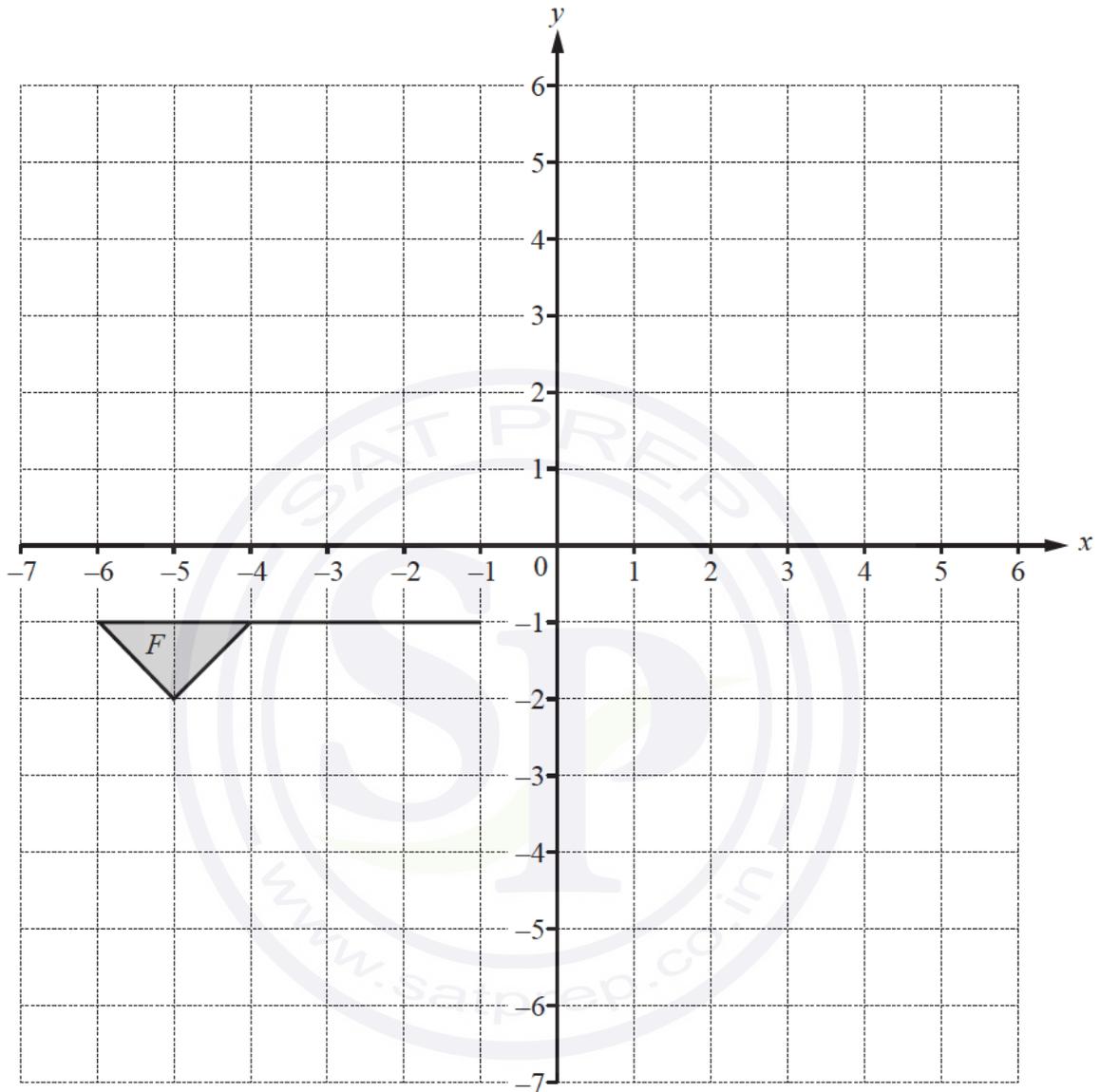
(e) Find $f^{-1}(x)$.

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



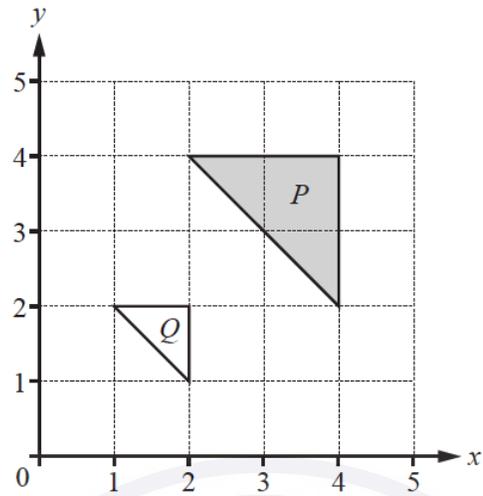
Question 50

(a)



Continue on the next page...

(b)



(i) Describe fully the **single** transformation that maps triangle P onto triangle Q .

.....
..... [3]

(c) The point A is translated to the point B by the vector $\begin{pmatrix} 4u \\ 3u \end{pmatrix}$.

$$|\vec{AB}| = 12.5$$

Find u .

$u =$ [3]

Question 51

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

(i) Find $gg(2)$.

..... [2]

(ii) Find $g(x+2)$, giving your answer in its simplest form.

..... [2]

(iii) Find x when $f(x) = 7$.

$x =$ [2]

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

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

(b) $h(x) = x^x, x > 0$

(i) Calculate $h(0.3)$.
Give your answer correct to 2 decimal places.

..... [2]

(ii) Find x when $h(x) = 256$.

$x =$ [1]

Question 52

$$f(x) = 8 - 3x$$

$$g(x) = \frac{10}{x+1}, x \neq -1$$

$$h(x) = 2^x$$

(a) Find

(i) $hf\left(\frac{8}{3}\right)$,

..... [2]

(ii) $gh(-2)$,

..... [2]

(iii) $g^{-1}(x)$,

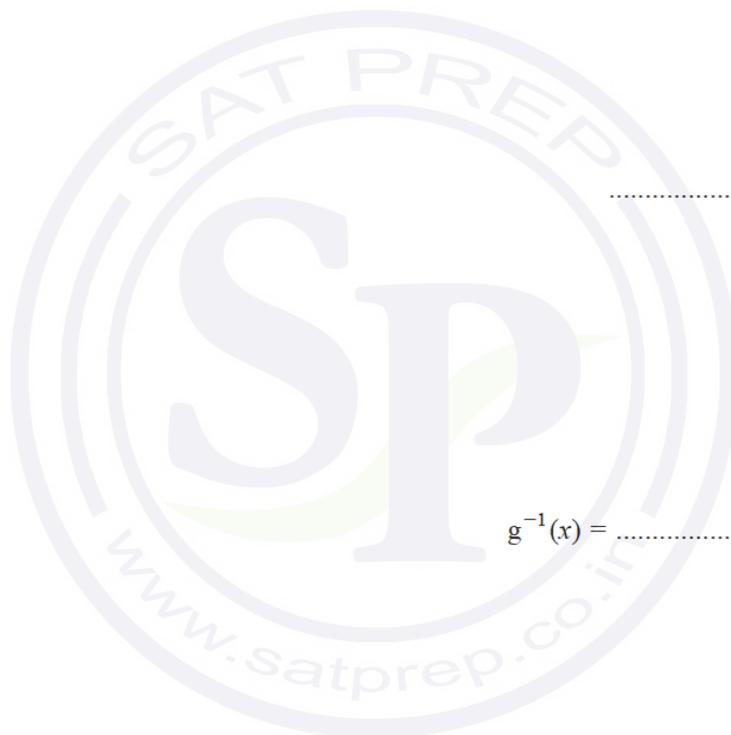
$g^{-1}(x) =$ [3]

(iv) $f^{-1}f(5)$.

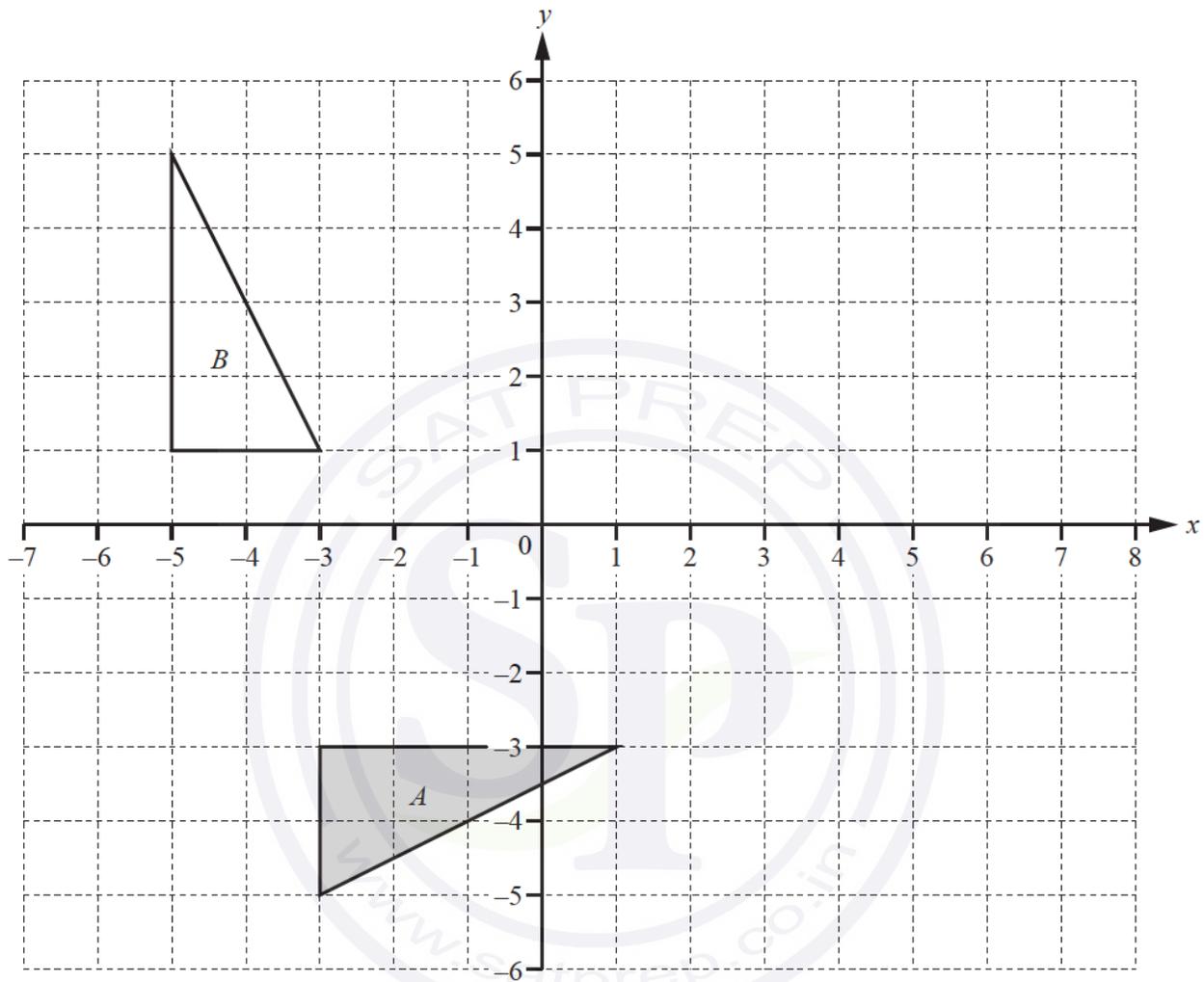
..... [1]

(b) Write $f(x) + g(x)$ as a single fraction in its simplest form.

..... [3]



Question 53



(a) (i) Draw the image of triangle *A* after a reflection in the line $x = 2$. [2]

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

(iii) Draw the image of triangle *A* after an enlargement by scale factor $-\frac{1}{2}$, centre (3, 1). [3]

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

.....
 [3]

Question 54

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

Find

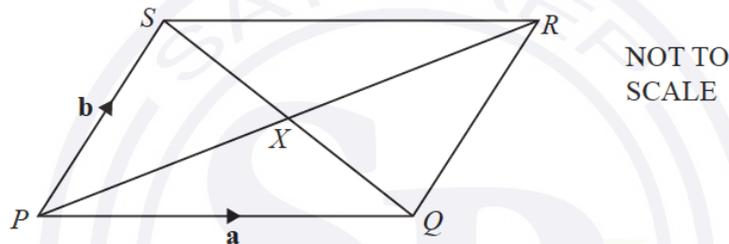
(i) $|\vec{OB}|$,

$|\vec{OB}| = \dots\dots\dots [3]$

(ii) \vec{BC} .

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

(b)



$PQRS$ is a parallelogram with diagonals PR and SQ intersecting at X .

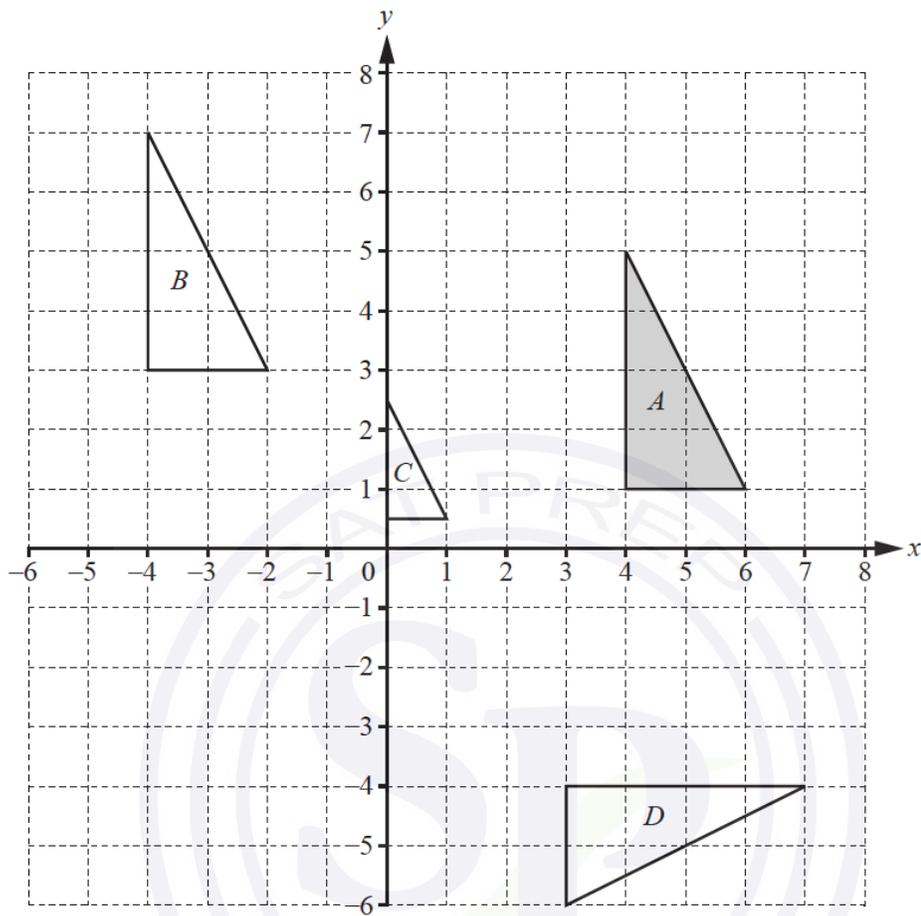
$\vec{PQ} = \mathbf{a}$ and $\vec{PS} = \mathbf{b}$.

Find \vec{QX} in terms of \mathbf{a} and \mathbf{b} .

Give your answer in its simplest form.

$\vec{QX} = \dots\dots\dots [2]$

Question 55



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

(i) triangle *A* onto triangle *B*,

.....
 [2]

(ii) triangle *A* onto triangle *C*,

.....
 [3]

(iii) triangle *A* onto triangle *D*.

.....
 [3]

Question 56

(a) $\mathbf{a} = \begin{pmatrix} -3 \\ 2 \end{pmatrix}$ $\mathbf{b} = \begin{pmatrix} 5 \\ 4 \end{pmatrix}$ $\mathbf{c} = \begin{pmatrix} 14 \\ 9 \end{pmatrix}$

(i) Find $3\mathbf{a} - 2\mathbf{b}$.

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

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

..... [2]

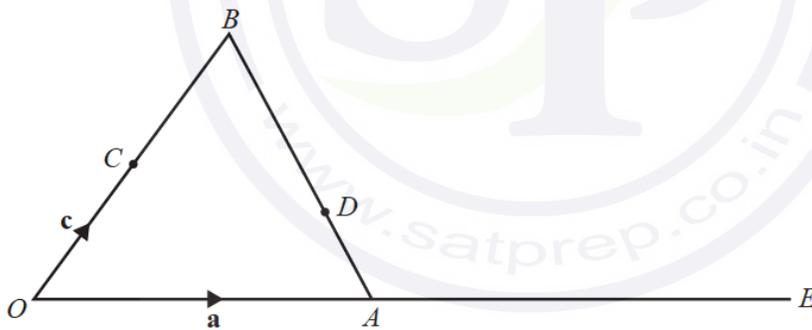
(iii) $m\mathbf{a} + n\mathbf{b} = \mathbf{c}$

Write down two simultaneous equations and solve them to find the value of m and the value of n . Show all your working.

$m = \dots\dots\dots$

$n = \dots\dots\dots$ [5]

(b)



NOT TO SCALE

OAB is a triangle and C is the mid-point of OB .
 D is on AB such that $AD : DB = 3 : 5$.
 OAE is a straight line such that $OA : AE = 2 : 3$.
 $\vec{OA} = \mathbf{a}$ and $\vec{OC} = \mathbf{c}$.

Continue on the next page...

(i) Find, in terms of \mathbf{a} and \mathbf{c} , in its simplest form,

(a) \vec{AB} ,

$$\vec{AB} = \dots\dots\dots [1]$$

(b) \vec{AD} ,

$$\vec{AD} = \dots\dots\dots [1]$$

(c) \vec{CE} ,

$$\vec{CE} = \dots\dots\dots [1]$$

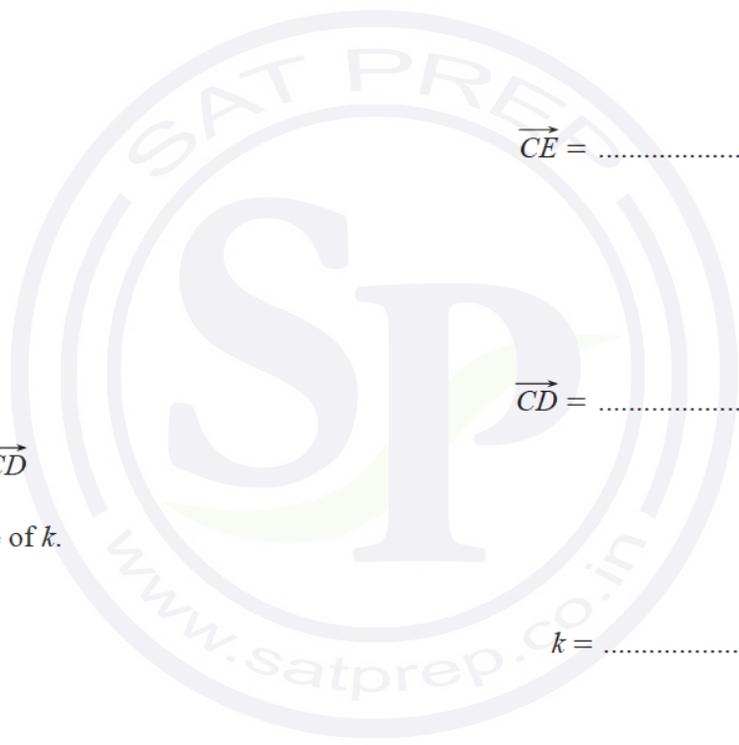
(d) \vec{CD} .

$$\vec{CD} = \dots\dots\dots [2]$$

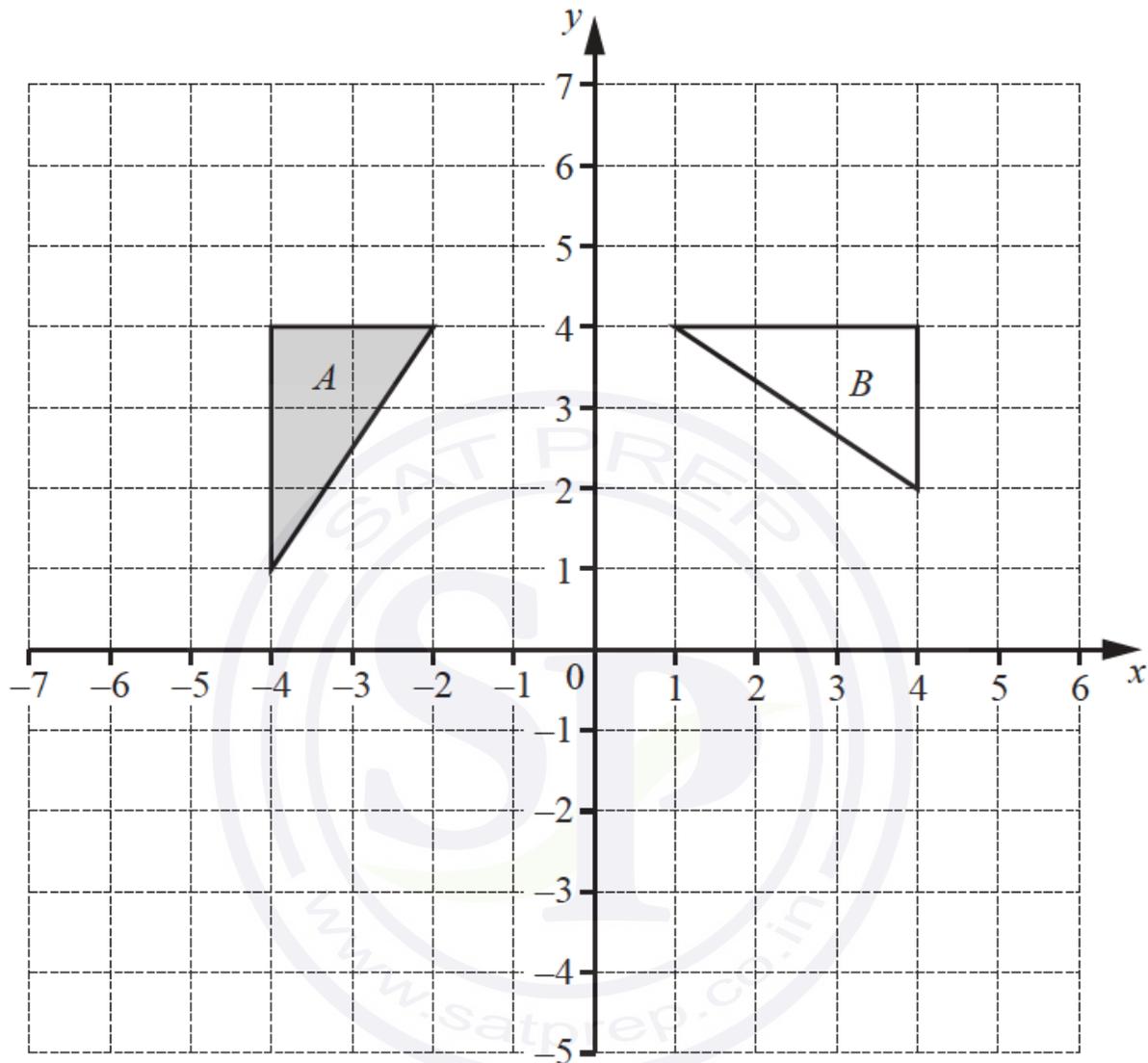
(ii) $\vec{CE} = k\vec{CD}$

Find the value of k .

$$k = \dots\dots\dots [1]$$



Question 57



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

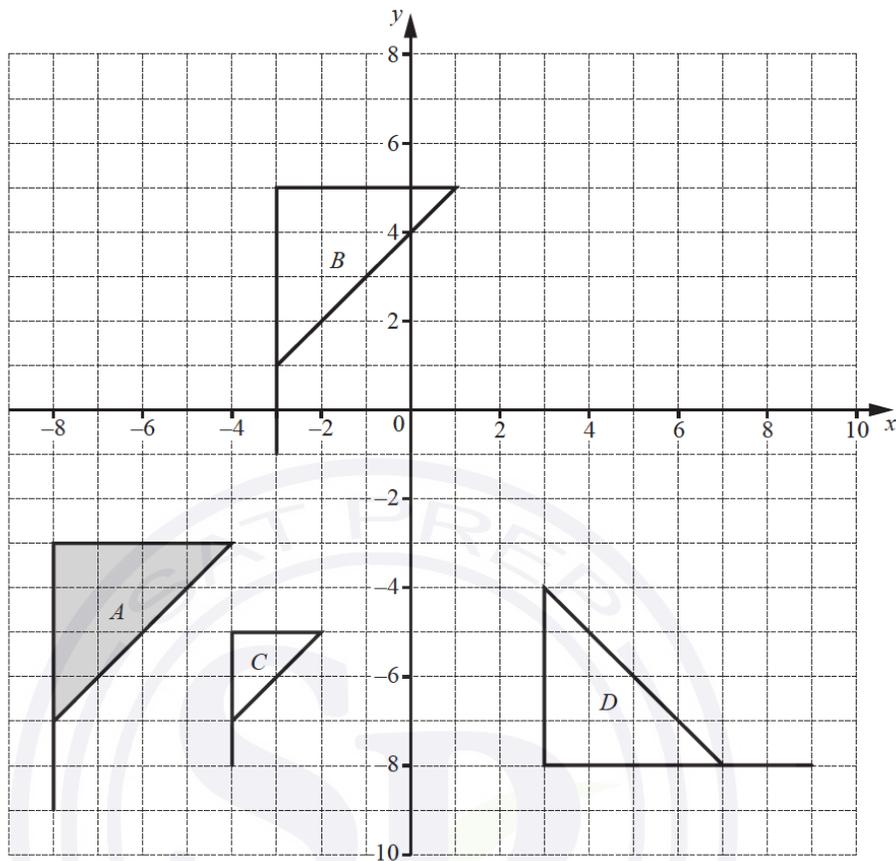
.....
 [3]

(b) On the grid, draw the image of

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

(ii) triangle *A* after a translation by the vector $\begin{pmatrix} 7 \\ -5 \end{pmatrix}$, [2]

Question 58



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

(i) flag *A* onto flag *B*,

.....
 [2]

(ii) flag *A* onto flag *C*,

.....
 [3]

(iii) flag *A* onto flag *D*.

.....
 [3]

(b) Draw the reflection of flag *A* in the line $y = -1$.

[2]

Question 59

$$f(x) = \frac{3}{x+2}, x \neq -2$$

$$g(x) = 8x - 5$$

$$h(x) = x^2 + 6$$

(a) Work out $g\left(\frac{1}{4}\right)$.

..... [1]

(b) Work out $ff(2)$.

..... [2]

(c) Find $gg(x)$, giving your answer in its simplest form.

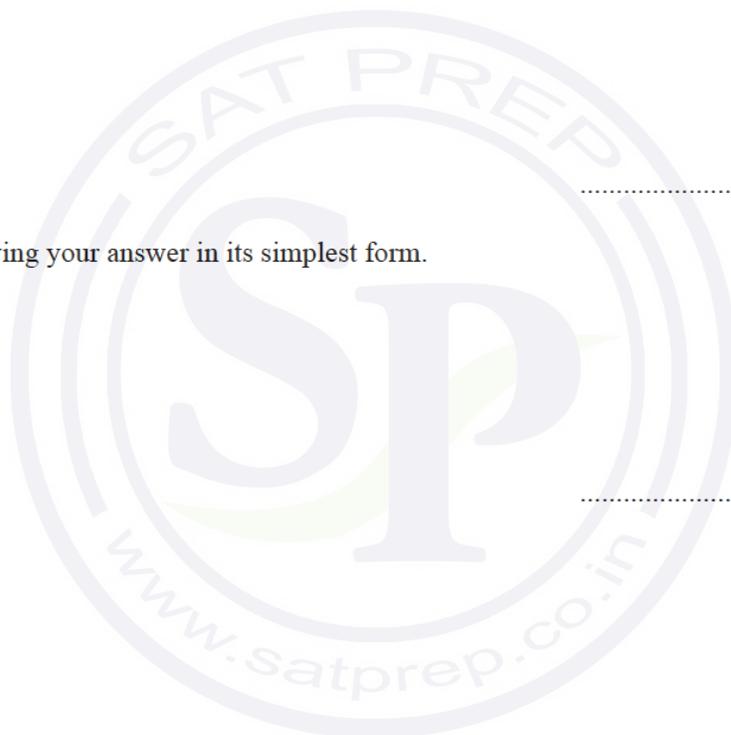
..... [2]

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

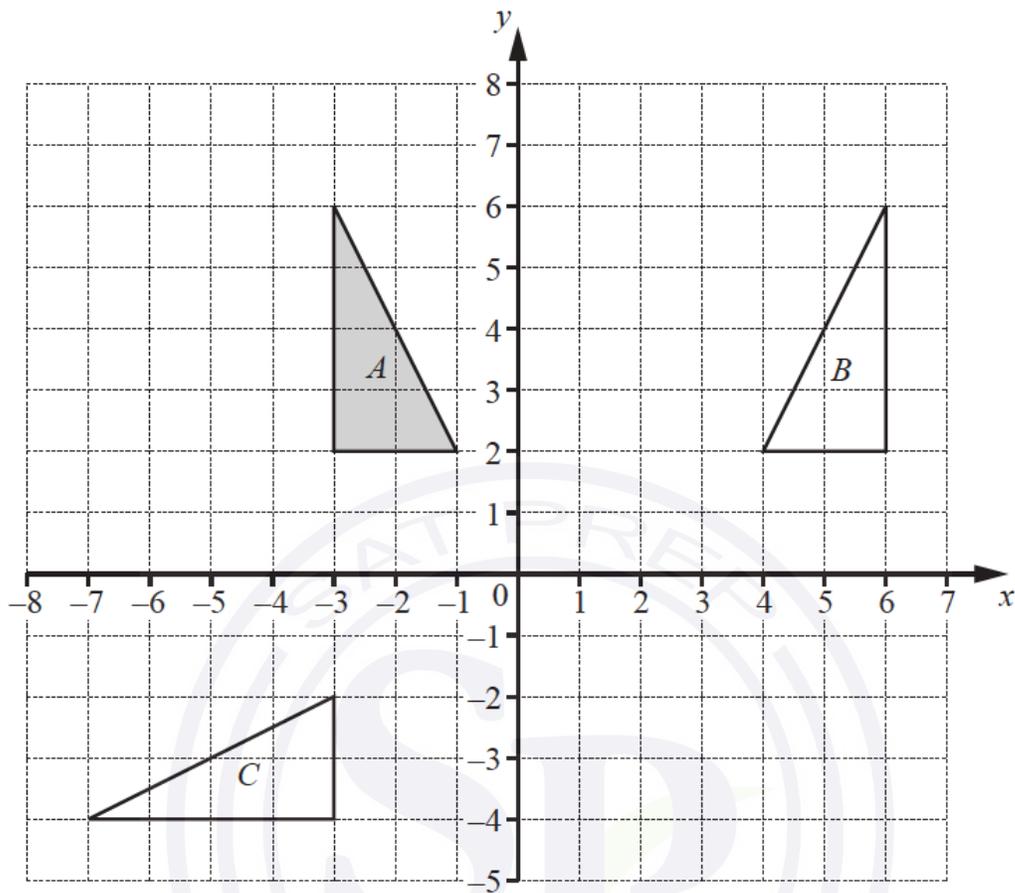
$g^{-1}(x) =$ [2]

(e) Write $g(x) - f(x)$ as a single fraction in its simplest form.

..... [3]



Question 60



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

(i) triangle *A* onto triangle *B*,

.....
 [2]

(ii) triangle *A* onto triangle *C*.

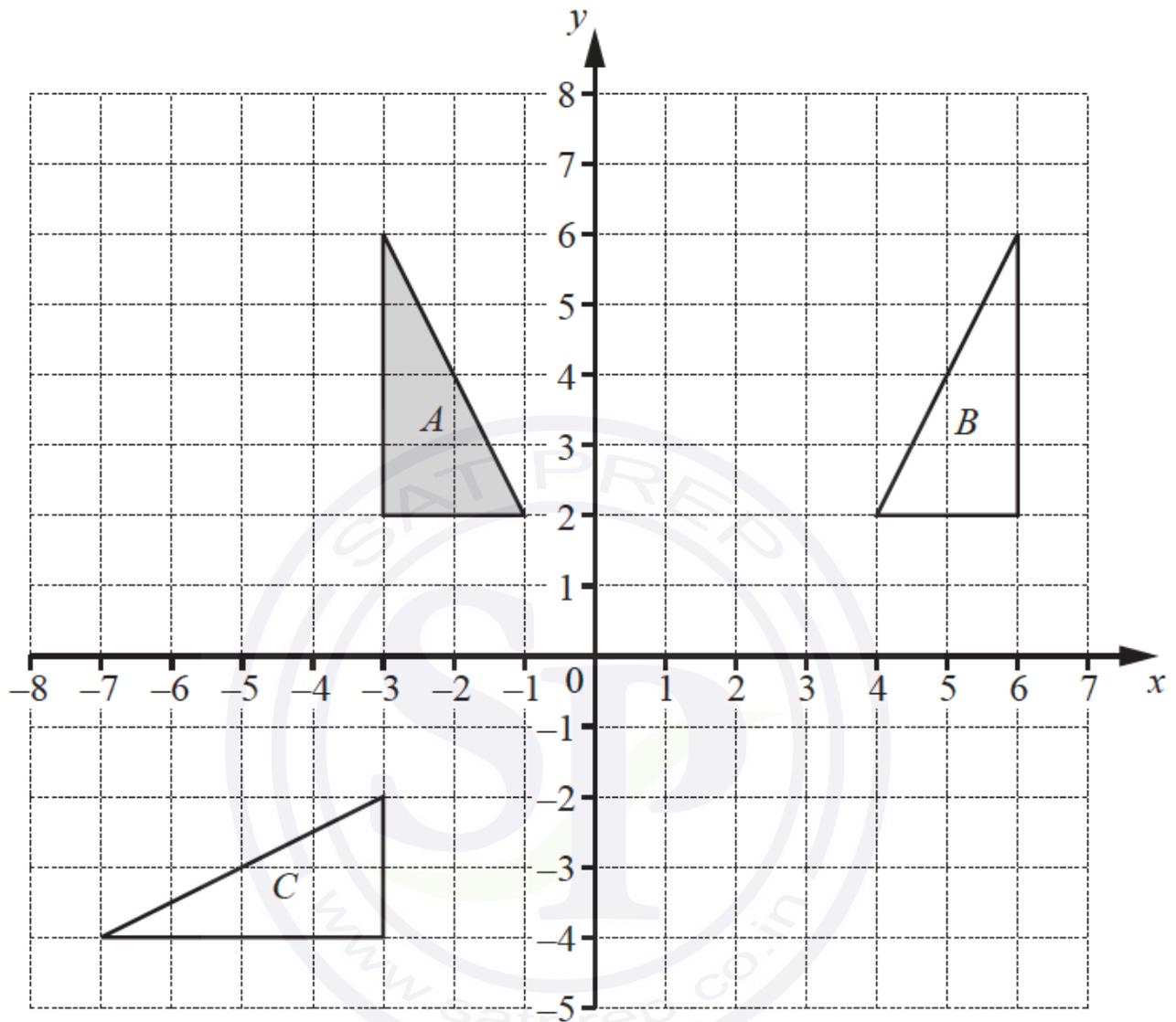
.....
 [3]

(b) On the grid, draw the image of

(i) triangle *A* after an enlargement, scale factor $-\frac{1}{2}$, centre $(3, 0)$, [2]

(ii) triangle *A* after a translation by the vector $\begin{pmatrix} -3 \\ 1 \end{pmatrix}$, [2]

Question 61



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

(i) triangle *A* onto triangle *B*,

.....

..... [2]

Continue on the next page...

(ii) triangle A onto triangle C .

.....
..... [3]

(b) On the grid, draw the image of

(i) triangle A after an enlargement, scale factor $-\frac{1}{2}$, centre $(3, 0)$, [2]

(ii) triangle A after a translation by the vector $\begin{pmatrix} -3 \\ 1 \end{pmatrix}$, [2]

Question 62

$$f(x) = 7x - 2$$

$$g(x) = x^2 + 1$$

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

(a) Find $gh(2)$.

..... [2]

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

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

(c) $gg(x) = ax^4 + bx^2 + c$

Find the values of a , b and c .

(c) $gg(x) = ax^4 + bx^2 + c$

Find the values of a , b and c .

$a =$

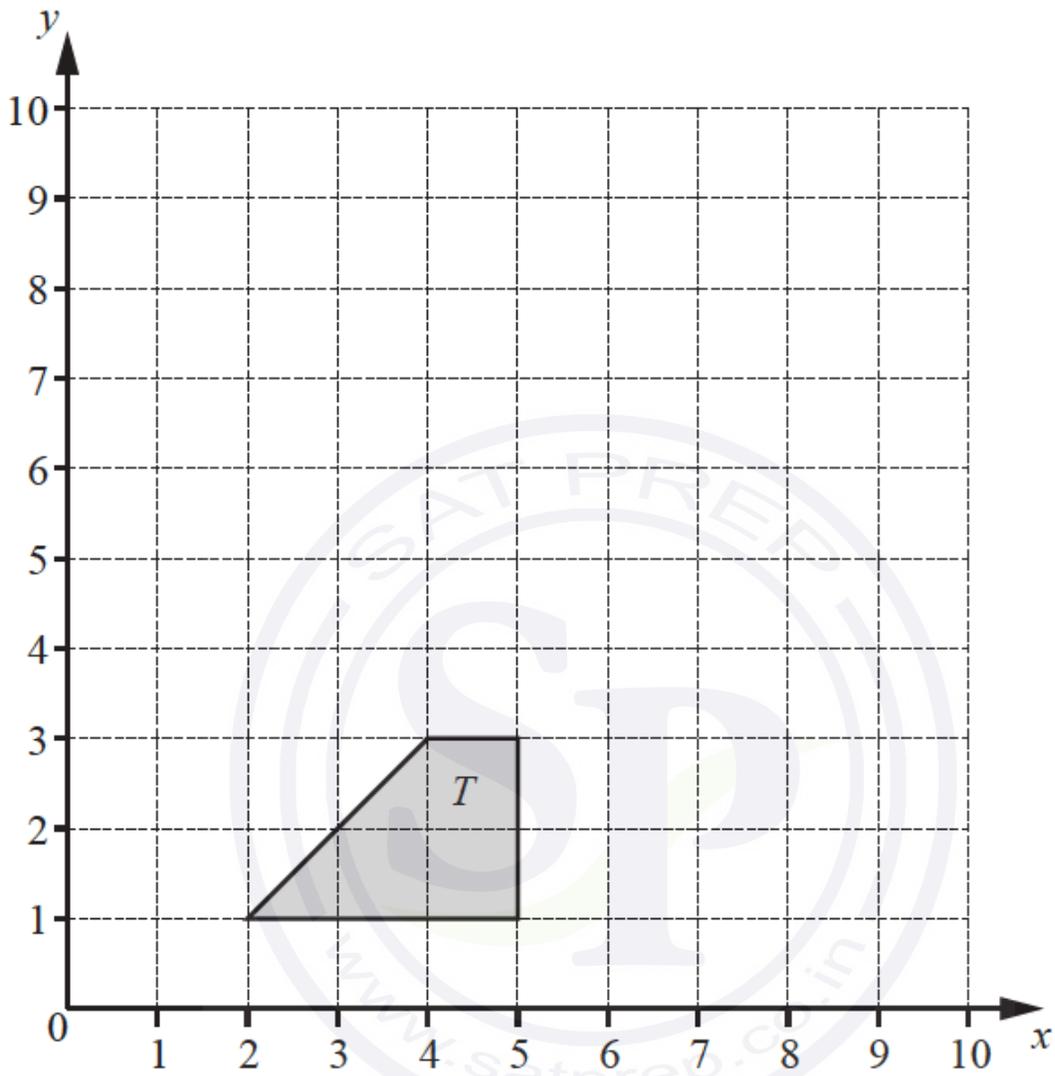
$b =$ |

$c =$ [3]

(d) Find x when $hf(x) = 81$.

$x =$ [3]

Question 63



- (a) (i) Translate shape *T* by the vector $\begin{pmatrix} -1 \\ 6 \end{pmatrix}$.
 Label the image *A*. [2]
- (ii) Rotate shape *T* about the point (5, 3) through 180°. Label the image *B*. [2]
- (iii) Describe fully the **single** transformation that maps shape *A* onto shape *B*.
 [3]

- (b) (i) Reflect shape *T* in the line $y = x$. [2]

Question 64

$$f(x) = 2x - 3$$

$$g(x) = 9 - x^2$$

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

(a) Find

(i) $f(4)$,

..... [1]

(ii) $hg(3)$,

..... [2]

(iii) $g(2x)$ in its simplest form,

..... [1]

(iv) $fg(x)$ in its simplest form.

..... [2]

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

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

(c) Find x when $5f(x) = 3$.

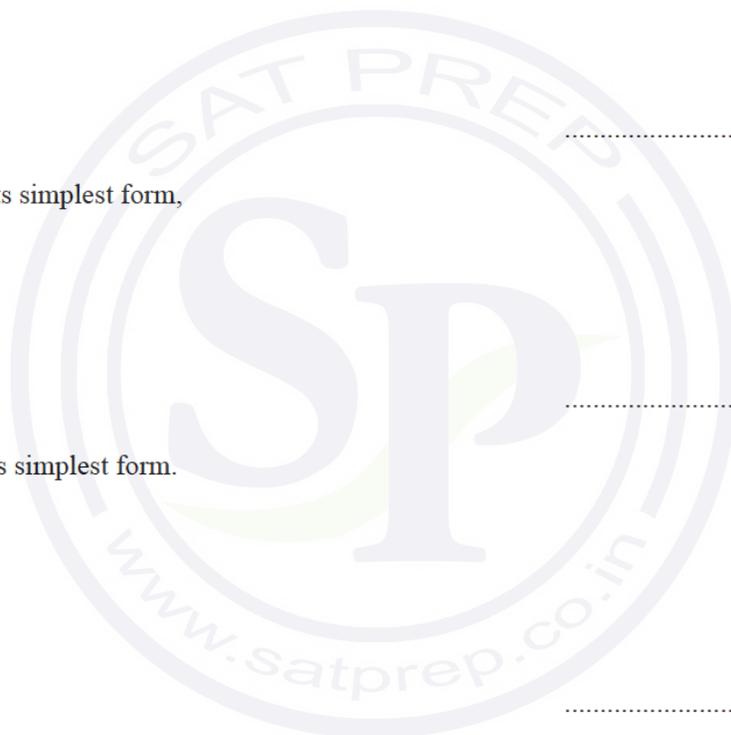
$x =$ [2]

(d) Solve the equation $gf(x) = -16$.

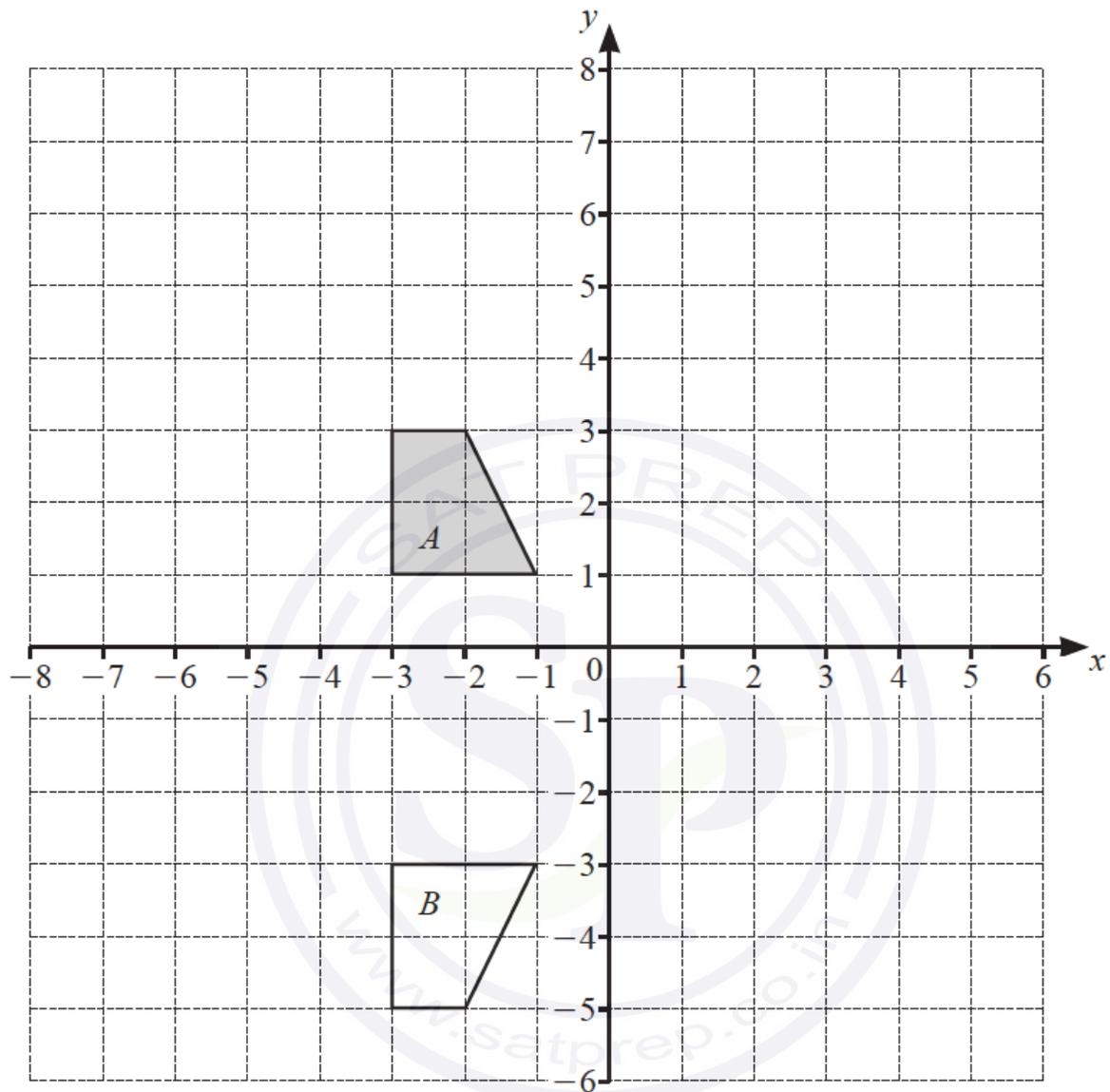
$x =$ or $x =$ [4]

(e) Find x when $h^{-1}(x) = -2$.

$x =$ [1]



Question 65



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

.....
 [2]

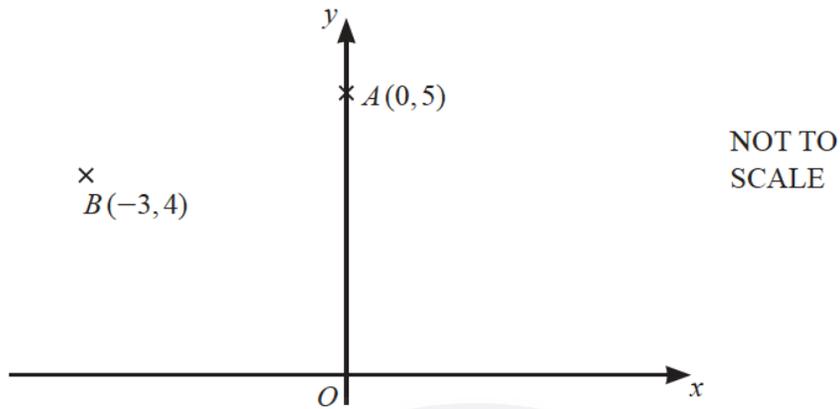
(b) On the grid, draw the image of

(i) shape *A* after a translation by the vector $\begin{pmatrix} -3 \\ 4 \end{pmatrix}$, [2]

(ii) shape *A* after a rotation through 180° about $(0, 0)$, [2]

(iii) shape *A* after an enlargement, scale factor 2, centre $(-7, 0)$. [2]

Question 66



(i) Write \vec{OA} as a column vector.

$$\vec{OA} = \begin{pmatrix} \\ \end{pmatrix} \quad [1]$$

(ii) Write \vec{AB} as a column vector.

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

(iii) A and B lie on a circle, centre O .

Calculate the length of the arc AB .

..... [6]

Question 67

$$f(x) = 7 - 2x \qquad g(x) = \frac{10}{x}, x \neq 0 \qquad h(x) = 27^x$$

(a) Find

(i) $f(-3)$,

..... [1]

(ii) $hg(30)$,

..... [2]

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

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

(b) Solve.

$$g(2x + 1) = 4$$

$x =$ [3]

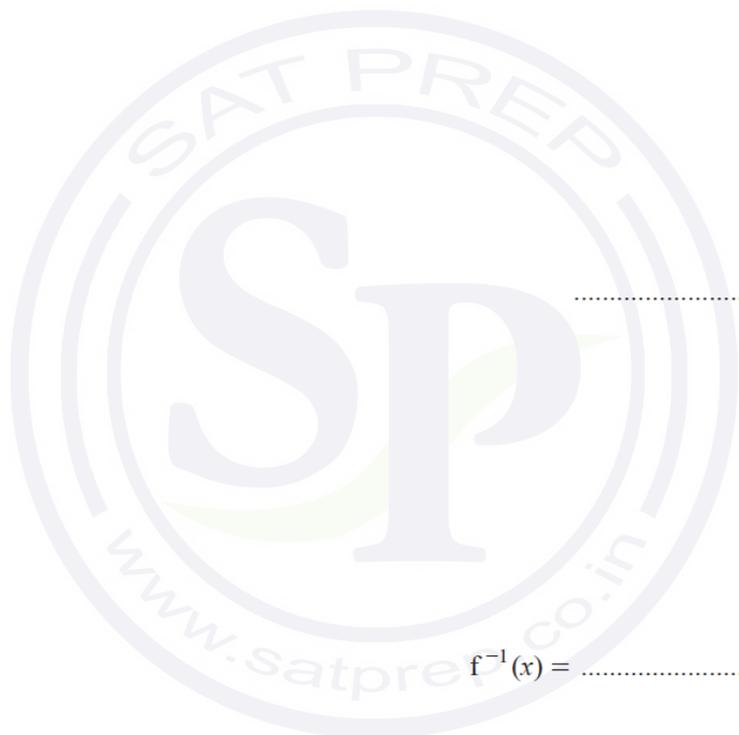
(c) Simplify, giving your answer as a single fraction.

$$\frac{1}{f(x)} + g(x)$$

..... [3]

(d) Find $h^{-1}(19\,683)$.

..... [1]



Question 68

A line joins $A (1, 3)$ to $B (5, 8)$.

- (a) (i) Find the midpoint of AB .

(.....,) [2]

- (ii) Find the equation of the line AB .
Give your answer in the form $y = mx + c$.

$y =$ [3]

- (b) The line AB is transformed to the line PQ .

Find the co-ordinates of P and the co-ordinates of Q after AB is transformed by

- (i) a translation by the vector $\begin{pmatrix} 5 \\ -2 \end{pmatrix}$,

P (.....,)

Q (.....,) [2]

- (ii) a rotation through 90° anticlockwise about the origin,

P (.....,)

Q (.....,) [2]

- (iii) a reflection in the line $x = 2$,

P (.....,)

Q (.....,) [2]

Continue on them next ...

Question 69

$$f(x) = 4x - 1$$

$$g(x) = x^2$$

$$h(x) = 3^{-x}$$

(a) Find in its simplest form

(i) $f(x-3)$,

..... [1]

(ii) $g(5x)$.

..... [1]

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

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

(c) Find the value of $hh(1)$, correct to 4 significant figures.

..... [3]

(d) (i) Show that $g(3x-2) - h(-3)$ can be written as $9x^2 - 12x - 23$.

[2]

(ii) Use the quadratic formula to solve $9x^2 - 12x - 23 = 0$.
Give your answers correct to 2 decimal places.

$x =$ or $x =$ [4]

(e) Find x when $f(61) = h(x)$.

$x =$ [2]

Question 70

$$f(x) = 7x - 4$$

$$g(x) = \frac{2x}{x-3}, x \neq 3$$

$$h(x) = x^2$$

(a) Find $g(6)$.

..... [1]

(b) Find $fg(4)$.

..... [2]

(c) Find $fh(x)$.

..... [1]

(d) Find $\frac{f(x)}{2} + g(x)$.

Give your answer as a single fraction, in terms of x , in its simplest form.

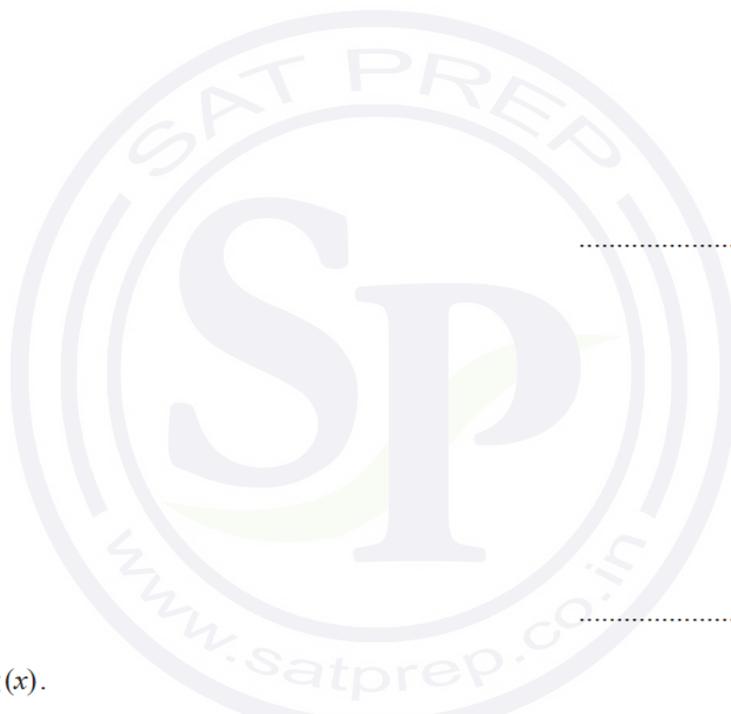
..... [3]

(e) Find the value of x when $f(x+2) = -11$.

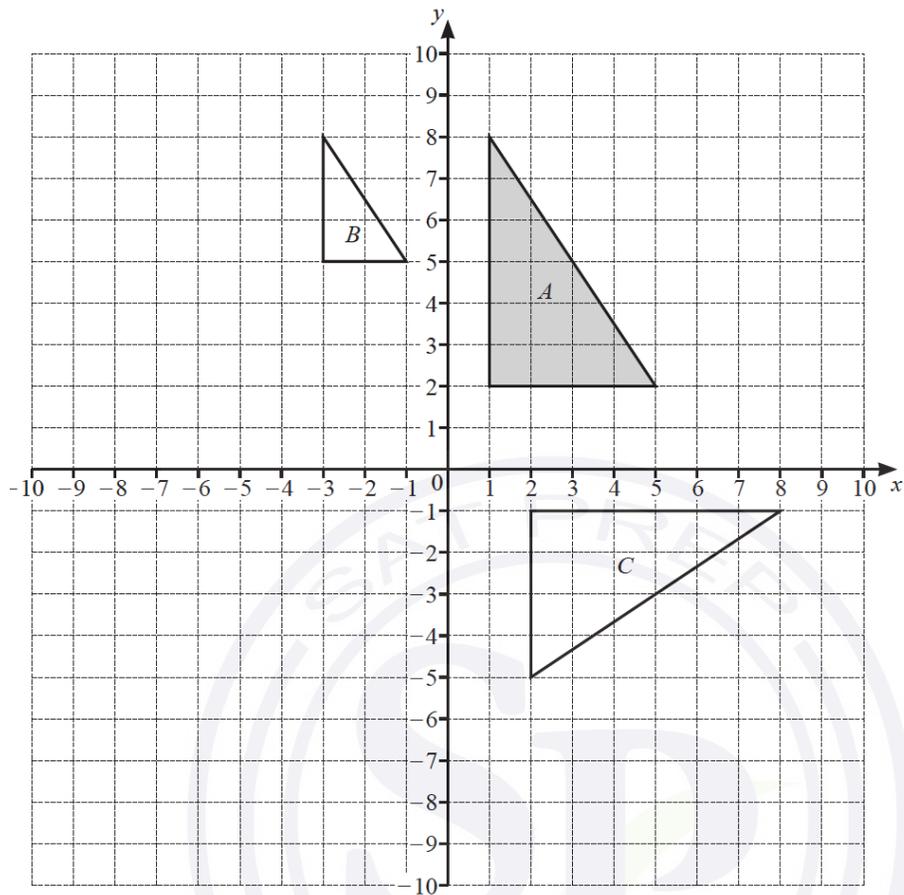
$x =$ [2]

(f) Find the values of p that satisfy $h(p) = p$.

..... [2]



Question 71



(a) (i) Draw the image of triangle A after a reflection in the line $y = -x$. [2]

(ii) Draw the image of triangle A after a translation by the vector $\begin{pmatrix} -2 \\ -9 \end{pmatrix}$. [2]

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

(i) triangle A onto triangle B ,

.....
 [3]

(ii) triangle A onto triangle C .

.....
 [3]

Question 72

$$f(x) = 3x + 2 \qquad g(x) = x^2 + 1 \qquad h(x) = 4^x$$

(a) Find $h(4)$.

..... [1]

(b) Find $fg(1)$.

..... [2]

(c) Find $gf(x)$ in the form $ax^2 + bx + c$.

..... [3]

(d) Find x when $f(x) = g(7)$.

$x =$ [2]

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

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

(f) Find $\frac{g(x)}{f(x)} + x$.

Give your answer as a single fraction, in terms of x , in its simplest form.

..... [3]

(g) Find x when $h^{-1}(x) = 2$.

$x =$ [1]

Question 73

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

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

$\left(\begin{array}{c} \\ \end{array} \right)$ [2]

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

..... [2]

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

Find the coordinates of B .

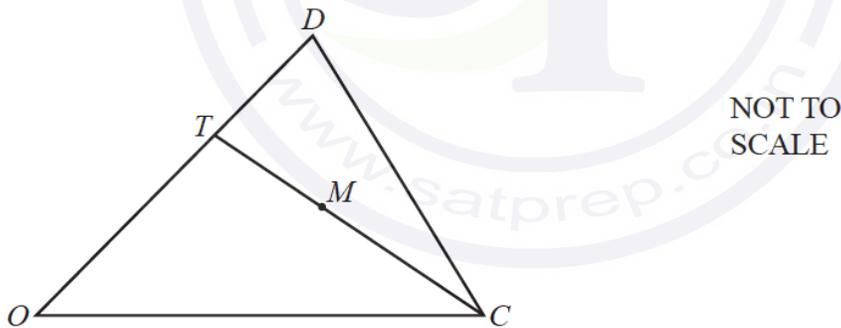
(.....,) [1]

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

Write down the coordinates of G .

(.....,) [1]

(d)



In the diagram, O is the origin, $OT = 2TD$ and M is the midpoint of TC .

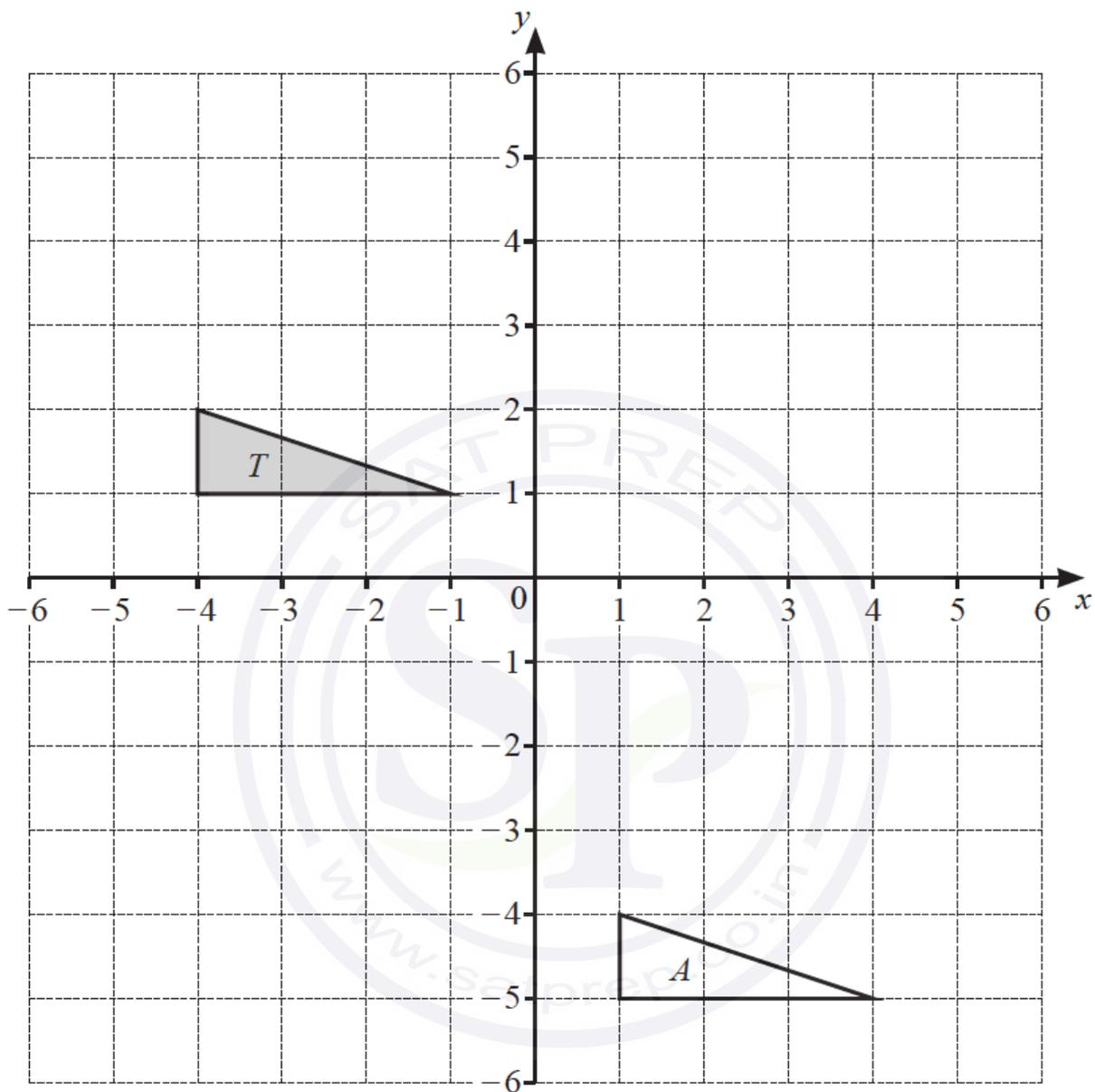
$\vec{OC} = \mathbf{c}$ and $\vec{OD} = \mathbf{d}$.

Find the position vector of M .

Give your answer in terms of \mathbf{c} and \mathbf{d} in its simplest form.

..... [3]

Question 74



- (a) Draw the image of triangle T after a reflection in the line $y = -1$. [2]
- (b) Draw the image of triangle T after a rotation through 90° clockwise about $(0, 0)$. [2]
- (c) Describe fully the **single** transformation that maps triangle T onto triangle A .

..... [2]

.....

Question 75

$$f(x) = 4 - 3x$$

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

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

(a) Find $fh(2)$.

..... [2]

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

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

(c) Simplify.

(i) $f(1 - 2x)$

..... [2]

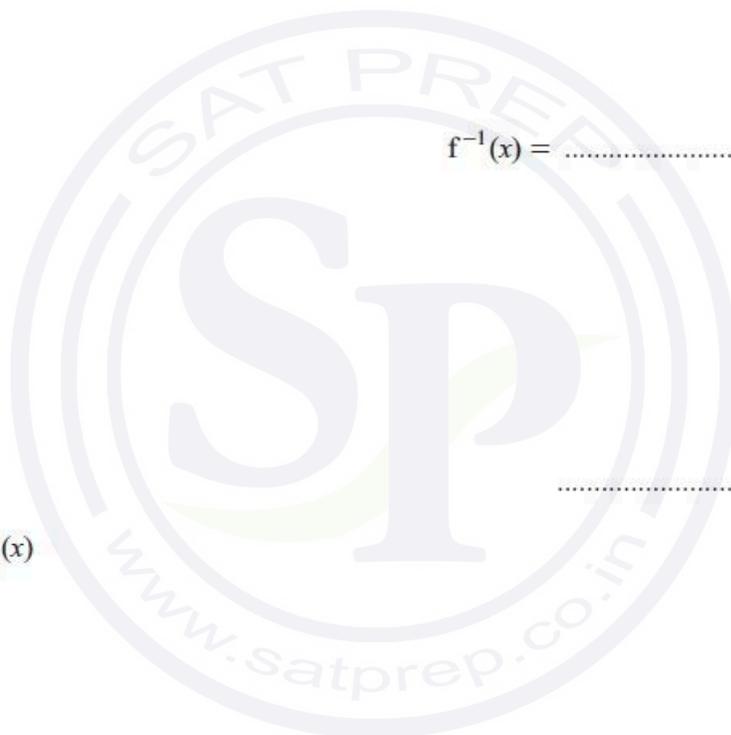
(ii) $gf(x) - 9g(x)$

..... [4]

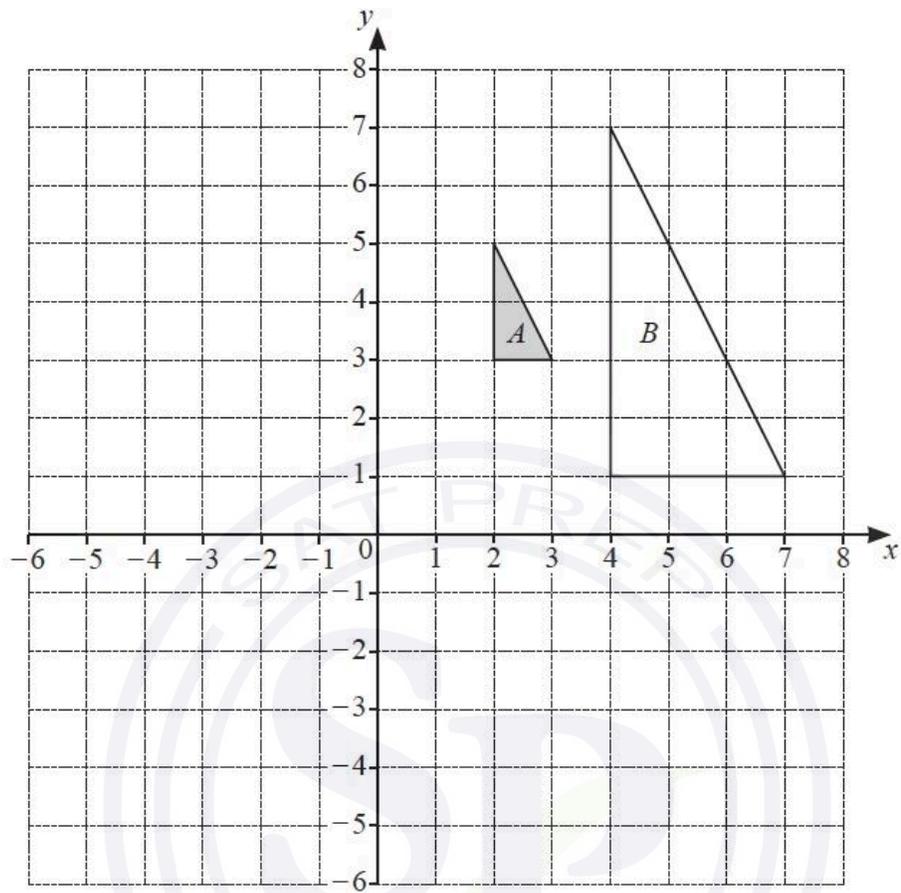
(d) $\frac{1}{h(x)} = 9^{kx}$

Find the value of k .

$k =$ [2]



Question 76



- (a) On the grid, draw the image of
- (i) triangle A after a rotation of 90° anticlockwise about $(0, 0)$. [2]
 - (ii) triangle A after a translation by the vector $\begin{pmatrix} 3 \\ -5 \end{pmatrix}$. [2]

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

.....

..... [3]

Question 77

$$f(x) = x^2 + 1 \quad g(x) = 1 - 2x \quad h(x) = \frac{1}{x}, \quad x \neq 0 \quad j(x) = 5^x$$

(a) Find the value of

(i) $f(3)$,

..... [1]

(ii) $gf(3)$.

..... [1]

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

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

(c) Find x when $h(x) = 2$.

$x =$ [1]

(d) Find $g(x)g(x) - gg(x)$, giving your answer in the form $ax^2 + bx + c$.

..... [4]

(e) Find $hh(x)$, giving your answer in its simplest form.

..... [1]

(f) Find $j(5)$.

..... [1]

(g) Find x when $j^{-1}(x) = 2$.

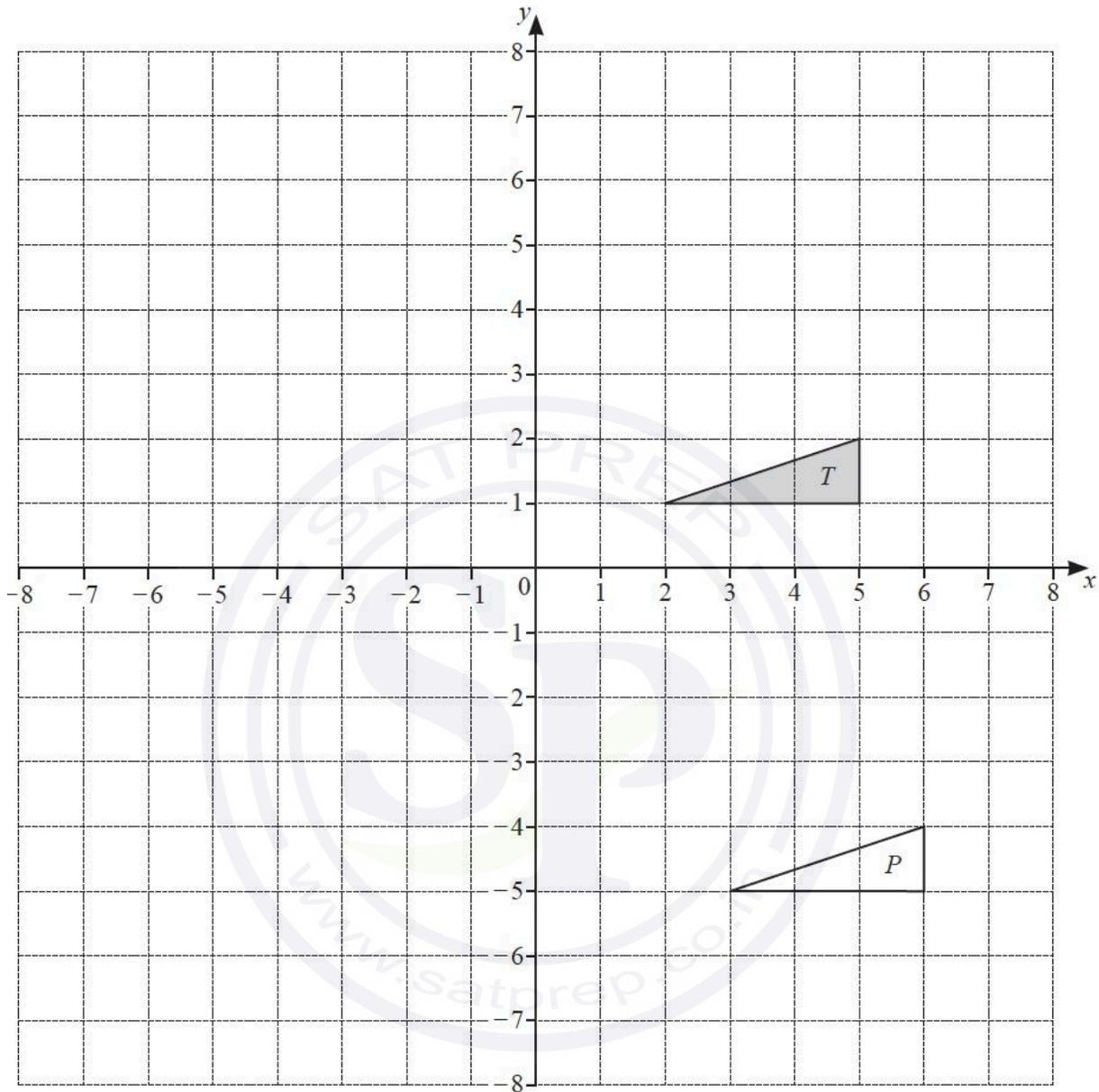
$x =$ [1]

(h) $j(x) = hg(-12)$

Find the value of x .

$x =$ [2]

Question 78



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

.....

[2]

(b) (i) Reflect triangle T in the line $x = 1$.

[2]

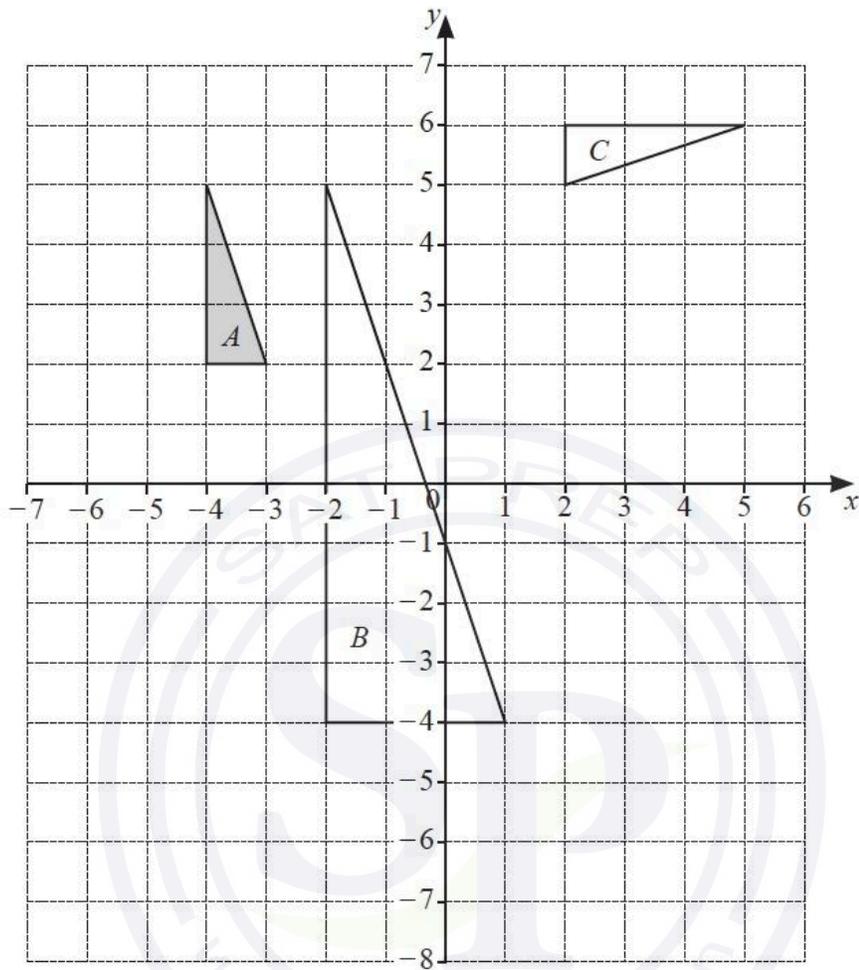
(ii) Rotate triangle T through 90° anticlockwise about $(6, 0)$.

[2]

(iii) Enlarge triangle T by a scale factor of -2 , centre $(1, 0)$.

[2]

Question 79



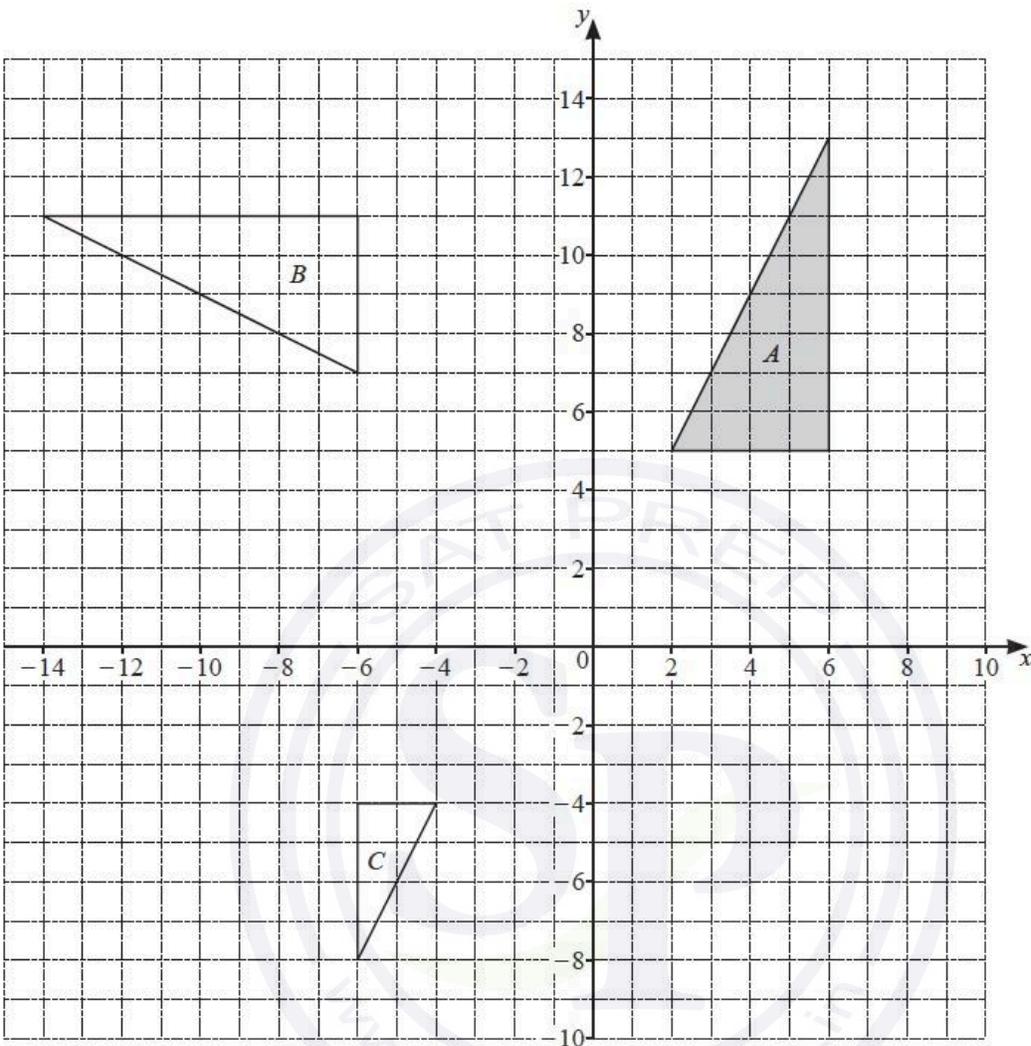
(a) Draw the image of shape *A* after a translation by the vector $\begin{pmatrix} 8 \\ -6 \end{pmatrix}$. [2]

(b) Draw the image of shape *A* after a reflection in the line $y = -1$. [2]

(c) Describe fully the **single** transformation that maps shape *A* onto shape *B*.
 [3]

(d) Describe fully the **single** transformation that maps shape *A* onto shape *C*.
 [3]

Question 80



(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 $\begin{pmatrix} -5 \\ -10 \end{pmatrix}$. [2]

(c) Draw the image of triangle *A* after a reflection in the line $y = 4$. [2]

Question 81

$f(x) = 3x - 2$

$g(x) = 5x - 7$

$h(x) = x^2 + x$

$j(x) = 3^x$

(a) Find

(i) $f(2)$,

..... [1]

(ii) $g(2)$,

..... [1]

(iii) $gf(2)$.

..... [1]

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

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

(c) Find $hf(x)$, giving your answer in the form $ax^2 + bx + c$.

..... [3]

(d) Find the derivative of $h(x)$.

..... [1]

(e) (i) Find x when $j^{-1}(x) = 4$.

$x =$ [1]

(ii) Simplify $j^{-1}j(x)$.

..... [1]

Question 82

The position vector of P is $\begin{pmatrix} -2 \\ 3 \end{pmatrix}$ and the position vector of Q is $\begin{pmatrix} -2 \\ 5 \end{pmatrix}$.

(i) Find the vector \vec{PQ} .

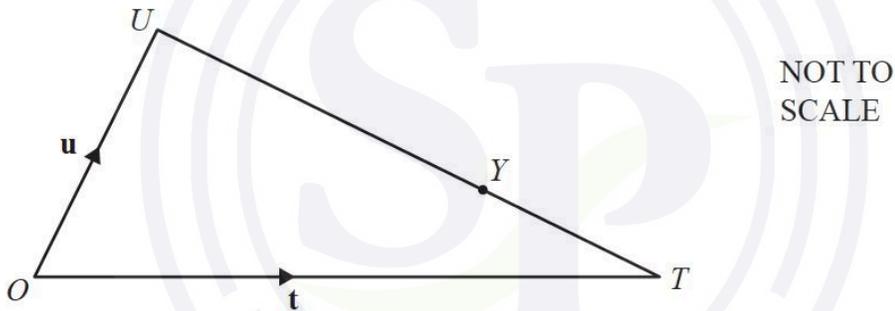
$$\begin{pmatrix} \\ \end{pmatrix} \quad [2]$$

(ii) R is the point such that $\vec{PR} = 3\vec{PQ}$.

Find the position vector of R .

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

Question 83



$\vec{OT} = \mathbf{t}$, $\vec{OU} = \mathbf{u}$ and $UY = 2YT$.

(i) Find \vec{OY} in terms of \mathbf{t} and \mathbf{u} .
Give your answer in its simplest form.

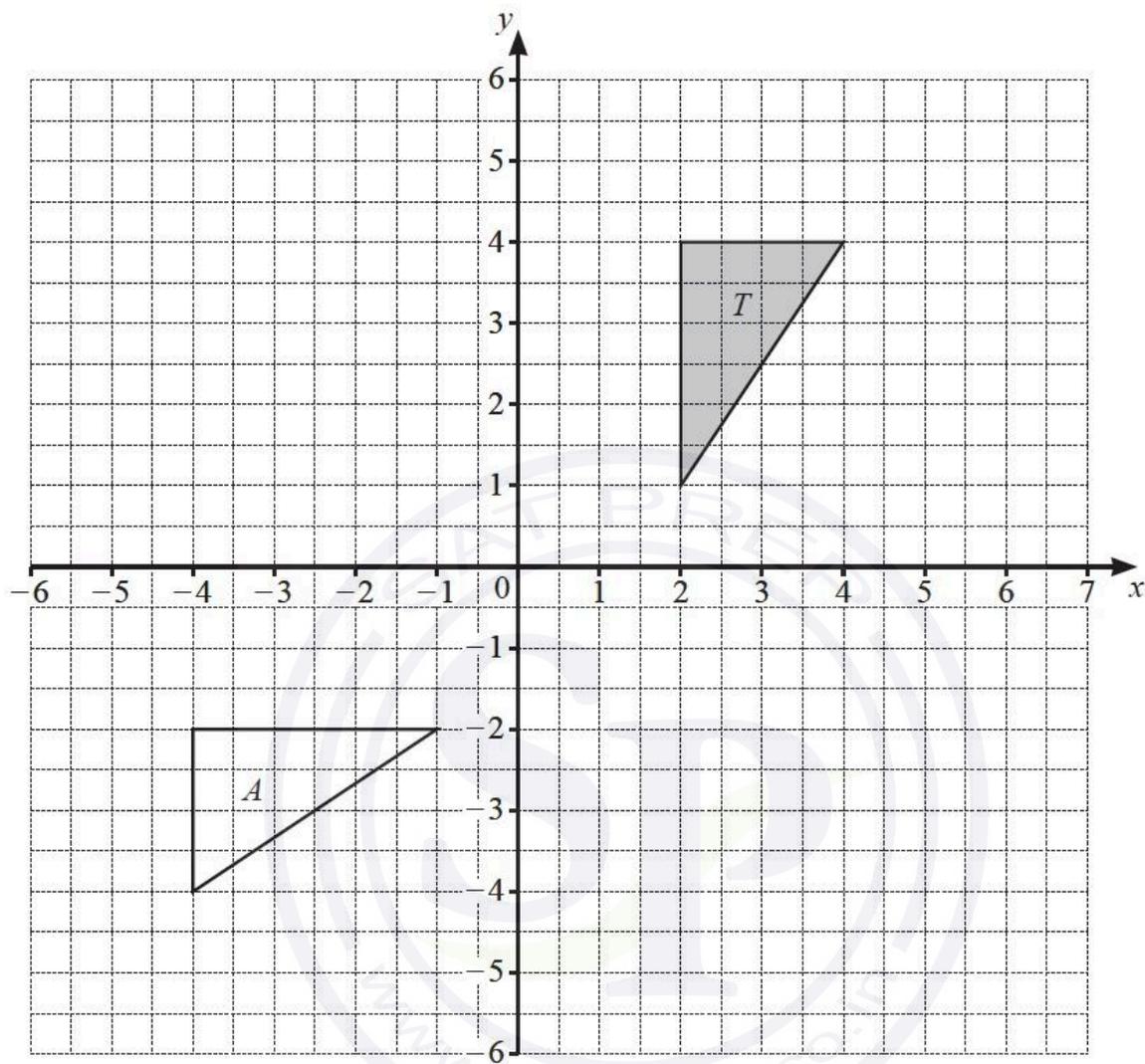
$$\vec{OY} = \dots\dots\dots [2]$$

(ii) Z is on OT and YZ is parallel to UO .

Find \vec{OZ} in terms of \mathbf{t} and/or \mathbf{u} .
Give your answer in its simplest form.

$$\vec{OZ} = \dots\dots\dots [1]$$

Question 84



- (a) On the grid, draw the image of
- (i) triangle T after a translation by the vector $\begin{pmatrix} 2 \\ -1 \end{pmatrix}$, [2]
 - (ii) triangle T after a rotation, 90° clockwise, about the origin, [2]
 - (iii) triangle T after an enlargement, scale factor $-\frac{1}{2}$, centre $(-2, 3)$. [2]
- (b) Describe fully the **single** transformation that maps triangle T onto triangle A .
-
- [2]

Question 85

(a) $\mathbf{a} = \begin{pmatrix} -3 \\ 8 \end{pmatrix}$ $\mathbf{b} = \begin{pmatrix} 2 \\ -5 \end{pmatrix}$

(i) Find

(a) $\mathbf{b} - \mathbf{a}$,

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

(b) $2\mathbf{a} + \mathbf{b}$,

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

(c) $|\mathbf{b}|$.

..... [2]

(ii) $\mathbf{a} + k\mathbf{b} = \begin{pmatrix} 13 \\ m \end{pmatrix}$, where k and m are integers.

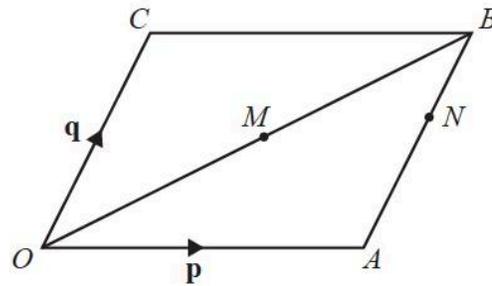
Find the value of k and the value of m .

$k =$

$m =$ [3]

Continue on the next page...

(b)



NOT TO SCALE

$OACB$ is a parallelogram and O is the origin.
 M is the midpoint of OB .
 N is the point on AB such that $AN : NB = 3 : 2$.
 $\vec{OA} = \mathbf{p}$ and $\vec{OC} = \mathbf{q}$.

(i) Find, in terms of \mathbf{p} and \mathbf{q} , in its simplest form.

(a) \vec{OB}

$\vec{OB} = \dots\dots\dots$ [1]

(b) \vec{CM}

$\vec{CM} = \dots\dots\dots$ [2]

(c) \vec{MN}

$\vec{MN} = \dots\dots\dots$ [2]

(ii) CB and ON are extended to meet at D .

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

$\dots\dots\dots$ [3]

Question 86

$$f(x) = 3 - 2x$$

$$g(x) = x^2 + 5$$

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

- (a) Find $f(-5)$.

..... [1]

- (b) Find $ff(x)$.

Give your answer in its simplest form.

..... [2]

- (c) Solve $g(x) = f(x) + 37$.

$x = \dots\dots\dots$ or $x = \dots\dots\dots$ [4]

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

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

- (e) Find $hf(x) + g(x)$.

Give your answer in its simplest form.

..... [5]

Question 87

$$f(x) = 2x - 1$$

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

$$h(x) = 4^x$$

$$j(x) = 2^x$$

- (a) Find the value of

- (i) $h(3)$,

..... [1]

- (ii) $fh(3)$.

..... [1]

- (b) Solve the equation $gf(x) = 0$.

$x = \dots\dots\dots$ or $x = \dots\dots\dots$ [4]

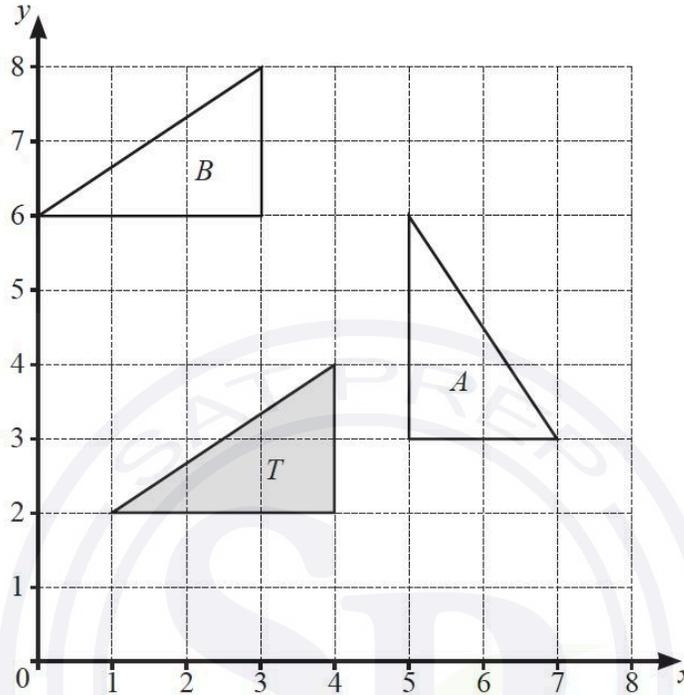
- (c) $p^{-1}(x) = f(x)$

Find $p(x)$.

..... [2]

Question 88

The diagram shows three triangles, T , A , and B , drawn on a 1 cm^2 grid.



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

.....
 [3]

- (b) (i) Describe fully the **single** transformation that maps triangle T onto triangle B .

.....
 [2]

- (ii) Calculate the distance that each point of triangle T moves when it is mapped onto triangle B .

..... cm [2]

Question 89

(a) F is the point $(5, -2)$ and $\vec{FG} = \begin{pmatrix} -2 \\ 3 \end{pmatrix}$.

Find

(i) the coordinates of point G ,

(.....,) [1]

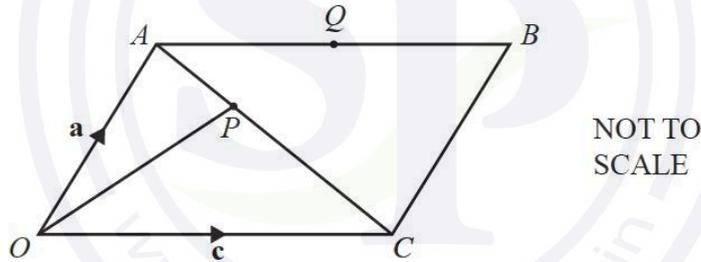
(ii) $5\vec{FG}$,

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

(iii) $|\vec{FG}|$.

..... [2]

(b)



$OACB$ is a parallelogram.

P is a point on AC and Q is the midpoint of AB .

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

(i) Find, in terms of \mathbf{a} and/or \mathbf{c}

(a) \vec{AQ} ,

$\vec{AQ} = \dots\dots\dots$ [1]

(b) \vec{OQ} .

Continue on the next page...

$$\overrightarrow{OQ} = \dots\dots\dots [1]$$

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

(a) Show that O, P and Q lie on a straight line.

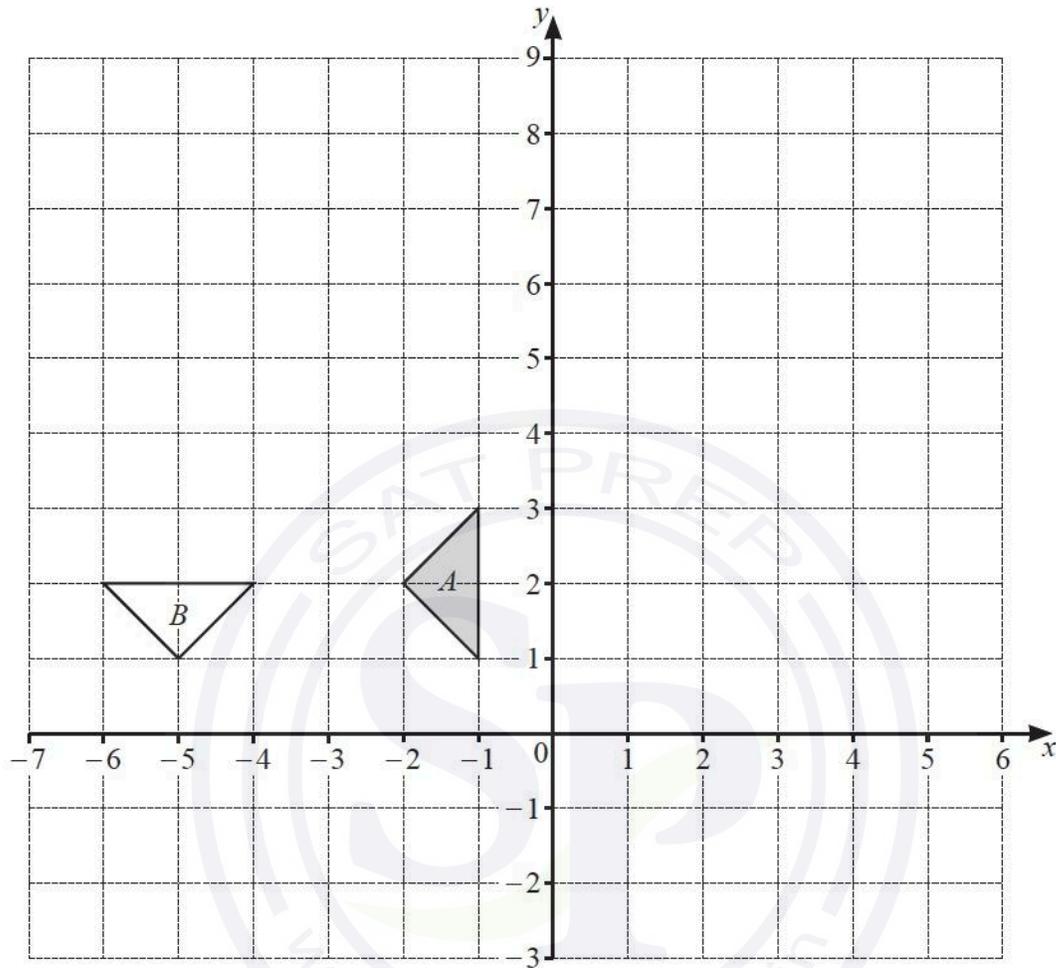
[2]

(b) Write down the ratio $OP : OQ$.
Give your answer in the form $1 : n$.

1 : $\dots\dots\dots$ [1]



Question 90



- (a) On the grid, draw the image of triangle *A* after
- (i) a translation by the vector $\begin{pmatrix} -4 \\ 5 \end{pmatrix}$, [2]
 - (ii) a reflection in the line $x = 1$, [2]
 - (iii) an enlargement, scale factor 2 and centre $(-5, -2)$. [2]

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

.....
 [3]

Question 91

$$f(x) = 3 - 5x$$

(i) Find x when $f(x) = -5$.

$$x = \dots\dots\dots [2]$$

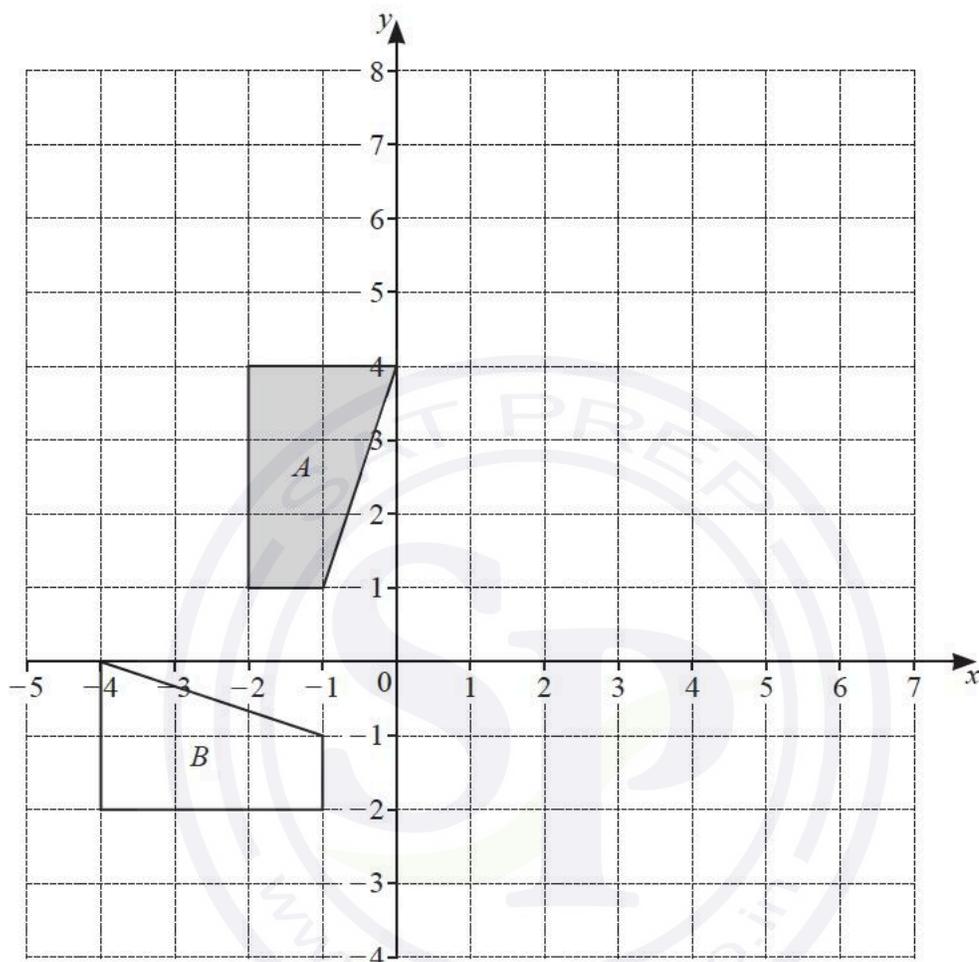
(ii) Find $f^{-1}(x)$.

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



Question 92

(a)



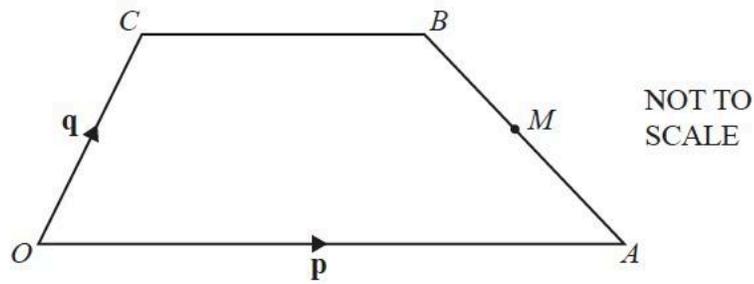
- (i) On the grid, draw the image of
 - (a) shape *A* after an enlargement, scale factor 2, centre (0, 1). [2]
 - (b) shape *A* after a reflection in the line $y = x - 1$. [3]

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

 [3]

Continue on the next page...

(b)



$OABC$ is a trapezium and O is the origin.

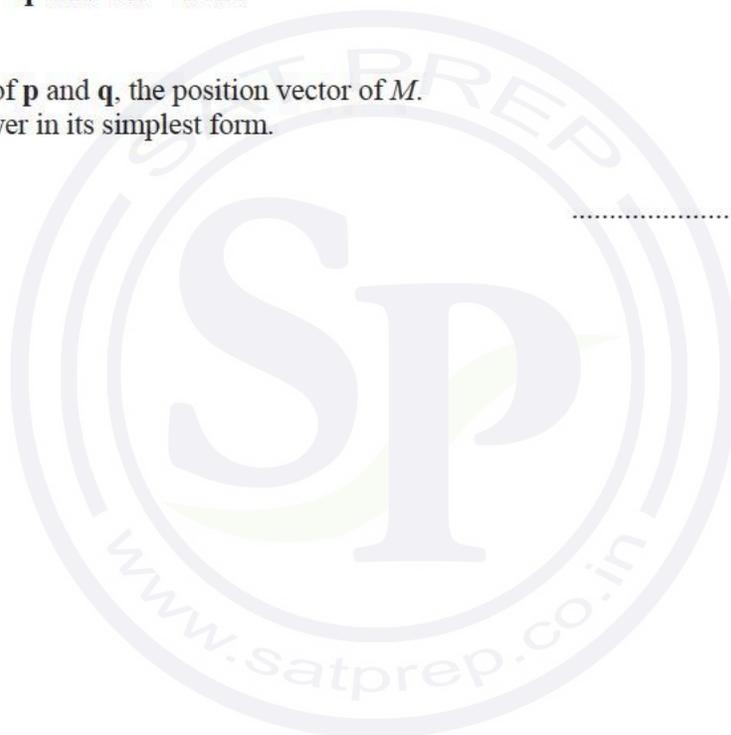
M is the midpoint of AB .

$\vec{OA} = \mathbf{p}$, $\vec{OC} = \mathbf{q}$ and $OA = 2CB$.

Find, in terms of \mathbf{p} and \mathbf{q} , the position vector of M .

Give your answer in its simplest form.

..... [3]



Question 93

$$f(x) = 1 + 4x$$

$$g(x) = x^2$$

(a) Find

(i) $gf(3)$,

..... [2]

(ii) $fg(x)$,

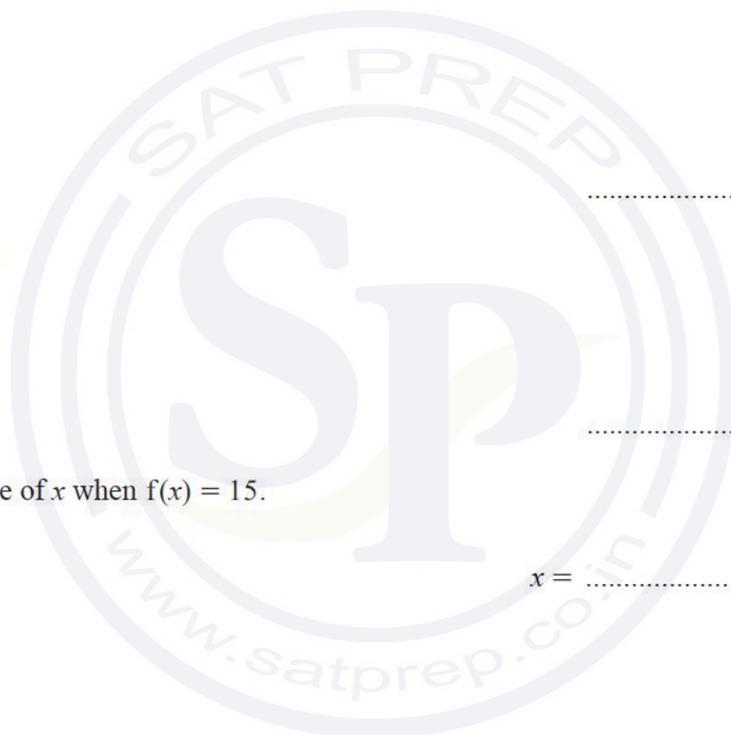
..... [1]

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

..... [1]

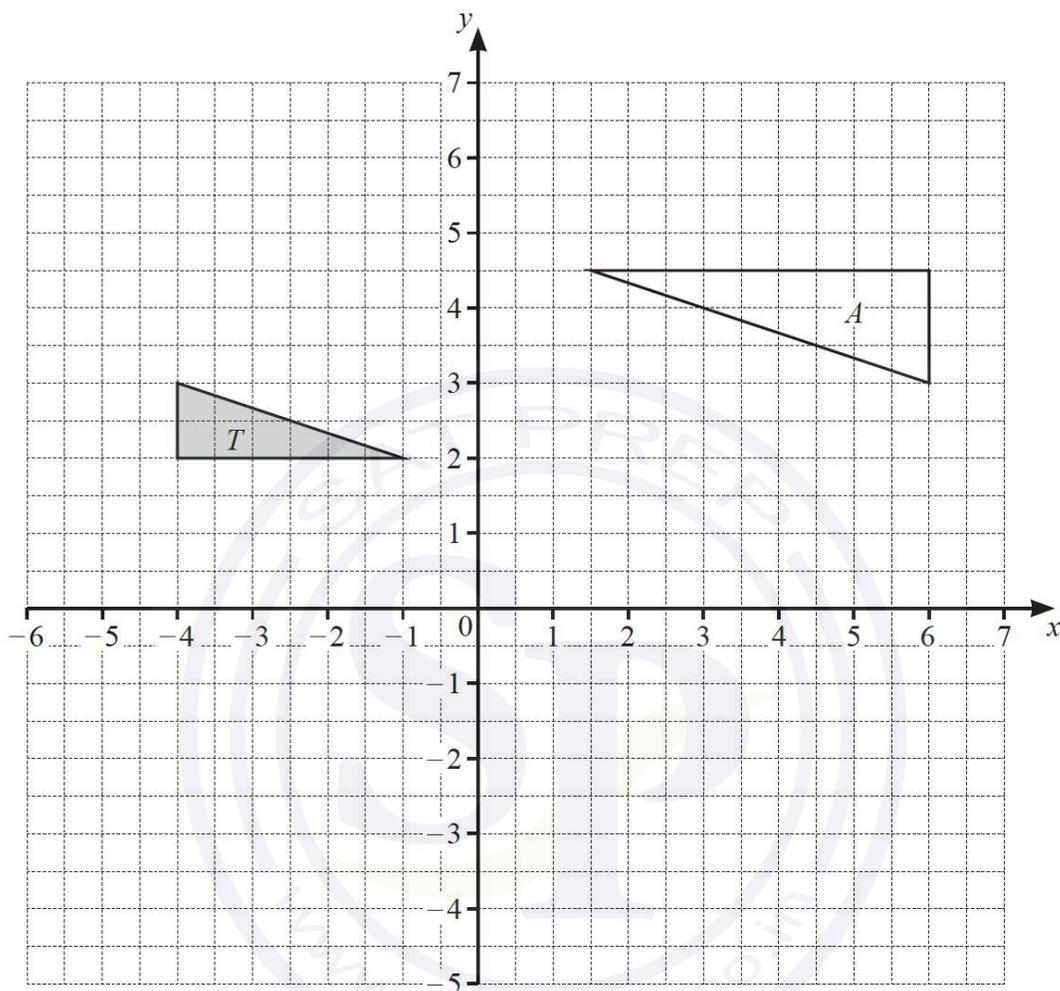
(b) Find the value of x when $f(x) = 15$.

$x =$ [2]



Question94

(a)



(i) Draw the image of triangle T after a reflection in the line $y = x$. [2]

(ii) Draw the image of triangle T after a translation by the vector $\begin{pmatrix} -1 \\ 3 \end{pmatrix}$. [2]

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

.....

..... [3]

Continue on the next page...

- (b) A quadrilateral P is enlarged by a scale factor of 1.2 to give quadrilateral Q .
The area of quadrilateral P is 20 cm^2 .

Calculate the area of quadrilateral Q .

..... cm^2 [2]



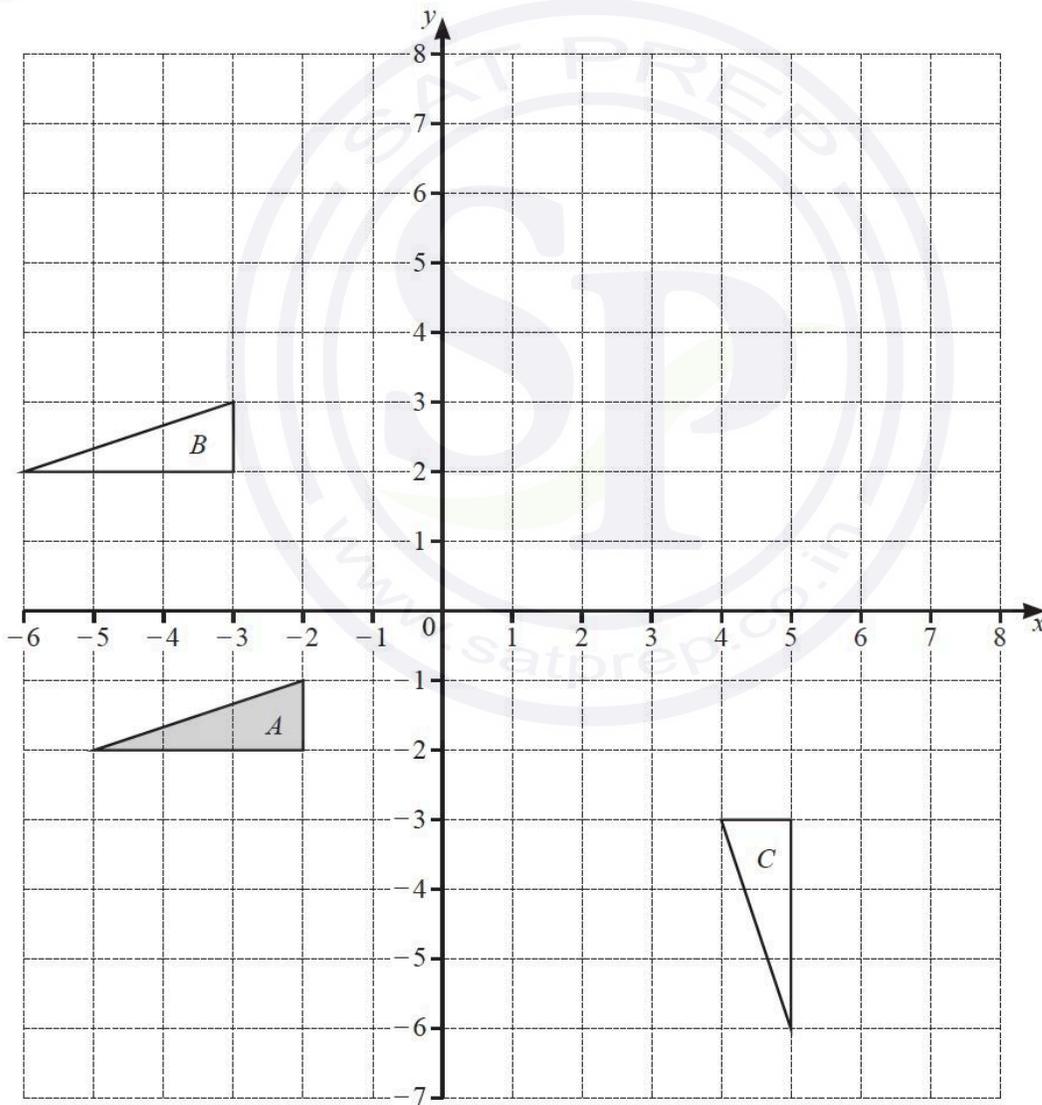
Question 95

(a) Draw the lines of symmetry of the rectangle.



[2]

(b)



Continue on the next page...

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

(a) triangle A onto triangle B ,

.....

..... [2]

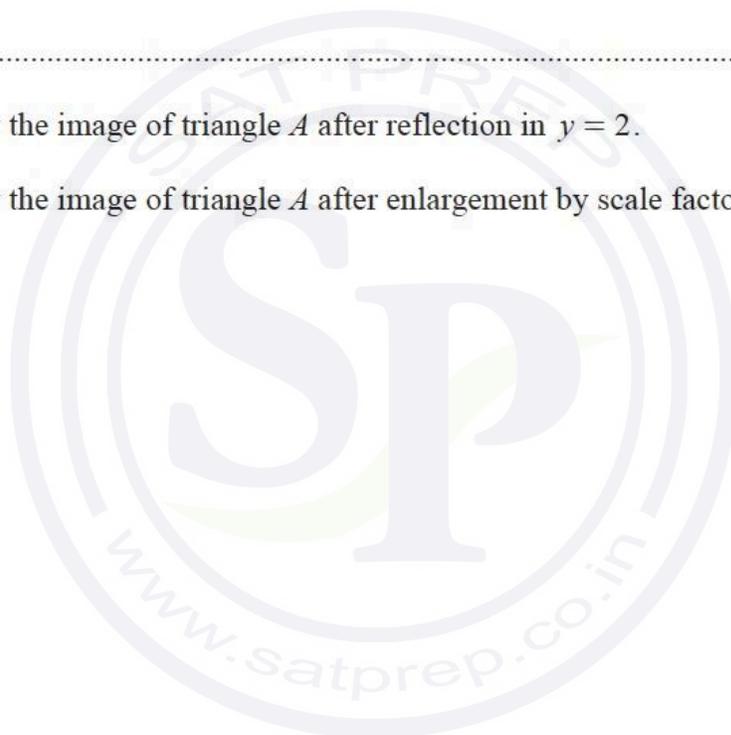
(b) triangle A onto triangle C .

.....

..... [3]

(ii) (a) Draw the image of triangle A after reflection in $y = 2$. [2]

(b) Draw the image of triangle A after enlargement by scale factor -2 , centre $(-1, 1)$. [2]



Question 96

$f(x) = 2x - 1$

$g(x) = 3x - 2$

$h(x) = \frac{1}{x}, x \neq 0$

$j(x) = 5^x$

(a) Find

(i) $f(2)$,

..... [1]

(ii) $gf(2)$.

..... [1]

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

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

(c) Find x when $h(x) = j(-2)$.

$x =$ [2]

(d) Write $f(x) - h(x)$ as a single fraction.

..... [2]

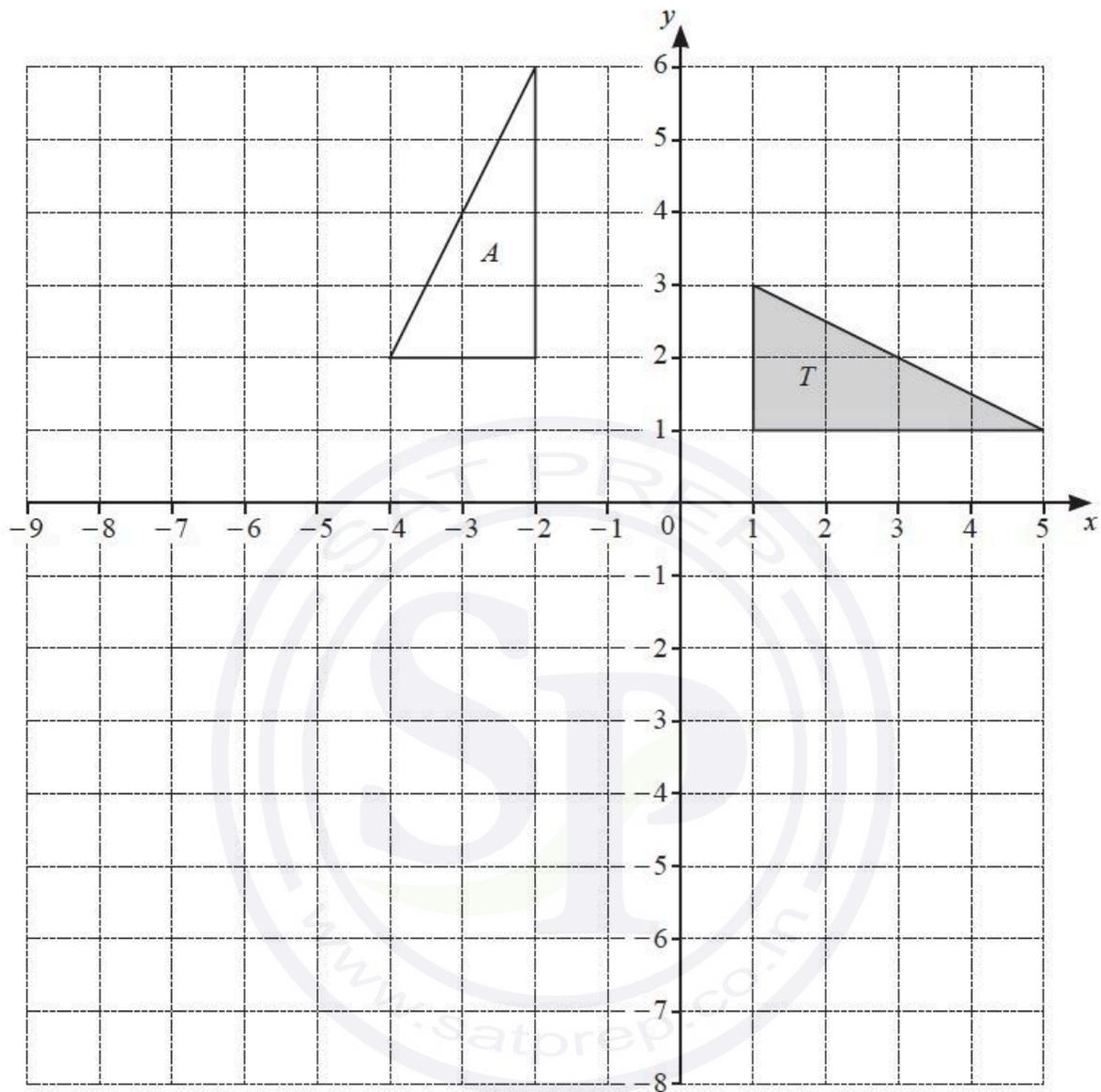
(e) Find the value of $jj(2)$.

..... [1]

(f) Find x when $j^{-1}(x) = 4$.

$x =$ [2]

Question 97



(a) Draw the reflection of triangle T in the line $y = -2$. [2]

(b) Draw the enlargement of triangle T with scale factor $\frac{1}{2}$ and centre of enlargement $(-5, -3)$. [2]

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

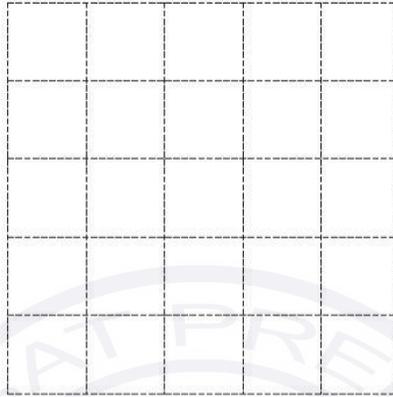
.....

..... [3]

Question 98

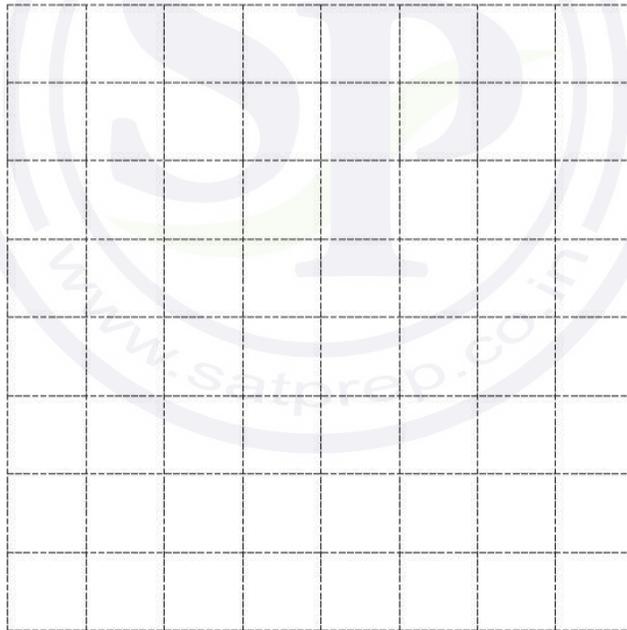
(a) $\mathbf{a} = \begin{pmatrix} 1 \\ 2 \end{pmatrix}$ $\mathbf{b} = \begin{pmatrix} -3 \\ 5 \end{pmatrix}$

(i) On the grid, draw and label vector $2\mathbf{a}$.



[1]

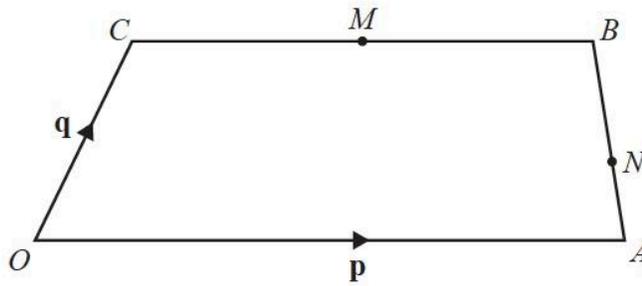
(ii) On the grid, draw and label vector $(\mathbf{a} - \mathbf{b})$.



[2]

Continue on the next page..

(b)



NOT TO SCALE

$OACB$ is a trapezium with OA parallel to CB .
 M is the midpoint of CB and N is the point on AB such that $AN : NB = 1 : 2$.
 O is the origin, $\vec{OA} = \mathbf{p}$, $\vec{OC} = \mathbf{q}$ and $\vec{CB} = \frac{3}{4}\mathbf{p}$.

(i) Find, in terms of \mathbf{p} and/or \mathbf{q} , in its simplest form

(a) \vec{OB}

$\vec{OB} = \dots\dots\dots$ [1]

(b) \vec{AB}

$\vec{AB} = \dots\dots\dots$ [2]

(c) \vec{MN} .

$\vec{MN} = \dots\dots\dots$ [3]

(ii) OA and MN are extended to meet at G .

Find the position vector of G in terms of \mathbf{p} .

$\dots\dots\dots$ [2]

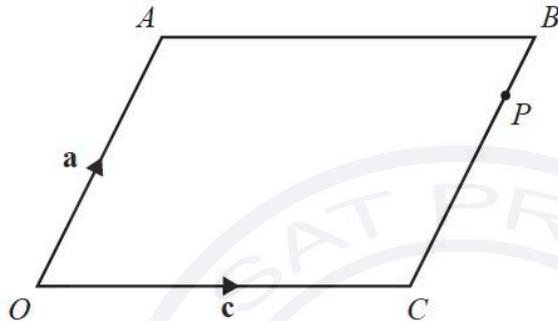
Question 99

(a) $\left| \begin{pmatrix} 9m \\ 40m \end{pmatrix} \right| = \frac{205}{2}$

Find the two possible values of m .

$m = \dots\dots\dots$ or $\dots\dots\dots$ [3]

(b)



NOT TO SCALE

$OACB$ is a parallelogram.

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

P is the point on CB such that $CP : PB = 3 : 1$.

(i) Find, in terms of \mathbf{a} and/or \mathbf{c} , in their simplest form,

(a) \vec{AC} ,

$\vec{AC} = \dots\dots\dots$ [1]

(b) \vec{CP} ,

$\vec{CP} = \dots\dots\dots$ [1]

(c) \vec{OP} .

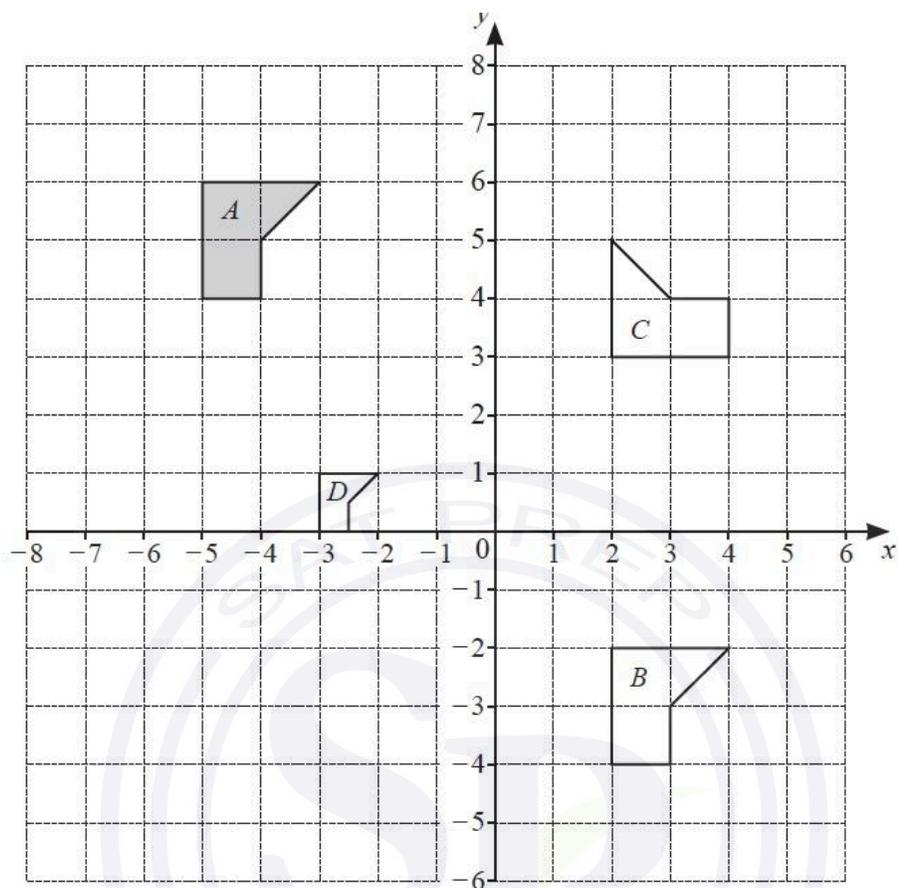
$\vec{OP} = \dots\dots\dots$ [1]

(ii) OP and AB are extended to meet at Q .

Find the position vector of Q .

$\dots\dots\dots$ [2]

Question 100



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

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

.....
 [2]

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

.....
 [3]

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

.....
 [3]

(b) On the grid, draw the image of shape *A* after a reflection in the line $y = x + 8$. [2]

Question 101

$$f(x) = 10 - x \qquad g(x) = \frac{2}{x}, \quad x \neq 0 \qquad h(x) = 2^x \qquad j(x) = 5 - 2x$$

(a) (i) Find $g\left(\frac{1}{2}\right)$.
 [1]

(ii) Find $hg\left(\frac{1}{2}\right)$.
 [1]

(b) Find x when $f(x) = 7$.
 $x =$ [1]

(c) Find x when $g(x) = h(3)$.
 $x =$ [2]

(d) Find $j^{-1}(x)$.
 $j^{-1}(x) =$ [2]

(e) Write $f(x) + g(x) + 1$ as a single fraction in its simplest form.
 [3]

(f) $(f(x))^2 - ff(x) = ax^2 + bx + c$
 Find the values of a , b and c .
 $a =$
 $b =$
 $c =$ [4]

(g) Find x when $h^{-1}(x) = 10$.
 $x =$ [2]

Question 102

(a) $\mathbf{p} = \begin{pmatrix} 2 \\ 3 \end{pmatrix}$ $\mathbf{q} = \begin{pmatrix} -1 \\ 1 \end{pmatrix}$

Find

(i) $3\mathbf{q}$,

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

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

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

(iii) $|\mathbf{p}|$.

..... [2]

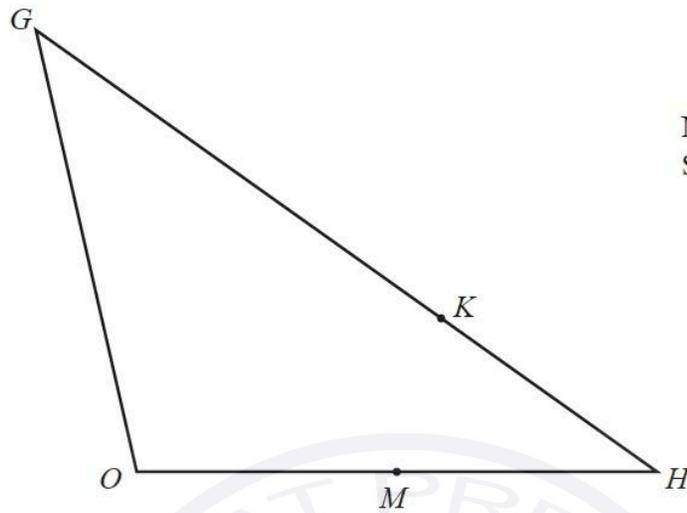
(b) B is the point $(2, 7)$ and $\overrightarrow{AB} = \begin{pmatrix} -4 \\ 6 \end{pmatrix}$.

Find the coordinates of A .

(.....,) [2]

Continue on the next page....

(c)



NOT TO SCALE

In triangle OGH , M is the midpoint of OH and K divides GH in the ratio $5 : 2$.

$\vec{OG} = \mathbf{g}$ and $\vec{OH} = \mathbf{h}$.

Find \vec{MK} in terms of \mathbf{g} and \mathbf{h} .

Give your answer in its simplest form.

$\vec{MK} = \dots\dots\dots$ [4]

Question 103

$f(x) = 2x - 1$

$g(x) = 3x + 2$

$h(x) = \frac{1}{x}, x \neq 0$

$j(x) = x^2$

(a) Find $j(-1)$.

$\dots\dots\dots$ [1]

(b) Find x when $f(x) + g(x) = 0$.

$x = \dots\dots\dots$ [2]

(c) Find $gg(x)$, giving your answer in its simplest form.

$\dots\dots\dots$ [2]

(d) Find $hf(x) + gh(x)$, giving your answer as a single fraction in its simplest form.

$\dots\dots\dots$ [4]

Continue on the next page...

(e) When $pp(x) = x$, $p(x)$ is a function such that $p^{-1}(x) = p(x)$.

Draw a ring around the function that has this property.

$$f(x) = 2x - 1$$

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

$$h(x) = \frac{1}{x}, x \neq 0$$

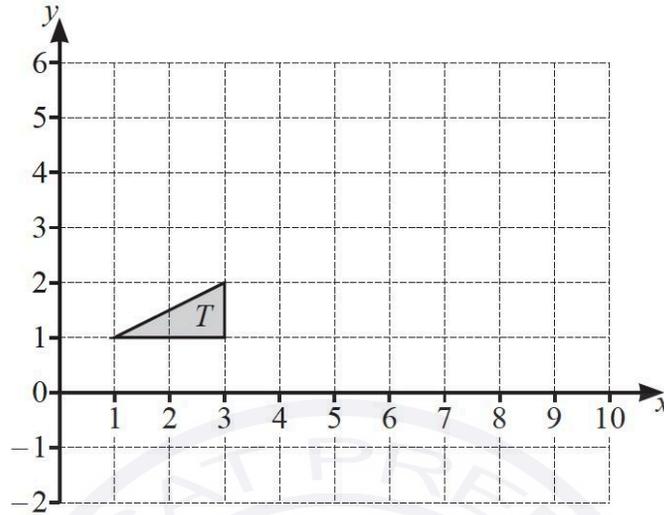
$$j(x) = x^2$$

[1]



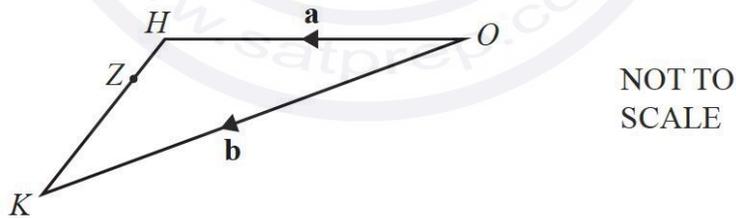
Question 104

(a)



- (i) Enlarge triangle T by scale factor 3, centre $(0, 2)$. [2]
- (ii) (a) Rotate triangle T about $(4, 2)$ by 90° clockwise. Label the image P . [2]
- (b) Reflect triangle T in the line $x + y = 6$. Label the image Q . [3]
- (c) Describe fully the **single** transformation that maps triangle P onto triangle Q . [2]

(b)



The diagram shows triangle OHK , where O is the origin.
 The position vector of H is \mathbf{a} and the position vector of K is \mathbf{b} .
 Z is the point on HK such that $HZ : ZK = 2 : 5$.

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

..... [3]

Question 105

$$f(x) = x - 4$$

$$g(x) = 2x + 5$$

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

(a) Find

(i) $f(-3)$

..... [1]

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

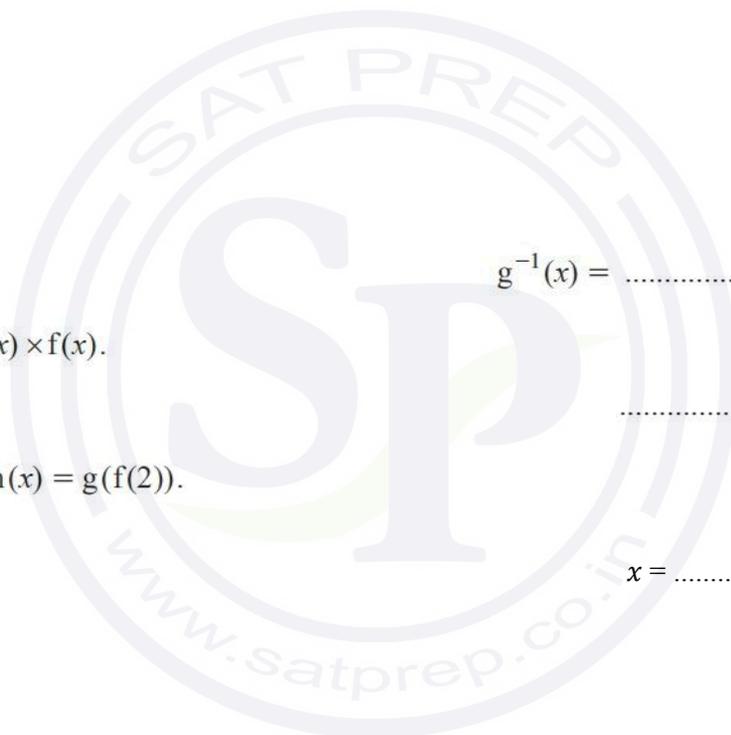
$g^{-1}(x) =$ [2]

(iii) $f(x) \times g(x) \times f(x)$.

..... [4]

(b) Find x when $h(x) = g(f(2))$.

$x =$ [2]



Question 106

$$f(x) = 5x - 3 \qquad g(x) = 64^x \qquad h(x) = \frac{2}{x+1}, \quad x \neq -1$$

(a) Find the value of

(i) $f(2)$

..... [1]

(ii) $gf(0.5)$.

..... [2]

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

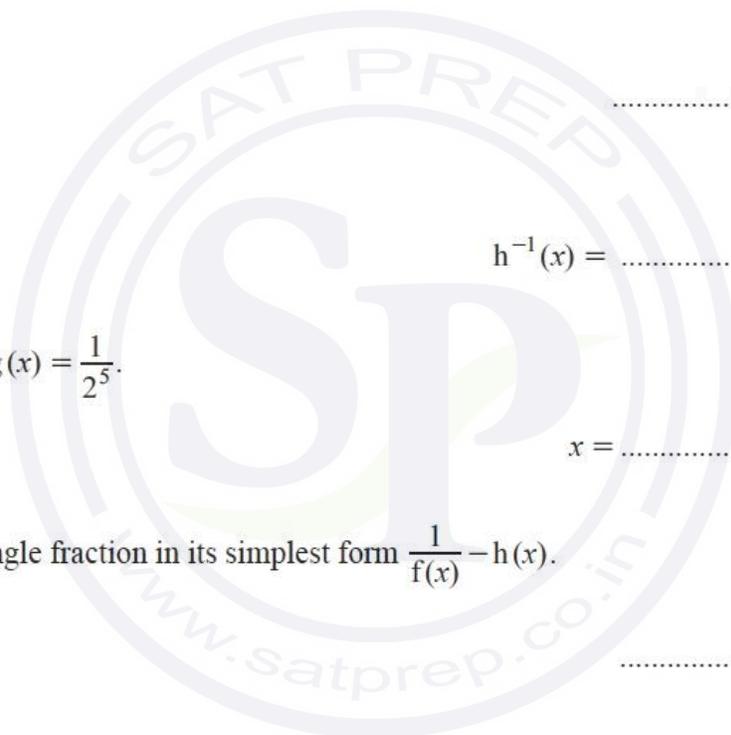
$$h^{-1}(x) = \text{.....} [3]$$

(c) Find x when $g(x) = \frac{1}{2^5}$.

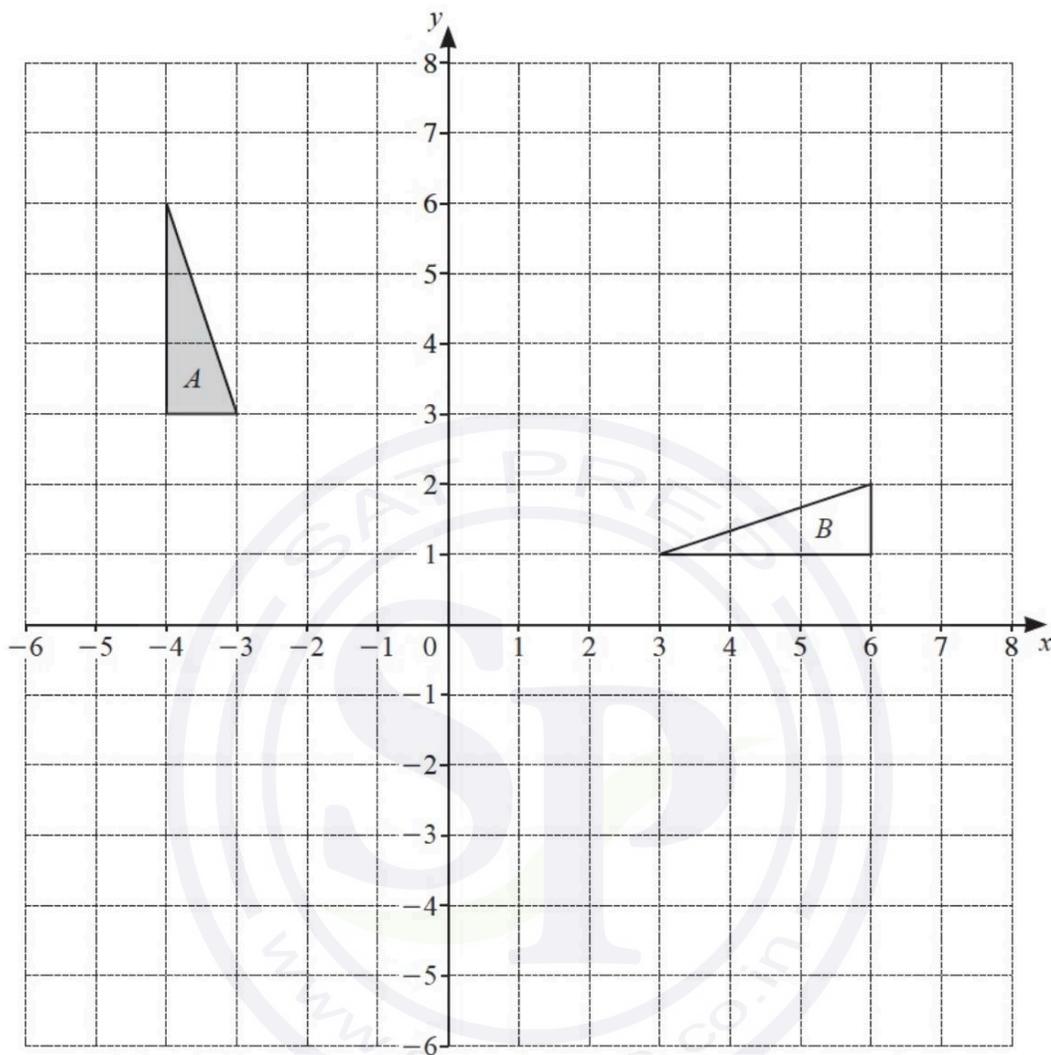
$$x = \text{.....} [2]$$

(d) Write as a single fraction in its simplest form $\frac{1}{f(x)} - h(x)$.

..... [4]



Question 107



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

.....

[3]

(b) Draw the image of triangle *A* after

(i) a reflection in the line $y = 1$

[2]

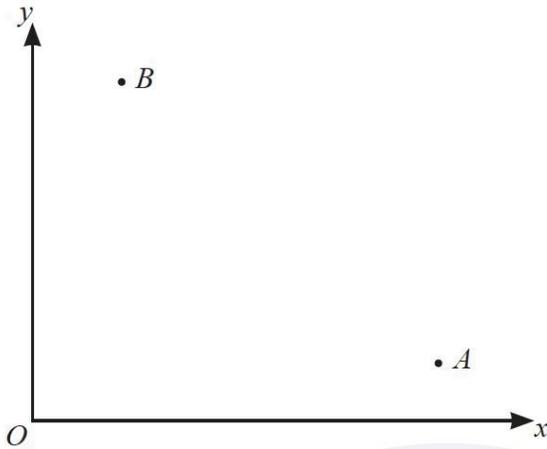
(ii) a translation by the vector $\begin{pmatrix} 5 \\ -7 \end{pmatrix}$

[2]

(iii) an enlargement, scale factor 2, centre $(-4, 5)$.

[2]

Question 108



NOT TO SCALE

O is the origin $(0, 0)$, A is the point $(8, 1)$ and B is the point $(2, 5)$.

Write as column vectors.

(i) \vec{OB}

$\vec{OB} = \begin{pmatrix} \\ \end{pmatrix}$ [1]

(ii) \vec{AB}

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

Question 109

$f(x) = 1 - 3x$ $g(x) = (x - 1)^2$ $h(x) = \frac{3}{x}, x \neq 0$

(a) Find $g(3)$.

..... [1]

(b) Find $f(x-2)$, giving your answer in its simplest form.

..... [2]

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

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

Continue on the next page...

(d) $gf(x) - g(x)f(x) = 3x^3 + ax^2 + bx + c$

Find the value of each of a , b and c .

$a = \dots\dots\dots$

$b = \dots\dots\dots$

$c = \dots\dots\dots$ [5]

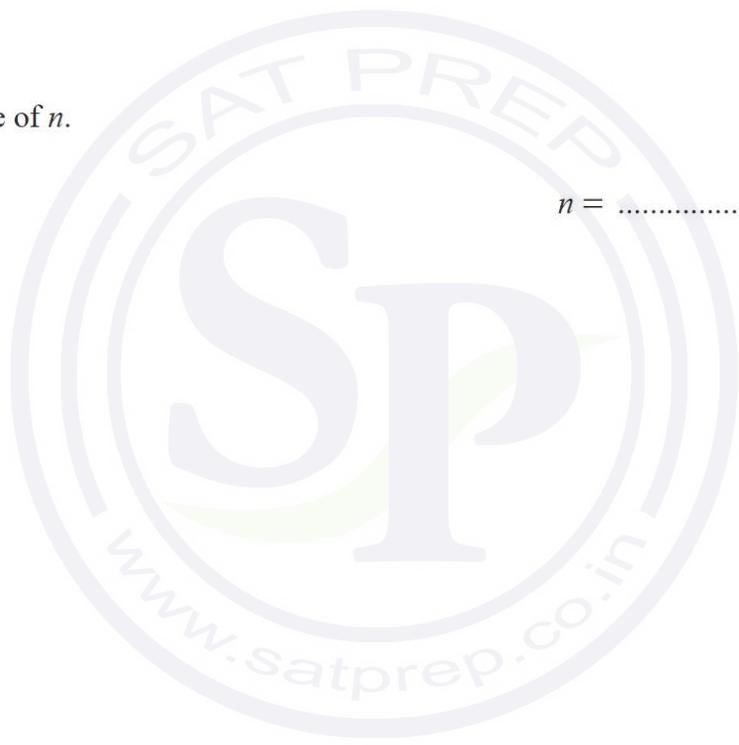
(e) Find $h(x) - f(x)$, giving your answer as a single fraction in its simplest form.

$\dots\dots\dots$ [3]

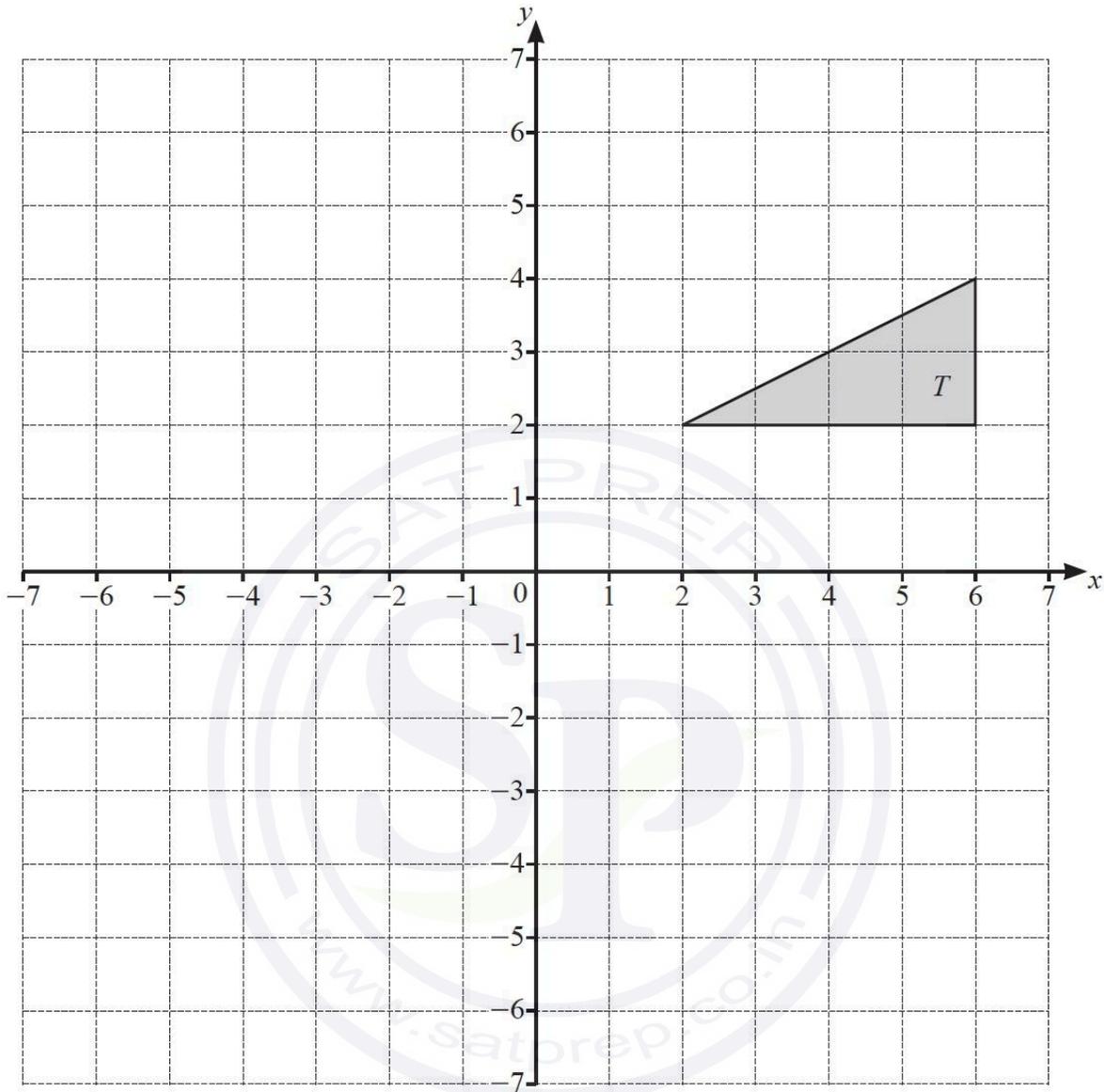
(f) $h(x^n) = 3x^7$

Find the value of n .

$n = \dots\dots\dots$ [1]



Question 110



Continue on the next page...

(a) (i) Translate triangle T by the vector $\begin{pmatrix} -1 \\ 1 \end{pmatrix}$. Label the image K . [2]

(ii) Describe fully the **single** transformation that maps triangle K onto triangle T .

.....

..... [1]

(b) Reflect triangle T in the line $y = 4$. [2]

(c) Rotate triangle T through 90° clockwise about $(0, 0)$. [2]

(d) (i) Enlarge triangle T by scale factor $-\frac{1}{2}$, centre $(0, 0)$. Label the image P . [2]

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

.....

..... [2]

Question 111

(a) ABC is a triangle.

B is the point $(1, -10)$, A is the point $(4, 14)$ and $\vec{CA} = \begin{pmatrix} -11 \\ 8 \end{pmatrix}$.

(i) Find the coordinates of C .

(.....,) [2]

(ii) Find \vec{BA} .

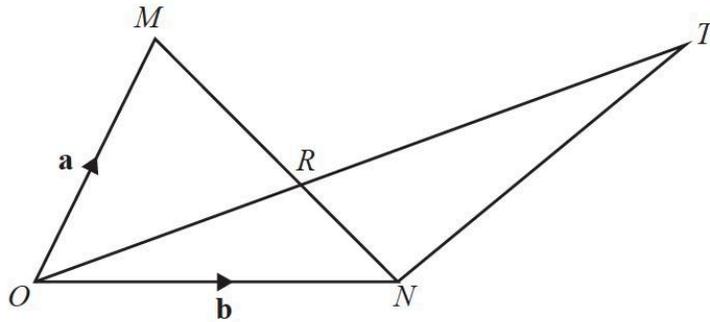
$\vec{BA} = \begin{pmatrix} \\ \end{pmatrix}$ [1]

(iii) Find $|\vec{CA}|$.

..... [2]

Continue on the next page...

(b)



NOT TO
SCALE

OMN is a triangle.

$\vec{OM} = \mathbf{a}$ and $\vec{ON} = \mathbf{b}$.

R is a point on MN such that $MR : RN = 3 : 2$.

ORT is a straight line.

(i) Show that $\vec{OR} = \frac{2}{5}\mathbf{a} + \frac{3}{5}\mathbf{b}$.

[3]

(ii) (a) $\vec{NT} = 4\mathbf{a} + k\mathbf{b}$ and $\vec{OT} = c\vec{OR}$.

Find the value of k and the value of c .

$k = \dots\dots\dots c = \dots\dots\dots$ [4]

(b) Find \vec{MT} .

$\vec{MT} = \dots\dots\dots$ [1]

Question 112

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

(a) Find

(i) $f(0)$

..... [1]

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

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

(iii) $gh(2)$.

..... [2]

(b) $g(2x) = 7$

Find the value of x .

$x =$ [2]

(c) Simplify $g(x^2) + gg(x) + 1$.

..... [3]

..... [3]

(d) Find $h^{-1}(16)$.

..... [2]

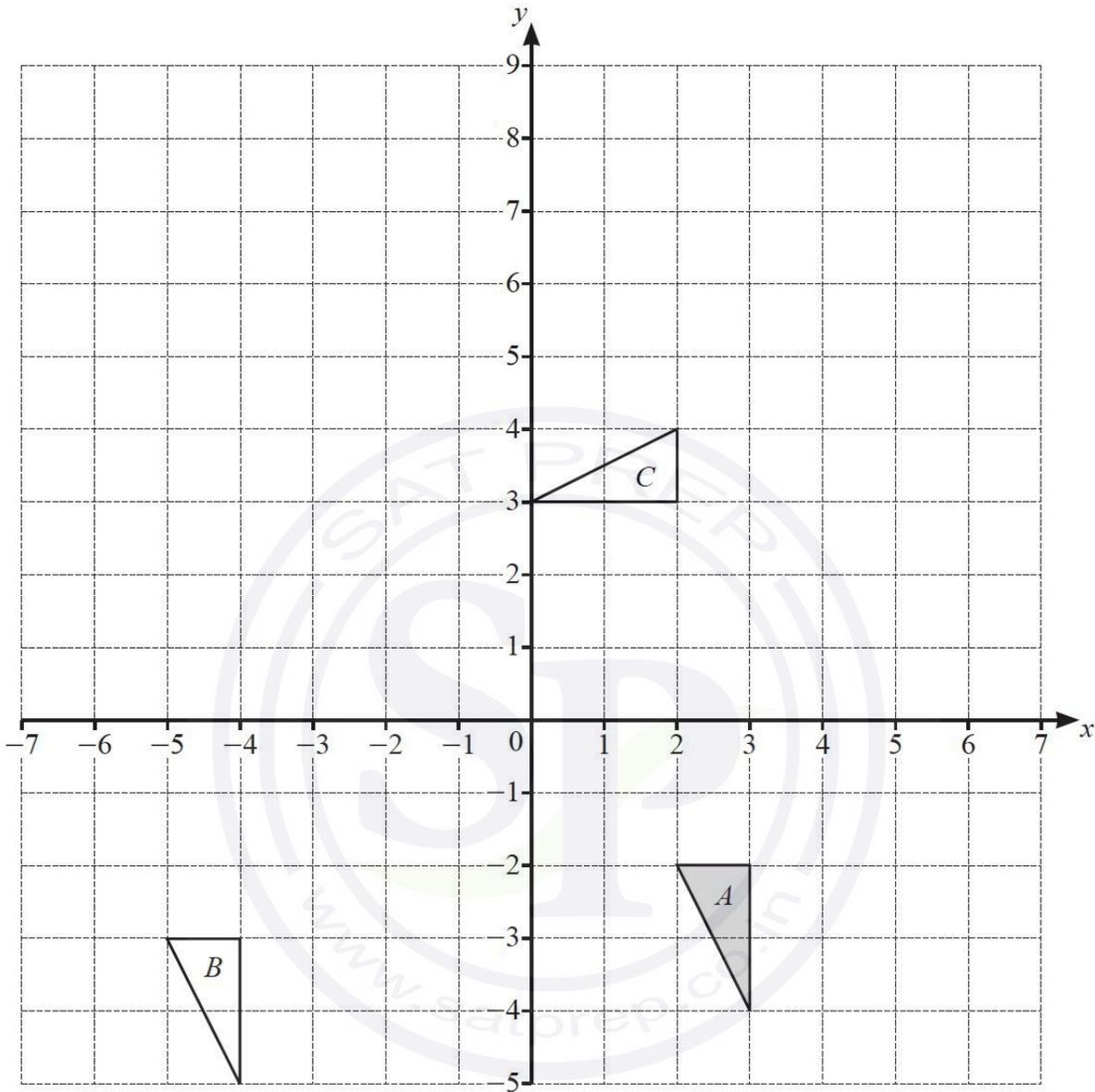
(e) $f(x) = (3x + 1)(x + 5)(x - 4)$

This can be written in the form $f(x) = ax^3 + bx^2 + cx + d$.

Find the value of each of a , b , c and d .

$a =$ $b =$ $c =$ $d =$ [3]

Question 113



Continue on the next page...

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

(i) shape A onto shape B

.....
 [2]

(ii) shape A onto shape C .

.....
 [3]

(b) On the grid, draw the image of

(i) shape A after a reflection in the line $y = 2$ [2]

(ii) shape A after an enlargement, scale factor -2 , centre $(0, 0)$. [2]

Question 114

$$f(x) = \frac{1}{x}, x \neq 0 \qquad g(x) = 3x - 5 \qquad h(x) = 2^x$$

(a) Find.

(i) $gf(2)$
 [2]

(ii) $g^{-1}(x)$
 $g^{-1}(x) = \dots\dots\dots$ [2]

(b) Find in its simplest form $g(x-2)$.
 [2]

(c) Find the value of x when

(i) $fg(x) = 0.1$
 $x = \dots\dots\dots$ [2]

(ii) $h(x) - g(7) = 0$.
 $x = \dots\dots\dots$ [2]

Question 115

(a) $\mathbf{p} = \begin{pmatrix} 8 \\ -5 \end{pmatrix}$ $\mathbf{q} = \begin{pmatrix} -4 \\ 5 \end{pmatrix}$

(i) Find $3\mathbf{q}$.

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

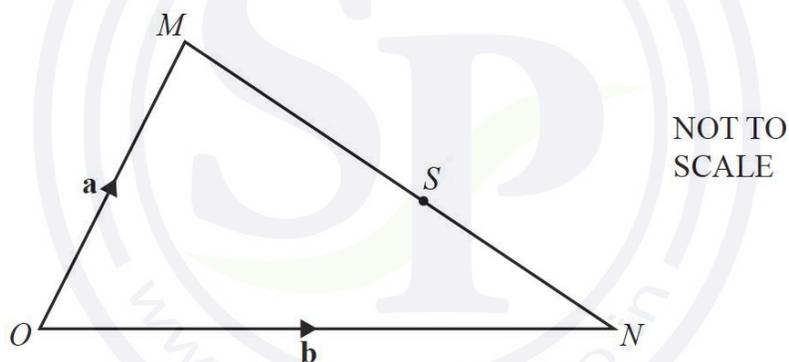
(ii) (a) Find $\mathbf{p} - \mathbf{q}$.

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

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

..... [2]

(b)



In triangle OMN , O is the origin, $\vec{OM} = \mathbf{a}$ and $\vec{ON} = \mathbf{b}$.
 S is a point on MN such that $MS : SN = 5 : 3$.

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

..... [3]

Question 116

$$f(x) = \frac{1}{4x-1}, x \neq \frac{1}{4} \qquad g(x) = 3^x$$

(i) Find $f(4)$.

..... [1]

(ii) Find $gg(2)$.

..... [2]

(iii) Find k when $g(k) = f(7)$.

..... [2]

Question 117

$$f(x) = 4x + 1 \qquad g(x) = 6 - 2x \qquad h(x) = 3^{x-2}$$

(a) Find

(i) $f(3)$

..... [1]

(ii) $gf(3)$.

..... [1]

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

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

(c) Find x when $f(x) = g(2x - 7)$.

$x =$ [4]

(d) Find the value of $hh(2)$.

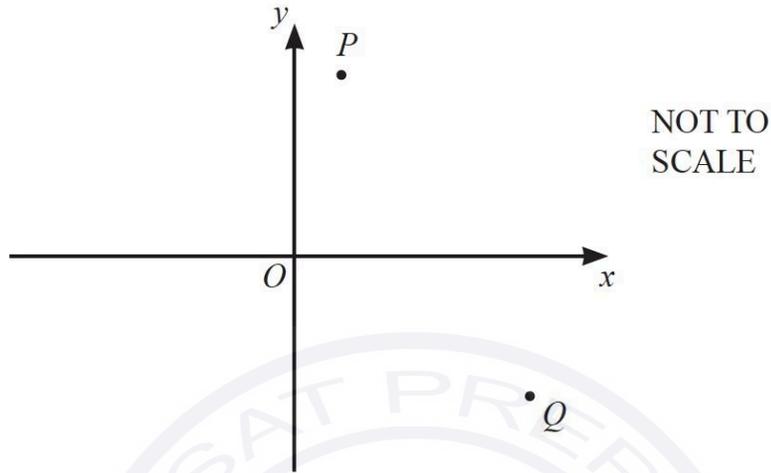
..... [2]

(e) Find x when $h^{-1}(x) = 10$.

$x =$ [2]

Question 118

- (a) P is the point $(1, 7)$.
 Q is the point $(5, -5)$.



(i) Find \vec{PQ} .

$$\vec{PQ} = \begin{pmatrix} \\ \end{pmatrix} \quad [2]$$

(ii) Show that $|\vec{OP}| = |\vec{OQ}|$.

[3]

(iii) PQ is a chord of a circle with centre O .

Calculate the circumference of this circle.

..... [2]

(iv) PQ is the diameter of a different circle with centre R .

Find the coordinates of R .

(..... ,) [2]

(v) Find the equation of the perpendicular bisector of PQ .

Give your answer in the form $y = mx + c$.

$y = \dots\dots\dots$ [4]

Continue on the next page...

- (b) The position vector of A is \mathbf{a} .
The position vector of B is \mathbf{b} .

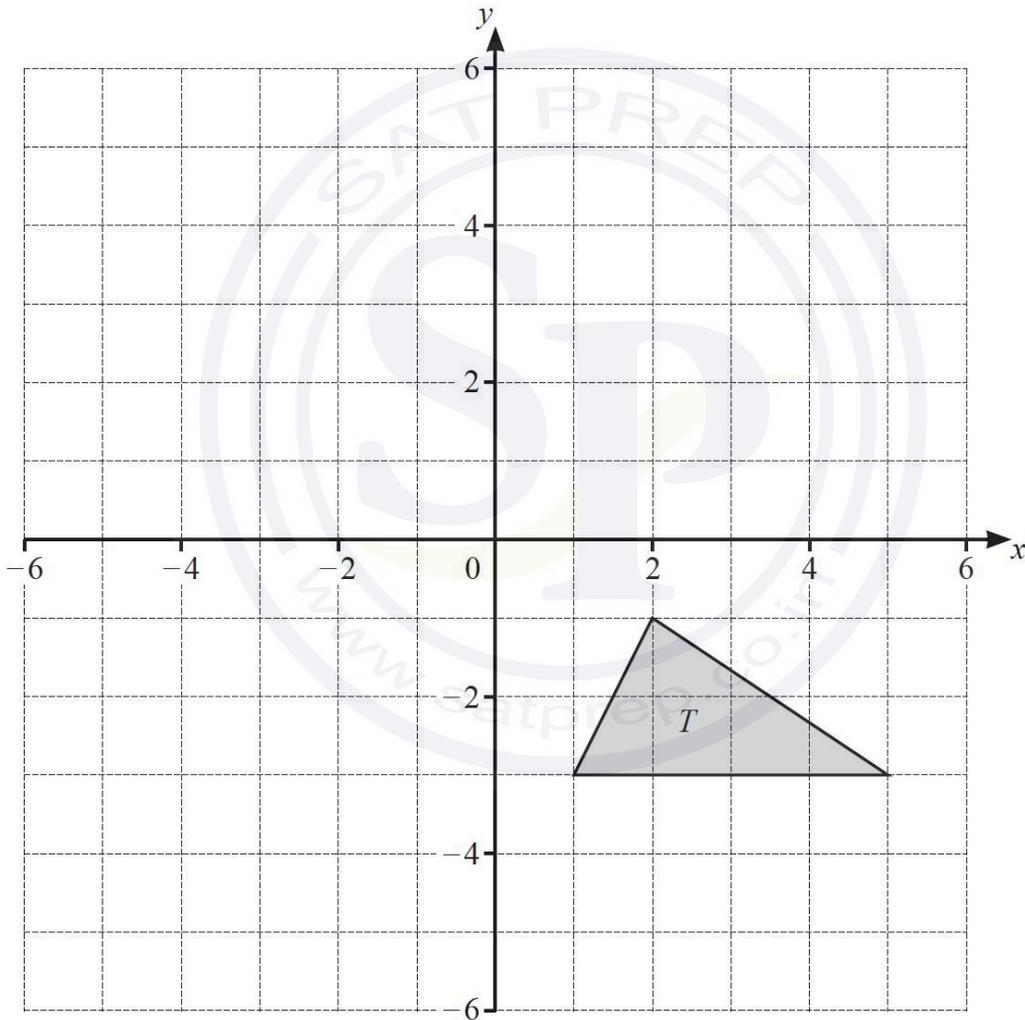
M is a point on AB such that $AM : MB = 2 : 3$.

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

..... [4]

Question 119

- (a)



On the grid, draw the image of

Continue on the next page...

(i) triangle T after a reflection in the x -axis [1]

(ii) triangle T after a translation by the vector $\begin{pmatrix} -5 \\ -2 \end{pmatrix}$ [2]

(iii) triangle T after an enlargement by scale factor $-\frac{1}{2}$ with centre $(-1, 1)$. [2]

(b) A shape P is enlarged by scale factor 3 to give shape Q .
Shape Q is then enlarged by scale factor $\frac{2}{5}$ to give shape R .

The area of shape P is 10 cm^2 .

Calculate the area of shape R .

..... cm^2 [3]

