KING EDWARD VI
HANDSWORTH GRAMMAR
SCHOOL FOR BOYS

KING EDWARD VI
ACADEMY TRUST
BIRMINGHAM

Year 9

2025 Mathematics 2026

Unit 14 Booklet – Part 1

HGS Maths

Tasks

Dr Frost Course

Name: _____

Class: _____

KING EDWARD VI
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KING EDWARD VI
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Year 9

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Unit 14 Booklet – Part 2

HGS Maths

Tasks

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Name: _____

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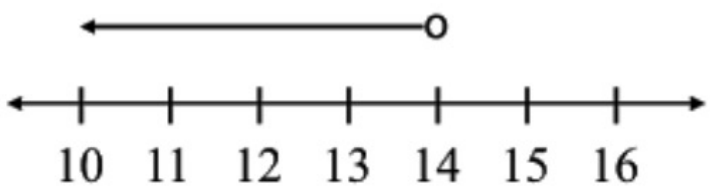
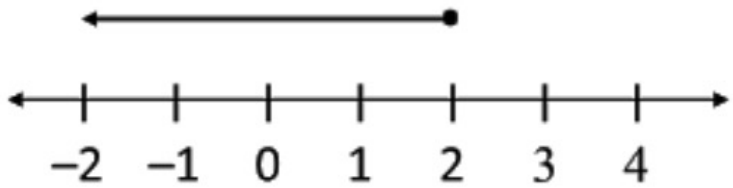
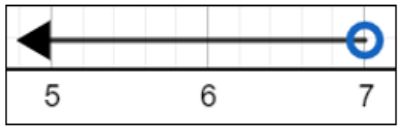
1 Linear Inequalities

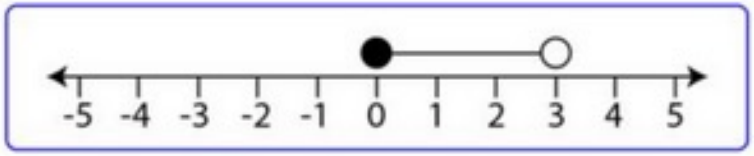
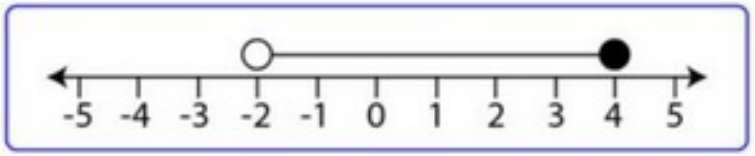
Worked Example	Your Turn
Represent on a number line: a) $x > -1$ b) $x \leq 1$	Represent on a number line: a) $x \leq -2$ b) $x > 2$

Worked Example	Your Turn
Write down the inequality for x shown on the number line:  	Write down the inequality for x shown on the number line: 

Fill in the Gaps

1) x is less than 7	$x < 7$	
2) x is less than or equal to 7		
3) x is more than 4		
4) x is more than 10		
5) x is more than 3.5		
6) x is more than or equal to 7.5		
7) x is less than or equal to 0		
8) x is more than or equal to 3.5		

Worked Example	Your Turn
Represent on a number line: a) $-1 < x \leq 2$ b) $-1 \leq x < 2$	Represent on a number line: a) $-2 \leq x < 1$ b) $-3 < x \leq 4$

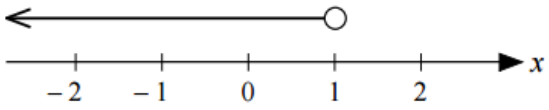
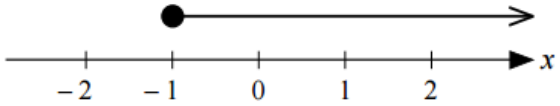
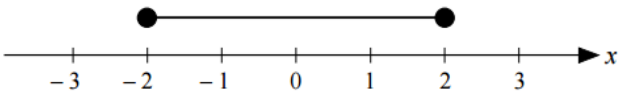
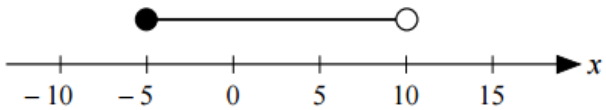
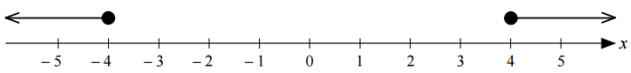
Worked Example	Your Turn
Write down the inequality for x shown on the number line:  	Write down the inequality for x shown on the number line: 

Worked Example	Your Turn
List the integers that satisfy $-4 \leq x < 5$	List the integers that satisfy $-7 < y \leq 2$

Worked Example	Your Turn
Plot $x < 3$ or $x > 7$ on a number line	Plot $x \leq -3$ or $x > 5$ on a number line

Set Notation

Complete the table

	Number Line	Set Notation
1		
2		
3		
4		$\{x:\ -1 < x < 3\}$
5		$\{x:\ -2 < x \leq 2\}$
6		
7		$\{x:\ x < -3\ or\ x > 3\}$
8		

Worked Example	Your Turn
Solve $2x - 8 < 16$	Solve $3x - 9 > 27$

Dr Frost 339b and 339h

Worked Example	Your Turn
Solve $-8 - 3x \geq -1$	Solve $-6 - 5x \leq 7$

Worked Example	Your Turn
Solve $7(x+3)-3(2x-6) \geq 84$	Solve $5(x-3)-2(2x-6) \geq 111$

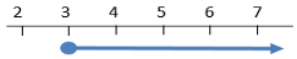
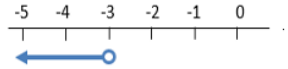
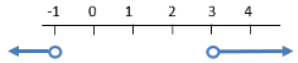
Worked Example	Your Turn
Solve $11 < \frac{5(2x-3)-2}{3}$	Solve $49 > \frac{3(4x+7)+5}{2}$

Dr Frost 339c, 339d and 339e

Worked Example	Your Turn
Work out the least integer value that satisfies the inequality: $9 > \frac{2(7-4x)}{3}$	Work out the least integer value that satisfies the inequality: $6 \geq \frac{5(5-2y)}{3}$

Worked Example	Your Turn
The width of a rectangle is a whole number of centimetres. The length of the rectangle is 9 cm longer than the width. The perimeter of the rectangle no more than 55 cm. Find the greatest possible width of the rectangle.	Freddie has n marbles. Souleymane had 4 times as many marbles as Freddie, but Souleymane has now lost 15 of them. Souleymane still has more marbles than Freddie. a) Write down an inequality in terms of n to show the above information. b) Use your inequality to find the least number of marbles that Freddie may have.

Fill in the Gaps

Q	*Inequality*	Represent on a number line	*Integer solutions*
1	$x > 3$		
2			$x = 3, 4, 5\ldots$
3			$x = -3, -4, -5\ldots$
4	$-3 \leq x$		
5	$x - 1 > 2$		
6			
7	$x + 5 \leq 2$		
8			
9			$x = 4, 5, 6 \ldots or$ $x = -1\ -2, -3\ldots.$
10	$< x \leq$		$x = -2, -1, 0, 1, 2, 3$
11	$x \geq 1\ and\ x < 3$		
12	$3x > 9$		

Worked Example	Your Turn
Solve: a) $9x + 4 < 2x + 60$ b) $3x - 23 \leq 7 - 2x$	Solve: a) $5x + 7 > 2x + 22$ b) $2x - 23 \geq 9 - 2x$

Worked Example	Your Turn
Solve: a) $3(x+2) < 2(x+3)$ b) $3(x+8) > 3(2-x)$	Solve: a) $7(x-3) \leq 2(x+7)$ b) $3(x-5) \geq 5(5-x)$

Worked Example	Your Turn
Solve: $\frac{5x-8}{3} \geq 2x + 3$	Solve: $\frac{2y+8}{5} \leq 3y + 1$

Worked Example	Your Turn
Solve: $\frac{2x+4}{5} > \frac{x-3}{2}$	Solve: $\frac{2a-1}{2} \geq \frac{4a+3}{5}$

Worked Example	Your Turn
Solve: a) $-1 < 2x + 3 < 9$ b) $-1 \leq 2x + 6 < 9$	Solve: a) $-9 < 2x + 3 < 1$ b) $-9 \leq 2x + 6 \leq 1$

Dr Frost 341b and 341f

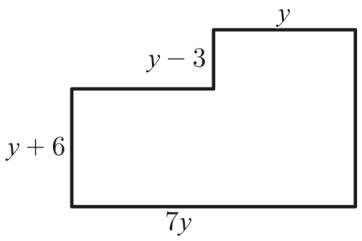
Worked Example	Your Turn
Solve the inequality $16 \leq 4x + 18 < 40$ where x is an integer. List all values of x	Solve the inequality $-14 \leq 2n - 5 \leq -2$ where n is an integer. List all values of n

Worked Example	Your Turn
Solve: $8 \leq -1 + \frac{1}{2}n < 10$	Solve: $5 \leq \frac{-9+5x}{2} < 15$

Worked Example	Your Turn
Solve: $5 < -2x + 18 \leq 17$	Solve: $-20 < 18 - 3n < 1$

Worked Example

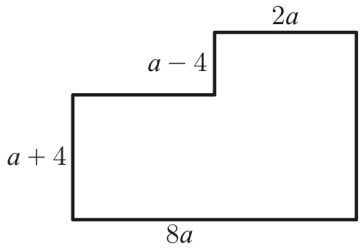
A tile is made of a rectangle of length $7y$ cm and width $(y + 6)$ cm and another rectangle of length y cm and width $(y - 3)$ cm is added to one corner as shown in the diagram.



Given that the perimeter of this tile is at least 96 cm and no more than 132 cm, determine the set of possible values of

Your Turn

A tile is made of a rectangle of length $8a$ cm and width $(a + 4)$ cm and another rectangle of length $2a$ cm and width $(a - 4)$ cm is added to one corner as shown in the diagram.



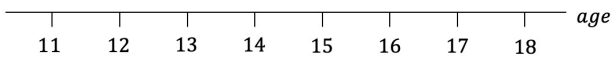
Given that the perimeter of this tile is more than 140 cm and less than 240 cm, determine the set of possible values of a

Worked Example

$12 \leq a \leq 17$

$a > 15$

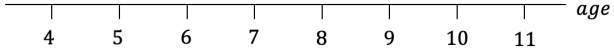
Combined



$x \leq 6$ or $x \geq 8$

$5 < x \leq 9$

Combined

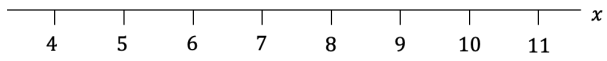


Your Turn

$x \leq 8$

$6 \leq x < 9$

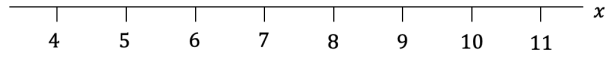
Combined



$x \leq 6$ or $x > 9$

$7 \leq x \leq 10$

Combined



Dr Frost 341g, 341h and 341i

Worked Example	Your Turn
Find the set of values of *x* for which: a) $3x - 5 < x + 8$ and $5x > x - 8$ b) $x - 5 > 1 - x$ or $15 - 3x > 5 + 2x$	Find the set of values of *x* for which: a) $2x + 3 < x + 7$ and $4x \geq 2x - 6$ b) $x - 4 \leq 3x - 2$ or $-7 - 2x > 3x - 1$

Worked Example	Your Turn
Solve the inequalities $7 < 3x - 20$ and $3x + 16 < 58$ Write down all the integer values of x that satisfy both of the inequalities.	Solve the inequalities $-10 < 4n + 11$ and $3n + 12 \leq 12$ Write down all the integer values of n that satisfy both of the inequalities.

Worked Example	Your Turn
Solve: $3 - x \leq 2 < 10 - 2x$	Solve: $1 + x < 5 \leq 7 + 5x$

Extra Notes

2 Straight Line Graphs

Worked Example

Plot the graph of $y = 2x + 1$ for the values $-2 \leq x \leq 2$

x					
y					
Coordinates					

Your Turn

Plot the graph of $y = 4x - 2$ for the values $-2 \leq x \leq 2$

x					
y					
Coordinates					

Dr Frost 267a and 273a

Worked Example

Plot the graph of $y = -2x + 1$ for the values $-2 \leq x \leq 2$

x					
y					
Coordinates					

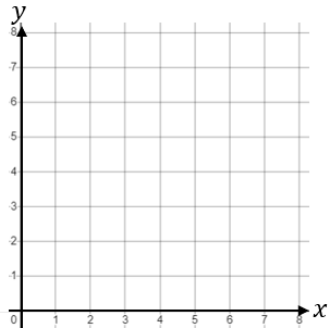
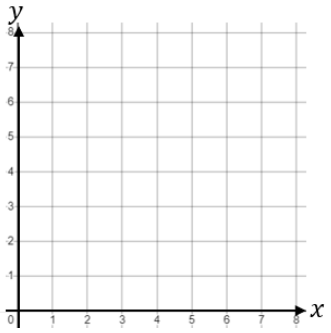
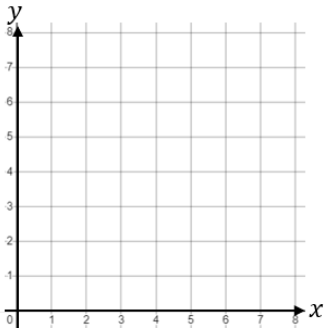
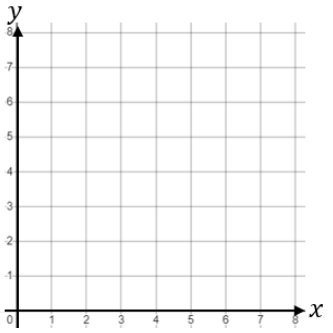
Your Turn

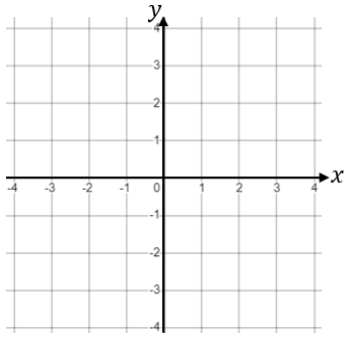
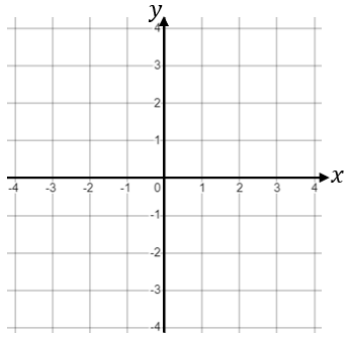
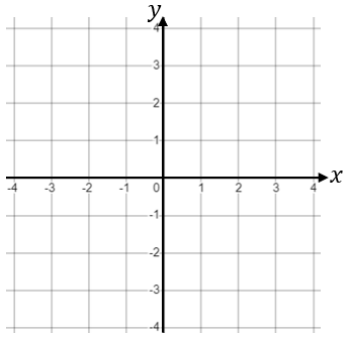
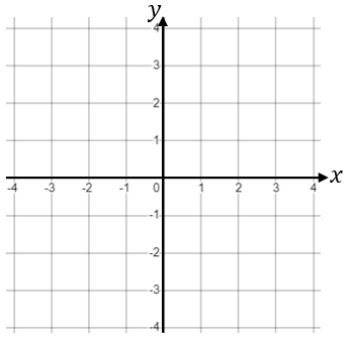
Plot the graph of $y = -4x - 2$ for the values $-2 \leq x \leq 2$

x					
y					
Coordinates					

Dr Frost 267b and 273b

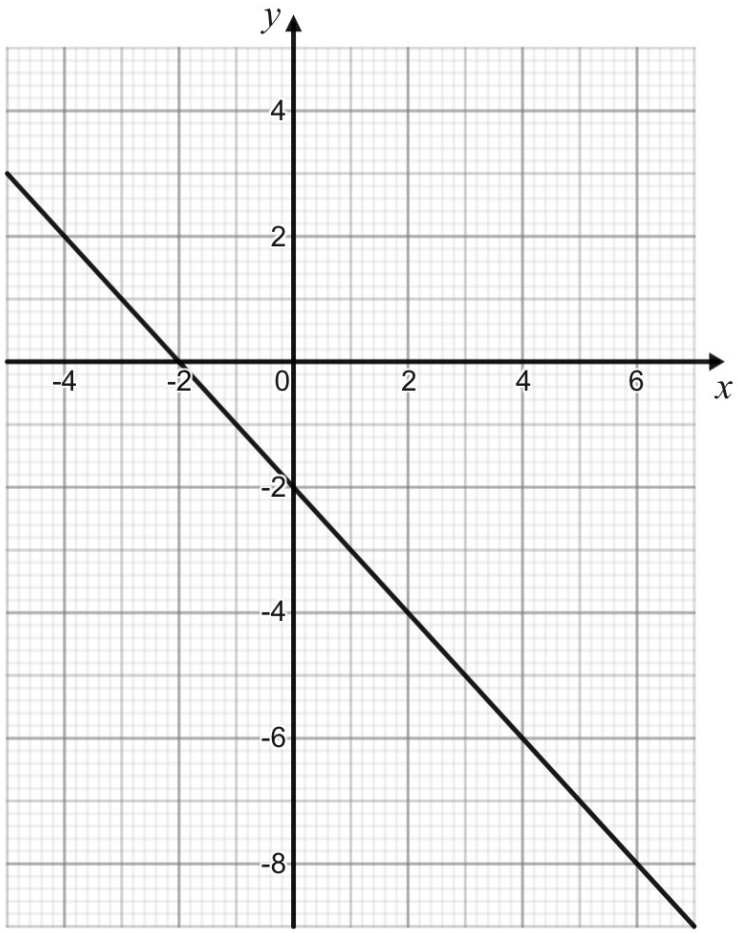
Fluency Practice

Equation	$y = x + 3$	$y = x + 1$	$y = 2x$	$y = 8 - x$
Table	x | 0 | 1 | 2 | 3 y | 3 | 4 | 5 |	x | 0 | 1 | 2 | 3 y | 1 | | | 4	x | 0 | 1 | 2 | 3 y | | | 4 | 6	x | 0 | 1 | 2 | 3 y | | | | 5
Graph				

Equation	$y = 2x + 1$	$y = x - 1$	$y = 2 - x$	$y = 0.5x + 3$
Table	x | -2 | -1 | 0 | 1 y | -3 | -1 | |	x | -2 | -1 | 0 | 1 y | | | -1 |	x | -2 | -1 | 0 | 1 y | | | 2 |	x | -2 | -1 | 0 | 1 y | | | | 3.5
Graph				

Worked Example

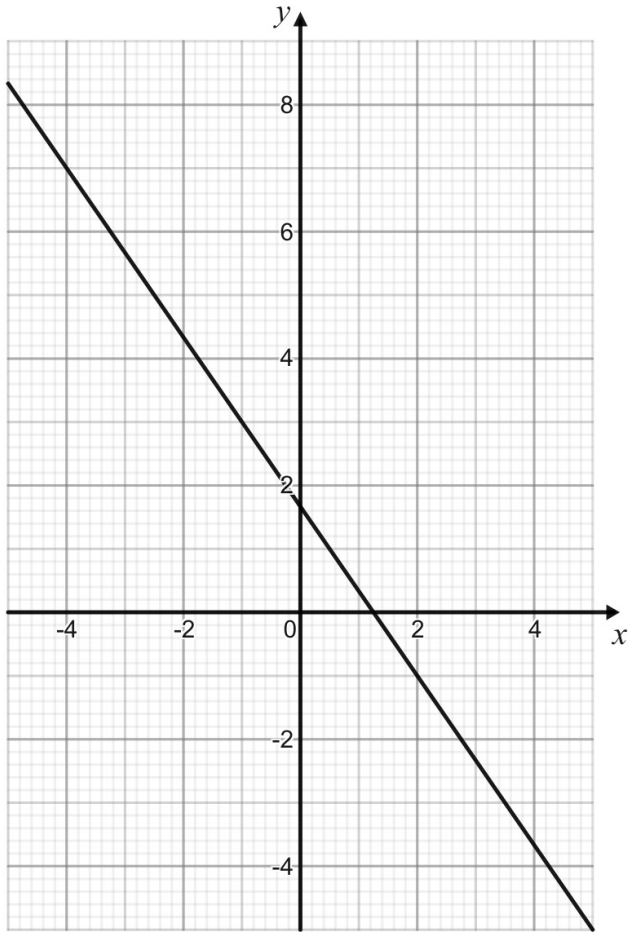
The line passes through the point $(6, c)$



Find the value of c

Your Turn

The line passes through the point $(-4, a)$



Find the value of a

Worked Example

Plot the graph of $2x + y = 8$ for the values $-2 \leq x \leq 2$

x					
y					
Coordinates					

Your Turn

Plot the graph of $2x - y = 8$ for the values $-2 \leq x \leq 2$

x					
y					
Coordinates					

Worked Example

Plot the graph of $x + 2y = 8$ for the values $-2 \leq x \leq 2$

x					
y					
Coordinates					

Your Turn

Plot the graph of $x - 2y = 8$ for the values $-2 \leq x \leq 2$

x					
y					
Coordinates					

Dr Frost 267c and 273c

Worked Example

Plot the graph of $2x + 3y = 12$

x	0	
y		0
Coordinates		

Your Turn

Plot the graph of $4x - 3y = 24$

x	0	
y		0
Coordinates		

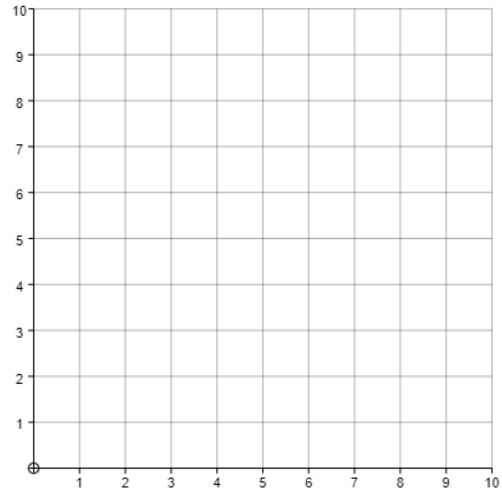
Dr Frost 273d and 273e

Plotting Linear Graphs Using the Cover-Up Method

(a) $2x + y = 6$

When $x = 0, y =$

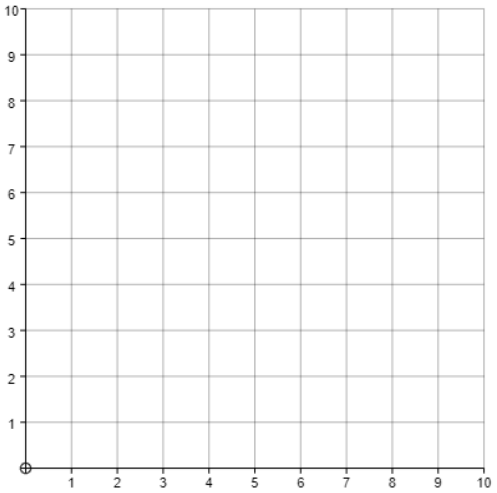
When $y = 0, x =$



(b) $x + 3y = 9$

When $x = 0, y =$

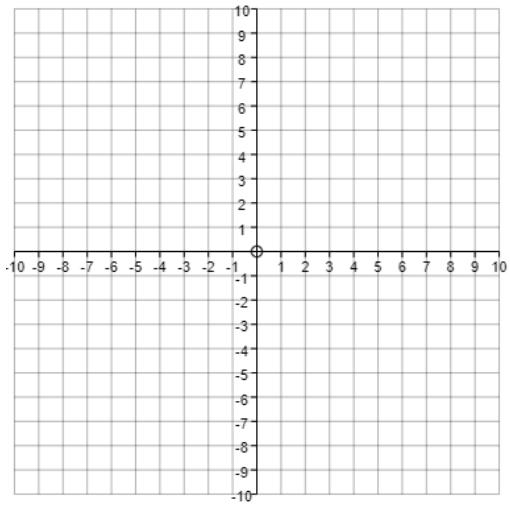
When $y = 0, x =$



(c) $5x + 2y = 10$

When $x = 0, y =$

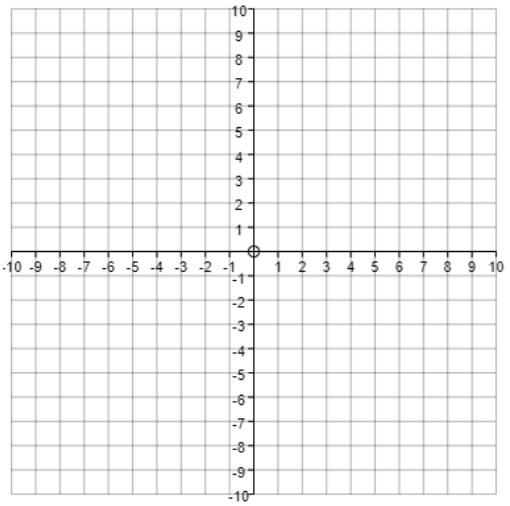
When $y = 0, x =$



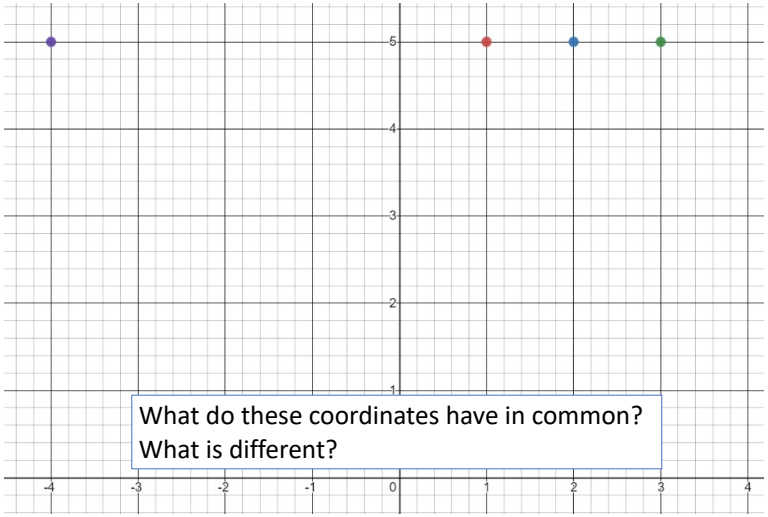
(d) $3x + 2y = 9$

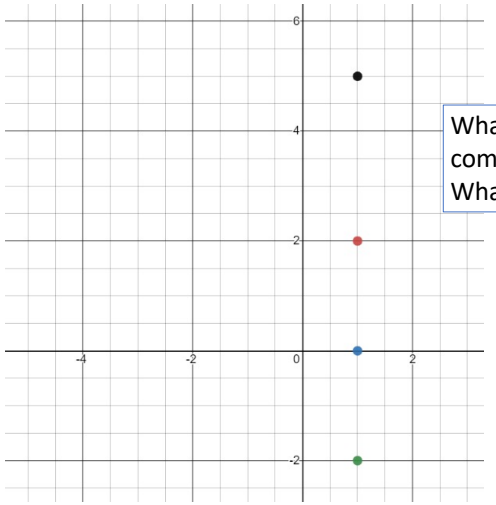
When $x = 0, y =$

When $y = 0, x =$

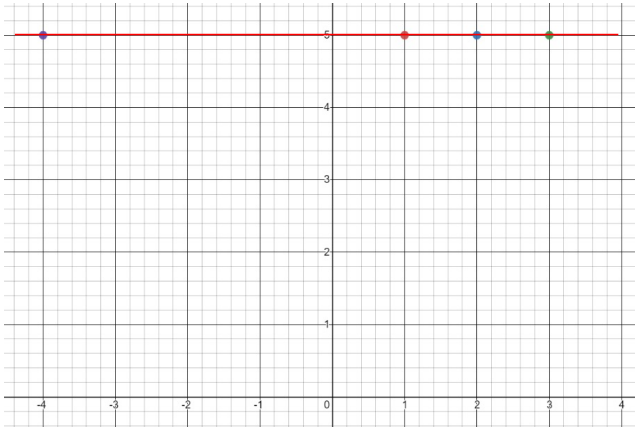


Horizontal and Vertical Lines





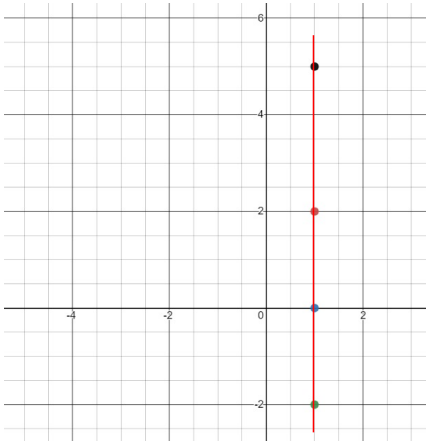
The relationship of the shared characteristic between points can be written as an equation.



All of these points have a y coordinate of 5.

The straight line can be described as y = 5 because this is true for every point on the line.

The relationship of the shared characteristic between points can be written as an equation.

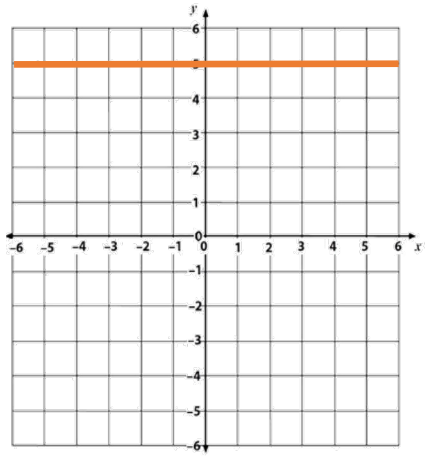


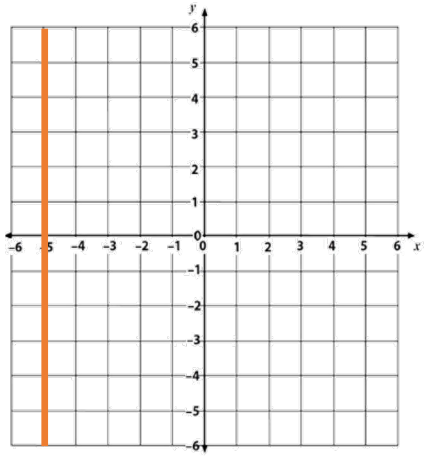
All of these points have an x coordinate of 1.

The straight line can be described as _____ because this is true for every point on the line.

Worked Example

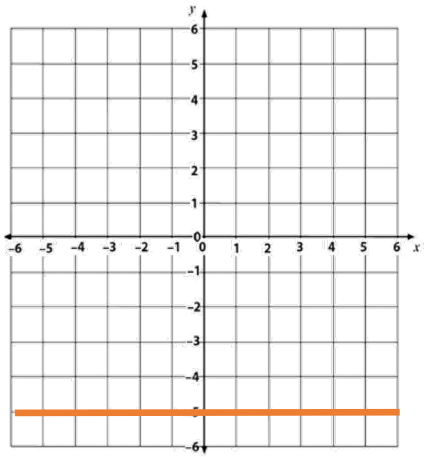
Find the equation of the line:

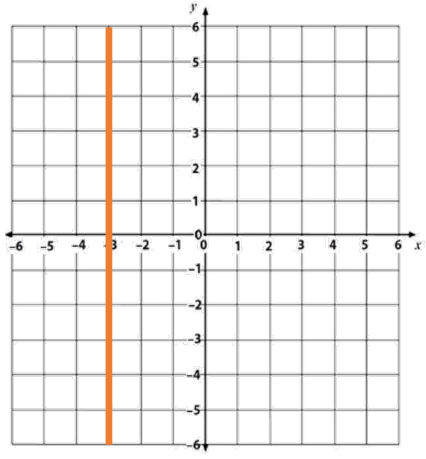




Your Turn

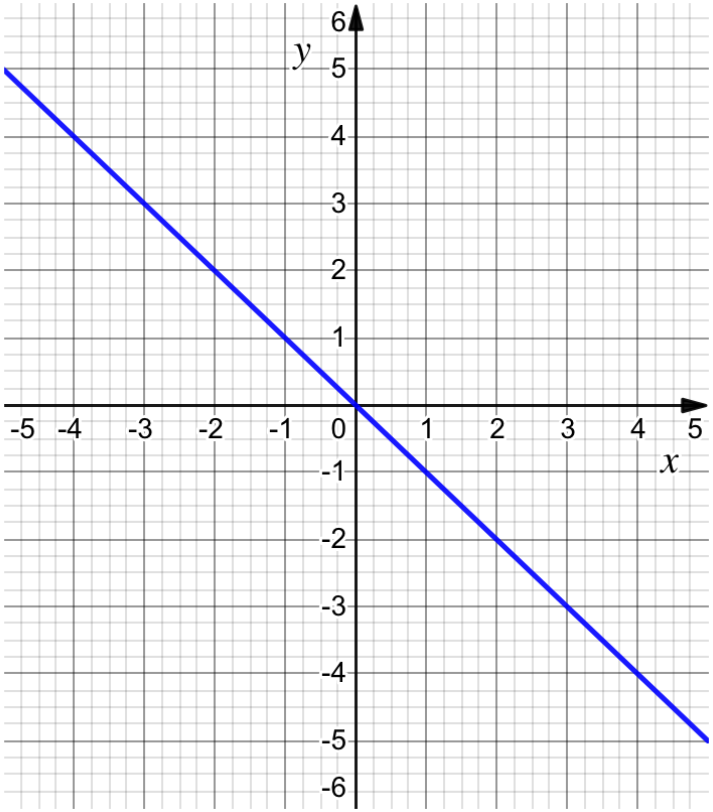
Find the equation of the line:





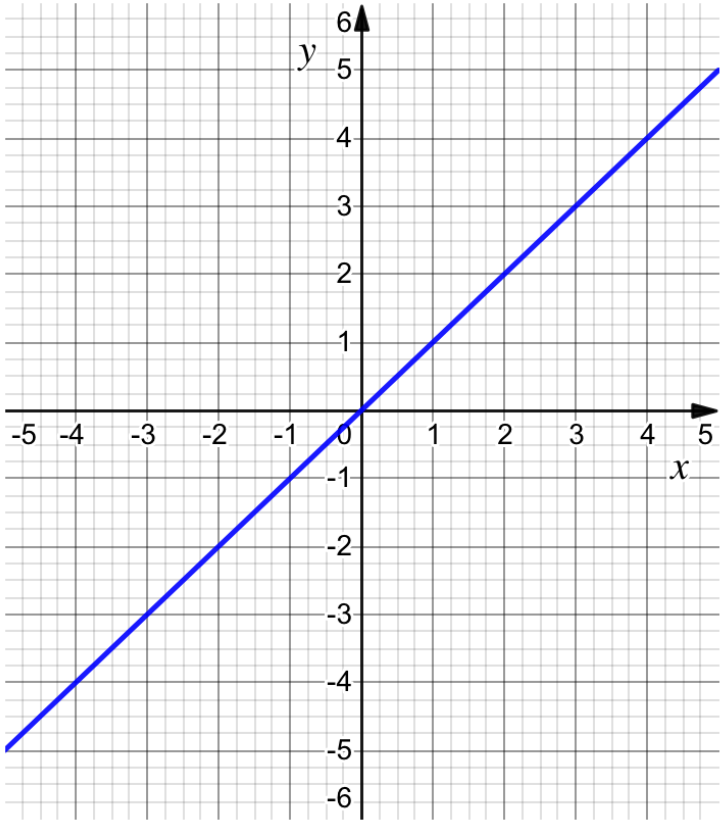
Worked Example

Find the equation of the line:

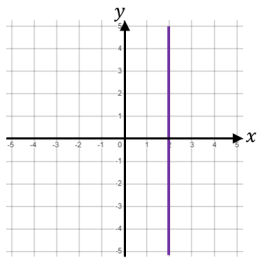


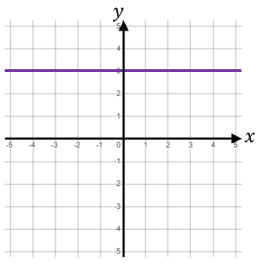
Your Turn

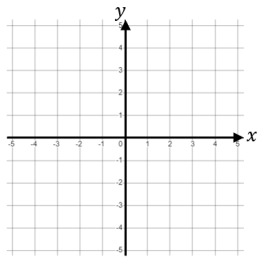
Find the equation of the line:

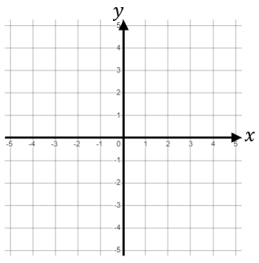


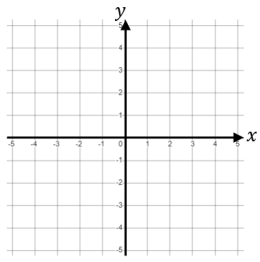
Dr Frost 268e and 272a

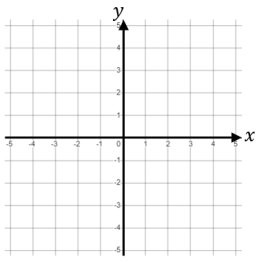
Graph	Points on Line
	$(2,1)$
	$(2,0)$
	$(2,-4)$
	Equation

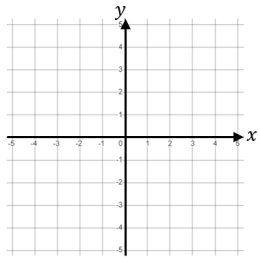
Graph	Points on Line
	$(1,3)$
	Equation

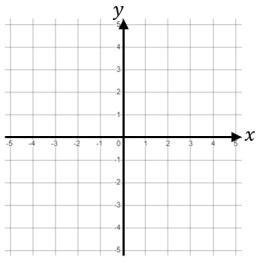
Graph	Points on Line
	$(3,1)$
	$(-1,1)$
	Equation
	$y = 1$

Graph	Points on Line
	$(-2,4)$
	Equation
	$x = -2$

Graph	Points on Line
	$(0,3)$
	$(0,-1)$
	Equation

Graph	Points on Line
	
	Equation
	$y = -2.5$

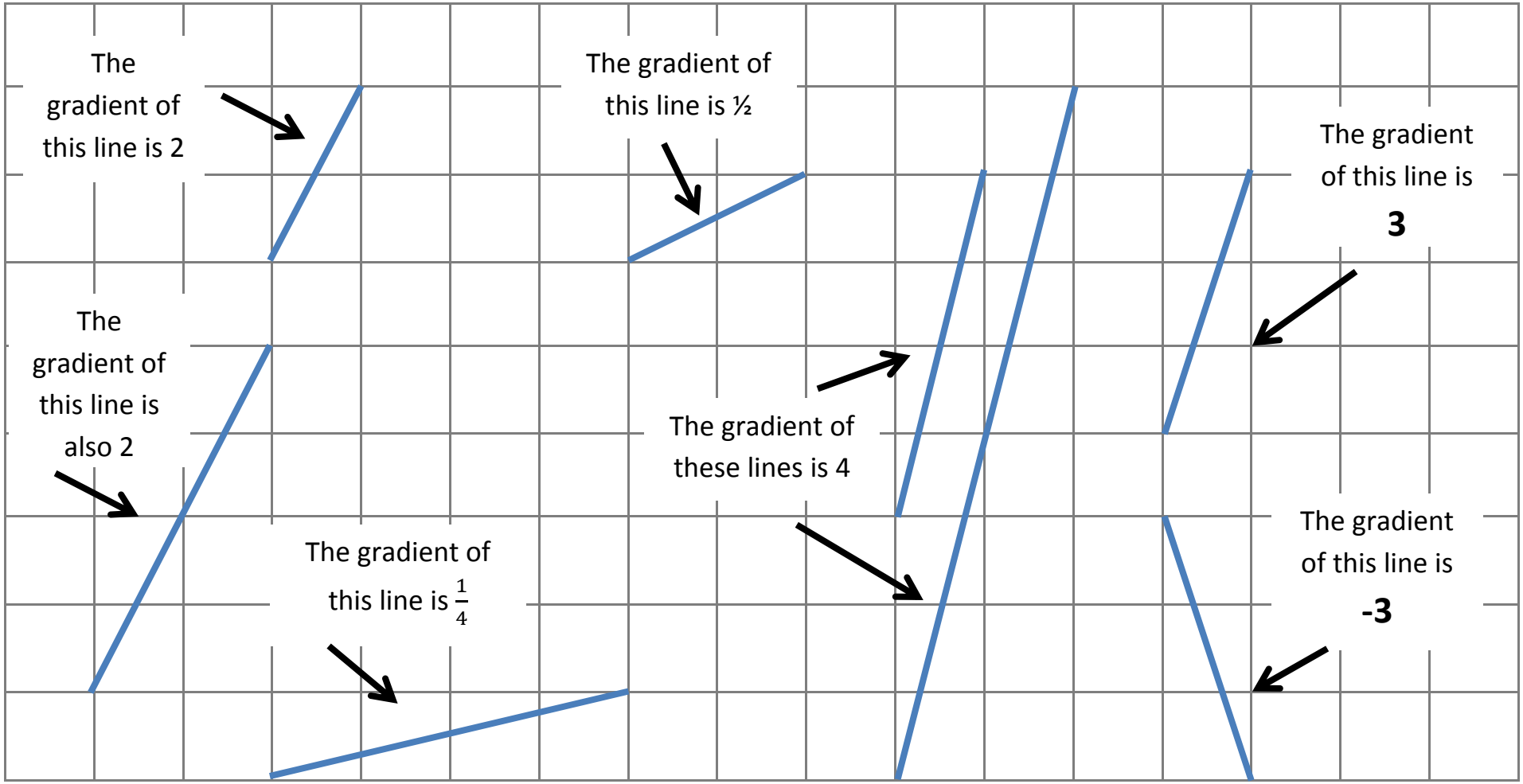
Graph	Points on Line
	$(2,2)$
	$(5,5)$
	$(-1,-1)$
	Equation

Graph	Points on Line
	
	Equation
	$y = -x$

Gradient

Fluency Practice

Look at these pictures and try to figure out what the word 'gradient' means:

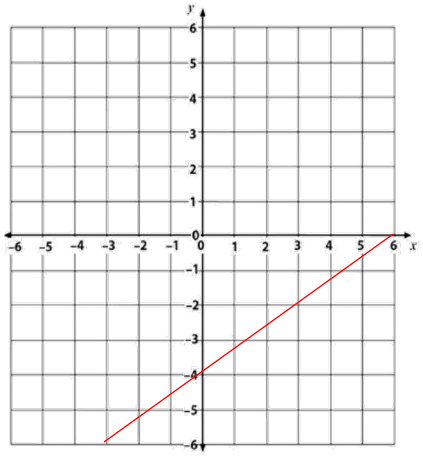


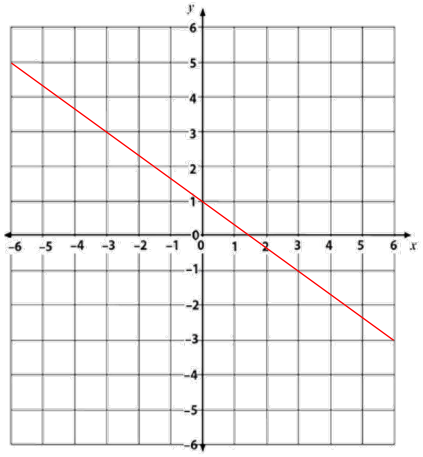
Dr Frost 270a, 270b and 270c

Worked Example	Your Turn
Calculate the gradient between the coordinates: a) $(-2, -1)$ and $(5, 7)$ b) $(2, -1)$ and $(-5, -7)$	Calculate the gradient between the coordinates: a) $(-4, 2)$ and $(6, 8)$ b) $(-4, 2)$ and $(-6, -8)$

Worked Example

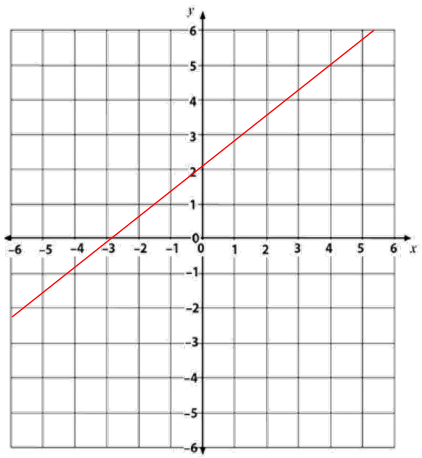
Find the gradient of:

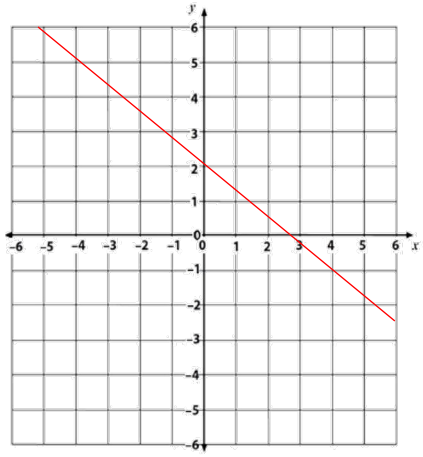




Your Turn

Find the gradient of:

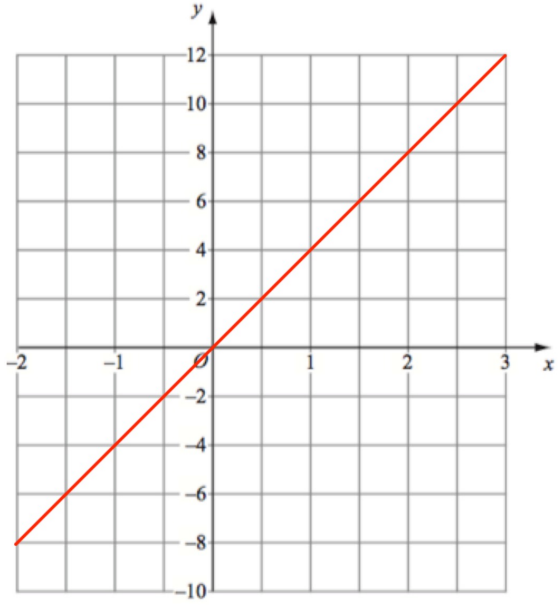




Dr Frost 270f

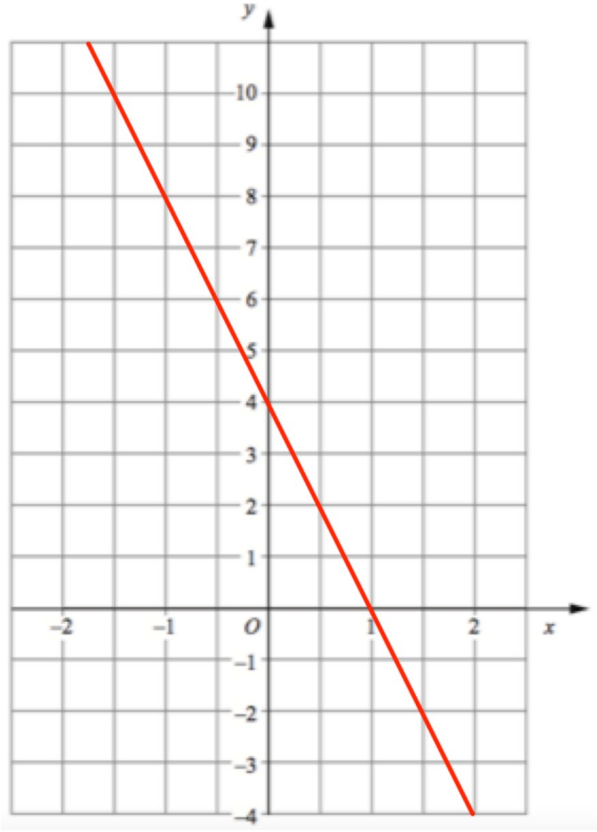
Worked Example

Find the gradient of:



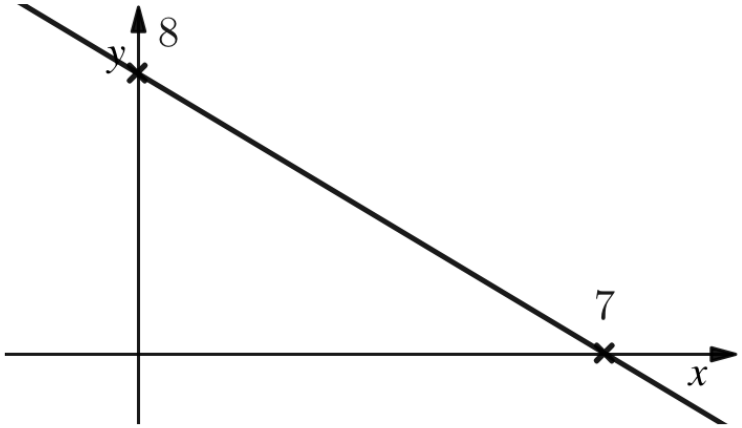
Your Turn

Find the gradient of:



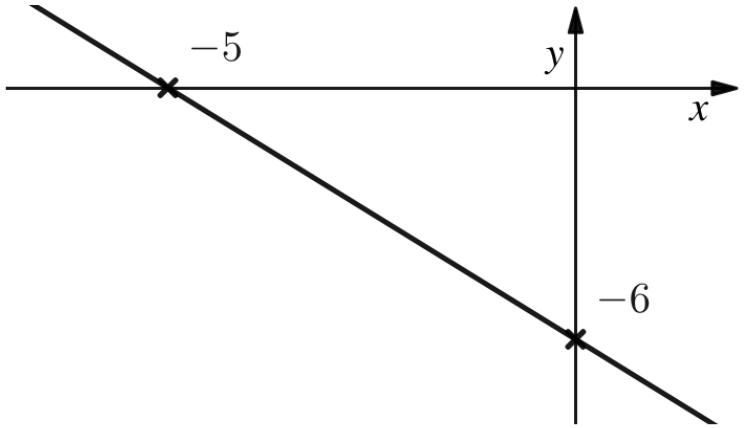
Worked Example

Find the gradient of:



Your Turn

Find the gradient of:



Worked Example	Your Turn
The gradient connecting the two points $(2a, 5)$ and $(7a, 8)$ is 6. Solve for a.	The gradient connecting the two points $(3a, 7)$ and $(5a, 12)$ is 6. Solve for a.

Worked Example	Your Turn
The gradient connecting the two points (2, 10) and (5, d) is 4. Solve for d.	The gradient connecting the two points (-3, -10) and (2, d) is 12. Solve for d.

Dr Frost 270m

Worked Example	Your Turn
The line L passes through the points $(-2, -6)$ and $(10, s)$. Given that the gradient of the line is $\frac{2}{3}$, find the value of s.	The line L passes through the points $(-3, -8)$ and $(-8, p)$. Given that the gradient of the line is $\frac{8}{5}$, find the value of p.

Collinear Lines

Worked Example	Your Turn
The coordinates $(5, -2)$, $(8, -1)$ and $(17, r)$ are collinear. Determine the value of r.	The coordinates $(-2, -1)$, $(18, 27)$ and $(33, s)$ are collinear. Determine the value of s.

Worked Example	Your Turn
Determine whether the points $A(2, -4)$, $B(12, 1)$ and $C(20, 5)$ are collinear.	Determine whether the points $A(5, -5)$, $B(17, 27)$ and $C(32, 62)$ are collinear.

Worked Example	Your Turn
$y = 2x - 1$ Gradient: y-intercept:	$y = 3x - 4$ Gradient: y-intercept:
$y = -2x + 6$ Gradient: y-intercept:	$y = -3x - 6$ Gradient: y-intercept:
$2x - 3y = 6$ Gradient: y-intercept:	$3x + 2y = 6$ Gradient: y-intercept:

Worked Example	Your Turn
Determine the steepest line. $5x - 2y = 8$ $x + 4y = 10$ $6x + 10y = -35$ $y = -\frac{4}{5}x + 15$	Determine the steepest line. $3x - 2y - 6 = 0$ $7x - 2y + 8 = 0$ $8x - 20y = -15$ $y = \frac{4}{5}x - 25$

Worked Example	Your Turn
Write in the form y$= mx + c$ the line with:	Write in the form $y = mx + c$ the line with:
Gradient 2 and y-intercept 3	Gradient 3 and y-intercept 4
Gradient $\frac{2}{3}$ and y-intercept -3	Gradient $-\frac{5}{6}$ and y-intercept -1
Gradient $-\frac{3}{2}$ and y-intercept 0	Gradient $\frac{3}{4}$ and y-intercept 0
Gradient 0 and y-intercept 4	Gradient 0 and y-intercept -5

Dr Frost 271a

Worked Example	Your Turn
Write in the form $ax + by = c$ (where a, b and c are integers in their lowest terms) the line with:	Write in the form $ax + by = c$ (where a, b and c are integers in their lowest terms) the line with:
Gradient 2 and y-intercept 3	Gradient 3 and y-intercept 4
Gradient $\frac{2}{3}$ and y-intercept -3	Gradient $-\frac{5}{6}$ and y-intercept -1
Gradient $-\frac{3}{2}$ and y-intercept 0	Gradient $\frac{3}{4}$ and y-intercept 0
Gradient 0 and y-intercept 4	Gradient 0 and y-intercept -5

Fill in the Gaps

Equation	Gradient	y-intercept
$y = 2x + 3$	2	$(0, 3)$
$y = 4x + 3$	4	
$y = 4x - 3$		$(0, -3)$
$y = 2x - 1$		
$y = 3x + 5$		
$y = x + 2$		
$y = 7x$		
$y = \frac{1}{2}x - 3$		
$y = \frac{2}{3}x + \frac{4}{3}$		
$y = -3x + 6$	-3	
$y = -2x - 1$		
$y = -5x + 2$		
$y = -x$		
$y = -\frac{1}{2}x + 4$		

Equation	Gradient	y-intercept
$y = -\frac{3}{2}x + 1$		
$y = -\frac{2}{5}x - \frac{4}{5}$		
	3	$(0, 6)$
	4	$(0, 1)$
	-2	$(0, 0)$
	1	$(0, -3)$
	$\frac{1}{3}$	$(0, -5)$
	$-\frac{4}{5}$	$\left(0, \frac{2}{5}\right)$
	-1	$(0, 8)$
$2y = 6x - 10$		
$y + 2x = 7$		
$6x + 3y = 18$		
$x - 2y = 8$		
$3y = 5x - 6$		

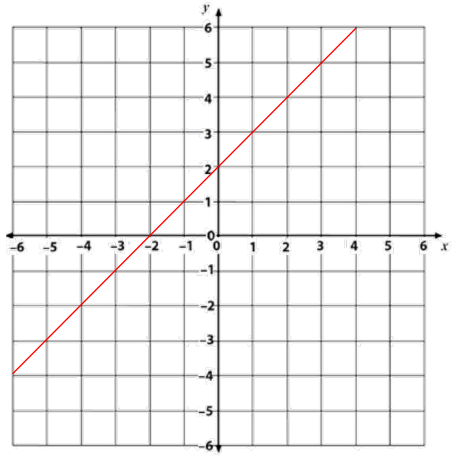
Fill in the Gaps

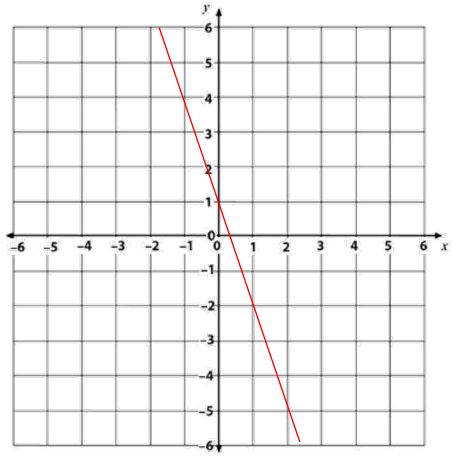
Equation of Line	Equation in $y = mx + c$ form	Gradient	y-intercept
$4x + y = 11$	$y = -4x + 11$	-4	$(0, 11)$
$y - 3x = 8$			
$0 = 5x + y + 7$			
$3 = 2x - y$			
$6 - 5x - y = 0$			
$2y = 7x$			
$9x + 15 = 3y$			
$5y - 10 = 30x$			
$4x + 3y = 11$			
$14 = 5y - 2x$			
$6x - 2y = 16$			
$30 = 8x - 5y$			
$x + \square y = \square$		$-\frac{1}{2}$	$(0, 3)$
$\square x - \square y = \square$		$\frac{4}{3}$	$\left(0, -\frac{7}{3}\right)$

Equation of Straight Line Graphs

Worked Example

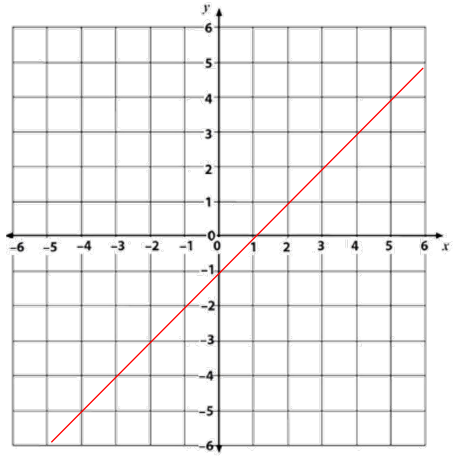
Find the equation of:

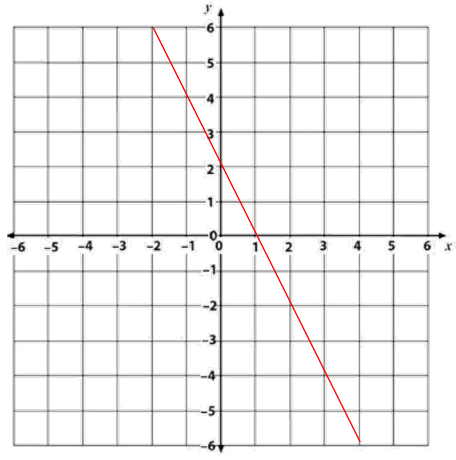




Your Turn

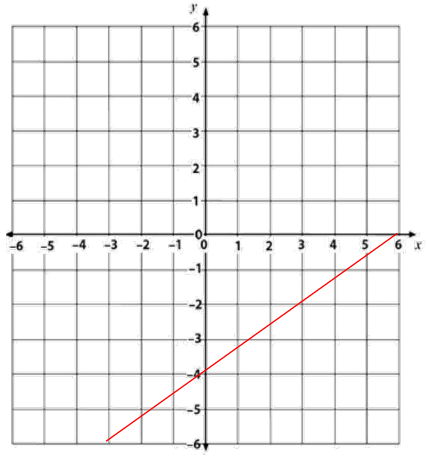
Find the equation of:

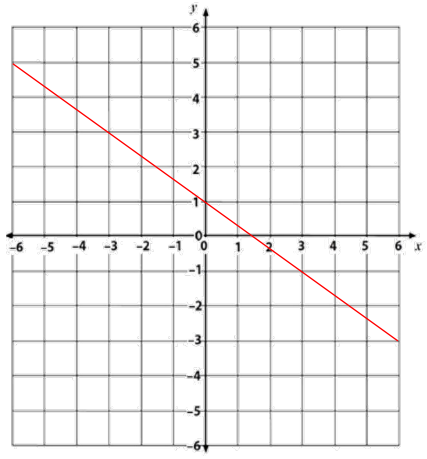




Worked Example

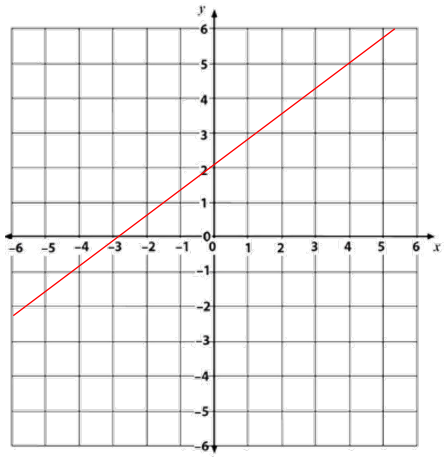
Find the equation of:

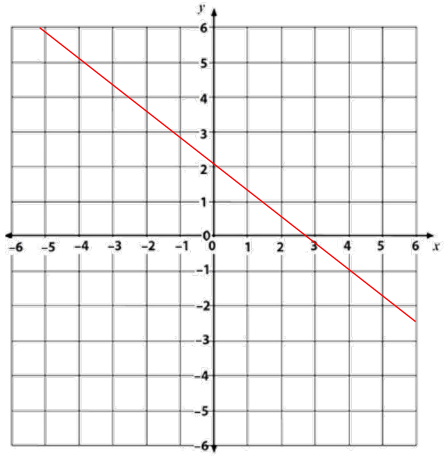


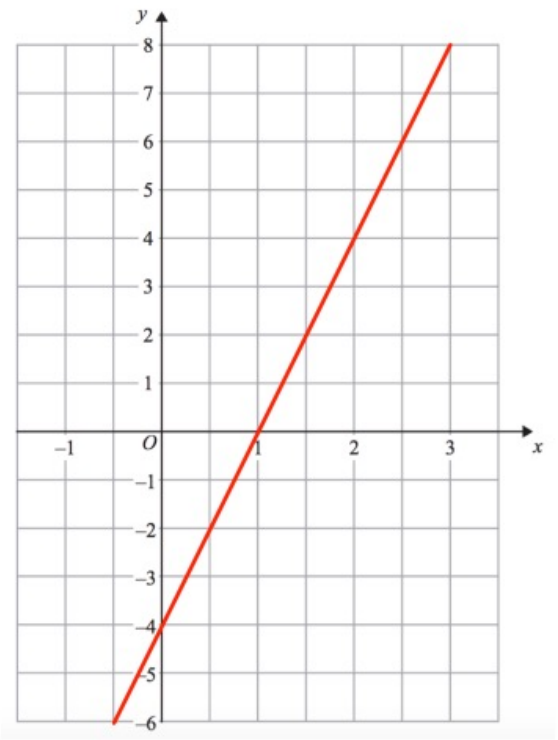
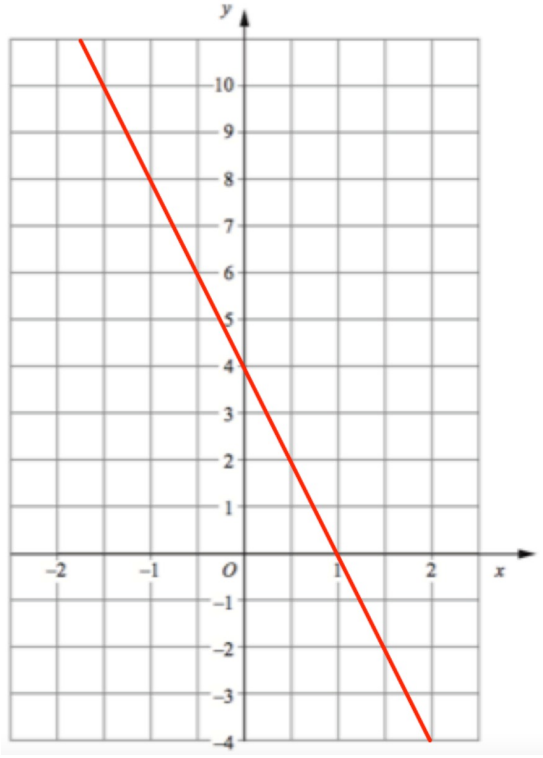


Your Turn

Find the equation of:





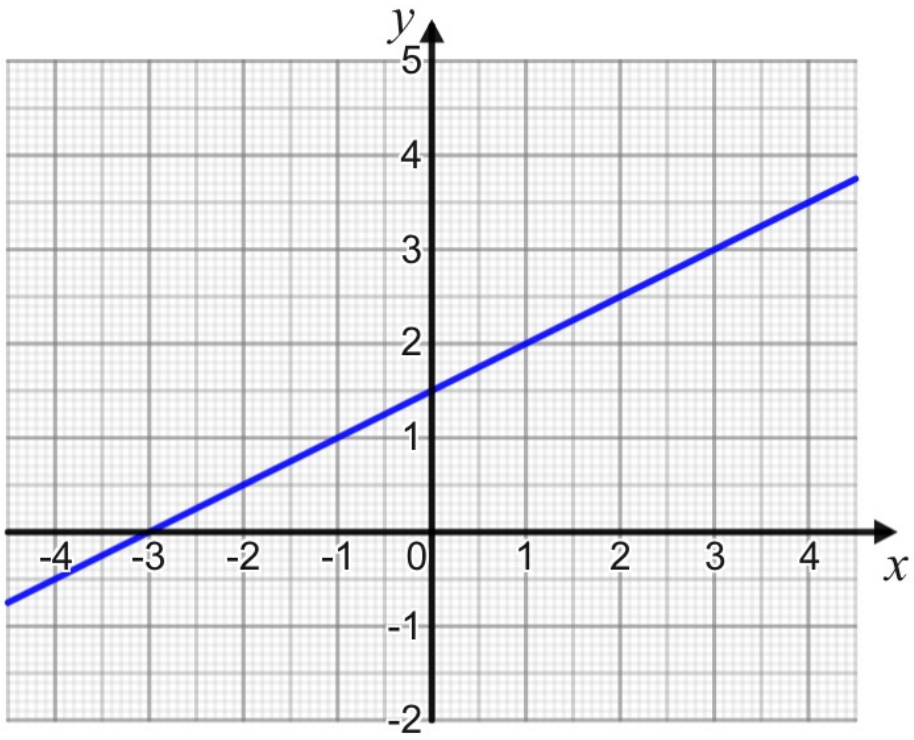
Worked Example	Your Turn
Find the equation of:  	Find the equation of: 

Dr Frost 272b, 272c and 272d

Worked Example

Write down the equation of the line drawn below.

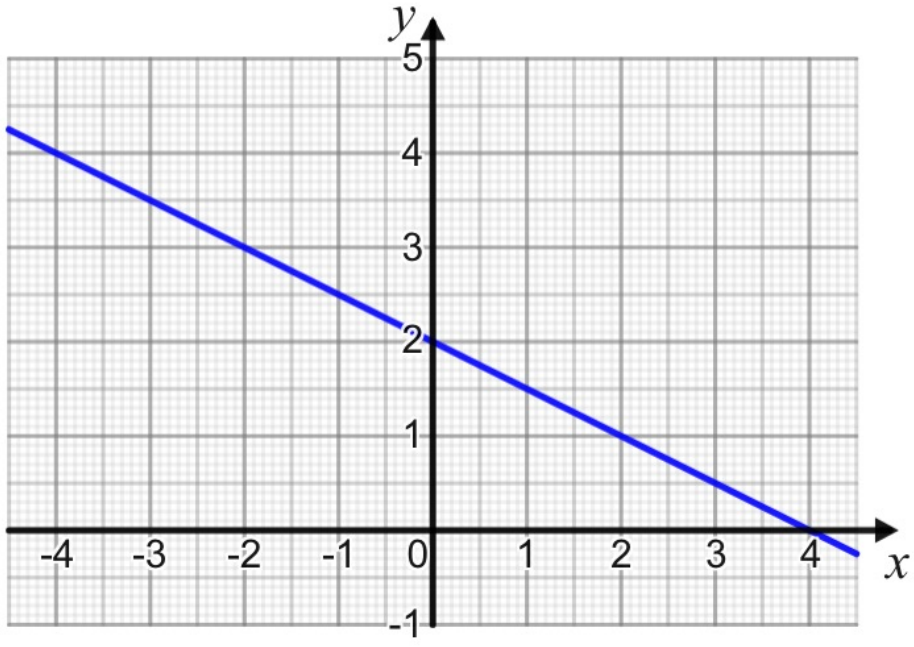
Give your answer in the form $ax + by = c$
where a, b and c are integers in their lowest terms.



Your Turn

Write down the equation of the line drawn below.

Give your answer in the form $ax + by = c$
where a, b and c are integers in their lowest terms.



Worked Example	Your Turn
Find the equation of the line, given a point and the gradient: $(-6, 22)$ Gradient 3	Find the equation of the line, given a point and the gradient: $(-2, 5)$ Gradient 4

Dr Frost 272f and 272g

Fill in the Gaps

Gradient	Point	Find c using $y = mx + c$	Equation of Line
2	$(3, 5)$	$5 = 2 \times 3 + c$ $c = -1$	$y = 2x - 1$
4	$(1, 9)$		
1	$(4, -3)$		
-2	$(7, 0)$		
-3	$(-1, 2)$		
$\frac{1}{2}$	$(4, 5)$		
$\frac{4}{3}$	$(-9, 1)$		
5	$(-3, -1)$		
-3	$(-2, 6)$		
$\frac{3}{2}$	$\left(\frac{1}{2}, 1\right)$		
-1	$\left(\frac{2}{3}, -\frac{1}{3}\right)$		
$-\frac{5}{2}$	$(3, 0)$		
6	$\left(-\frac{1}{2}, \frac{3}{4}\right)$		

Worked Example	Your Turn
Write the equation of the line with gradient $-\frac{2}{3}$ and that passes through the point $(1, 5)$ Give your answer in the form $ax + by = c$ where a, b and c are integers in their lowest terms.	Write the equation of the line with gradient $\frac{4}{5}$ and that passes through the point $(-5, 1)$ Give your answer in the form $ax + by = c$ where a, b and c are integers in their lowest terms.

Worked Example	Your Turn
Write the equation of the line in the form $y = mx + c$ which passes through the points $(2, 3)$ and $(5, -9)$	Write the equation of the line in the form $y = mx + c$ which passes through the points $(3, 10)$ and $(-5, 18)$

Fill in the Gaps

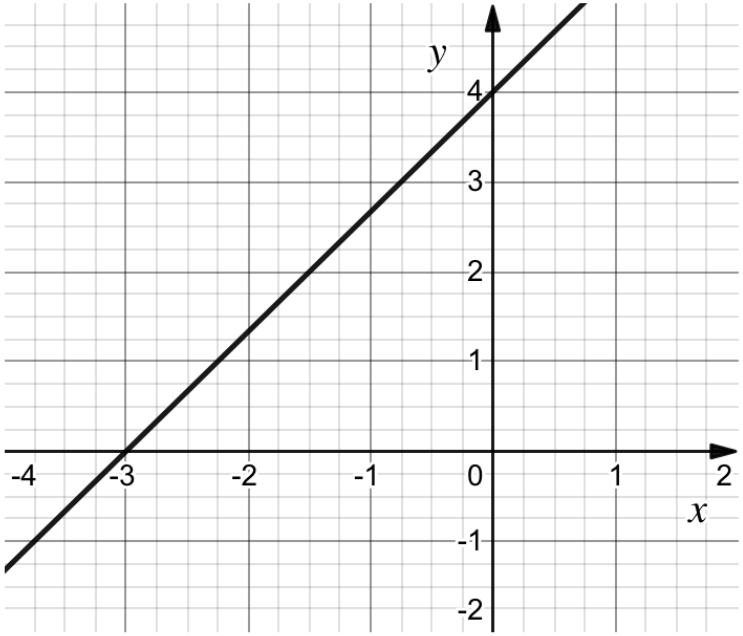
(x_1, y_1)	(x_2, y_2)	Find m using $\frac{y_2-y_1}{x_2-x_1}$	Gradient m	Find c using $y = mx + c$	Equation of Line
$(1, 3)$	$(2, 5)$	$\frac{5-3}{2-1} = \frac{2}{1}$	2	$3 = 2 \times 1 + c$ $c = 1$	$y = 2x + 1$
$(2, 0)$	$(5, 9)$				
$(4, 1)$	$(5, 6)$				
$(7, 11)$	$(8, 10)$				
$(2, -3)$	$(5, 3)$				
$(3, -2)$	$(1, 8)$				
$(-6, -1)$	$(-2, 1)$				
$(9, 7)$	$(3, 9)$				
$\left(\frac{1}{2}, -3\right)$	$\left(-\frac{1}{2}, -\frac{5}{2}\right)$				

Worked Example	Your Turn
Write the equation of the line in the form $ax + by = c$ (where a, b and c are integers in their lowest terms) which passes through the points $(2, -3)$ and $(7, -5)$	Write the equation of the line in the form $ax + by = c$ (where a, b and c are integers in their lowest terms) which passes through the points $(3, -2)$ and $(-7, 5)$

x-intercept and y-intercept

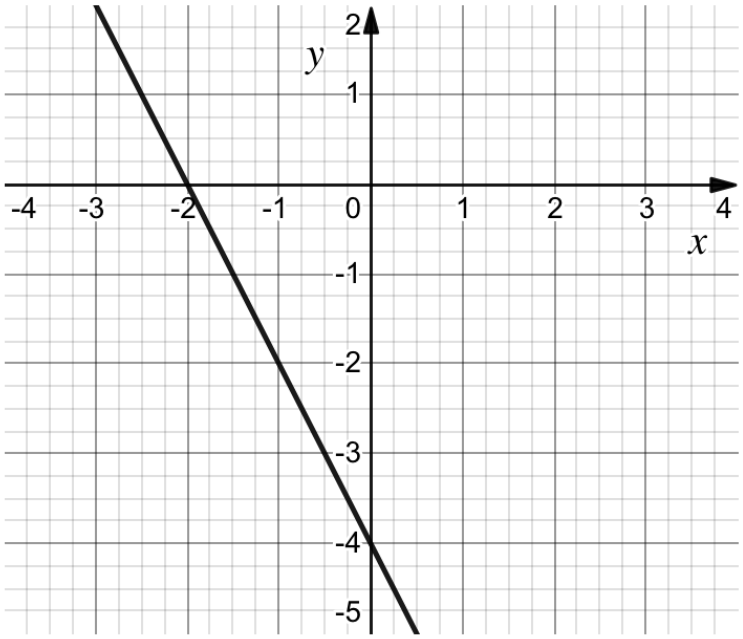
Worked Example

Find where the line intercepts the axes:



Your Turn

Find where the line intercepts the axes:



Worked Example

Find where the line intercepts the axes:

Line	x-intercept	y-intercept
$y = 3x - 2$		
$3x + 2y = 6$		

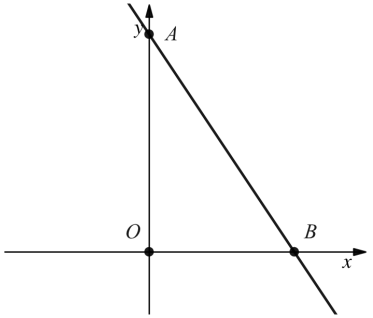
Your Turn

Find where the line intercepts the axes:

Line	x-intercept	y-intercept
$y = 5 - 4x$		
$5x - 4y = 20$		

Worked Example

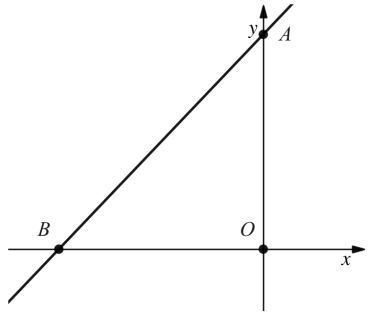
A sketch of the line with equation $7x + 2y = 14$ is shown below. The line passes through the points A and B.



Calculate the area of the triangle OAB.

Your Turn

A sketch of the line with equation $7x - 4y = -28$ is shown below. The line passes through the points A and B.



Calculate the area of the triangle OAB.

Dr Frost 269d

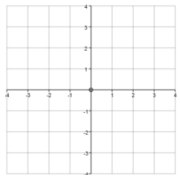
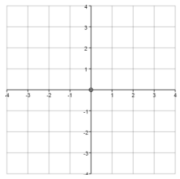
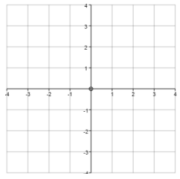
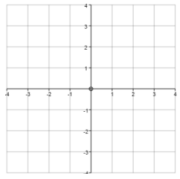
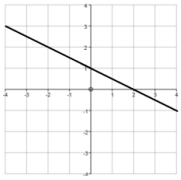
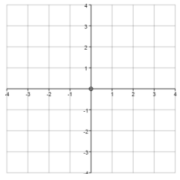
Does a Point lie on a Straight Line?

Worked Example	Your Turn
Does the point $(2, 9)$ lie on the line $y = 4x + 1$?	Does the point $(2, 6)$ lie on the line $y = 9 - 2x$?

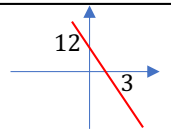
Worked Example	Your Turn
Determine whether the point with coordinates $(5, 8)$ lies on, above or below the line with equation $5y - 4x = -5$	Determine whether the point with coordinates $(2, -1)$ lies on, above or below the line with equation $3y - 5x = -7$

Worked Example	Your Turn
The point $(t, -3)$ lies on the line $-5y + x = 14$. Calculate the value of t.	The point $(r, -4)$ lies on the line $-2y + x = 7$. Calculate the value of r.

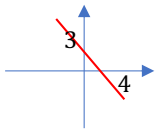
Fill in the Gaps

Equation of Straight Line	Graph	Gradient	Y-Intercept	A Point on the Line	Another Point on the Line
$y = x - 3$				$(-5, \square)$	$(\square, 10)$
$y = 1 + 2x$				$(2, \square)$	$(\square, -7)$
		-1	$(0, 2)$	$(2, \square)$	$(\square, -7)$
		-3		$(1, 0)$	$(\square, 9)$
				$(-8, \square)$	$(\square, 2)$
				$(1, 1)$	$(5, 13)$

Fill in the Gaps

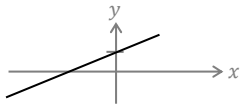
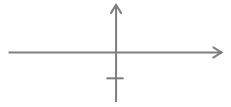
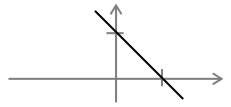
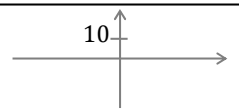
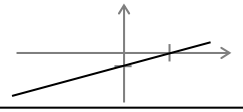
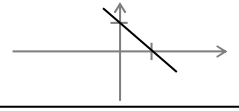
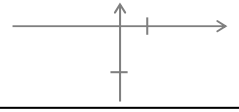
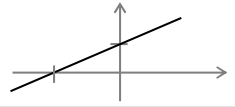
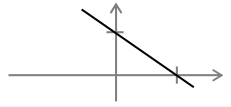
	$y = mx + c$	$ax + by = d$	Gradient	x intercept	y intercept	Sketch
1.	$y = 2x + 8$					
2.		$2x - y = -6$				
3.			3	$(-3, 0)$		
4.				$(3, 0)$	$(0, -9)$	
5.			4		$(0, -12)$	
6.						
7.				$(12, 0)$	$(0, 3)$	

Fill in the Gaps

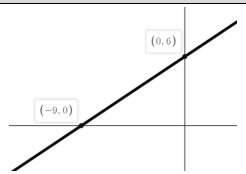
	$y = mx + c$	$ax + by = d$	Gradient	x intercept	y intercept	Sketch
8.	$y = -\frac{1}{3}x + 4$					
9.		$4x + 3y = 12$				
10.						
11.			$\frac{3}{4}$	$(4, 0)$		
12.		$3x - 4y = 24$				
13.			$1\frac{3}{4}$	$(8, 0)$		
14.				No intercept	$(0, -14)$	

Fill in the Gaps

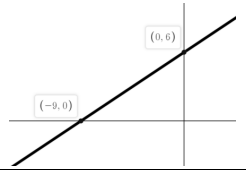
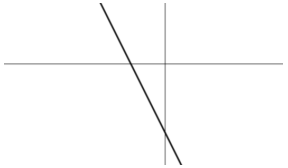
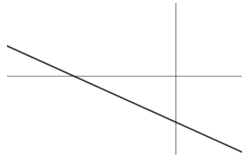
Linear Graphs Plotting, Reading, Calculating Complete the missing information.

	Equation	Gradient	y-Intercept	Table of Values	Sketch (label marked intercepts)	Coordinates on the Line
A	$y = 2x + 6$			x: −2, −1, 0, 1, 2 / y: 2, , , 8,		(3,) (5,)
B			-2	x: −2, −1, 0, 1, 2 / y: −10, −6, , 2, 6		(6,) (-3,)
C	$y = 4 - x$			x: −2, −1, 0, 1, 2 / y: , , , ,		(3,) (-4,)
D				x: −2, −1, 0, 1, 2 / y: 16, 13, , ,		(4,) (-5,)
E	$y = \frac{x}{2} - 8$			x: −4, −2, 0, 2, 4 / y: , , , ,		(-6,) (3,)
F	$2x + y = 10$			x: , 0 / y: 0,		(4,) (, 20)
G				x: −2, 0, 3 / y: , −2, 16		(, 4) (-3,)
H				x: −4, −2, 0, 2, 4 / y: , , 1, 4,		(6,) (-12,)
I	$2x + 3y = 24$			x: , 0 / y: 0,		(6,) (, -6)

Fill in the Gaps

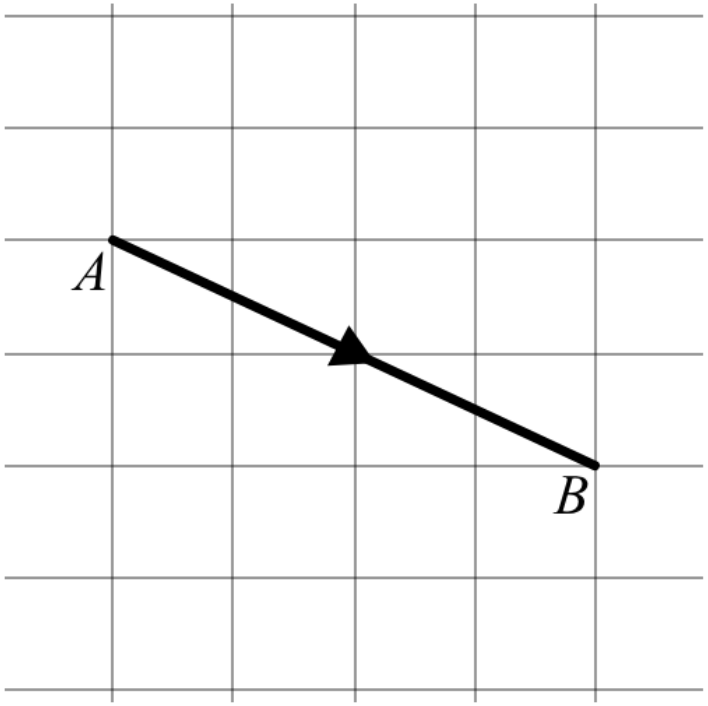
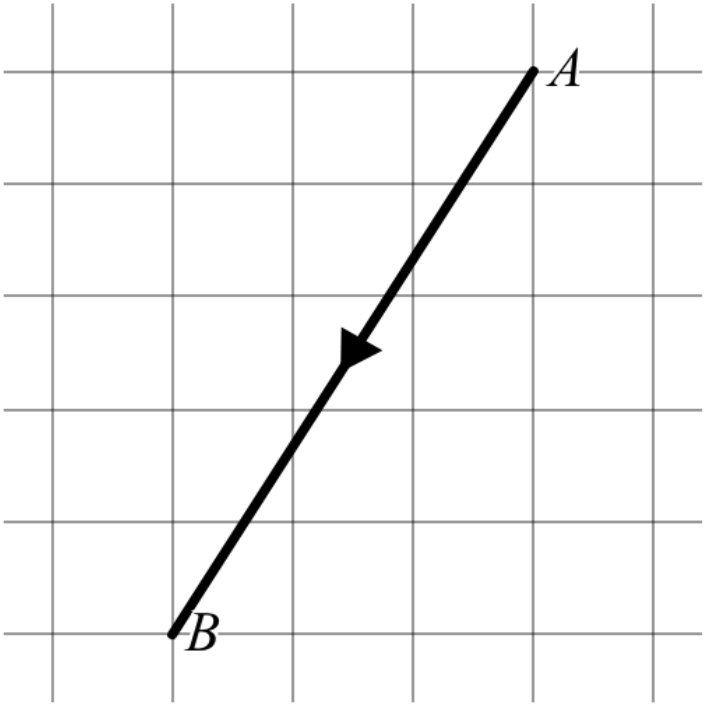
Equation of line $y = mx + c$	Equation of line $ax + by + c = 0$, $a, b, c \in \mathbb{Z}$	Gradient of line m	y axis intercept	x axis intercept	Area of triangle enclosed by line and the coordinate axes.	Sketch
Eg1: $y = \frac{2}{3}x + 6$	$2x - 3y + 18 = 0$	$m = \frac{2}{3}$	$x = 0, y = 6$ $\rightarrow (0, 6)$	$y = 0, x = -9$ $\rightarrow (-9, 0)$	Area $= \frac{1}{2}bh$ $\rightarrow \frac{1}{2}(6)(9) = 27 units^2$	
1) $y = \frac{1}{2}x - 5$						
2)		$m = 3$	$x = 0, y = 8$ $\rightarrow (0, 8)$			
3)	$3x + 4y = 12$					
4)			$(0, 7)$	$(14, 0)$		
5)		$m = -\frac{1}{3}$		$(-9, 0)$		

Fill in the Gaps

Equation of line $y = mx + c$	Equation of line $ax + by + c = 0$, $a, b, c \in \mathbb{Z}$	Gradient of line m	y axis intercept	x axis intercept	Area of triangle enclosed by line and the coordinate axes.	Sketch
Eg1: $y = \frac{2}{3}x + 6$	$2x - 3y + 18 = 0$	$m = \frac{2}{3}$	$x = 0, y = 6$ $\rightarrow (0, 6)$	$y = 0, x = -9$ $\rightarrow (-9, 0)$	Area $= \frac{1}{2}bh$ $\rightarrow \frac{1}{2}(6)(9) = 27 units^2$	
6)		$m > 0$	$(0, -6)$		Area $= 7.5\ units^2$	
7)		$m = -5$			Area $= 10\ units^2$	
8)	$x + ky - 6 = 0$ $k \in \mathbb{R}$	$m = -\frac{1}{4}$				
9) $y = \frac{3}{4}x + k$ $k > 0, k \in \mathbb{R}$					Area $= 6\ units^2$	
10)						

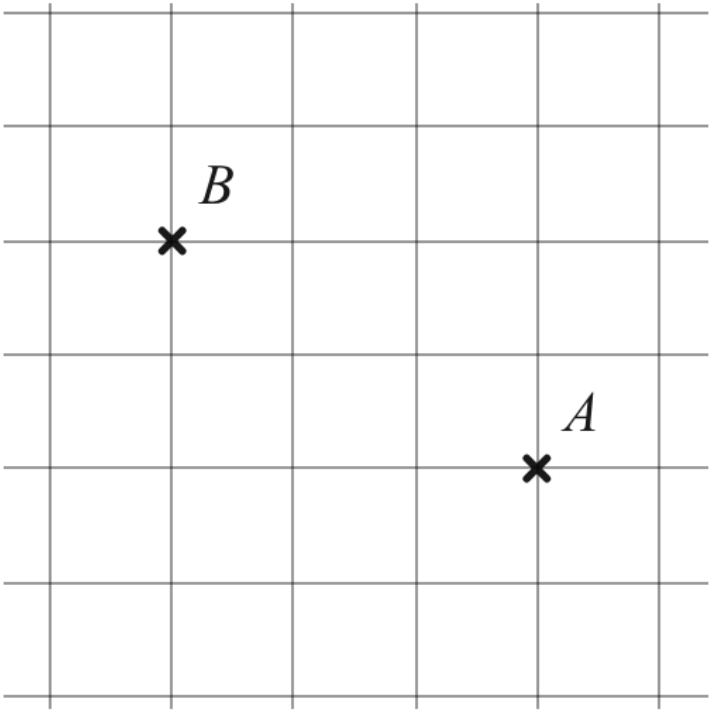
Extra Notes

3 Basic Vectors

Worked Example	Your Turn
Determine the vector for AB 	Determine the vector for AB 

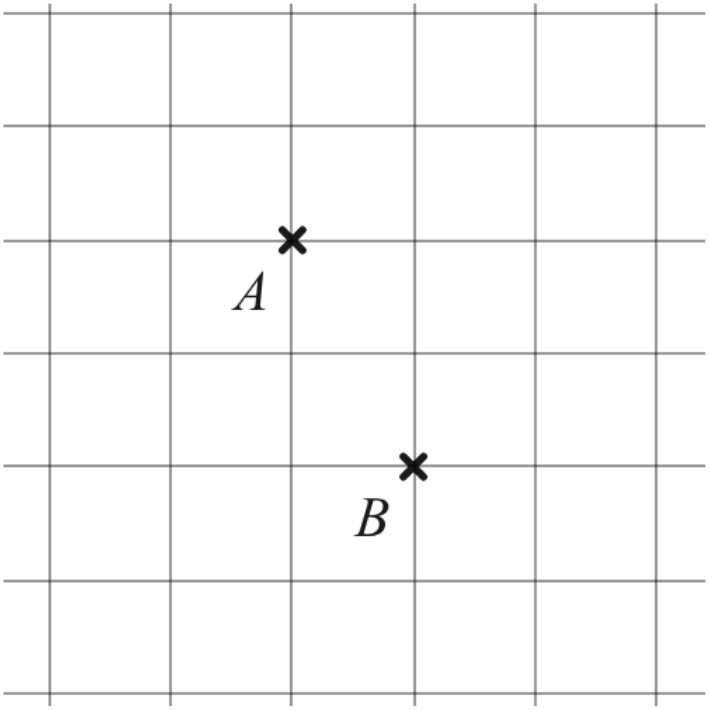
Worked Example

Determine the vector to move from A to B.



Your Turn

Determine the vector to move from A to B.



Worked Example

$\boldsymbol{a} = \begin{pmatrix} 2 \\ 3 \end{pmatrix}$

Find 3**a** and draw it below

Your Turn

$\boldsymbol{a} = \begin{pmatrix} 2 \\ 3 \end{pmatrix}$

Find -2**a** and draw it below

Dr Frost 373a, 373b, 373c and 373d

Worked Example	Your Turn
$\boldsymbol{a} = \begin{pmatrix} 2 \\ 3 \end{pmatrix}$ $\boldsymbol{b} = \begin{pmatrix} 5 \\ 7 \end{pmatrix}$ Find 3**a** – 2**b**	$\boldsymbol{a} = \begin{pmatrix} 2 \\ 3 \end{pmatrix}$ $\boldsymbol{b} = \begin{pmatrix} 5 \\ 7 \end{pmatrix}$ Find 4**a** – 3**b**

Dr Frost 373e and 373g

Worked Example	Your Turn
Give that: $m\begin{pmatrix}5\\-8\end{pmatrix} - 2\begin{pmatrix}-8\\-7\end{pmatrix} = \begin{pmatrix}36\\-18\end{pmatrix}$ Work out the value of m.	Give that: $m\begin{pmatrix}2\\-5\end{pmatrix} + 4\begin{pmatrix}2\\1\end{pmatrix} = \begin{pmatrix}18\\-21\end{pmatrix}$ Work out the value of m.

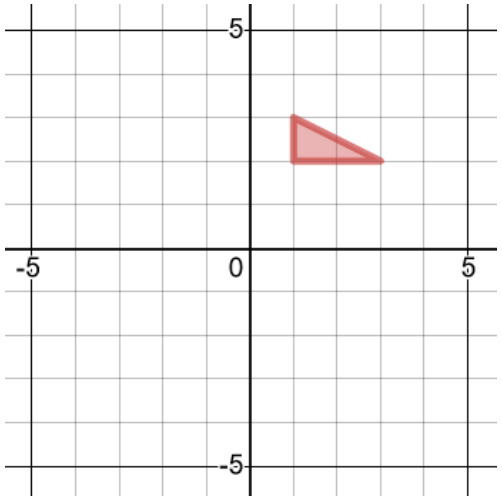
Extra Notes

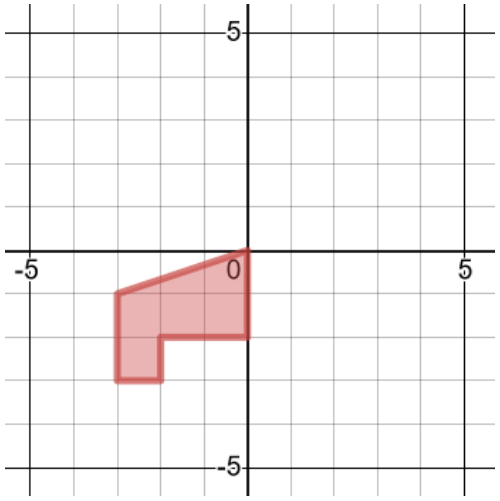
4 Transformations

Reflections

Worked Example

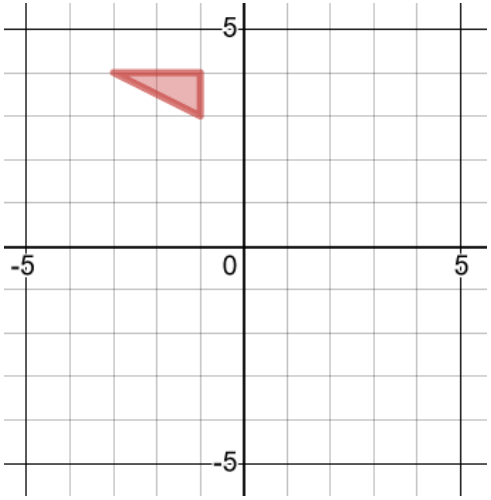
Reflect in the x-axis

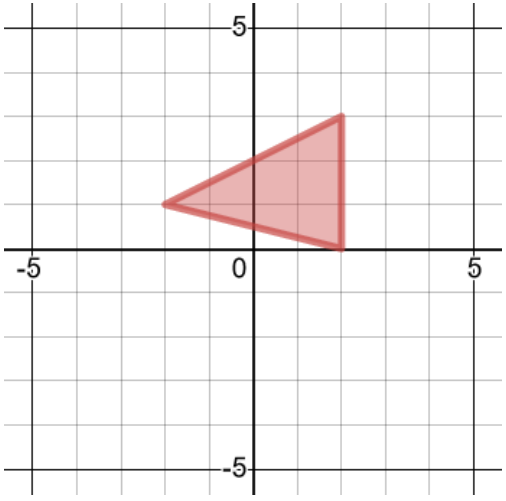




Your Turn

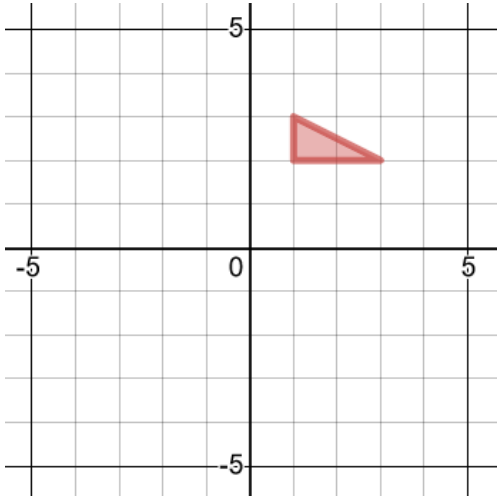
Reflect in the x-axis

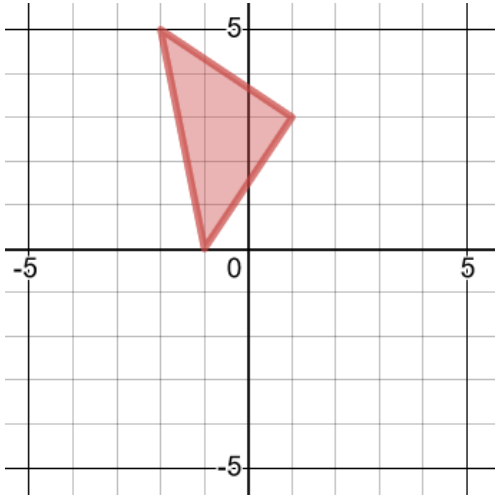




Worked Example

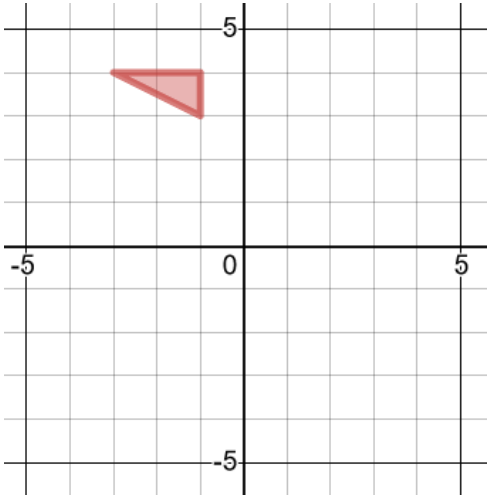
Reflect in the y-axis

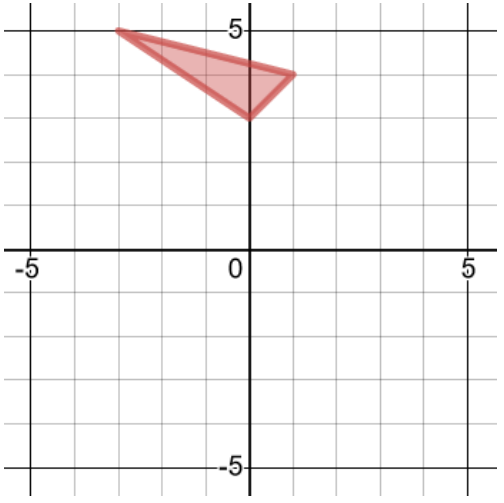




Your Turn

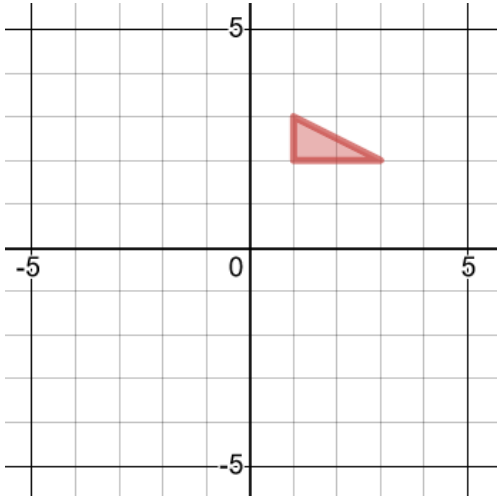
Reflect in the y-axis



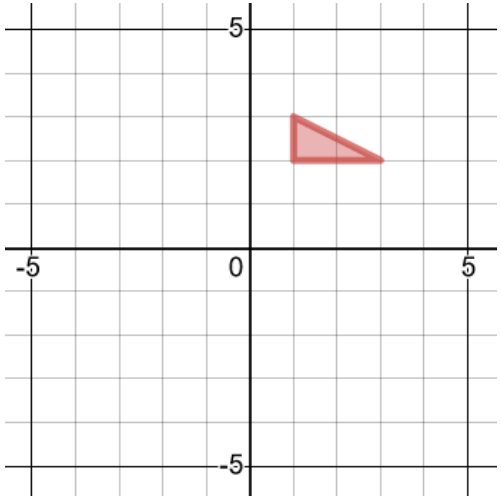


Worked Example

Reflect in the line $y = 1$

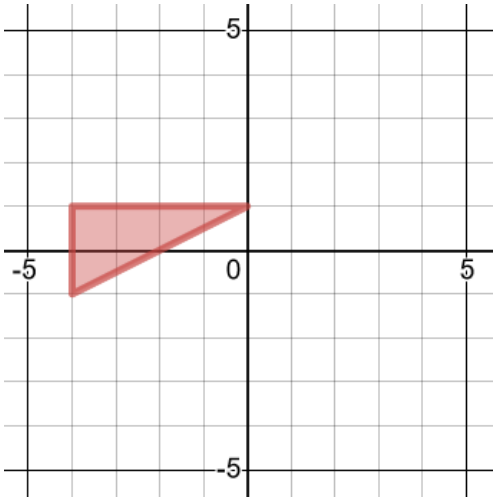


Reflect in the line $x = 3$

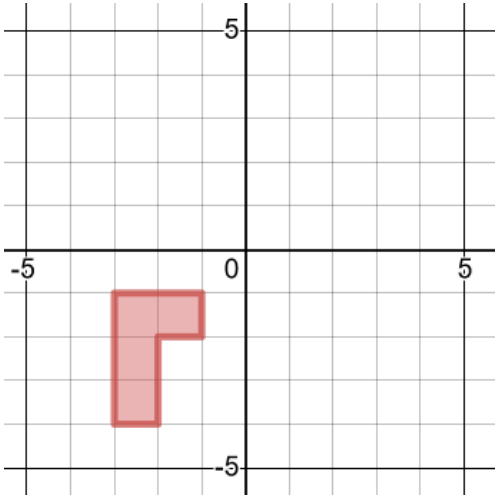


Your Turn

Reflect in the line $y = 2$

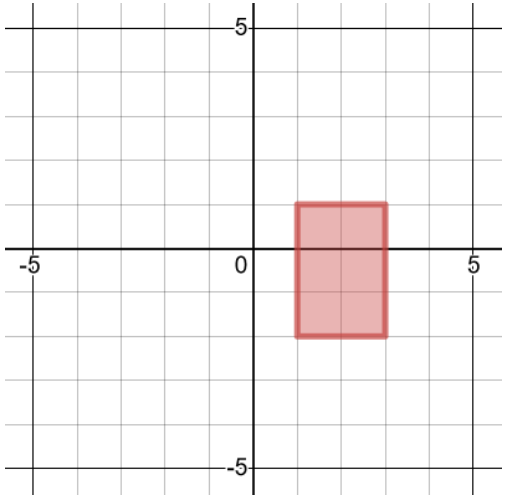


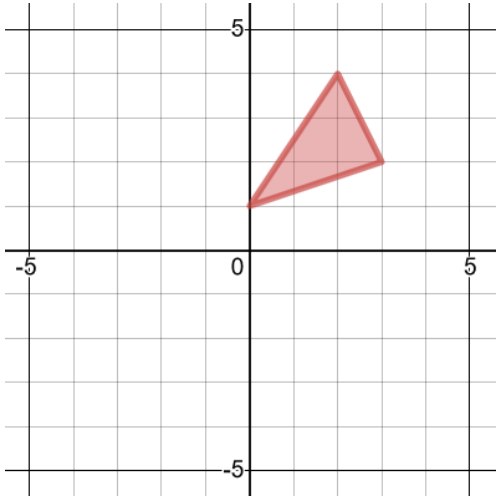
Reflect in the line $x = 1$



Worked Example

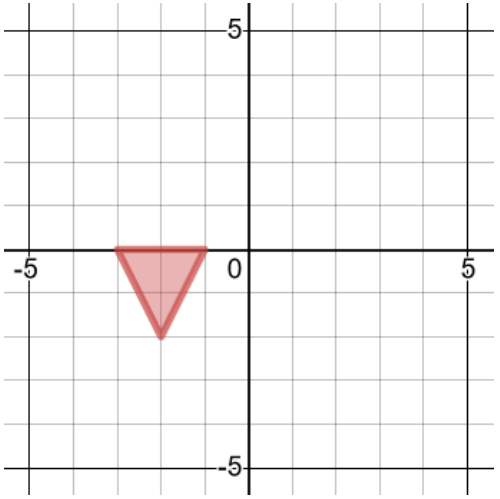
Reflect in the line $y = x$

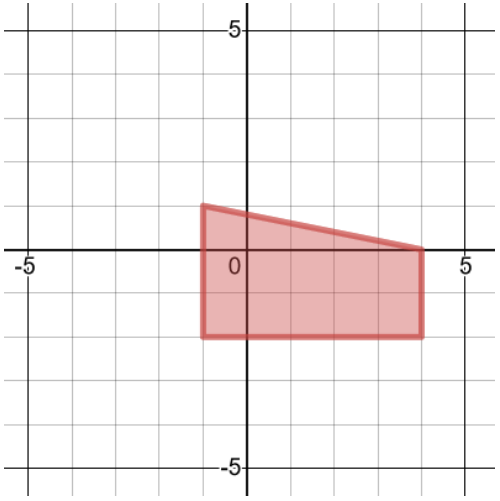




Your Turn

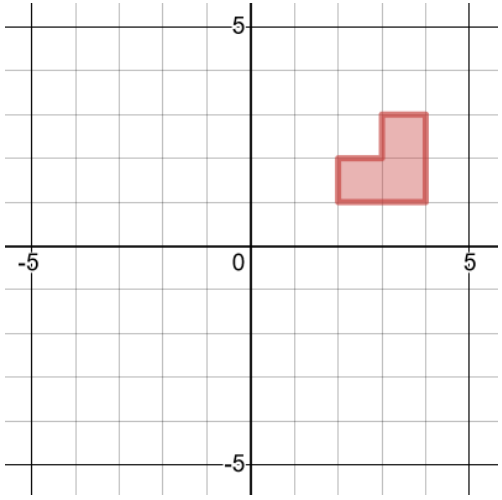
Reflect in the line $y = x$

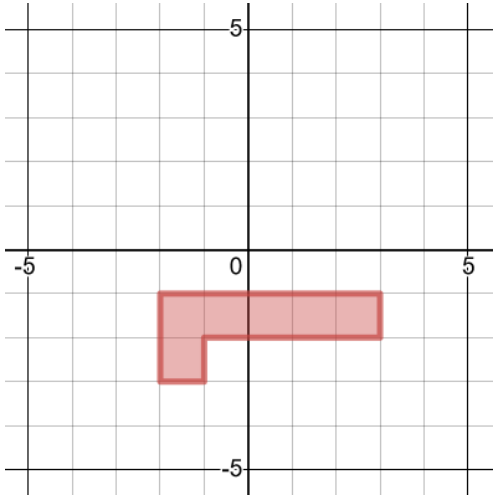




Worked Example

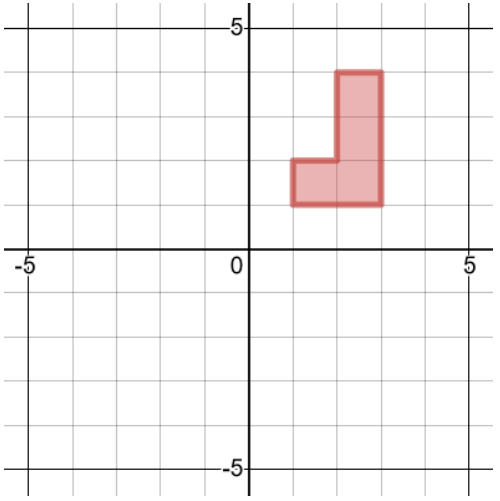
Reflect in the line $y = -x$

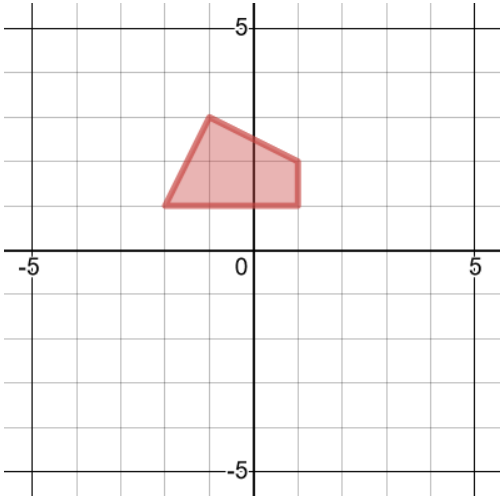




Your Turn

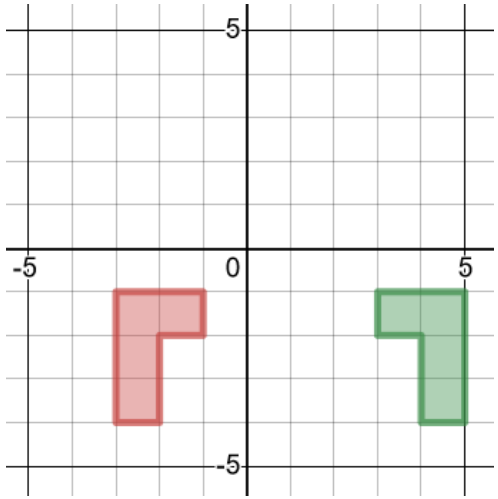
Reflect in the line $y = -x$

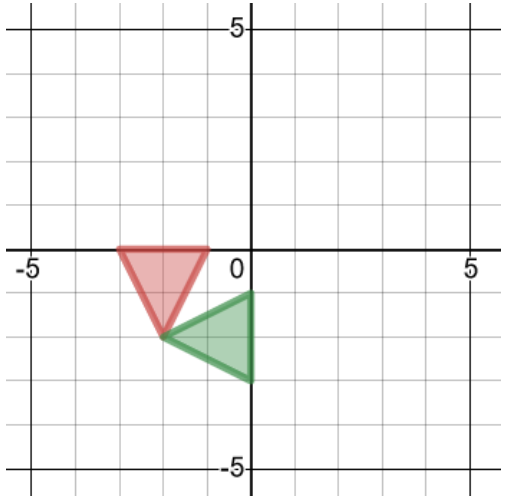




Worked Example

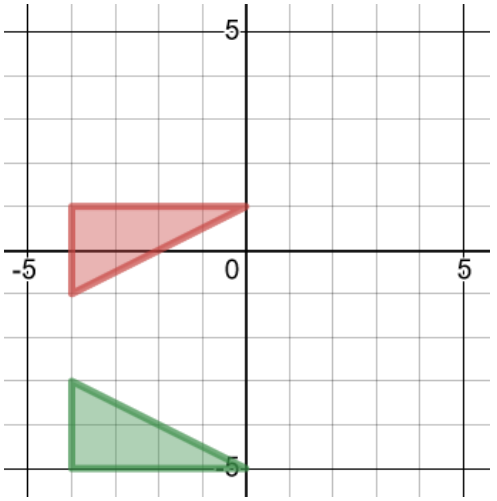
Describe the single transformation of the red object onto the green image

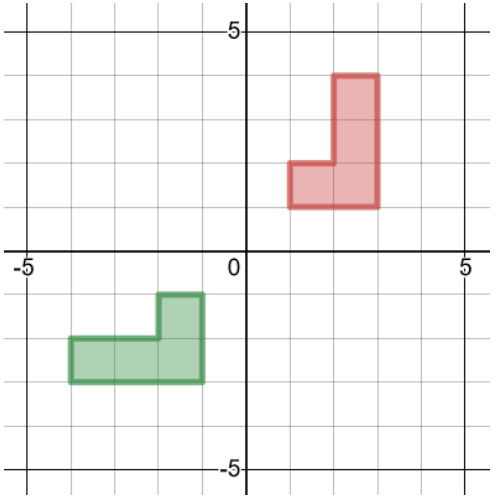




Your Turn

Describe the single transformation of the red object onto the green image



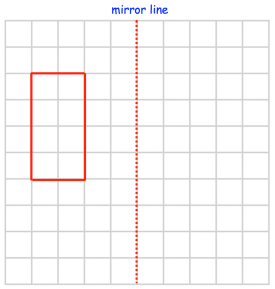


Dr Frost 279a and 279b

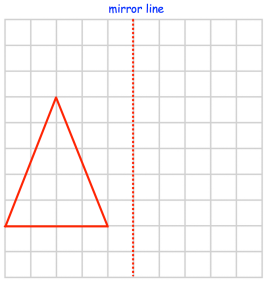
Fluency Practice

Question 1: Reflect each shape in the mirror line given

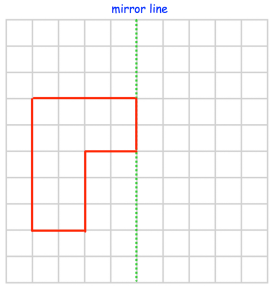
(a)



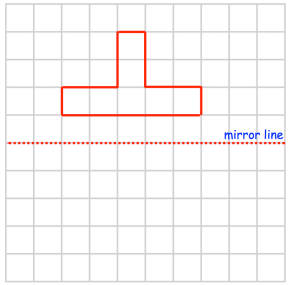
(b)



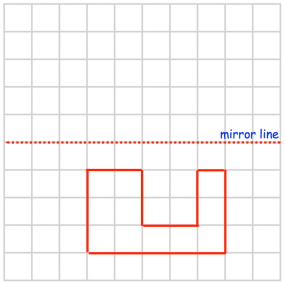
(c)



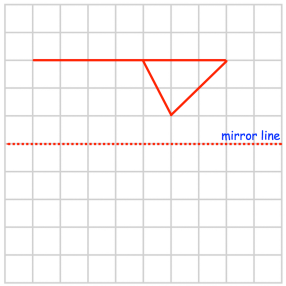
(d)



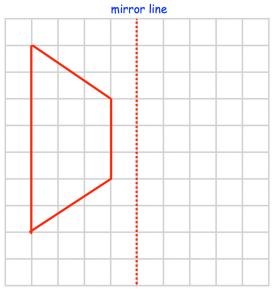
(e)



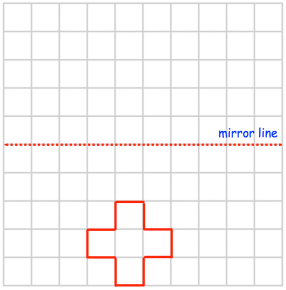
(f)



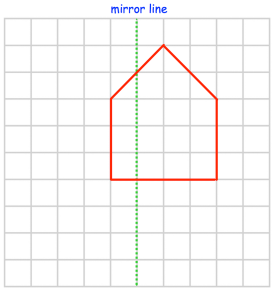
(g)



(h)

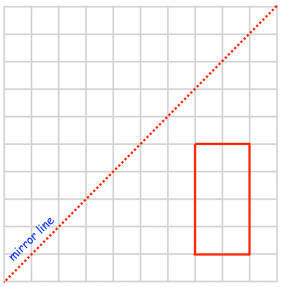


(i)

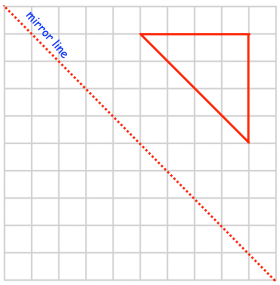


Question 2: Reflect each shape in the mirror line given

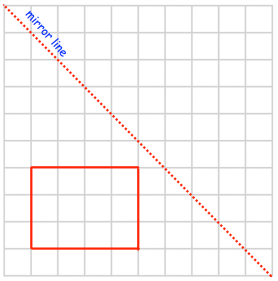
(a)



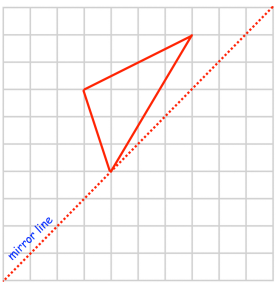
(b)



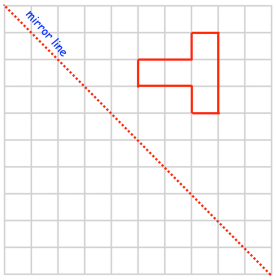
(c)



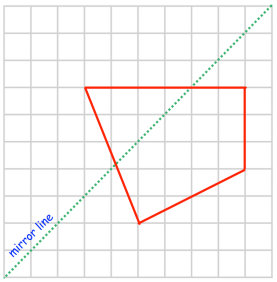
(d)



(e)

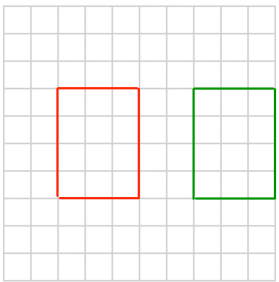


(f)

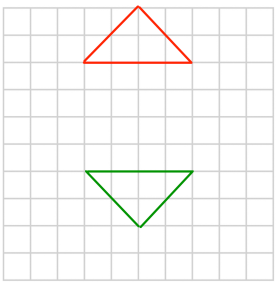


Question 3: Find the mirror line for each of the reflections below.

(a)

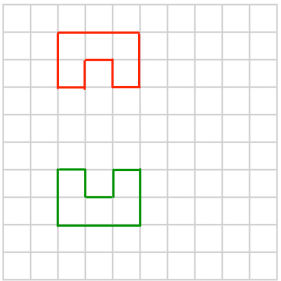


(b)

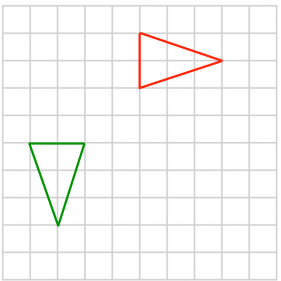


(c)

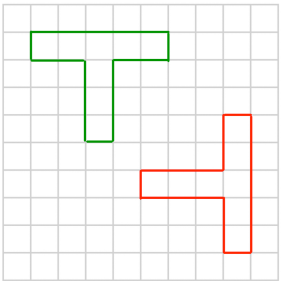
(d)



(e)

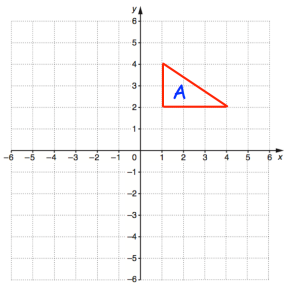


(f)

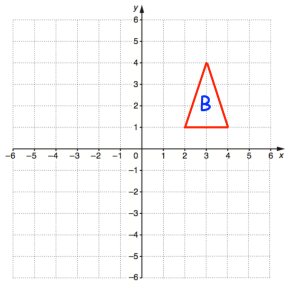


Question 4:

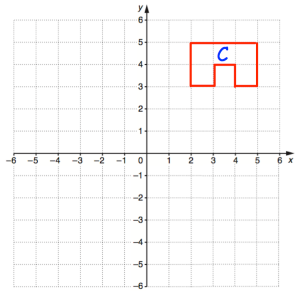
(a) Reflect triangle A in the x-axis



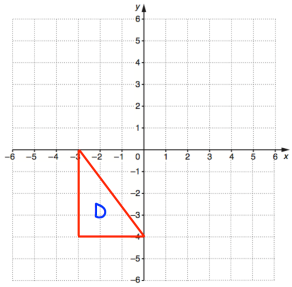
(b) Reflect triangle B in the y-axis



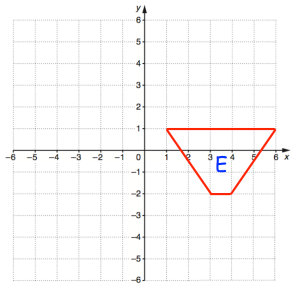
(c) Reflect shape C in the x-axis



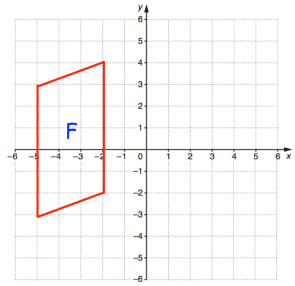
(d) Reflect shape D in the y-axis



(e) Reflect shape E in the y-axis

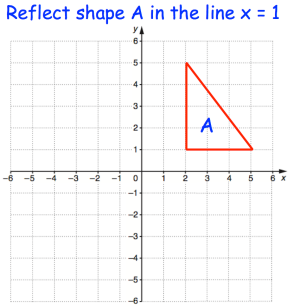


(f) Reflect shape F in the x-axis

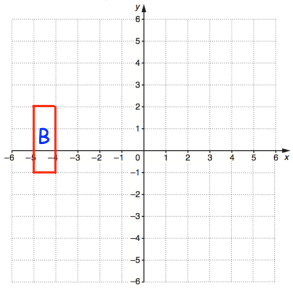


Question 5:

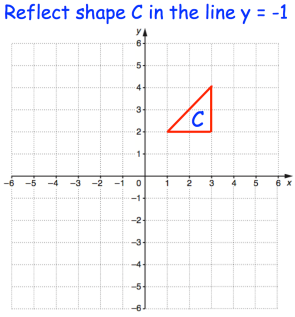
(a) Reflect shape A in the line x = 1



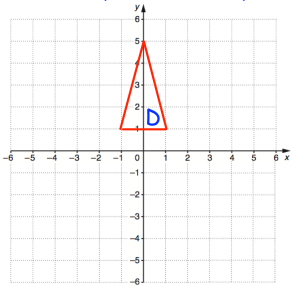
(b) Reflect shape B in the line x = -2



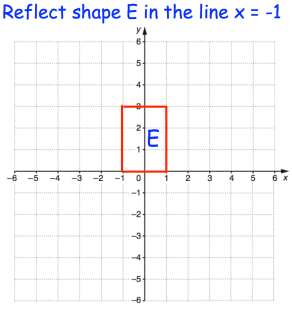
(c) Reflect shape C in the line y = -1



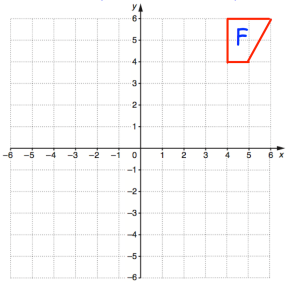
(d) Reflect shape D in the line y = 2



(e) Reflect shape E in the line x = -1

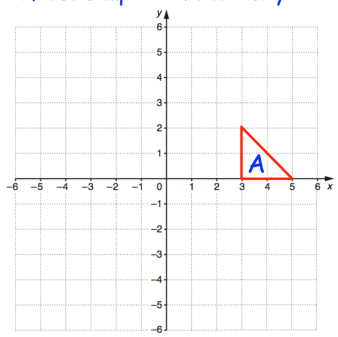


(f) Reflect shape F in the line y = 3

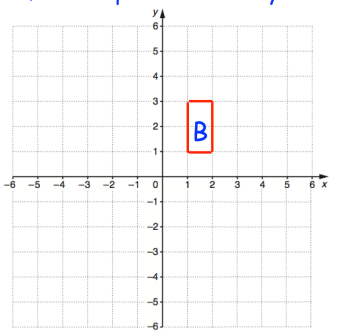


Question 6:

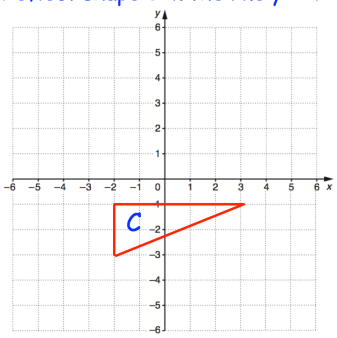
(a) Reflect shape A in the line y = x



(b) Reflect shape B in the line y = -x

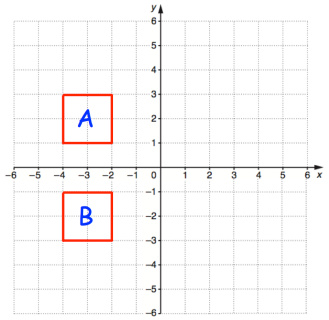


(c) Reflect shape C in the line y = x

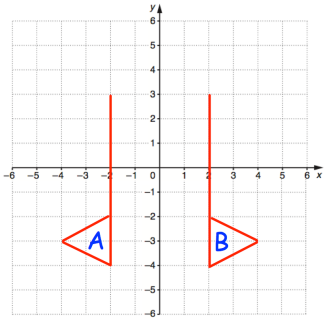


Question 7: Describe fully the single transformation that takes shape A to shape B.

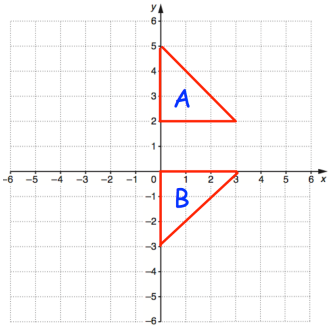
(a)



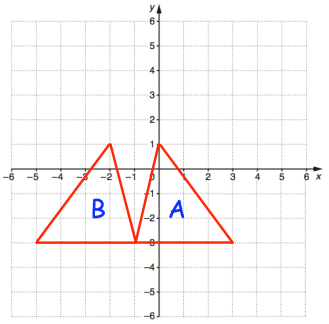
(b)



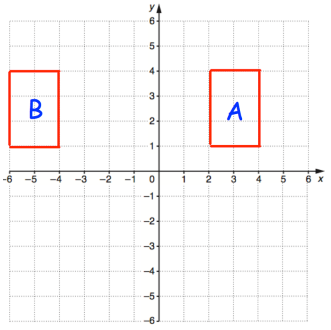
(c)



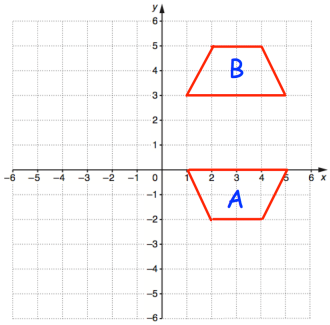
(d)



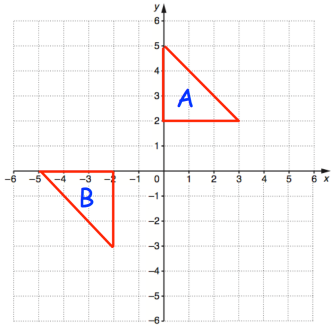
(e)



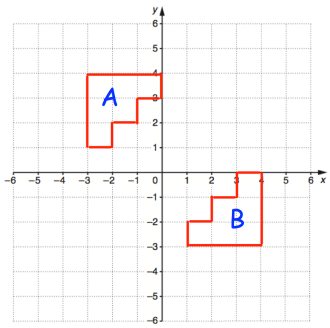
(f)



(g)



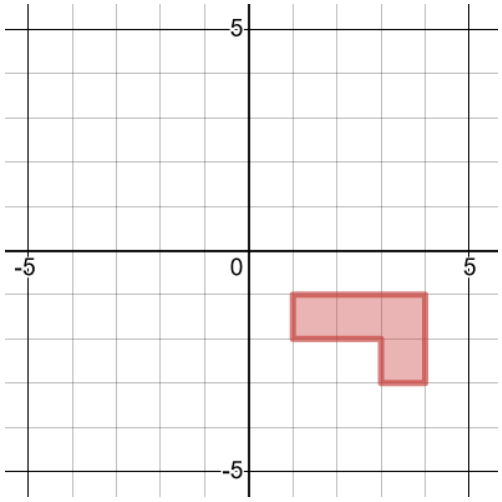
(h)



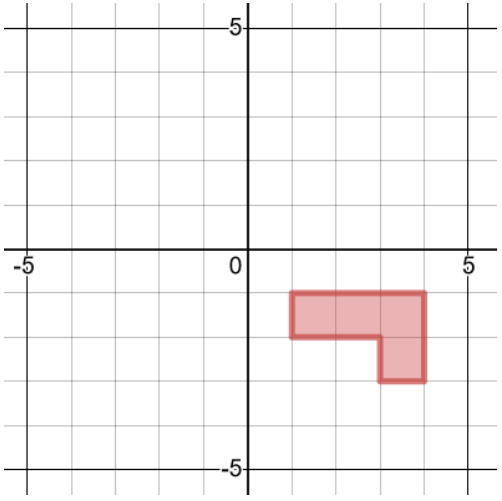
Rotations

Worked Example

Rotate $90°$ clockwise about the origin

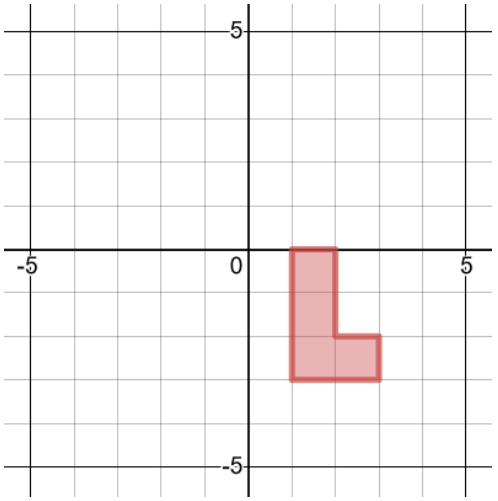


Rotate $90°$ anticlockwise about the origin

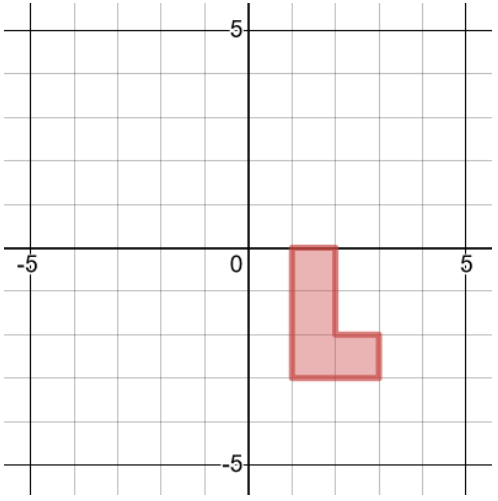


Your Turn

Rotate $90°$ clockwise about the origin

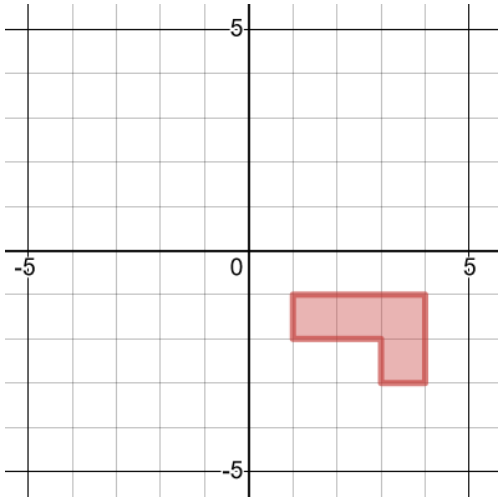


Rotate $90°$ anticlockwise about the origin

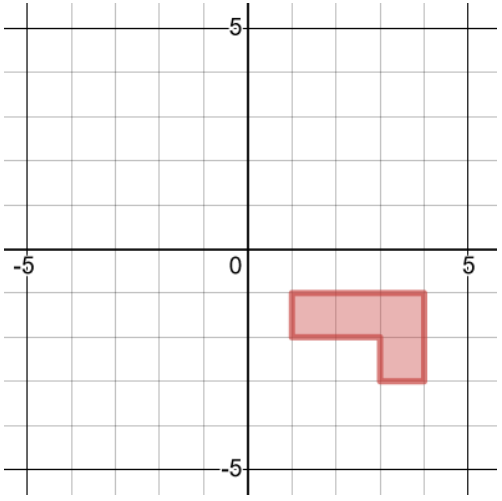


Worked Example

Rotate $90°$ clockwise about $(1, -1)$

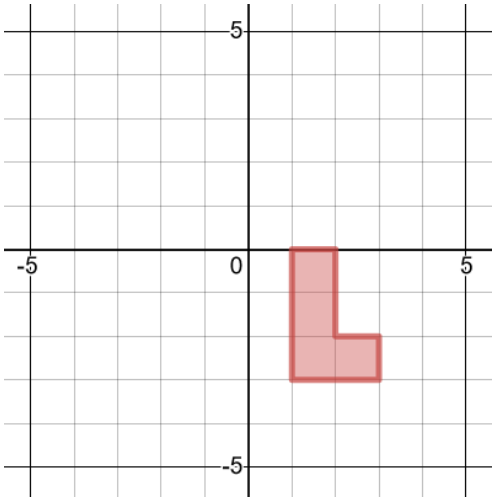


Rotate $90°$ anticlockwise about $(1, -1)$

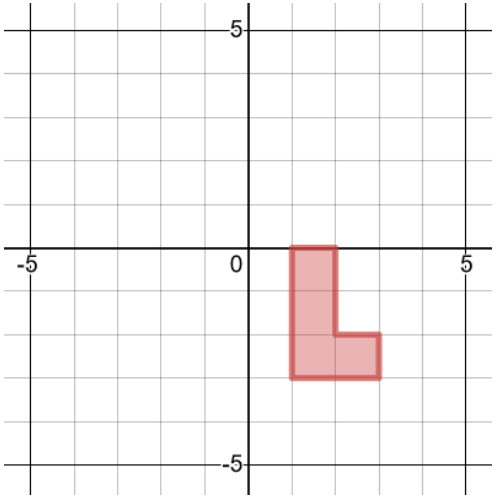


Your Turn

Rotate $90°$ clockwise about $(1, -1)$

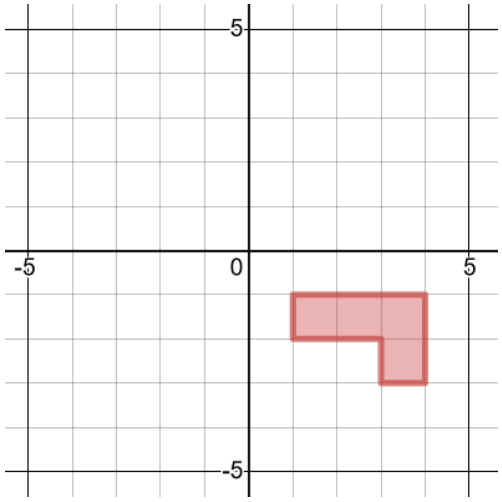


Rotate $90°$ anticlockwise about $(1, -1)$

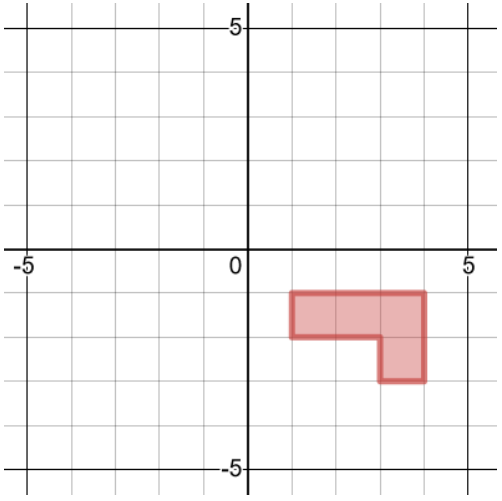


Worked Example

Rotate $180°$ about the origin

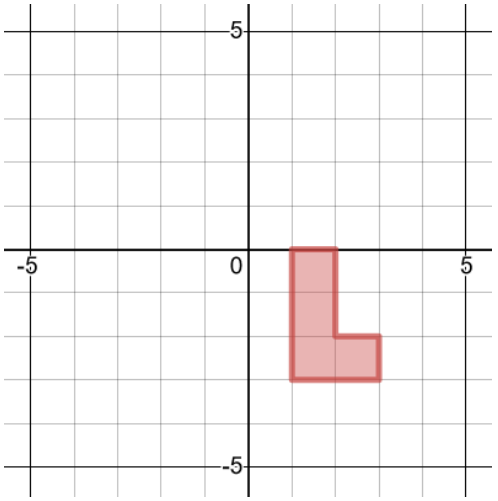


Rotate $180°$ about $(1, -1)$

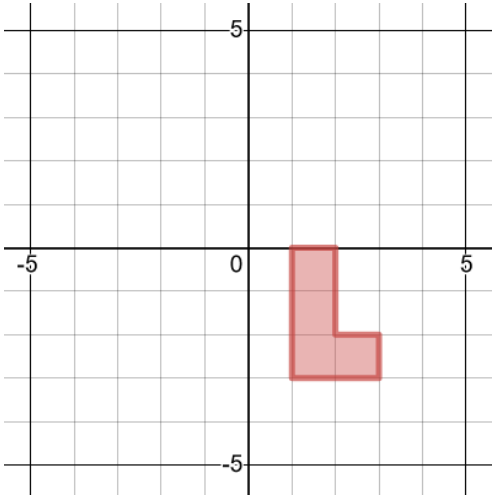


Your Turn

Rotate $180°$ about the origin



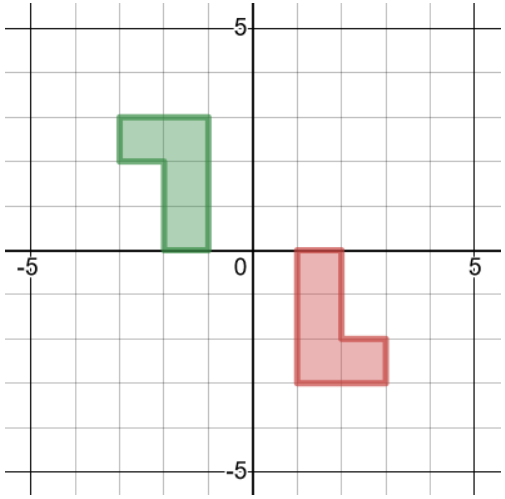
Rotate $180°$ about $(1, -1)$

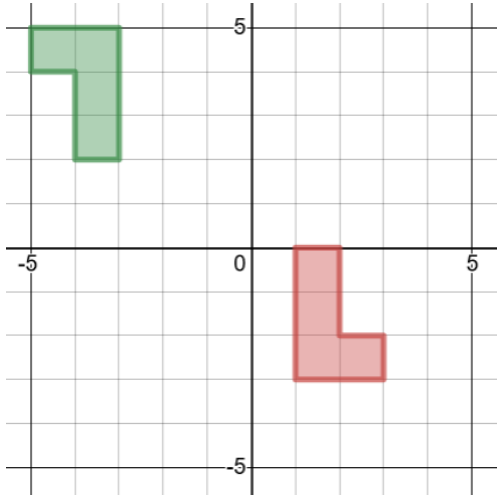


Dr Frost 281b and 281c

Worked Example

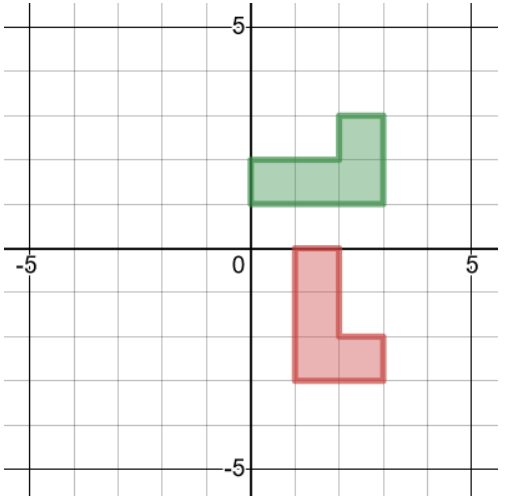
Describe the single transformation of the red object onto the green image.

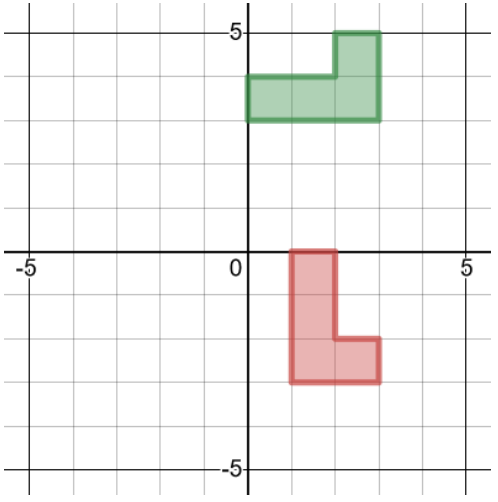




Your Turn

Describe the single transformation of the red object onto the green image.

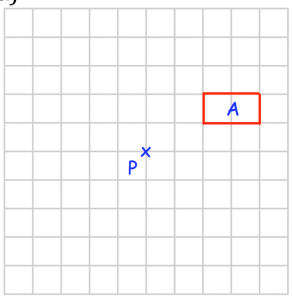




Dr Frost 282a and 282b

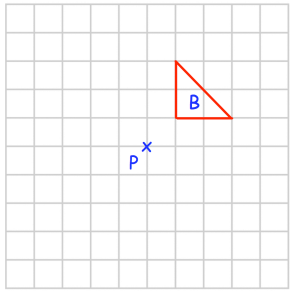
Question 1: Rotate each of the shapes below as instructed, using P as the centre of rotation.

(a)



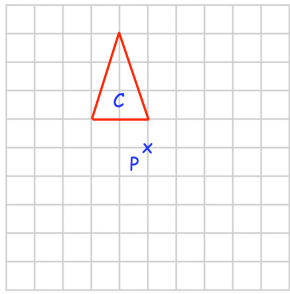
rotate 90° clockwise about P

(b)



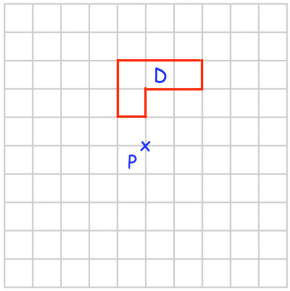
rotate 90° anticlockwise about P

(c)



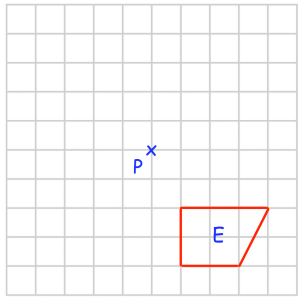
rotate 90° clockwise about P

(d)



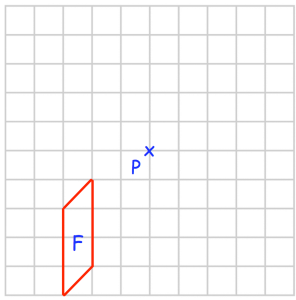
rotate 180° about P

(e)



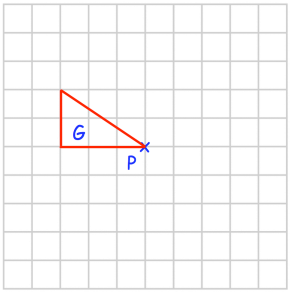
rotate 90° anticlockwise about P

(f)



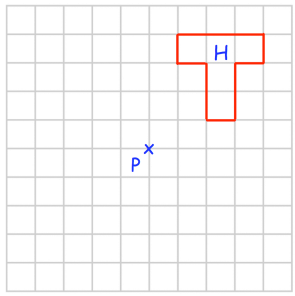
rotate 180° about P

(g)



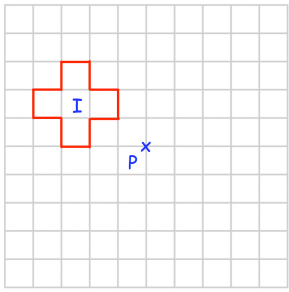
rotate 90° clockwise about P

(h)



rotate 270° clockwise about P

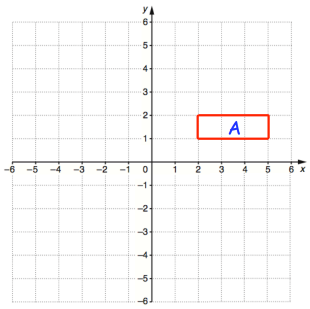
(i)



rotate 270° anticlockwise about P

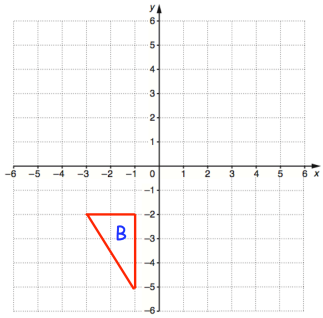
Question 2: Rotate each of the shapes below as instructed, using the origin, (0,0), as the centre of rotation.

(a)



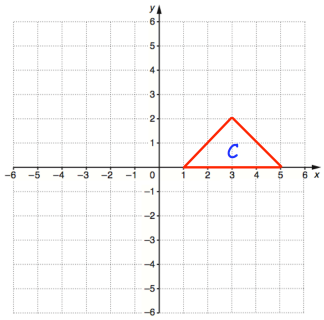
rotate 180° about (0, 0)

(b)



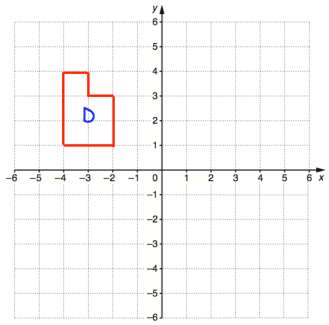
rotate 90° clockwise about (0, 0)

(c)



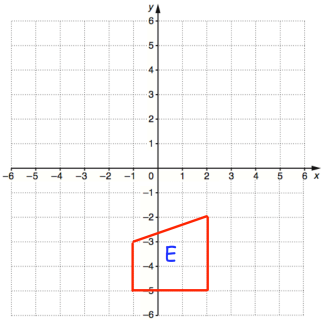
rotate 90° anticlockwise about (0, 0)

(d)



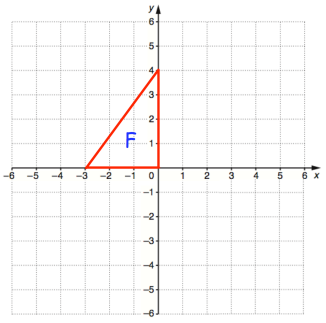
rotate 90° clockwise about (0, 0)

(e)



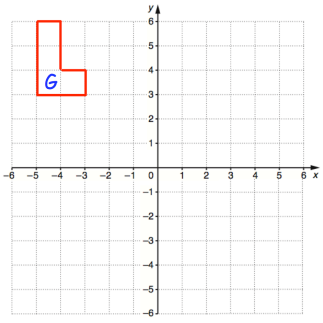
rotate 90° anticlockwise about (0, 0)

(f)



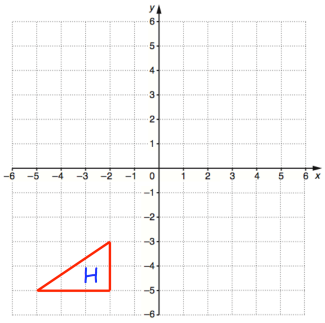
rotate 180° about (0, 0)

(g)



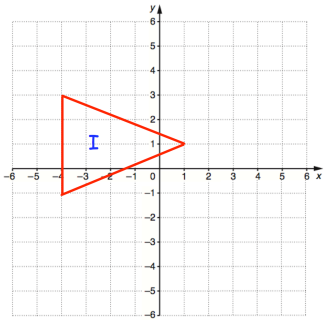
rotate 90° anticlockwise about (0, 0)

(h)



rotate 180° about (0, 0)

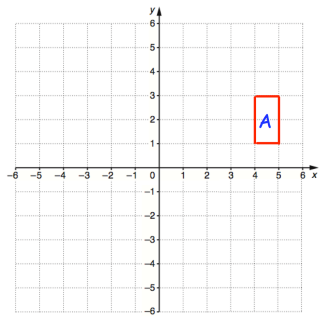
(i)



rotate 90° clockwise about (0, 0)

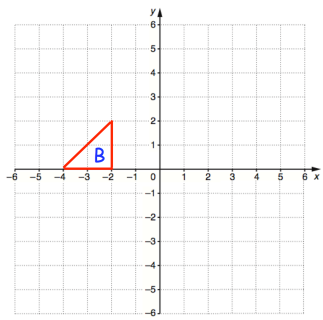
Question 3: Rotate each of the shapes below as instructed.

(a)



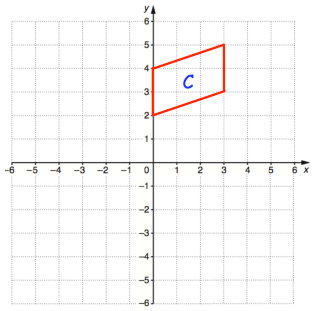
rotate 90° anticlockwise about (0, 1)

(b)



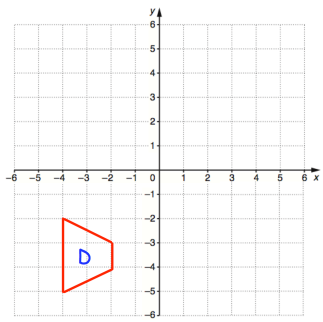
rotate 90° clockwise about (-1, -2)

(c)



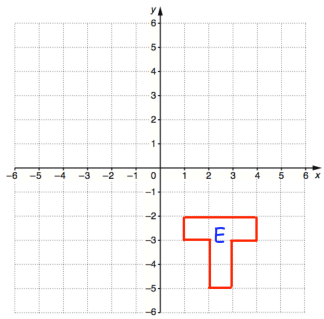
rotate 180° about (1, 1)

(d)



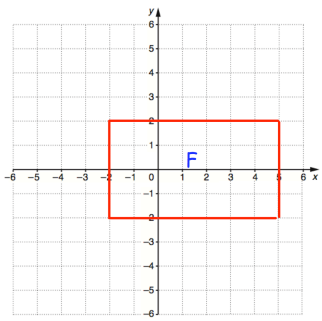
rotate 90° anticlockwise about (-4, 0)

(e)



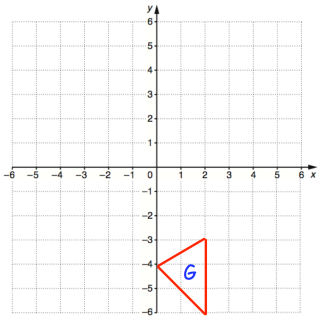
rotate 180° about (-1, 0)

(f)



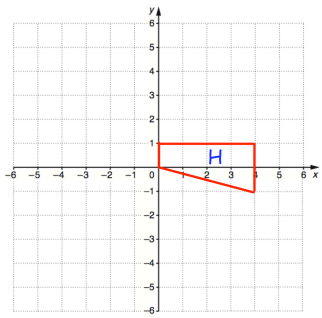
rotate 90° clockwise about (-1, 2)

(g)



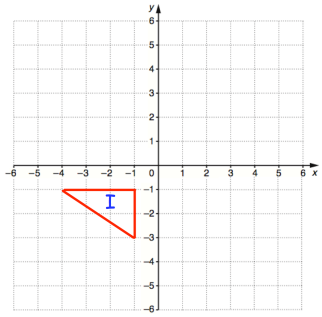
rotate 90° clockwise about (5, 0)

(h)



rotate 90° anticlockwise about (3, 0)

(i)

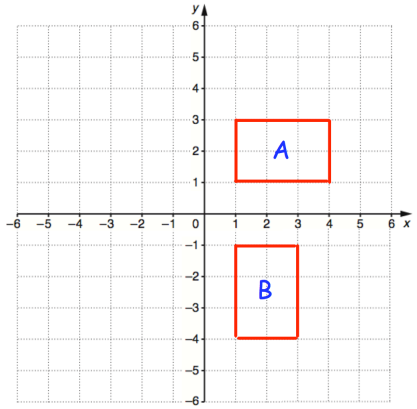


rotate 180° about (1, 1)

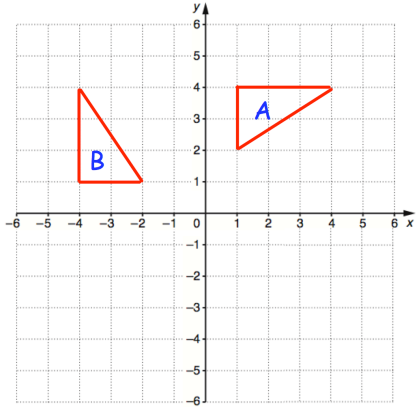
Fluency Practice

Question 4: Describe fully the single transformation that takes shape A to shape B.

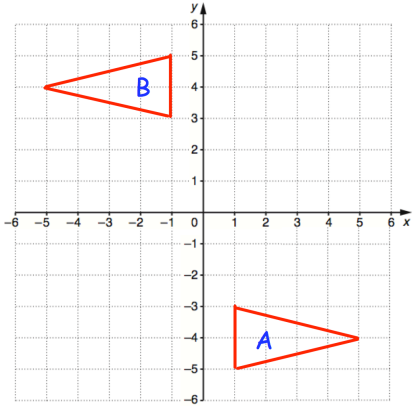
(a)



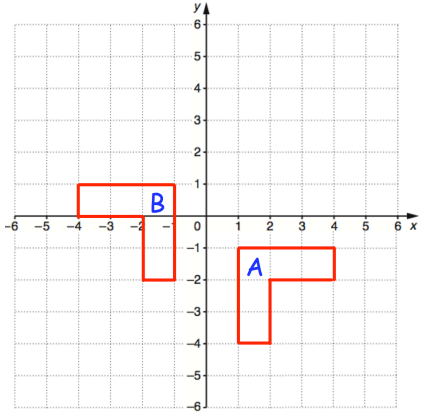
(b)



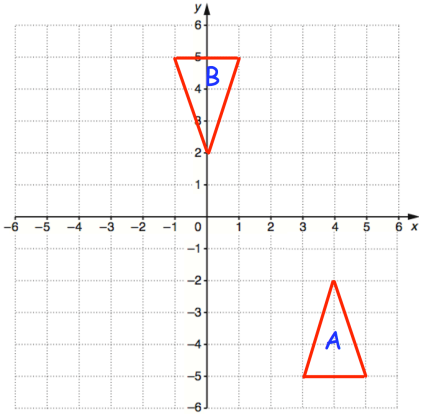
(c)



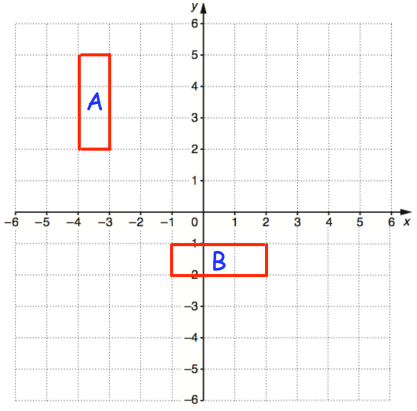
(d)



(e)



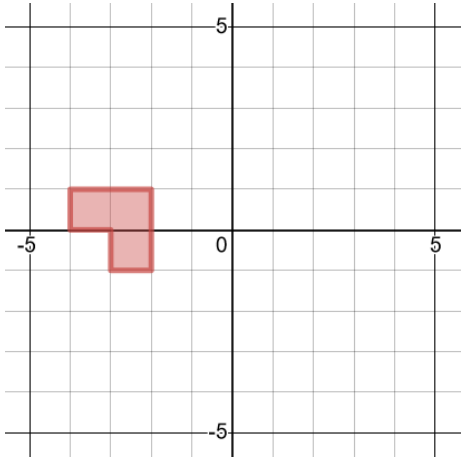
(f)



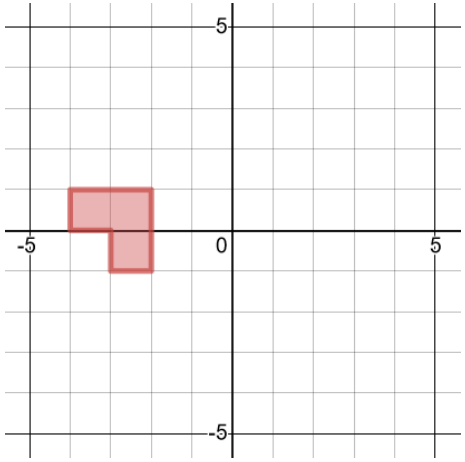
Translations

Worked Example

Translate by vector $\begin{pmatrix}3\\2\end{pmatrix}$

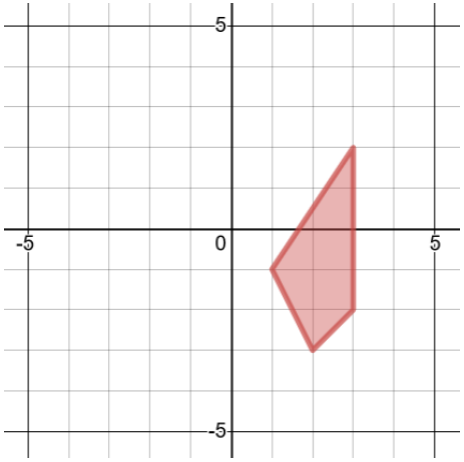


Translate by vector $\begin{pmatrix}2\\-3\end{pmatrix}$

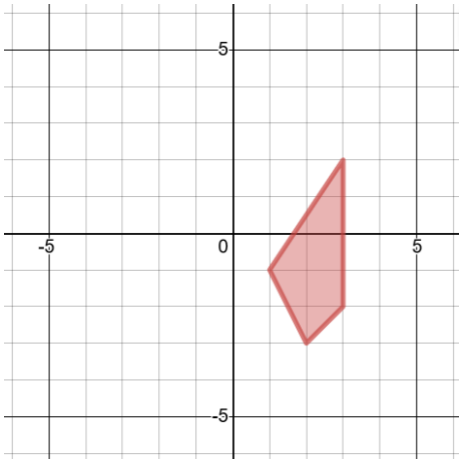


Your Turn

Translate by vector $\begin{pmatrix}2\\3\end{pmatrix}$



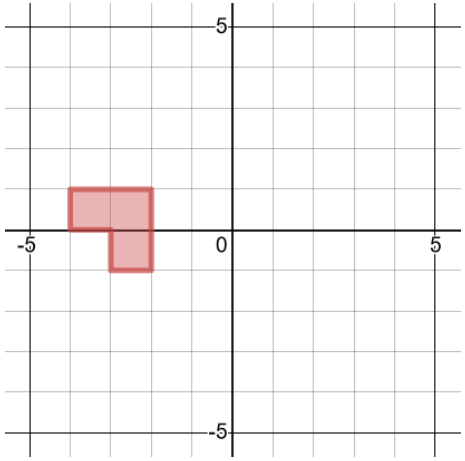
Translate by vector $\begin{pmatrix}3\\-2\end{pmatrix}$



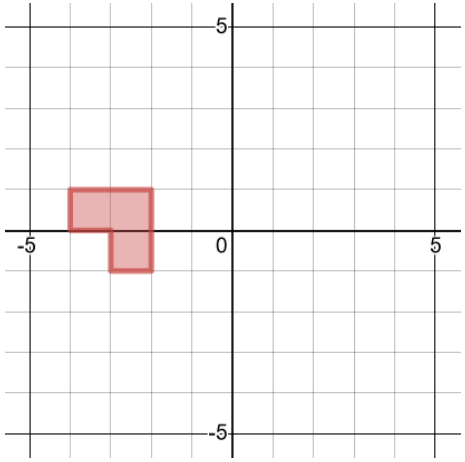
Dr Frost 374a and 374b

Worked Example

Translate by vector $\begin{pmatrix} -2 \\ -3 \end{pmatrix}$

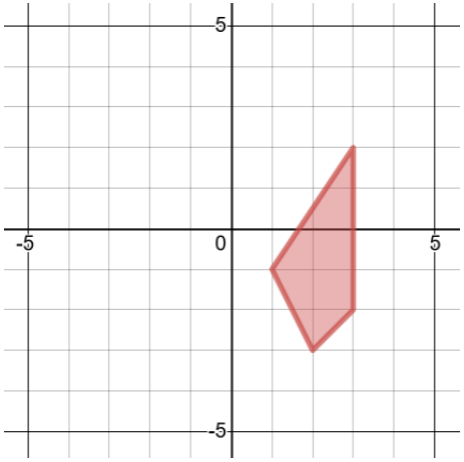


Translate by vector $\begin{pmatrix} 3 \\ -2 \end{pmatrix}$ and then by vector $\begin{pmatrix} -4 \\ 5 \end{pmatrix}$

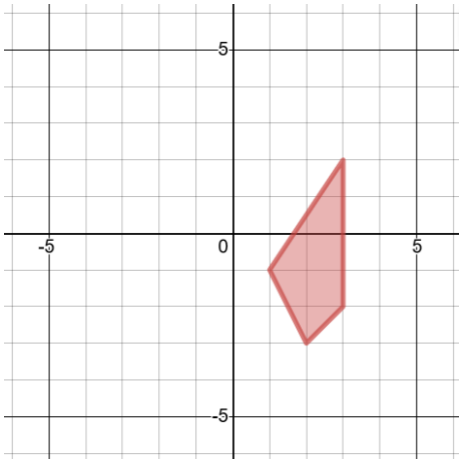


Your Turn

Translate by vector $\begin{pmatrix} -3 \\ -2 \end{pmatrix}$

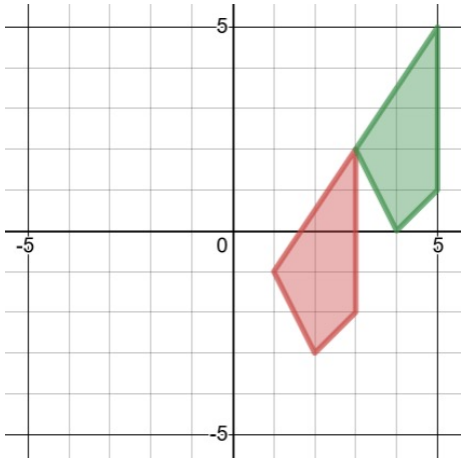


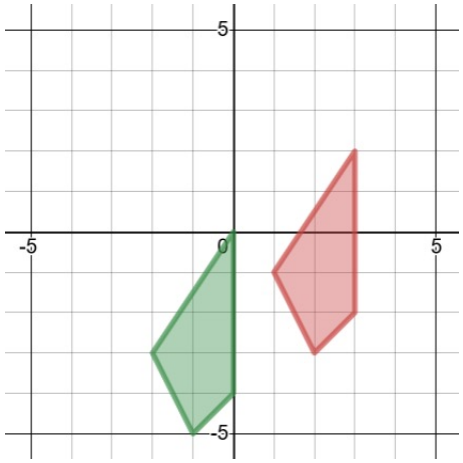
Translate by vector $\begin{pmatrix} 2 \\ -3 \end{pmatrix}$ and then by vector $\begin{pmatrix} -5 \\ 4 \end{pmatrix}$



Worked Example

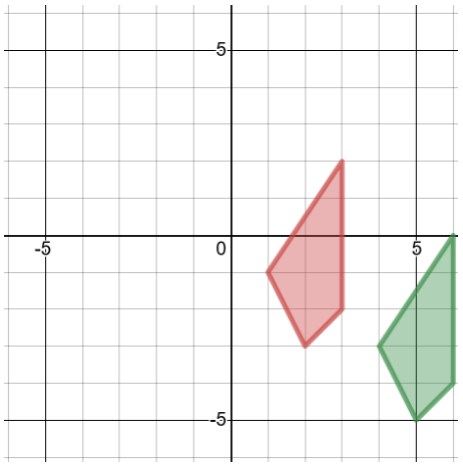
Describe the single transformation of the red object onto the green image.

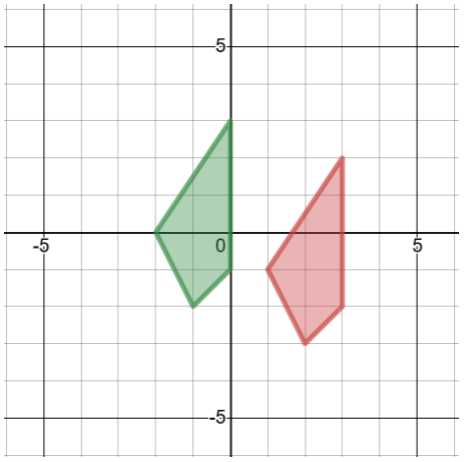




Your Turn

Describe the single transformation of the red object onto the green image.

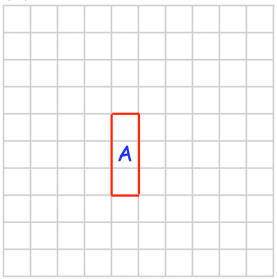




Dr Frost 375a, 375b and 375c

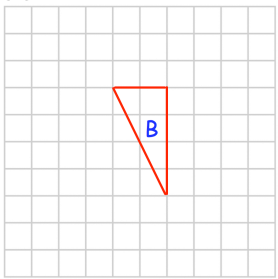
Question 1: Translate each of the shapes below as instructed.

(a)



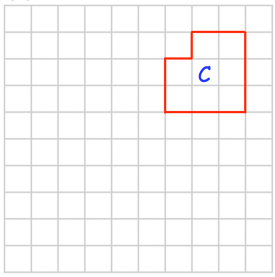
Translate A by $\begin{pmatrix} 3 \\ 1 \end{pmatrix}$

(b)



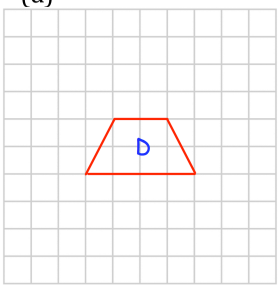
Translate B by $\begin{pmatrix} 2 \\ -2 \end{pmatrix}$

(c)



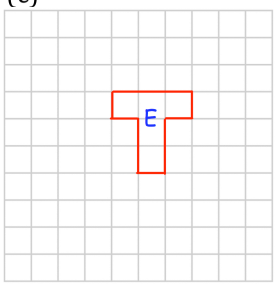
Translate C by $\begin{pmatrix} 0 \\ -5 \end{pmatrix}$

(d)



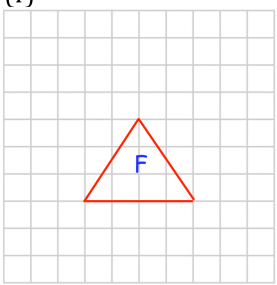
Translate D by $\begin{pmatrix} -3 \\ 3 \end{pmatrix}$

(e)



Translate E by $\begin{pmatrix} -2 \\ -4 \end{pmatrix}$

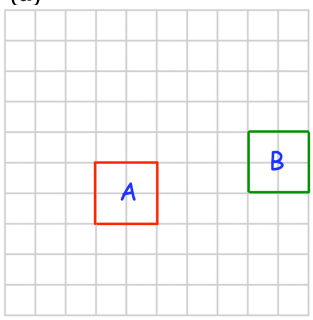
(f)



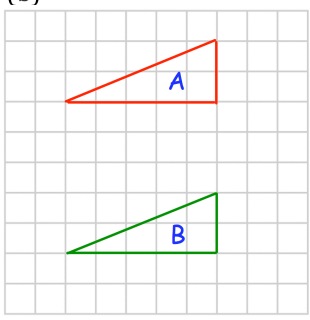
Translate F by $\begin{pmatrix} 1.5 \\ 0 \end{pmatrix}$

Question 2: Describe fully each translation that takes shape A to shape B

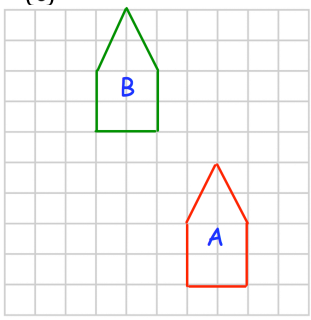
(a)



(b)

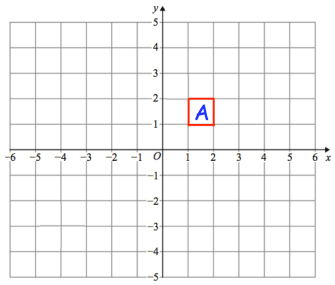


(c)



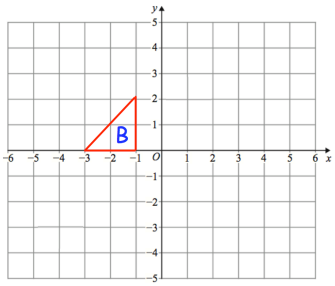
Question 3: Translate each of the shapes below as instructed.

(a)



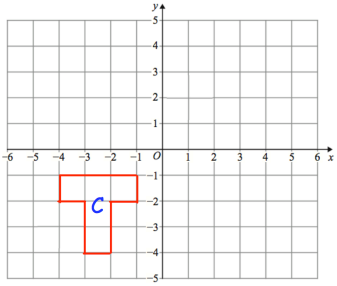
Translate A by $\begin{pmatrix} 2 \\ -3 \end{pmatrix}$

(b)



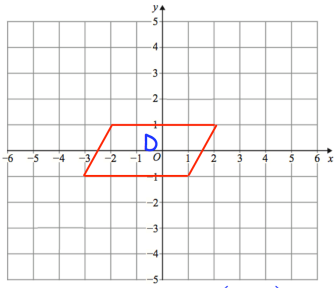
Translate B by $\begin{pmatrix} 6 \\ 1 \end{pmatrix}$

(c)



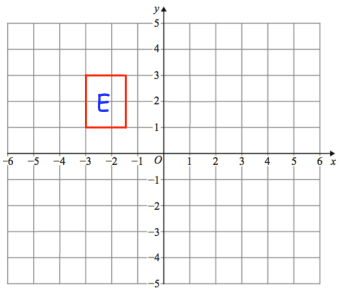
Translate C by $\begin{pmatrix} -1 \\ 5 \end{pmatrix}$

(d)



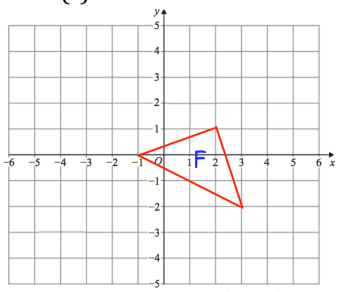
Translate D by $\begin{pmatrix} -3 \\ -2 \end{pmatrix}$

(e)



Translate E by $\begin{pmatrix} 4.5 \\ -4 \end{pmatrix}$

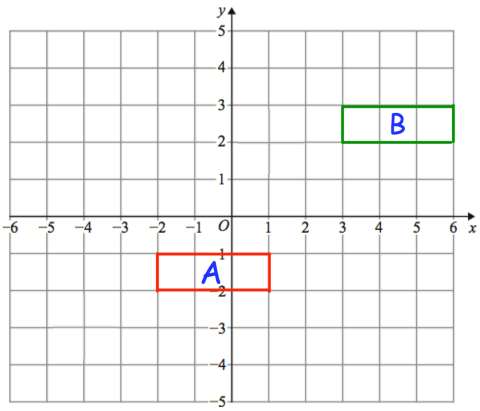
(f)



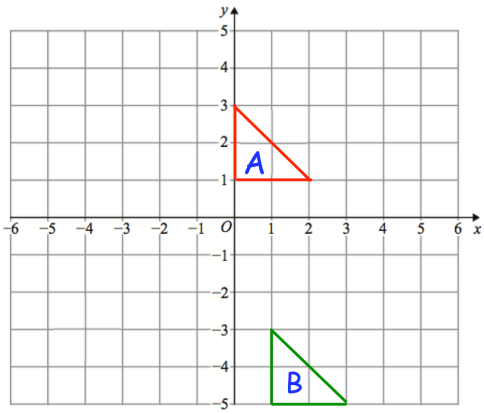
Translate F by $\begin{pmatrix} -1 \\ 1 \end{pmatrix}$

Question 4: Describe fully the single transformation that takes shape A to shape B

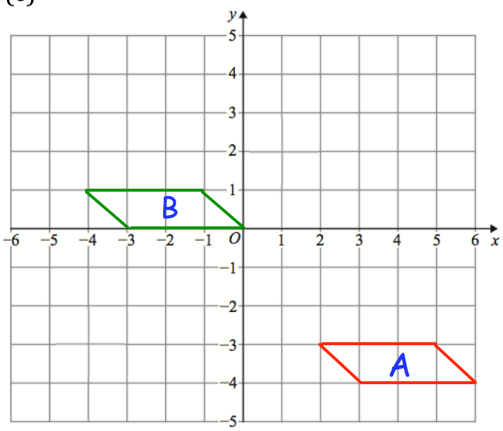
(a)



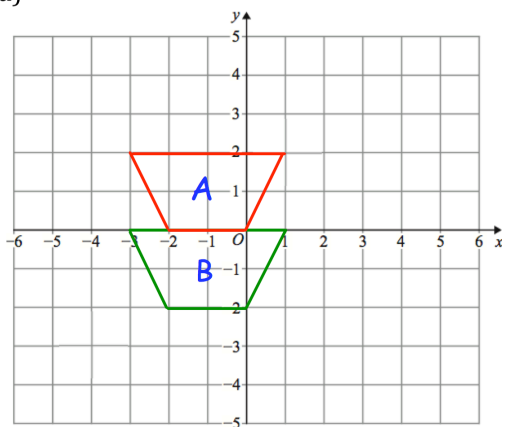
(b)



(c)



(d)

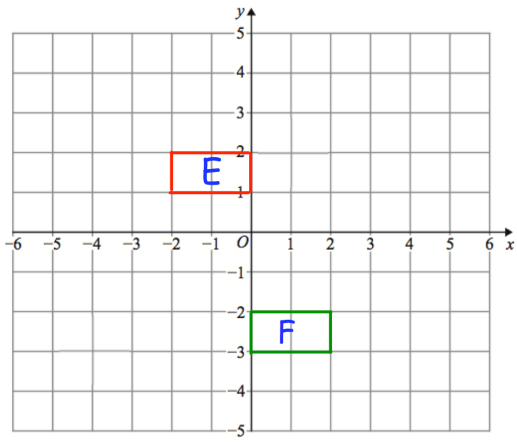


Question 5: The translation vector to take shape C to shape D is $\begin{pmatrix} 2 \\ -5 \end{pmatrix}$

What translation vector takes shape D to shape C?

Question 6: Edward has been asked to translate shape E by $\begin{pmatrix} -4 \\ 2 \end{pmatrix}$

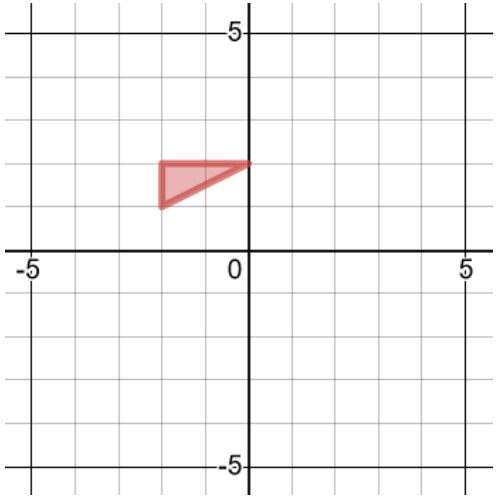
He has labelled his answer shape F
Can you spot any mistakes?



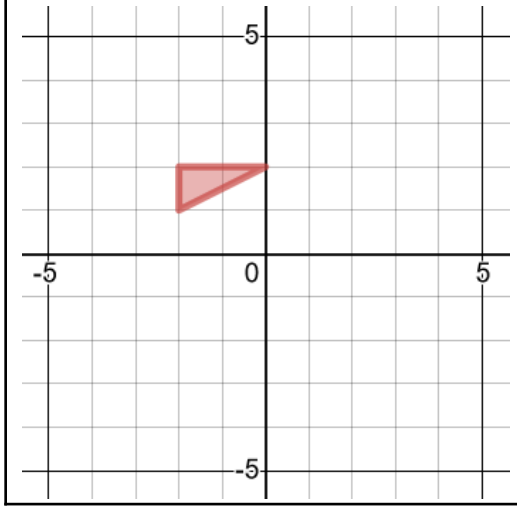
Enlargements

Worked Example

Enlarge about $(-4, 3)$, scale factor 2

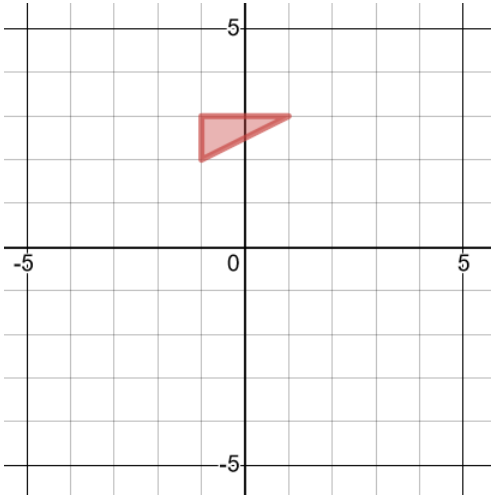


Enlarge about $(-2, 4)$, scale factor 3

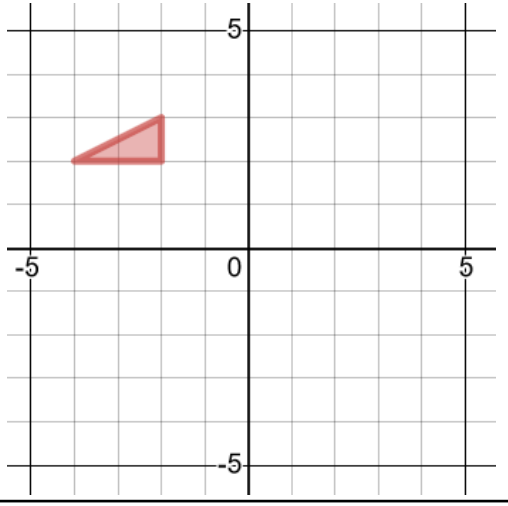


Your Turn

Enlarge about $(-3, 3)$, scale factor 2



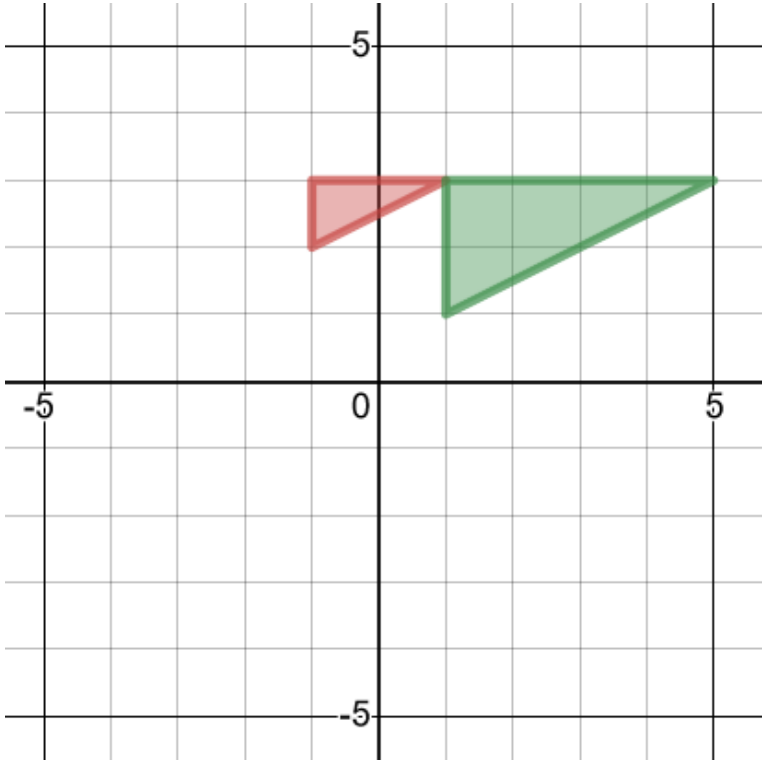
Enlarge about $(-4, 4)$, scale factor 3



Dr Frost 295b

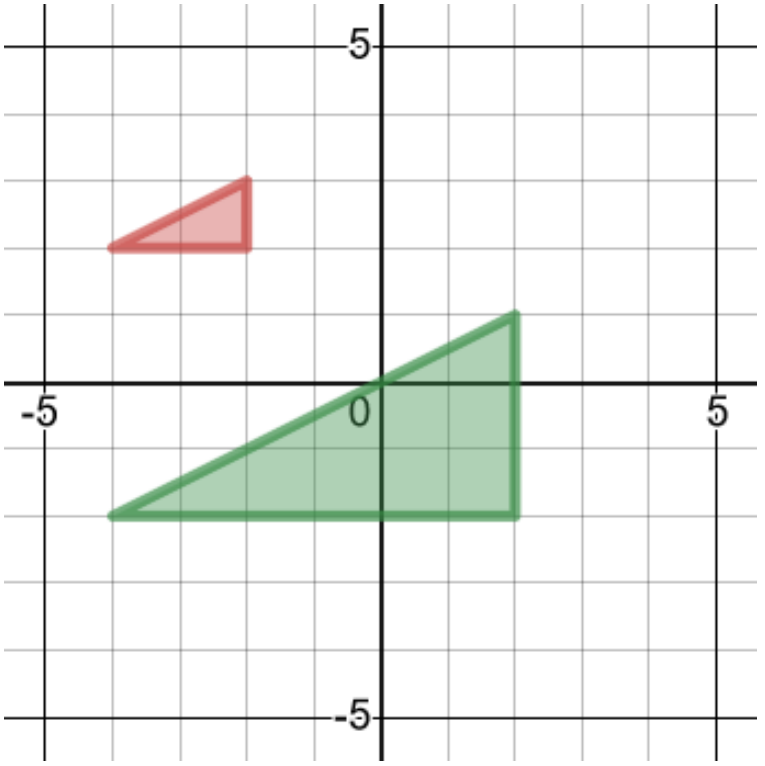
Worked Example

Describe the single transformation of the red object onto the green image



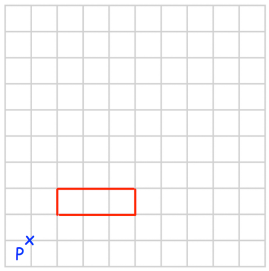
Your Turn

Describe the single transformation of the red object onto the green image



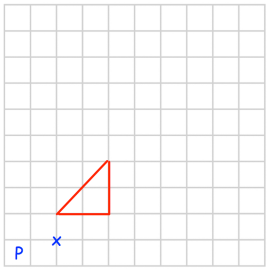
Question 1: Enlarge each shape by the scale factor given
Use P as the centre of enlargement.

(a)



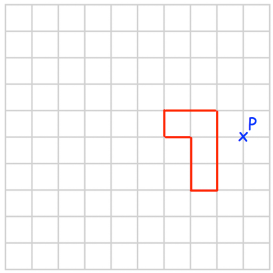
Enlarge by scale factor 2

(b)



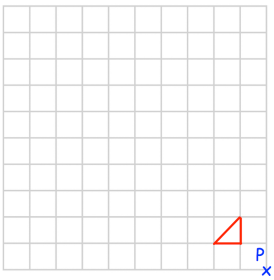
Enlarge by scale factor 3

(c)



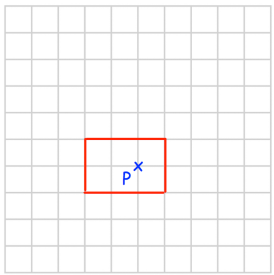
Enlarge by scale factor 2

(d)



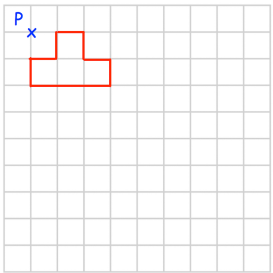
Enlarge by scale factor 4

(e)



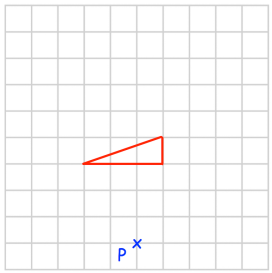
Enlarge by scale factor 2

(f)



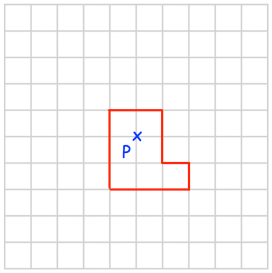
Enlarge by scale factor 3

(g)



Enlarge by scale factor 2

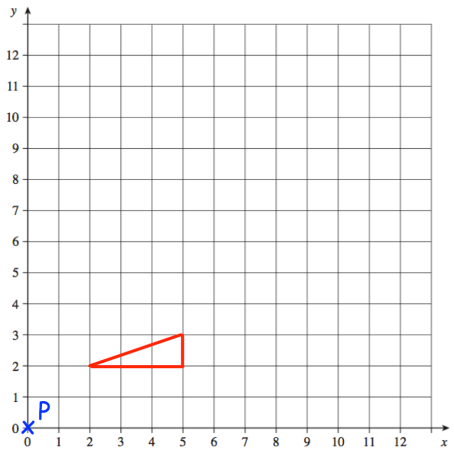
(h)



Enlarge by scale factor 2

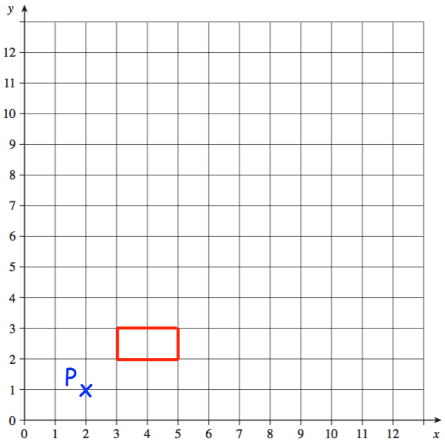
Question 2: Enlarge each shape by the scale factor given
Use P as the centre of enlargement.

(a)



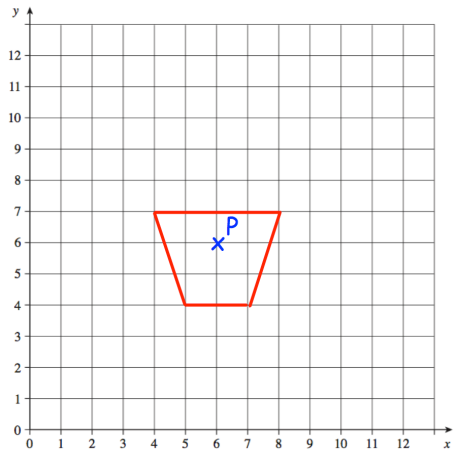
Enlarge by scale factor 2

(b)



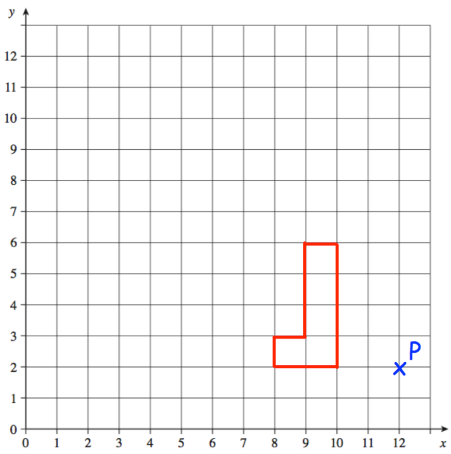
Enlarge by scale factor 3

(c)



Enlarge by scale factor 3

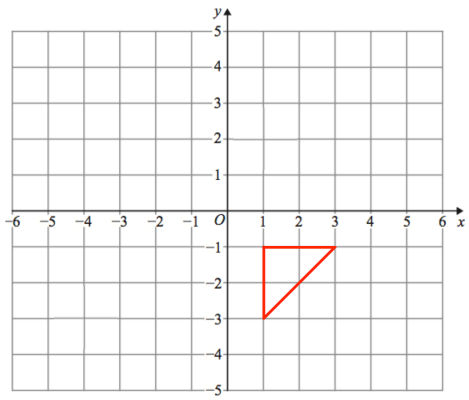
(d)



Enlarge by scale factor 2

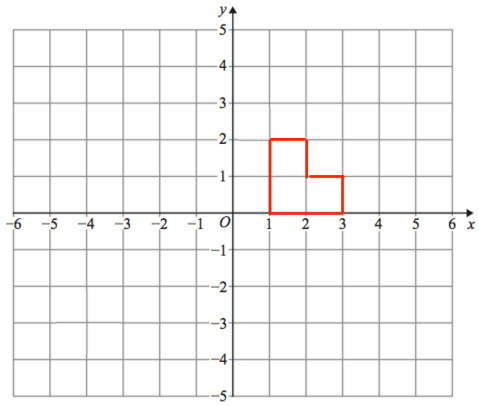
Question 3: Enlarge each shape by the scale factor given
The coordinates for each centre of enlargement are given.

(a)



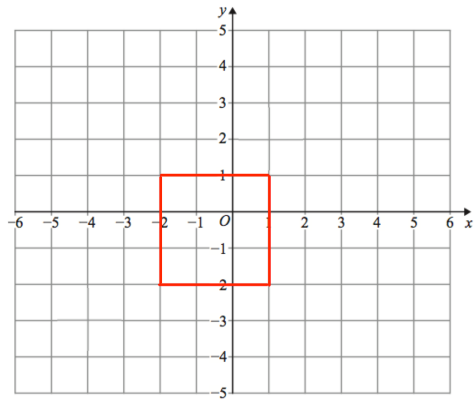
Enlarge by scale factor 2 using
(4, -3) as the centre of enlargement

(b)



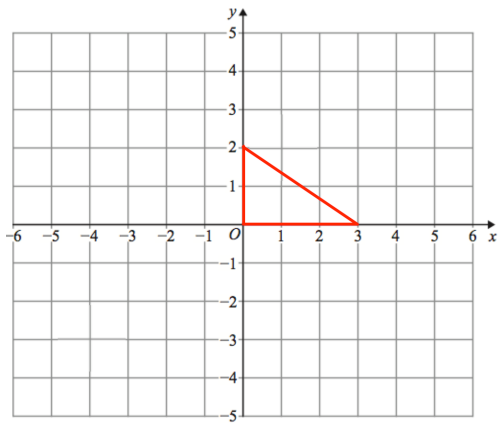
Enlarge by scale factor 3 using
(3, 2) as the centre of enlargement

(c)



Enlarge by scale factor 2 using
(0, -1) as the centre of enlargement

(d)

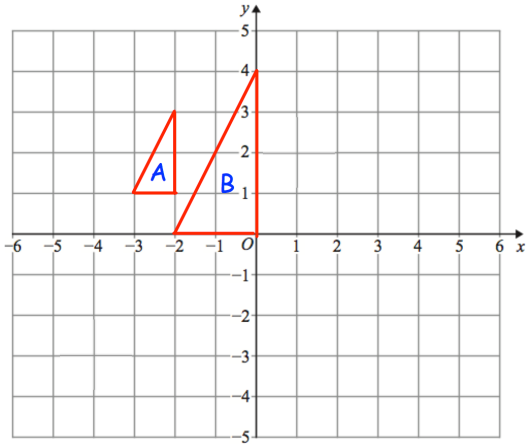


Enlarge by scale factor 2 using
the origin as the centre of enlargement

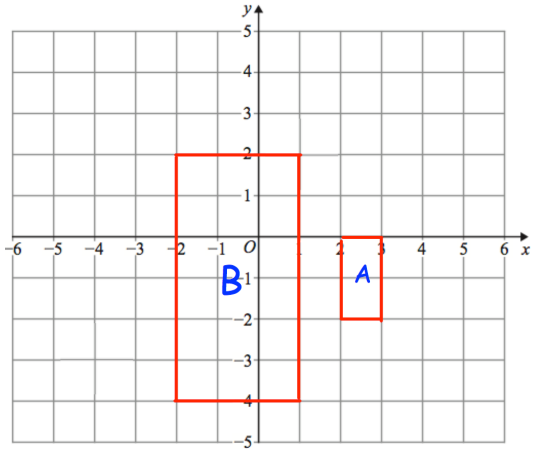
Fluency Practice

Question 4: Describe fully the single transformation that takes shape A to shape B.

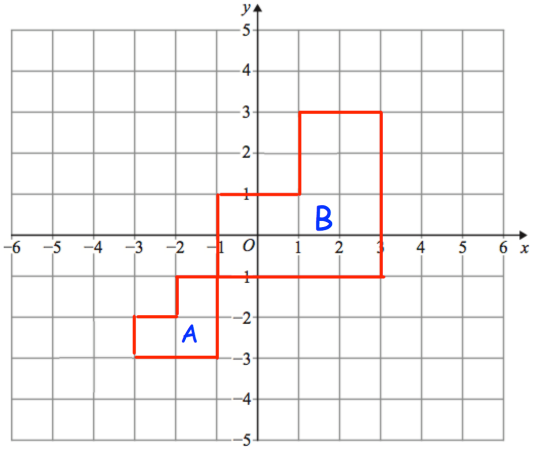
(a)



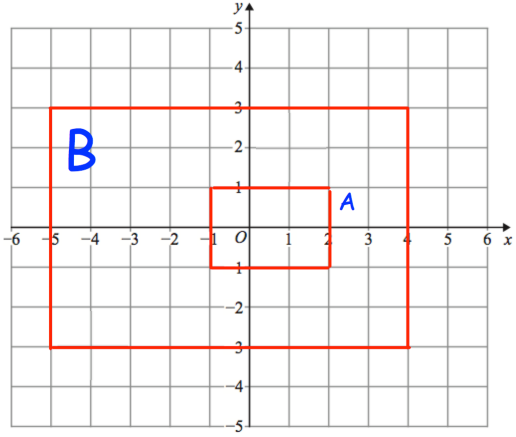
(b)



(c)

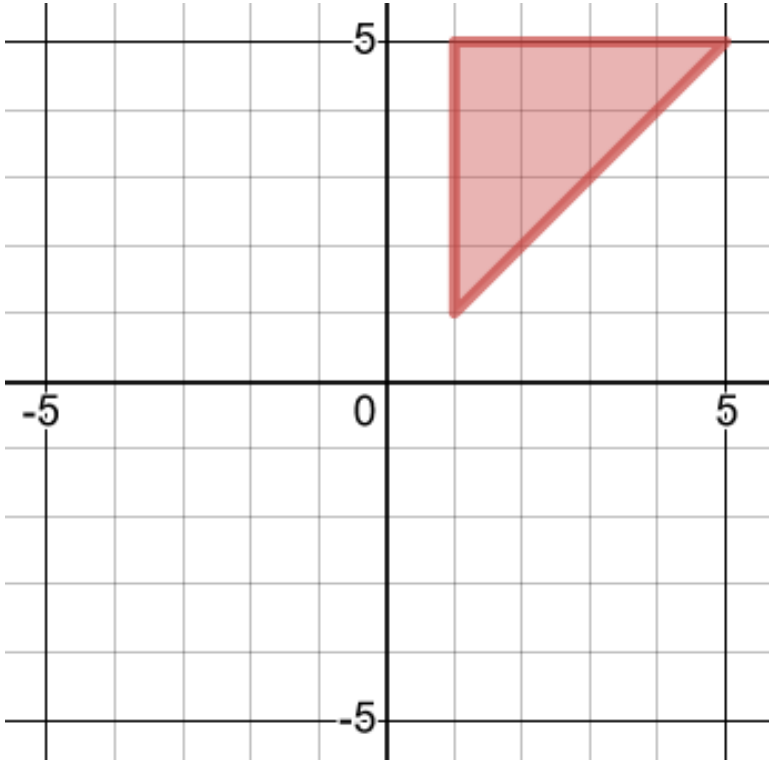


(d)



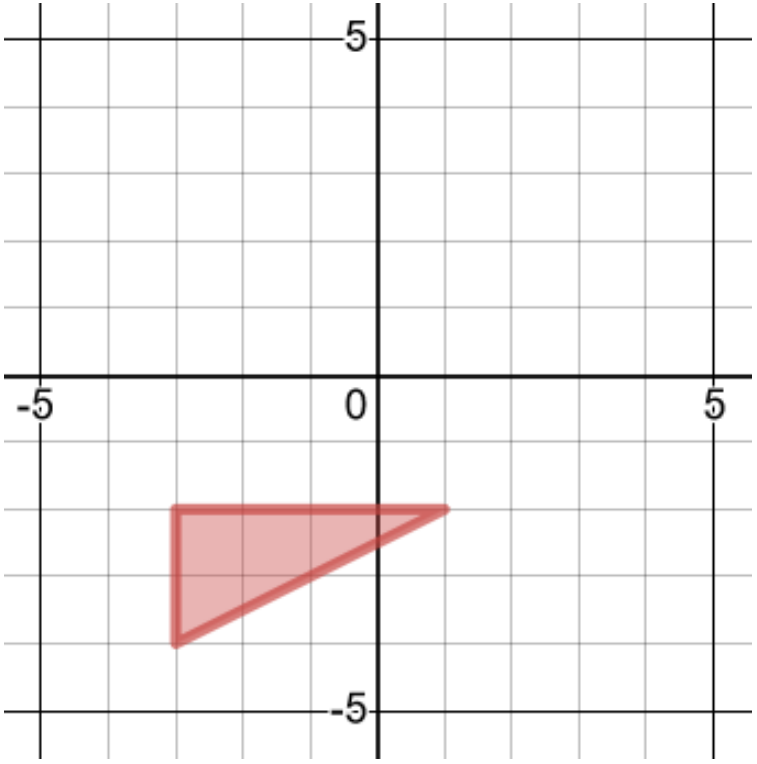
Worked Example

Enlarge about $(-3, -3)$, scale factor $\frac{1}{2}$



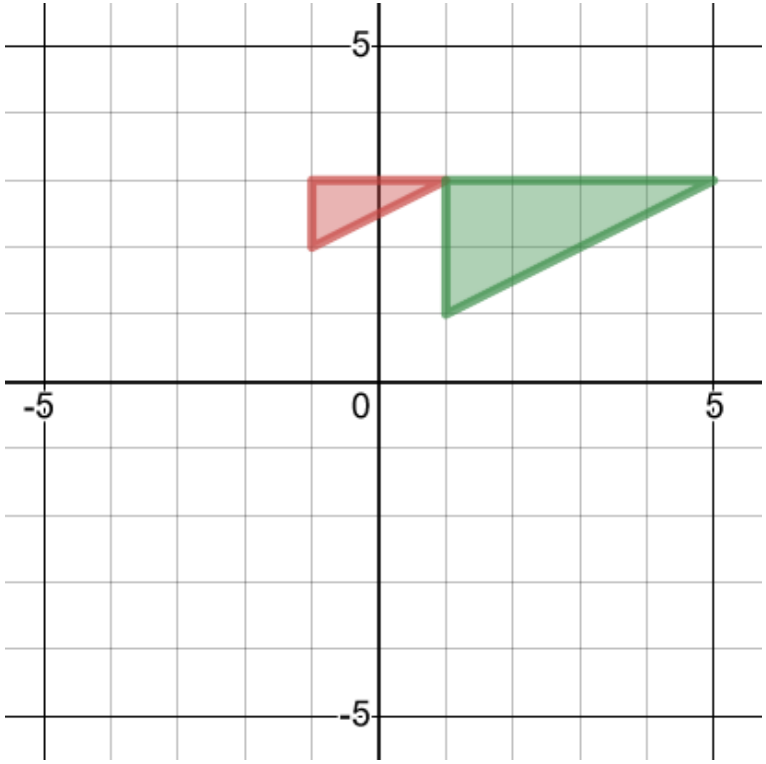
Your Turn

Enlarge about $(-1, 0)$, scale factor $\frac{1}{2}$



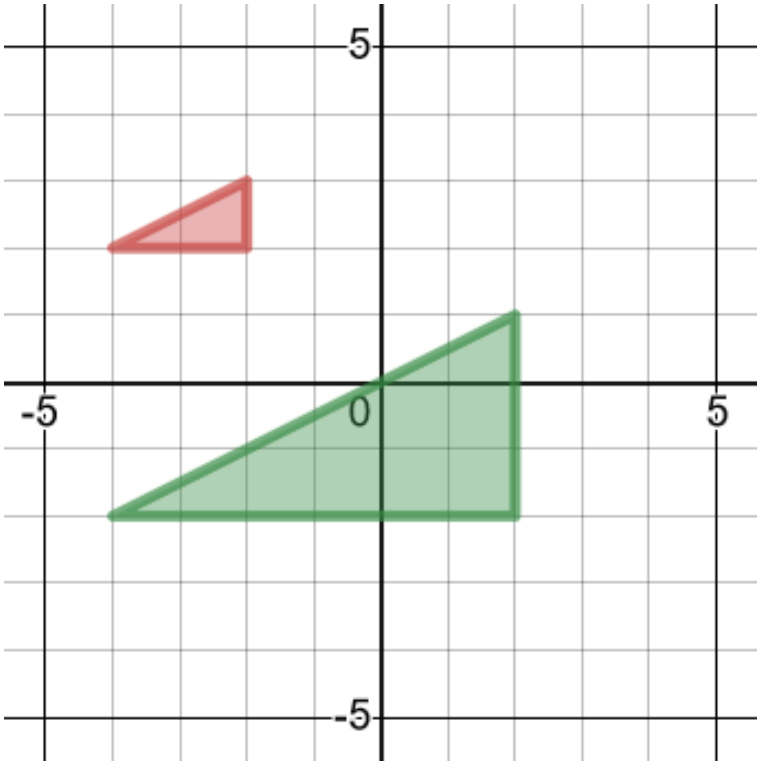
Worked Example

Describe the single transformation of the green object onto the red image



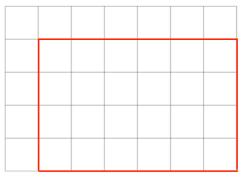
Your Turn

Describe the single transformation of the green object onto the red image



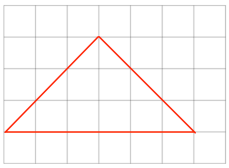
Question 1: Copy these shapes and then enlarge by the scale factor given.

(a)



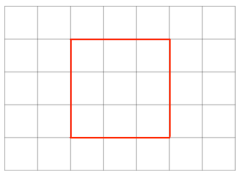
Enlarge by scale factor $\frac{1}{2}$

(b)



Enlarge by scale factor $\frac{1}{3}$

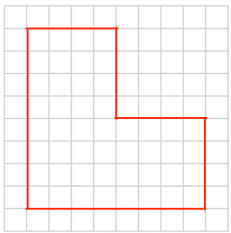
(c)



Enlarge by scale factor $\frac{2}{3}$

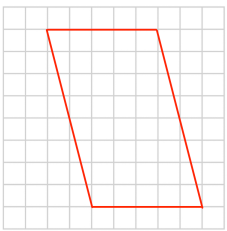
Question 2: Copy these shapes and then enlarge by the scale factor given.

(a)



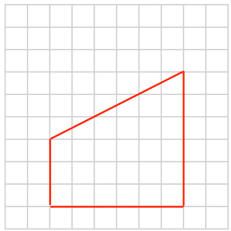
Enlarge by scale factor $\frac{1}{4}$

(b)



Enlarge by scale factor $\frac{1}{2}$

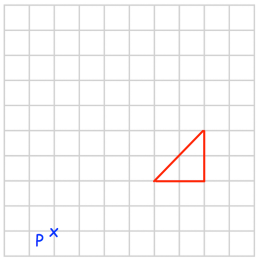
(c)



Enlarge by scale factor $1\frac{1}{3}$

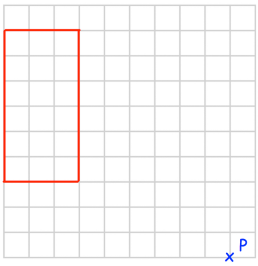
Question 3: Enlarge each shape by the scale factor given
Use P as the centre of enlargement.

(a)



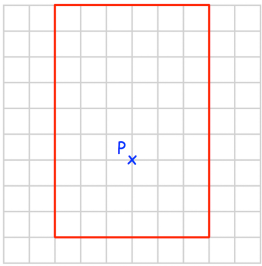
Enlarge by scale factor $\frac{1}{2}$

(b)



Enlarge by scale factor $\frac{1}{3}$

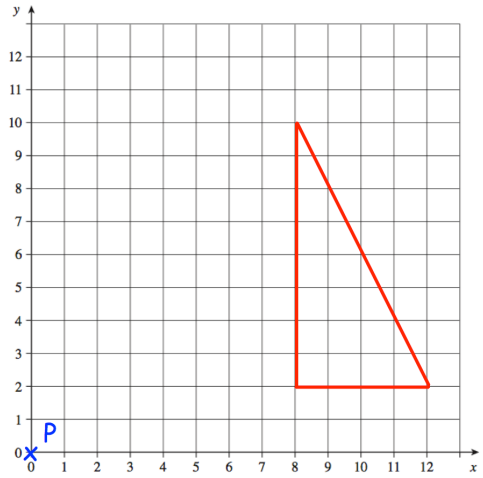
(c)



Enlarge by scale factor $\frac{2}{3}$

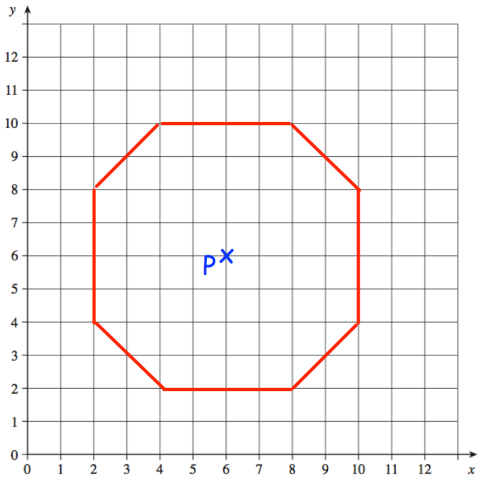
Question 4: Enlarge each shape by the scale factor given
Use P as the centre of enlargement.

(a)



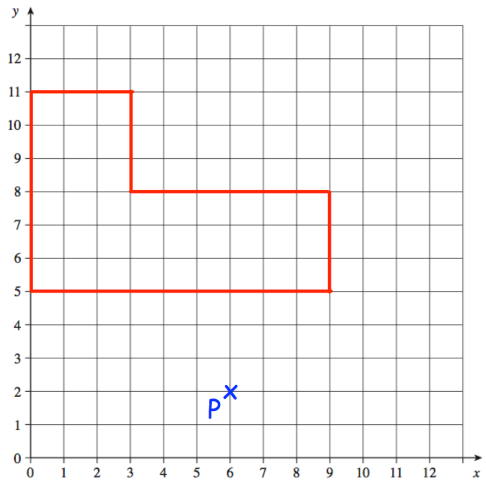
Enlarge by scale factor $\frac{1}{4}$

(b)



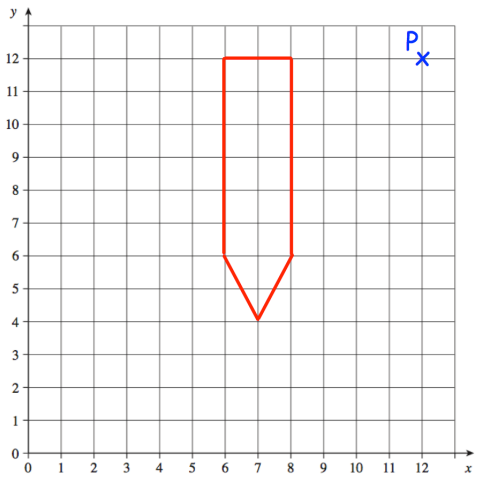
Enlarge by scale factor $\frac{1}{2}$

(c)



Enlarge by scale factor $\frac{2}{3}$

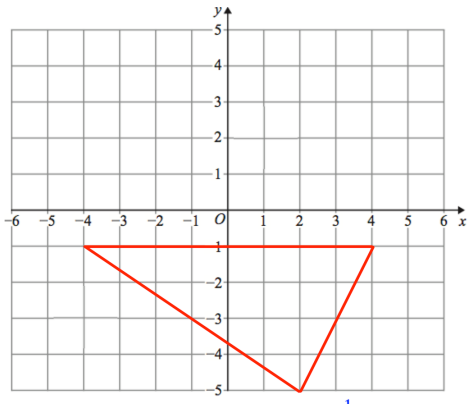
(d)



Enlarge by scale factor $1\frac{1}{2}$

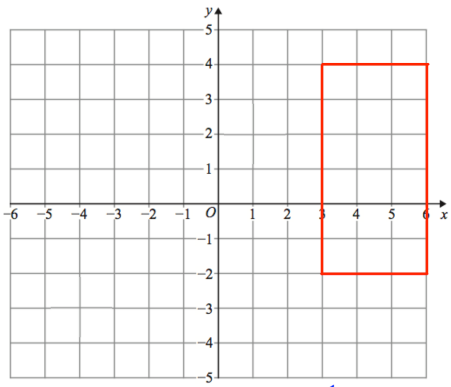
Question 5: Enlarge each shape by the scale factor given
The coordinates for each centre of enlargement are given.

(a)



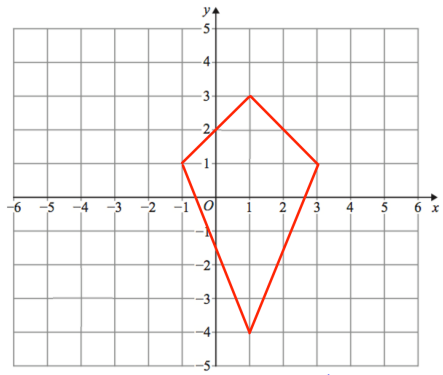
Enlarge by scale factor $\frac{1}{2}$ using
(0, 1) as the centre of enlargement

(b)



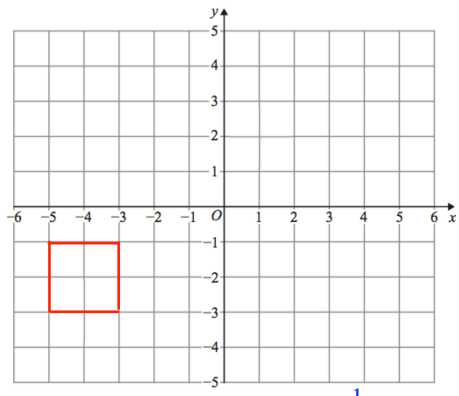
Enlarge by scale factor $\frac{1}{3}$ using
(-3, 1) as the centre of enlargement

(c)



Enlarge by scale factor $\frac{1}{2}$ using
(-5, -5) as the centre of enlargement

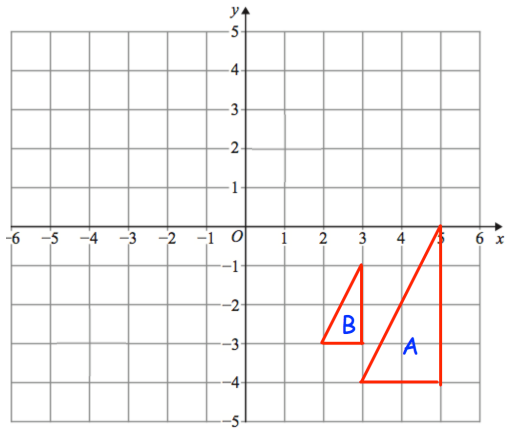
(d)



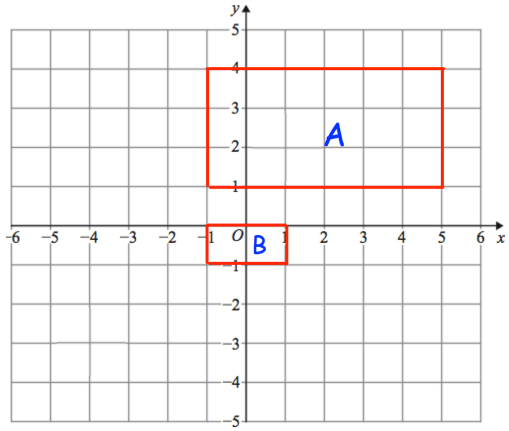
Enlarge by scale factor $2\frac{1}{2}$ using
(-5, -3) as the centre of enlargement

Question 6: Describe fully the single transformation that takes shape A to shape B.

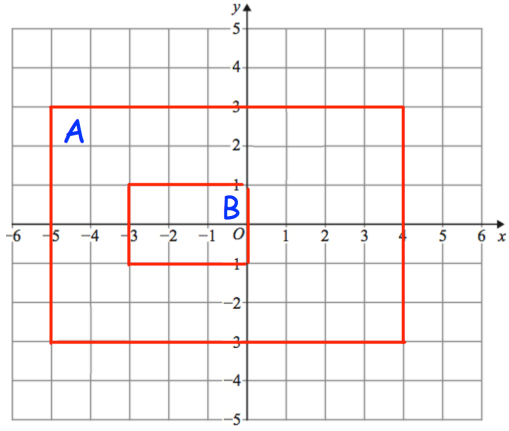
(a)



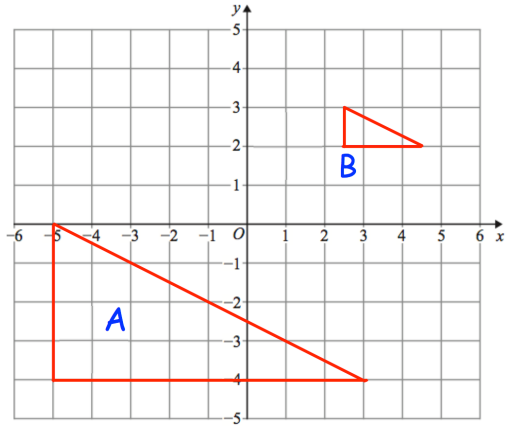
(b)



(c)

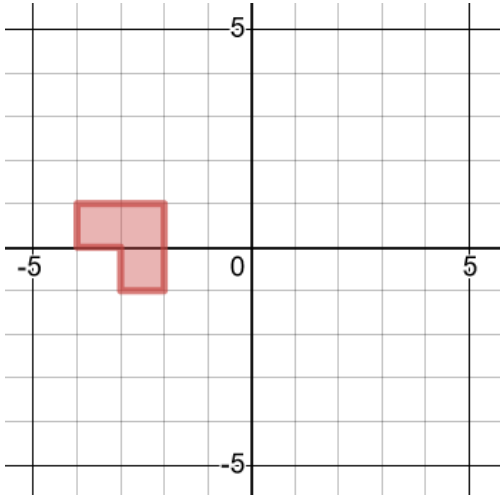


(d)

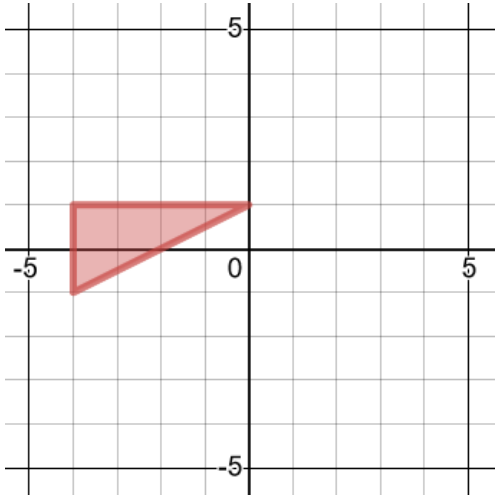


Worked Example

Enlarge about $(-2, 1)$, scale factor -2

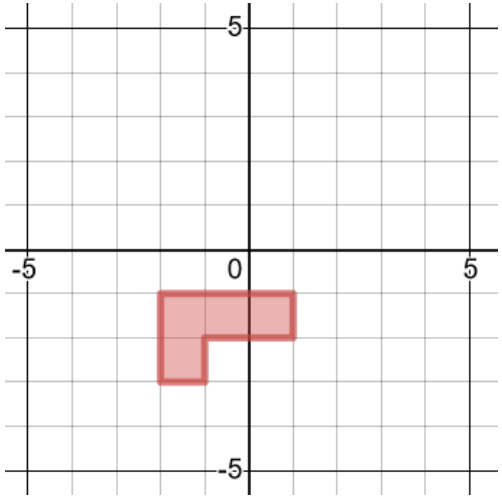


Enlarge about $(-2, -3)$, scale factor $-\frac{1}{2}$

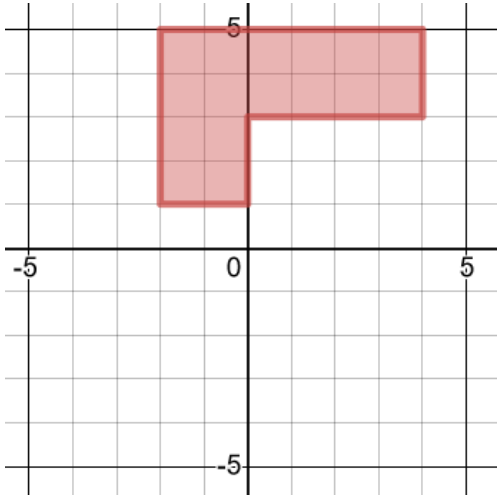


Your Turn

Enlarge about $(0, -1)$, scale factor -2



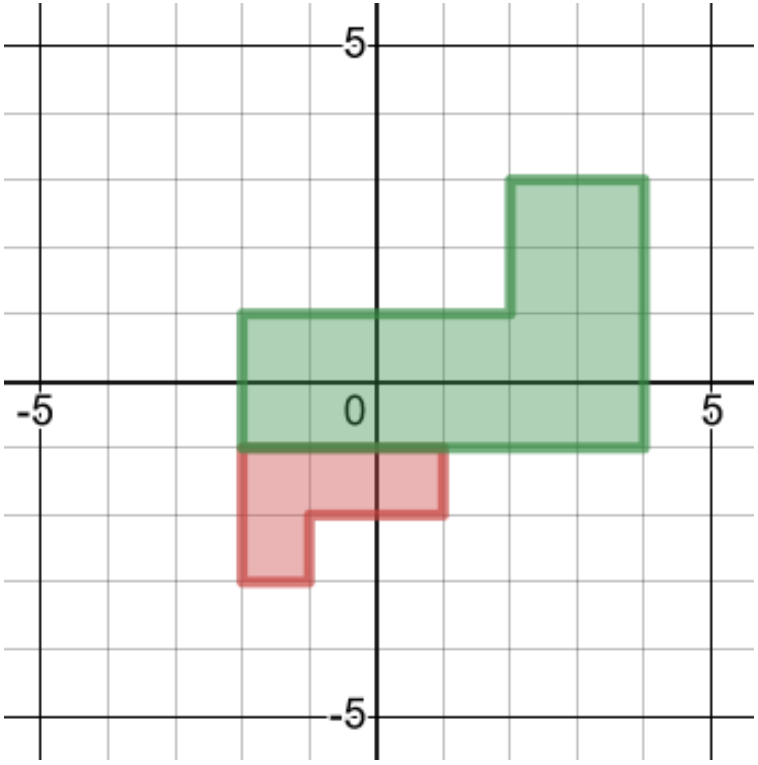
Enlarge about $(2, -1)$, scale factor $-\frac{1}{2}$



Dr Frost 376a and 376b

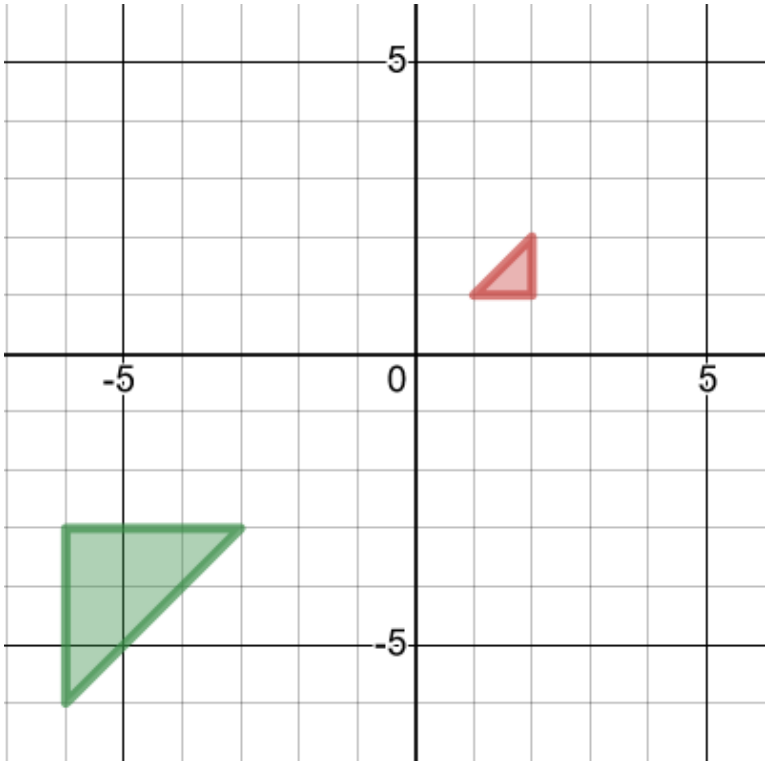
Worked Example

Describe the single transformation of the red object onto the green image



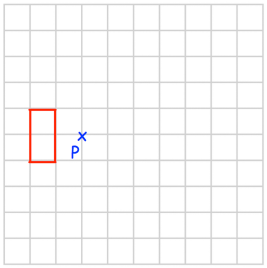
Your Turn

Describe the single transformation of the red object onto the green image



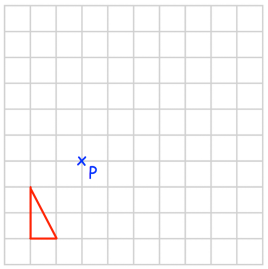
Question 1: Enlarge each shape by the scale factor given
Use P as the centre of enlargement.

(a)



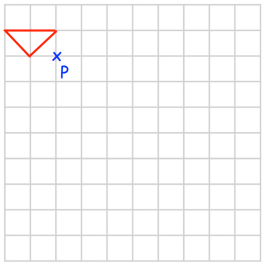
Enlarge by scale factor -3

(b)



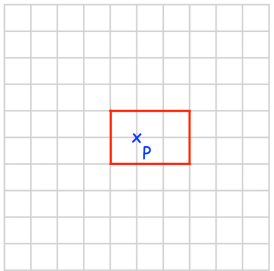
Enlarge by scale factor -2

(c)



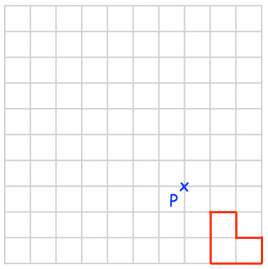
Enlarge by scale factor -4

(d)



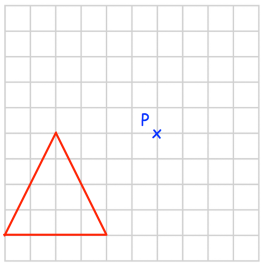
Enlarge by scale factor -2

(e)



Enlarge by scale factor -2

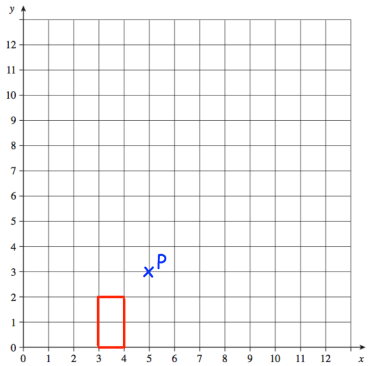
(f)



Enlarge by scale factor $-\frac{1}{2}$

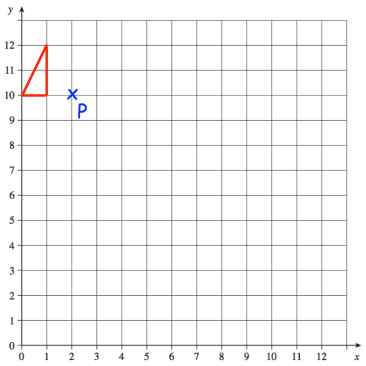
Question 2: Enlarge each shape by the scale factor given
Use P as the centre of enlargement.

(a)



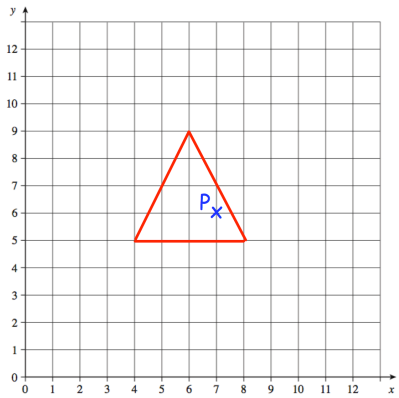
Enlarge by scale factor -3

(b)



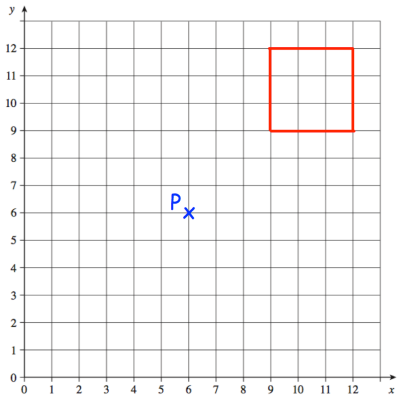
Enlarge by scale factor -4

(c)



Enlarge by scale factor -2

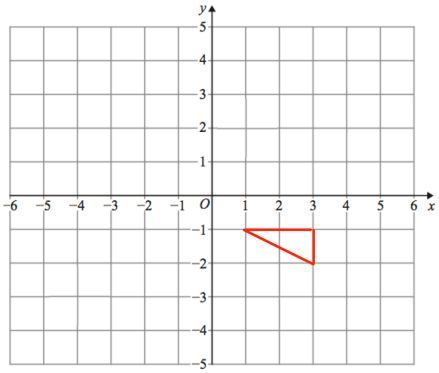
(d)



Enlarge by scale factor $-\frac{1}{3}$

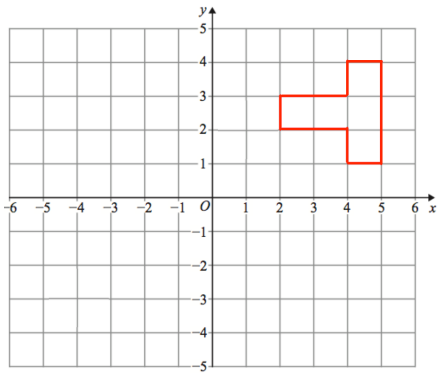
Question 3: Enlarge each shape by the scale factor given
The coordinates for each centre of enlargement are given.

(a)



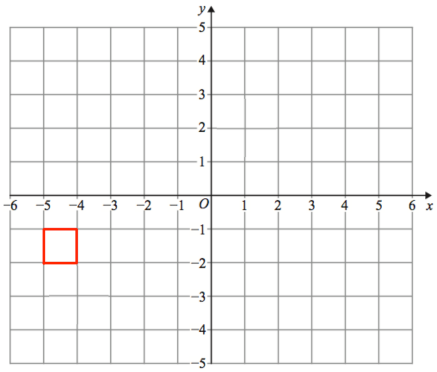
Enlarge by scale factor -2 using
(0, 0) as the centre of enlargement

(b)



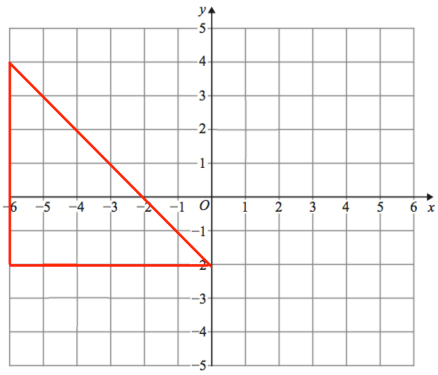
Enlarge by scale factor -2 using
(2, 2) as the centre of enlargement

(c)



Enlarge by scale factor -4 using
(-3, -1) as the centre of enlargement

(d)

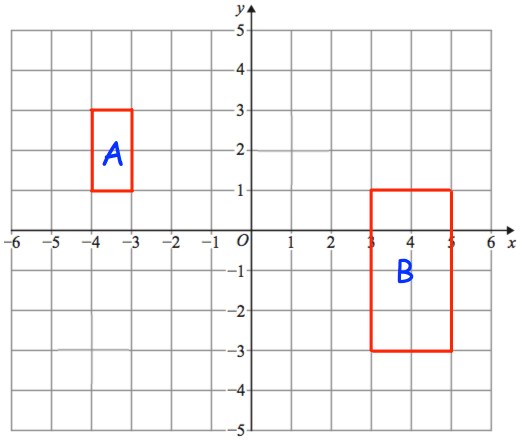


Enlarge by scale factor $-\frac{1}{2}$ using
(0, -2) as the centre of enlargement

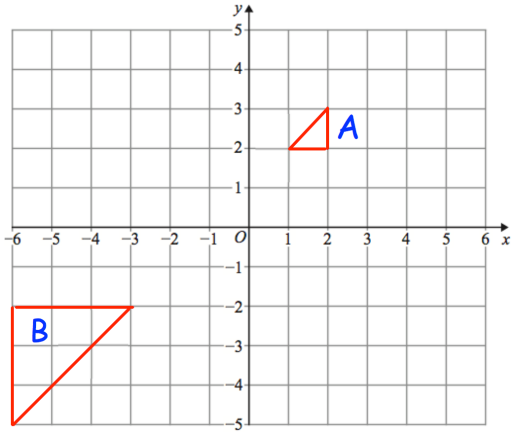
Fluency Practice

Question 4: Describe fully the single transformation that takes shape A to shape B.

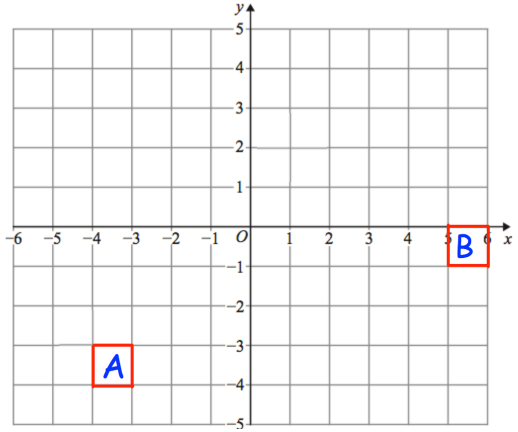
(a)



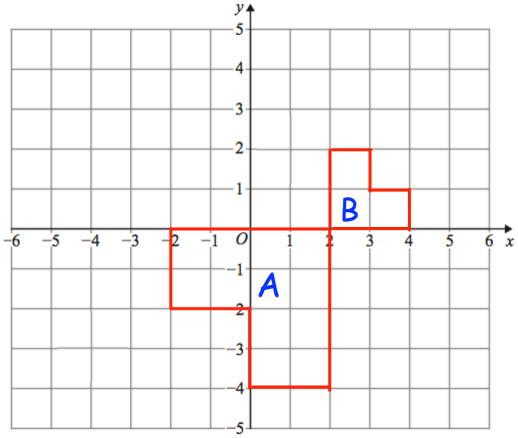
(b)



(c)



(d)



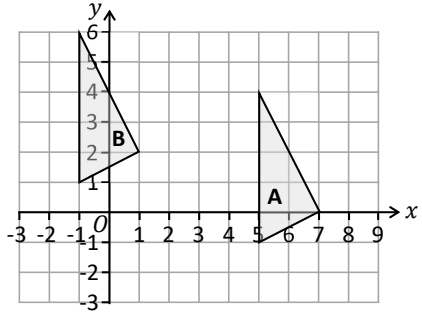
Mixed Transformations

Fluency Practice

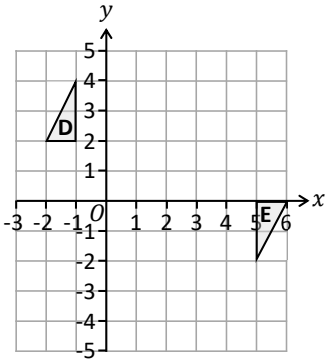
Transformations

1. Describe the single transformation that maps shape A onto shape B.

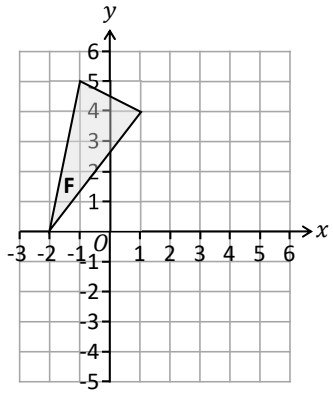
Translate triangle B by the vector $\begin{pmatrix} 3 \\ -4 \end{pmatrix}$
Label the new triangle C.



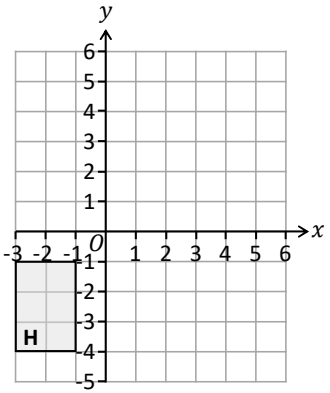
2. Describe the **2 reflections** that map shape D onto shape E.



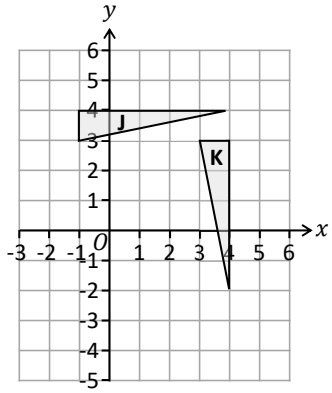
3. Reflect triangle F
in the line $y = x$
Label the new triangle G.



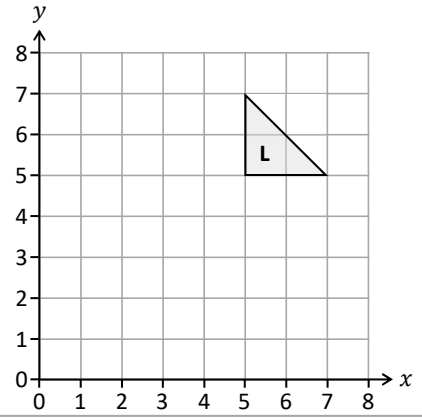
4. Rotate shape H
90° clockwise about (3, −3).
Label the new shape I.



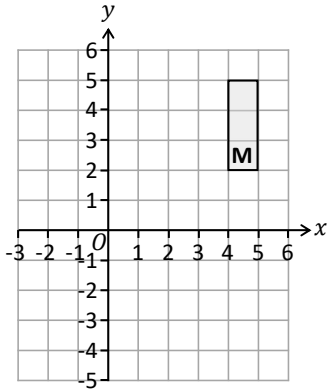
5. Describe the single transformation that maps shape J onto shape K.



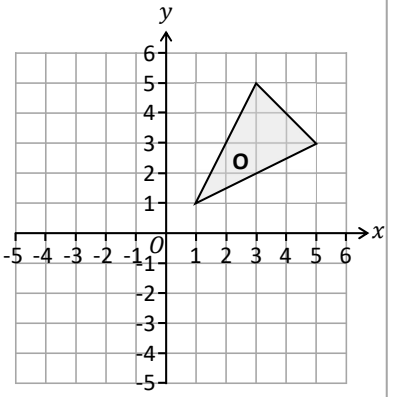
6. Use the centre of enlargement (7, 7) to enlarge shape L by a scale factor of 3.
& then enlarge shape L by a scale factor of $\frac{1}{2}$.



7. Enlarge shape M by scale factor −2 with (3, 2) as the centre of enlargement.
Label the new shape N.



8. Enlarge triangle O by scale factor $-\frac{1}{2}$ with centre of enlargement (− 1, 3).
Label the triangle P.

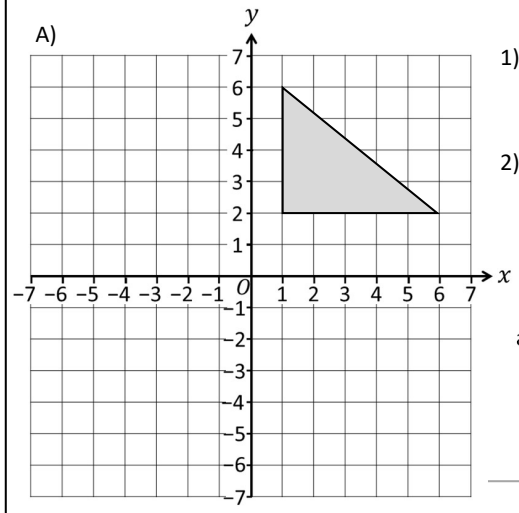


Combined Transformations

Fluency Practice

Combining Transformations ①

A)

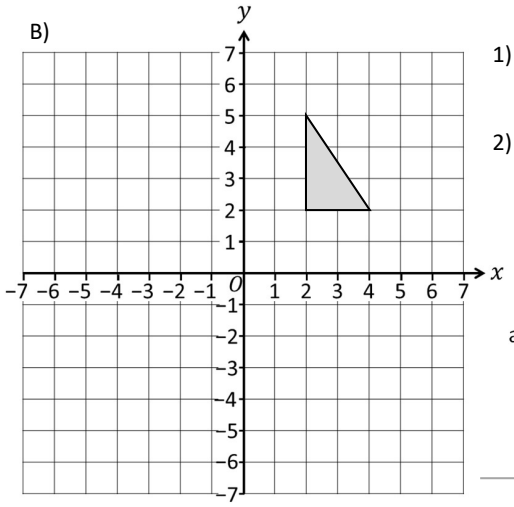


1) Translate by the vector $\begin{pmatrix} -7 \\ -4 \end{pmatrix}$

2) Translate by the vector $\begin{pmatrix} 8 \\ -4 \end{pmatrix}$

Describe as a single transformation:

B)

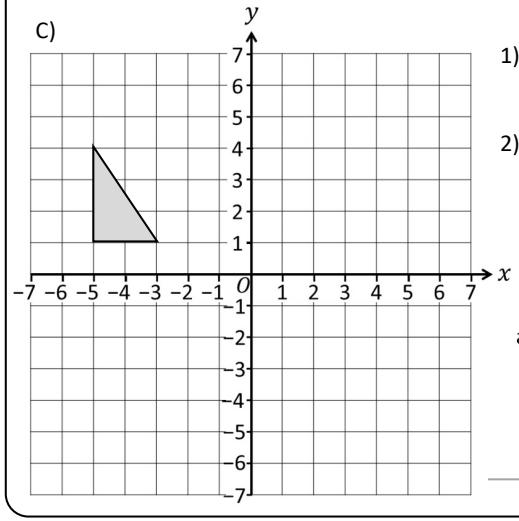


1) Rotate 90° clockwise about the origin.

2) Translate by the vector $\begin{pmatrix} 0 \\ 4 \end{pmatrix}$

Describe as a single transformation:

C)

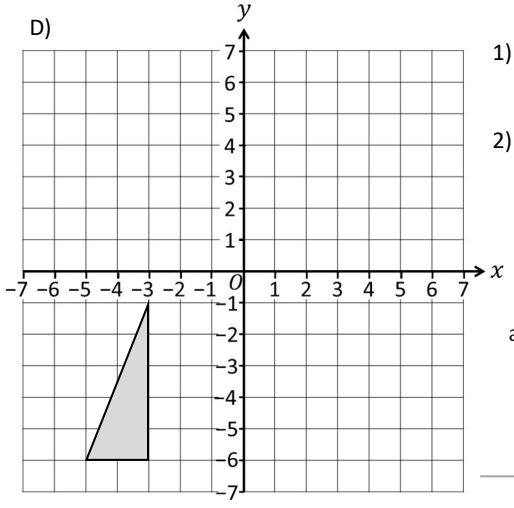


1) Rotate 180° about the origin.

2) Reflect in the line $y = 0$

Describe as a single transformation:

D)



1) Reflect in the line $x = -1$

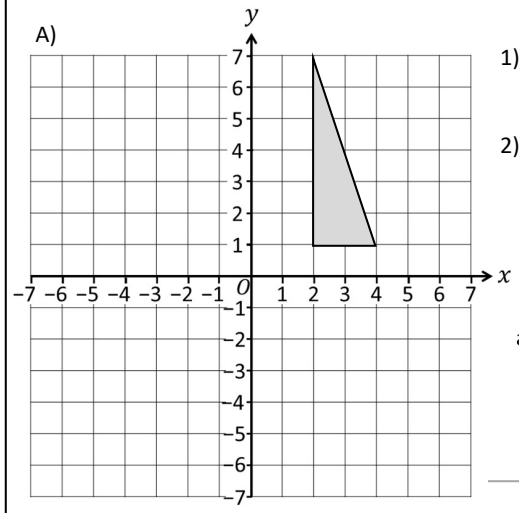
2) Reflect in the line $y = -1$

Describe as a single transformation:

Fluency Practice

Combining Transformations ②

A)

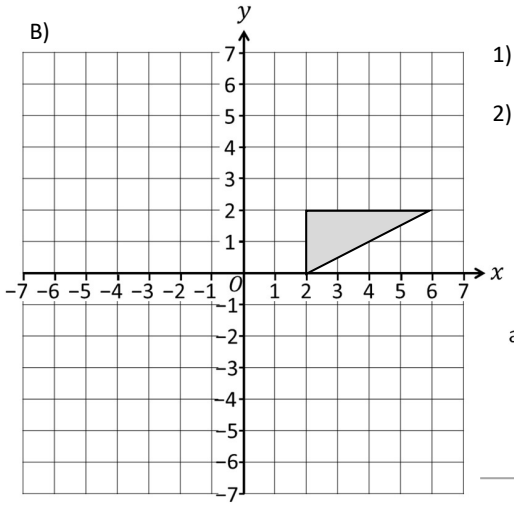


1) Rotate 180° about (1, 0).

2) Translate by the vector $\begin{pmatrix} -2 \\ 4 \end{pmatrix}$

Describe as a single transformation:

B)

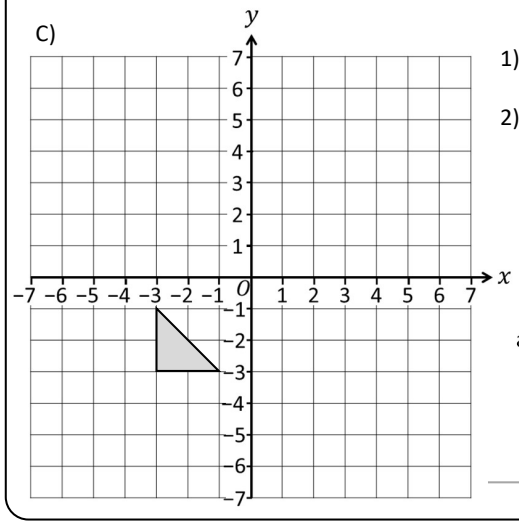


1) Reflect in the line $y = x$

2) Reflect in the line $x = -1$

Describe as a single transformation:

C)

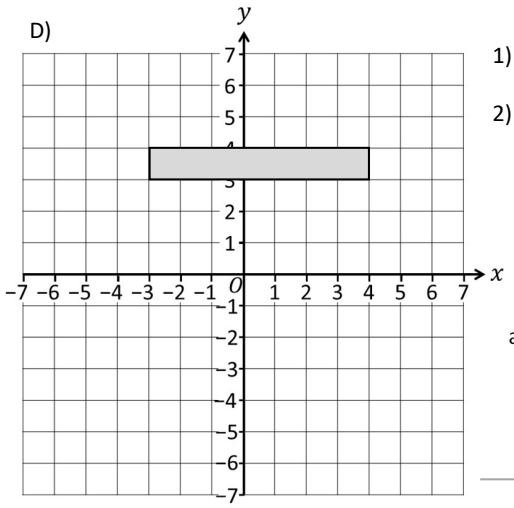


1) Reflect in the line $y = -x$

2) Reflect in the line $x = -1$

Describe as a single transformation:

D)



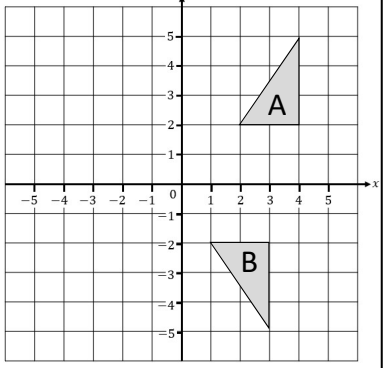
1) Reflect in the line $y = x$

2) Rotate 180° about the origin.

Describe as a single transformation:

Fluency Practice

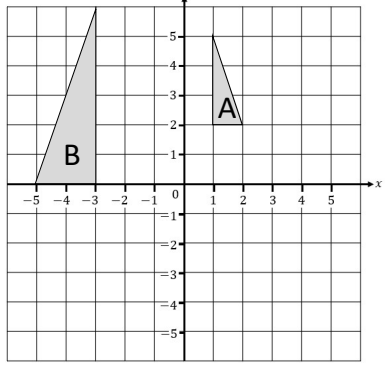
A



T1)

T2)

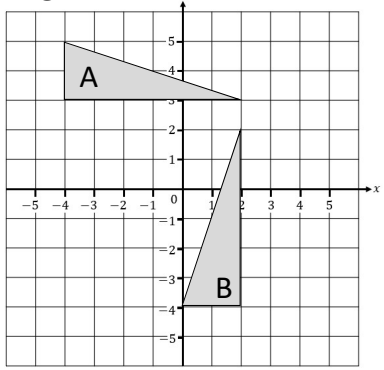
B



T1)

T2)

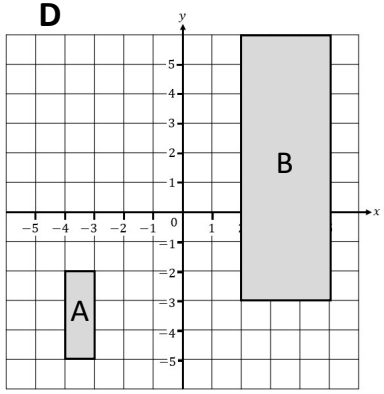
C



T1)

T2)

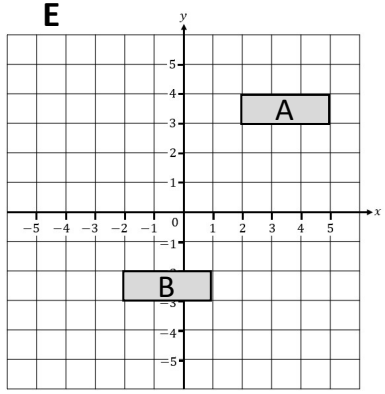
D



T1)

T2)

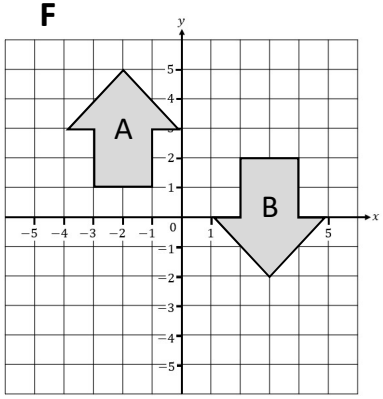
E



T1)

T2)

F



T1)

T2)

How is each shape transformed from A to B?

Pick **only** from those below.

Reflected in $y = 0$

Translation $\begin{pmatrix} 1 \\ 3 \end{pmatrix}$

Reflected in $x = 0$

Enlarged, SF = 2, (1, 4)

Rotated 180° clockwise around (0,0)

Rotated 90° anticlockwise around (2,3)

Enlarged, SF = 3, (-5,-5)

Translation $\begin{pmatrix} -1 \\ 0 \end{pmatrix}$

Translation $\begin{pmatrix} 4 \\ 2 \end{pmatrix}$

Reflected in $y = 1$

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

Translated $\begin{pmatrix} 0 \\ -1 \end{pmatrix}$

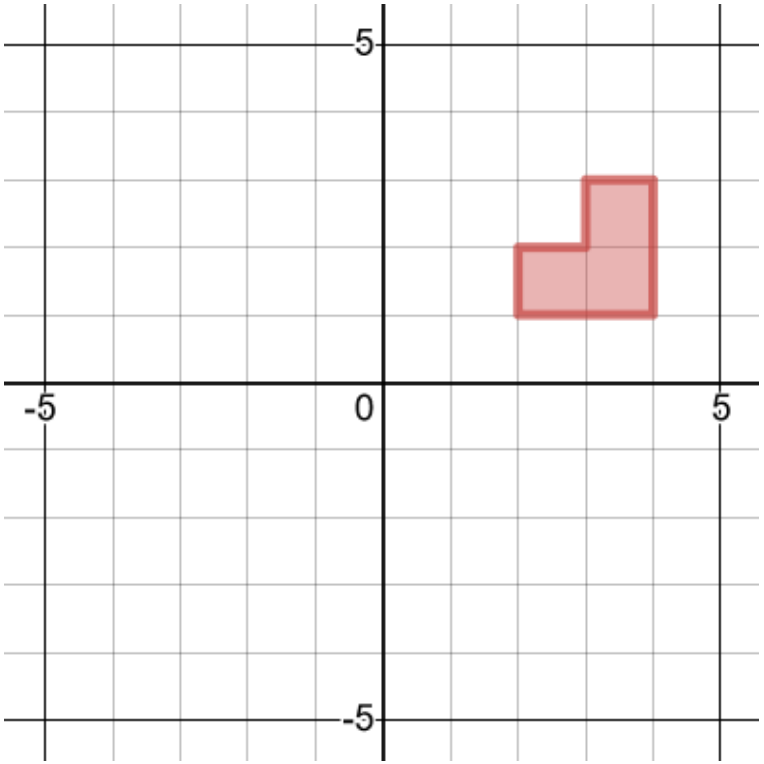
Extra Notes

5 Invariant Points

Worked Example

Reflect in the line $y = x$

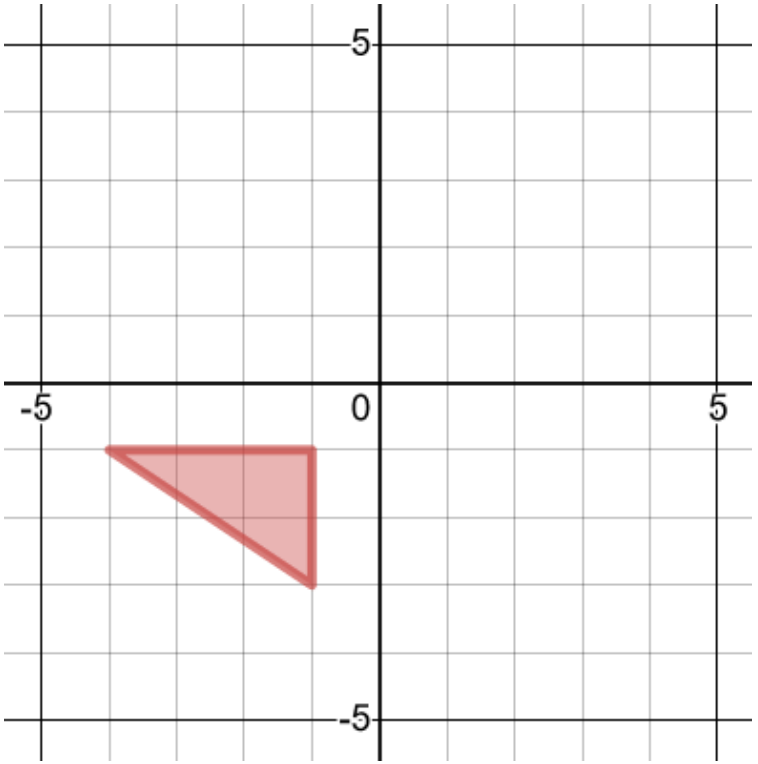
Are there any invariant points?



Your Turn

Reflect in the line $y = -1$

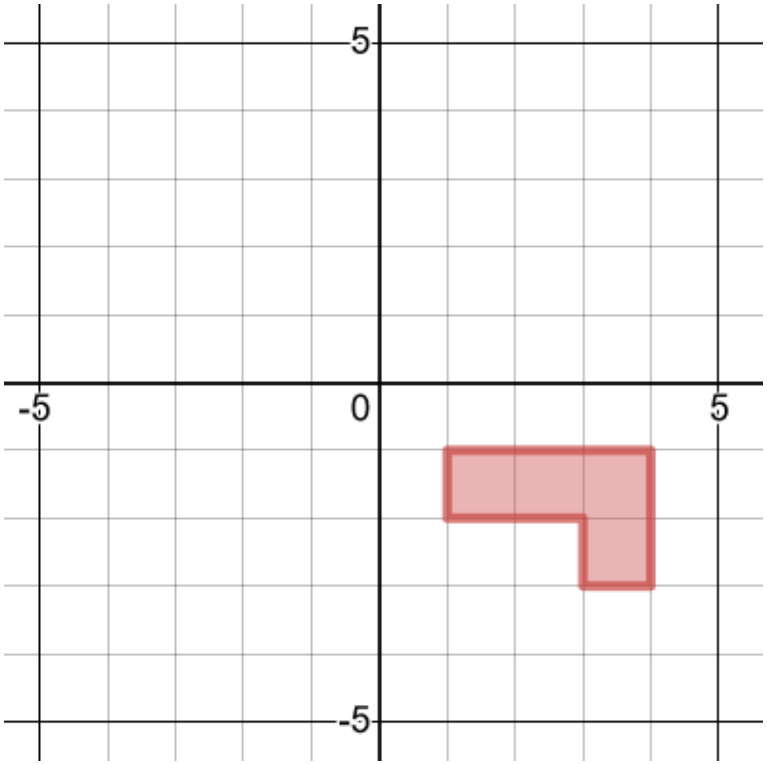
Are there any invariant points?



Worked Example

Rotate $180°$ about $(1, -1)$

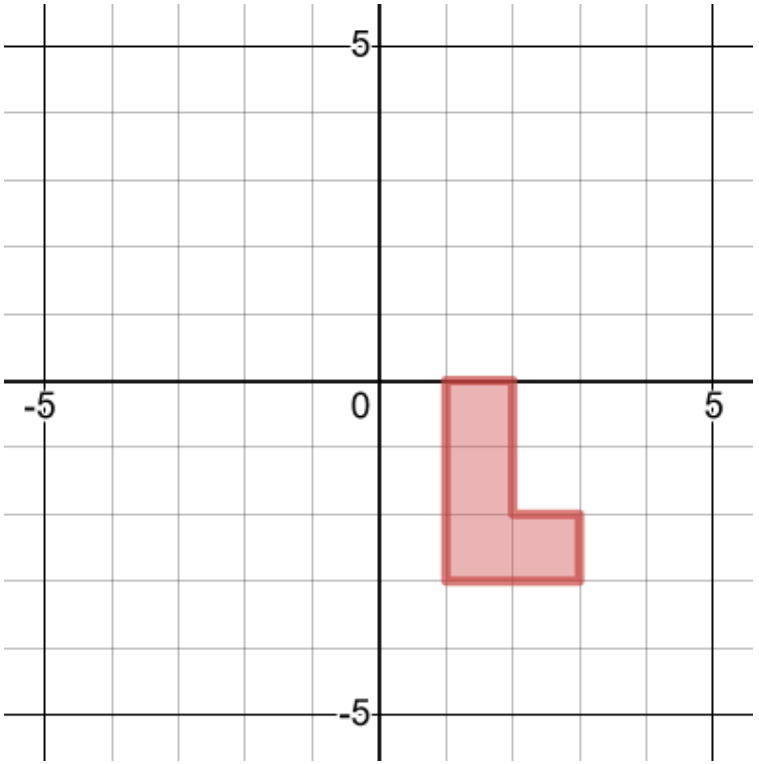
Are there any invariant points?



Your Turn

Rotate $180°$ about $(1, 0)$

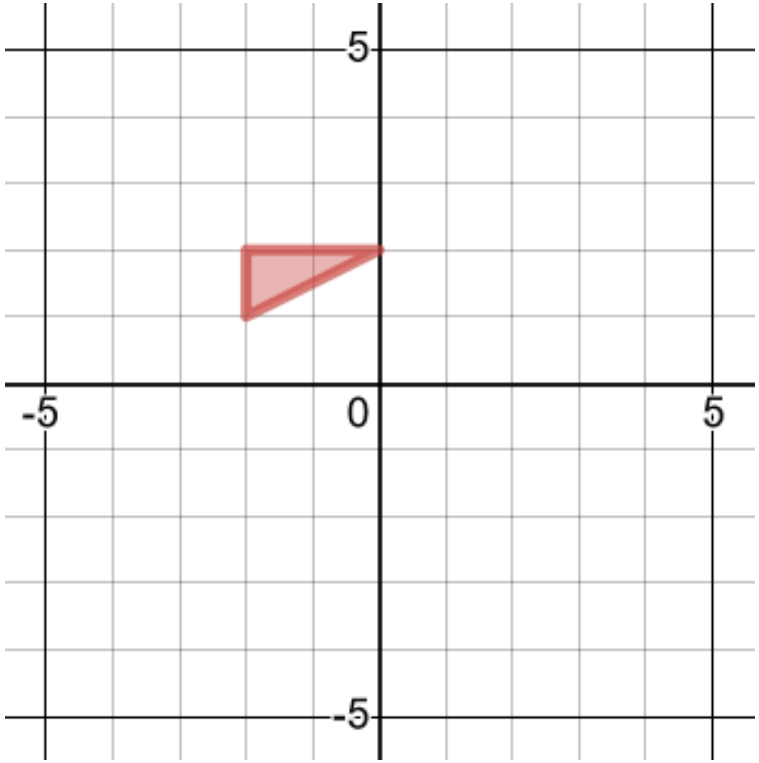
Are there any invariant points?



Worked Example

Are there any invariant points?

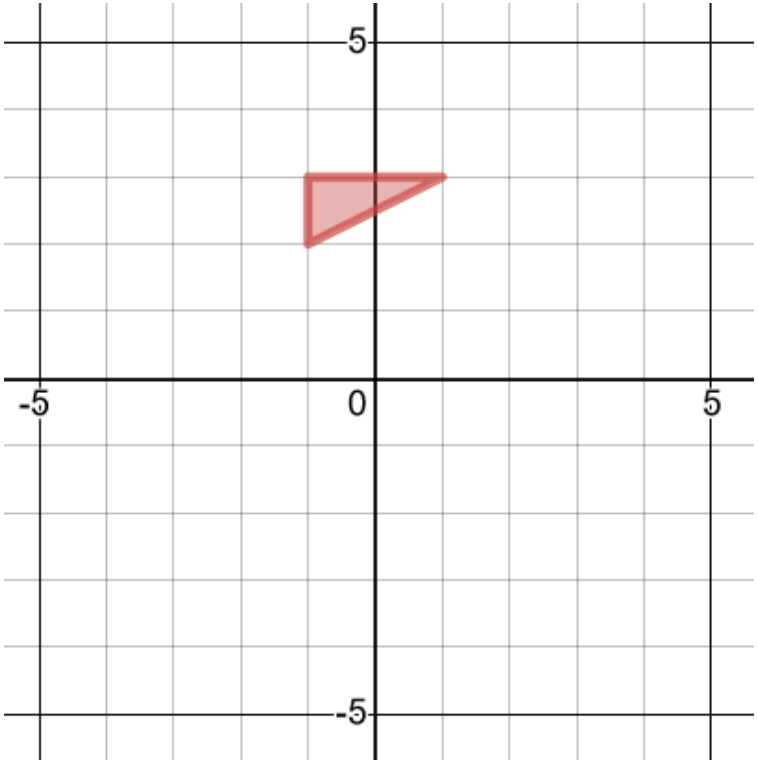
Enlarge about $(-2, 2)$, scale factor 2



Your Turn

Are there any invariant points?

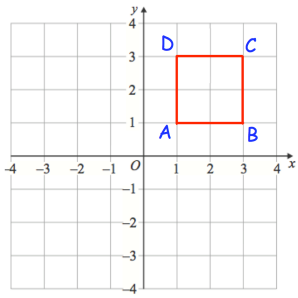
Enlarge about $(-1, 2)$, scale factor 3



Question 1: ABCD is a square.

(a) Translate ABCD using vector $\begin{pmatrix} -3 \\ -1 \end{pmatrix}$

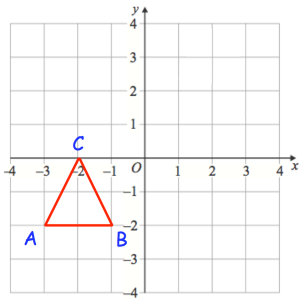
(b) Are there any invariant points?
If so, which point(s) are invariant?



Question 2: ABC is an isosceles triangle.

(a) Reflect ABC in the x-axis

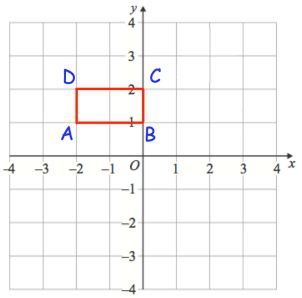
(b) Are there any invariant points?
If so, which point(s) are invariant?



Question 3: ABCD is a rectangle.

(a) Enlarge ABCD by scale factor 2, with centre of enlargement $(-2,2)$

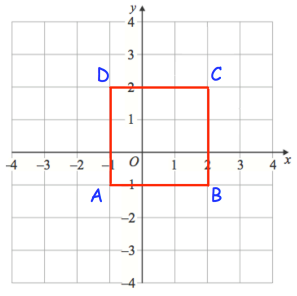
(b) Are there any invariant points?
If so, which point(s) are invariant?



Question 4: ABCD is a square

(a) Reflect ABCD in the line $y = x$

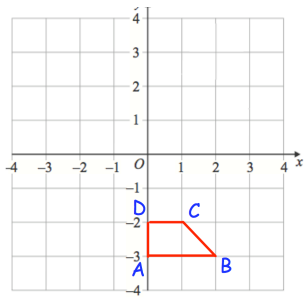
(b) Are there any invariant points?
If so, which point(s) are invariant?



Question 5: ABCD is a trapezium

(a) Enlarge ABCD by scale factor −2, with centre of enlargement $(1, -2)$

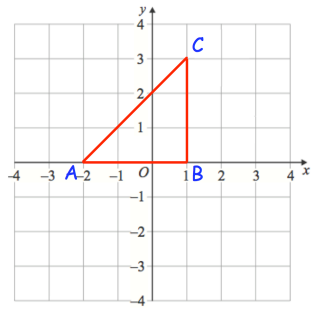
(b) Are there any invariant points?
If so, which point(s) are invariant?



Question 6: ABC is a triangle.

(a) Rotate ABC 90° clockwise about $(1, 0)$

(b) Are there any invariant points?
If so, which point(s) are invariant?



Question 7: A sketch of triangle ABC is shown

For each transformation below, write down the letter(s) of any vertices that are invariant.

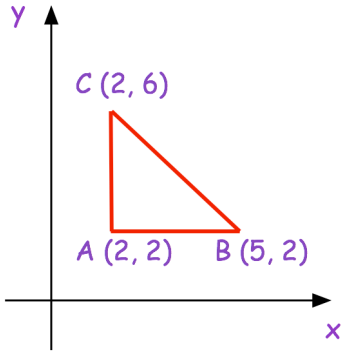
(a) Rotation 180° about the point A

(b) Enlargement by scale factor ½ with centre (2, 6)

(c) Reflection in the line $x = 5$

(d) Reflection in the line $y = x$

(e) Reflection in the line $y = 2$



Question 8: A sketch of quadrilateral ABCD is shown.

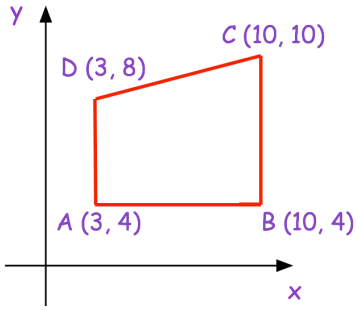
For each transformation below, write down the letter(s) of any vertices that are invariant.

(a) Reflection in the line $y = 8$

(b) Enlargement by scale factor −4 with centre A

(c) Reflection in the line $x = 3$

(d) Reflection in the line $y = x$



Apply

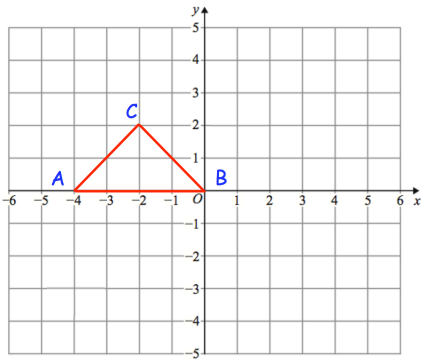
Question 1: ABC is a triangle.

Describe fully a **single** transformation of ABC so that:

(a) None of the vertices are invariant.

(b) Exactly one vertex is invariant.

(c) Exactly two vertices are invariant.



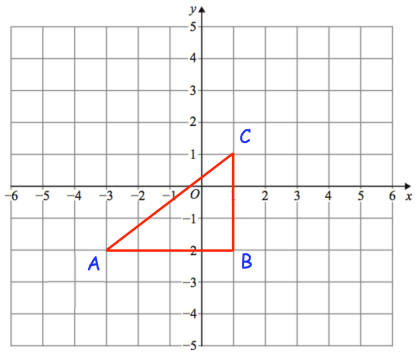
Question 2: Here is triangle ABC

Olivia says "if ABC is reflected in the line $x = -3$ there is one invariant point."

Amelia says "if ABC is reflected in the line $y = -2$ there are two invariant points."

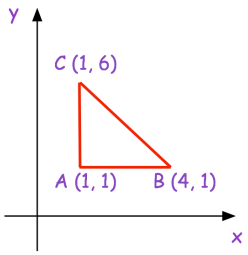
Isla says "if ABC is reflected in the line $x = 1$ there are two vertices that are invariant."

Which student is incorrect? Explain your answer.



Question 3: Here is a sketch of triangle ABC.

Describe fully a **single** transformation of ABC so that all the points on AC are invariant and the point B is not invariant.



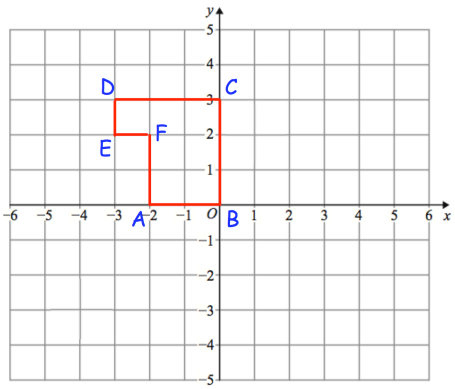
Question 4: Here is shape ABCDEF

Describe fully **single** transformations so that from the six vertices:

(a) only vertices B and C are invariant.

(b) only vertex F is invariant.

(c) only vertices B, D and F are invariant.



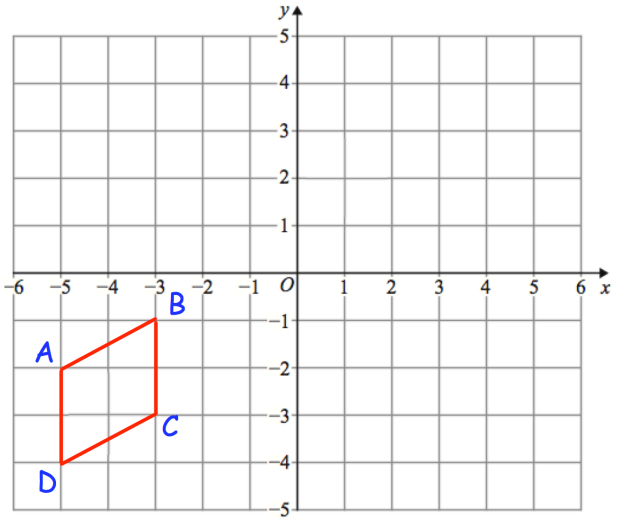
Purposeful Practice

Purposeful Practice

Question 5: Here is quadrilateral ABCD

ABCD is reflected in the line $x = -1$
followed by a reflection in the line $y = -x$
followed by a rotation of 180° about $(-1, -1)$

Which of the vertices are invariant?

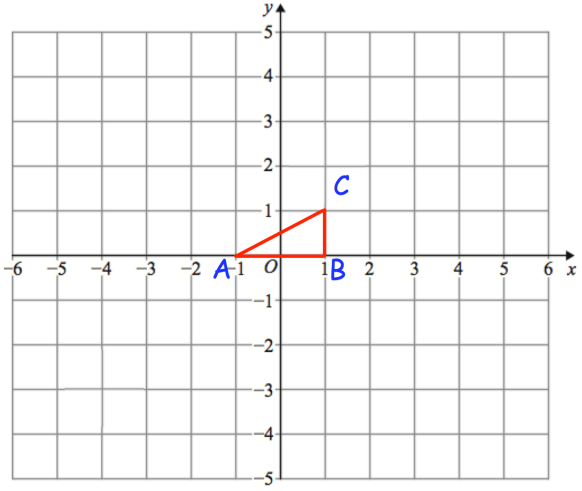


Question 6: Shown is triangle ABC

ABC is rotated 180° about $(-1, 2)$ and then

translated by the vector $\begin{pmatrix} 2 \\ -4 \end{pmatrix}$

Write down the coordinate of the invariant point.



Extra Notes