



KING EDWARD VI  
HANDSWORTH GRAMMAR  
SCHOOL FOR BOYS



KING EDWARD VI  
ACADEMY TRUST  
BIRMINGHAM

**2023**      **Year 10**      **2024**  
**Mathematics**  
**Unit 16 Booklet**

HGS Maths



Tasks



Dr Frost Course



**Name:** \_\_\_\_\_

**Class:** \_\_\_\_\_

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# 1 Recurring Decimals

## Worked Example

Express as a decimal:

a)  $\frac{2}{9}$

b)  $\frac{2}{11}$

c)  $\frac{2}{15}$

## Your Turn

Express as a decimal:

a)  $\frac{8}{9}$

b)  $\frac{8}{11}$

c)  $\frac{4}{15}$

# Activity

Fraction	Decimal	Prime Factors of Denominator	Recurring or Terminating
$\frac{1}{2}$			
$\frac{1}{3}$			
$\frac{1}{4}$			
$\frac{1}{5}$			
$\frac{1}{6}$			
$\frac{1}{7}$			
$\frac{1}{8}$			
$\frac{1}{9}$			
$\frac{1}{10}$			
$\frac{1}{11}$			
$\frac{1}{12}$			
$\frac{1}{13}$			
$\frac{1}{14}$			
$\frac{1}{15}$			
$\frac{1}{16}$			
$\frac{1}{17}$			
$\frac{1}{18}$			
$\frac{1}{19}$			
$\frac{1}{20}$			

## Activity

	Fraction	Factorised	The Law of Cancellation	Simplest Form	Factors of Denominator	Kind of Decimal
(i)	$\frac{8}{12}$					
(ii)	$\frac{3}{16}$					
(iii)	$\frac{9}{27}$					
(iv)	$\frac{12}{30}$					
(v)	$\frac{7}{32}$					
(vi)	$\frac{15}{21}$					
(vii)	$\frac{3}{10}$					
(viii)	$\frac{3}{18}$					
(ix)	$\frac{6}{33}$					
(x)	$\frac{3}{75}$					

### Worked Example

Express as a simplified fraction:

$0.\dot{4}$

### Your Turn

Express as a simplified fraction:

$0.\dot{7}$

### Worked Example

Express as a simplified fraction:

$0.\dot{5}\dot{4}$

### Your Turn

Express as a simplified fraction:

$0.\dot{2}\dot{7}$



**Worked Example**

Express as a simplified fraction:

$0.\dot{2}7\dot{9}$

**Your Turn**

Express as a simplified fraction:

$0.\dot{8}3\dot{7}$

### Worked Example

Express as a simplified fraction:

$0.\overline{789}$

### Your Turn

Express as a simplified fraction:

$0.5\overline{79}$

**Worked Example**

Express as a simplified fraction:

$3.\overline{7654}$

**Your Turn**

Express as a simplified fraction:

$7.\overline{5309}$

## Fill in the Gaps

$x$ as recurring decimal	Write out multiples of $x$	Subtract	$x$ as a fraction
$x = 0.\dot{7}$	$10x = 7.\dot{7} = 7.77777 \dots$ $x = 0.\dot{7} = 0.77777 \dots$	$9x = 7$	$x = \frac{7}{9}$
$x = 0.\dot{2}$	$10x =$ $x =$		
$x = 0.\dot{3}\dot{5}$	$100x = 35.\dot{3}\dot{5} = 35.3535 \dots$ $x = 0.\dot{3}\dot{5} = 0.3535 \dots$	$99x = 35$	
$x = 0.\dot{4}\dot{1}$	$100x =$ $x =$		
$x = 0.\dot{2}\dot{7}$			
$x = 0.\dot{6}\dot{1}\dot{3}$	$1000x =$		
$x = 0.0\dot{2}$	$100x = 2.\dot{2} = 2.22222 \dots$ $10x =$		
$x = 0.1\dot{4}\dot{3}$			
$x = 0.9\dot{3}\dot{2}$			
$x = 0.9\dot{3}\dot{2}$			
$x = 0.0\dot{0}\dot{5}$			

### Worked Example

Write the fraction  $0.1\dot{3}\dot{6} \times 0.\dot{5}$  as a fraction in its simplest form

### Your Turn

Write the fraction  $0.6\dot{8}\dot{1} \times 0.\dot{1}$  as a fraction in its simplest form

## Extra Notes

## 2 Parallel and Perpendicular Lines

### Worked Example

- a) Write down the equation of a line parallel to  $y = 2x - 3$
- b) Write down the equation of the line that is parallel to  $y = 6x + 1$  and passes through  $(0, 8)$

### Your Turn

- a) Write down the equation of a line parallel to  $y = -2x + 3$
- b) Write down the equation of the line that is parallel to  $y = -6x - 1$  and passes through  $(0, -8)$



### Worked Example

Write down the equation parallel to  $y = 4x + 1$  which passes through  $(2, 17)$

### Your Turn

Write down the equation parallel to  $y = 8x + 5$  which passes through  $(2, 26)$

### Worked Example

Find the equation of the line parallel to  $y = -\frac{1}{3}x - 4$  that passes through  $(-2, 5)$

### Your Turn

Find the equation of the line parallel to  $y = -\frac{1}{2}x - 3$  that passes through  $(-2, 5)$

## Worked Example

Write the negative reciprocals of:

a) 6

b)  $\frac{1}{6}$

c)  $\frac{5}{6}$

## Your Turn

Write the negative reciprocals of:

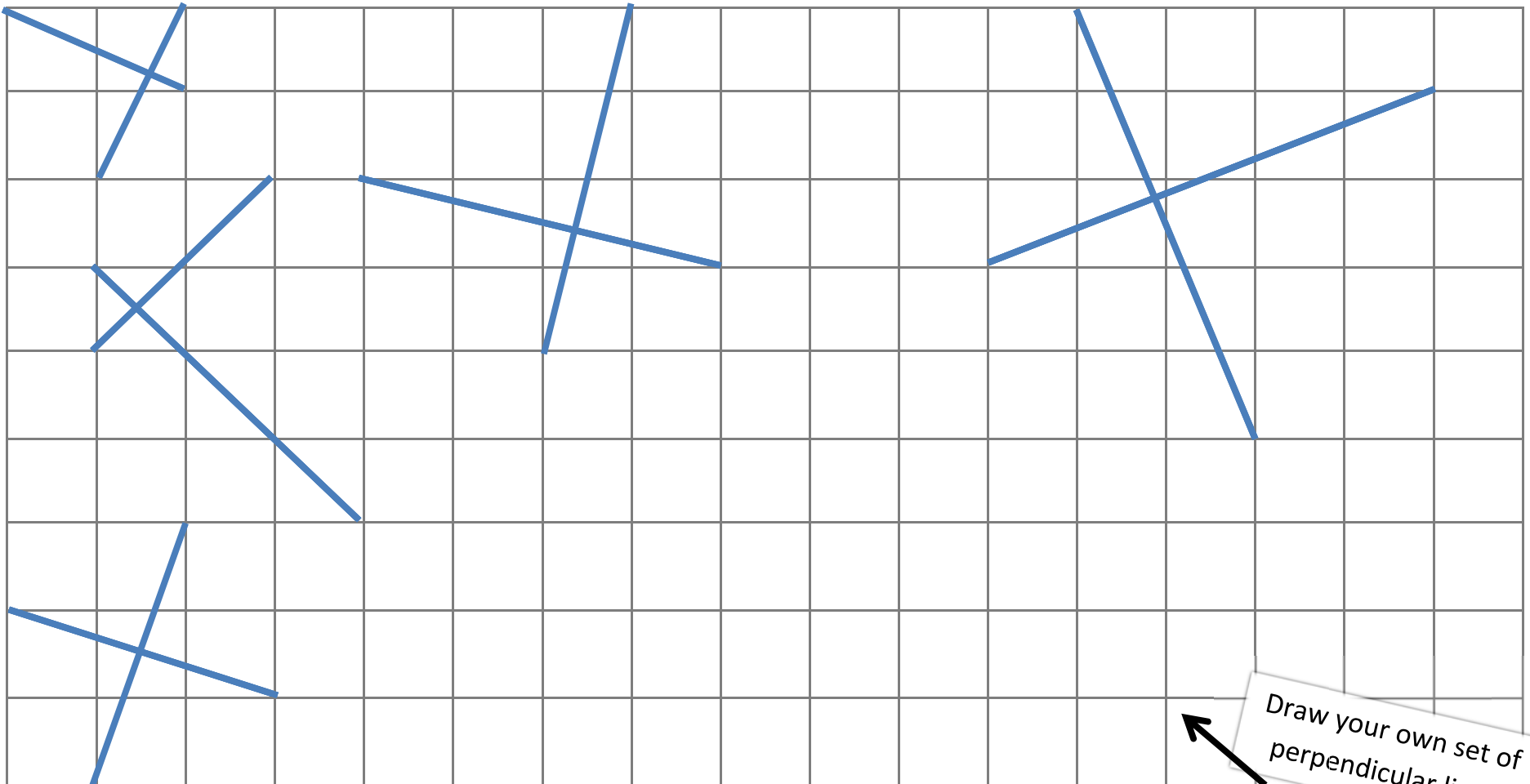
a) 7

b)  $\frac{1}{7}$

c)  $\frac{2}{7}$

# Fluency Practice

Calculate the gradient of each of these pairs of perpendicular lines. Simplify your answers. What do you notice?



Draw your own set of perpendicular lines

### Worked Example

- a) Write down the equation of a line perpendicular to  $y = 2x - 3$
- b) Write down the equation of the line that is perpendicular to  $y = \frac{1}{2}x + 3$  and passes through  $(0, -1)$

### Your Turn

- a) Write down the equation of a line perpendicular to  $y = -2x + 3$
- b) Write down the equation of the line that is perpendicular to  $y = -\frac{1}{2}x + 3$  and passes through  $(0, 1)$

### Worked Example

Write down the equation perpendicular to  $y = 4x + 1$  which passes through  $(8, 17)$

### Your Turn

Write down the equation perpendicular to  $y = 8x + 5$  which passes through  $(16, 26)$

### Worked Example

Find the equation of the line perpendicular to  $y = \frac{1}{2}x - 4$  that passes through  $(-2, 5)$

### Your Turn

Find the equation of the line perpendicular to  $y = -\frac{4}{3}x + 3$  that passes through  $(-12, -5)$

### Worked Example

Find the equation of the line perpendicular to  $3x + 2y = 5$  which passes through the point  $(3, 7)$

### Your Turn

Find the equation of the line perpendicular to  $2x + 3y = 5$  which passes through the point  $(4, 7)$



**Worked Example**

Find the midpoint of the line segment between  $(-2,4)$  and  $(-9,9)$

**Your Turn**

Find the midpoint of the line segment between  $(2, -4)$  and  $(11,8)$

### Worked Example

$A$  is the point  $(3, 8)$   
 $B$  is the point  $(1, -2)$   
 $C$  is the midpoint of  $AB$

Find the equation of the line perpendicular to  $AB$  which passes through  $C$

### Your Turn

$A$  is the point  $(3, 8)$   
 $B$  is the point  $(1, 4)$   
 $C$  is the midpoint of  $AB$

Find the equation of the line perpendicular to  $AB$  which passes through  $C$

## Worked Example

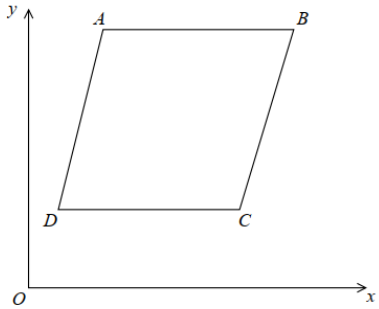
ABCD is a rhombus.

A has coordinates (5, 10)

The equation of  $DB$  is

$$y = \frac{1}{2}x + 5$$

Find an equation of diagonal  $AC$



## Your Turn

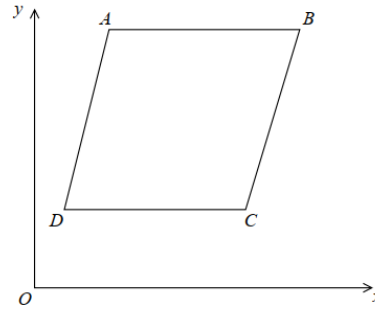
ABCD is a rhombus.

A has coordinates (5, 11)

The equation of  $DB$  is

$$y = \frac{1}{2}x + 6$$

Find an equation of diagonal  $AC$



## Fill in the Gaps

Equation	Point on the Line (1)	Point on the Line (2)	Gradient	y intercept	The parallel line that goes through (2, 5)	Gradient of all perpendicular lines
$y = 2x + 8$						
$y = 4x - 1$						
	(1, 5)	(3, 11)				
	(5, 9)	(8, 12)				
	(4, 6)	(6, 2)				
	(4, 3)		-3			
	(2, 9)		6			
	(-1, 2)		3			
	(2, 10)			(0, 4)		
	(3, 11)				$y = 5x - 5$	
	(4, 3)					-2

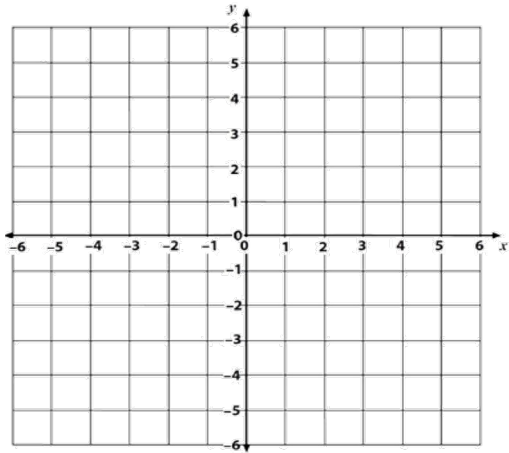
## Extra Notes

## 3 Graphical Inequalities

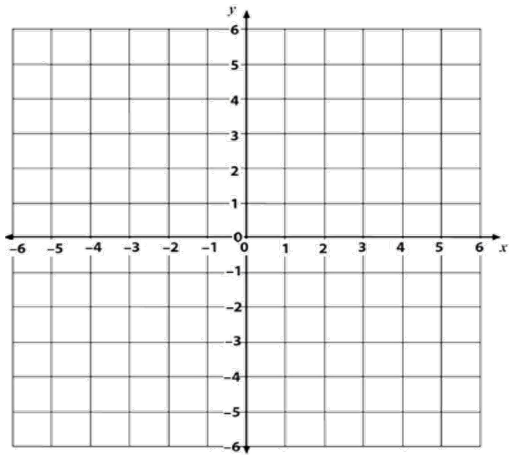
## Worked Example

Shade the region which satisfies the inequality:

a)  $x > 3$



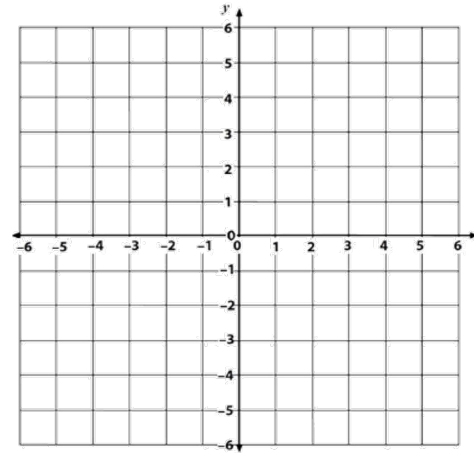
b)  $y \leq -2$



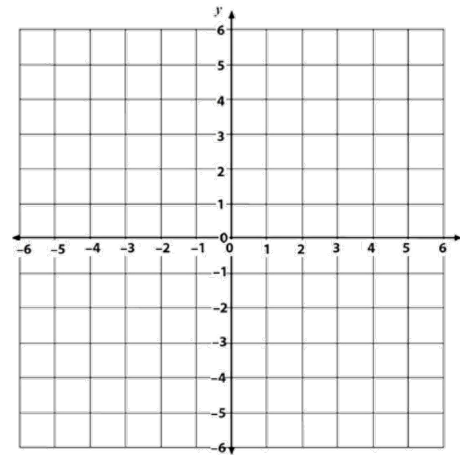
## Your Turn

Shade the region which satisfies the inequality:

a)  $x < 5$



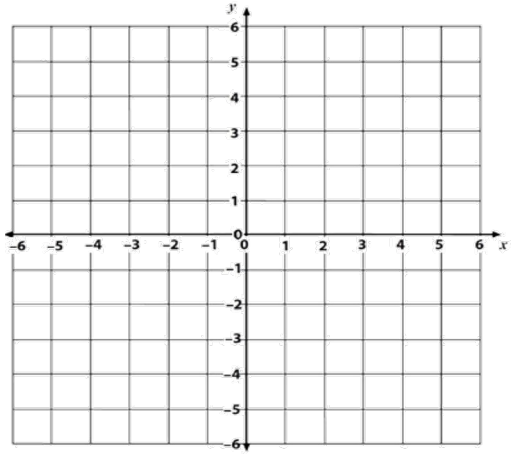
b)  $y \geq -4$



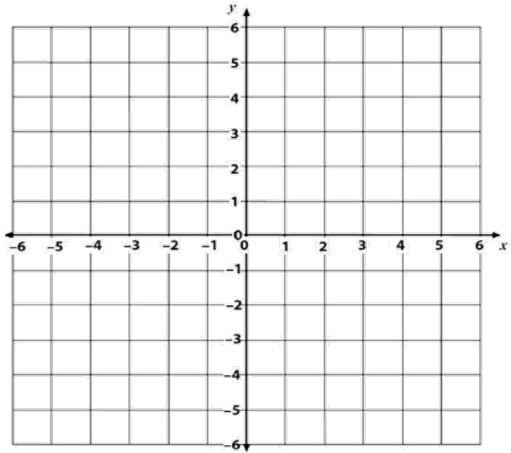
## Worked Example

Shade the region which satisfies the inequality:

a)  $-2 \leq x < 5$



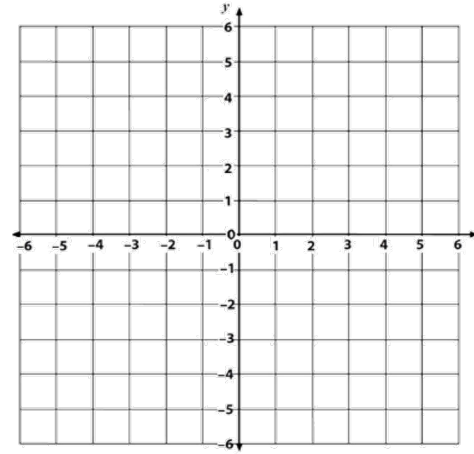
b)  $-2 \leq y < 5$



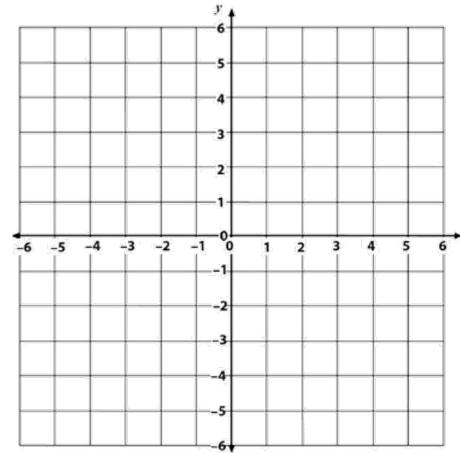
## Your Turn

Shade the region which satisfies the inequality:

a)  $-4 < x \leq 3$



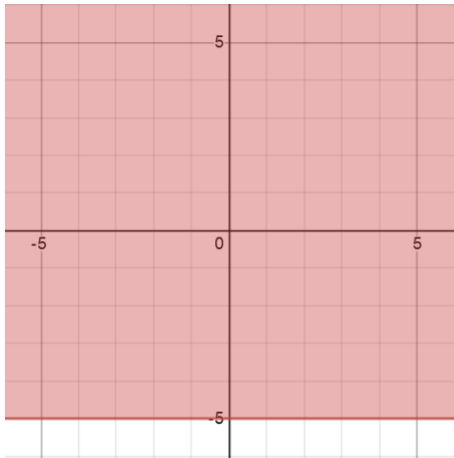
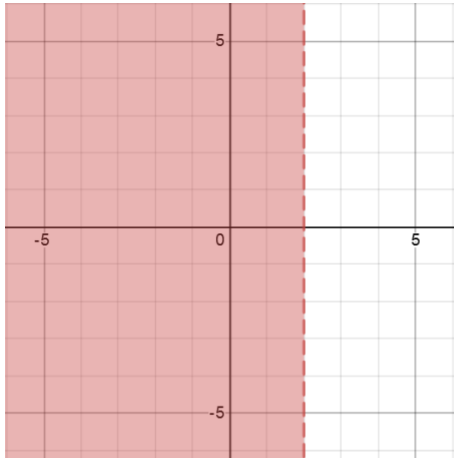
b)  $-4 < y \leq 3$





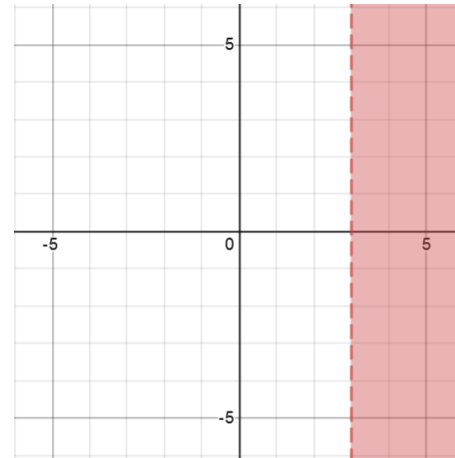
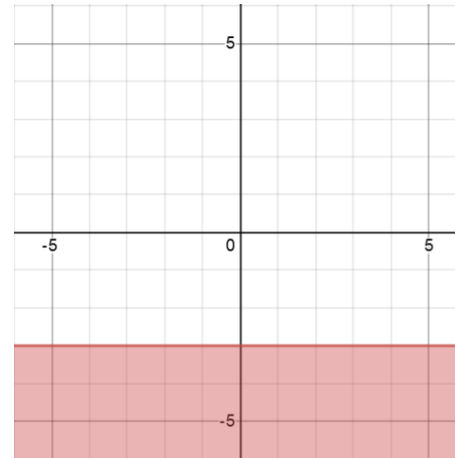
## Worked Example

Write the inequality that defines the red region:



## Your Turn

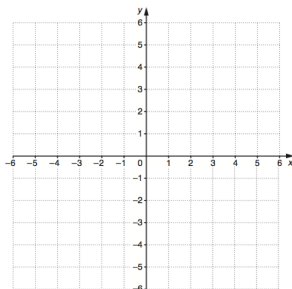
Write the inequality that defines the red region:



# Fluency Practice

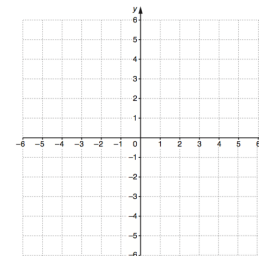
Question 1: On copies of the grid below, clearly indicate the region that satisfies each inequality.

- (a)  $x > 2$     (b)  $x < 4$     (c)  $x \leq -1$     (d)  $x > 0$   
 (e)  $x \geq -3$     (f)  $y < 1$     (g)  $y \geq -2$     (h)  $y \leq 4$   
 (i)  $y > 2$     (j)  $x \geq 3$     (k)  $y < 0$     (l)  $x < -5$

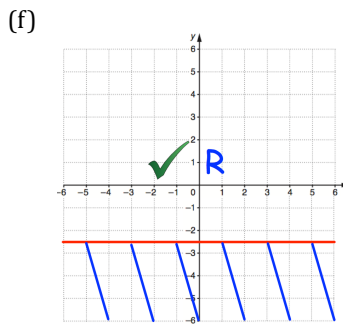
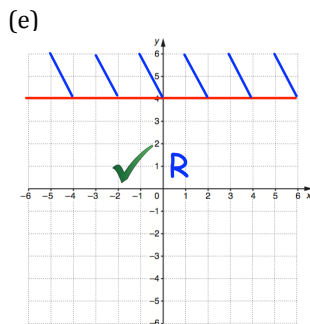
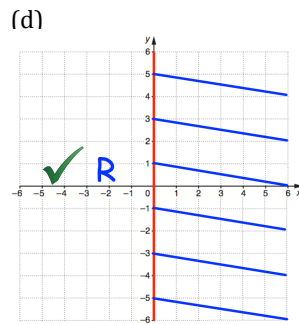
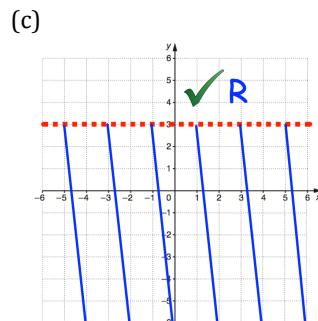
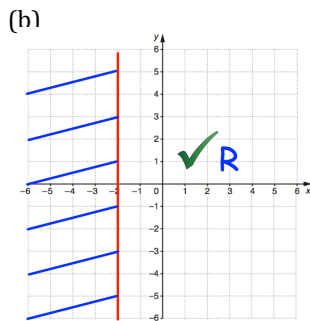
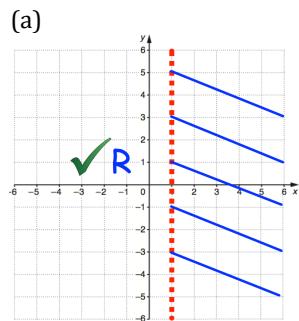


Question 3: On copies of the grid below, clearly indicate the region that satisfies each inequality.

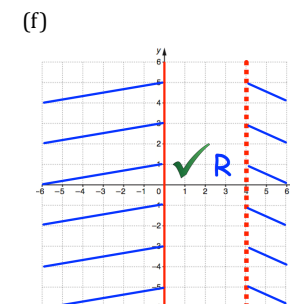
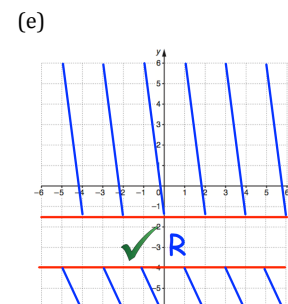
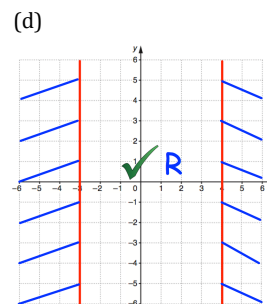
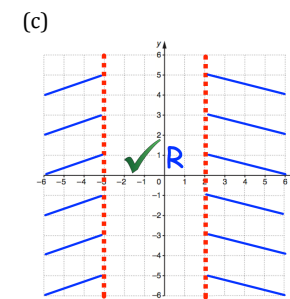
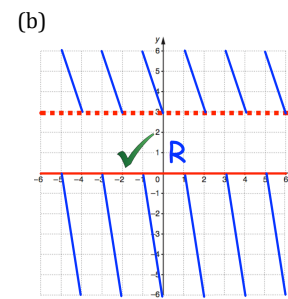
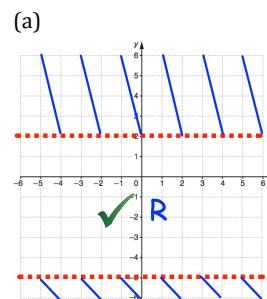
- (a)  $-4 < x < 1$     (b)  $0 \leq x \leq 5$     (c)  $-3 \leq x < 3$   
 (d)  $-5 \leq y \leq -2$     (e)  $-1 < y < 4$     (f)  $-1 < y \leq 2.5$   
 (g)  $-2 < x \leq 3$     (h)  $-4 \leq y \leq 2$     (i)  $-2 \leq y < 2$



Question 2: Write down the inequality represented in each diagram below.



Question 4: Write down the inequality represented in each diagram below.

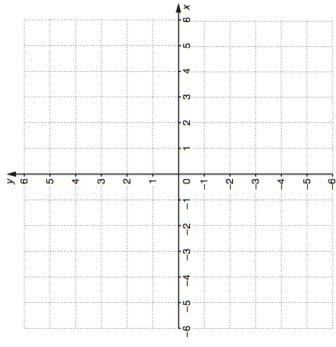


Question 5: On a grid, clearly indicate the region that satisfies the following inequalities.

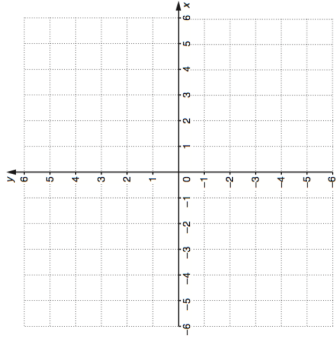
- (a)  $-2 < x < 3$  and  $y \geq -1$     (b)  $-5 \leq y \leq 1$  and  $x < 3$     (c)  $1 < x \leq 3$  and  $-2 \leq y < 0$

# Templates

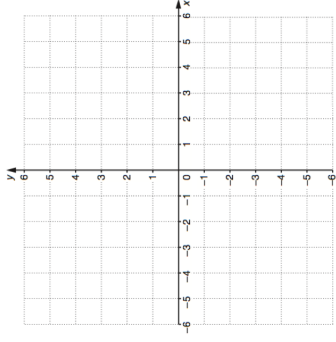
Question 1(a)



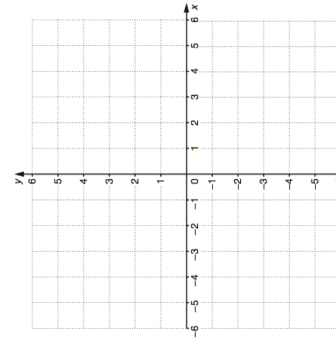
1(b)



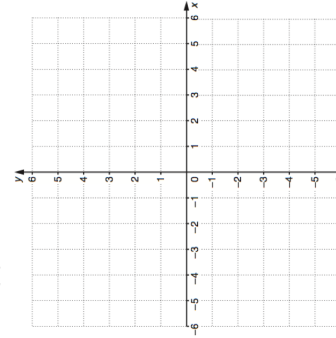
1(c)



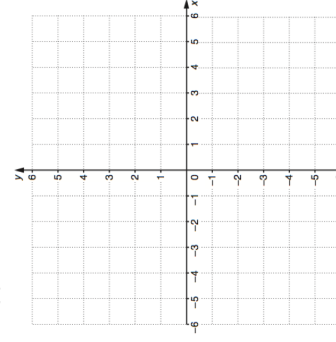
Question 1(d)



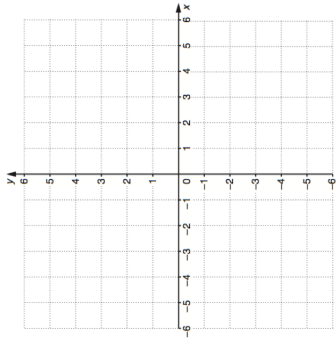
1(e)



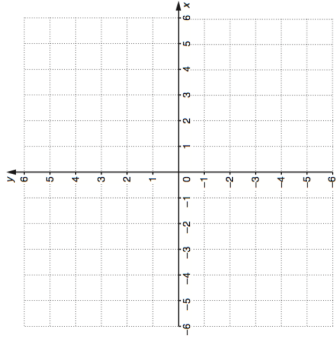
1(f)



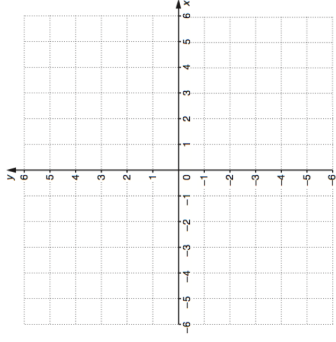
Question 1(g)



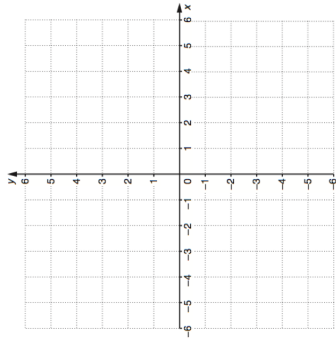
1(h)



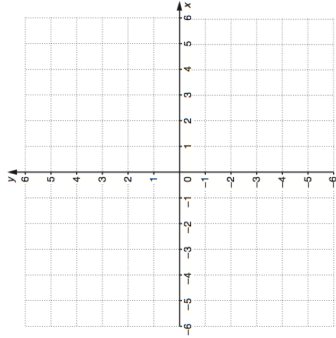
1(i)



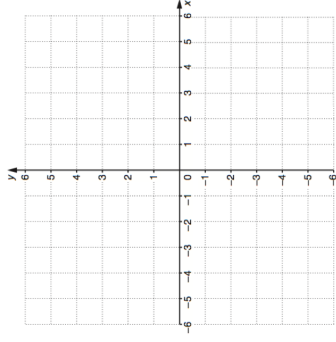
Question 1(j)



1(k)

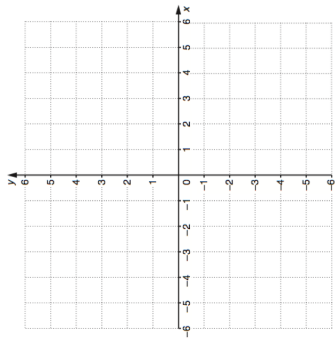


1(l)

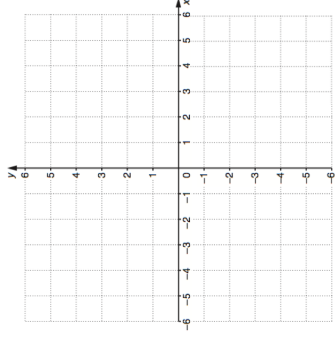


# Templates

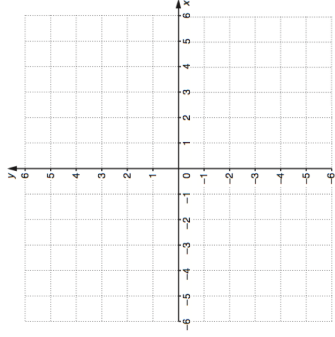
Question 3(a)



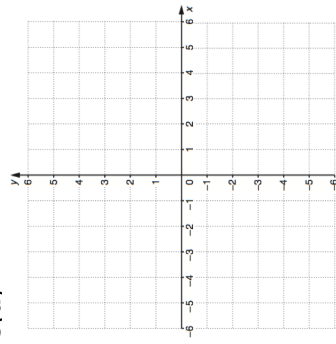
3(b)



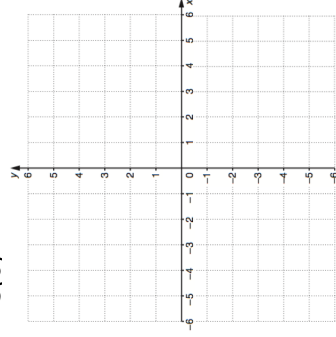
3(c)



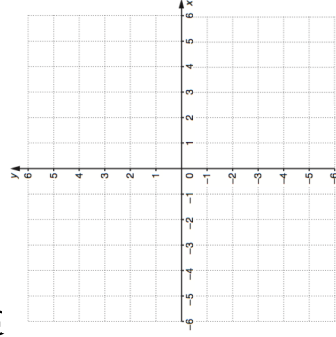
3(d)



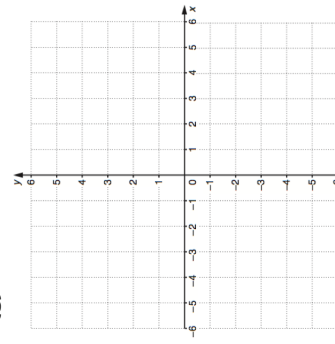
3(e)



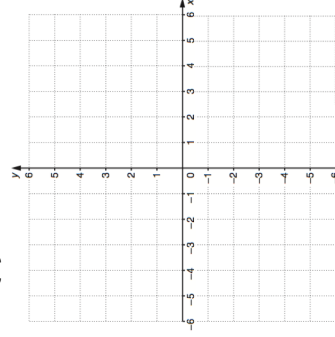
3(f)



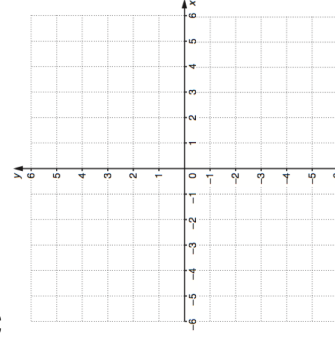
3(g)



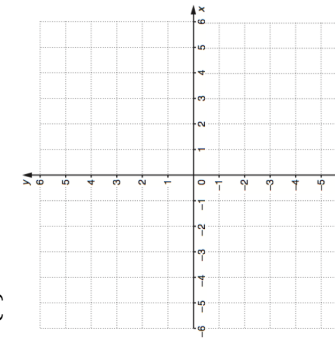
3(h)



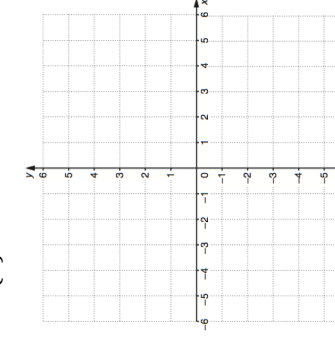
3(i)



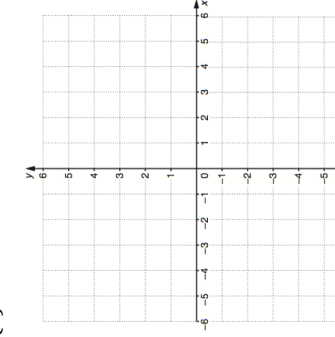
5(a)



5(b)

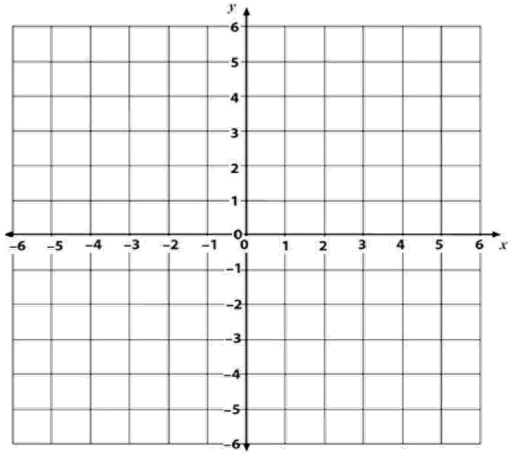


5(c)

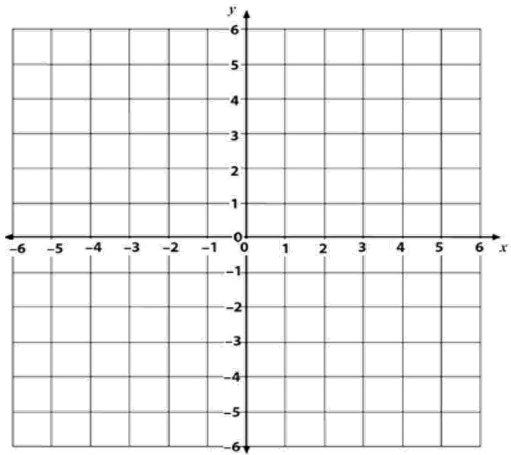


## Worked Example

Shade the region which satisfies the inequality:  
 $y > 2x + 3$

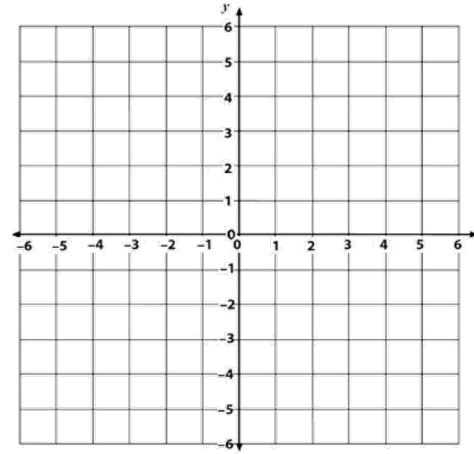


$y < -2x + 3$

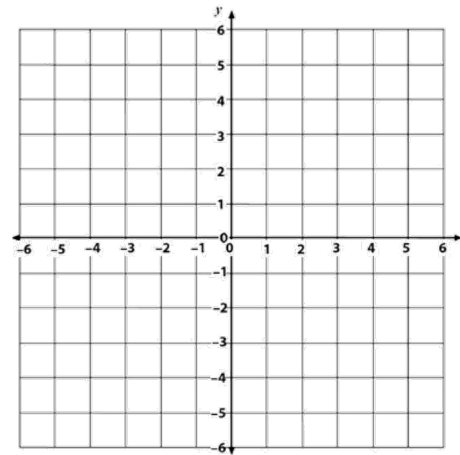


## Your Turn

Shade the region which satisfies the inequality:  
 $y < 4x - 1$

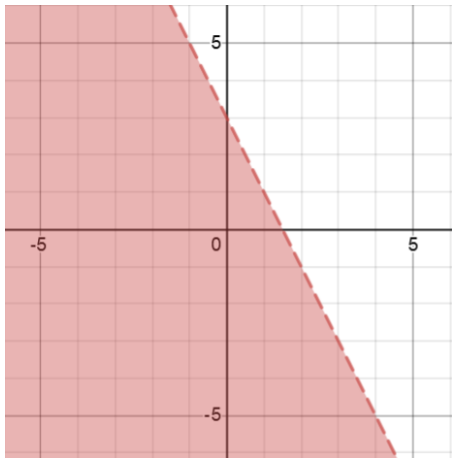
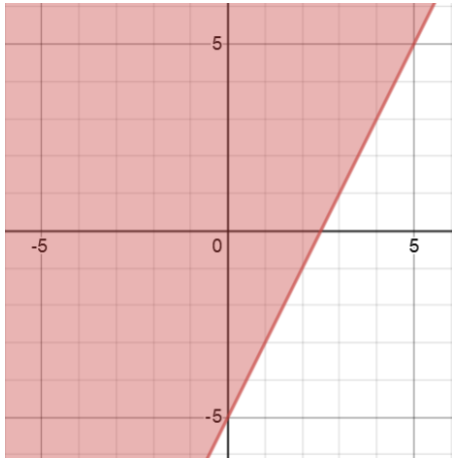


$y > -4x - 1$



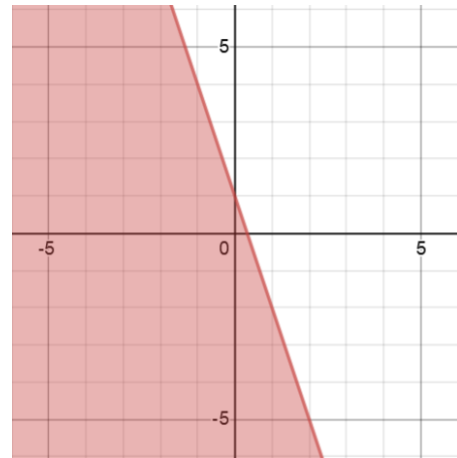
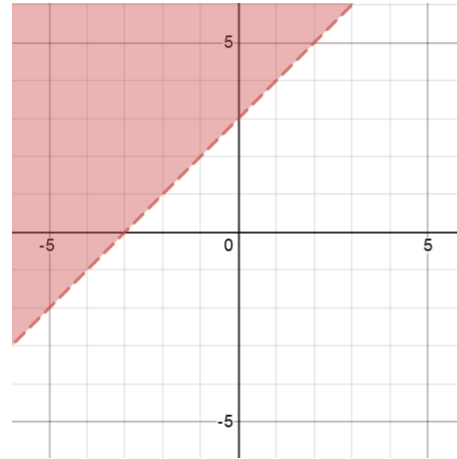
## Worked Example

Write the inequality that defines the red region:



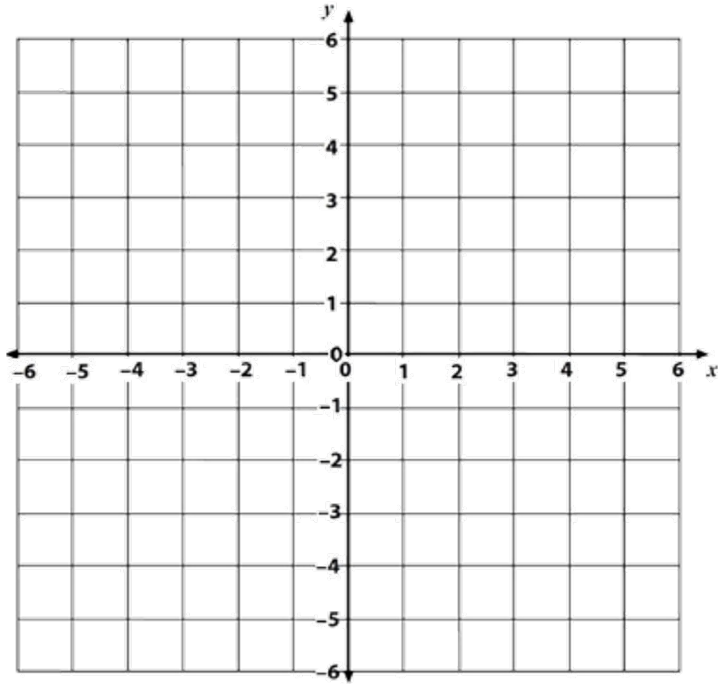
## Your Turn

Write the inequality that defines the red region:



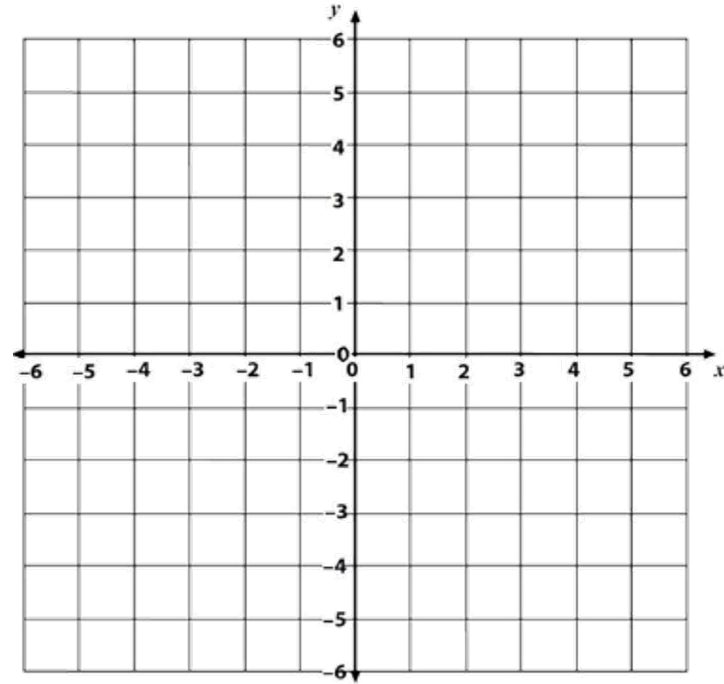
## Worked Example

Shade the region which satisfies the inequalities. Label it R.  
 $x \leq 3$ ,  $y > 1$  and  $y \geq x + 3$



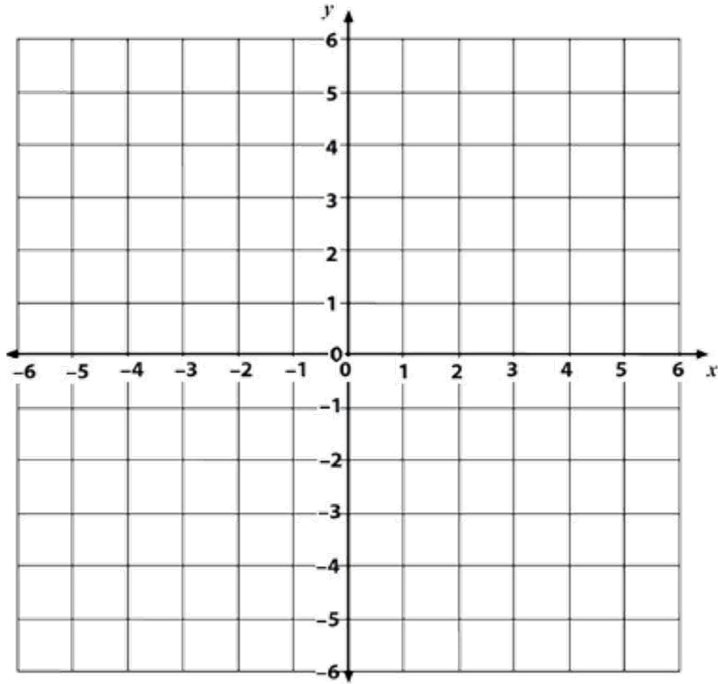
## Your Turn

Shade the region which satisfies the inequalities. Label it R.  
 $x < 4$ ,  $y \geq 3$ ,  $y \geq x + 2$



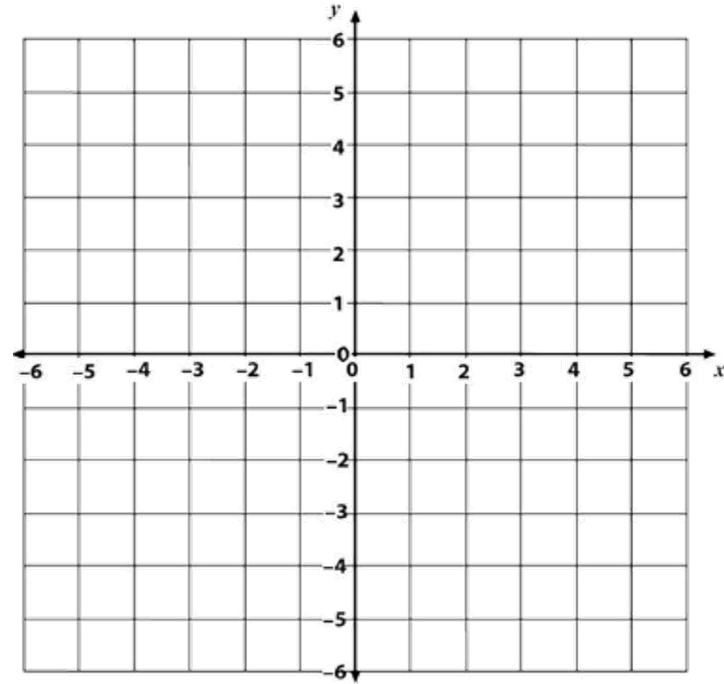
## Worked Example

Shade the region which satisfies the inequalities. Label it R.  
 $x \geq 2, y > -1$  and  $x + y \leq 5$



## Your Turn

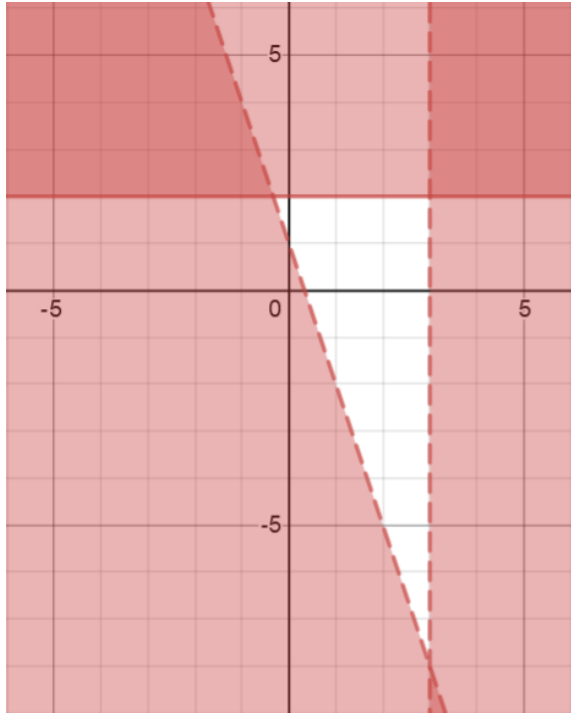
Shade the region which satisfies the inequalities. Label it R.  
 $x \geq 2, y > 1$  and  $x + y \leq 6$





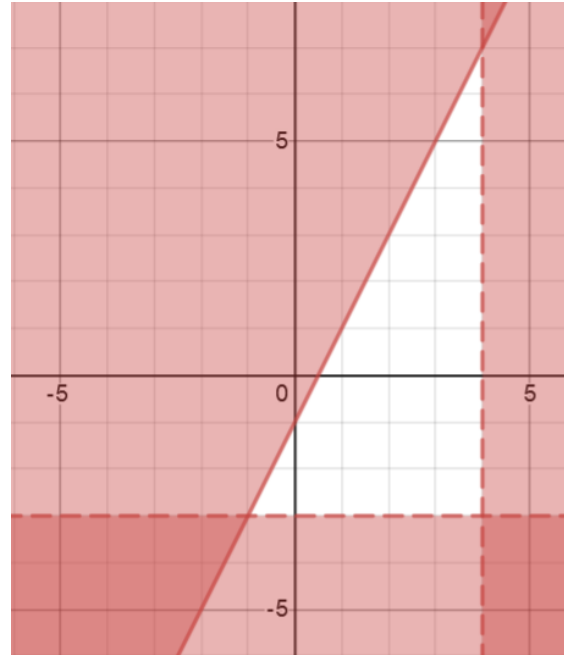
## Worked Example

Write the inequalities that define the unshaded region:



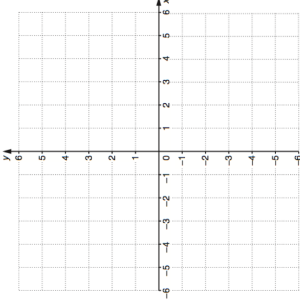
## Your Turn

Write the inequalities that define the unshaded region:



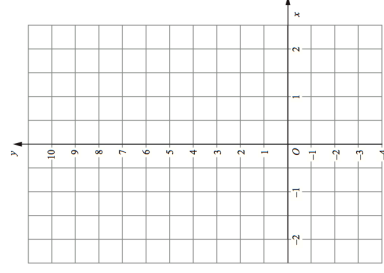
# Fluency Practice

Question 1: On copies of the grid below, clearly indicate the region that satisfies each inequality.



- (a)  $y < x + 1$       (b)  $y \leq 2x + 2$       (c)  $y > 3x - 1$
- (d)  $y \geq x + 3$       (e)  $y > 2x$       (f)  $y \leq 4x$
- (g)  $y < -2x + 1$       (h)  $y \geq \frac{1}{2}x + 2$       (i)  $x + y < 4$

Question 2: On copies of the grid below, clearly indicate the region that satisfies each inequality.



- (a)  $y > 3x + 4$       (b)  $y \geq 5x - 1$
- (c)  $y \leq 4x + 1$       (d)  $y < -2x + 5$
- (e)  $x + y < 2$       (f)  $y > -x - 2$
- (g)  $y \geq 5 - 2x$       (h)  $x + y \geq 7$
- (i)  $3x + y > 3$       (j)  $5x + 2y > 4$

Question 3: Write down the inequality represented in each diagram below.

(a)

(b)

(c)

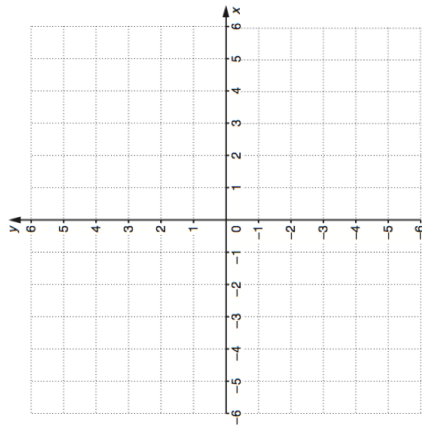
(d)

(e)

(f)

# Fluency Practice

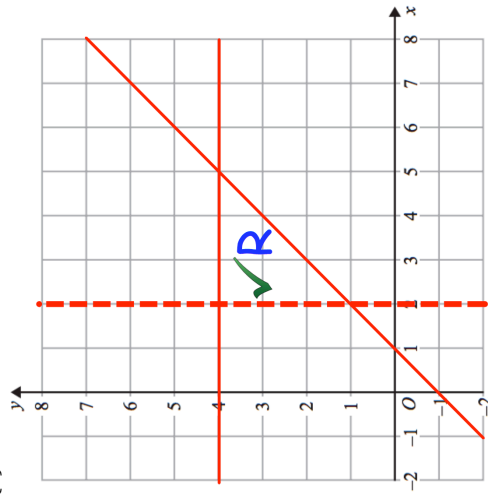
Question 4: On copies of the grid below, clearly indicate the region that satisfies the following inequalities.



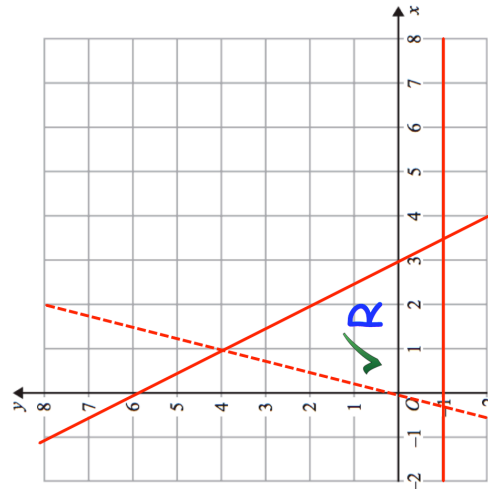
- (a)  $y > x - 1$ ,  $x \geq -2$  and  $y < 2$
- (b)  $y \leq 2x$ ,  $x \leq 2$  and  $y > -4$
- (c)  $y \leq -2x + 2$ ,  $x \geq 0$  and  $y > x - 4$
- (d)  $x + y < 3$ ,  $-2 \leq x < 3$  and  $y \geq 0$
- (e)  $y \leq 5x - 4$ ,  $y > x - 4$  and  $y \leq -\frac{1}{2}x + 2$
- (f)  $y \leq -2x + 4$ ,  $y < 2x - 6$  and  $-4 < y < -3$

Question 5: State the inequalities that the region labelled R satisfies.

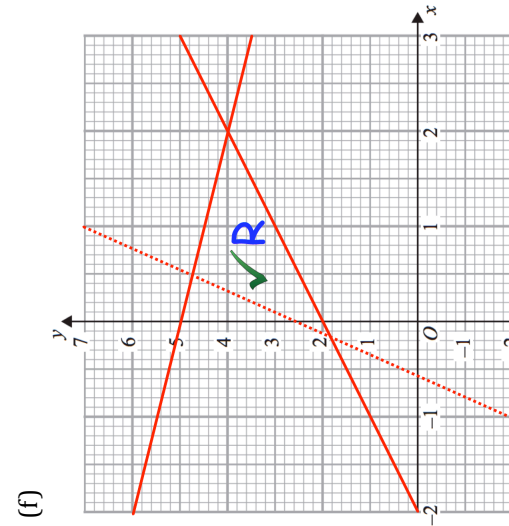
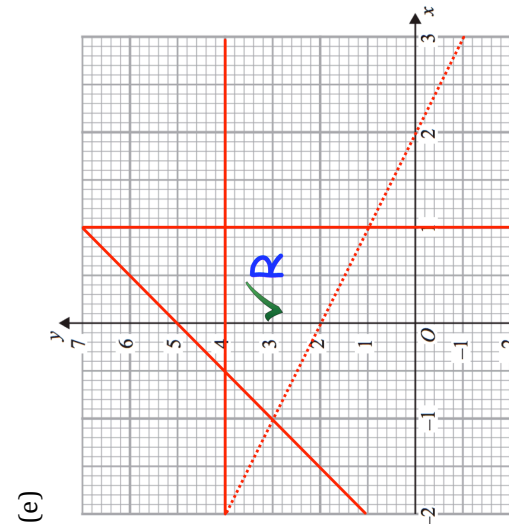
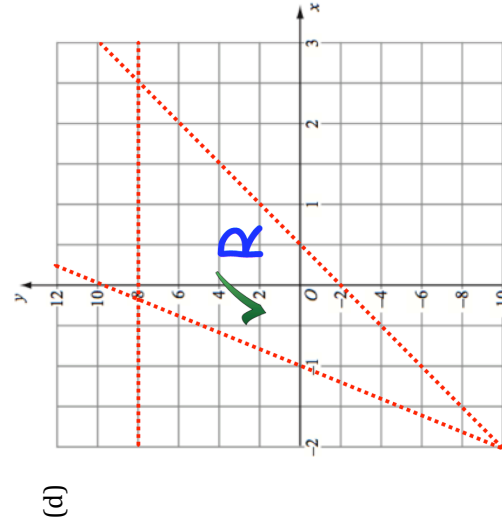
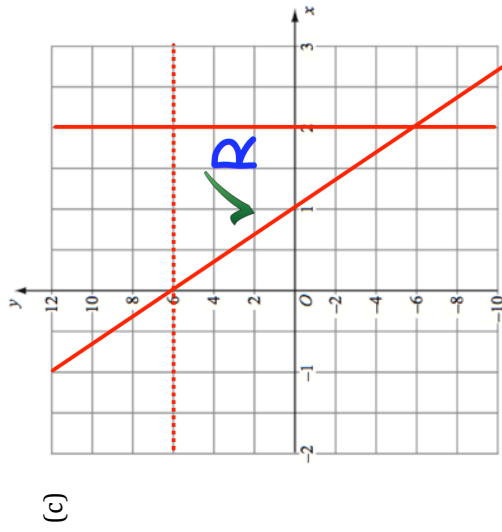
(a)



(b)

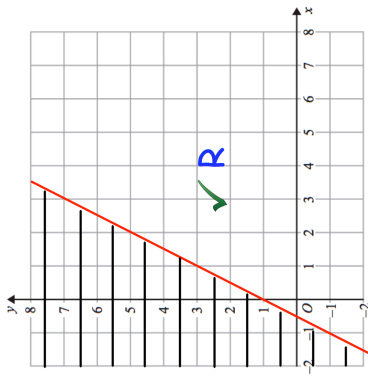


# Fluency Practice

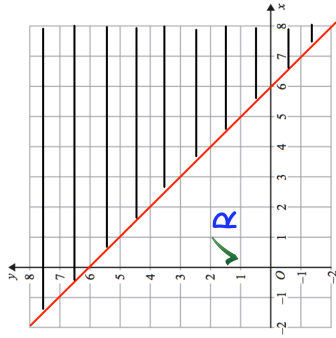


## Extension

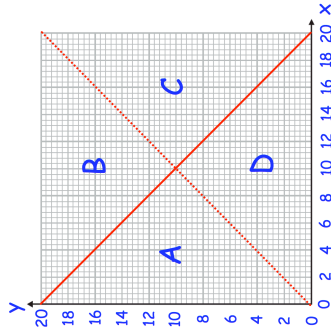
Question 1: Taylor has been asked to represent graphically  $y \geq 2x + 1$   
Can you spot her mistake?



Question 2: Conor has been asked to represent graphically  $x + y < 6$   
Can you spot his mistake?



Question 3: At a fitness class, the maximum number of people who can attend is 20.  
There are more men than women that attend the fitness class.  
 $y$  = number of men that attend the fitness class.  
 $x$  = number of women that attend the fitness class.  
Which region A, B, C or D represents the information above?

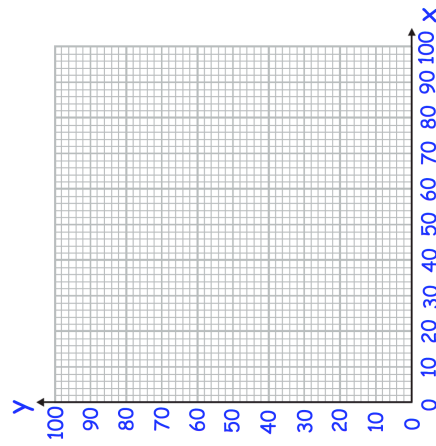


Question 4: A greengrocer sells apples and oranges.

One morning day he sells  
up to 50 apples  
up to 60 oranges  
no more than a total of 90 pieces of fruit.

Let  $x$  be the number of apples sold.  
Let  $y$  be the number of orange sold.

Show the region that satisfies these inequalities



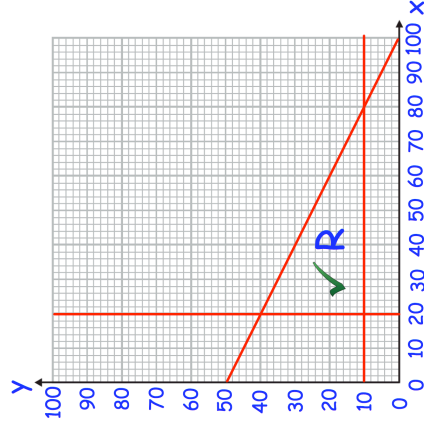
## Extension

Question 5: The region below shows information about the number first class passengers and the number of economy passengers on a flight.

$x$  = number of economy passengers and  $y$  = number of first class passengers

- (a) Can 15 first class and 60 economy passengers be on the flight?  
 (b) Can 30 economy and 40 first class passenger be on the flight?

The profit made by the airline for each economy passenger is £90 and for each first class passenger is £200.



(c) What is the maximum profit the airline can make on one flight?

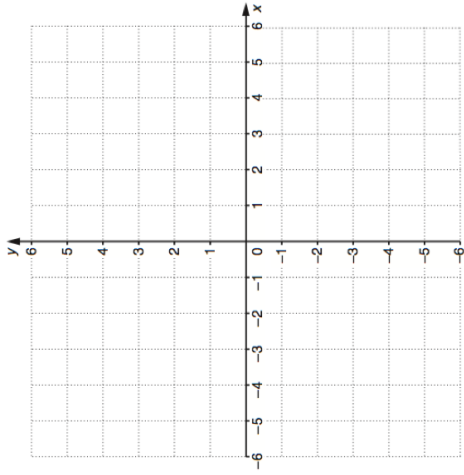
Question 6: A football stadium holds a maximum of 1000 fans.  
 Adult tickets cost £5 each and child tickets cost £2 each.  
 The football club needs to raise at least £3000 to cover costs.  
 The football club aims to sell at least one child ticket for two adult tickets sold  
 Let  $x$  = number of child tickets sold and  $y$  = number of adult tickets sold

Explain why: (a)  $x + y \leq 1000$       (b)  $2x + 5y \geq 3000$       (c)  $y \leq 2x$

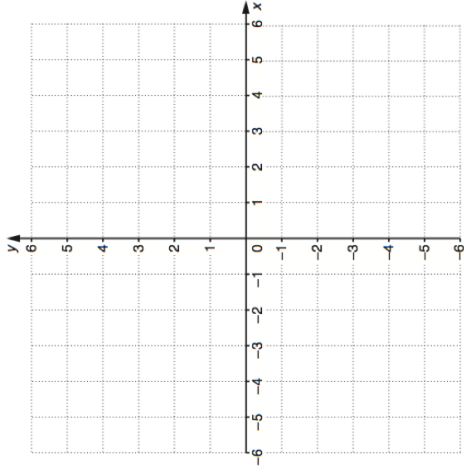
(d) Represent this information on a graph.

# Templates

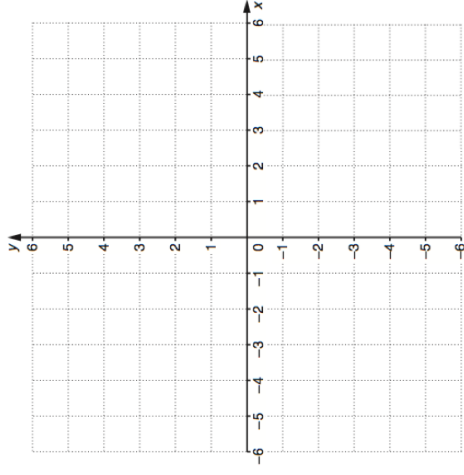
1(a)



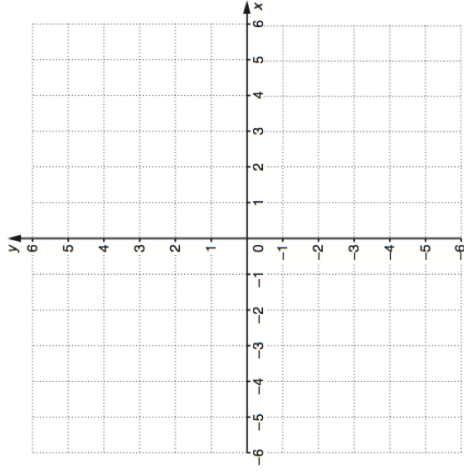
1(b)



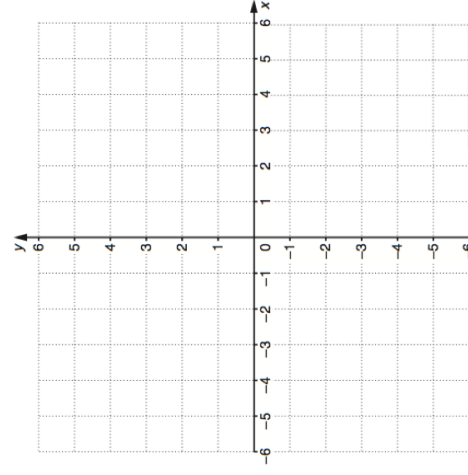
1(c)



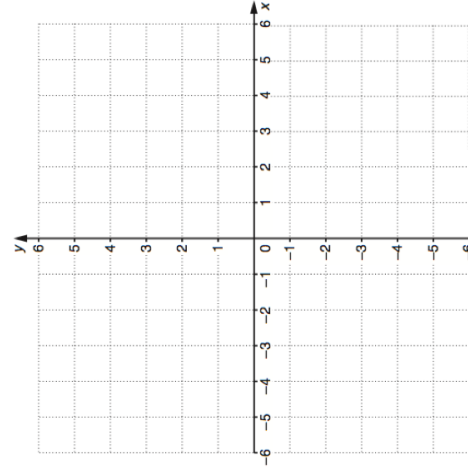
1(d)



1(e)

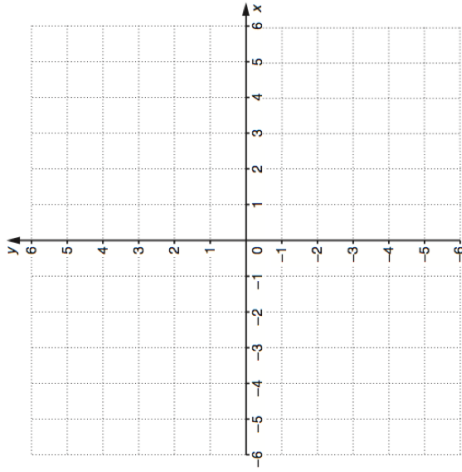


1(f)

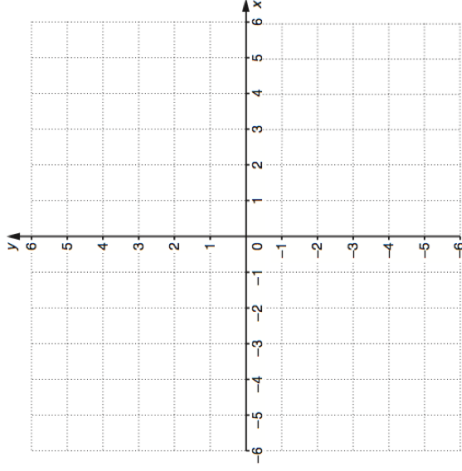


# Templates

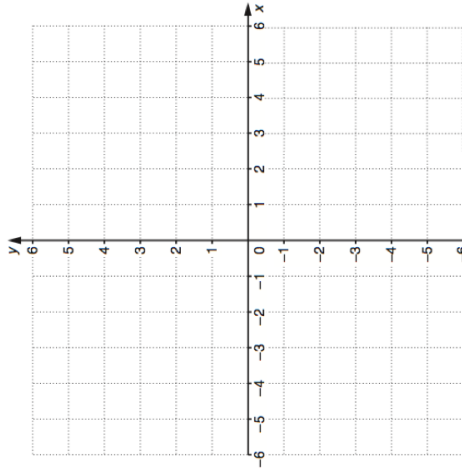
1(g)



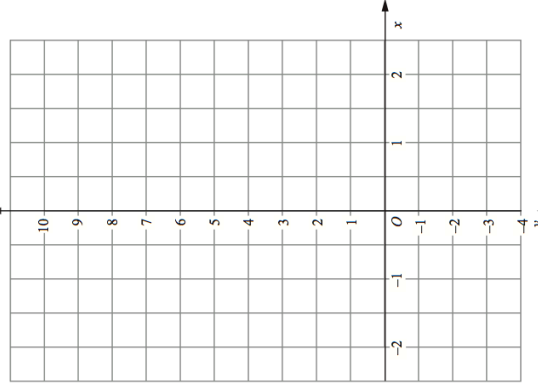
1(h)



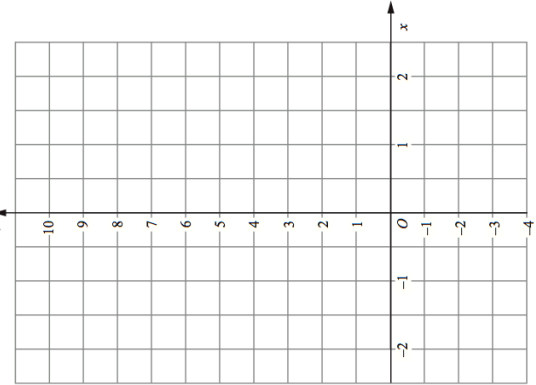
1(f)



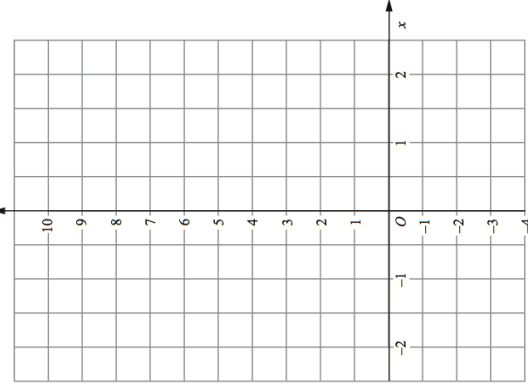
2(a)



2(b)



2(c)

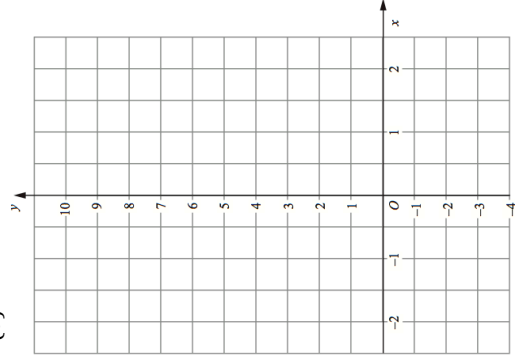


© COI

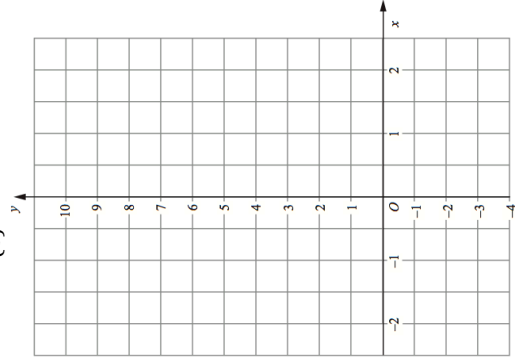


# Templates

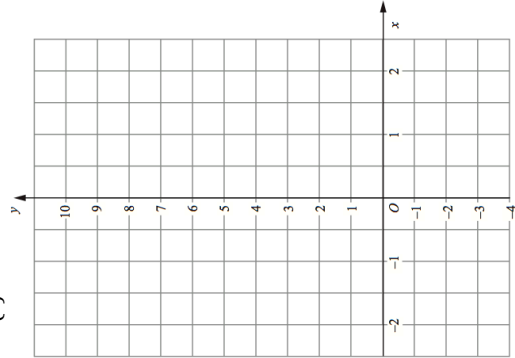
2(d)



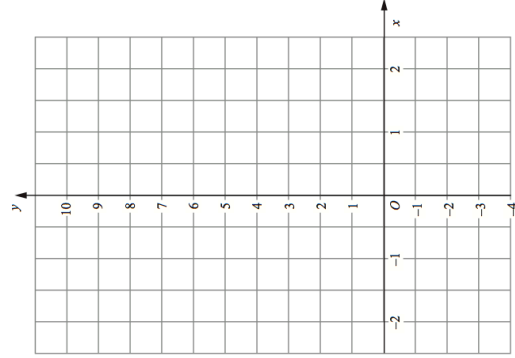
2(e)



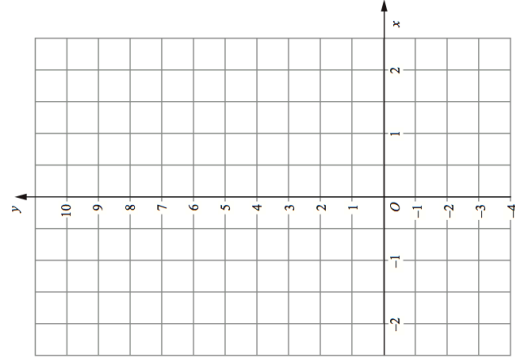
2(f)



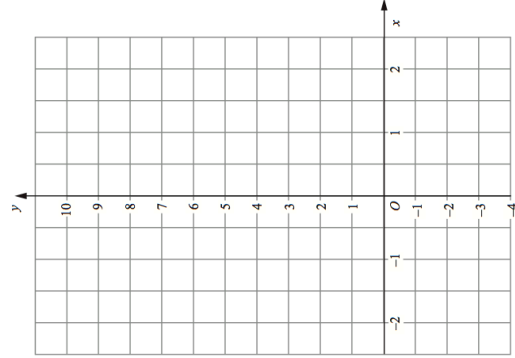
2(g)



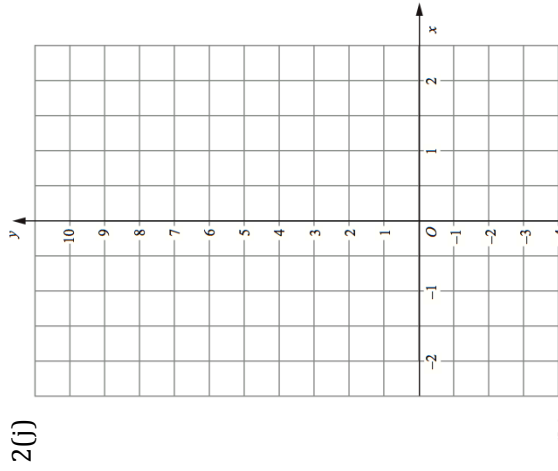
2(h)



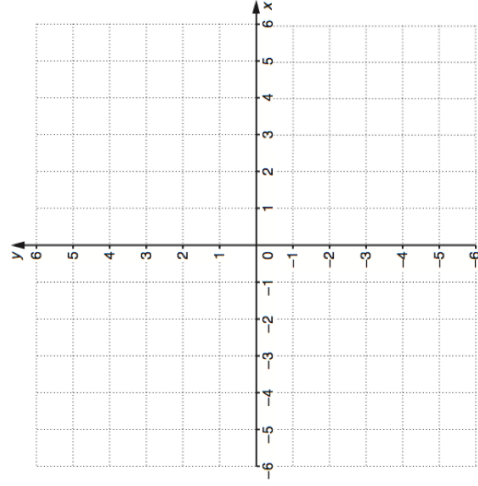
2(i)



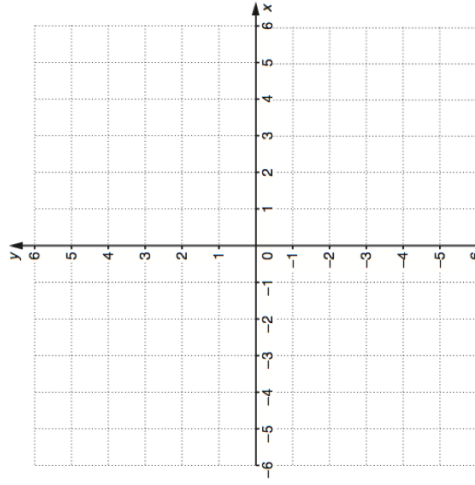
# Templates



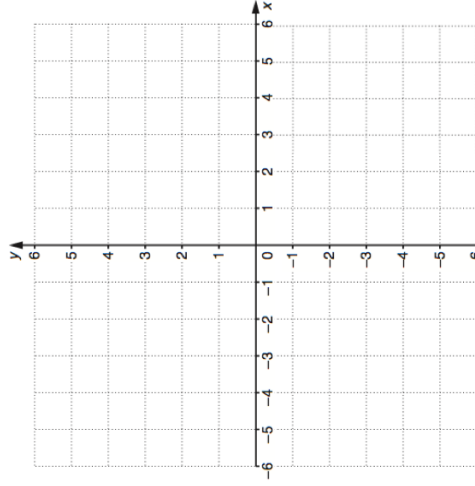
3(a)



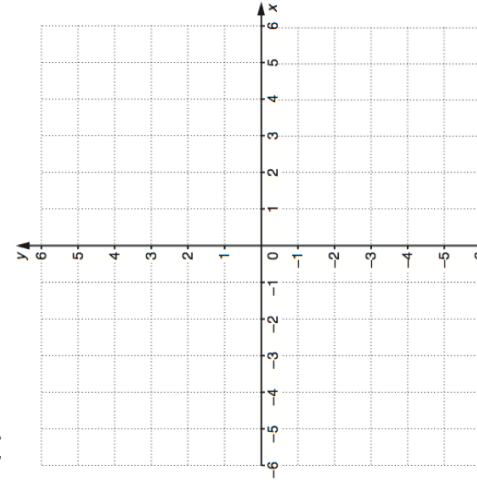
3(b)



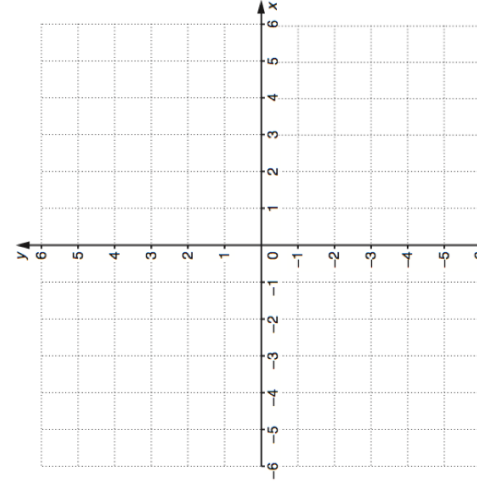
3(c)



3(d)

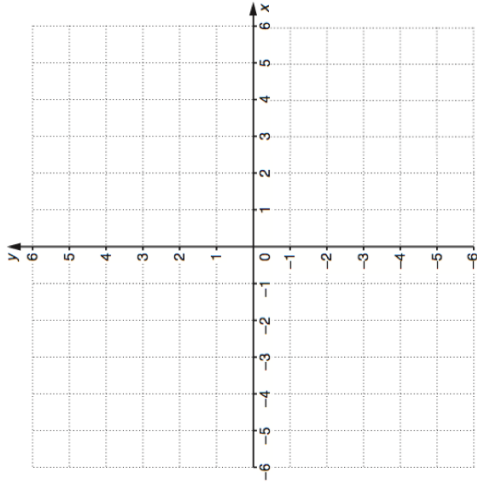


3(e)

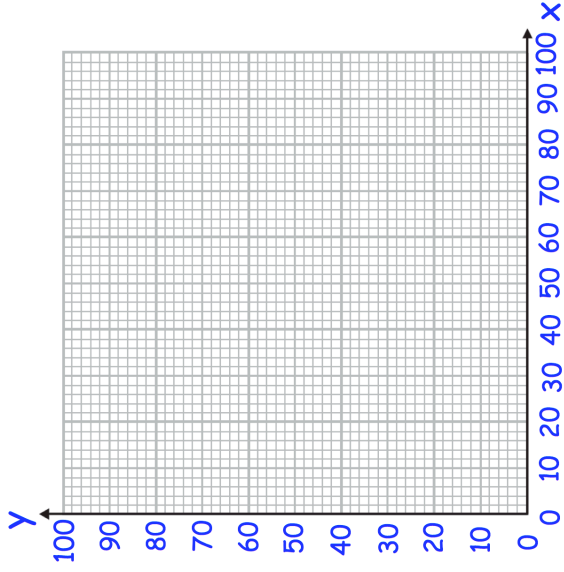


# Templates

3(f)



Apply 4



Apply 5



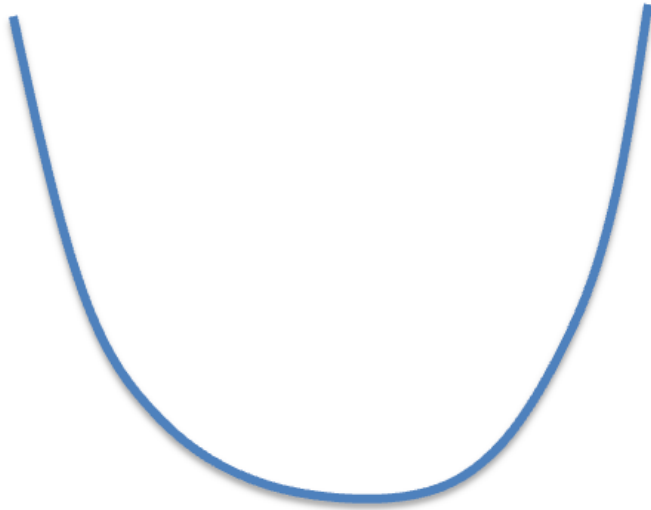
## Extra Notes

## 4 Non-Linear Graphs

## Quadratic Graphs

$$y = ax^2 + bx + c$$

When  $a > 0$



$$y = ax^2 + bx + c$$

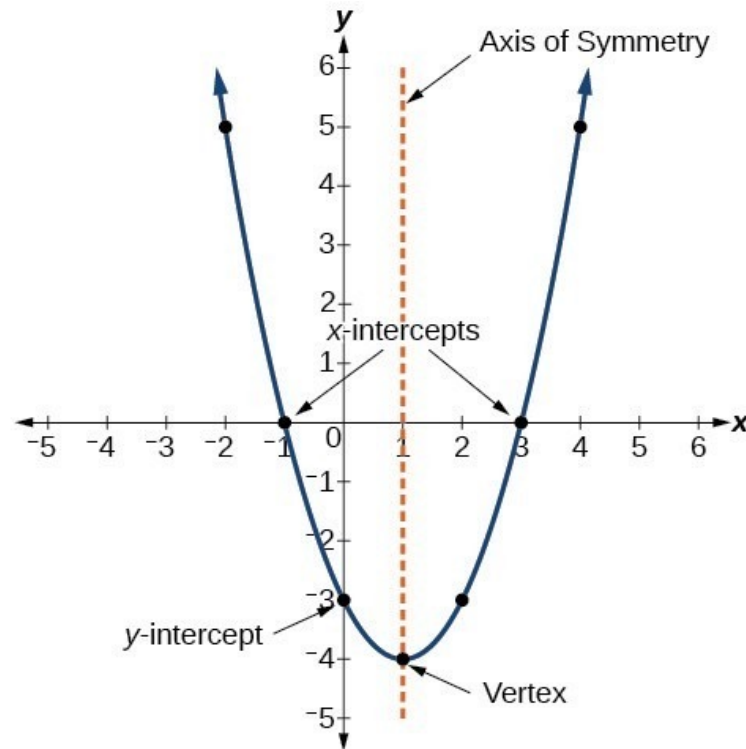
When  $a < 0$



The line for a quadratic equation is known as a **parabola**.

## Interpreting Quadratic Graphs

- **y-intercept** – where the graph intercepts the  $y$ -axis
- **x-intercept** or **root** or **solution** – where the graph intercepts the  $x$ -axis
- **Turning point** or **vertex** or **minimum/maximum** – where the graph stops decreasing and starts increasing or vice-versa

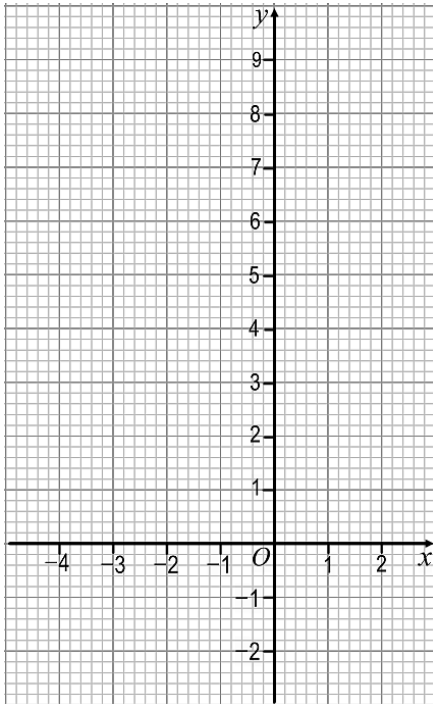


## Worked Example

- a) Complete the table and draw the graph of  $y = x^2 + 2x$  for  $x = -4$  to  $x = 2$
- b) Write down the equation of the line of symmetry of your graph
- c) Use your graph to find:
- the value of  $y$  when  $x = 0.5$
  - the values of  $x$  when  $y = 6$

Here is a table of values for  $y = x^2 + 2x$ .

$x$	-4	-3	-2	-1	0	1	2
$y$	8		0	-1			8

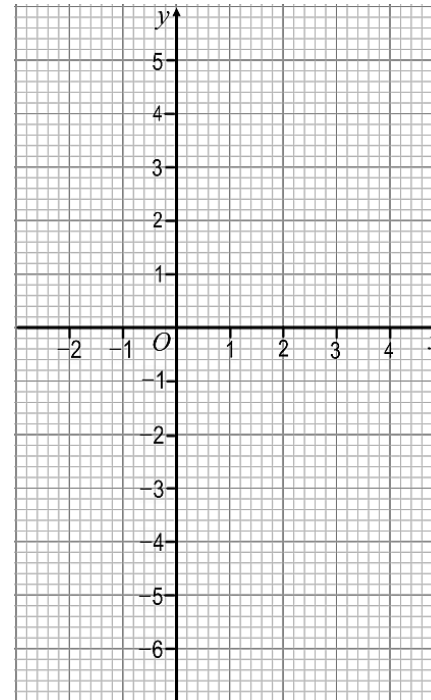


## Worked Example

- a) Complete the table and draw the graph of  $y = x^2 - 2x - 4$  for  $x = -2$  to  $x = 4$
- b) Write down the equation of the line of symmetry of your graph
- c) Write down the values of  $x$  where the graph crosses the  $x$ -axis

Here is a table of values for  $y = x^2 - 2x - 4$ .

$x$	-2	-1	0	1	2	3	4
$y$		-1	-4			-1	





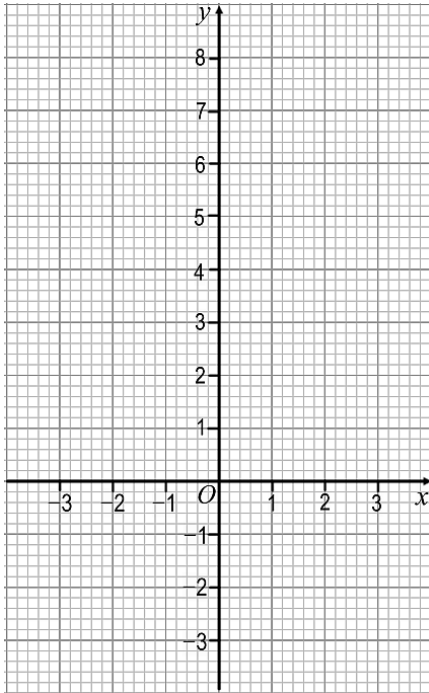
## Fluency Practice

1. Here is a table of values for  $y = x^2 - 2$ .

<b><math>x</math></b>	-3	-2	-1	0	1	2	3
<b><math>y</math></b>	7		-1	-2			7

a) Complete the table of values.

b) On the grid, draw the graph of  $y = x^2 - 2$  for  $x = -3$  to  $x = 3$ .



c) Write down the equation of the line of symmetry of your graph.

d) Write down the coordinates of the minimum point.

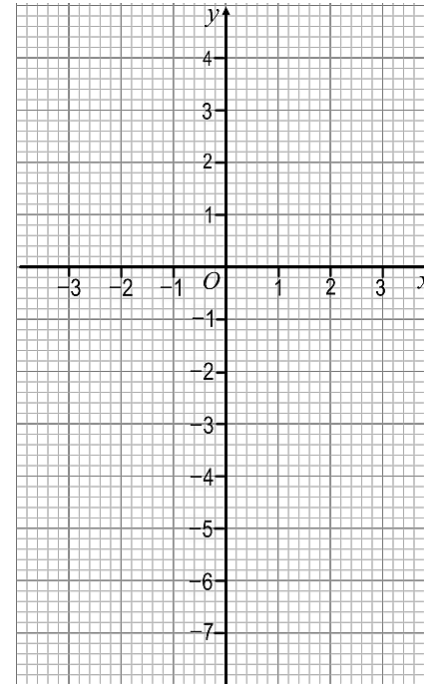
## Fluency Practice

2. Here is the table of values for  $y = 3 - x^2$ .

<b><math>x</math></b>	-3	-2	-1	0	1	2	3
<b><math>y</math></b>	-6		2	3		-1	

a) Complete the table of values.

b) On the grid, draw the graph of  $y = 3 - x^2$  for  $x = -3$  to  $x = 3$ .



c) Write down the coordinates of the maximum point.

d) Write down the values of  $x$  where the graph crosses the  $x$ -axis.

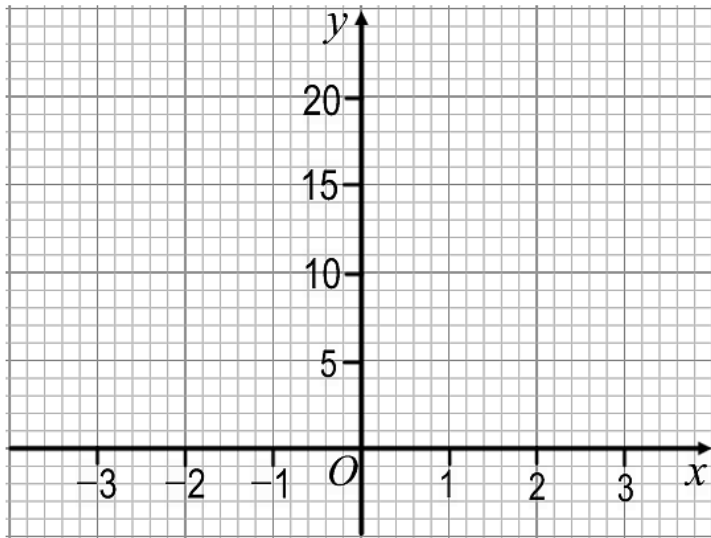
## Fluency Practice

3. Here is a table of values for  $y = 2x^2 + 1$ .

<b><i>x</i></b>	-3	-2	-1	0	1	2	3
<b><i>y</i></b>		9		1	3	9	

a) Complete the table of values.

b) On the grid, draw the graph of  $y = 2x^2 + 1$  for  $x = -3$  to  $x = 3$ .



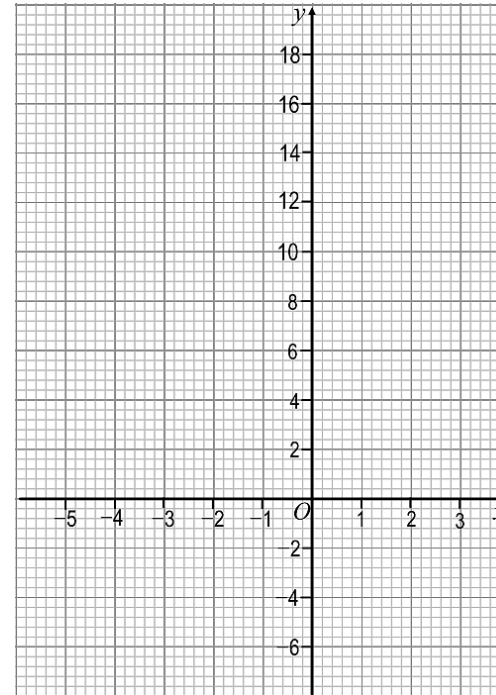
c) Use your graph to find:

i) the value of  $y$  when  $x = -2.5$

ii) the two values of  $x$  when  $y = 6$ .

## Fluency Practice

4. a) On the grid, draw the graph of  $y = x^2 + 3x - 2$  for the values of  $x$  from  $-5$  to  $3$ .



b) Use your graph to:

i) write down the values of  $x$  when the graph crosses the  $x$ -axis

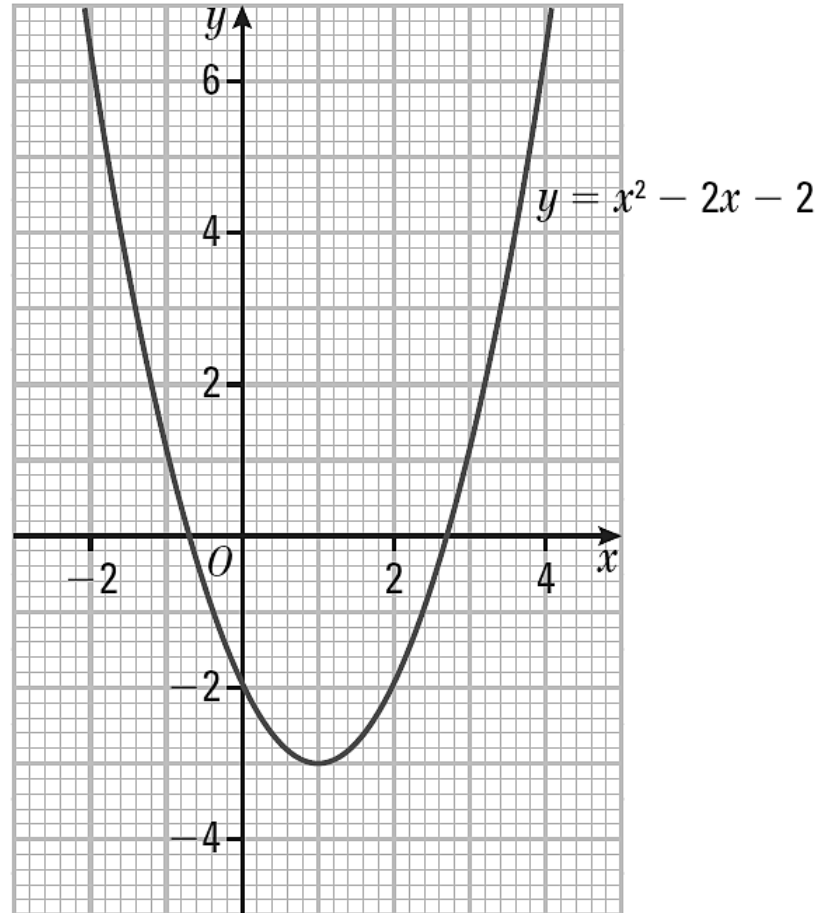
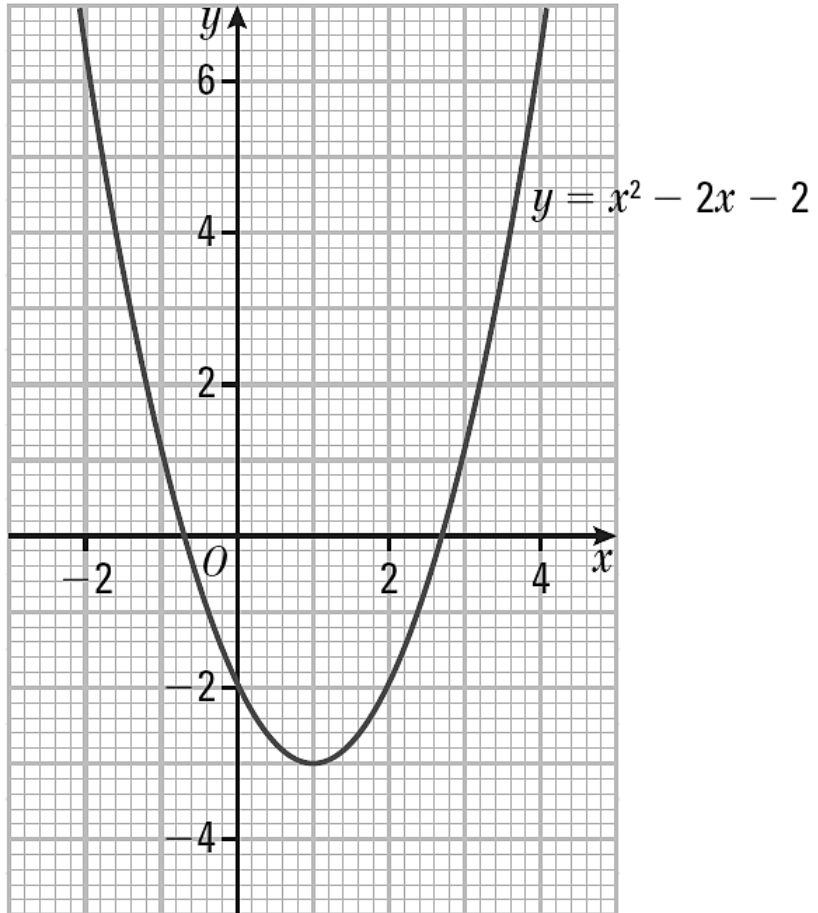
ii) draw in and write down the equation of the line of symmetry.

## Worked Example

Use this graph to solve these equations:

a)  $x^2 - 2x - 2 = 0$

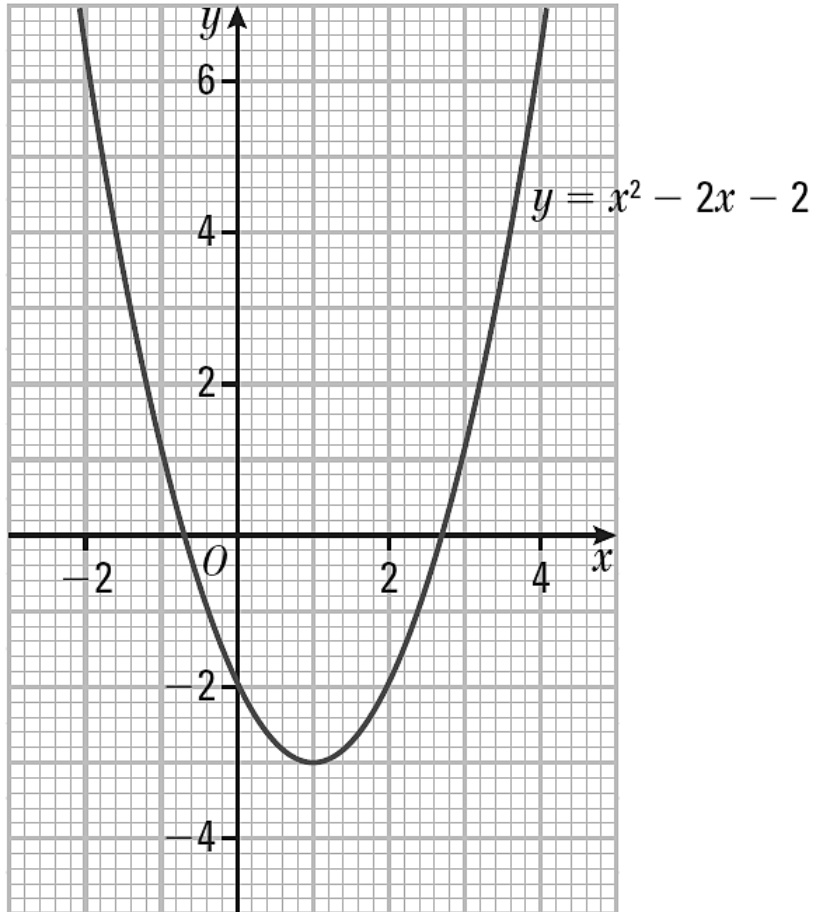
b)  $x^2 - 2x - 5 = 0$



## Worked Example

Use this graph to solve these equations:

c)  $x^2 - 2x - 2 = x$

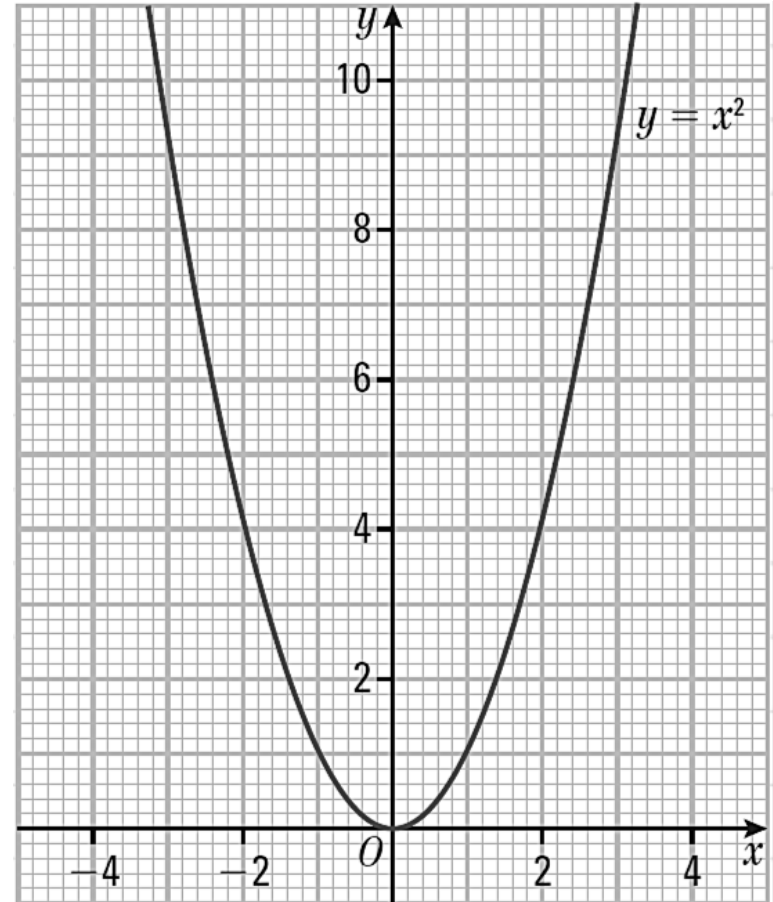
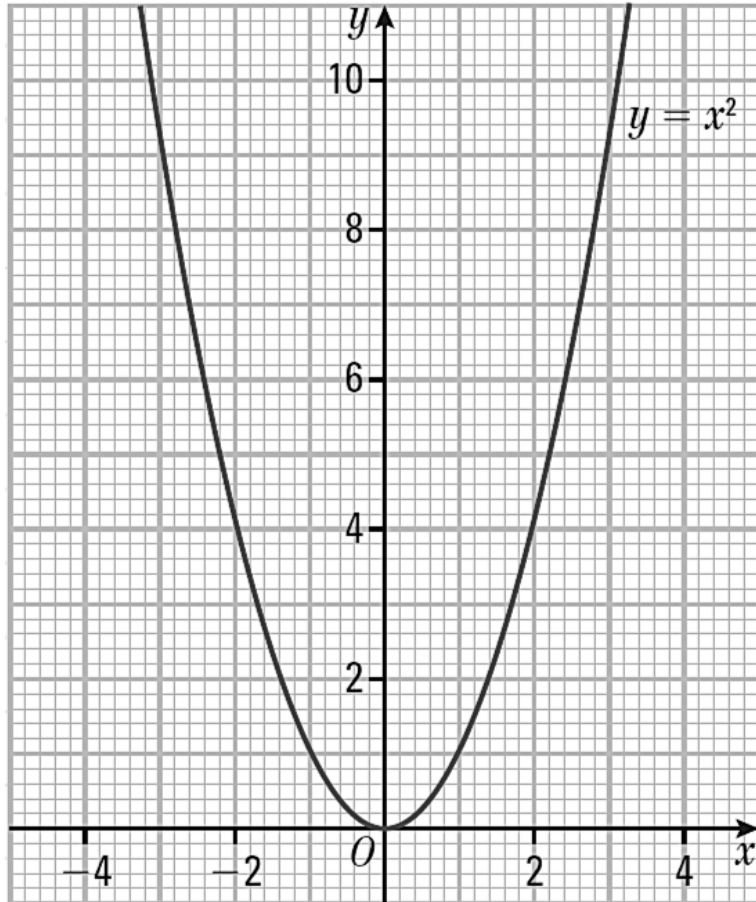


## Worked Example

Use this graph to solve these equations:

a)  $x^2 = 2x + 3$

b)  $x^2 = x + 4$

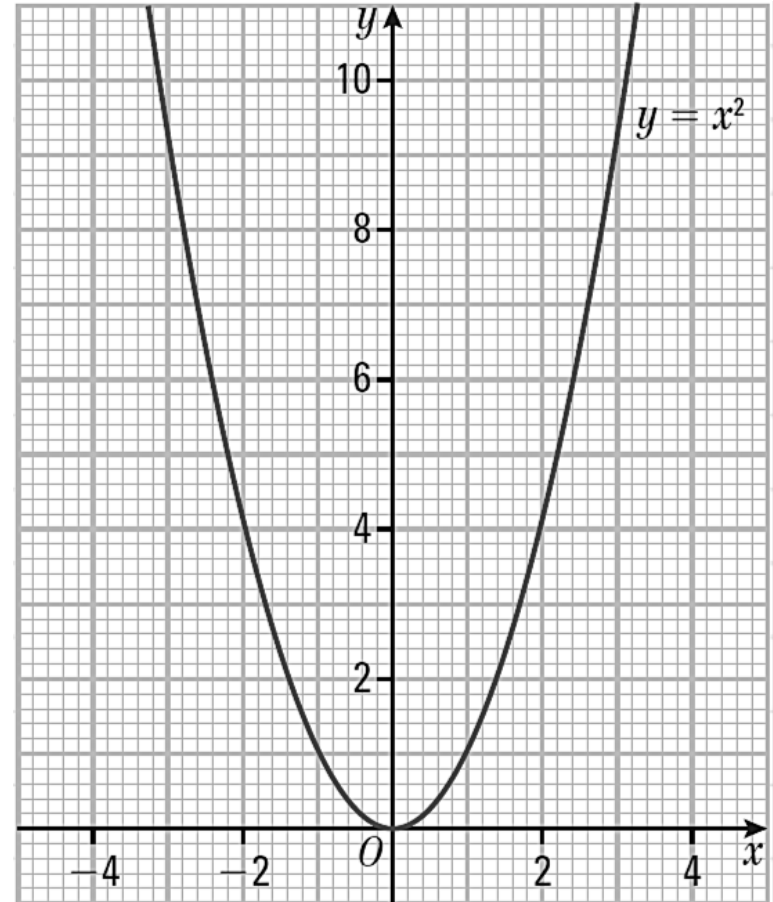
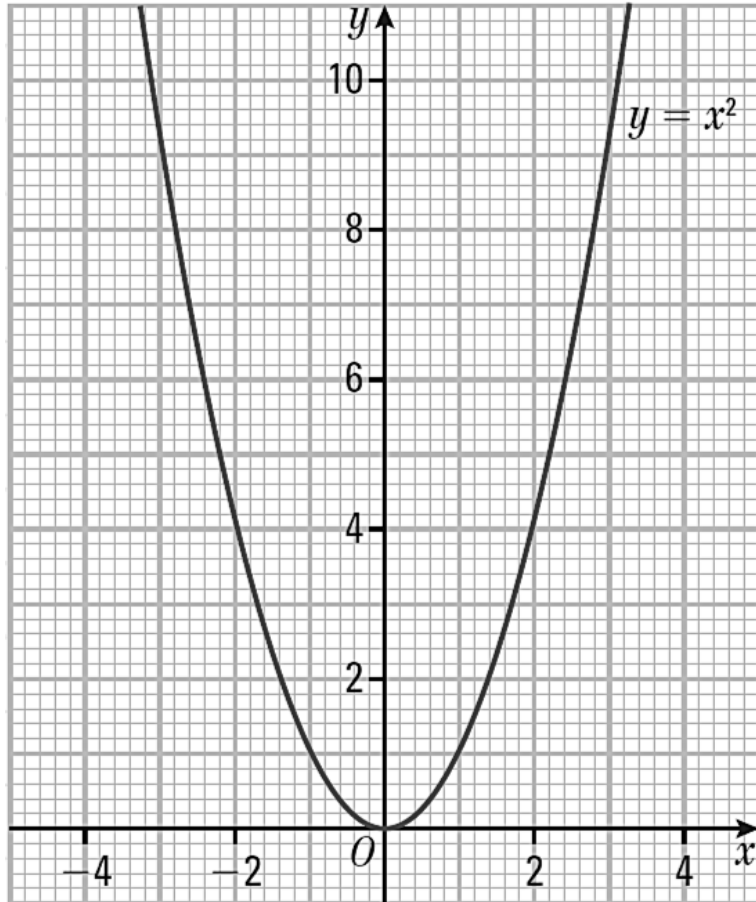


## Worked Example

Use this graph to solve these equations:

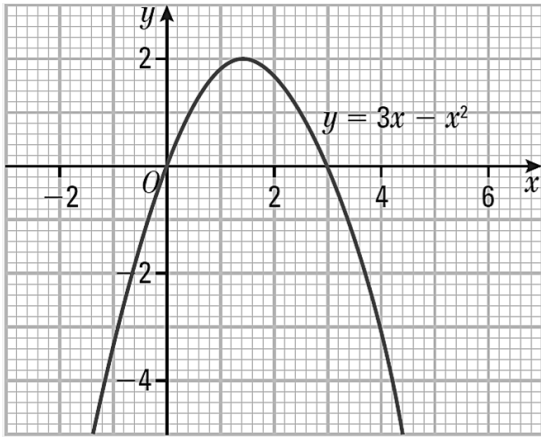
c)  $x^2 + x - 1 = 0$

d)  $x^2 - 2x - 1 = 0$



## Fluency Practice

1. Use this graph to solve the equations.

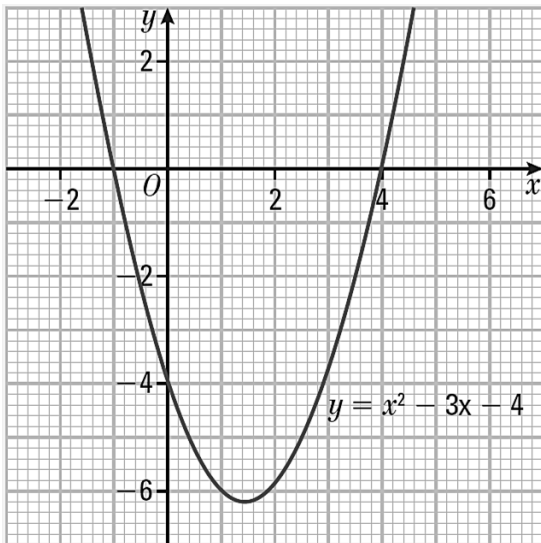


a)  $3x - x^2 = 0$

b)  $3x - x^2 = 1$

c)  $3x - x^2 = -4$

2. Use this graph to solve the equations.



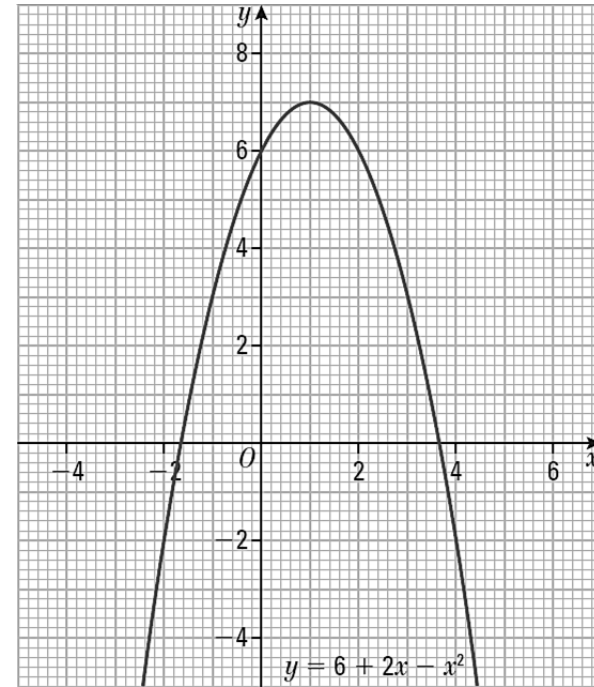
a)  $x^2 - 3x - 4 = 0$

b)  $x^2 - 3x - 4 = 2$

c)  $x^2 - 3x - 4 = -5$

## Fluency Practice

3. Use this graph to solve the equations.



a)  $6 + 2x - x^2 = 0$

b)  $4 + 2x - x^2 = 0$

c)  $6 + 2x - x^2 = x$

d)  $3 + 3x - x^2 = 0$

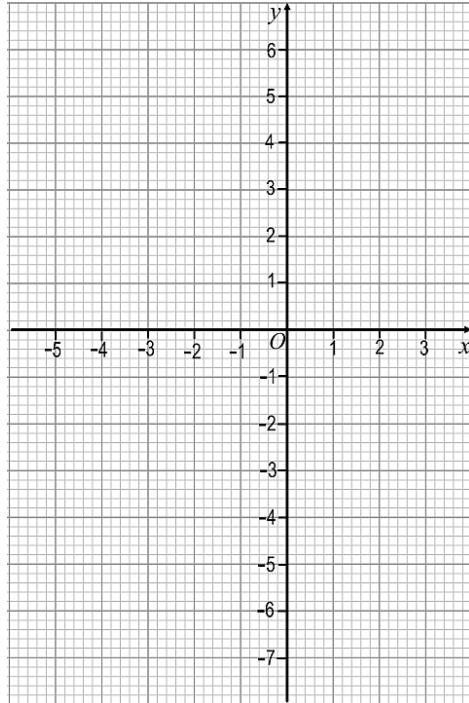
## Fluency Practice

4. Here is a table of values for  $y = x^2 + 3x - 4$ .

$x$	-5	-4	-3	-2	-1	0	1	2
$y$	6	0		-6		-4		

a) Complete the table of values.

b) On the grid, draw the graph of  $y = x^2 + 3x - 4$ .

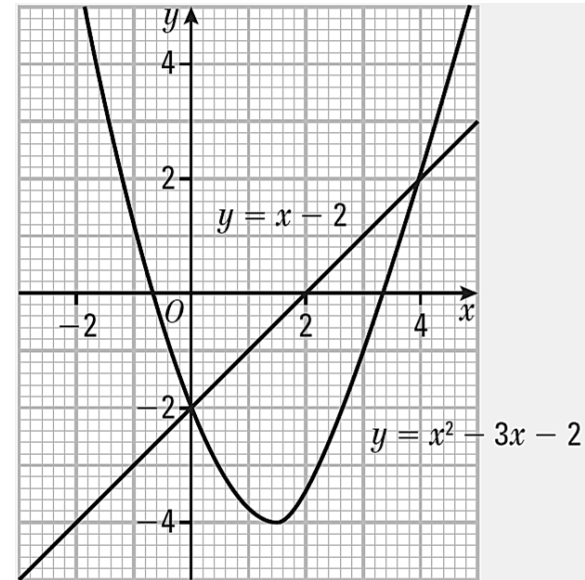


c) Use your graph to solve the equation  $x^2 + 3x - 4 = 2$ .

d) By drawing a suitable straight line on your graph, solve the equation  $x^2 + 3x - 4 = x + 1$ .

## Fluency Practice

5. The graphs  $y = x^2 - 3x - 2$  and  $y = x - 2$  are shown below.



a) Show that the equation  $x^2 - 3x - 2 = x - 2$  can be rewritten as  $x^2 - 4x = 0$ .

b) Solve the equation  $x^2 - 4x = 0$ .

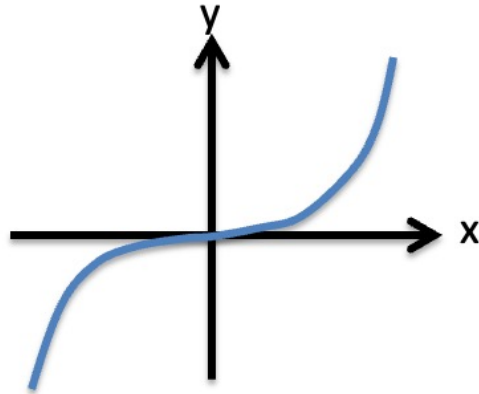
c) The equation  $x^2 - 2x - 4 = 0$  can be solved by drawing a suitable straight line on the graph. Find the equation of this straight line and solve the equation  $x^2 - 2x - 4 = 0$ .



## Cubic Graphs

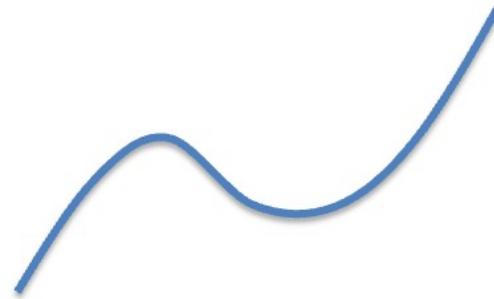
$$y = ax^3$$

When  $a > 0$



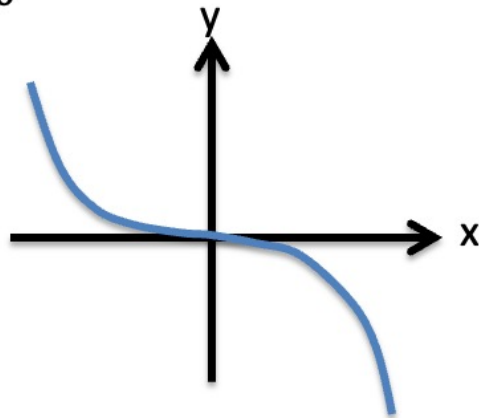
$$y = ax^3 + bx^2 + cx + d$$

When  $a > 0$



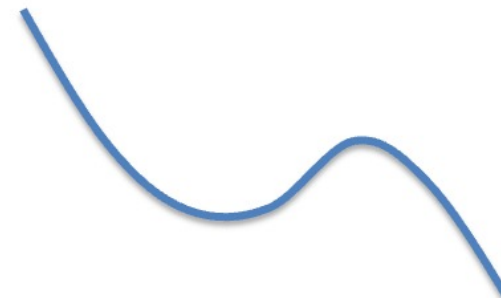
$$y = ax^3$$

When  $a < 0$



$$y = ax^3 + bx^2 + cx + d$$

When  $a < 0$

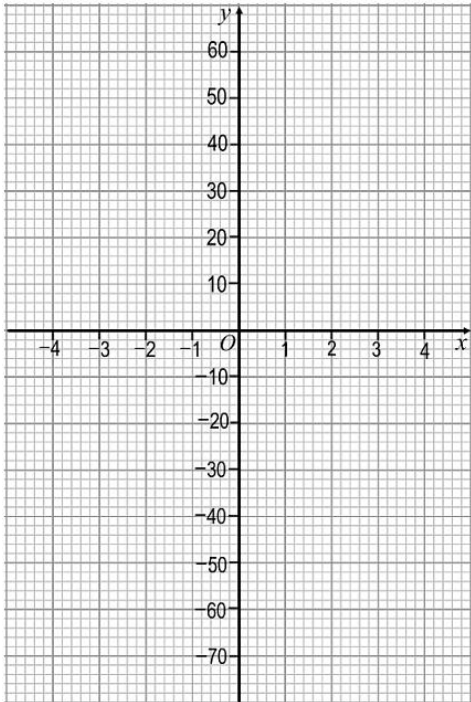


## Worked Example

- a) Complete the table and draw the graph of  $y = x^3 - 4$  for  $x = -4$  to  $x = 4$   
 b) Use the graph to find the value of  $y$  when  $x = 4$

Here is a table of values for  $y = x^3 - 4$ .

$x$	-4	-3	-2	-1	0	1	2	3	4
$y$									

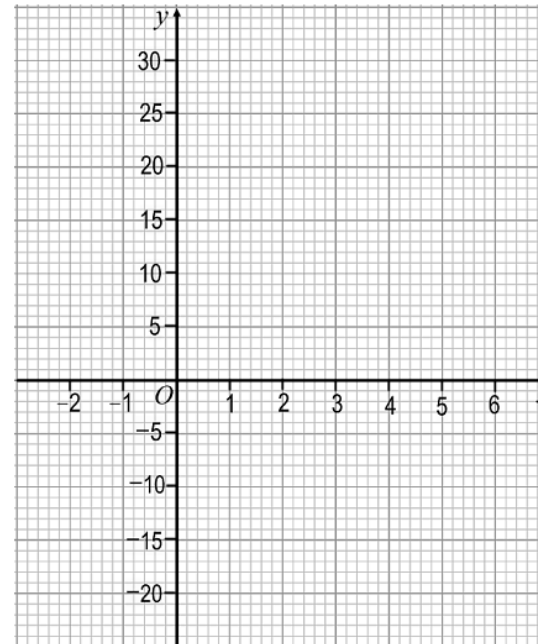


## Worked Example

- a) Complete the table and draw the graph of  $y = x^3 - 4x^2 + 5$  for  $x = -2$  to  $x = 5$   
 b) Use your graph to find the solutions to:  
 i)  $x^3 - 4x^2 + 5 = 0$   
 ii)  $x^3 - 4x^2 - x + 5 = 0$

Here is a table of values for  $y = x^3 - 4x^2 + 5$ .

$x$	-2	-1	0	1	2	3	4	5
$y$	-19		5			-4	5	



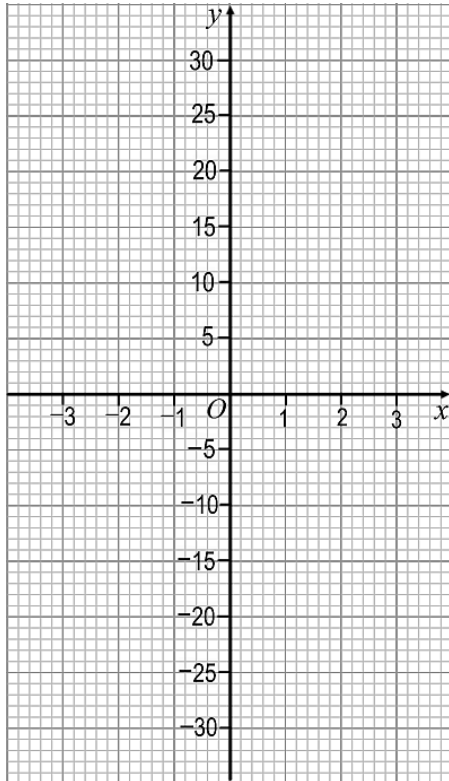
## Fluency Practice

1. Here is a table of values for  $y = x^3 + 1$ .

$x$	-3	-2	-1	0	1	2	3
$y$							

a) Complete the table of values.

b) On the grid, draw the graph of  $y = x^3 + 1$  for  $-3 \leq x \leq 3$ .



c) Use your graph to find the value of  $y$  when  $x = 1.5$ .

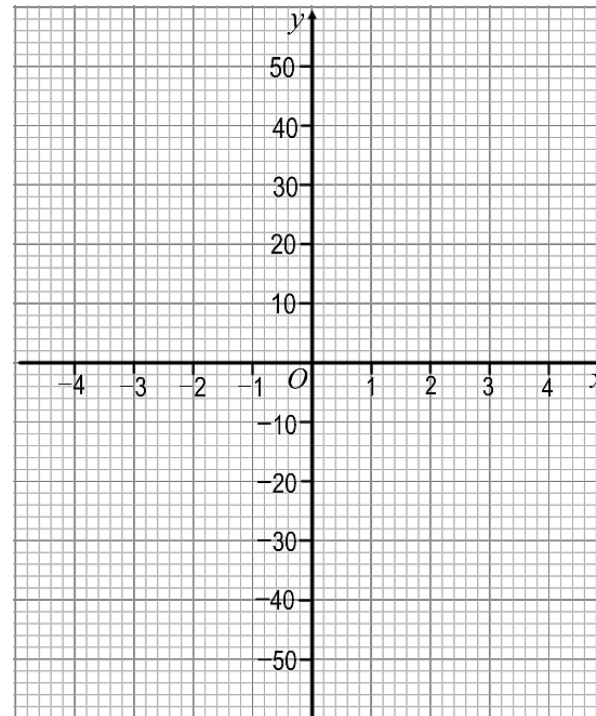
## Fluency Practice

2. Here is the table of values for  $y = x^3 - 5x$ .

$x$	-4	-3	-2	-1	0	1	2	3	4
$y$		-12			0	-4		12	44

a) Complete the table of values.

b) On the grid, draw the graph of  $y = x^3 - 5x$  for  $-4 \leq x \leq 4$ .



c) Use your graph to find the solutions to the equation  $x^3 - 5x = 0$ .

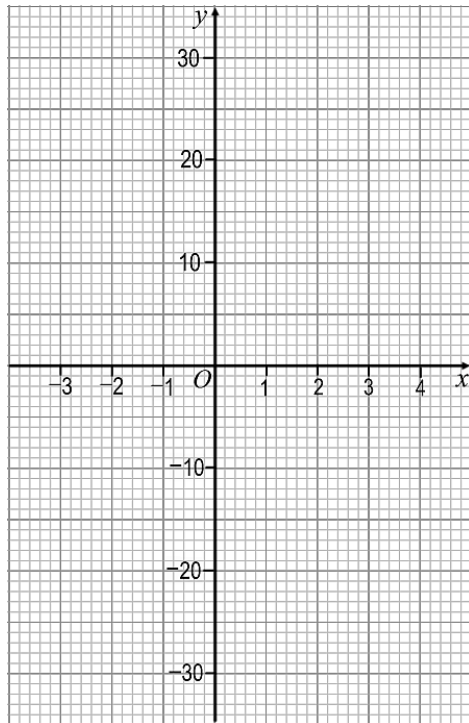
## Fluency Practice

3. Here is a table of values for  $y = 6x + x^2 - x^3$ .

$x$	-3	-2	-1	0	1	2	3	4
$y$		0	-4			8	0	

a) Complete the table of values.

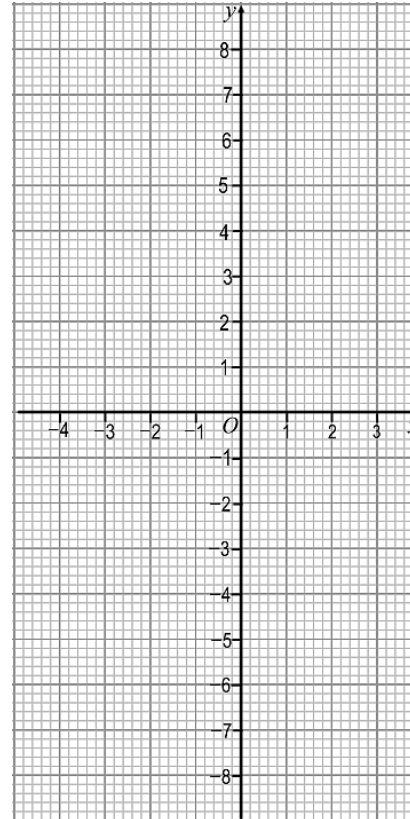
b) On the grid, draw the graph of  $y = 6x + x^2 - x^3$  for  $-3 \leq x \leq 4$ .



c) By drawing a suitable line on your diagram, solve the equation  $6x + x^2 - x^3 = x - 2$ .

## Fluency Practice

4. a) On the grid, draw the graph of  $y = x^3 + x^2 - 4x - 2$  for the values of  $x$  from  $-3$  to  $2$ .



b) By drawing a suitable line on your diagram, solve the equation  $x^3 + x^2 - 5x - 2 = 0$ .

## Reciprocal Graphs

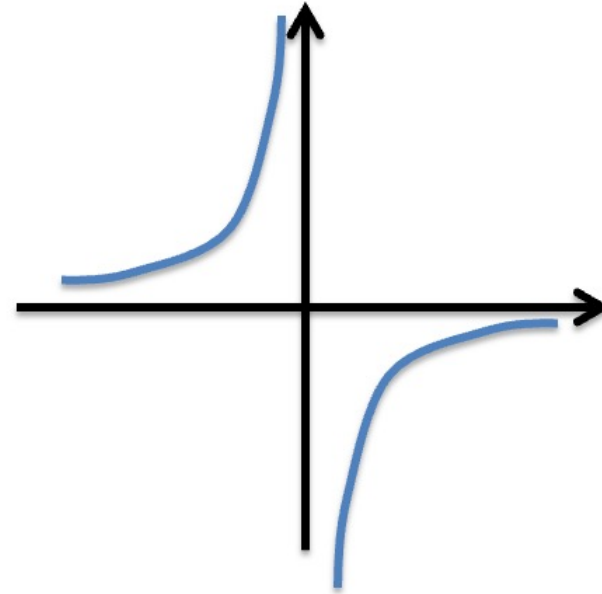
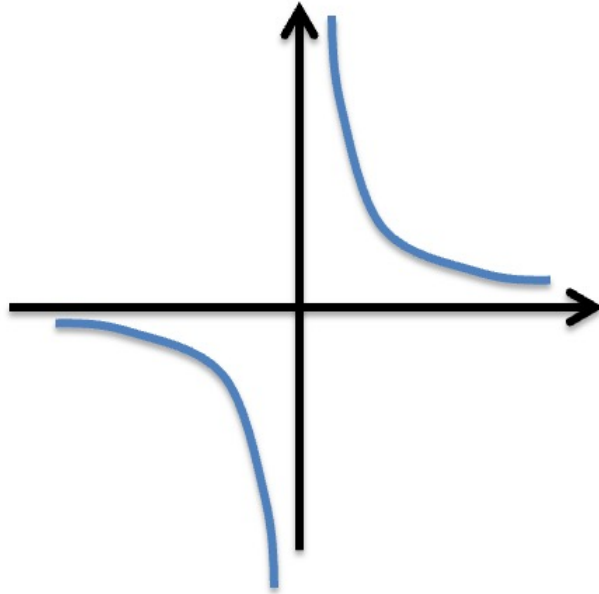
$$y = \frac{a}{x}$$

When  $a > 0$

$a$  is a constant while  $x$  is a variable, so we might have  $y = \frac{3}{x}$

$$y = \frac{a}{x}$$

When  $a < 0$



The lines  $x = 0$  and  $y = 0$  are called asymptotes.  
**An asymptote is a straight line which the curve approaches at infinity.**

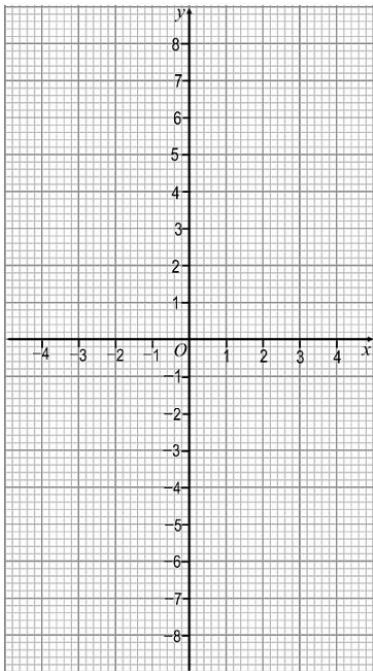
## Worked Example

Complete the tables and draw the graph of  $y = \frac{2}{x}$  for  $x = -5$  to  $x = 5$

Here is a table of values for  $y = \frac{2}{x}$ .

$x$	0.25	0.4	0.5	0.8	1	2	4	5
$y$								

$x$	-0.25	-0.4	-0.5	-0.8	-1	-2	-4	-5
$y$								



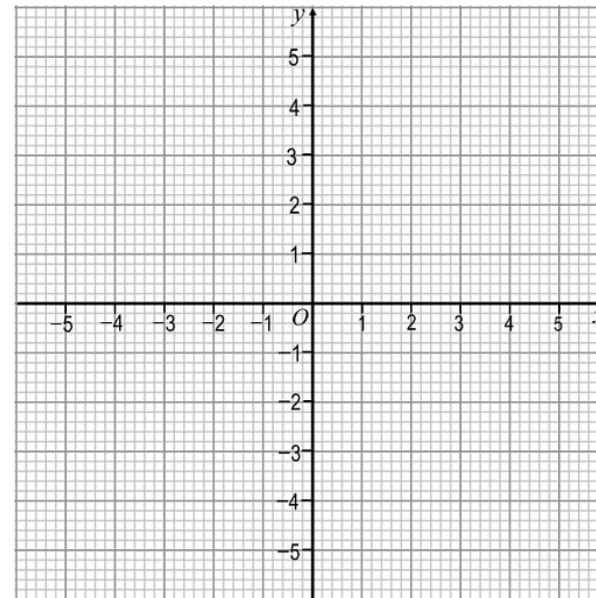
## Worked Example

Complete the tables and draw the graph of  $y = -\frac{1}{x}$  for  $x = -5$  to  $x = 5$

Here is a table of values for  $y = -\frac{1}{x}$ .

$x$	0.2	0.4	0.5	0.8	1	2	3	4	5
$y$									

$x$	-0.2	-0.4	-0.5	-0.8	-1	-2	-3	-4	-5
$y$									



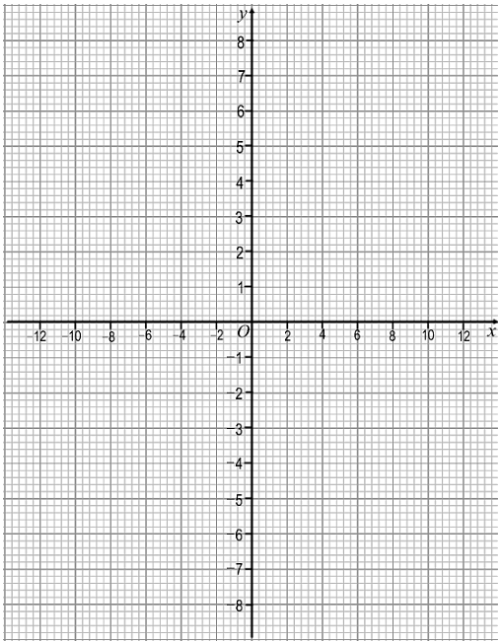
## Worked Example

Complete the tables and draw the graph of  $y = \frac{4}{x-1}$  for  $x = -12$  to  $x = 12$

Here is a table of values for  $y = \frac{4}{x-1}$ .

$x$	1.5	2	3	5	6	9	11
$y$							

$x$	0.5	0	-1	-3	-4	-7	-9
$y$							



## Fluency Practice

1. Here are some table of values for  $y = \frac{4}{x}$ .

<b><i>x</i></b>	0.2	0.4	0.5	1	2	4	5	8	10
<b><i>y</i></b>		10		4	2		0.8		

<b><i>x</i></b>	-10	-8	-5	-4	-2	-1	-0.5	-0.4	-0.2
<b><i>y</i></b>									

a) Complete the table of values.

b) On your additional sheet, draw the graph of  $y = \frac{4}{x}$  for  $-10 \leq x \leq 10$ .

c) Use your graph to find an estimate for the solutions of  $\frac{4}{x} = 4 - x$ .

2. On your additional sheet, draw the graph of  $y = -\frac{3}{x}$  for  $-10 \leq x \leq 10$ .

## Fluency Practice

3. a) Here are some table of values for  $y = \frac{8}{x+2}$ .

<b><i>x</i></b>	-12	-10	-7	-6	-4	-3	-1	0	2	3	6	8
<b><i>y</i></b>												

b) On your additional sheet, draw the graph of  $y = \frac{8}{x+2}$  for  $-12 \leq x \leq 12$ .

c) For which values of  $x$  is  $y = \frac{8}{x+2}$  not defined?

4. a) Complete the table of values for  $y = 3 - \frac{2}{x}$ ,  $x \neq 0$ .

<b><i>x</i></b>	-3	-2	-1	-0.5	-0.1	0.1	0.5	1	2	3
<b><i>y</i></b>										

b) On your additional sheet, draw the graph of  $y = 3 - \frac{2}{x}$  for  $-3 \leq x \leq 3$ .

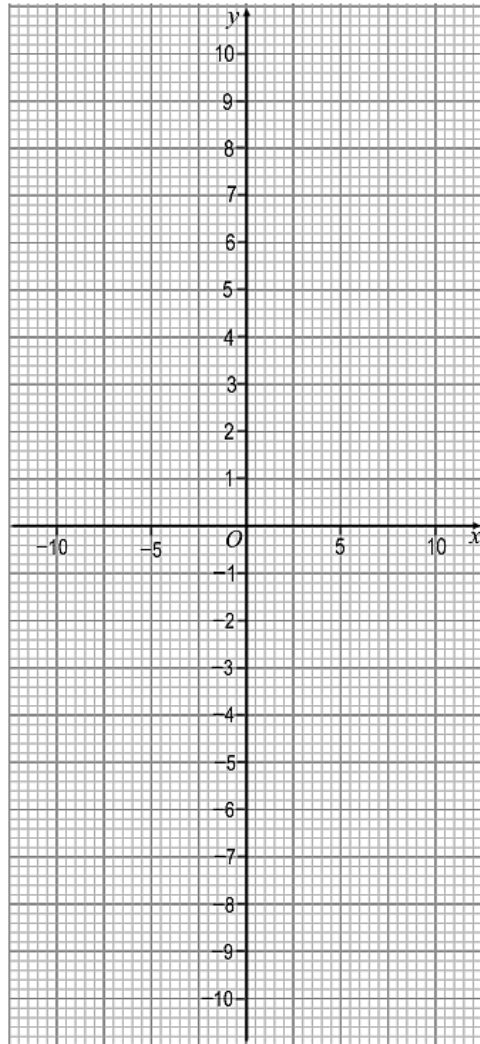
c) This graph approaches two lines without touching them. These lines are called asymptotes. Write down the equation of each of these two lines.



## Fluency Practice

Question 1

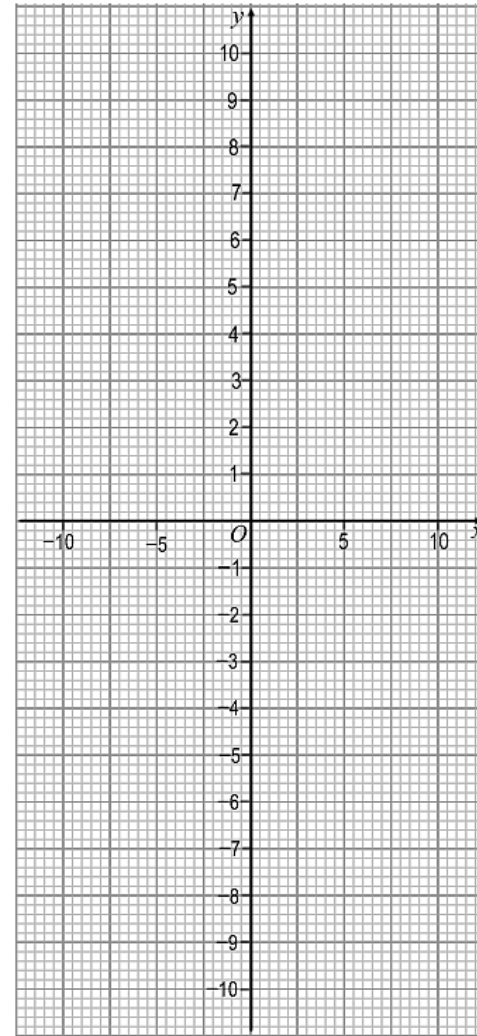
$$y = \frac{4}{x}$$



## Fluency Practice

Question 2

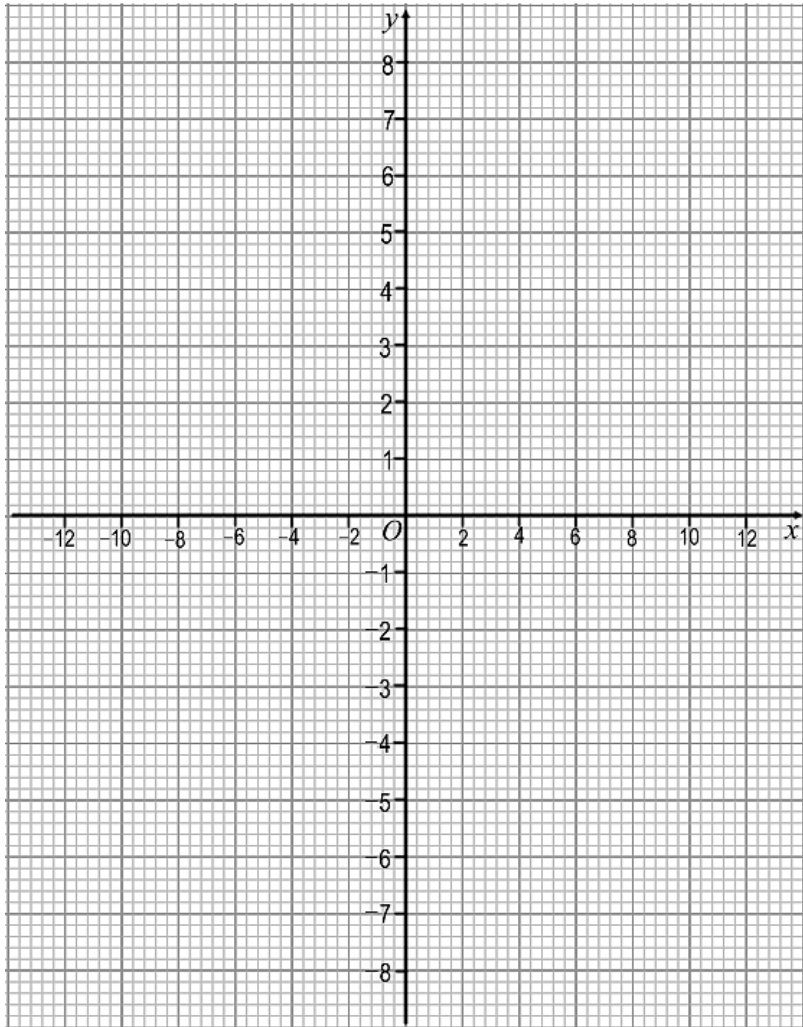
$$y = -\frac{3}{x}$$



## Fluency Practice

Question 3

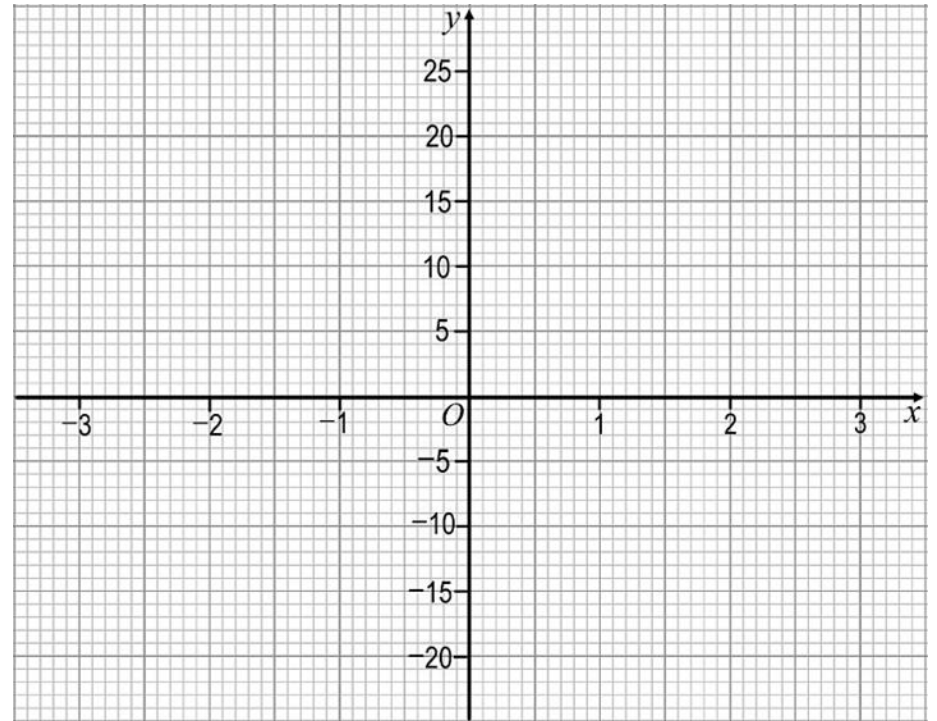
$$y = \frac{8}{x+2}$$



## Fluency Practice

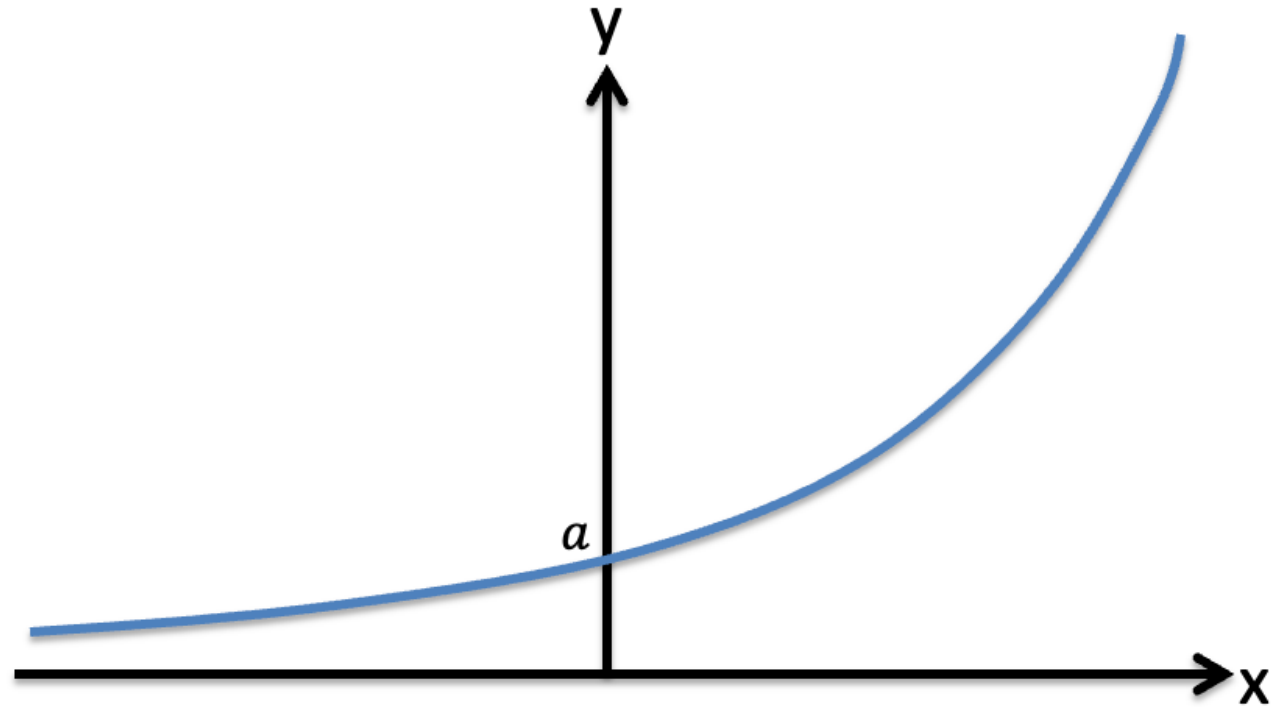
Question 4

$$y = 3 - \frac{2}{x}$$



## Exponential Graphs

$$y = a \times b^x$$



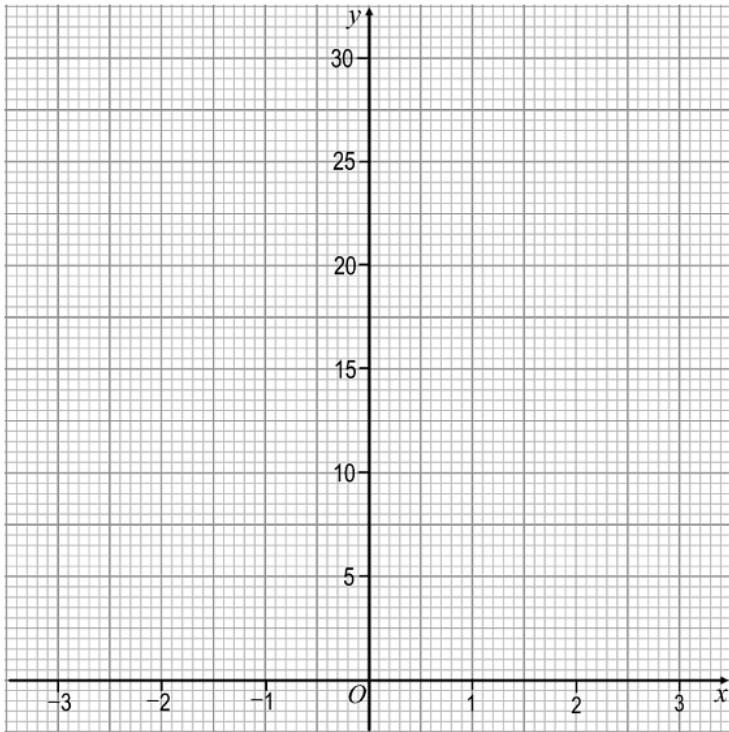
The  $y$ -intercept is  $a$  because  $a \times b^0 = a \times 1 = a$ .  
(unless  $a = 0$ , but let's not go there!)

## Worked Example

- a) Complete the tables and draw the graph of  $y = 3^x$  for  $x = -3$  to  $x = 3$   
 b) Use your graph to estimate the solution to  $3^x = 20$

Here is a table of values for  $y = 3^x$ .

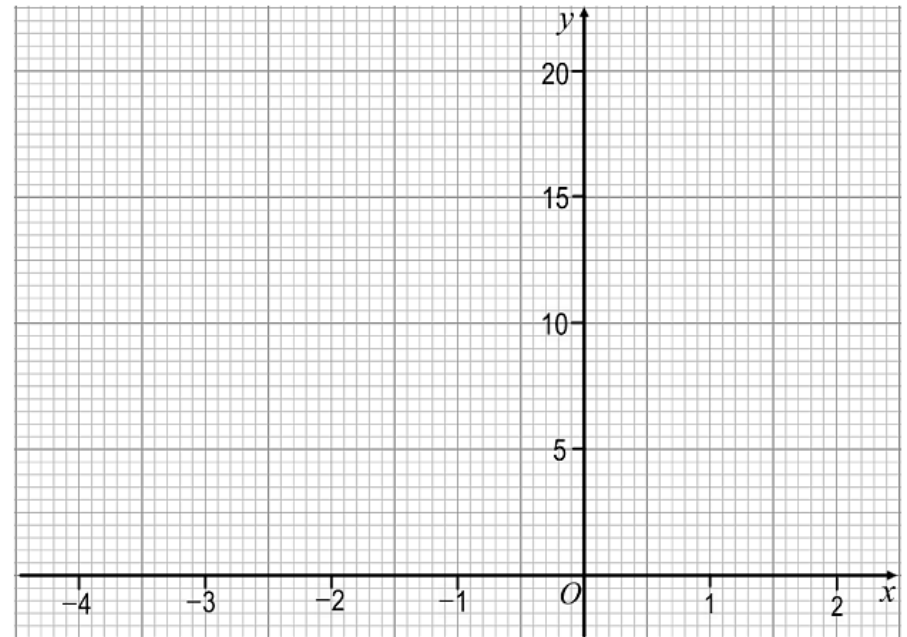
$x$	-3	-2	-1	0	1	2	3
$y$							



- a) Complete the tables and draw the graph of  $y = 2^{-x}$  for  $x = -4$  to  $x = 2$   
 b) Use your graph to estimate  
 i) the value of  $y$  when  $x = 0.5$   
 ii) the solution to the equation  $2^{-x} = 10$

Here is a table of values for  $y = 2^{-x}$ .

$x$	-4	-3	-2	-1	0	1	2
$y$							

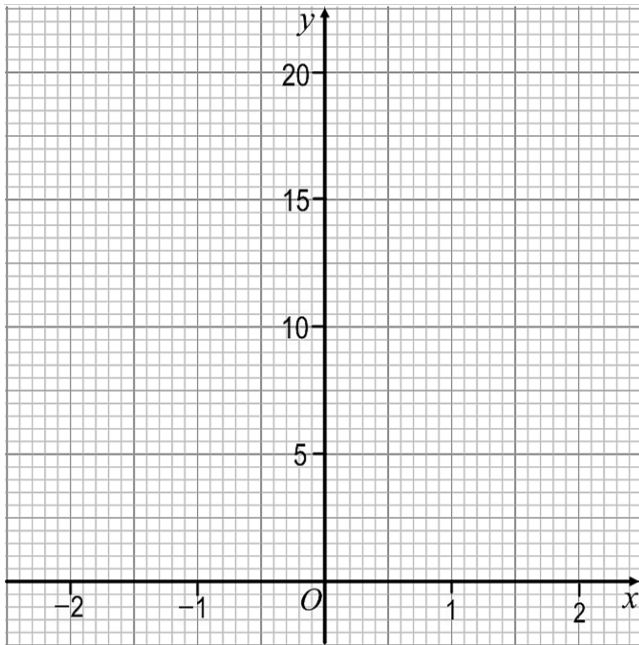


## Fluency Practice

1. Here is a table of values for  $y = 4^x$ .

$x$	-2	-1	0	1	2
$y$					

- a) Complete the table of values.
- b) On the grid, draw the graph of  $y = 4^x$  for  $-2 \leq x \leq 2$ .



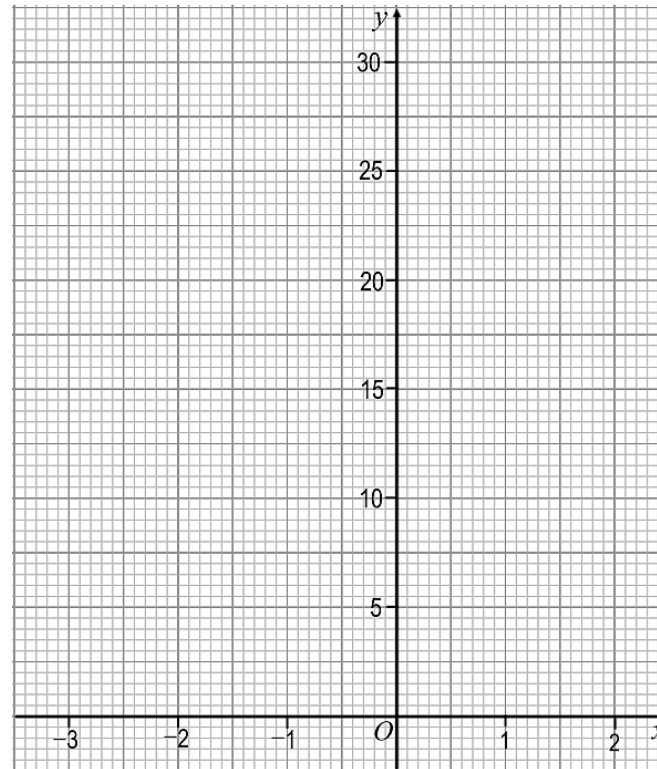
- c) Use your graph to find an estimate for:
  - i) the value of  $y$  when  $x = 1.5$
  - ii) the value of  $x$  when  $y = 11$

## Fluency Practice

2. Here is the table of values for  $y = 3^{-x}$ .

$x$	-3	-2	-1	0	1	2
$y$						

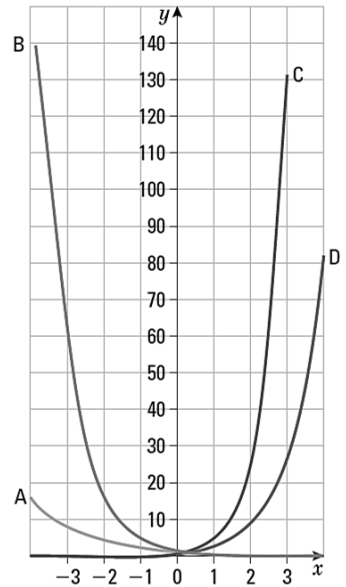
- a) Complete the table of values.
- b) On the grid, draw the graph of  $y = 3^{-x}$  for  $-3 \leq x \leq 2$ .



- c) Use your graph to find the solution to the equation  $3^{-x} = 7$ .

# Fluency Practice

3. The diagram shows the graphs of  $y = 3^x$ ,  $y = 2^{-x}$ ,  $y = 5^x$  and  $y = \left(\frac{1}{4}\right)^x$ .



Match each graph to its equation.

4. The number of rabbits,  $n$ , in a particular population grows at a rate given by the equation  $n = 5 \times 2^y$  where  $y$  is the number of years.

a) How many rabbits were there initially (when  $y = 0$ )?

b) How many rabbits are there after 6 years?

c) How many years will it take for the rabbit population to exceed 5000?

## Extra Notes