



KING EDWARD VI  
HANDSWORTH GRAMMAR  
SCHOOL FOR BOYS



KING EDWARD VI  
ACADEMY TRUST  
BIRMINGHAM

**Year 10**

**2025 Mathematics 2026**

**Unit 16 Tasks – Part 1**

**DO NOT WRITE INSIDE**



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**Year 10**

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**Unit 16 Tasks – Part 2**

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# 1 Recurring Decimals

## Intelligent Practice

Write the following out fully:

- 1)  $0.\dot{5}$
- 2)  $0.4\dot{5}$
- 3)  $0.\dot{4}5$
- 4)  $0.34\dot{5}$
- 5)  $0.\dot{3}45$
- 6)  $0.2\dot{3}45$
- 7)  $0.\dot{2}345$
- 8)  $1.\dot{2}345$

Write the following using dot notation:

- 1)  $0.666 \dots$
- 2)  $0.7666 \dots$
- 3)  $0.767676 \dots$
- 4)  $0.8767676 \dots$
- 5)  $0.876876876 \dots$
- 6)  $0.9876876876 \dots$
- 7)  $0.987698769876 \dots$
- 8)  $10.987698769876 \dots$

# Purposeful Practice

## changing a fraction into a decimal

(1) work out what these fractions are as decimals by division (without using a calculator)

(a)  $\frac{2}{5}$  (b)  $\frac{3}{8}$  (c)  $\frac{7}{8}$  (d)  $\frac{4}{5}$  (e)  $\frac{3}{25}$  (f)  $\frac{7}{20}$  (g)  $\frac{3}{80}$

why do you think these fractions as decimals terminate?

(2) work out what these fractions are as decimals by division (without using a calculator)

(a)  $\frac{1}{6}$  (b)  $\frac{5}{6}$  (c)  $\frac{1}{9}$  (d)  $\frac{2}{9}$  (e)  $\frac{1}{11}$  (f)  $\frac{2}{11}$  (g)  $\frac{1}{22}$

(3) work out what these fractions are as decimals by division (without using a calculator)

(a)  $\frac{1}{7}$  (b)  $\frac{2}{7}$  (c)  $\frac{3}{7}$  (d)  $\frac{4}{7}$  (e)  $\frac{5}{7}$  (f)  $\frac{6}{7}$

$2 \times 7 = 14$	$6 \times 7 = 42$
$3 \times 7 = 21$	$7 \times 7 = 49$
$4 \times 7 = 28$	$8 \times 7 = 56$
$5 \times 7 = 35$	$9 \times 7 = 63$

what patterns can you find in the recurring decimal values of sevenths?

# Purposeful Practice

## changing a fraction into a decimal

(1) work out what these fractions are as decimals by division (without using a calculator)

(a)  $\frac{1}{25}$  (b)  $\frac{1}{40}$  (c)  $\frac{1}{80}$  (d)  $\frac{1}{16}$  (e)  $\frac{1}{32}$  why do you think these fractions as decimals terminate?

(2) work out what these fractions are as decimals by division (without using a calculator)

(a)  $\frac{1}{13}$  (b)  $\frac{2}{13}$  (c)  $\frac{3}{13}$  (d)  $\frac{4}{13}$  (e)  $\frac{5}{13}$

$2 \times 13 = 26$	$6 \times 13 = 78$
$3 \times 13 = 39$	$7 \times 13 = 91$
$4 \times 13 = 52$	$8 \times 13 = 104$
$5 \times 13 = 65$	$9 \times 13 = 117$

(3) work out which fraction is bigger (with a calculator)

(a)  $\frac{5}{9}$  or  $\frac{6}{11}$

(b)  $\frac{7}{8}$  or  $\frac{17}{20}$

(c)  $\frac{2}{11}$  or  $\frac{3}{17}$

(d)  $\frac{4}{17}$  or  $\frac{15}{62}$

(4) without a calculator

$$\frac{27}{40} = 0.675$$

$$\frac{29}{40} = 0.725$$

what are:

(a)  $\frac{31}{40}$

(b)  $\frac{37}{40}$

(5) without a calculator

$$\frac{29}{32} = 0.90625$$

what are:

(a)  $\frac{29}{320}$

(b)  $\frac{290}{32}$

(c)  $\frac{13}{32}$

(d)  $\frac{21}{32}$

# Fluency Practice

**A**  $0.6\overline{78}$ 

0	•	6							
---	---	---	--	--	--	--	--	--	--

  
 $0.6\overline{7}$ 

0	•	6							
---	---	---	--	--	--	--	--	--	--

  
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## Ordering Recurring Decimals

**F**  $0.\overline{5}$ 

0	•								
---	---	--	--	--	--	--	--	--	--

  
 $0.5\overline{6}$ 

0	•								
---	---	--	--	--	--	--	--	--	--

  
 $0.5\overline{65}$ 

0	•	5	6	5	5				
---	---	---	---	---	---	--	--	--	--

  
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**B**  $0.25\overline{2}$ 

0	•								
---	---	--	--	--	--	--	--	--	--

  
 $0.2\overline{5}$ 

0	•								
---	---	--	--	--	--	--	--	--	--

  
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**G**  $0.0\overline{81}$ 

•			0				
---	--	--	---	--	--	--	--

  
 $0.0\overline{81}$ 

•	0	8					
---	---	---	--	--	--	--	--

  
 $0.0\overline{81}$ 

•				1			
---	--	--	--	---	--	--	--

  
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**C**  $0.5\overline{65}$ 

0	•	5	6	5					
---	---	---	---	---	--	--	--	--	--

  
 $0.56\overline{6}$ 

0	•								
---	---	--	--	--	--	--	--	--	--

  
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**H**  $0.13\overline{1}$ 

•					1		
---	--	--	--	--	---	--	--

  
 $0.13\overline{1}$ 

•		1					
---	--	---	--	--	--	--	--

  
 $0.13\overline{1}$ 

•			1				
---	--	--	---	--	--	--	--

  
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**D**  $0.7\overline{8}$ 

0	•			8			
---	---	--	--	---	--	--	--

  
 $0.7\overline{8}$ 

0	•					8	
---	---	--	--	--	--	---	--

  
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**I**  $9.79\overline{8}$ 

•							
---	--	--	--	--	--	--	--

  
 $9.79\overline{8}$ 

•							
---	--	--	--	--	--	--	--

  
 $9.79\overline{87}$ 

•							
---	--	--	--	--	--	--	--

  
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**E**  $0.10\overline{2}$ 

0	•	1	0	2	1		
---	---	---	---	---	---	--	--

  
 $0.1\overline{2}$ 

0	•				2		
---	---	--	--	--	---	--	--

  
 <

## Purposeful Practice

By writing the denominator as a product of its prime factors, decide if each of these fractions would convert to a terminating or recurring decimal.

- (a)  $\frac{1}{8}$  (b)  $\frac{1}{25}$  (c)  $\frac{1}{15}$   
(d)  $\frac{1}{14}$  (e)  $\frac{1}{50}$  (f)  $\frac{1}{16}$   
(g)  $\frac{1}{30}$  (h)  $\frac{1}{12}$  (i)  $\frac{1}{40}$

Write out the following recurring decimals to show the first 10 decimal places.

- (a)  $0.\dot{4}$  (b)  $0.\dot{7}$   
(c)  $0.\dot{1}4$  (d)  $0.\dot{2}3$   
(e)  $0.\dot{1}2\dot{3}$  (f)  $0.\dot{4}6\dot{1}$   
(g)  $0.0\dot{5}$  (h)  $0.1\dot{7}2$

Use your calculator to convert the following fractions into terminating or recurring decimals.

- (a)  $\frac{4}{9}$  (b)  $\frac{2}{5}$  (c)  $\frac{3}{10}$   
(d)  $\frac{7}{11}$  (e)  $\frac{5}{16}$  (f)  $\frac{1}{8}$   
(g)  $\frac{4}{7}$  (h)  $\frac{29}{100}$  (i)  $\frac{3}{35}$

Use your calculator to convert the following fractions into recurring decimals.

- (a)  $\frac{1}{9}$  (b)  $\frac{2}{9}$  (c)  $\frac{3}{9}$

Can you spot a pattern?

Use your calculator to convert the following fractions into recurring decimals.

- (a)  $\frac{12}{99}$  (b)  $\frac{13}{99}$  (c)  $\frac{14}{99}$

Can you spot a pattern?

## Fluency Practice

For each of the following values of  $x$ , find

- a)  $10x$
  - b)  $100x$
  - c)  $1000x$
  - d)  $2x$
  - e)  $20x$
- 
- 1)  $x = 0.\dot{1}$
  - 2)  $x = 0.0\dot{1}$
  - 3)  $x = 0.00\dot{1}$
  - 4)  $x = 0.\dot{2}$
  - 5)  $x = 0.\dot{3}$
  - 6)  $x = 0.\dot{2}\dot{5}$
  - 7)  $x = 0.\dot{7}\dot{2}$
  - 8)  $x = 0.0\dot{2}\dot{5}$
  - 9)  $x = 0.1\dot{2}\dot{5}$
  - 10)  $x = 1.34\dot{2}\dot{4}$
  - 11)  $x = 0.\dot{2}\dot{2}\dot{4}$
  - 12)  $x = 0.0\dot{2}\dot{2}\dot{4}$
  - 13)  $x = 0.2\dot{2}\dot{2}\dot{4}$
  - 14)  $x = 1.01\dot{1}0\dot{1}$

## Purposeful Practice

Given that  $0.333\dots = \frac{1}{3}$

Write these as fractions:

a)  $1.333\dots$

b)  $0.4333\dots$

c)  $0.35333\dots$

d)  $3.333\dots$

## Purposeful Practice

Given that  $\frac{5}{17} = 0.\dot{2}94117647058823\dot{5}$ , **write down** the following fractions as recurring decimals.

a)  $\frac{12}{17}$

b)  $\frac{1}{34}$

c)  $\frac{27}{34}$

## Purposeful Practice

Which if the following fractions is equivalent to a recurring decimal?

(a)  $\frac{7}{10}$

(b)  $\frac{7}{9}$

(c)  $\frac{7}{100}$

(d)  $\frac{7}{11}$

(e)  $\frac{7}{20}$

(f)  $\frac{7}{30}$

Using an algebraic method, write the following recurring decimals as a fraction.

(a)  $0.\dot{4}$

(b)  $0.\dot{8}$

(c)  $0.\dot{1}\dot{3}$

(d)  $0.\dot{4}\dot{5}$

(e)  $0.\dot{5}\dot{7}$

(f)  $0.\dot{4}\dot{1}\dot{2}$

(g)  $0.\dot{1}\dot{2}\dot{7}$

(h)  $0.\dot{6}\dot{7}\dot{5}$

Using an algebraic method, write the following recurring decimals as a fraction.

(a)  $0.0\dot{4}$

(b)  $0.0\dot{6}$

(c)  $0.\dot{2}\dot{3}$

(d)  $0.\dot{1}\dot{6}$

(e)  $0.\dot{2}\dot{1}\dot{7}$

(f)  $0.00\dot{4}\dot{5}$

(g)  $0.0\dot{1}\dot{5}\dot{5}$

(h)  $0.3\dot{6}\dot{9}\dot{5}$

Use an algebraic method to show that:

(a)  $0.\dot{1}\dot{5} = \frac{5}{33}$

(b)  $0.\dot{1}\dot{4}\dot{4} = \frac{16}{111}$

(c)  $0.\dot{7}\dot{1} = \frac{32}{45}$

Using an algebraic method, find  $0.\dot{9}$  as a fraction.

## Fluency Practice

Q	Express as a simplified fraction	Answers
1	0.222 ...	
2	0.222	
3	$0.\dot{2}\dot{3}$	
4	0.23	
5	$0.\dot{2}0\dot{3}$	
6	0.203	
7	$0.02\dot{0}\dot{3}$	
8	0.0203	
9	$2.4\dot{6}0\dot{5}$	
10	2.4605	

## Purposeful Practice

<p><b>A1</b> State the conditions under which a fraction can be written as a <b>terminating</b> decimal.</p>	<p><b>A2</b> State the conditions under which a fraction can be written as a <b>recurring</b> decimal.</p>	<p><b>A3</b> Which of the following can be written as <b>terminating</b> decimals:</p> $\frac{2}{3} \quad \frac{3}{4} \quad \frac{4}{9} \quad \frac{5}{6} \quad \frac{5}{8} \quad \frac{3}{7} \quad \frac{3}{5}$	<p><b>A4</b> Which of the following can be written as <b>recurring</b> decimals:</p> $\frac{5}{12} \quad \frac{7}{25} \quad \frac{3}{14} \quad \frac{5}{16} \quad \frac{5}{32} \quad \frac{5}{11}$
<p><b>B1</b> Show that <math>0.\dot{5} = \frac{5}{9}</math></p>	<p><b>B2</b> Show that <math>0.7\dot{3} = \frac{11}{15}</math></p>	<p><b>B3</b> Show that <math>0.61\dot{6} = \frac{37}{60}</math></p>	<p><b>B4</b> Show that <math>3.5\dot{2} = 3\frac{47}{90}</math></p>
<p><b>C1</b> Show that <math>0.2\dot{7} = \frac{3}{11}</math></p>	<p><b>C2</b> Show that <math>0.2\dot{5}\dot{7} = \frac{17}{66}</math></p>	<p><b>C3</b> Show that <math>0.44\dot{7} = \frac{149}{333}</math></p>	<p><b>C4</b> Show that <math>2.5\dot{1} = 2\frac{17}{33}</math></p>
<p><b>D1</b> Work out <math>0.2\dot{7} \times 3</math>, writing your answer as a fraction in its simplest terms.</p>	<p><b>D2</b> Work out <math>0.5\dot{7} - 0.2\dot{6}</math>, writing your answer as a fraction in its simplest terms.</p>	<p><b>D3</b> <math>x</math> is a whole number such that <math>1 \leq x \leq 9</math></p> <p>Write the recurring decimal <math>0.1\dot{x}</math> as a fraction in its simplest terms.</p>	<p><b>D4</b> <math>y</math> is a whole number such that <math>1 \leq y \leq 9</math></p> <p>Show that <math>0.\dot{3}y = \frac{y}{33}</math></p>

## Problem Solving

These decimals have one digit recurring:

$$0.\dot{2} = 0.22222222 \dots$$

$$0.07\dot{2} = 0.07222222 \dots$$

- 1) Write three different decimals with one digit recurring.
- 2) Convert you decimals in part one into fractions in their simplest form. Use the algebraic method.
- 3) Find five fractions with different denominators when in simplest form that have one digit recurring.
- 4) Find the prime factors of the denominators. What do you notice?
- 5) Find five fractions with different denominators when in simplest form that have two digits recurring.
- 6) Find the prime factors of the denominators. What do you notice?
- 7) Repeat 5 and 6 for 3 digits recurring.
- 8) Investigate for other decimals with different number of digits recurring.

## Purposeful Practice

Instructions: Convert the decimal in the middle box to a fraction, giving your answer in its simplest form. Then fill in the remaining boxes, making the minimum change possible from the middle box.

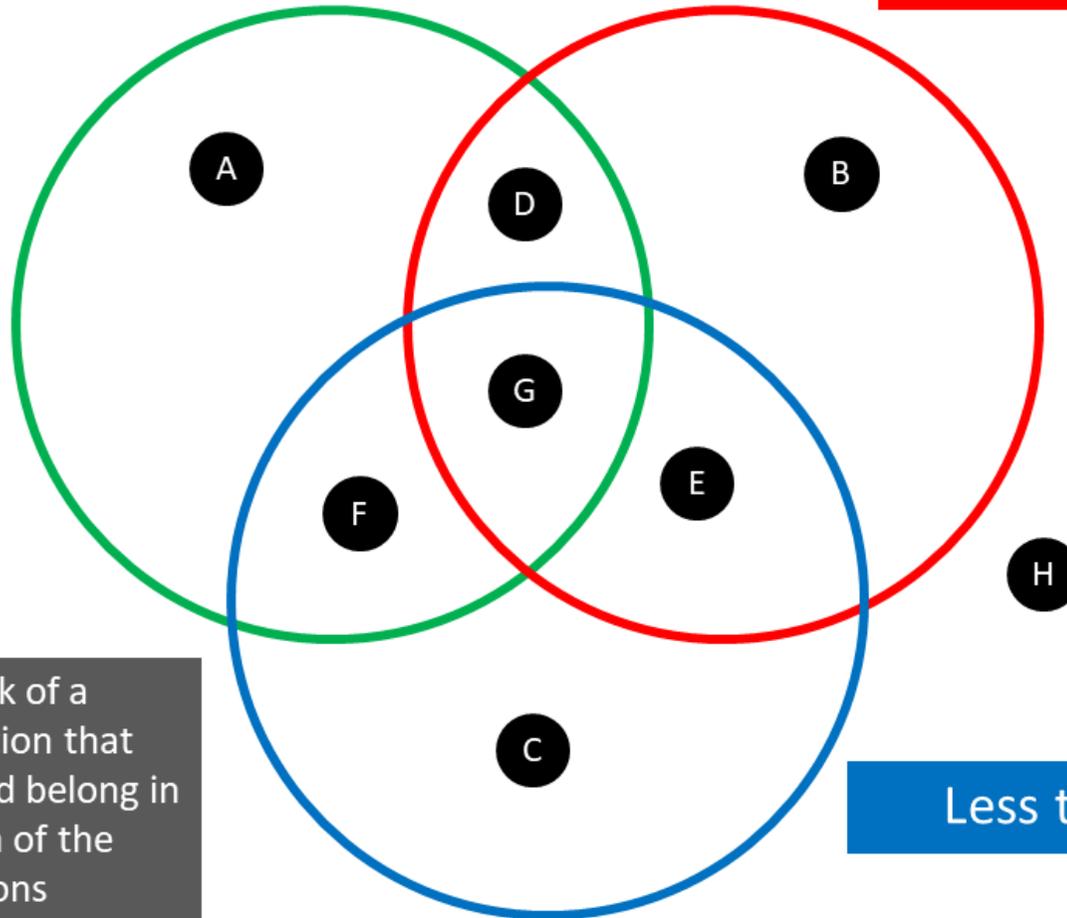
**Number of digits which recur when expressed as a decimal**

	Less	Same	More
More			
Same		<b>0.36</b>	
Less			

# Problem Solving

Can be expressed as a recurring decimal

Denominator is a prime number



If you think a region is impossible to fill, convince me why!

Think of a fraction that could belong in each of the regions

Less than  $\frac{1}{2}$

## Fluency Practice

Prove each of the following sums using recurring decimals.

Prove that  $0.\dot{1} \times 0.\dot{2}\dot{7} = \frac{1}{33}$

Prove that  $0.\dot{5} \times 0.\dot{8}\dot{1} = \frac{5}{11}$

Prove that  $0.\dot{1}\dot{8} \div 0.\dot{4} = \frac{9}{22}$

Prove that  $0.\dot{8} \div 0.\dot{7}\dot{2} = 1\frac{2}{9}$

Prove that  $0.\dot{1}\dot{2}\dot{6} \div 0.\dot{2} = \frac{5}{8}$

Prove that  $0.\dot{1}\dot{9}\dot{4} \div 0.\dot{4} = \frac{7}{16}$

## Purposeful Practice

(a) Using algebra, show that

$$0.\dot{2} + 0.\dot{2}\dot{3} = \frac{5}{11}$$

(b) Using algebra, show that

$$1.\dot{3}\dot{8}\dot{1} - 0.\dot{8}\dot{1} = \frac{31}{55}$$

(a) Using algebra, show that

$$0.5 \times 0.\dot{5}\dot{4} = \frac{10}{33}$$

(b) Using algebra, show that

$$4 \times 0.\dot{8}\dot{5} \times 0.\dot{1}\dot{5} = \frac{14}{27}$$

(a) Using algebra, show that

$$0.\dot{7} \div 0.\dot{2}\dot{1} = 3\frac{13}{19}$$

(b) Using algebra, show that

$$0.\dot{3}\dot{5} \div 1.\dot{2}\dot{7} = \frac{32}{115}$$

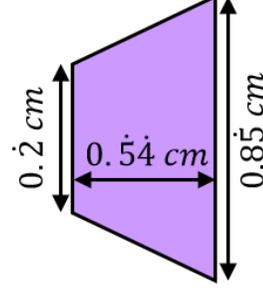
(a) Show that the mean of the three numbers

$$0.\dot{8}, 0.\dot{8}\dot{1} \text{ and } 0.\dot{8}\dot{1}$$

can be written in its simplest form as a fraction  $\frac{a}{b}$ , where  $a$  and  $b$  are integers to be found.

(b) Using algebra, prove that the area of the trapezium shown is

$$\frac{97}{330} \text{ cm}^2$$



## Fluency Practice

Question 1: Use division to convert these fractions to recurring decimals.

(a)  $\frac{1}{3}$  (b)  $\frac{2}{3}$  (c)  $\frac{4}{9}$  (d)  $\frac{7}{9}$  (e)  $\frac{1}{6}$  (f)  $\frac{5}{6}$

(g)  $\frac{3}{11}$  (h)  $\frac{8}{15}$  (i)  $\frac{5}{22}$  (j)  $\frac{1}{7}$  (k)  $\frac{1}{30}$  (l)  $\frac{6}{7}$

Question 2: Convert the following recurring decimals to fractions.  
Give each answer in its simplest form.

- (a) 0.5555... (b) 0.1111... (c) 0.121212...  
 (d) 0.363636... (e) 0.919191... (f) 0.727272...  
 (g) 0.125125... (h) 0.621621... (i) 0.204204...

Question 3: Convert the following recurring decimals to fractions.  
Give each answer in its simplest form.

- (a)  $0.\dot{2}$  (b)  $0.\dot{8}$  (c)  $0.\dot{1}8$   
 (d)  $0.\dot{5}\dot{3}$  (e)  $0.\dot{7}\dot{5}$  (f)  $0.\dot{6}\dot{3}$   
 (g)  $0.\dot{1}\dot{1}\dot{2}$  (h)  $0.\dot{3}\dot{3}\dot{9}$  (i)  $0.\dot{1}\dot{7}\dot{1}$

Question 4: Convert the following recurring decimals to fractions.  
Give each answer in its simplest form.

- (a) 0.533333... (b) 0.266666... (c) 0.088888...  
 (d) 0.1353535... (e) 0.4505050... (f) 0.9121212...  
 (g) 0.0152152... (h) 0.1233333... (i) 0.354141414...

## Fluency Practice

Question 5: Convert the following recurring decimals to fractions.  
Give each answer in its simplest form.

- (a)  $0.\dot{2}8$       (b)  $0.\dot{0}3$       (c)  $0.\dot{9}6$       (d)  $0.\dot{5}\dot{2}\dot{1}$   
(e)  $0.\dot{3}\dot{9}\dot{0}$       (f)  $0.\dot{1}\dot{2}\dot{3}\dot{5}$       (g)  $0.\dot{1}\dot{2}\dot{6}$       (h)  $0.\dot{5}\dot{0}\dot{3}\dot{5}$

Question 6: Convert the following recurring decimals to fractions.  
Give each answer in its simplest form.

- (a) 1.555...      (b) 1.45454545...      (c) 1.24444...  
(d) 2.0717171...      (e) 1.3599999...      (f) 3.8123123...

Question 7: Convert the following recurring decimals to fractions.  
Give each answer in its simplest form.

- (a)  $1.\dot{2}$       (b)  $1.\dot{6}\dot{4}$       (c)  $1.\dot{9}\dot{2}$   
(d)  $2.\dot{0}\dot{3}$       (e)  $3.\dot{6}\dot{5}\dot{9}$       (f)  $8.\dot{6}\dot{7}\dot{9}$

Apply

Question 1: Work out the following addition.  
Give your answer as a simplified fraction

$$0.\dot{5} + 0.\dot{2}\dot{1}$$

Question 2: Work out the following  
Give your answer as a simplified fraction

$$0.\dot{2}\dot{7} + 0.\dot{6}\dot{4} \div 0.5\dot{3}$$

## Purposeful Practice

Question 3: Arrange in order from smallest to largest.

$$\frac{61}{330} \quad 0.1\overline{78} \quad 3^{-2} \quad \frac{19}{110}$$

Question 4: Mark is converting  $0.2\overline{51}$  into a fraction.

Can you spot any mistakes?

$$x = 0.2\overline{51}$$

$$x = 0.2515151\dots$$

$$10x = 2.515151\dots$$

$$100x = 251.515151\dots$$

$$90x = 249$$

$$x = \frac{249}{90}$$

## Problem Solving

In each question, the variables  $x$  and  $y$  represent a single digit from 1 to 9. Give all your answers in their lowest terms.

1. Convert  $0.\dot{x}$  to a fraction.
2. Convert  $0.3\dot{x}$  to a fraction.
3. Convert  $0.x5$  to a fraction.
4. Convert  $0.7\dot{x}$  to a fraction.
5. Convert  $0.\dot{x}y$  to a fraction.
6. Work out  $0.\dot{x}y - 0.y\dot{x}$ , giving your answer as a fraction.
7.  $0.\dot{x}y - 0.y\dot{x} = 0.54$ . How many possible pairs of values of  $x$  and  $y$  are there?
8. The fraction  $\frac{1}{n}$ , where  $n$  is a positive integer, is converted to a decimal. What values of  $n$  will give a terminating decimal? [Hint – use your calculator to try various values of  $n$ ]
9. How many fractions of the form  $\frac{1}{n}$ , where  $n$  is an integer such that  $1 \leq n \leq 30$ , give a terminating decimal?

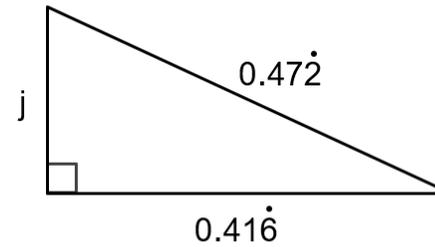
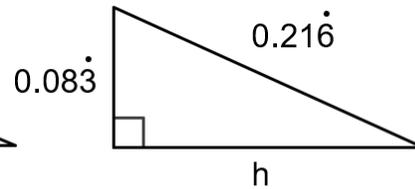
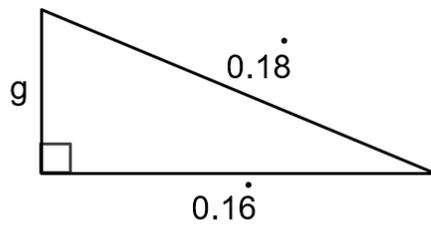
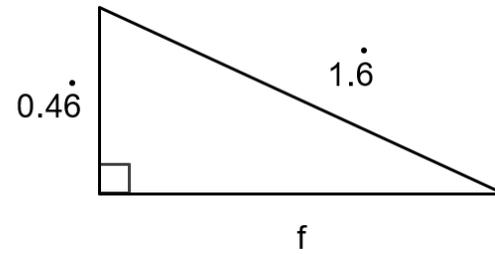
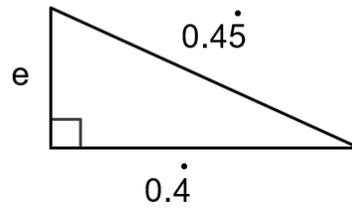
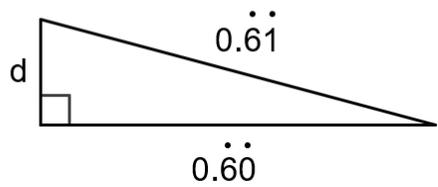
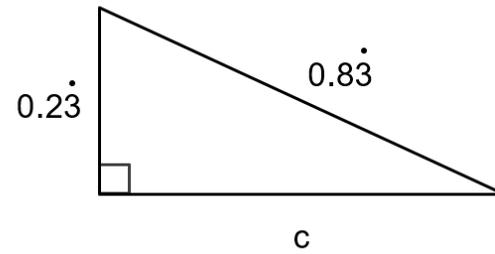
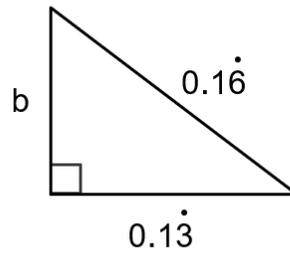
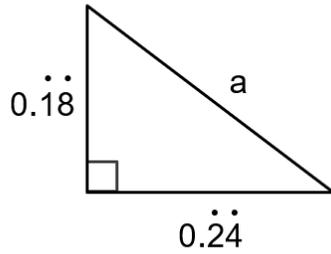
10. Giving your answer as a fraction, work out the value of 
$$\frac{1}{10} + \frac{1}{100} + \frac{1}{1000} + \frac{1}{10000} + \dots$$

Fill in each box in the table with either “always recurring”, “always terminating”, or “sometimes recurring, sometimes terminating”. Provide an example for each case.

$a$	$b$	$a \times b$	$a + b$	$a \div b$
Recurring	Recurring			
Recurring	Terminating			
Terminating	Terminating			

# Fluency Practice

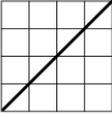
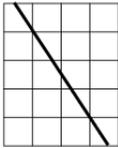
find the length of the missing side as a fraction in its simplest form



## 2 Parallel and Perpendicular Lines

## Fluency Practice

Decide whether each pair of lines is parallel or not parallel.

<b>1</b>	The line with equation $y = -2x + 9$	The line with equation $10 - 2x = y$	Parallel Not Parallel								
<b>2</b>	The line with equation $y = 4x + 3$	The line with equation $y = 3 - 4x$	Parallel Not Parallel								
<b>3</b>	The line with equation $x - 1 = y$	The line shown on the grid 	Parallel Not Parallel								
<b>4</b>	The line with equation $y = 2x - 4$	The line with equation $3y = 9 + 6x$	Parallel Not Parallel								
<b>5</b>	The line with equation $\frac{1}{2}x - 4 = y$	The line with equation $2y = 8 + x$	Parallel Not Parallel								
<b>6</b>	The line shown on the grid 	The line with equation $2y = 3x - 11$	Parallel Not Parallel								
<b>7</b>	The line that passes through $(0, 0)$ and $(3, 9)$	The line with equation $y - 3x = 12$	Parallel Not Parallel								
<b>8</b>	The line with equation $5x + 2y = 20$	The line with equation $20 - \frac{5}{2}x = y$	Parallel Not Parallel								
<b>9</b>	The line with equation $2y + x - 8 = 0$	The line that passes through $(-1, 3)$ and $(2, -3)$	Parallel Not Parallel								
<b>10</b>	The line with table <table border="1" style="display: inline-table; border-collapse: collapse; text-align: center;"> <tbody> <tr> <td style="padding: 2px;"><math>x</math></td> <td style="padding: 2px;">2</td> <td style="padding: 2px;">4</td> <td style="padding: 2px;">6</td> </tr> <tr> <td style="padding: 2px;"><math>y</math></td> <td style="padding: 2px;">9</td> <td style="padding: 2px;">6</td> <td style="padding: 2px;">3</td> </tr> </tbody> </table>	$x$	2	4	6	$y$	9	6	3	The line with equation $6x - 4y = 12$	Parallel Not Parallel
$x$	2	4	6								
$y$	9	6	3								

## Intelligent Practice

Write down the equation:

Parallel to the line	Goes through the point	Answer
$y = 3x + 2$	$(0,7)$	
$y = 3x + 2$	$(3,0)$	
$y = 3x + 2$	$(3,7)$	
$y = 3x + 10$	$(3,7)$	
$y = 2x - 2$	$(3,7)$	
$y = 2x - 2$	$(-3,7)$	
$y = 2x - 2$	$(0,0)$	

## Purposeful Practice

Decide whether each of these pairs of straight lines is parallel or not parallel:

(a)  $y = 2x + 7$  and  $y = 2x - 5$

(b)  $y = 3x + 4$  and  $y = 5x + 4$

(c)  $y = 5x - 3$  and  $y = 5x$

(d)  $y = -4x + 1$  and  $y = 4x + 2$

(e)  $y = \frac{1}{2}x - 8$  and  $y = 9 + \frac{1}{2}x$

(f)  $y = -5 + 2x$  and  $y = 5 - 2x$

(a) Write down the equation of the straight line that is parallel to  $y = 4x - 1$  and passes through  $(0, 5)$

(b) Write down the equation of the straight line that is parallel to  $y = -2x + 7$  and passes through  $(0, 3)$

(c) Write down the equation of the straight line that is parallel to  $y = \frac{3}{4}x - 2$  and passes through  $(0, -8)$

(d) Write down the equation of the straight line that is parallel to  $y = \frac{7}{2}x + \frac{1}{2}$  and passes through the origin

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

(b) Write down the equation of the straight line that is parallel to  $y - 4x = 1$  and passes through  $(0, -\frac{5}{2})$

(c) Write down the equation of the straight line that is parallel to  $3x + y - 5 = 0$  and passes through  $(0, 1)$

Match the pairs of parallel lines:

$y = -7x + 3$

$y + 3x = 7$

$7 + 3x = y$

$7x + y + 3 = 0$

$7y = 7 - 21x$

$y = 3x$

## Purposeful Practice



Line A passes through the points  $(2, 1)$  and  $(5, 10)$

Find the equation of the line parallel to A that passes through  $(2, 5)$

[3]



Line A passes through the points  $(2, 1)$  and  $(5, 10)$

Line B passes through the points  $(4, 7)$  and  $(2, 1)$

Show that Line A and Line B are parallel

[4]



Line A passes through the points  $(3, 6)$  and  $(5, -2)$

Line B passes through the points  $(2, 5)$  and  $(8, k)$

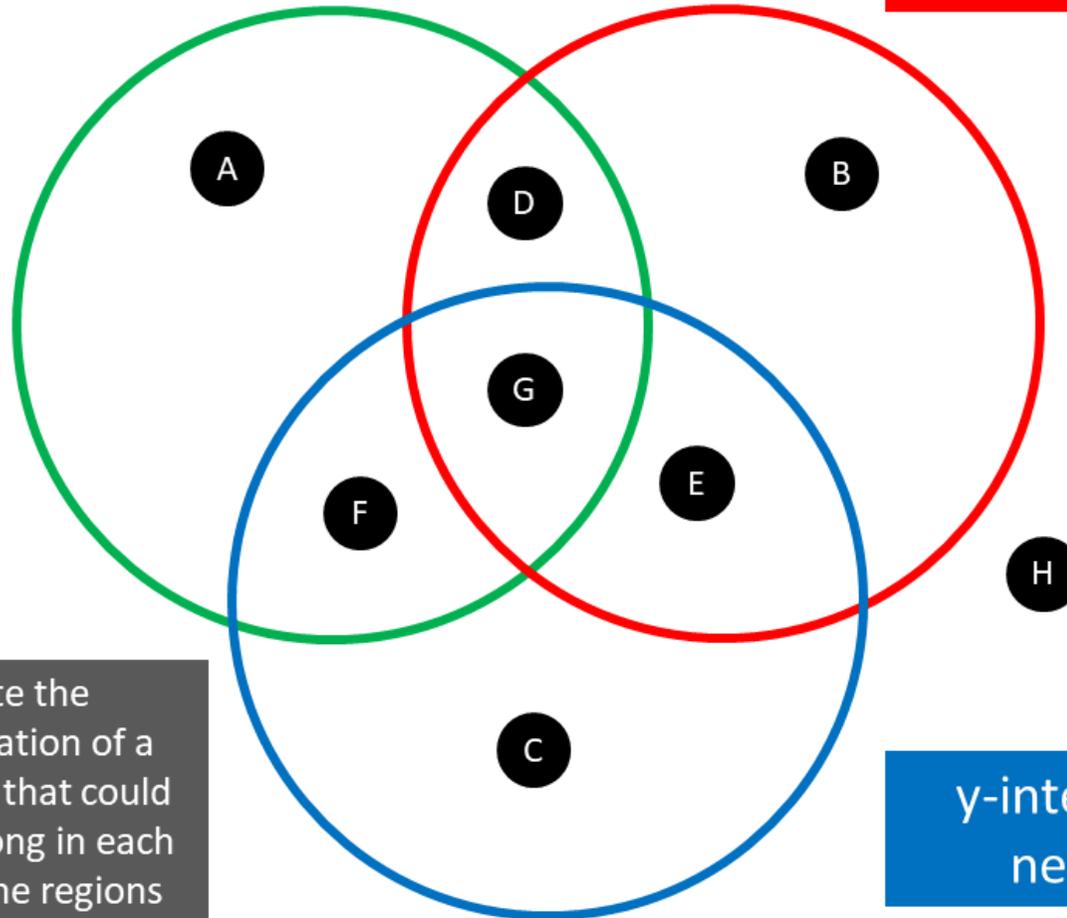
Line A and Line B are parallel. Find the value of  $k$ .

[4]

# Problem Solving

Parallel to  $y = 4x$

Passes through  
(2, 5)



If you think a region is impossible to fill, convince me why!

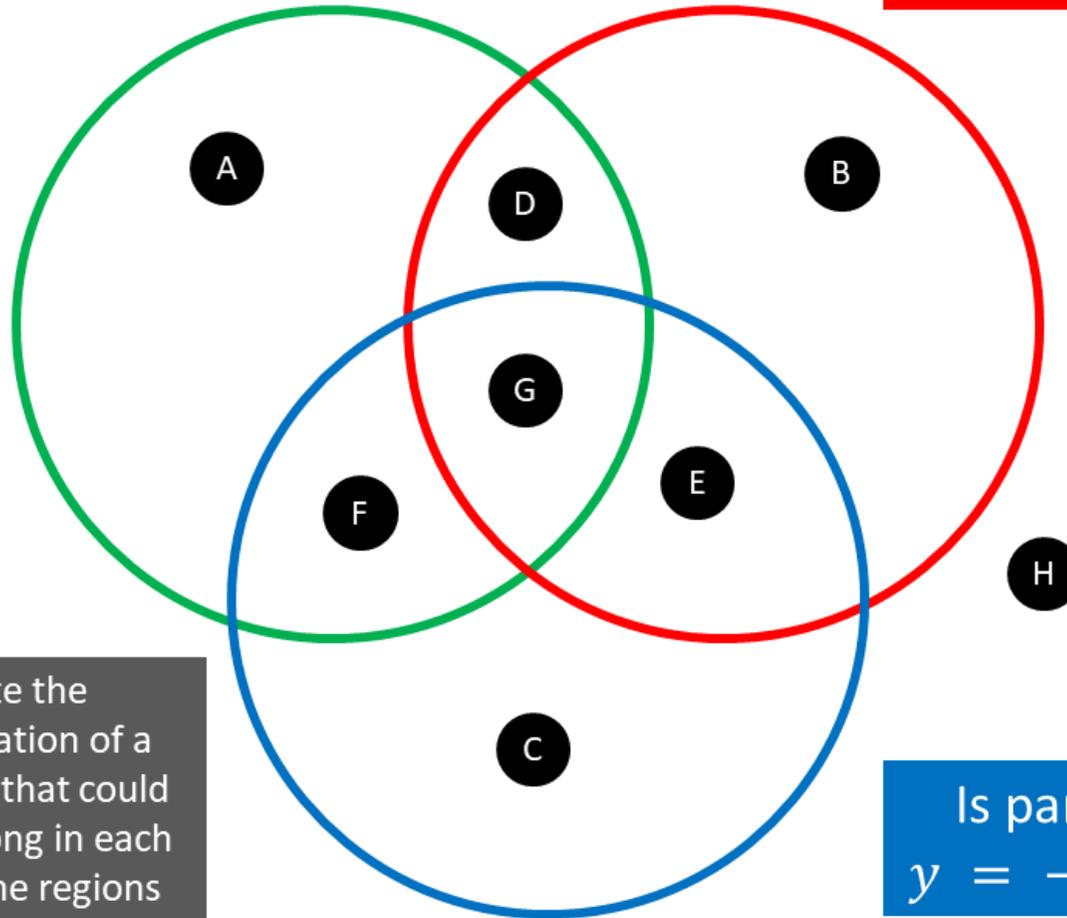
Write the equation of a line that could belong in each of the regions

y-intercept is negative

# Problem Solving

Crosses y-axis at  
 $(0, 4)$

Crosses x-axis at  
 $(2, 0)$



If you think a region is impossible to fill, convince me why!

Write the equation of a line that could belong in each of the regions

Is parallel to  
 $y = -2x + 1$

## Fluency Practice

Q	Work out the:	Answers
1	reciprocal of 0.6	
2	negative reciprocal of $\frac{5}{3}$	
3	reciprocal of 1.4	
4	negative reciprocal of $1\frac{4}{5}$	
5	reciprocal of $-\frac{9}{5}$	
6	negative reciprocal of $\frac{5}{9}$	
7	reciprocal of 0.35	
8	negative reciprocal of $-2\frac{6}{7}$	
9	product of the reciprocal and negative reciprocal of $x$	
10	sum of the reciprocal and negative reciprocal of $x$	

## Intelligent Practice

Write down the equation:

Perpendicular to the line	Goes through the point	Answer
$y = -x + 2$	$(0,7)$	
$y = 2x + 2$	$(0,7)$	
$y = 2x + 2$	$(12,7)$	
$y = 3x + 2$	$(12,7)$	
$y = 3x + 2$	$(10,7)$	
$y = 3x + 2$	$(-12,7)$	
$y = 2x + 2$	$(0,0)$	

## Purposeful Practice

Find the equation of the line that has:

- (a)** Gradient 2 and goes through (0, 5)
- (b)** Gradient -3 and goes through (0, 7)
- (c)** Gradient  $\frac{2}{3}$  and goes through (0, 4)
- (d)** Gradient -4 and goes through (0, -1)
- (e)** Gradient 1 and goes through (0, -6)

Find the equation of the line that is:

- (a)** Parallel to the line  $y = 4x + 7$  and passes through (0, 2)
- (b)** Parallel to the line  $y = -2x + 4$  and passes through (0, 6)
- (c)** Parallel to the line  $y = 3x + 1$  and passes through (0, -4)
- (d)** Parallel to the line  $y = x + 6$  and passes through (0, 5)
- (e)** Parallel to the line  $y = \frac{1}{2}x + 3$  and passes through (0, -1)

Find the equation of the line that is:

- (a)** Perpendicular to the line  $y = 2x + 5$  and passes through (0, 7)
- (b)** Perpendicular to the line  $y = \frac{1}{3}x + 4$  and passes through (0, -5)
- (c)** Perpendicular to the line  $y = -5x + 1$  and passes through (0, 2)
- (d)** Perpendicular to the line  $y = -\frac{1}{4}x + 5$  and passes through (0, -4)
- (e)** Perpendicular to the line  $y = 3x - 1$  and passes through (0, 3)

Match the pairs of perpendicular lines.

$x = 6$	$x + y = 5$	$y = 8x - 9$
$2y = x + 4$	$2x + y = 9$	$y = -\frac{1}{8}x + 6$
$5y = 2x + 15$	$y = 0.1x + 2$	$y = -2$
$y = 33 - 10x$	$2y + 5x = 2$	$y = x + 4$

## Fluency Practice

Equation of line $l_1$	Two points that $l_1$ passes through.		Equation of a line perpendicular to $l_1$ , through point A, in the form $ax + by + c = 0$
	Point A	Point B	
$2x + 3y - 5 = 0$	$(-5, a)$  $a$	$(b, -5)$  $b =$	
	$(-4, 1)$	$(-3, -2)$	
	$(a, 1)$  $a =$	$(b, 3)$  $b =$	$x + 3y - 3 = 0$
$-x + 6y + 17 = 0$		$(b, -2)$  $b =$	$6x + y - 65 = 0$

## Purposeful Practice



Write down the equation of a line perpendicular to  $y = 3x + 3$  [1]



Write down the equation of the line perpendicular to  $y = \frac{1}{2}x + 4$  which passes through (0,7) [2]



Line A passes through the points (-3, -1) and (-1, 9).  
Line B passes through the points (-2, 1) and (k, 4).  
Line A and Line B are perpendicular.  
Find the value of k. [4]

## Fluency Practice

In each question you will need to use the formula  $y = mx + c$ .

Find the equation of the line perpendicular to the line  $y = 2x + 3$  and passes through the point  $(4, 11)$

Where does the line cross the  $x$  and  $y$  axis?

Find the equation of the line perpendicular to the line  $y = 3x - 5$  and passes through the point  $(3, 4)$

Where does the line cross the  $x$  and  $y$  axis?

Find the equation of the line perpendicular to the line  $y = -2x + 8$  and passes through the point  $(6, -4)$

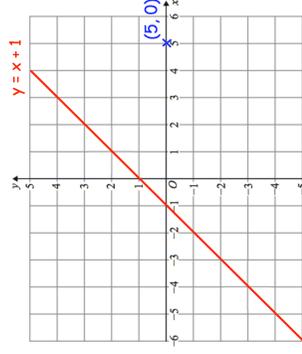
Find the equation of the line perpendicular to the line  $y = -3x + 5$  and passes through the point  $(6, -13)$

Find the equation of the line perpendicular to the line  $y = \frac{1}{2}x + 4$  and passes through the point  $(6, 7)$

Find the equation of the line perpendicular to the line  $y = 5x - 9$  and passes through the point  $(10, 41)$

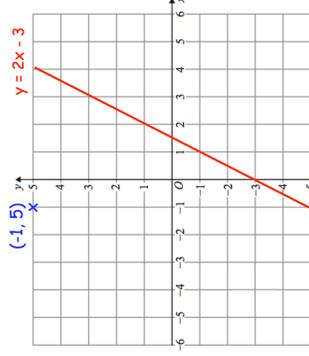
# Fluency Practice

Question 1: Shown on the grid is the line,  $y = x + 1$ , and the point  $(5, 0)$



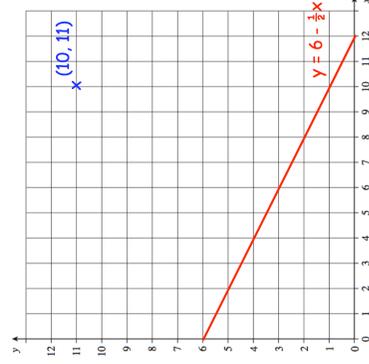
- (a) Find the gradient of a line perpendicular to  $y = x + 1$
- (b) Find the equation of the line perpendicular to  $y = x + 1$  that passes through the point  $(5, 0)$
- (c) Find the point where your answer to (b) and the line  $y = x + 1$  intersect.
- (d) Calculate the distance between your answer to (c) and the point  $(5, 0)$

Question 2: Shown on the grid is the line,  $y = 2x - 3$ , and the point  $(-1, 5)$



- (a) Find the gradient of a line perpendicular to  $y = 2x - 3$
- (b) Find the equation of the line perpendicular to  $y = 2x - 3$  that passes through  $(-1, 5)$
- (c) Find the point where your answer to (b) and the line  $y = 2x - 3$  intersect.
- (d) Calculate the distance between your answer to (c) and the point  $(-1, 5)$

Question 3: Shown on the grid is the line,  $y = 6 - \frac{1}{2}x$  and the point  $(10, 11)$



- (a) Find the equation of the line perpendicular to  $y = 6 - \frac{1}{2}x$  that passes through  $(10, 11)$ .
- (b) Find where your answer to (a) intersects  $y = 6 - \frac{1}{2}x$
- (c) Calculate the shortest distance between the  $(10, 11)$  and the line  $y = 6 - \frac{1}{2}x$

## Fluency Practice

Question 4: Calculate the shortest distances between the following lines and points.

- (a) The line  $y = -x + 2$  and the point  $(8, 4)$
- (b) The line  $y = 4x + 7$  and the point  $(-13, 6)$
- (c) The line  $x - 3y + 9 = 0$  and the point  $(5, 38)$

Question 5: Calculate the shortest distances between the following lines and points.

- (a) The line  $y = 5x + 1$  and the point  $(3, 3)$
- (b) The line  $y = -2x - 15$  and the point  $(-1, -4)$
- (c) The line  $2x + y + 5 = 0$  and the point  $(0, 0)$

Apply

Question 1: The line  $L_1$  has equation  $y = 2x - 4$   
The line  $L_2$  has equation  $y = -3x + 11$   
The line  $L_3$  has equation  $y = x$   
 $L_1$  and  $L_2$  meet at the point A.

Work out the shortest distance between the line  $L_3$  and the point A.

Question 2: ABC is a triangle.  
A is the point  $(-5, 2)$   
B is the point  $(0, 8)$   
C is the point  $(9, 3)$

Work out the area of triangle ABC.

## Fluency Practice

**PAR. or PERP. ?**

For lines 1-10, which line is **PARALLEL** and which is **PERPENDICULAR**?

L <sub>1</sub>	$y = 5 - x$	$2y = 4x - 6$	$y + x = 3$	$y = x + 5$
L <sub>2</sub>	$y = 3x + 5$	$y = 6 - \frac{x}{3}$	$y = 5x - 3$	$y = 5 + 3x$
L <sub>3</sub>	$y = 4 - 2x$	$y + 2x = 7$	$y = 2x - 3$	$2y = x - 3$
L <sub>4</sub>	$x + y = 7$	$2y = 5 - x$	$y = \frac{x}{2} - 6$	$x + y = 6$
L <sub>5</sub>	$2y = 4x - 5$	$y - 2x = 8$	$y - 3x = 9$	$y = 1 - \frac{1}{2}x$
L <sub>6</sub>	$y - 3x = 8$	$3y = 6 - x$	$2y - 6x = 10$	$6x + 3y = 7$
L <sub>7</sub>	$2x + y = 4$	$4y - 6x = 9$	$y = \frac{x}{2} - 3$	$4x + 2y = 7$
L <sub>8</sub>	$2y = x - 10$	$4y = 2x + 7$	$3y - x = 6$	$2y = 10 - 4x$
L <sub>9</sub>	$4y + x = 16$	$3y - 12x = 3$	$8y = 4 - 2x$	$2y + 4x = -3$
L <sub>10</sub>	$4y - 3x = 12$	$8y = 12 - 6x$	$6y + 8x = 5$	$8 = 3x - 4y$

## Fluency Practice

Q	Find the equation of the line that is:	Answers
1	Parallel to $y = 2x + 5$ and passes through $(4, 9)$	
2	Perpendicular to $y = 2x + 5$ and passes through $(4, 9)$	
3	Parallel to $y = 3x - 4$ and passes through $(9, 4)$	
4	Perpendicular to $y = 3x - 4$ and passes through $(9, 4)$	
5	Parallel to $y = \frac{1}{2}x + 5$ and passes through $(4, 9)$	
6	Perpendicular to $y = \frac{1}{2}x + 5$ and passes through $(4, 9)$	
7	Parallel to $y = -\frac{1}{3}x - 4$ and passes through $(-12, 1)$	
8	Perpendicular to $y = -\frac{1}{3}x - 4$ and passes through $(-12, 1)$	
9	Parallel to $2x + 3y = 5$ and passes through $(12, -5)$	
10	Perpendicular to $2x + 3y = 5$ and passes through $(12, -5)$	
11	Parallel to $3x - 5y = 2$ and passes through $(-15, 2)$	
12	Perpendicular to $3x - 5y = 2$ and passes through $(-15, 2)$	

## Fluency Practice

Q	Find the equation of the line that is:	Answers
1	Parallel to the line connecting $(2, 5)$ and $(7, 15)$ and passes through $(1, -4)$	
2	Perpendicular to the line connecting $(2, 5)$ and $(7, 15)$ and passes through $(4, -1)$	
3	Parallel to the line connecting $(2, 5)$ and $(7, -15)$ and passes through $(1, -4)$	
4	Perpendicular to the line connecting $(2, 5)$ and $(7, -15)$ and passes through $(4, -1)$	
5	Parallel to the line connecting $(-2, 5)$ and $(-7, -15)$ and passes through $(1, -4)$	
6	Perpendicular to the line connecting $(2, -5)$ and $(7, -25)$ and passes through $(4, 1)$	
7	Perpendicular to the line connecting $(2, 5)$ and $(8, 17)$ and passes through its midpoint	
8	Perpendicular to the line connecting $(1, 4)$ and $(7, 22)$ and passes through its midpoint	

## Fluency Practice

Decide whether each of these pairs of lines is perpendicular, parallel or neither:

(a)  $y = 2x - 1$  and  $y = -\frac{1}{2}x + 5$

(b)  $y = \frac{1}{3}x + 2$  and  $y = \frac{1}{3}x - 4$

(c)  $y = 1 - 4x$  and  $y = -\frac{1}{4}x + \frac{3}{4}$

(d)  $y = \frac{2}{3}x$  and  $y = -\frac{3}{2}x - 6$

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

(b) Write down the equation of the straight line that is perpendicular to the line  $y = \frac{1}{4}x - 5$  and passes through  $(0, 7)$

(c) Write down the equation of the straight line that is perpendicular to the line  $y = -\frac{1}{2}x$  and passes through  $(0, -4)$

(a) Write down the equation of the straight line that is perpendicular to the line  $y = 4 - 5x$  and passes through  $(0, -8)$

(b) Write down the equation of the straight line that is perpendicular to the line  $y + 3x = 9$  and passes through  $(0, 0)$

(c) Write down the equation of the straight line that is perpendicular to the line  $2y = -5x + 6$  and passes through  $(0, 4)$

Match the pairs of perpendicular lines:

$$y = \frac{2}{3}x - 1$$

$$y = \frac{1}{2}x + \frac{3}{2}$$

$$y - 3x = 2$$

$$2 - 3x = 2y$$

$$3 - 2x = y$$

$$3y + x + 2 = 0$$

## Fluency Practice

- (a)** Find the equation of the line with gradient 7 that passes through  $(1, 3)$
- (b)** Find the equation of the line with gradient  $-2$  that passes through  $(4, 3)$
- (c)** Find the equation of the line with gradient 2 that passes through  $(1, -4)$
- (d)** Find the equation of the line with gradient  $-3$  that passes through  $(-1, 6)$

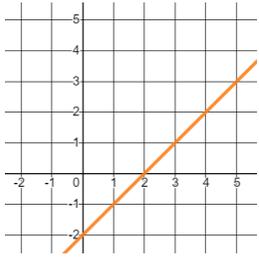
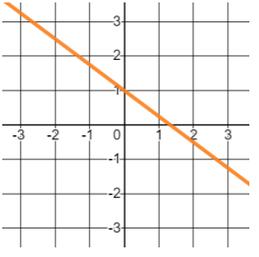
- (e)** Find the equation of a line which is parallel to  $y = 2x + 1$  and passes through  $(3, 1)$ .
- (f)** Find the equation of a line which is parallel to  $y = 3x + 1$  and passes through  $(6, 10)$ .
- (g)** Find the equation of a line which is parallel to  $y = 5x - 2$  and passes through  $(5, 7)$ .
- (h)** Find the equation of a line which is parallel to  $y = 4x - 7$  and passes through  $(4, -3)$ .

- (i)** Find the equation of a line which is perpendicular to  $y = 2x + 6$  and passes through  $(6, 4)$ .
- (j)** Find the equation of a line which is perpendicular to  $y = -4x + 7$  and passes through  $(12, 15)$ .
- (k)** Find the equation of a line which is perpendicular to  $y = \frac{1}{5}x + 6$  and passes through  $(3, 1)$ .
- (l)** Find the equation of a line which is perpendicular to  $y = -\frac{1}{6}x + 3$  and passes through  $(2, 10)$ .

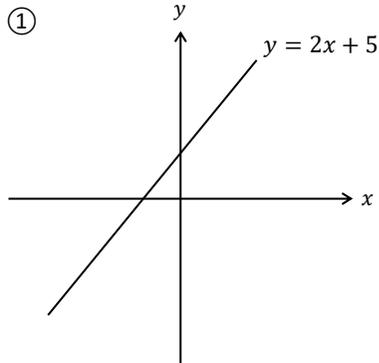
## Fluency Practice

<b>Coordinates and Straight Lines</b>			
<b>(a)</b>	<b>(b)</b>	<b>(c)</b>	<b>(d)</b>
Write down the gradient of the line with equation $y = -3x + 5$	Write down the y-intercept of the line with equation $y = 5x - 1$	Write down the gradient of the line with equation $y = \frac{2}{3}x - 1$	Write down the y-intercept of the line with equation $y = 6 - 5x$
<b>(e)</b>	<b>(f)</b>	<b>(g)</b>	<b>(h)</b>
Write down the equation of the line with gradient 4 and y-intercept $(0, -3)$	Find the midpoint of the line segment joining $(5, 2)$ and $(9, -2)$	Write down the equation of the line with y-intercept $(0, 7)$ and gradient $-\frac{1}{2}$	Find the equation of the line parallel to $y = 3x - 1$ that passes through $(0, 6)$
<b>(i)</b>	<b>(j)</b>	<b>(k)</b>	<b>(l)</b>
Find the midpoint of the line segment joining $(-4, 1)$ and $(-8, 5)$	Find the length of the line joining $(3, 1)$ and $(7, 4)$	Find the equation of the line parallel to $y = -\frac{3}{2}x$ that passes through $(0, 5)$	Find the length of the line joining $(-1, 3)$ and $(4, 12)$
<b>(m)</b>	<b>(n)</b>	<b>(o)</b>	<b>(p)</b>
Find the equation of the line with gradient 2 that passes through $(5, 3)$	Find the equation of the line parallel to $y = -3x$ that passes through $(2, 4)$	Find the equation of the line that passes through $(5, 4)$ and $(3, 10)$	Find the equation of the line that is perpendicular to $y = -2x + 1$ and passes through $(-3, 5)$

## Fluency Practice

<b>(a)</b>	<b>(b)</b>	<b>(c)</b>	<b>(d)</b>
Write down the gradient and y-intercept of the straight line with equation $y = 5x - 2$	Write down the gradient and y-intercept of the straight line with equation $y = -\frac{1}{2}x + 7$	Write down the gradient and y-intercept of the straight line with equation $3y = 2x - 9$	Find the gradient of the line joining $(2, 5)$ and $(4, 11)$
<b>(e)</b>	<b>(f)</b>	<b>(g)</b>	<b>(h)</b>
Find the equation of the line. 	Find the equation of the line. 	Write down the equation of the line that is parallel to $y = -4x - 9$ and passes through $(0, 2)$	Write down the equation of the line that is perpendicular to $y = -3x$ and passes through the point $(0, -5)$
<b>(i)</b>	<b>(j)</b>	<b>(k)</b>	
Find the equation of the line that has a gradient of 2 and passes through $(4, 3)$	Find the equation of the line that is perpendicular to the line $2y = x - 8$ and passes through $(-1, 9)$	Find the equation of the line that passes through $(2, 9)$ and $(5, 3)$ .	

# Fluency Practice



On the axes, sketch the graphs:

$y = 3x$        $y = 2x - 6$

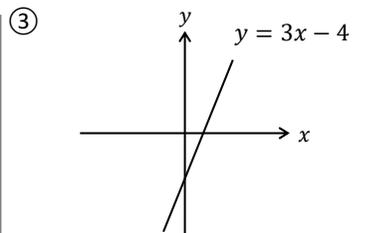
$y = \frac{x}{2} + 5$

②

$y = 3x + 5$   
 Gradient = \_\_\_\_\_  
 y-intercept = \_\_\_\_\_

$y = 8 - 2x$   
 Gradient = \_\_\_\_\_  
 y-intercept = \_\_\_\_\_

$2y + x = 7$   
 Gradient = \_\_\_\_\_  
 y-intercept = \_\_\_\_\_

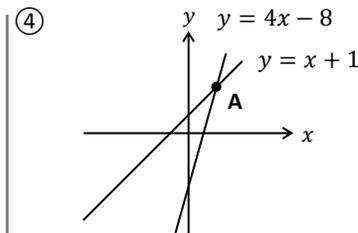


Which coordinates are on this graph?

- (4, 8)      (0, 4)      (-2, -2)

Complete these coordinates for the graph  $2y = 5x + 2$

- (4, y)      (x, 6)      (x, -9)



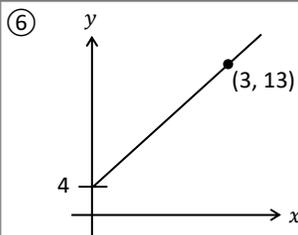
Find the coordinates of point A.

Find the coordinates of the point where the graphs  $y = 3x + 9$  &  $y = \frac{x}{2} + 4$  intersect.

⑤

Line N is parallel to the graph  $y = 5x - 7$  & passes through (4, 22).  
 Find the equation of Line N

Line O is parallel to the graph  $y = 5 - 2x$  & passes through (5, -13).  
 Find the equation of Line O



Find the equation of this line.

Line P passes through (1, 3) & (3, 11).  
 Find the equation of this line.

Line Q passes through (-2, 10) & (5, -4).  
 Find the equation of this line.

⑦

$y = 2x + 5$   
 Find the gradient of a line perpendicular to this graph.

$y = 10 - 4x$   
 Find the gradient of a line perpendicular to this graph.

$3y + 2x = 7$   
 Find the gradient of a line perpendicular to this graph.

⑧

Line R is perpendicular to the graph  $y = 2x + 4$  & passes through (8, 2).  
 Find the equation of Line R

Line S passes through (4, 6) & (8, 8)  
 Line T is perpendicular to this line & passes through its midpoint.  
 Find the equation of Line T.

## Purposeful Practice

Harder Coordinate Geometry		
(a)	(b)	(c)
Find an equation of the line that passes through the points $(4, 2)$ and $(-8, 11)$ . Give your answer in the form $ax + by = c$ where $a$ , $b$ and $c$ are integers.	The straight line $L$ has equation $5x - 3y = 18$ . Find an equation of the line that is parallel to $L$ and crosses the $x$ -axis at $(4, 0)$ .	The straight line $L_1$ has equation $x + 2y - 7 = 0$ . The straight line $L_2$ passes through the points $(-2, -6)$ and $(5, 8)$ . Show that the lines $L_1$ and $L_2$ are perpendicular to each other.
(d)	(e)	(f)
The straight line $L$ passes through the points $(1, -1)$ and $(5, 9)$ . Find an equation of the line that is parallel to $L$ and passes through the point $(2, 4)$ . Give your answer in the form $ax + by + c = 0$ where $a$ , $b$ and $c$ are integers.	The straight line $L_1$ has equation $2x - 3y = 4$ . The straight line $L_2$ is perpendicular to $L_1$ and passes through the point $(1, 2)$ . Find the equation of the line $L_2$ and the coordinates of the point where it crosses the $x$ -axis.	$ABC$ is a triangle, where $\widehat{BAC} = 90^\circ$ . The point $C$ has coordinates $(9, 5)$ and points $A$ and $B$ lie on the line with equation $2x + 3y = 7$ . Find the equation of the line that passes through $A$ and $C$ , giving your answer in the form $ax + by = c$ where $a$ , $b$ and $c$ are integers.

## Fluency Practice

Find the midpoints of the line segments joining:

- (a)  $(4, 5)$  and  $(8, 1)$
- (b)  $(6, 0)$  and  $(12, 4)$
- (c)  $(8, -2)$  and  $(4, -10)$
- (d)  $(3, -1)$  and  $(-5, 1)$
- (e)  $(4, 7)$  and  $(3, 3)$
- (f)  $(9, -1)$  and  $(6, 3)$
- (g)  $(0, 5)$  and  $(-4, 8)$
- (h)  $(-2, -3)$  and  $(4, -4)$
- (i)  $(1.5, 3)$  and  $(7.5, 2.5)$
- (j)  $(-3.5, 9)$  and  $(-2.5, 4)$

Find the lengths of the line segments joining:

- (a)  $(1, 1)$  and  $(4, 5)$
- (b)  $(8, 4)$  and  $(2, -4)$
- (c)  $(-2, 5)$  and  $(3, 17)$
- (d)  $(6, 3)$  and  $(5, -4)$
- (e)  $(4, 7)$  and  $(3, 3)$
- (f)  $(9, -1)$  and  $(6, 3)$
- (g)  $(0, 5)$  and  $(-4, 8)$
- (h)  $(-2, -3)$  and  $(4, -4)$

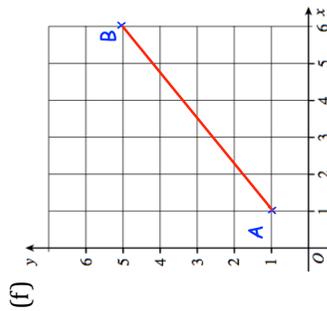
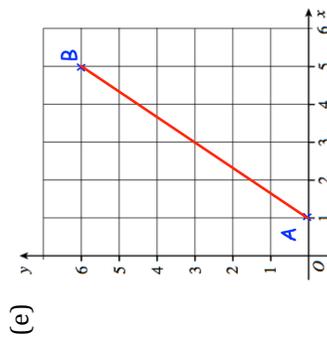
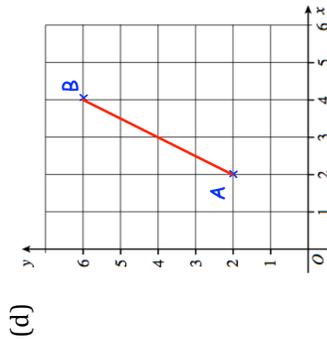
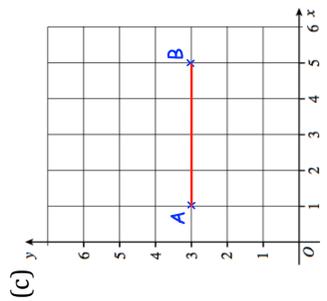
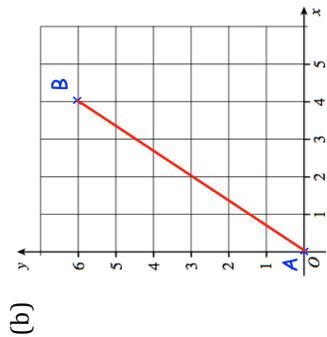
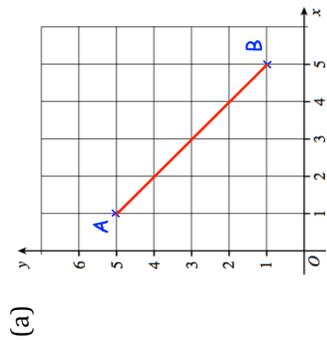
The line segment AB has the midpoint  $(7, 5)$ . If point A is  $(3, 4)$ , what are the coordinates of point B?

The line segment CD has the midpoint  $(-2, 4)$ . If point D is  $(5, -1)$ , what are the coordinates of point C?

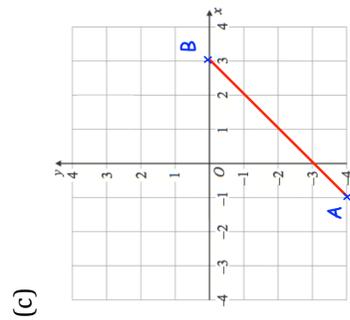
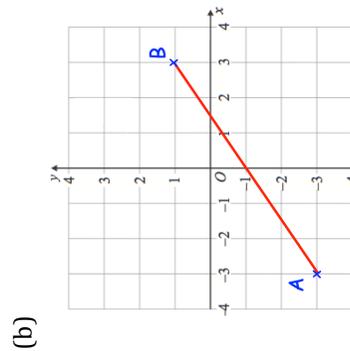
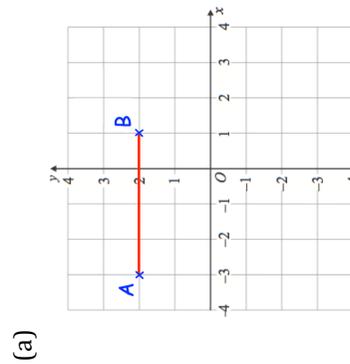
The line segment AB has length 10. If point A is  $(8, 11)$ , find as many possible positions for point B as you can.

# Fluency Practice

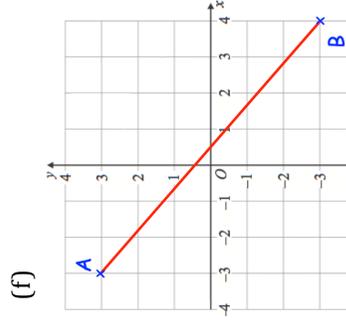
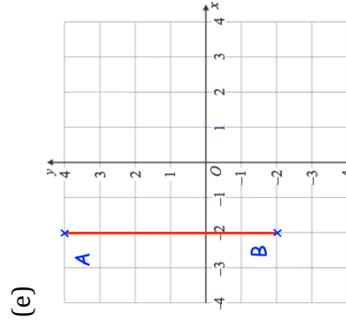
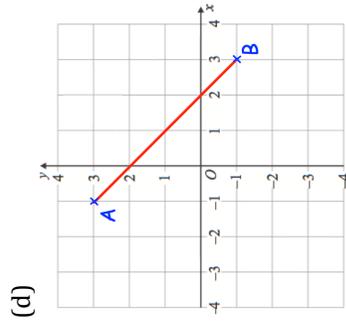
Question 1: Find the coordinates of the midpoints of the following line segments.



Question 2: Find the coordinates of the midpoints of the following line segments.



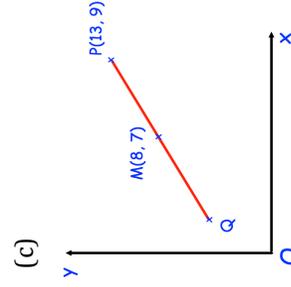
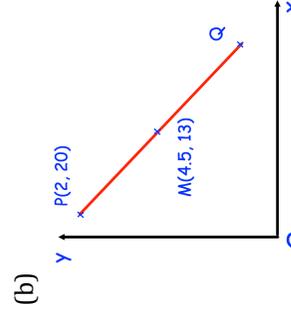
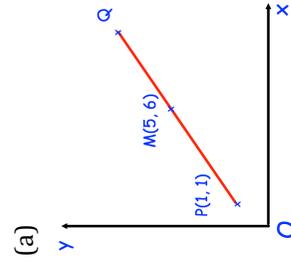
# Fluency Practice



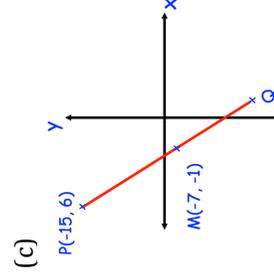
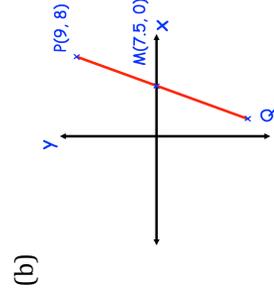
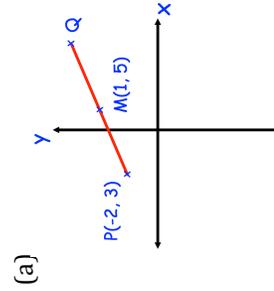
Question 3: Find the midpoint of the line joining these pairs of points

- (a) (2, 4) and (6, 10)
- (b) (1, 4) and (9, 12)
- (c) (0, 7) and (6, 1)
- (d) (-5, 2) and (5, -4)
- (e) (-3, 9) and (7, -1)
- (f) (0, -4) and (9, 0)
- (g) (-10, -6) and (-2, 8)
- (h) (0, 5) and (-11, -10)
- (i) (9, 8) and (4, 8)

Question 4: M is the midpoint of PQ in each diagram below.  
Find the coordinates of Q in each diagram.



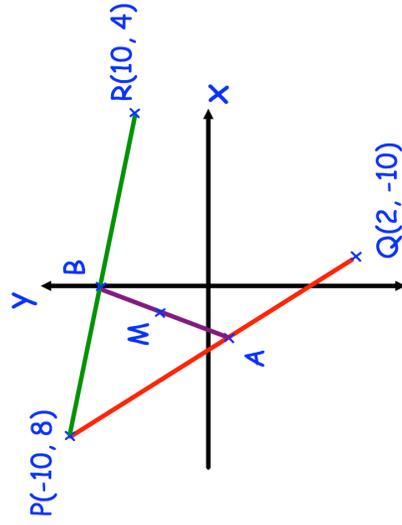
Question 5: M is the midpoint of PQ in each diagram below.  
Find the coordinates of Q in each diagram.



# Purposeful Practice

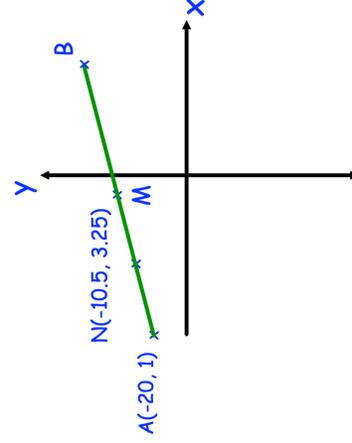
## Apply

Question 1: A is the midpoint of the line PQ.  
B is the midpoint of the line PR.  
M is the midpoint of the line AB.  
Find the coordinates of the point M



Question 2: M is the midpoint of the line AB.  
The coordinates of the point M are (7, 2)  
The coordinates of the point B are (11, 8)  
The coordinates of the point C are (7, -4)  
Find the area of triangle ACM.

Question 3: M is the midpoint of AB.  
N is the midpoint of AM.  
Find the coordinates of the point B.



# Fluency Practice

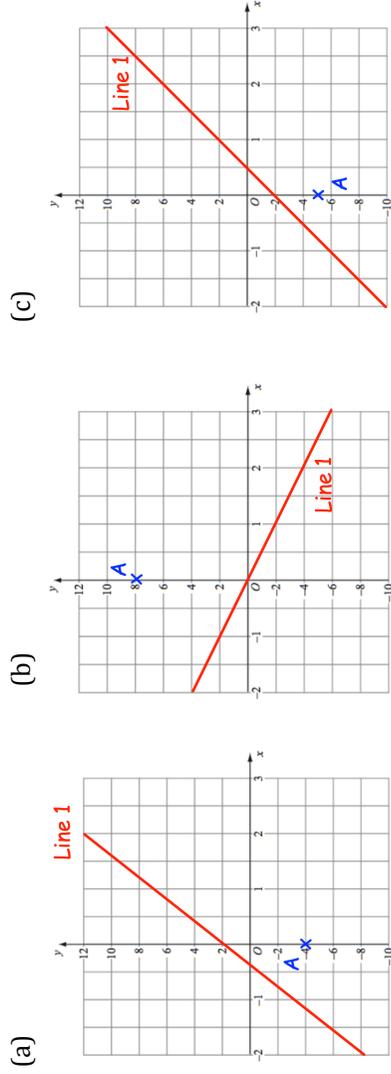
Question 1: Write down the equation of a line parallel to each of the following

- (a)  $y = 2x + 3$       (b)  $y = 5x - 3$       (c)  $y = -3x + 1$       (d)  $y = x - 7$   
 (e)  $y = -7x - 10$       (f)  $y = -x$       (g)  $y = 10x$       (h)  $y = 4$   
 (i)  $x + y = 5$       (j)  $2x + y - 1 = 0$       (k)  $x - 2y + 5 = 0$       (l)  $3x - 4y - 9 = 0$

Question 2: Write down the equation of each of the following lines

- (a) Parallel to  $y = 3x + 5$  and passing through  $(0, 2)$   
 (b) Parallel to  $y = 4x - 1$  and passing through  $(0, 6)$   
 (c) Parallel to  $y = 5x$  and passing through  $(0, -3)$   
 (d) Parallel to  $y = -2x + 10$  and passing through the origin  
 (e) Parallel to  $x + y = 8$  and passing through  $(0, -4)$   
 (f) Parallel to  $x - 2y + 3 = 0$  and passing through  $(0, 5)$

Question 3: Write down the equation of the line parallel to Line 1 and passing through A.



## Fluency Practice

Question 4: Write down the equation of each of the following lines

- (a) Parallel to  $y = 2x - 1$  and passing through  $(1, 8)$
- (b) Parallel to  $y = 3x + 2$  and passing through  $(1, 1)$
- (c) Parallel to  $y = 5x - 4$  and passing through  $(2, 9)$
- (d) Parallel to  $y = 3x - 7$  and passing through  $(4, 15)$
- (e) Parallel to  $y = 4x$  and passing through  $(-1, 3)$
- (f) Parallel to  $y = -2x + 5$  and passing through  $(-3, 0)$
- (g) Parallel to  $y = 6x + 3$  and passing through  $(10, 5)$
- (h) Parallel to  $y = -\frac{1}{2}x + 1$  and passing through  $(3, 0)$
- (i) Parallel to  $x + y = 10$  and passing through  $(4, 0)$
- (j) Parallel to  $x - 3y - 6 = 0$  and passing through  $(-9, -2)$

Question 5: Write down the negative reciprocal of each number below.

- (a) 4      (b)  $\frac{2}{3}$       (c)  $-6$       (d) 8      (e)  $\frac{1}{2}$       (f) 1
- (g)  $-\frac{1}{3}$       (h)  $-\frac{2}{5}$       (i)  $\frac{4}{7}$       (j)  $1\frac{1}{2}$       (k)  $-1$       (l)  $-1\frac{3}{4}$

Question 6: Write down the equation of a line perpendicular to each of the following

- (a)  $y = 4x + 2$       (b)  $y = 2x - 7$       (c)  $y = -5x + 2$       (d)  $y = x - 3$
- (e)  $y = -x + 1$       (f)  $y = \frac{1}{2}x + 3$       (g)  $y = \frac{3}{4}x - 2$       (h)  $y = -\frac{1}{5}x + 1$
- (i)  $y = -\frac{2}{3}x - 5$       (j)  $x + y = 12$       (k)  $x - 2y + 8 = 0$       (l)  $5x - 3y - 3 = 0$

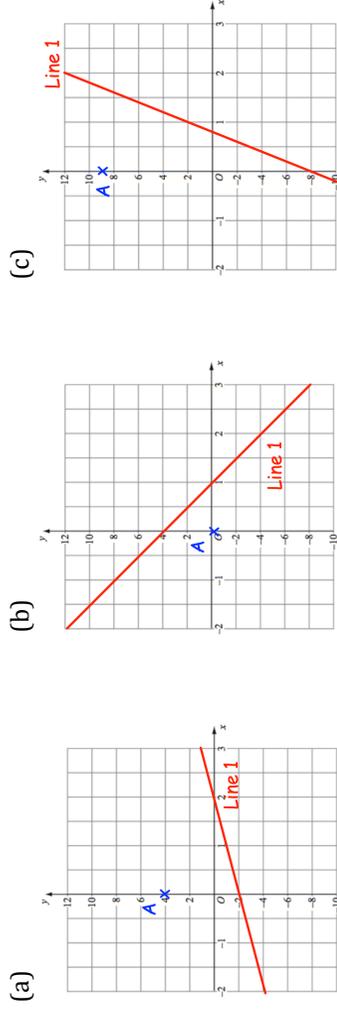
Question 7: Write down the equation of each of the following lines

- (a) Perpendicular to  $y = 2x + 4$  and passing through  $(0, 3)$
- (b) Perpendicular to  $y = -3x - 8$  and passing through  $(0, -2)$
- (c) Perpendicular to  $x + y = 6$  and passing through  $(0, 1)$

# Fluency Practice

- (d) Perpendicular to  $y = \frac{1}{3}x - 2$  and passing through the origin
- (e) Perpendicular to  $y = -\frac{1}{5}x + 8$  and passing through  $(0, -2)$
- (f) Perpendicular to  $y = -\frac{2}{9}x - 10$  and passing through  $(0, 6)$

Question 8: Write down the equation of the line perpendicular to Line 1 & passing through A.



Question 9: Write down the equation of each of the following lines

- (a) Perpendicular to  $y = 2x - 1$  and passing through  $(4, 0)$
- (b) Perpendicular to  $y = -3x + 4$  and passing through  $(6, 1)$
- (c) Perpendicular to  $y = 4x$  and passing through  $(-12, 5)$
- (d) Perpendicular to  $y = -\frac{1}{2}x + 1$  and passing through  $(3, -7)$
- (e) Perpendicular to  $y = \frac{2}{3}x + 4$  and passing through  $(-6, -4)$
- (f) Perpendicular to  $y = -\frac{3}{5}x - 2$  and passing through  $(9, 9)$
- (g) Perpendicular to  $x + 4y - 6 = 0$  and passing through  $(1, 8)$

$y = 2x$	$y = \frac{1}{2}x + 1$
$y = 3x + 2$	$y = -5x$
$y = 5x - 4$	$y = -2x + 3$
	$y = 3x - 2$

Apply

Question 1: Write down the equations of the lines, from the box, that are:

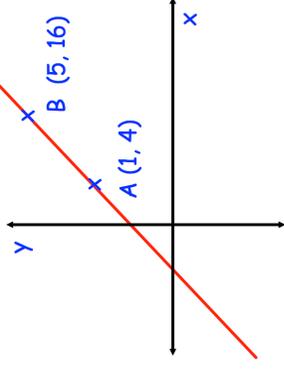
- (a) parallel
- (b) perpendicular
- (c) cross the y-axis at  $(0, 3)$
- (d) pass through the origin
- (e) pass through the point  $(1, 1)$

# Fluency Practice

Question 2: Are the lines  $2x + y = 8$  and  $y = 2x + 5$  parallel?

Question 3: Are the lines  $4x - y - 5 = 0$  and  $x + 4y + 1 = 0$  perpendicular?

Question 4: A straight line passes through the points  $A(1, 4)$  and  $B(5, 16)$ .



(a) Find the equation of the line parallel to  $AB$  that passes through  $(1, 7)$

(b) Find the equation of the line perpendicular to  $AB$  that passes through the midpoint of  $AB$ .

Question 5: The line  $L$  has equation  $y = 2x + 8$

The line  $L$  crosses the  $x$ -axis at the point  $A$ .

The line  $M$  is perpendicular to Line  $L$  and passes through the point  $A$

(a) Find the coordinates of the point  $A$ .

(b) Find equation of the Line  $M$ .

Question 6: The point  $A$  has coordinates  $(-12, -7)$  and the point  $B$  has coordinates  $(-8, 1)$

Find the equation of the line parallel to  $AB$  and passing through  $(2, 5)$

Question 7: The line  $L$  passes through the points  $(-2, 1)$  and  $(2, 3)$ .

The line  $N$  passes through the points  $(4, 7)$  and  $(12, 11)$ .

Bryan says that the lines  $L$  and  $N$  are parallel.

Is Bryan correct? Explain your answer.

Question 8: The point  $C$  has coordinates  $(2, -3)$  and the point  $D$  has coordinates  $(4, 6)$ .

Find the equation of the line perpendicular to  $CD$  and passing through  $D$ .

Question 9: The line  $Q$  passes through the points  $(-10, -2)$  and  $(-8, -8)$

The line  $R$  passes through the points  $(1, 2)$  and  $(10, a)$

The lines  $Q$  and  $R$  are perpendicular.

Find  $a$ .

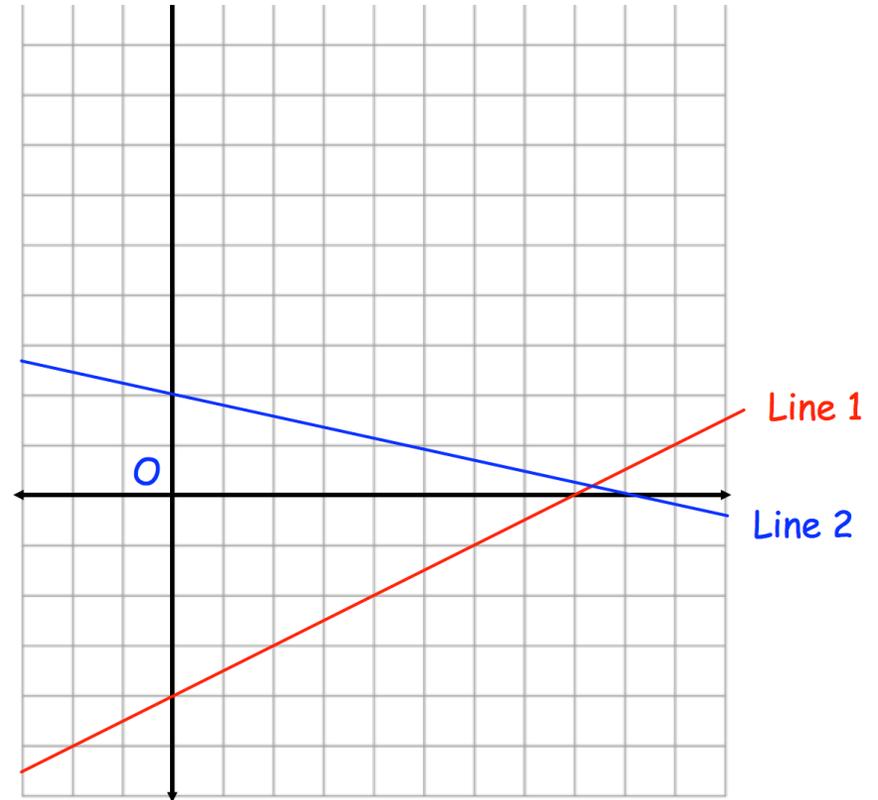
## Fluency Practice

Question 10: Two straight lines are shown.

Line 1 has equation  $y = \frac{3}{2}x - 24$

(a) Find the equation of Line 2

(b) Are the lines perpendicular?



# Purposeful Practice

perpendiculars

based on CBSE(10) exam questions

- (1) prove that the triangle with vertices:  
 $A(3, 0)$ ,  $B(6, 4)$  and  $C(-1, 3)$   
is right-angled  
show that it is also isosceles

- (2) triangle  $ABC$  is isosceles with  $AC = BC$   
if  $A = (3, -2)$  and  $B = (5, 2)$   
and the coordinates of  $C$  are  $(12, k)$   
a) find the value of  $k$   
b) find the area of triangle  $ABC$

- (3) triangle  $ABC$  has vertices:  
 $A = (3, 3)$ ,  $B = (3, -7)$  and  $C = (6, -6)$   
a) show that the triangle is right-angled  
b) show that the centre of the circle that passes  
through  $A$ ,  $B$  and  $C$  lies on  $AB$   
c) find the area of triangle  $ABC$

- (4) a) which point on the  $y$ -axis is equidistant from  
 $(5, -3)$  and  $(-4, 6)$  ?  
b) which point on the  $x$ -axis is equidistant from  
 $(2, -5)$  and  $(-2, 9)$  ?

- (5) the point  $P(x, y)$  is equidistant from  
 $A(5, 1)$  and  $C(-1, 5)$   
a) prove that  $2y = 3x$   
b) find the other two coordinates of the square  
 $ABCD$

- (6) the point  $P(x, y)$  is equidistant from  
 $E(4, 3)$  and  $G(-3, 4)$   
a) prove that  $y = 7x$   
b) find the other two coordinates of the  
square  $EFGH$   
c) which square,  $ABCD$  (above) or  $EFGH$   
has the larger area?

- (7) the point  $P(x, y)$  is equidistant from  
 $A(a + b, b - a)$  and  
 $B(a - b, a + b)$   
prove that  $ay = bx$

- (8) the triangle with vertices:  
 $A(4, 7)$ ,  $B(t, 6)$  and  $C(8, 1)$   
is right-angled at  $B$   
find the values of  $t$

# Purposeful Practice

## lines and perpendiculars

based on GCSE exam questions

- (1) the straight line  $L_1$  passes through the points with coordinates  $(4, 8)$  and  $(12, 4)$   
the straight line  $L_2$  passes through the origin  $(O)$  and has gradient  $-3$

the two lines meet at point  $P$   
find the coordinates of  $P$

the perpendicular to  $L_1$  from the origin meets  $L_1$  at  $Q$

establish that  $\triangle OPQ$  is an isosceles right angled triangle

what is its area?

- (2) the point  $P = (3, 4)$  and  $Q = (a, b)$

a line perpendicular to  $PQ$  is:  $3x + 2y = 7$

find an expression for  $b$  in terms of  $a$   
and give four possible coordinates for  $Q$   
[other than  $(3, 4)$ ]

- (3)  $PQR$  is a triangle with vertices  $P, Q$  and  $R$   
 $P = (-3, -6), Q = (1, 4)$  and  $R = (5, -2)$   
 $M$  is the midpoint of  $PQ$   
 $N$  is the midpoint of  $QR$

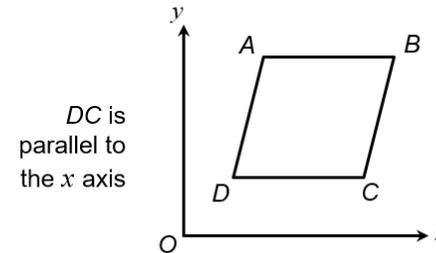
prove that  $MN$  is parallel to  $PR$   
establish that the length  $MN = \frac{1}{2} PR$

- (4)  $ABCD$  is a rhombus with  $A = (5, 11)$   
the equation of the diagonal  $DB$  is  $y = \frac{1}{2}x + 6$

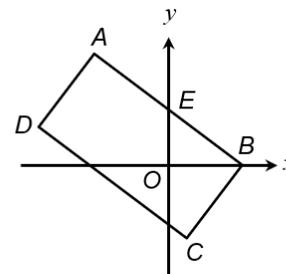
find an equation of the diagonal  $AC$

what are the coordinates of the centre of the rhombus?

what are the coordinates of (i)  $B$  (ii)  $D$  (iii)  $C$ ?



- (5)



$ABCD$  is a rectangle  
the equation of the line  
 $AB$  is  $x + 2y = 12$

$AE = EB$

find an equation for  $AD$

find an equation for  $DC$

what are the coordinates  
of (i)  $A$  (ii)  $D$  (iii)  $C$ ?

## Purposeful Practice

**Give an Example**

**Straight Lines**

<b>A</b>	The equation of a straight line with a y-intercept of $(0, 3)$	
<b>B</b>	The equation of a straight line with a gradient of 4	
<b>C</b>	A pair of coordinates that join to make a line with midpoint $(4, -3)$	
<b>D</b>	The equation of a straight line that is parallel to the line $y = -2x + 9$	
<b>E</b>	A pair of coordinates that join to make a line of length 5	
<b>F</b>	The equation of a straight line that is steeper than the line $y = 1 + \frac{3}{2}x$	
<b>G</b>	A pair of coordinates that join to make a line with gradient $-\frac{1}{2}$	
<b>H</b>	The equation of a straight line that is perpendicular to the line $y = 2x - 5$	
<b>I</b>	The equation of a line with a positive gradient that passes through $(4, 1)$	
<b>J</b>	The equation of a line with a negative gradient that passes through $(5, -2)$	
<b>K</b>	A pair of coordinates that join to make a line with gradient $-\frac{3}{4}$ and length 10	
<b>L</b>	A pair of coordinates that join to make a line with a midpoint of $(-3, 6)$ which is perpendicular to the line $3x + y = 2$	

# Problem Solving

	<b>All Sides Equal</b>	<b>Has 4 Right Angles</b>	<b>Diagonals Cross at Right Angles</b>
<b>Forms a Parallelogram</b>			
<b>Diagonals not Equal in Length</b>			

Put these cards into the correct part of the table.

$y = 2x - 1$ $y = 2x - 11$ $2y = 3 - x$ $4y = -(2x - 16)$
--

$y = x + 3$ $y = x - 5$ $7y = -35 - 49x$ $7x = 35 - y$
---

<b>IT'S IMPOSSIBLE!</b>
-----------------------------

There are 3 missing spaces. Create sets of equations for them.

# Exam Questions

**Q1.**  $y = 5x - 4$  is the equation of a straight line.

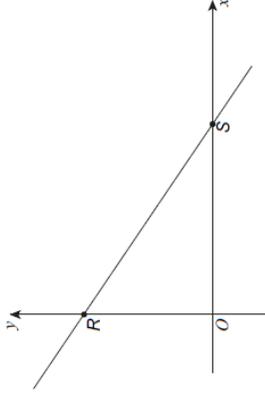
(a) Write down the gradient of the line  $y = 5x - 4$

Answer ..... (1)

(b) Write down the coordinates of the  $y$ -intercept of the line  $y = 5x - 4$

Answer (....., .....), ..... (1)  
 (Total 2 marks)

**Q2.** A sketch of  $2x + 3y = 12$  is shown.



(a) Work out the coordinates of  $R$ .

Answer (....., .....), ..... (1)

(b) Work out the coordinates of  $S$ .

Answer (....., .....), ..... (2)  
 (Total 3 marks)

**Q3.**

(a) Write down the equation of a straight line that is parallel to  $y = 5x + 6$

..... (1)

(b) Find an equation of the line that is perpendicular to the line  $y = 5x + 6$  and passes through the point  $(-2, 5)$ .

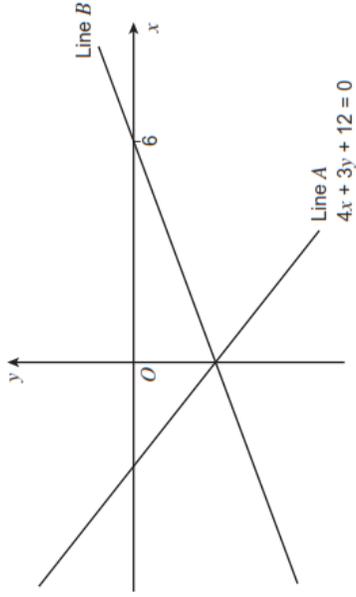
..... (3)  
 (Total 4 marks)

# Exam Questions

**Q4.** Lines,  $A$  and  $B$ , intersect on the  $y$ -axis.

Line  $B$  intersects the  $x$ -axis at the point  $(6, 0)$ .

The equation of line  $A$  is  $4x + 3y + 12 = 0$



Work out the equation of line  $B$ .

Answer .....

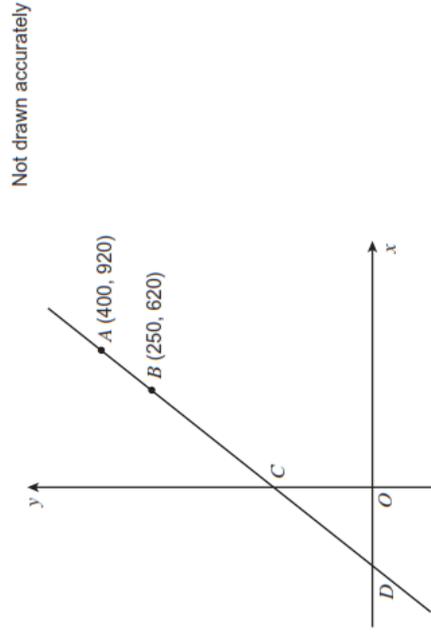
(Total 4 marks)

**Q5.** The diagram shows a line  $ABCD$ .

$A$  is the point  $(400, 920)$ .

$B$  is the point  $(250, 620)$ .

The line cuts the  $y$ -axis at  $C$  and the  $x$ -axis at  $D$ .



Work out the coordinates of  $C$  and  $D$ .

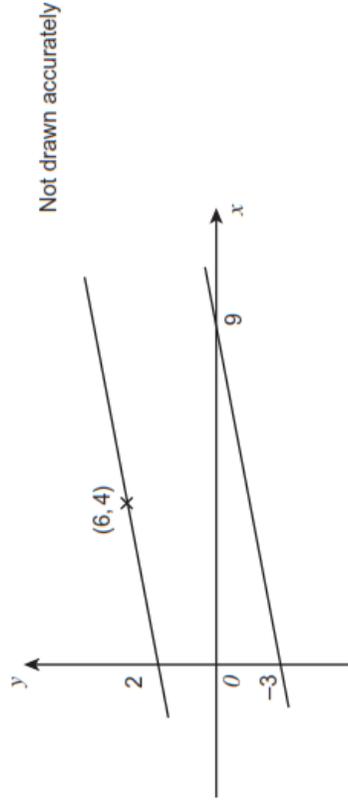
$C$  ( ..... , ..... )

$D$  ( ..... , ..... )

# Exam Questions

(Total 4 marks)

**Q6.** Two straight lines are shown.

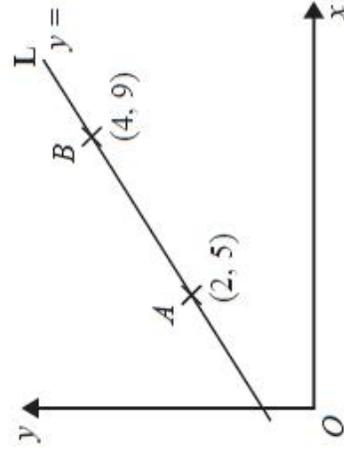


Prove that the lines never meet.

Page 97

(Total 3 marks)

**Q7.**



The point  $A$  has coordinates  $(2, 5)$ .

The point  $B$  has coordinates  $(4, 9)$ .

The line  $L$  passes through the points  $A$  and  $B$ .

The equation of line  $L$  is  $y = 2x + 1$

$M$  is the midpoint of the line segment  $AB$ .

Find an equation of the line that is perpendicular to line  $L$  and passes through  $M$ .

# Exam Questions

(Total 4 marks)

**\*Q8.**  $A$  is the point with coordinates  $(1, 3)$   
 $B$  is the point with coordinates  $(4, -1)$   
The straight line  $L$  goes through both  $A$  and  $B$ .  
Is the line with equation  $2y = 3x - 4$  perpendicular to line  $L$ ?  
You must show how you got your answer.

Page 98

(Total 4 marks)

**Q9.**

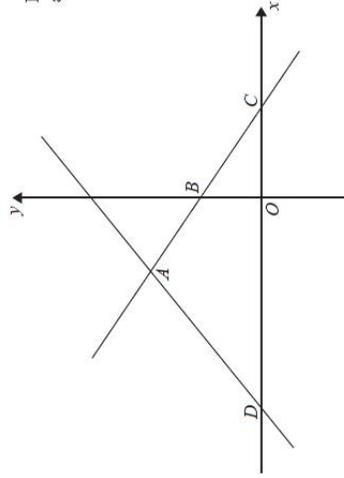


Diagram NOT  
accurately drawn

In the diagram,  $ABC$  is the line with equation  $y = -\frac{1}{2}x + 5$

$AB = BC$

$D$  is the point with coordinates  $(-13, 0)$

Find an equation of the line through  $A$  and  $D$ .

## Fluency Practice

- (a) A line segment joins point A (1, 2) to point B (4, 8). Point C divides the line segment in the ratio AC : CB = 2 : 1. Find the coordinates of point C.
- (b) A line segment joins point A (3, 1) to point B (11, 5). Point C divides the line segment in the ratio AC : CB = 3 : 1. Find the coordinates of point C.
- (c) A line segment joins point A (3, 2) to point B (8, 12). Point C divides the line segment in the ratio AC : CB = 1 : 4. Find the coordinates of point C.

- (a) A line segment joins point A (2, -3) to point B (5, 9). Point C divides the line segment in the ratio AC : CB = 2 : 1. Find the coordinates of point C.
- (b) A line segment joins point A (6, -4) to point B (11, 6). Point C divides the line segment in the ratio AC : CB = 3 : 2. Find the coordinates of point C.
- (c) A line segment joins point A (-8, -7) to point B (12, 3). Point C divides the line segment in the ratio AC : CB = 2 : 3. Find the coordinates of point C.

- (a) A line segment joins point A (9, -1) to point B (5, 7). Point C divides the line segment in the ratio AC : CB = 1 : 7. Find the coordinates of point C.
- (b) A line segment joins point A (1, 5) to point B (-5, 2). Point C divides the line segment in the ratio AC : CB = 5 : 1. Find the coordinates of point C.

A line segment joins point A (5, 2) with point B. Point C with coordinates (4, 4) divides the line segment in the ratio AC : CB = 1 : 3. Find the coordinates of B.

## Fluency Practice

### dividing a line segment in a ratio

- (1)  $A$  is the point  $(4, 3)$   
 $C$  is the point  $(22, 27)$

$B$  divides the line segment  $AC$  in the ratio  $1 : 2$   
find the coordinates of  $B$

- (2)  $P$  is the point  $(1, 3)$   
 $R$  is the point  $(11, 18)$

$Q$  divides the line segment  $PR$  in the ratio  $1 : 1\frac{1}{2}$   
find the coordinates of  $Q$

- (3)  $Q$  is the point  $(5, 2)$   
 $R$  is the point  $(9, 10)$

$Q$  divides the line segment  $PR$  in the ratio  $1 : 2$   
find the coordinates of  $P$

- (4)  $P$  is the point  $(-5, 11)$   
 $R$  is the point  $(16, -3)$

$Q$  divides the line segment  $PR$  in the ratio  $3 : 4$   
find the coordinates of  $Q$

- (5)  $A$  is the point  $(-1, -7)$   
 $C$  is the point  $(24, 23)$

$B$  divides the line segment  $AC$  in the ratio  $2 : 3$   
find the coordinates of  $B$

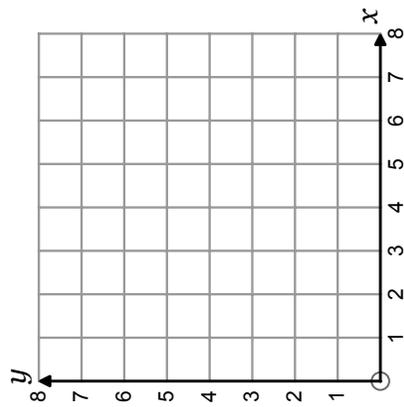
- (6)  $A$  is the point  $(-2, -4)$   
 $C$  is the point  $(22, 4)$

$B$  divides the line segment  $AC$  in the ratio  $5 : 3$   
find the coordinates of  $B$

### 3 Graphical Inequalities

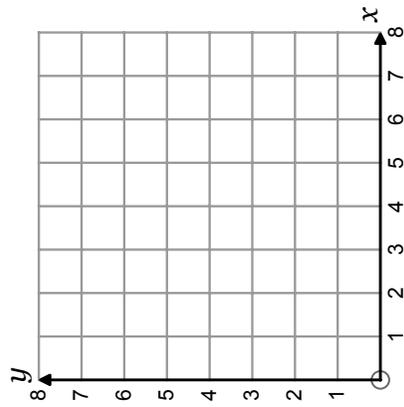
# Fluency Practice

1.



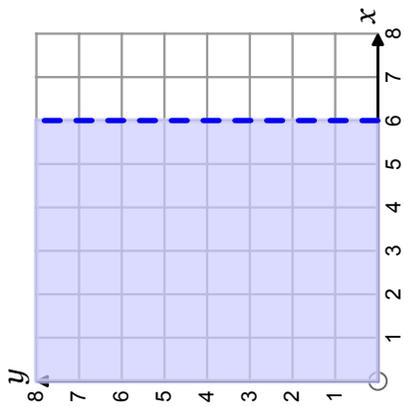
Shade the region:  $x \geq 3$ .

2.



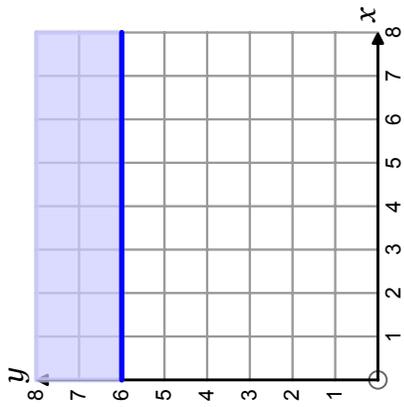
Shade the region:  $y < 5$ .

3.



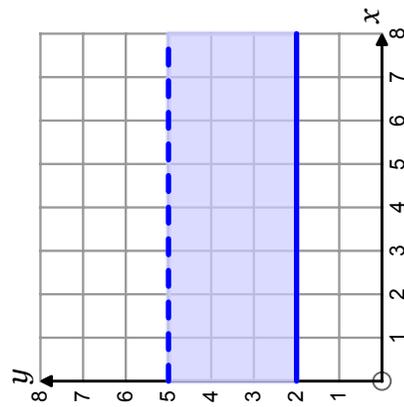
State the inequality: \_\_\_\_\_

4.



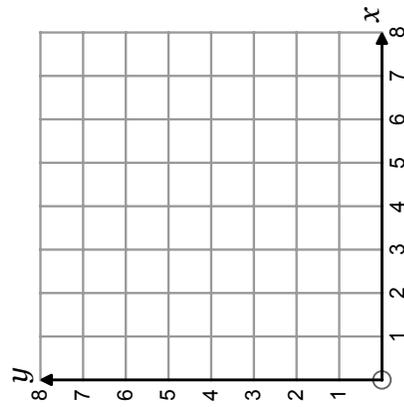
State the inequality: \_\_\_\_\_

5.



State the inequality: \_\_\_\_\_

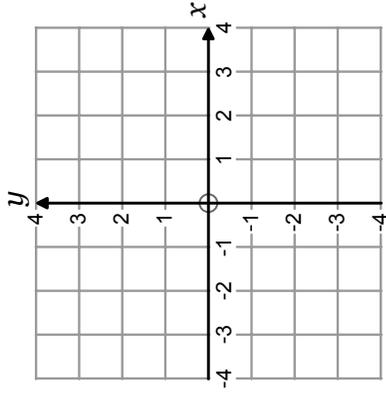
6.



Shade the region:  $1 < x < 4$ .

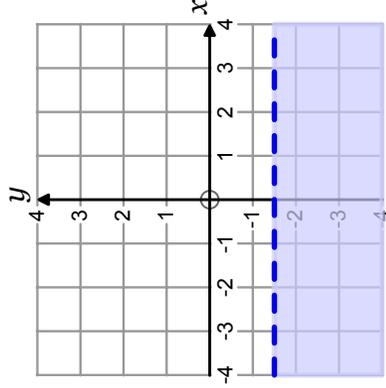
# Fluency Practice

7.



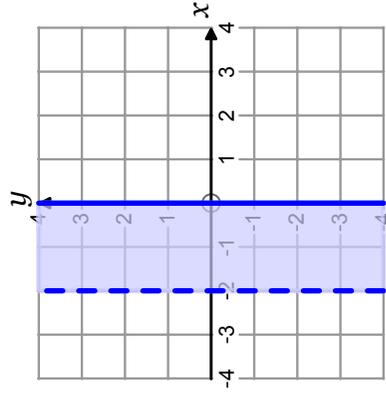
Shade the region:  $y > -1$ .

8.



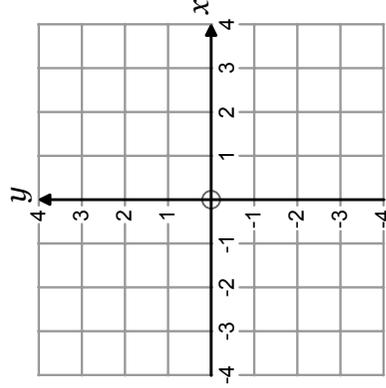
State the inequality: \_\_\_\_\_

9.



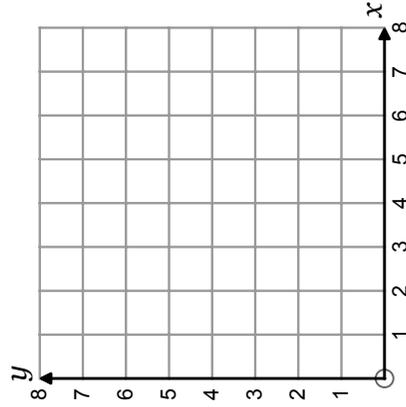
State the inequality: \_\_\_\_\_

10.



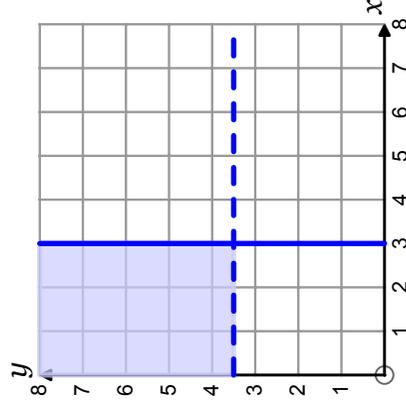
Shade the region:  $-3 \leq y \leq -1$ .

11.



Shade the region of points that satisfy  
**both:**  $2 < x < 7$  and  $2 < y < 5$ .

12.



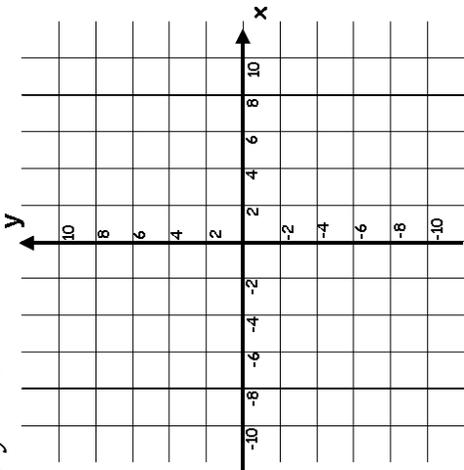
State two inequalities to describe  
the shaded region:

\_\_\_\_\_ and \_\_\_\_\_

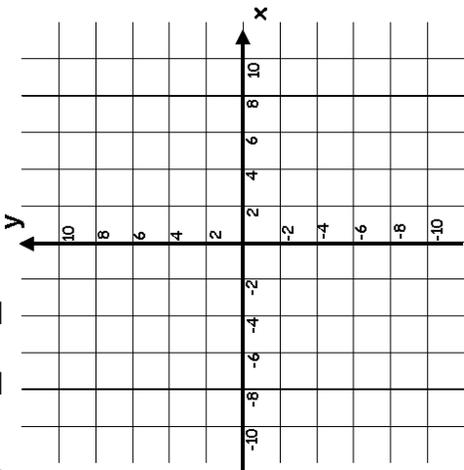
# Fluency Practice

Show the regions that satisfy the inequality(ies) given on the set of axes.

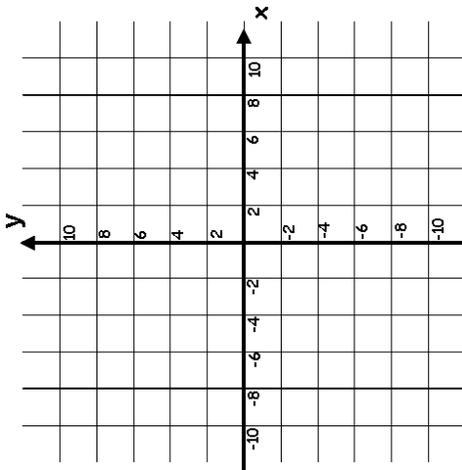
a)  $y > 3$



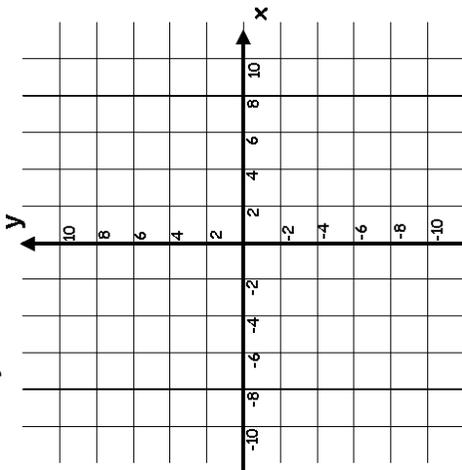
d)  $-4 \leq x \leq 5$



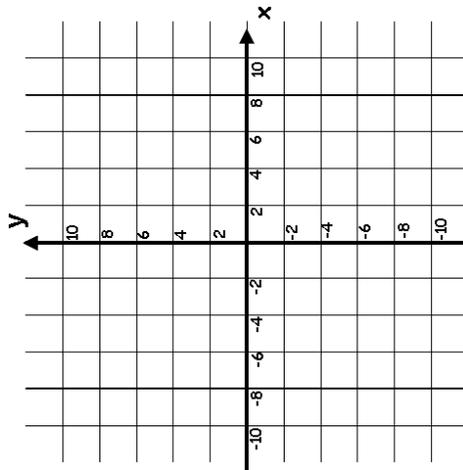
b)  $x \leq -4$



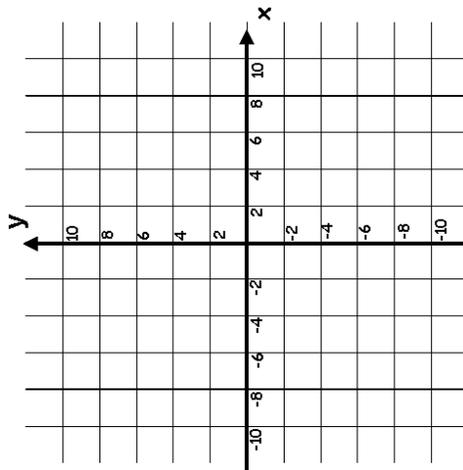
e)  $-6 < y \leq 2$



c)  $y > 2$  and  $x < 0$

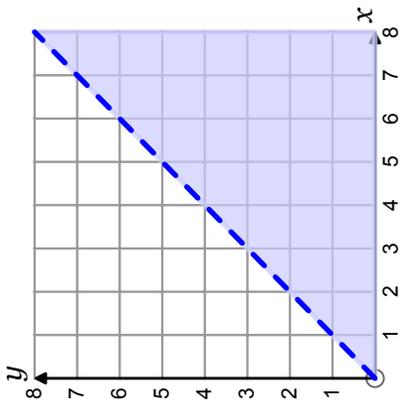


f)  $-4 \leq x < 4$  and  $-2 < y < 8$



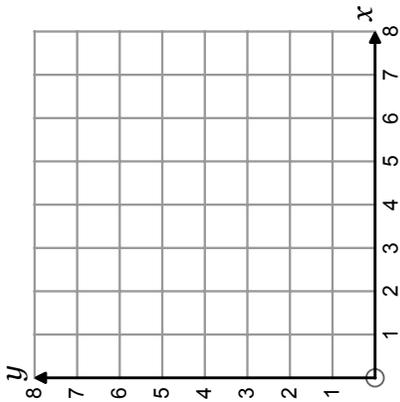
# Fluency Practice

1.



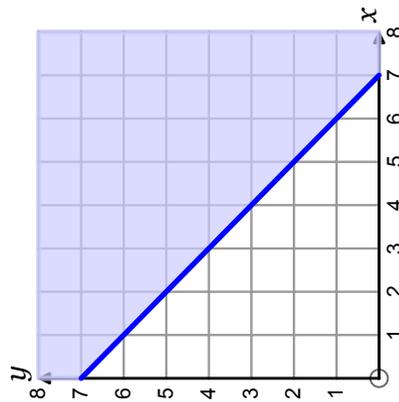
State the inequality: \_\_\_\_\_

2.



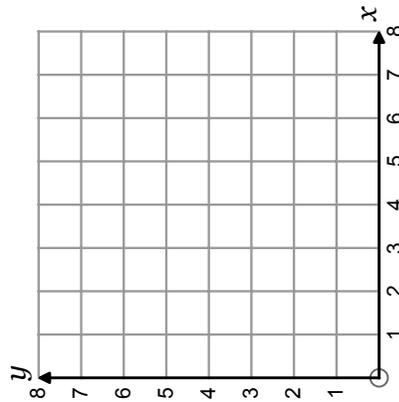
Shade the region:  $y \geq x + 2$ .

3.



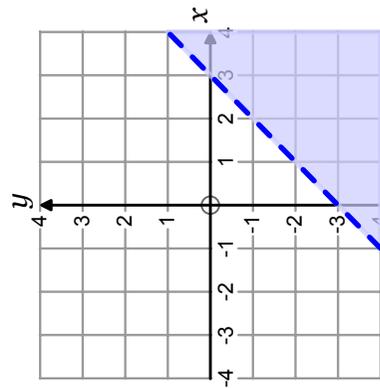
State the inequality: \_\_\_\_\_

4.



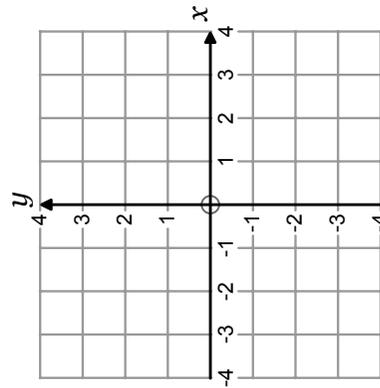
Shade the region:  $y > 2x + 2$ .

5.



State the inequality: \_\_\_\_\_

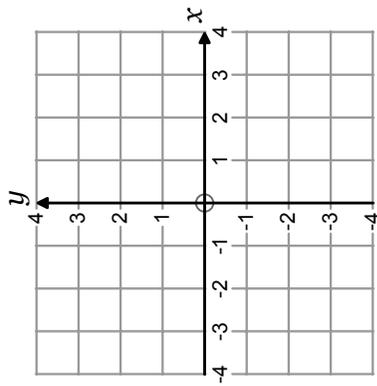
6.



Shade the region:  $y \geq \frac{1}{2}x$ .

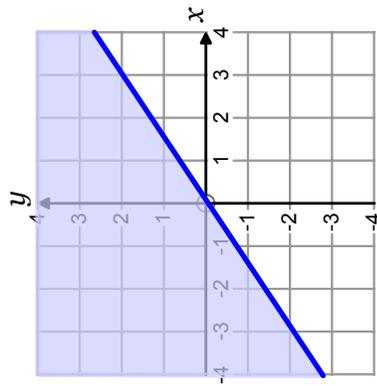
# Fluency Practice

7.



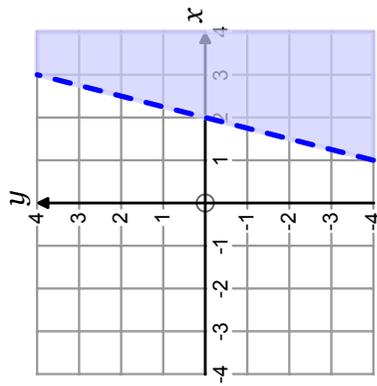
Shade the region:  $y < -3x - 2$ .

8.



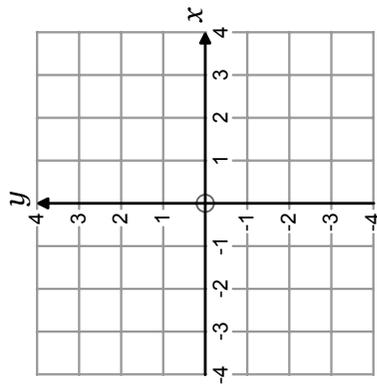
State the inequality: \_\_\_\_\_

9.



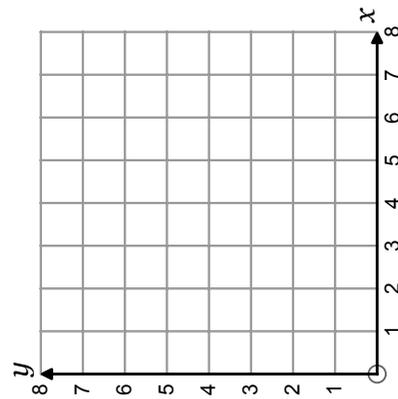
State the inequality: \_\_\_\_\_

10.



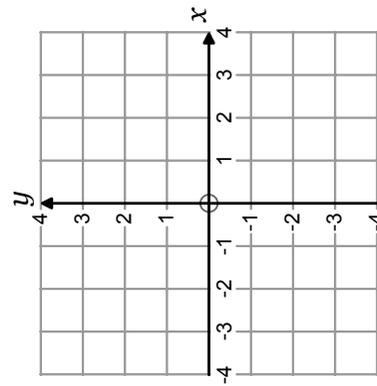
Shade the region:  $x + y \leq 3$ .

11.



Shade the region:  $2x + 6y > 12$

12.

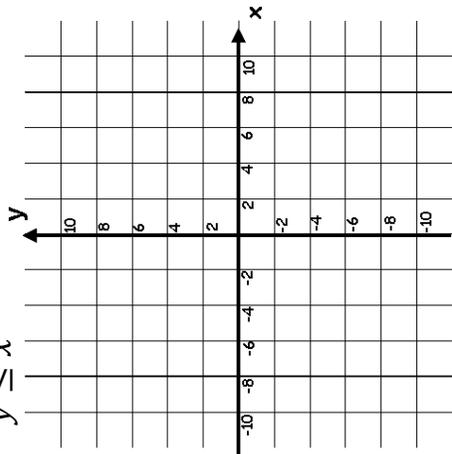


Shade the region:  $2x - 3y \leq 6$

# Fluency Practice

Show the regions that satisfy the inequality(ies) given on the set of axes.

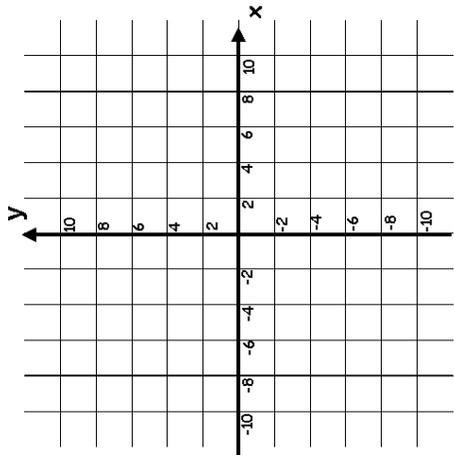
a)  $y \leq x$



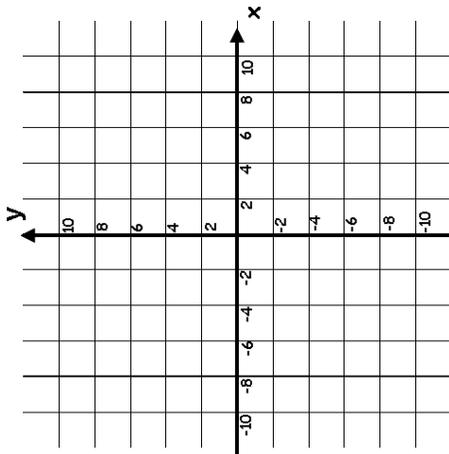
d)  $y \geq x - 2$  and  $y < x + 1$

x	0	1	2	
y				

x	0	1	2	
y				



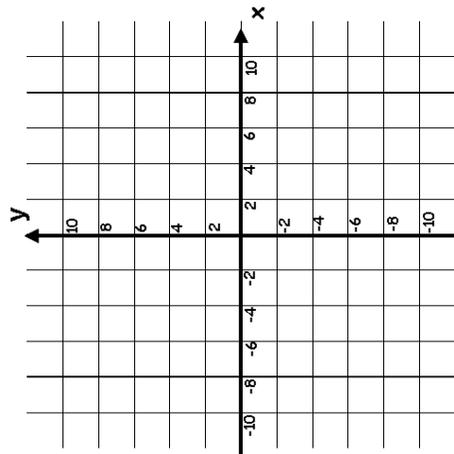
b)  $y > x$  and  $x \geq 5$



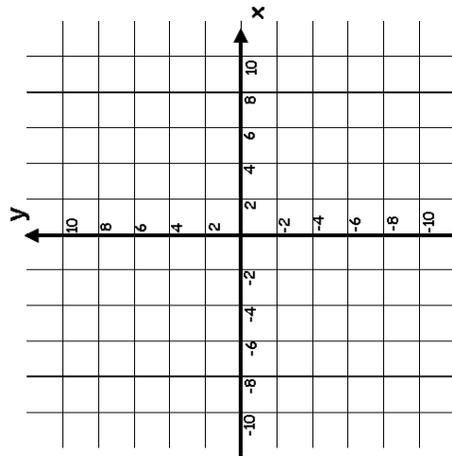
e)  $y > 2x$  and  $y > \frac{1}{2}x$

x	0	1	2	
y				

x	0	1	2	
y				



c)  $y < x, y > 2$  and  $x < 6$

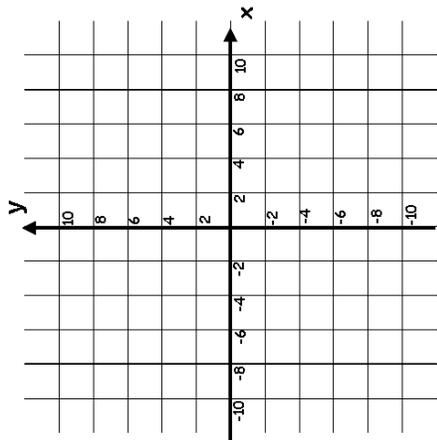


# Fluency Practice

f)  $y > 3x$  and  $y < 2 - x$

x	0	1	2	
y				

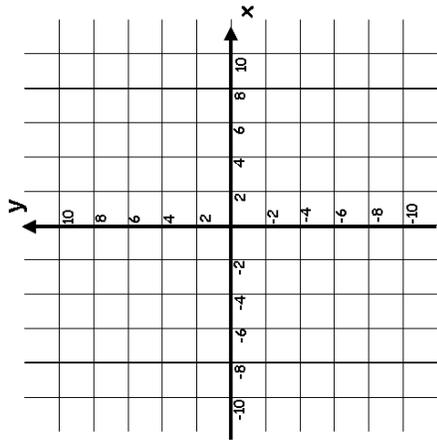
x	0	1	2	
y				



h)  $y \geq 2x + 1$  and  $y < x + 1$

x	0	1	2	
y				

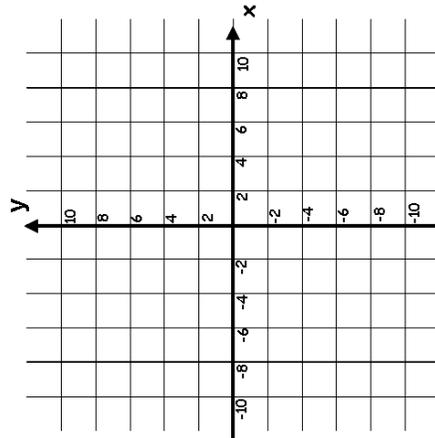
x	0	1	2	
y				



g)  $y \geq x - 4$  and  $y < 4 - 2x$

x	0	1	2	
y				

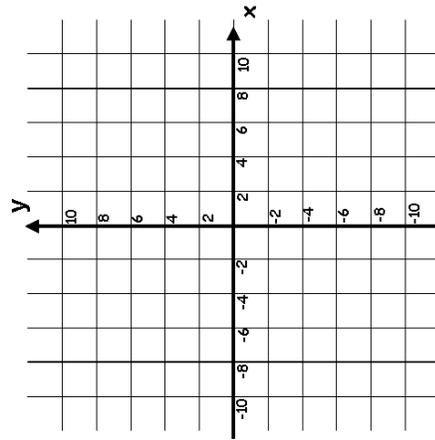
x	0	1	2	
y				



i)  $y > 4x + 1$  and  $y > -2 - x$

x	0	1	2	
y				

x	0	1	2	
y				

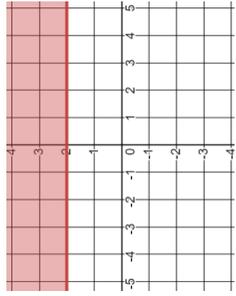


# Fluency Practice

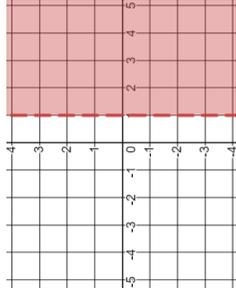
## Describing Graphical Inequalities

Write down the inequality or inequalities that define the shaded region.

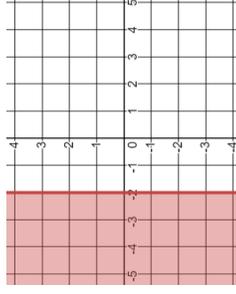
**(a)**



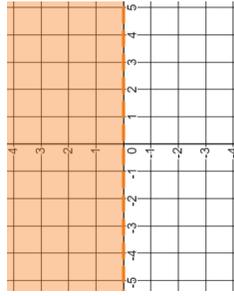
**(b)**



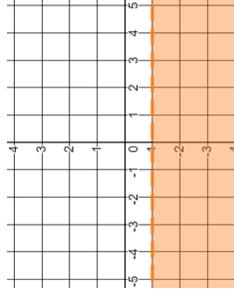
**(c)**



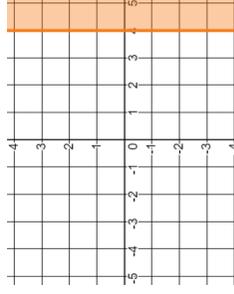
**(d)**



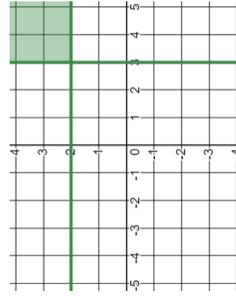
**(e)**



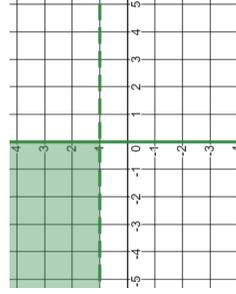
**(f)**



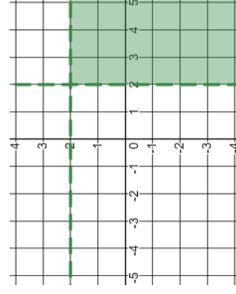
**(g)**



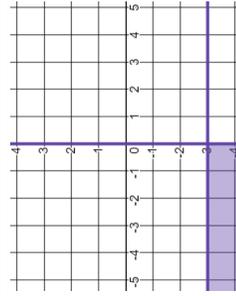
**(h)**



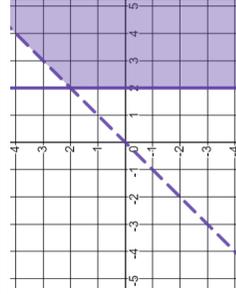
**(i)**



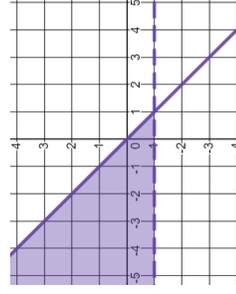
**(j)**



**(k)**



**(l)**

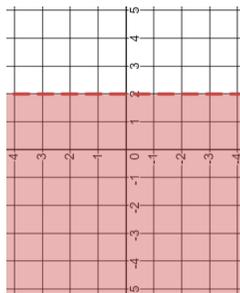


# Fluency Practice

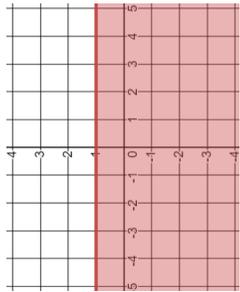
## Describing Harder Graphical Inequalities

Write down the inequality or inequalities that define the shaded region.

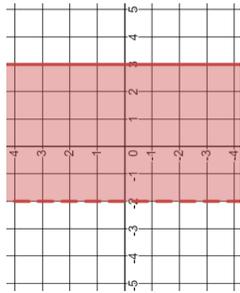
**(a)**



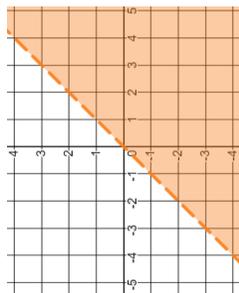
**(b)**



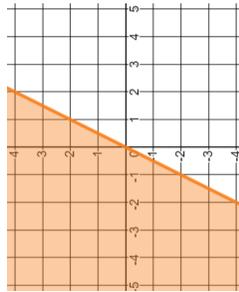
**(c)**



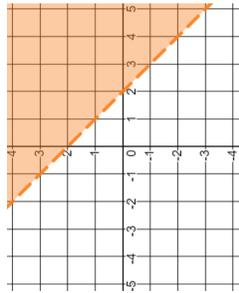
**(d)**



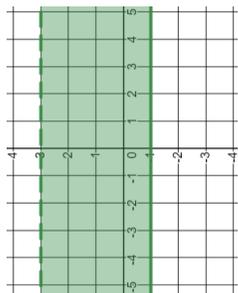
**(e)**



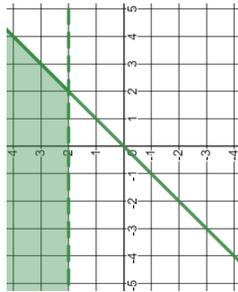
**(f)**



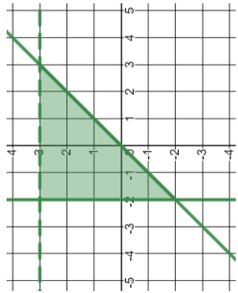
**(g)**



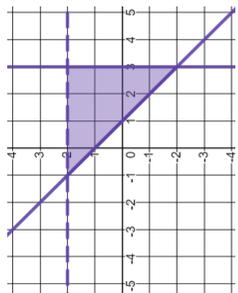
**(h)**



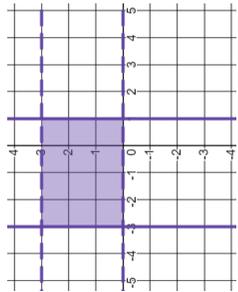
**(i)**



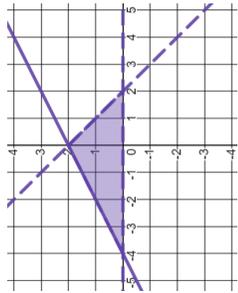
**(j)**



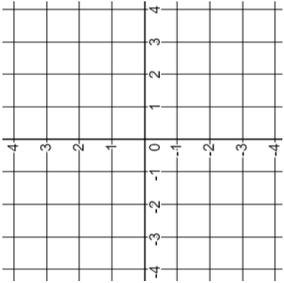
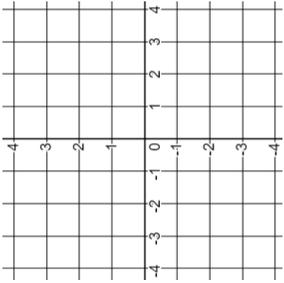
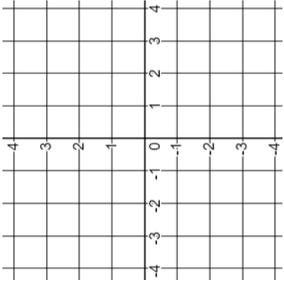
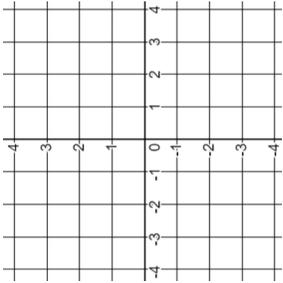
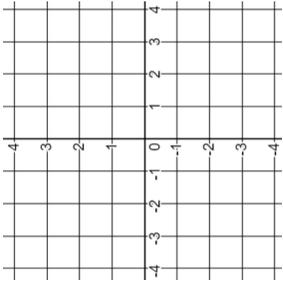
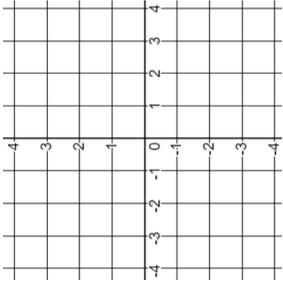
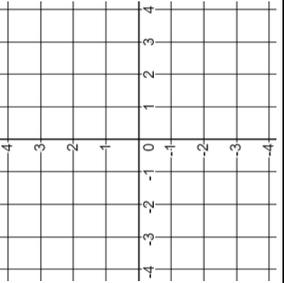
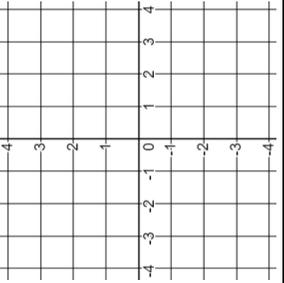
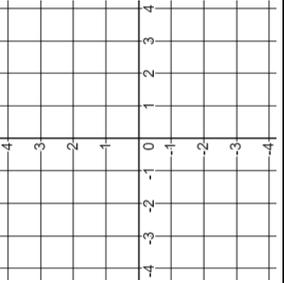
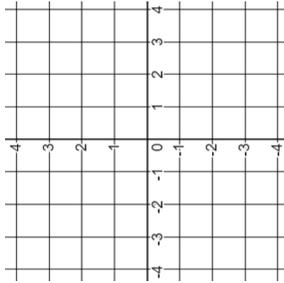
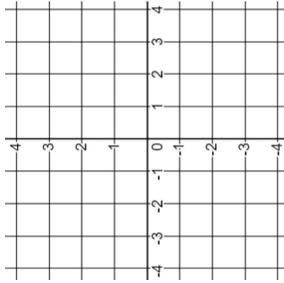
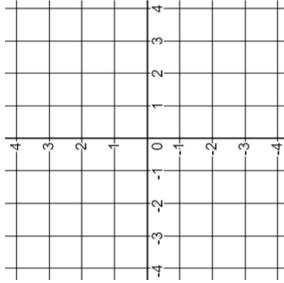
**(k)**



**(l)**

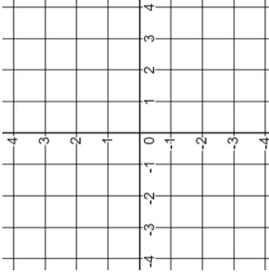
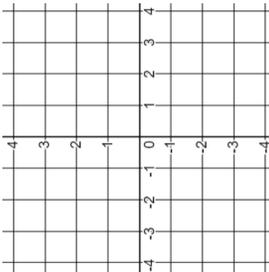
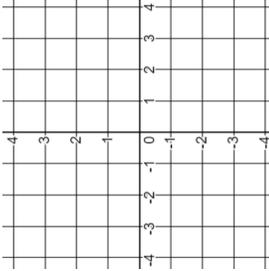
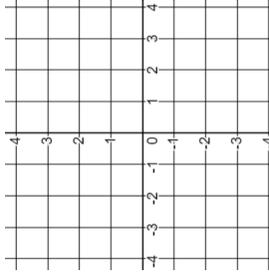
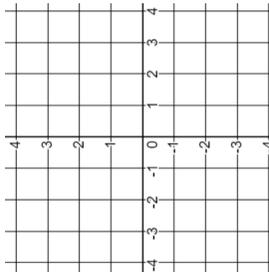
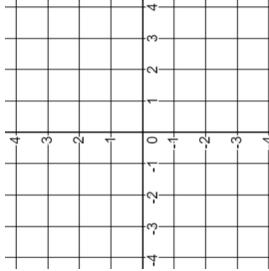
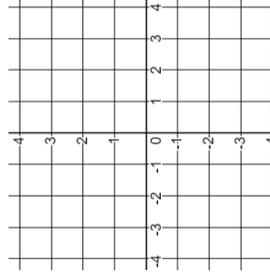
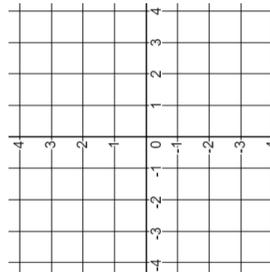
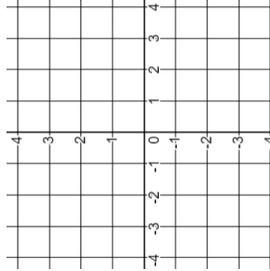
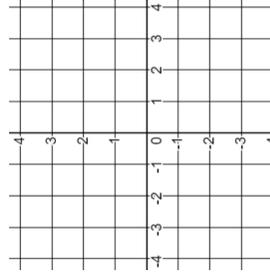
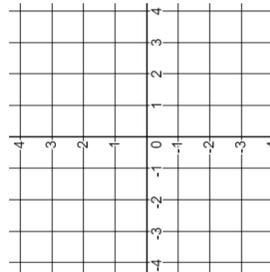
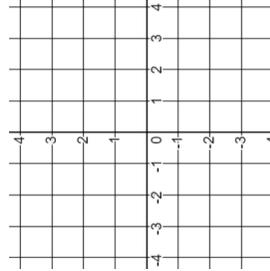


# Fluency Practice

Shading Graphical Inequalities		
<b>(a)</b>	<b>(b)</b>	<b>(c)</b>
$y > 1$	$y \leq -2$	$x < 0$
		
<b>(d)</b>	<b>(e)</b>	<b>(f)</b>
$x \geq 3$	$y \geq 0$	$x \leq -3$
		
<b>(g)</b>	<b>(h)</b>	<b>(i)</b>
$x \geq 2$ and $y < 1$	$x < -1$ and $y > 3$	$x \leq 0$ and $y < 0$
		
<b>(j)</b>	<b>(k)</b>	<b>(l)</b>
$x \geq -1$ and $y \geq 3$	$y \geq x$ and $x < 2$	$y < -x$ and $y \leq -1$
		

# Fluency Practice

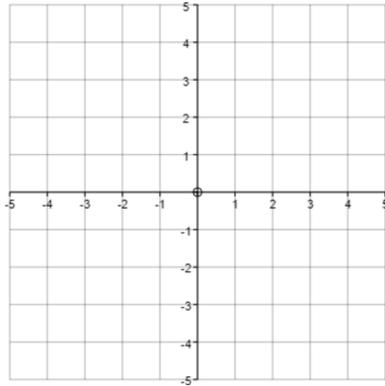
## Shading Harder Graphical Inequalities

Shading Harder Graphical Inequalities		
<b>(a)</b>	<b>(b)</b>	<b>(c)</b>
$y \geq -1$	$x < 2$	$y > x$
		
<b>(d)</b>	<b>(e)</b>	<b>(f)</b>
$y \geq 0.5x - 1$	$x + y \leq 3$	$-3 \leq y < 2$
		
<b>(g)</b>	<b>(h)</b>	<b>(i)</b>
$-2 \leq x < 3$	$x \geq 0$ and $y < x$	$x \geq -1, y > 0$ and $x + y < 2$
		
<b>(j)</b>	<b>(k)</b>	<b>(l)</b>
$2 < x < 4$ and $-1 \leq y \leq 1$	$y < 2x, x + y \leq 4$ and $y > 0$	$y < x, y \geq -2$ and $2x + y < 4$
		

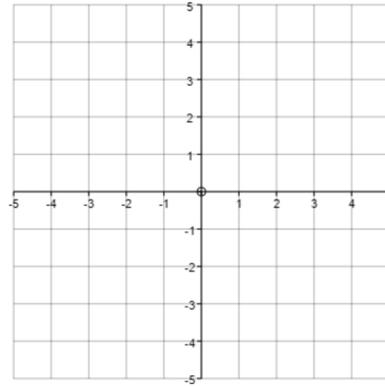
# Fluency Practice

## Shading and Describing Harder Graphical Inequalities

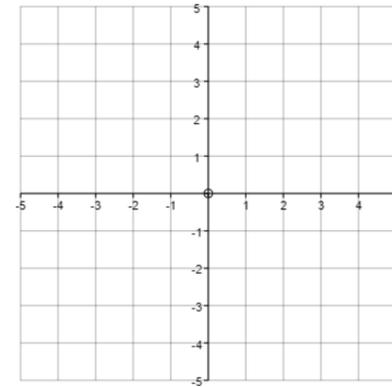
Shade the region that satisfies the inequalities  $x \leq 4$   $y \geq -1$   $y \leq x$



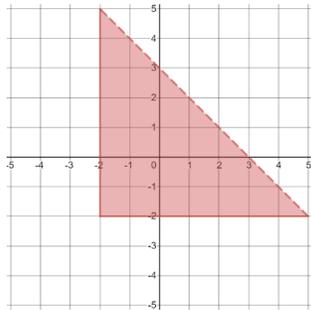
Shade the region that satisfies the inequalities  $x > -1$   $y \geq 0$   $x + y \leq 3$



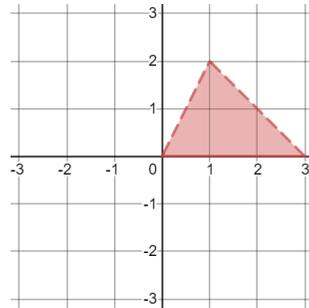
Shade the region that satisfies the inequalities  $2x + 3y < 6$   $y \leq x + 2$   $y > -1$



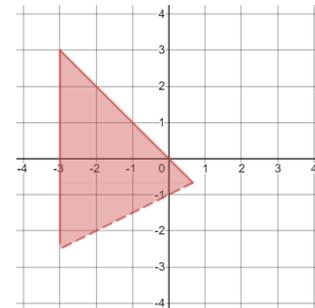
Write down the inequalities which fully describe the shaded region.



Write down the inequalities which fully describe the shaded region.



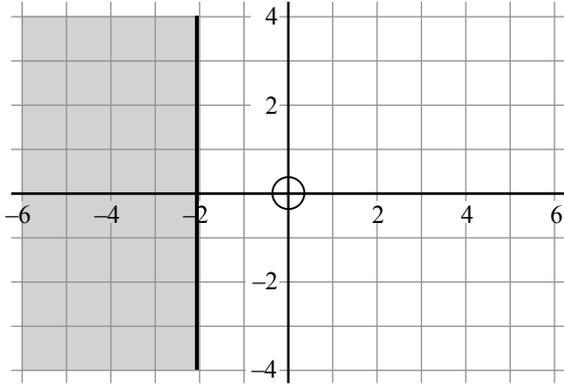
Write down the inequalities which fully describe the shaded region.



# Fluency Practice

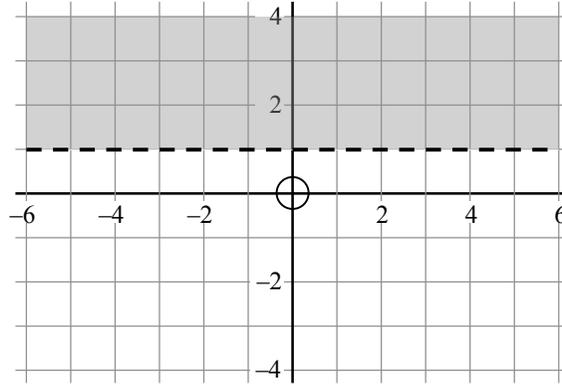
**A1**

Write down the inequality which defines the unshaded region.



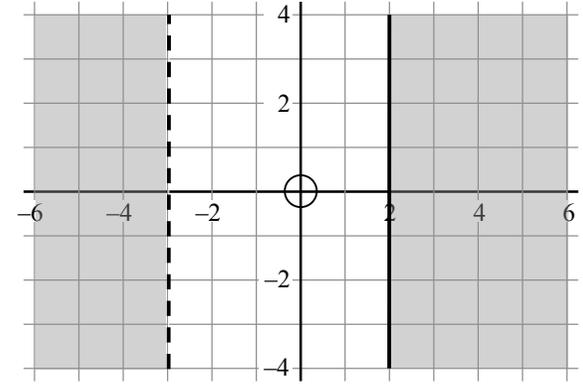
**A2**

Write down the inequality which defines the unshaded region.



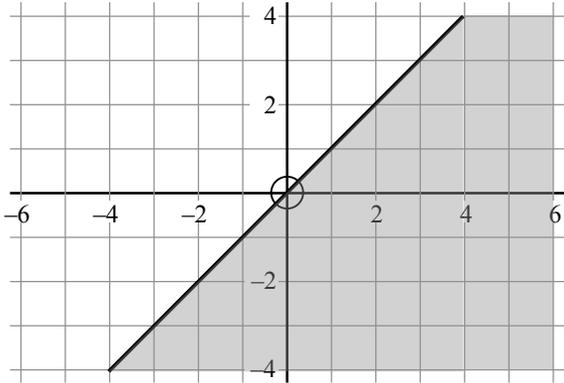
**A3**

Write down the inequalities which define the unshaded region.



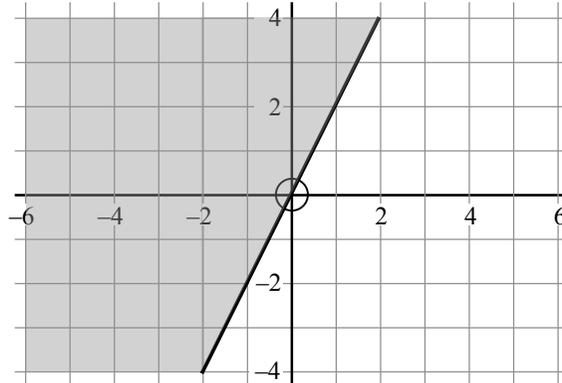
**B1**

Write down the inequality which defines the unshaded region.



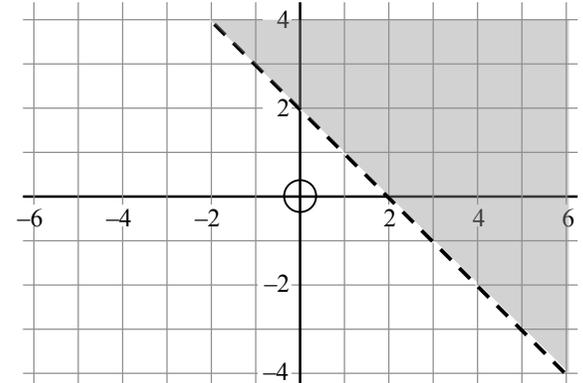
**B2**

Write down the inequality which defines the unshaded region.



**B3**

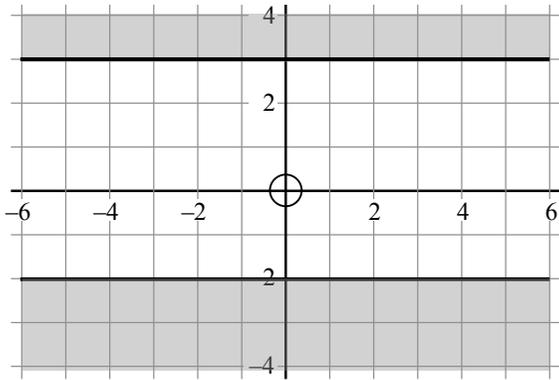
Write down the inequality which defines the unshaded region.



# Fluency Practice

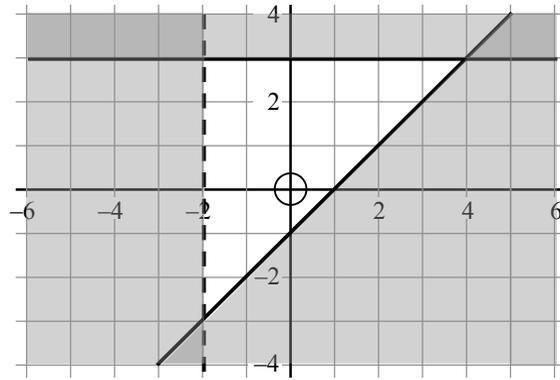
**A1**

Write down the inequalities which fully define the unshaded region.



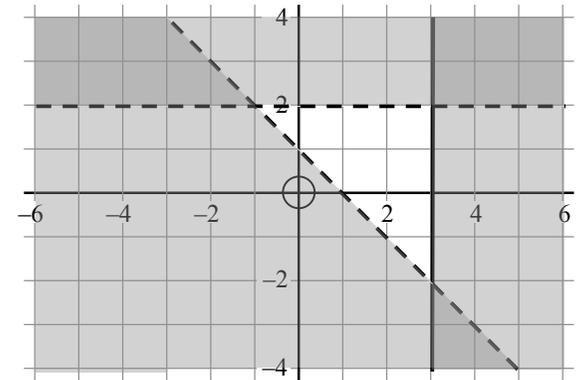
**A2**

Write down the inequalities which fully define the unshaded region.



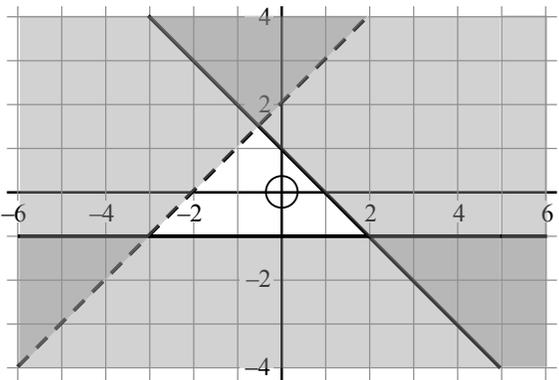
**A3**

Write down the inequalities which fully define the unshaded region.



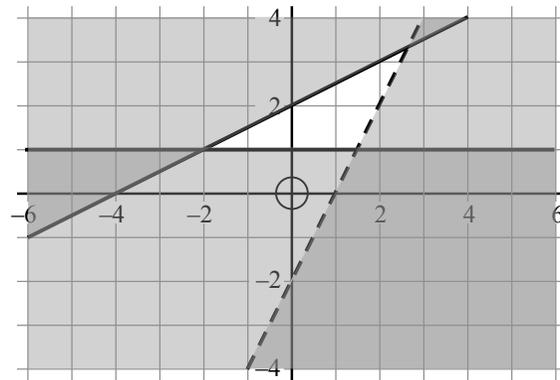
**B1**

Write down the inequalities which fully define the unshaded region.



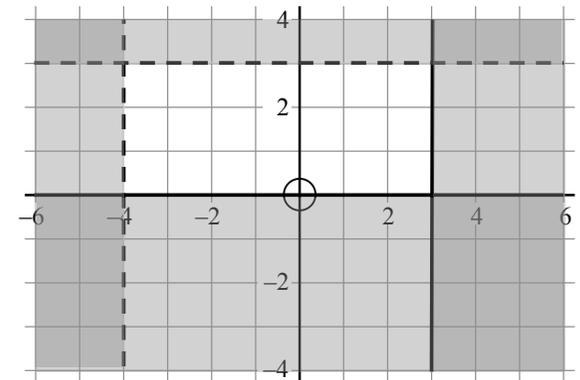
**B2**

Write down the inequalities which fully define the unshaded region.



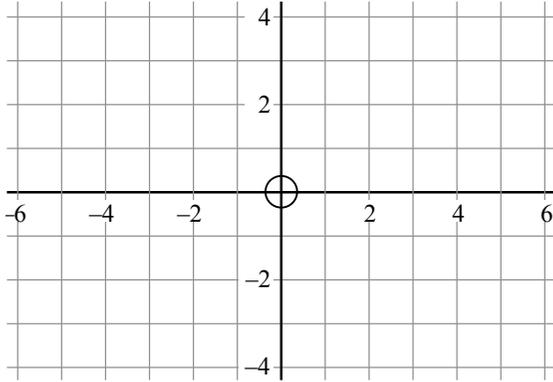
**B3**

Write down the inequalities which fully define the unshaded region.

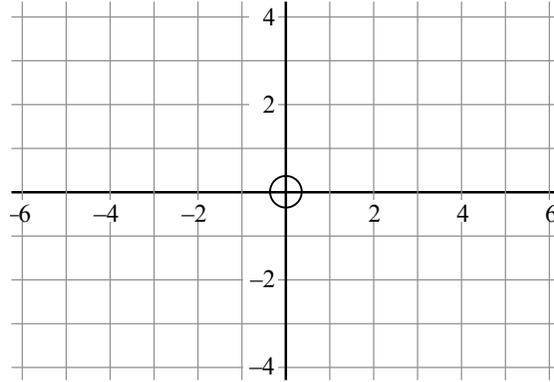


# Fluency Practice

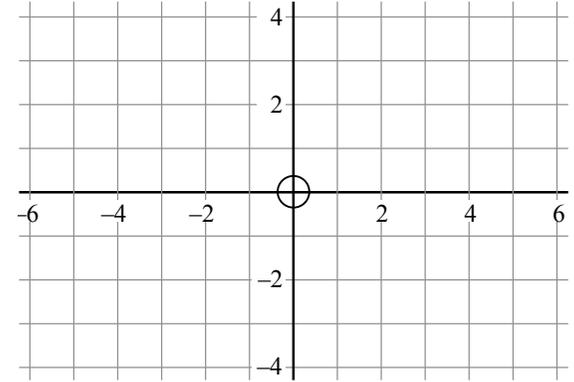
**A1** Show, by shading on the grid, the region defined by  $y \geq -1$   
Label your region **R**.



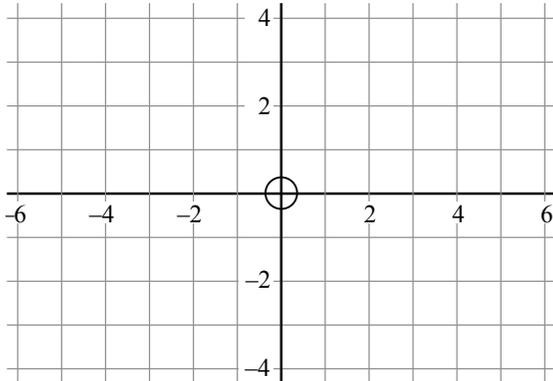
**A2** Show, by shading on the grid, the region defined by  $x < 3$   
Label your region **R**.



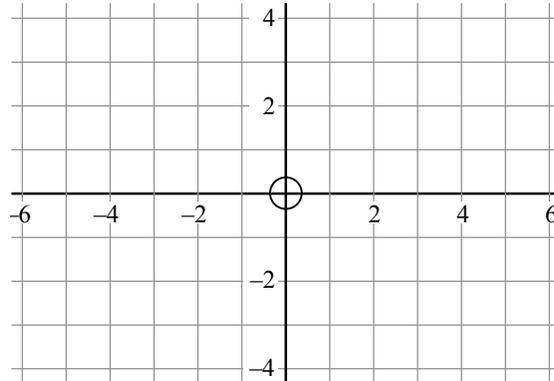
**A3** Show, by shading on the grid, the region defined by  $y < x$   
Label your region **R**.



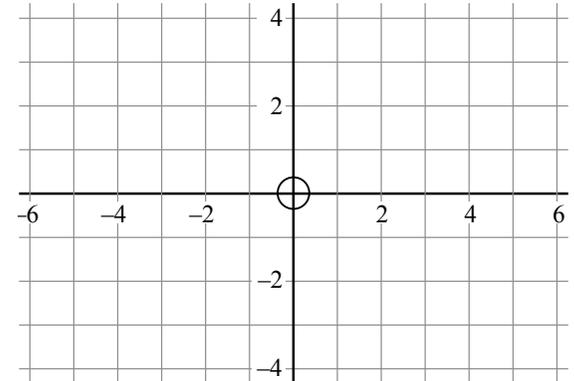
**B1** Show, by shading on the grid, the region defined by  $y \geq 0.5x - 1$   
Label your region **R**.



**B2** Show, by shading on the grid, the region defined by  $x + y \leq 3$   
Label your region **R**.

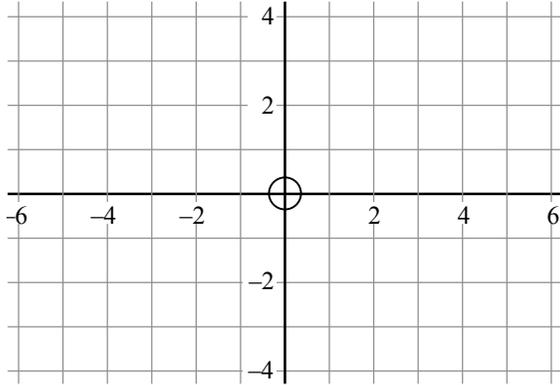


**B3** Show, by shading on the grid, the region defined by  $-3 \leq y < 2$   
Label your region **R**.

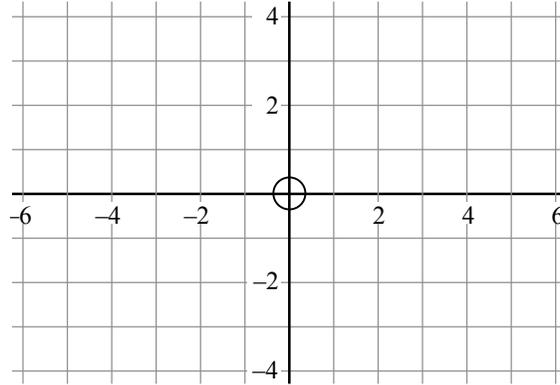


# Fluency Practice

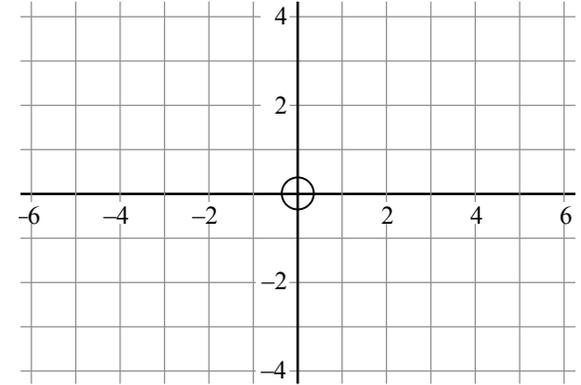
**A1** Show, by shading on the grid, the region defined by  $-4 \leq x \leq 3$   
Label your region **R**.



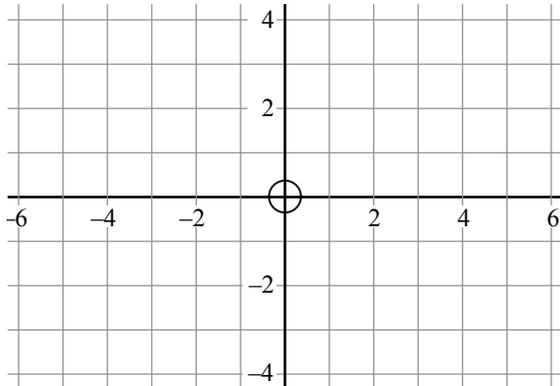
**A2** Show by shading on the grid the region defined by  $x \geq -3$ ,  $y < 2$  and  $y > x$   
Label your region **R**.



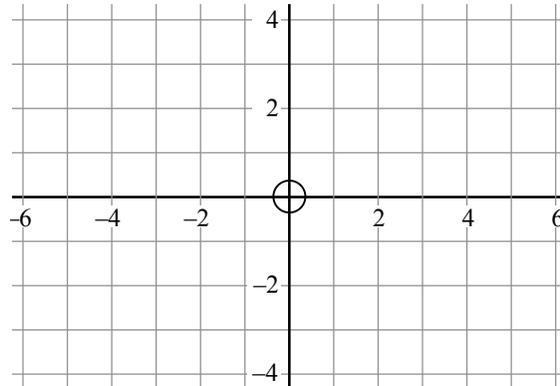
**A3** Show by shading on the grid the region defined by  $x + y \leq -1$ ,  $x \geq -4$  and  $y \geq -3$   
Label your region **R**.



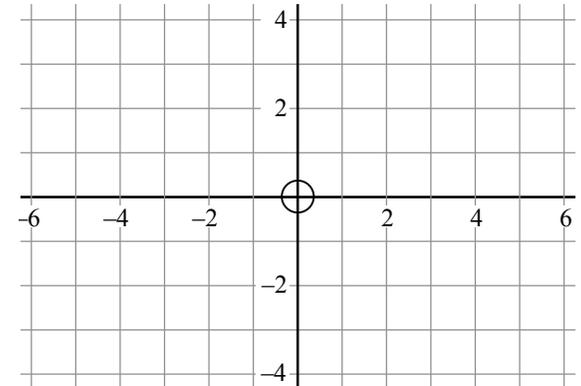
**B1** Show by shading on the grid the region defined by  $-2 < y \leq 3$  and  $-3 \leq x < 5$   
Label your region **R**.



**B2** Mark with a cross (x) a point on the grid which satisfies both the inequalities  $x > 1$  and  $x - 3y > 3$



**B3** Show by shading on the grid the region defined by  $y > x + 3$ ,  $x \geq -3$  and  $2y - x \leq 4$   
Label your region **R**.



# Purposeful Practice

linear inequalities: regions

(1)  $y \leq 2x + 3$

$$x \leq 3$$

$$y \geq 5$$

(2)  $x + 2y \geq 8$

$$x \leq 6$$

$$y \leq 3$$

(3)  $x + y \geq 9$

$$x \leq 4$$

$$y \leq x + 5$$

(4)  $y \geq 2x - 3$

$$y \geq 3$$

$$y \leq x + 2$$

(5)  $y \leq \frac{1}{3}x + 6$

$$y \geq x$$

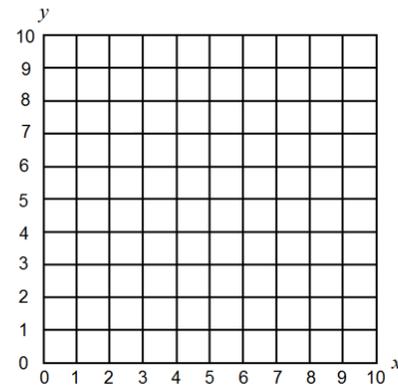
$$y \geq 7$$

(6)  $x + 2y \geq 8$

$$x \leq 6$$

$$2y \leq 3x - 8$$

find each of these regions  
on a 10 by 10 grid:



the region for all questions should  
be a triangle with an area of  
4 squares

establish that this is the case

# Purposeful Practice

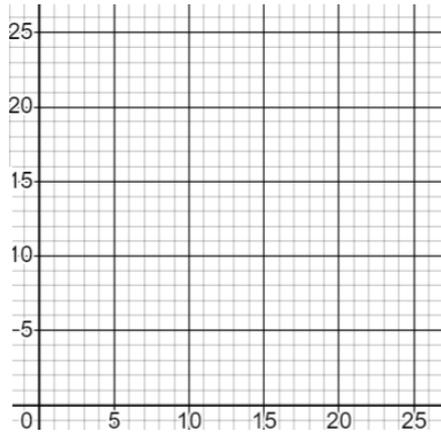
## Graphical Inequalities Worded Problems

**(a)**

Junior's pencil case contains pens and pencils. The total number of pens and pencils is less than 25. The number of pens is greater than 5. The number of pencils is between 4 and 16.

(a) By letting  $x$  represent the number of pens and  $y$  the number of pencils, write inequalities to represent this problem.

(b) Represent this problem graphically, shading the region which satisfies all the inequalities.

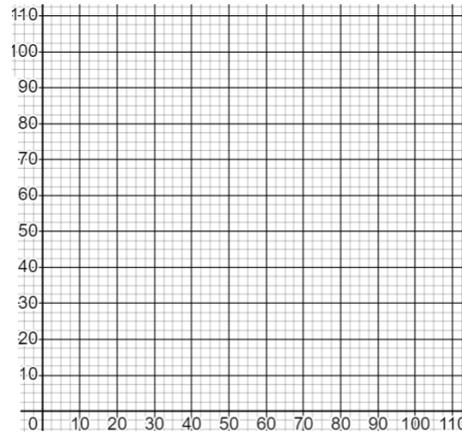


**(b)**

A factory manufactures beds and sofas. Each week it makes at least 30 beds and between 40 and 100 sofas. The factory always manufactures more sofas than beds.

(a) By letting  $x$  represent the number of beds and  $y$  the number of sofas, write inequalities to represent this problem.

(b) Represent this problem graphically, shading the region which satisfies all the inequalities.

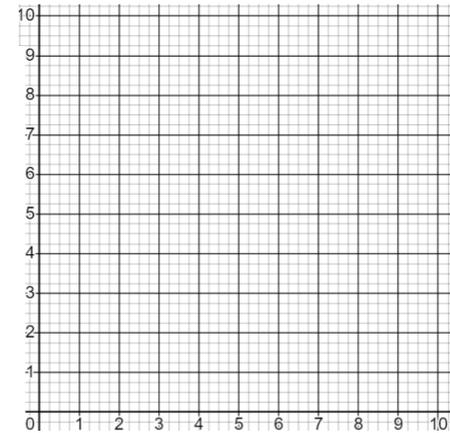


**(c)**

Maya is baking cakes and brownies. Each cake needs 50g of sugar and 20g of flour. Each cookie needs 30g of sugar and 50g of flour. She has 300g of sugar and 200g of flour and wants to make at least 2 cakes.

(a) By letting  $x$  represent the number of cakes and  $y$  the number of cookies, write inequalities to represent this problem.

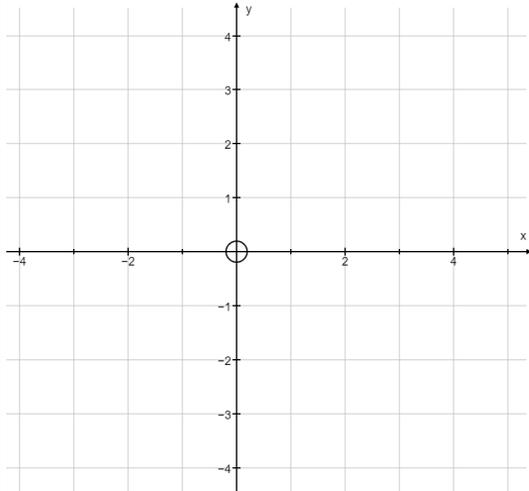
(b) Represent this problem graphically, shading the region which satisfies all the inequalities.



# Purposeful Practice

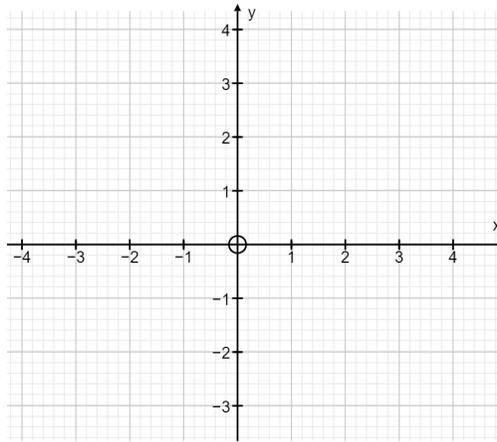
Identify the region described by the inequalities and calculate the perimeter of the region.

$$\begin{aligned}y &\geq 1 \\x &\geq 2 \\2y + x &\leq 6\end{aligned}$$



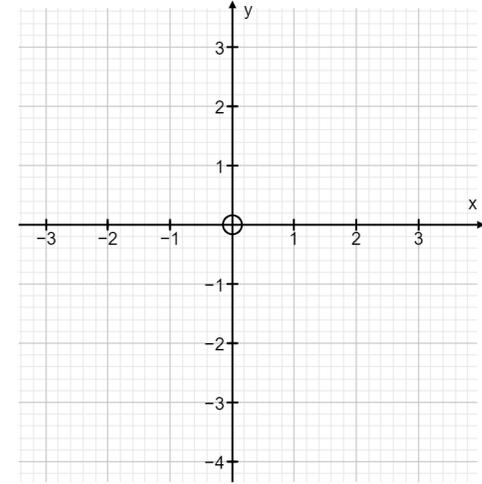
Perimeter:

$$\begin{aligned}y &\geq 0 \\y &\leq 1.5x \\y &\geq 3x - 9 \\y &\leq 3\end{aligned}$$



Perimeter:

$$\begin{aligned}y &\leq 4x + 11 \\5y + 4x &\leq 7 \\y &\geq -1\end{aligned}$$

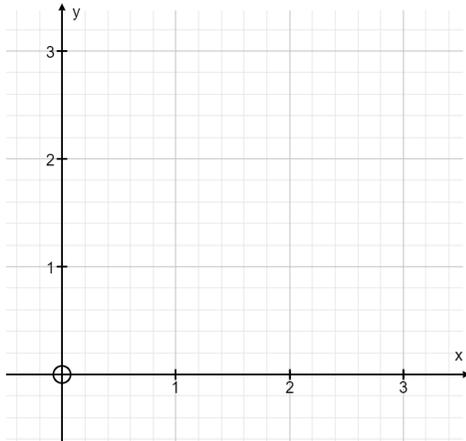


Perimeter:

## Purposeful Practice

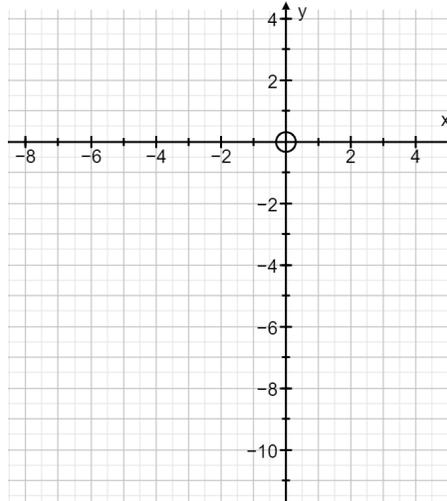
Identify the region described by the inequalities and calculate the perimeter of the region.

$$\begin{aligned}y &\geq \frac{2}{3}x \\ y &\leq 1.5x \\ x &\leq 3 \\ y &\leq 3\end{aligned}$$



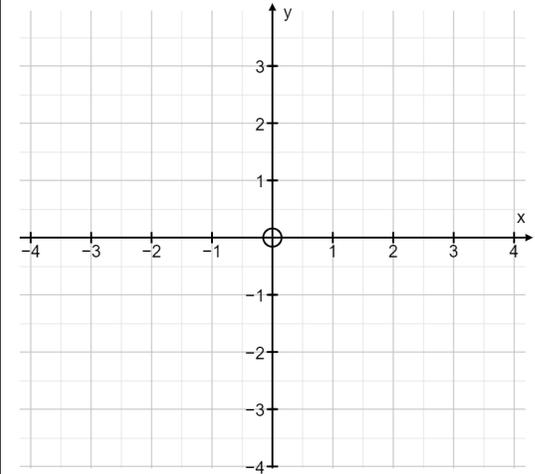
Perimeter:

$$\begin{aligned}2y + 2x &\leq 7 \\ 2x - 2y &\leq 7 \\ 2y - 4x &\geq 7\end{aligned}$$



Perimeter:

$$\begin{aligned}3y + x &\leq 6 \\ 4x - 3y &\leq 9 \\ 3y - x &\leq 6 \\ 4x + 3y &\geq -9\end{aligned}$$

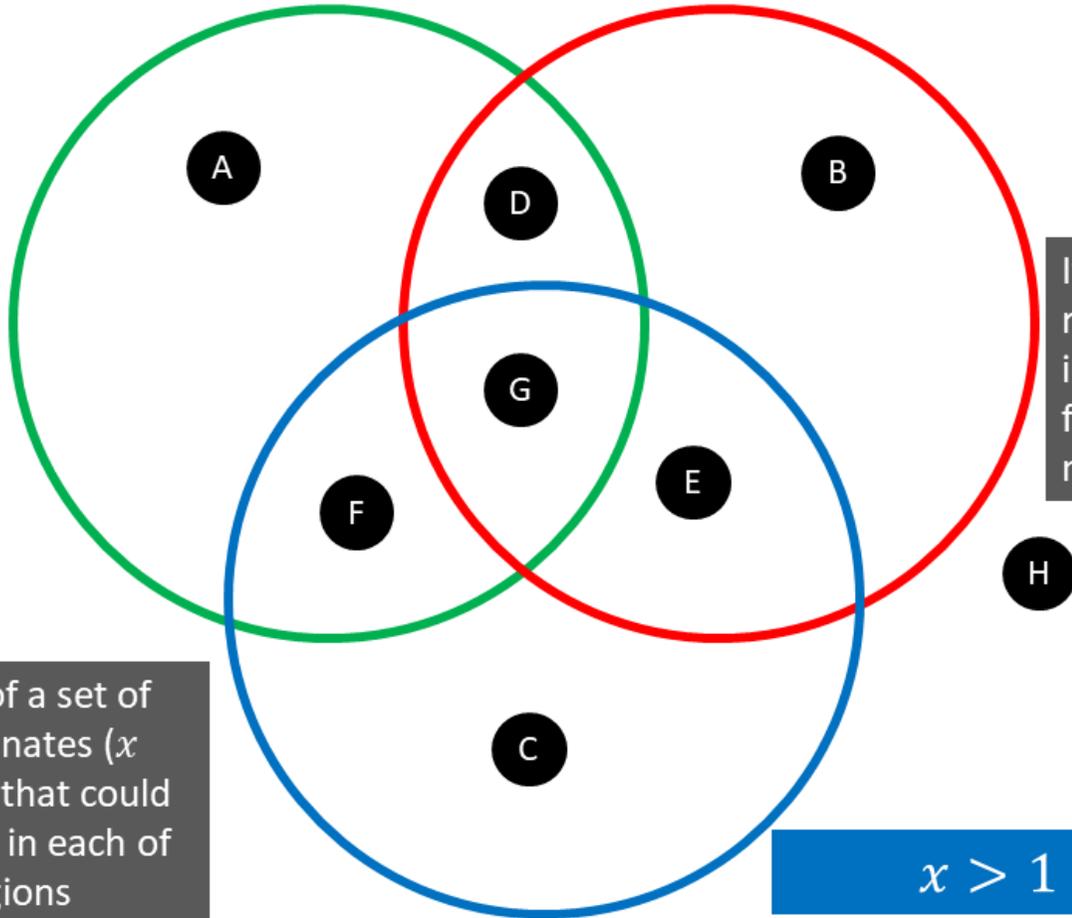


Perimeter:

# Problem Solving

$$y < 2x$$

$$y < 6$$



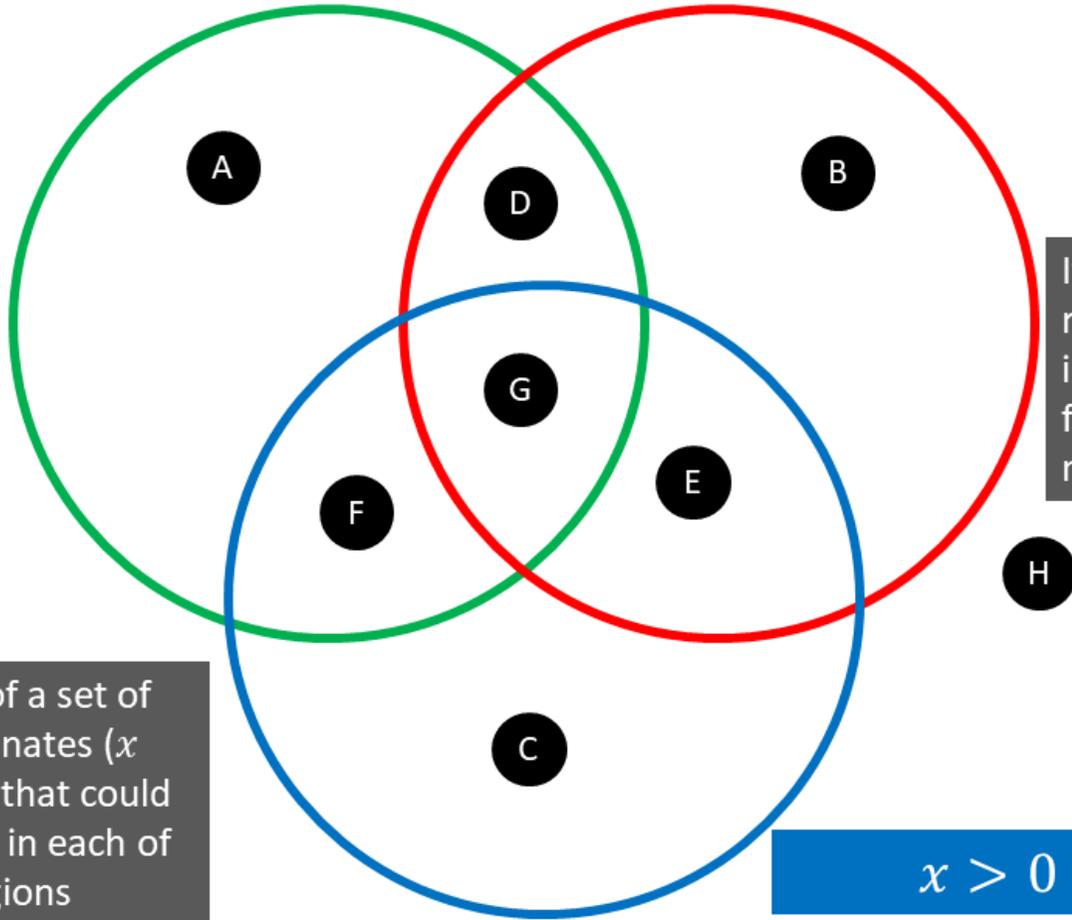
Think of a set of co-ordinates ( $x$  and  $y$ ) that could belong in each of the regions

If you think a region is impossible to fill, convince me why!

# Problem Solving

$$y < x$$

$$x + y < 8$$



If you think a region is impossible to fill, convince me why!

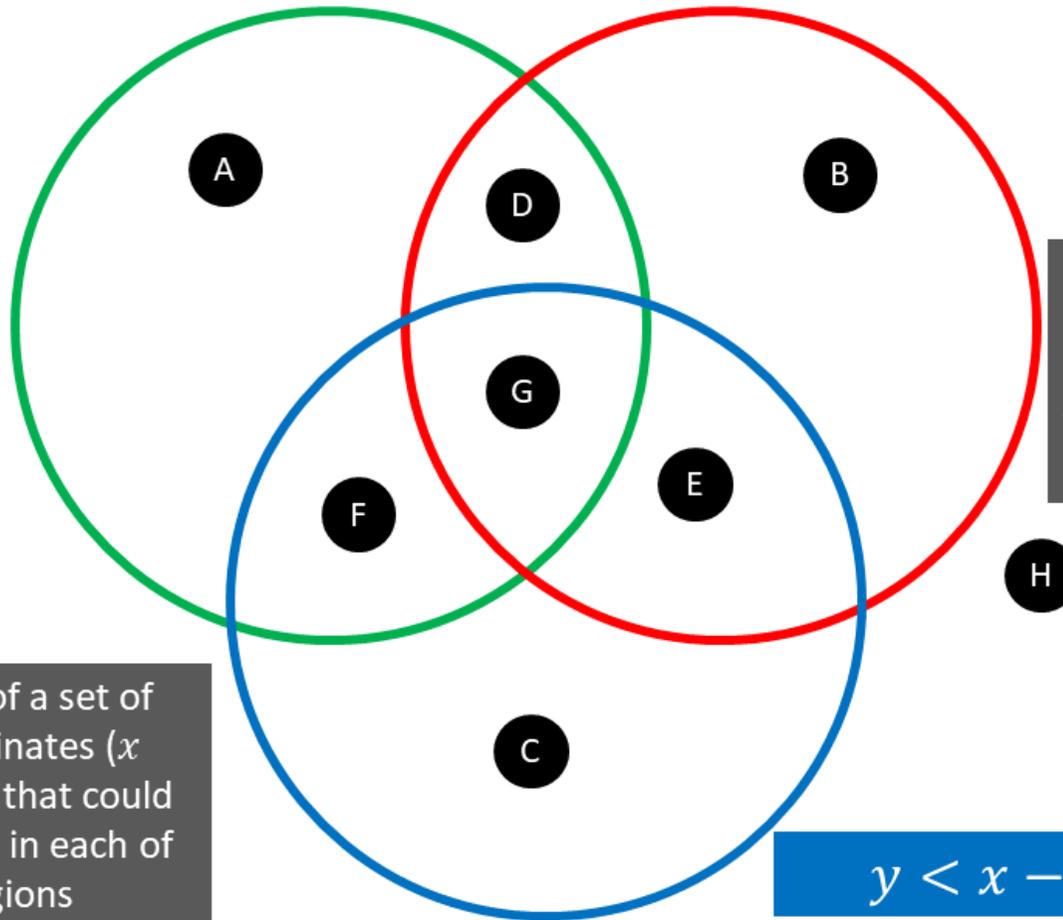
Think of a set of co-ordinates ( $x$  and  $y$ ) that could belong in each of the regions

$$x > 0$$

# Problem Solving

$$y > 2x + 1$$

$$x + y < 1$$



If you think a region is impossible to fill, convince me why!

Think of a set of co-ordinates ( $x$  and  $y$ ) that could belong in each of the regions

$$y < x - 1$$

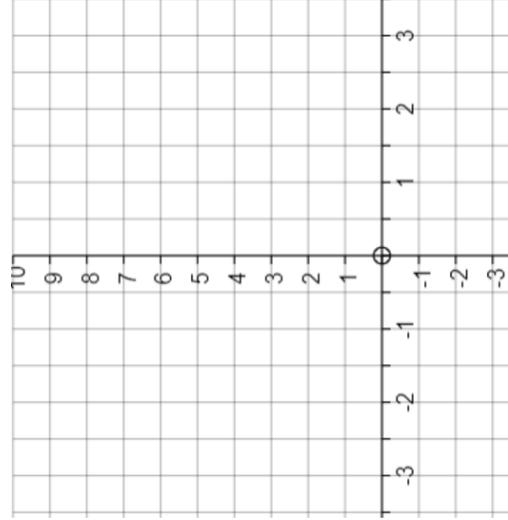
## 4 Non-Linear Graphs

# Fluency Practice

## Plotting Quadratic Graphs

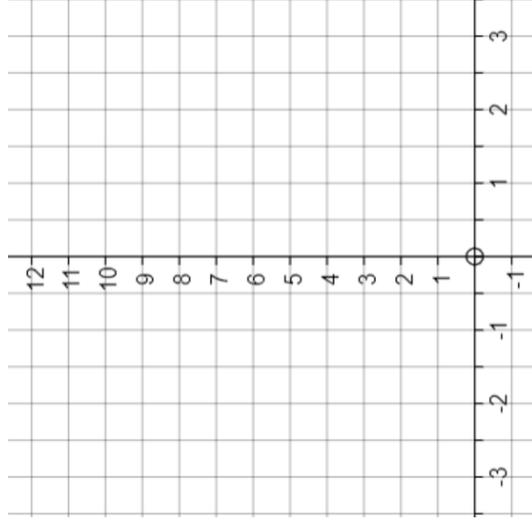
**(a)  $y = x^2$**

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



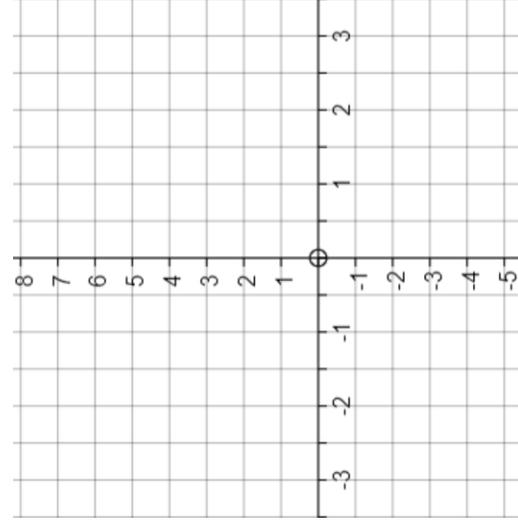
**(b)  $y = x^2 + 3$**

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



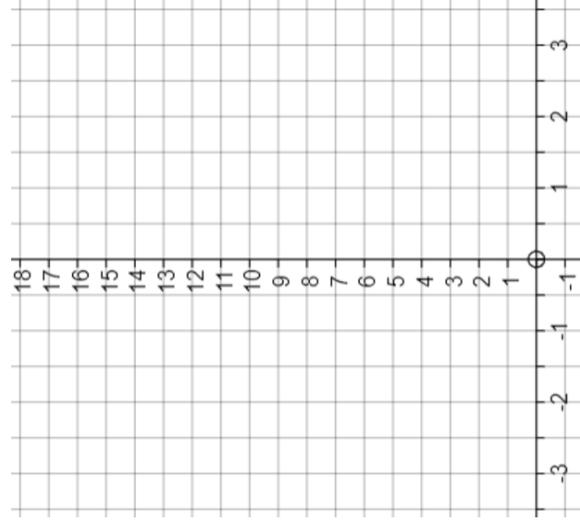
**(c)  $y = x^2 - 2$**

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



**(d)  $y = 2x^2$**

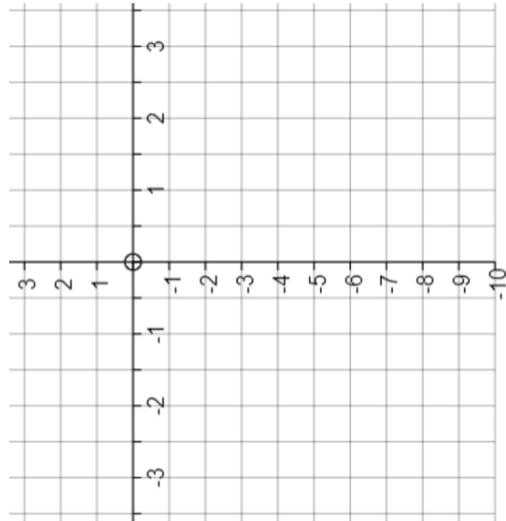
$x$	-3	-2	-1	0	1	2	3
$y$							



# Fluency Practice

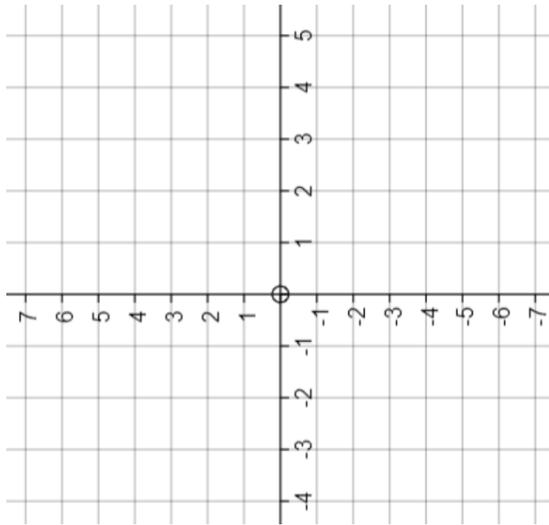
**(e)**  $y = -x^2$

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



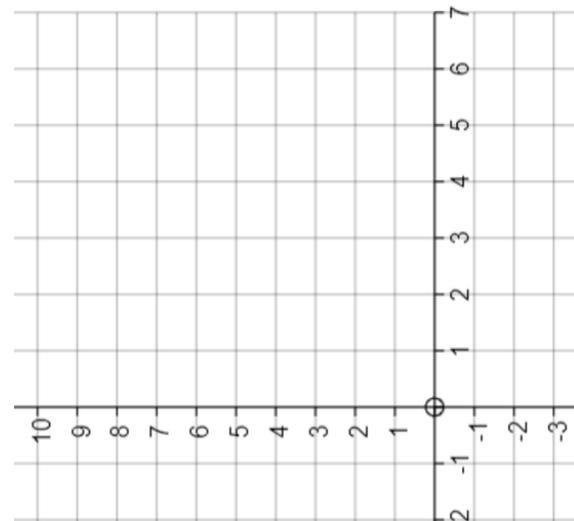
**(f)**  $y = x^2 - x - 6$

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



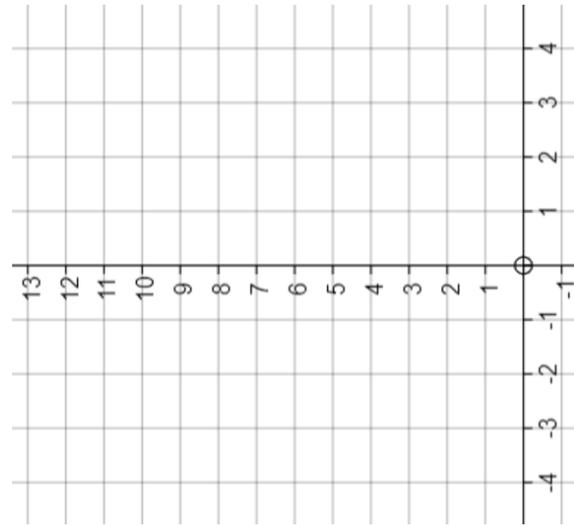
**(g)**

Plot the graph of  $y = x^2 - 5x + 4$  for  $-1 \leq x \leq 6$



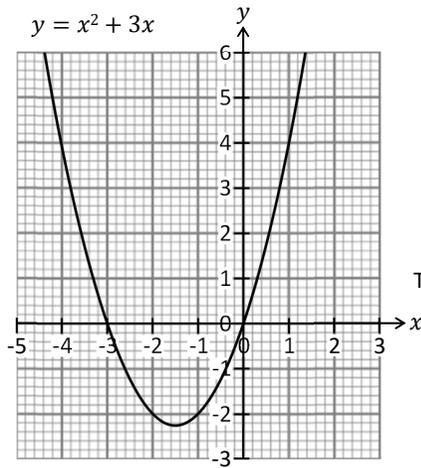
**(h)**

Plot the graph of  $y = 12 + x - x^2$  for  $-3 \leq x \leq 4$



# Fluency Practice

## Reading the Significant Points of a Quadratic Curve



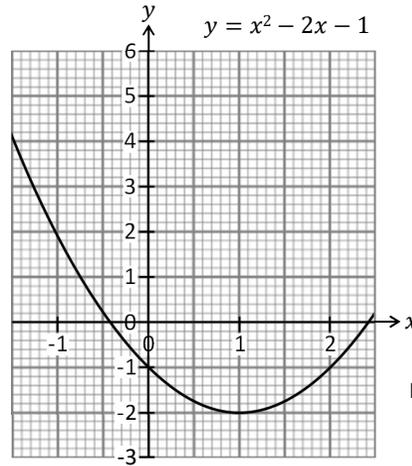
Roots: \_\_\_\_\_

y-intercept: \_\_\_\_\_

Turning Point: \_\_\_\_\_

Min or Max? \_\_\_\_\_

Use each graph to *estimate* each piece of information.

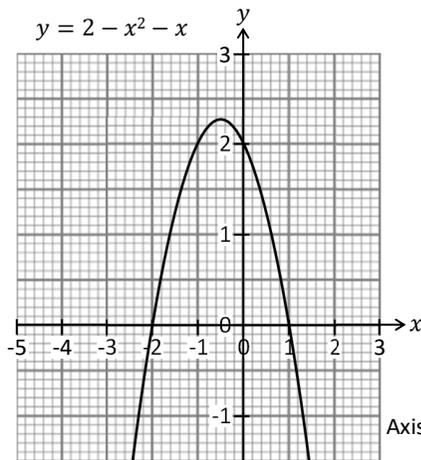


Solutions: \_\_\_\_\_

y-intercept: \_\_\_\_\_

Vertex: \_\_\_\_\_

Min or Max? \_\_\_\_\_



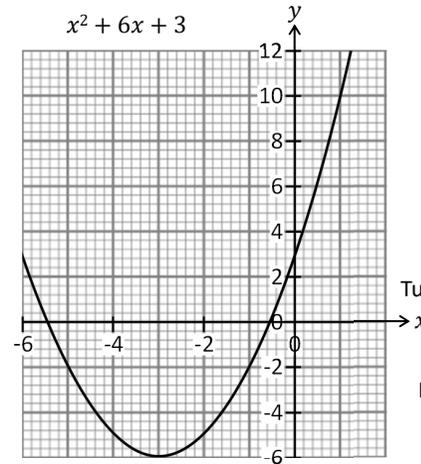
x-intercepts: \_\_\_\_\_

y-intercept: \_\_\_\_\_

Turning Point: \_\_\_\_\_

Min or Max? \_\_\_\_\_

Parabola's Axis of Symmetry: \_\_\_\_\_



Roots: \_\_\_\_\_

y-intercept: \_\_\_\_\_

Turning Point: \_\_\_\_\_

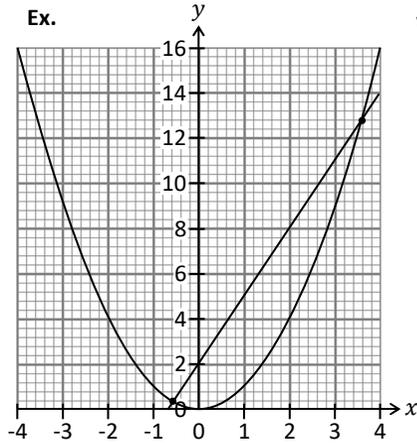
Min or Max? \_\_\_\_\_

# Fluency Practice

The graph  $y = x^2$  has been drawn on the grid.

Solving Equations using  $y = x^2$

Ex.



We will use it to solve this equation

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

rearrange ↓

$$x^2 = 3x + 2$$

Where the curve  $x^2$  intersects  
the line  $3x + 2$ ,  
the equation is true.

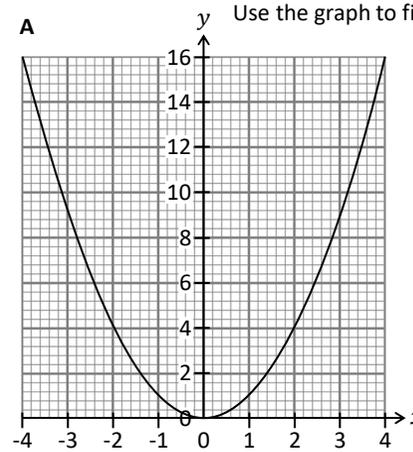
$$x = \underline{\quad -0.6 \quad}$$

or

$$x = \underline{\hspace{2cm}}$$

These are *estimates*.

A



Use the graph to find estimates for the solutions to:

$$x^2 - x - 4 = 0$$

rearrange ↓

$$x^2 = x + 4$$

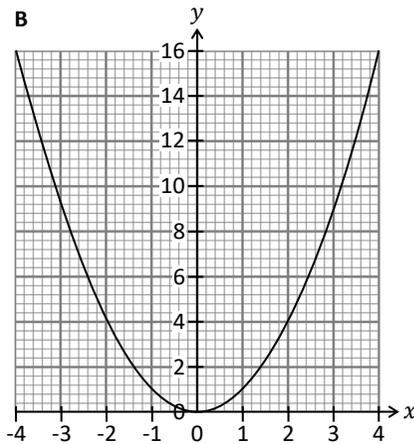
$$x = \underline{\hspace{2cm}}$$

or

$$x = \underline{\hspace{2cm}}$$

Use the graph to find estimates for the solutions of this equation.

B



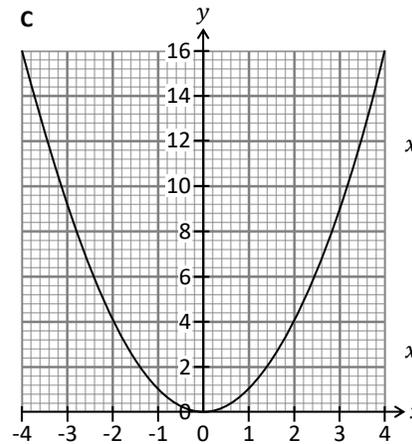
$$x^2 + 2x - 4 = 0$$

$$x = \underline{\hspace{2cm}}$$

or

$$x = \underline{\hspace{2cm}}$$

C



$$x^2 - 2x - 7 = 0$$

$$x = \underline{\hspace{2cm}}$$

$$x^2 - 3x + 1 = 0$$

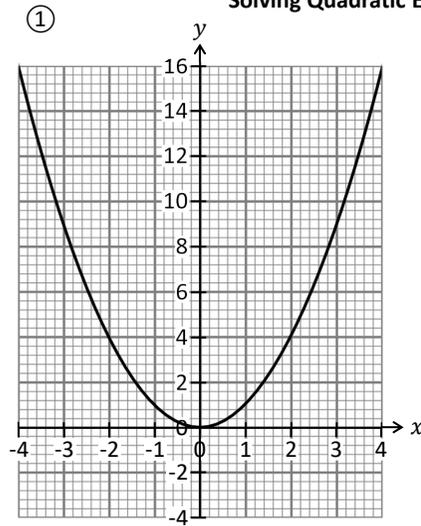
$$x = \underline{\hspace{2cm}}$$

# Fluency Practice

$y = x^2$   
has been drawn on the grid.

Use the graph to  
solve the equation:

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

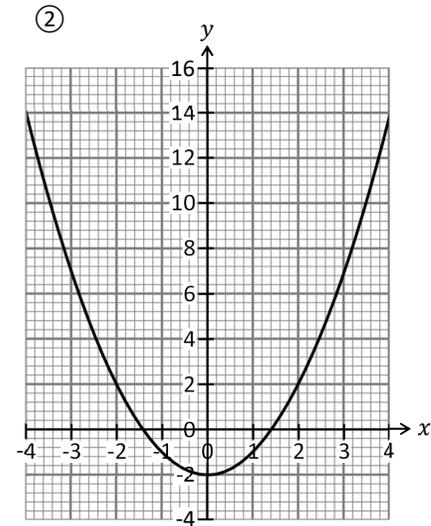


Solving Quadratic Equations: Intersection

$y = x^2 - 2$   
has been drawn on the grid.

Use the graph to  
solve the equation:

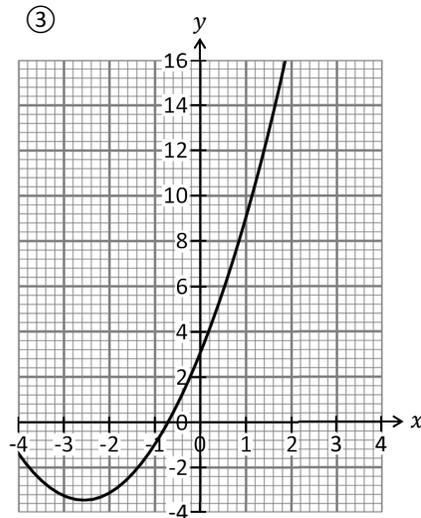
$$x^2 - x - 5 = 0$$



$y = x^2 + 5x + 3$   
has been drawn on the grid.

Use the graph to  
solve the equation:

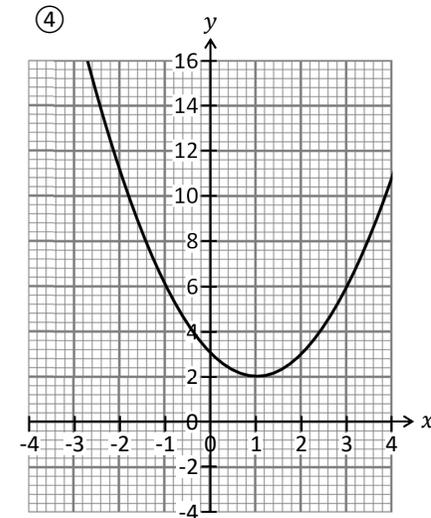
$$x^2 + 3x - 1 = 0$$



$y = x^2 - 2x + 3$   
has been drawn on the grid.

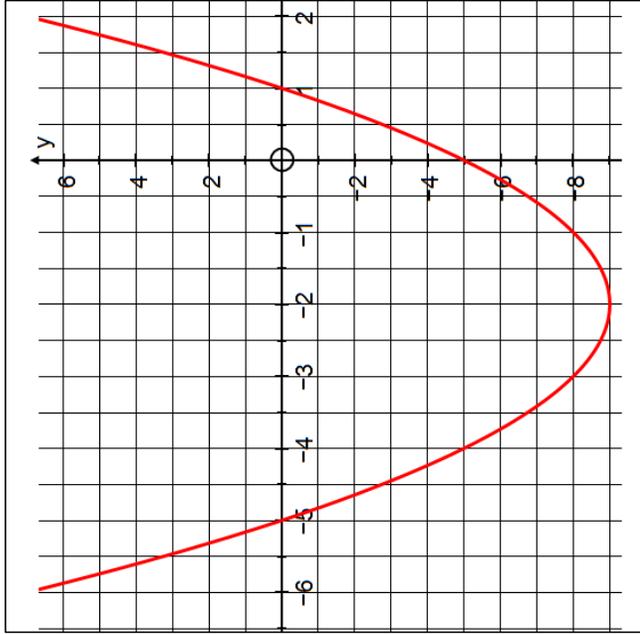
Use the graph to  
solve the equation:

$$x^2 + 2x - 2 = 0$$



# Fluency Practice

1) Here is the graph of  $y = x^2 + 4x - 5$



Use the graph to solve the following equations:

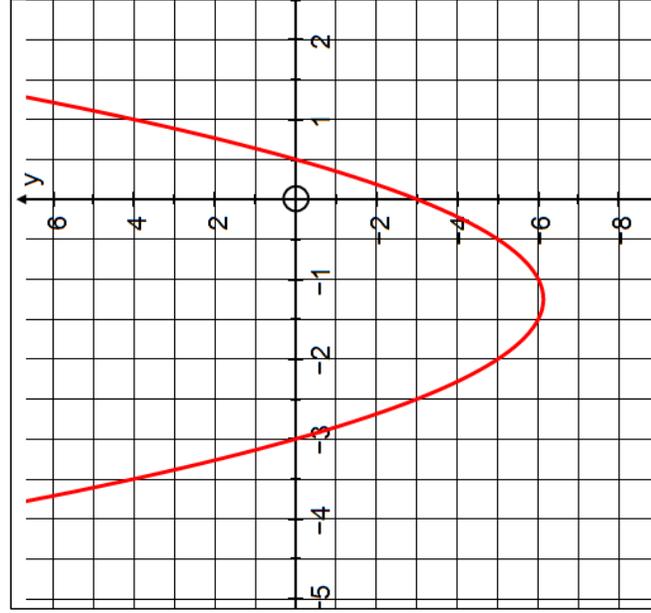
(a)  $x^2 + 4x - 5 = 0$

(b)  $x^2 + 4x - 5 = 4$

(c)  $x^2 + 4x - 5 = -6$

(d)  $x^2 + 4x - 5 = x$

2) Here is the graph of  $y = 2x^2 + 5x - 3$



Use the graph to solve the following equations:

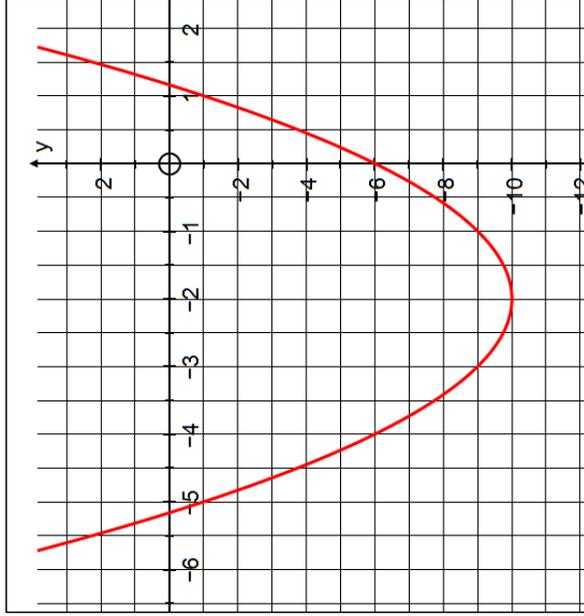
(a)  $2x^2 + 5x - 3 = 2x + 1$

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

(c)  $2x^2 + 5x + 2 = 0$

# Fluency Practice

3) Here is the graph of  $y = x^2 + 4x - 6$



Use the graph to solve the following equations:

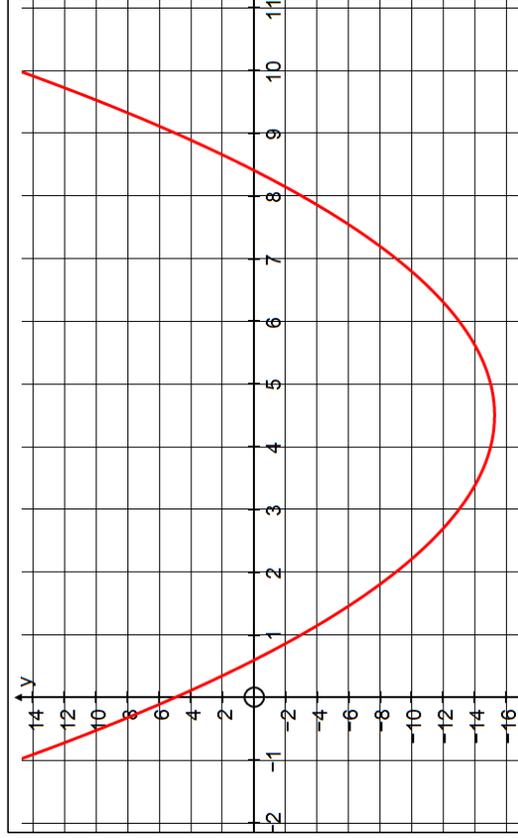
(a)  $x^2 + 4x - 6 = -10$

(b)  $x^2 + 4x - 6 = -11$

(c)  $x^2 + 3x - 6 = 0$

(d)  $x^2 + 5x - 2 = 0$

4) This is the graph of  $y = x^2 - 9x + 5$



Use the graph to solve:

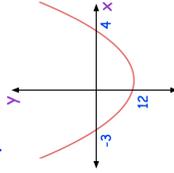
(a)  $x^2 - 11x + 12 = 0$

(b)  $x^2 - 6x + 3 = 0$

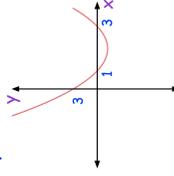
# Fluency Practice

Question 1: Using the graphs below, solve each equation.

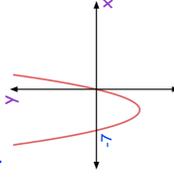
$y = x^2 - x - 12$



$y = x^2 - 4x + 3$



$y = x^2 + 7x$



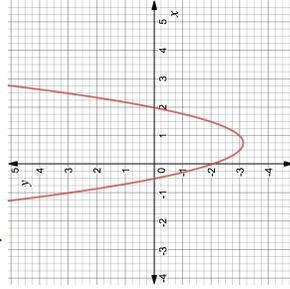
(a) Solve  $x^2 - x - 12 = 0$

(b) Solve  $x^2 - 4x + 3 = 0$

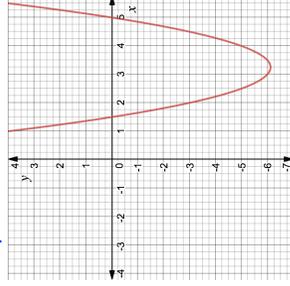
(c) Solve  $x^2 + 7x = 0$

Question 2: Using the graphs below, solve each equation

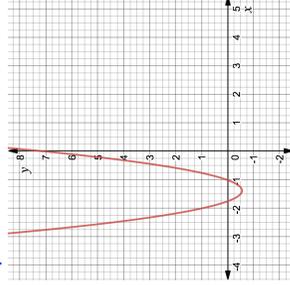
$y = 2x^2 - 3x - 2$



$y = 2x^2 - 13x + 15$



$y = 4x^2 + 11x + 7$



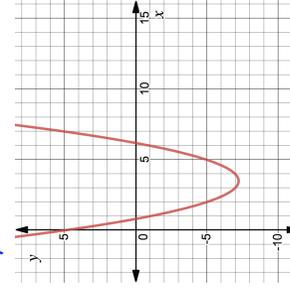
(a) Solve  $2x^2 - 3x - 2 = 0$

(b) Solve  $2x^2 - 13x + 15 = 0$

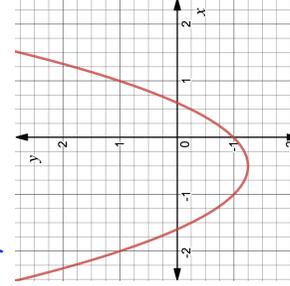
(c) Solve  $4x^2 + 11x + 7 = 0$

Question 3: Using the graphs, find estimates of the solutions to the following equations

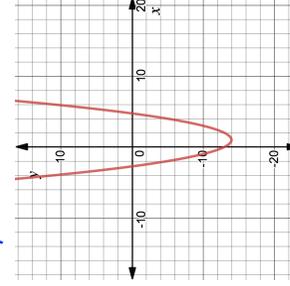
$y = x^2 - 7x + 5 = 0$



$y = x^2 + x - 1$



$y = x^2 - 2x - 13 = 0$



(a)  $x^2 - 7x + 5 = 0$

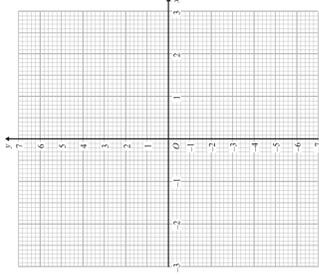
(b)  $x^2 + x - 1 = 0$

(c)  $x^2 - 2x - 13 = 0$

# Fluency Practice

Question 4: (a) Complete the table of values of  $y = x^2 - x - 5$

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



(b) On a copy of the grid, draw the graph of  $y = x^2 - x - 5$  for the value of  $x$  from  $-3$  to  $3$

(c) Use your graph to find estimates of the solutions to the equation  $x^2 - x - 5 = 0$

Question 5: Solve each of the following equations graphically

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

(b)  $x^2 + 8x + 5 = 0$

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

(d)  $x^2 - 5x - 8 = 0$

(e)  $x^2 + 4x - 10 = 0$

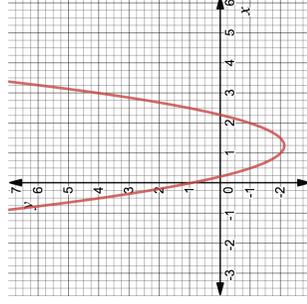
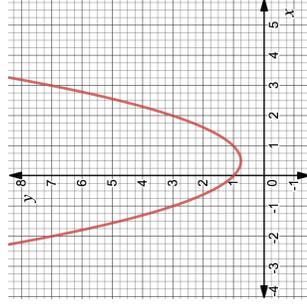
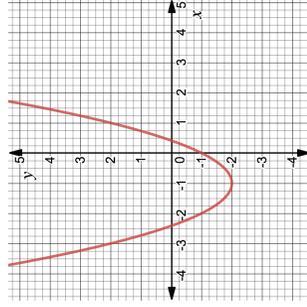
(f)  $2x^2 + 3x - 6 = 0$

Question 6: Using the graphs below, solve each equation

$y = x^2 + 2x - 1$

$y = x^2 - x + 1$

$y = 2x^2 - 5x + 1$



(a) Solve  $x^2 + 2x - 1 = 2$

(b) Solve  $x^2 - x + 1 = 7$

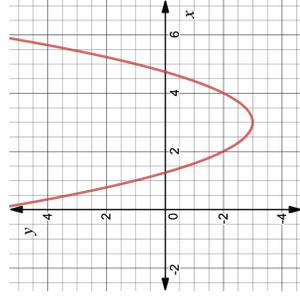
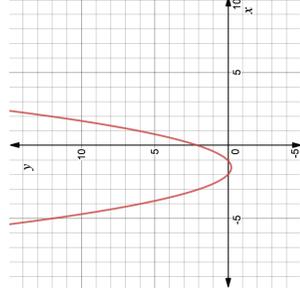
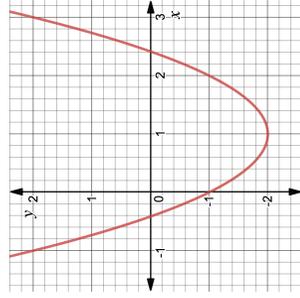
(c) Solve  $2x^2 - 5x + 1 = 1$

Question 7: Using the graphs, find estimates of the solutions to the following equations

$y = x^2 - 2x - 1$

$y = x^2 + 3x + 2$

$y = x^2 - 6x + 6$



(a)  $x^2 - 2x - 1 = 1$

(b)  $x^2 + 3x + 2 = 11$

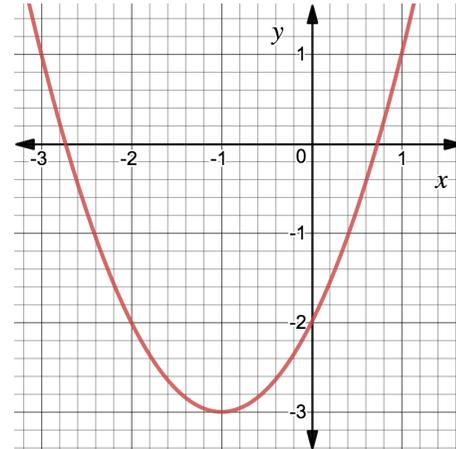
(c)  $x^2 - 6x + 6 = -1$

## Purposeful Practice

### Apply

Question 1: The graph of  $y = f(x)$  is drawn on the grid.

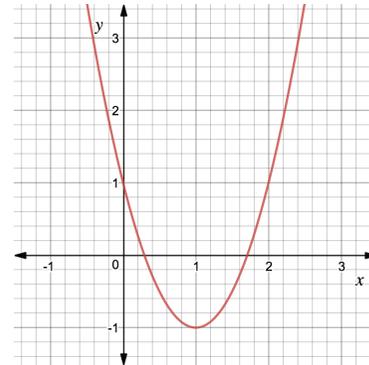
- (a) Write down estimates for the roots of  $f(x) = 0$
- (b) Use the graph to find an estimates for the roots of  $f(x) = -1$
- (c) Write down the coordinates of the turning point of the graph



Question 2: The grid below shows the graph of  $y = 2x^2 - 4x + 1$

The graph of  $2x^2 - 4x + 1 = k$  has exactly one solution.

Use the graph to find the value of  $k$



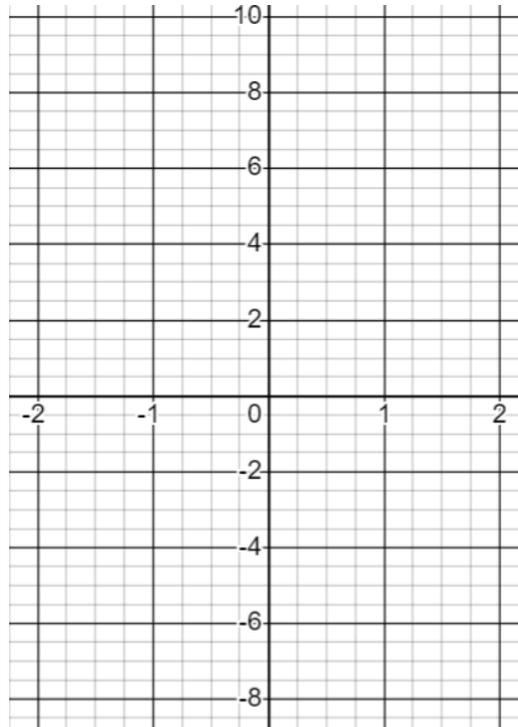
# Fluency Practice

## Plotting Cubic Graphs

**(a)**

Plot the graph of  $y = x^3 + 1$   
from  $x = -2$  to  $x = 2$

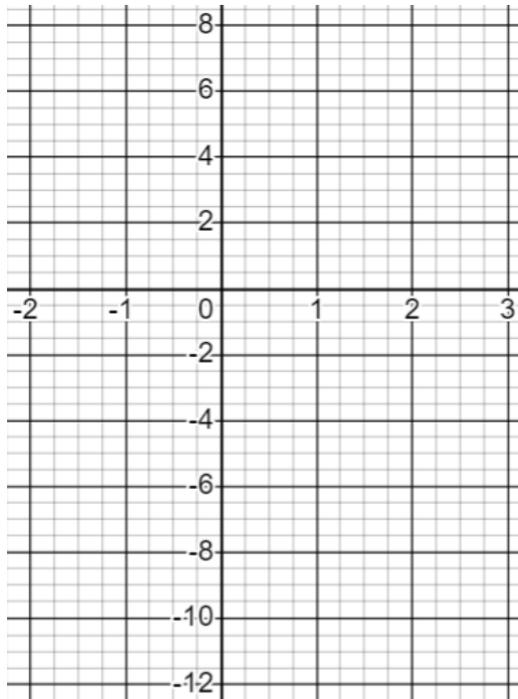
$x$	-2	-1	0	1	2
$y$					



**(b)**

Plot the graph of  $y = x^3 - 2x^2 - x + 2$   
from  $x = -2$  to  $x = 3$

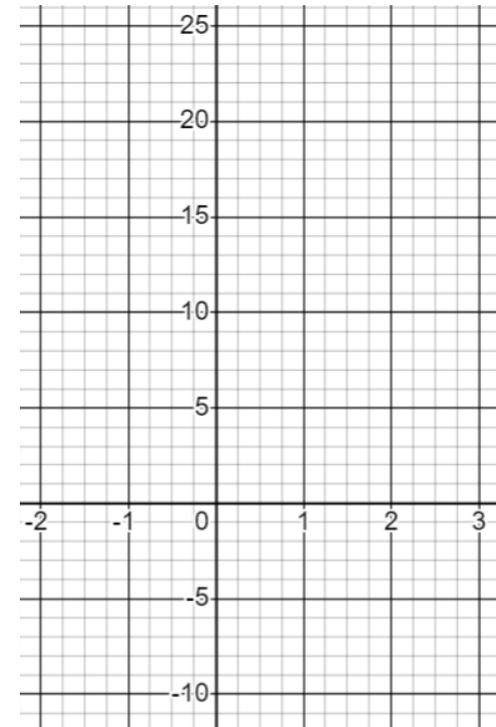
$x$	-2	-1	0	1	2	3
$y$						



**(c)**

Plot the graph of  $y = 3 - x + 2x^2 - x^3$   
from  $x = -2$  to  $x = 3$

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



# Fluency Practice

## Plotting Cubics

Use a table of values to plot each graph.

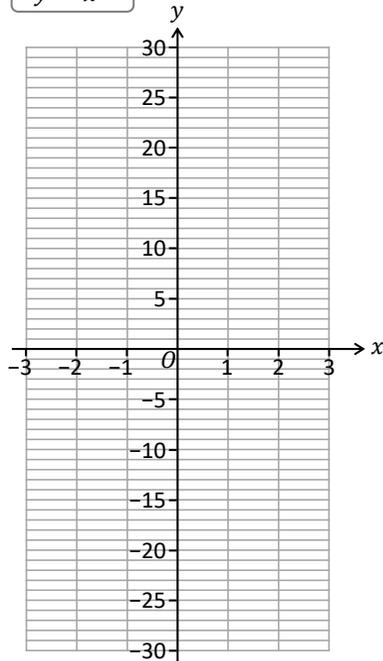
What effect does each term in the equation have on the cubic shape?

What comments can you make about the changing gradient of each curve?

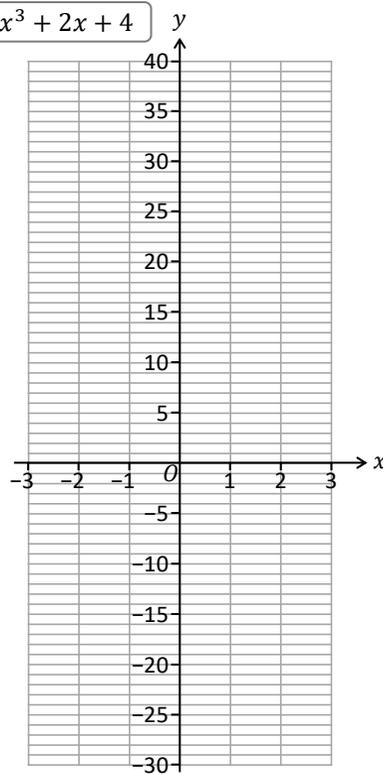
x	-3	-2	-1	0	1	2	3
y							

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

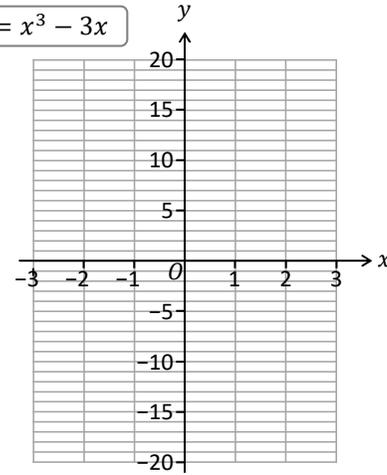
$$y = x^3$$



$$y = x^3 + 2x + 4$$

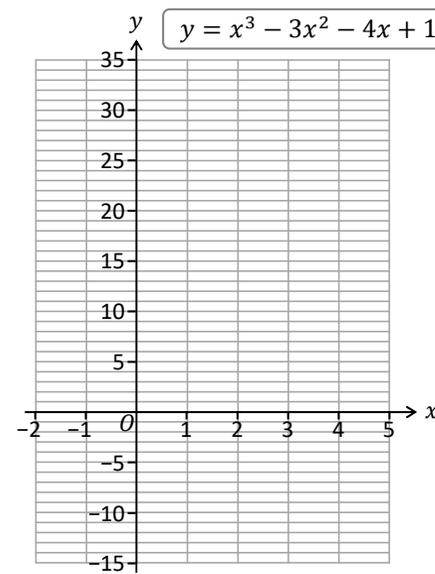


$$y = x^3 - 3x$$



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

$$y = x^3 - 3x^2 - 4x + 1$$



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

# Fluency Practice

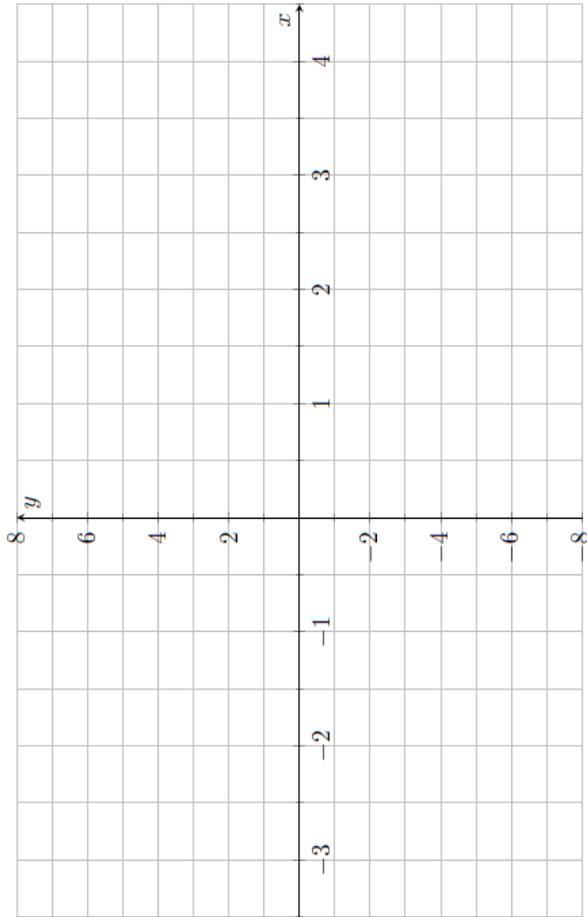
## Solving Equations Graphically

**(a)**

Plot the graph of  $y = 6 + x - x^2$ . Use the graph to find the solutions to equation

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

(b)  $6 + x - x^2 = -6$

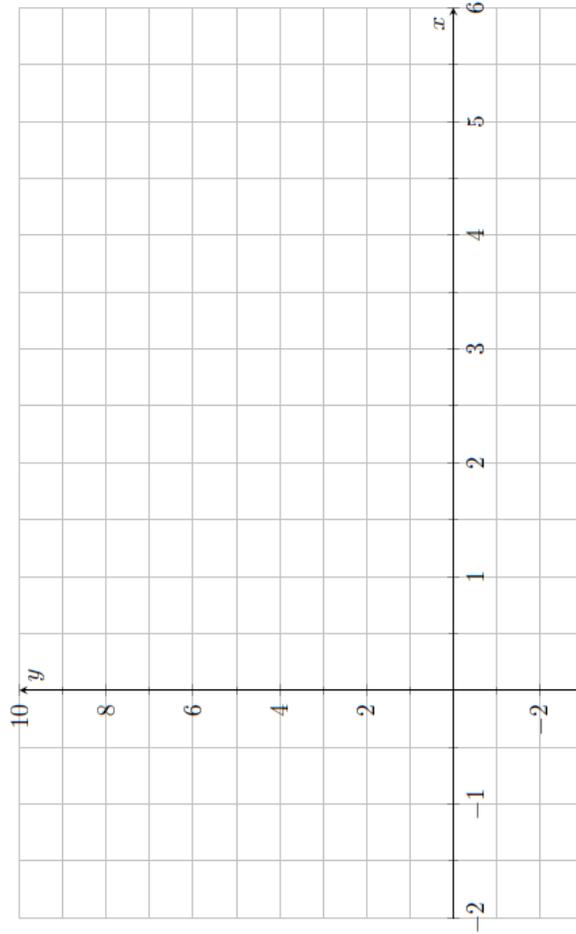


**(b)**

Plot the graph of  $y = x^2 - 4x + 3$ . Use the graph to find the solutions to equation

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

(b)  $x^2 - 4x + 3 = 8$



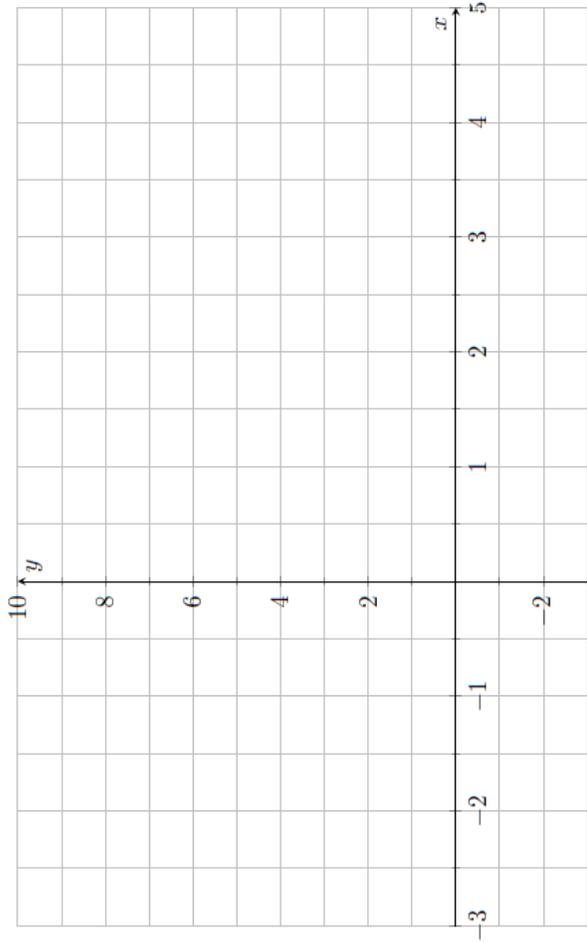
# Fluency Practice

**(c)**

Plot the graph of  $y = 8 + 2x - x^2$ . Use the graph to find the solutions to the equation

(a)  $8 + 2x - x^2 = 5$

(b)  $8 + 2x - x^2 = 8 - x$

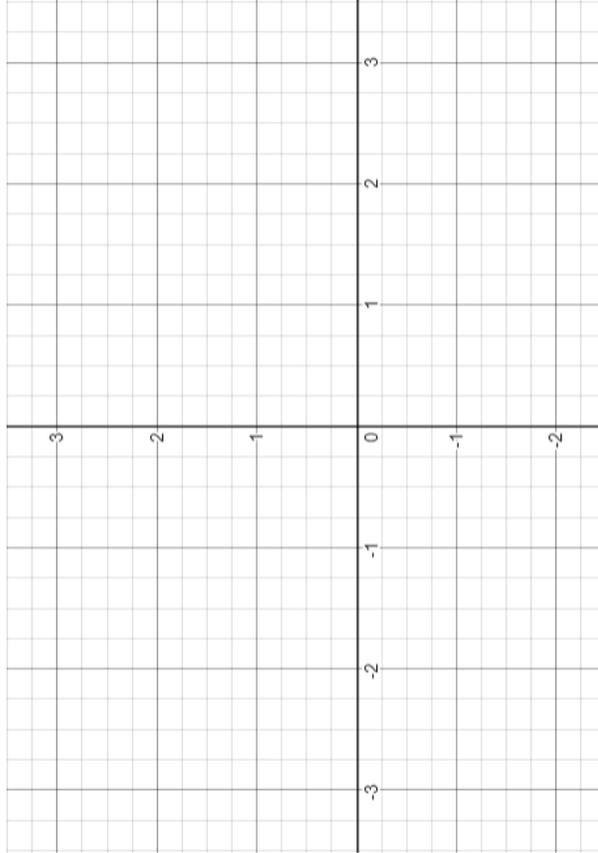


**(d)**

Plot the graph of  $y = x^3 - 3x$ . Use the graph to estimate the solutions to the equation

(a)  $x^3 - 3x = 1$

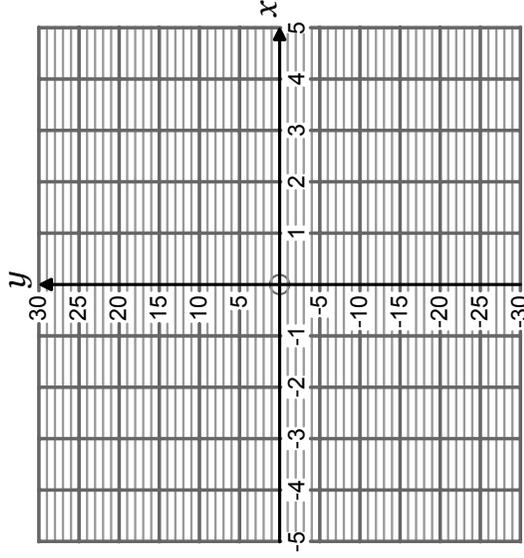
(b)  $x^3 - 3x = x + 1$



# Fluency Practice

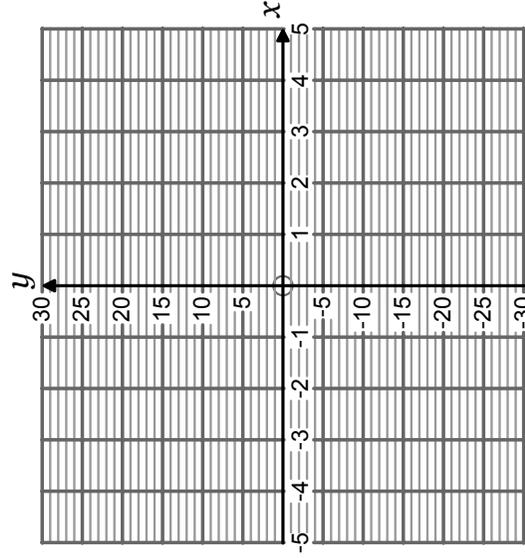
1. Plot the graph of  $y = x^3$

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



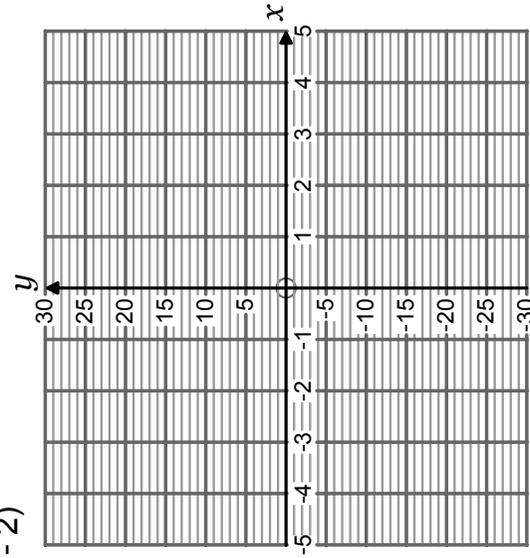
2. Plot the graph of  $y = 9x - x^3$

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



3. Plot the graph of  $y = x(x+3)(x-2)$

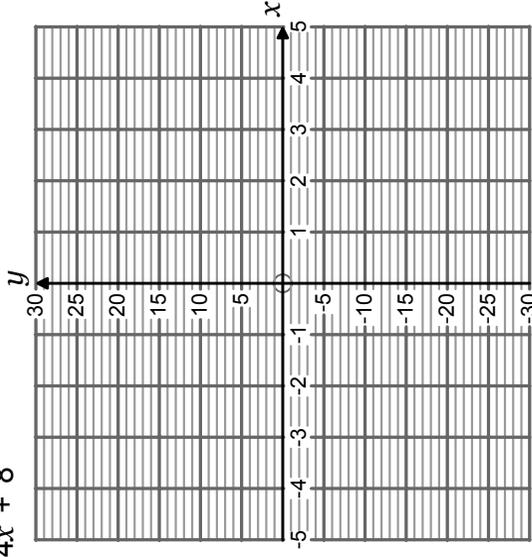
$x$	$y$
-4	
-3	
-2	
-1	
0	
1	
2	
3	
4	



## Fluency Practice

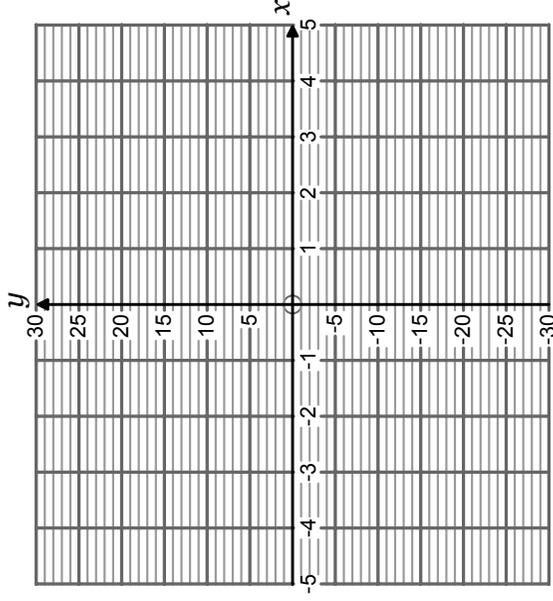
4. Plot the graph of  $y = x^3 - 2x^2 - 4x + 8$

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



5. Plot the graph of  $y = -(x+1)^3$

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

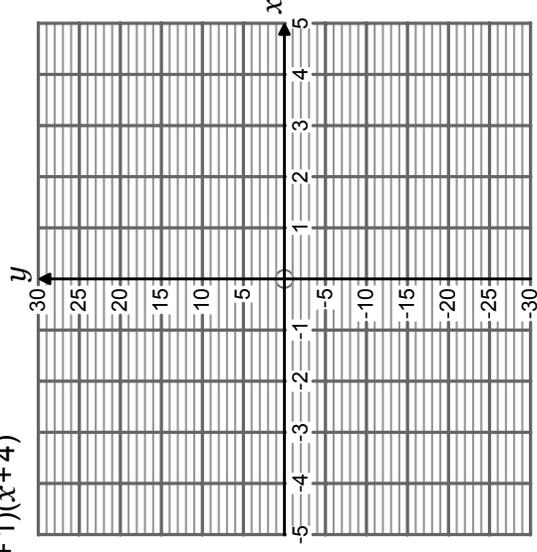


6. True or false?
- All cubic graphs pass through the origin.
  - All cubic graphs have a line of symmetry.
  - All cubic graphs intersect the  $x$ -axis at least once.
  - The coefficient of  $x^3$  determines the shape of the graph.
  - Cubic graphs have asymptotes.

# Fluency Practice

7. a) Plot the graph of  $y = (x - 3)(x + 1)(x + 4)$

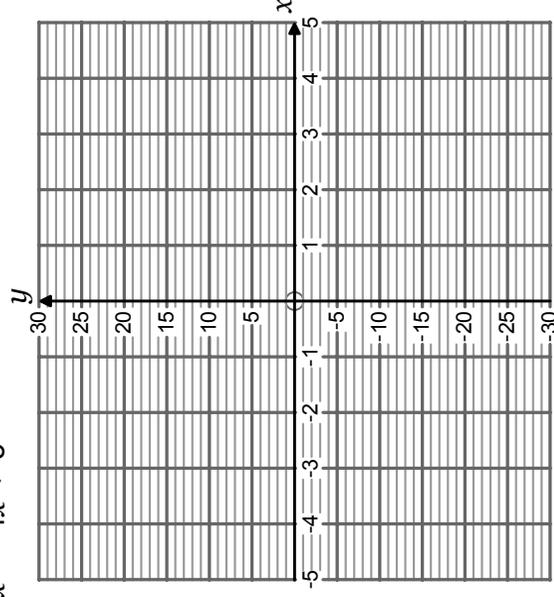
$x$	$y$
-5	
-4	
-3	
-2	
-1	
0	
1	
2	
3	



- b) Use your graph to estimate the solutions of:  $(x - 3)(x + 1)(x + 4) = 5$

8. a) Plot the graph of  $y = -x^3 + x^2 - 4x + 5$

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



- b) Use your graph to estimate the solution of:  $-x^3 + x^2 - 4x + 5 = -15$

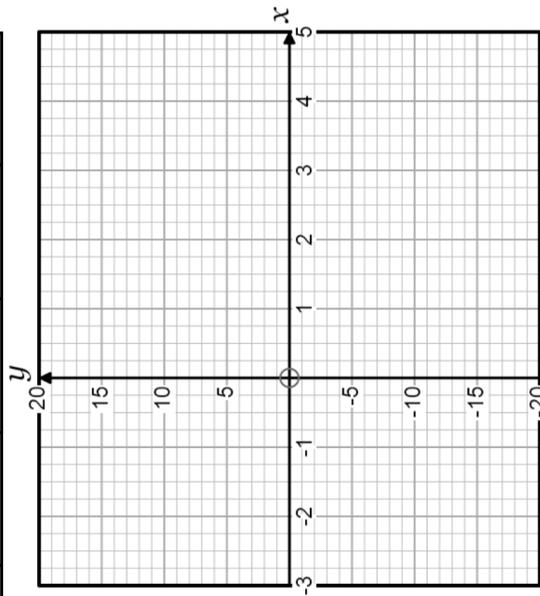
9. Work out the  $y$ -intercept of the graphs of each of these cubic functions.

- a)  $y = x^3 + 4$       b)  $y = 2x^3 + x - 1$       c)  $y = -x^3$   
 d)  $y = x(x^2 + 4)$       e)  $y = (x + 3)^3$       f)  $y = (x - 2)(x - 3)^2$

# Fluency Practice

1. Draw the graph of  $y = x^3 - 4x^2 + 3$

x	-2	-1	0	1	2	3	4
y							



2. Estimate the roots of

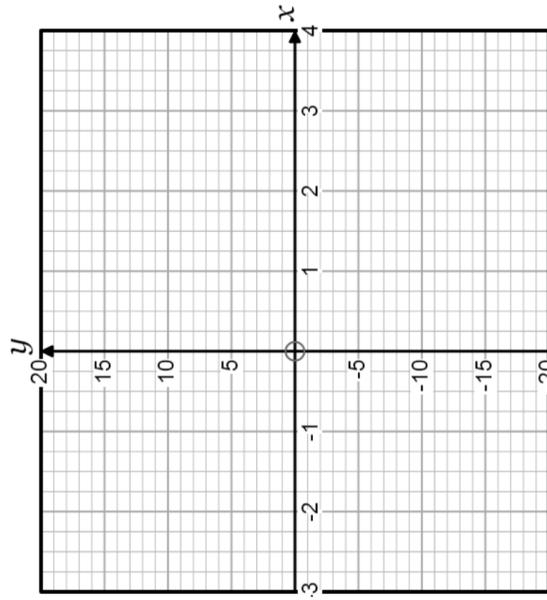
$$y = x^3 - 4x^2 + 3$$

3. Estimate the co-ordinates of the turning points of

$$y = x^3 - 4x^2 + 3$$

4. Draw the graph of  $y = 2x(x-2)(x+2)$

x	-2.5	-2	-1	0	1	2	2.5
y							



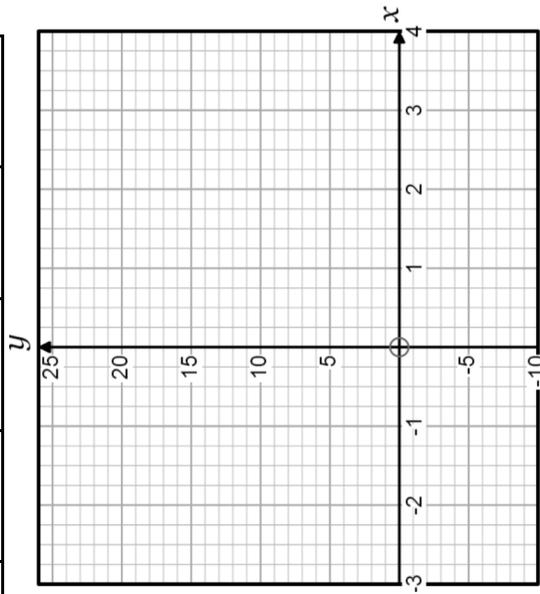
5. What are the roots of  $y = 2x(x-2)(x+2)$ ?

6. Estimate the co-ordinates of the turning points of  $y = 2x(x-2)(x+2)$

# Fluency Practice

7. Draw the graph of  $y = 5 - x^3 + 3x^2$

x	-2	-1	0	1	2	3	4
y							



8. Estimate the roots of  $y = 5 - x^3 + 2x^2$

9. Estimate the co-ordinates of the turning points of  $y = 5 - x^3 + 2x^2$

10. Why is this cubic graph 'upside down'?

11. Match the graphs to their functions:


$y = -x^2$

$y = 2x$

$y = (x-3)(x+1)$

$y = x^2 - 10$

$y = -x^3$

$y = 4 - x$

$y = 0.5x^2$

$y = x^3$

$y = x^3 - 3$

$y = (x-5)(x-3)(x+1)$

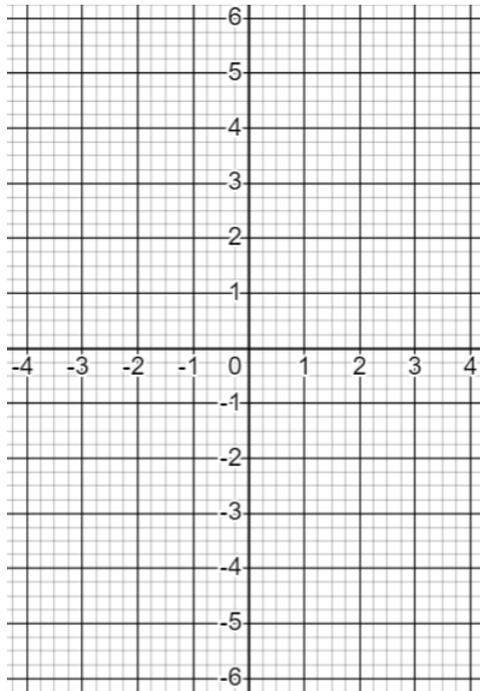
# Fluency Practice

## Plotting Reciprocal Graphs

**(a)**

Plot the graph of  $y = \frac{2}{x}$   
from  $x = -4$  to  $x = 4$

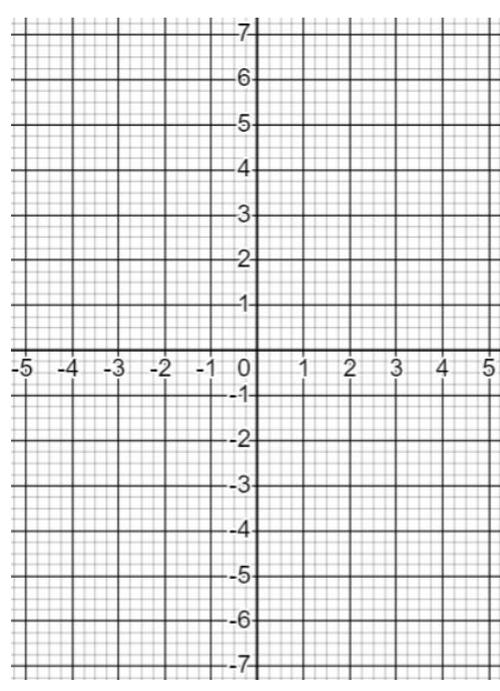
x	-4	-2	-1	0	1	2	4
y							



**(b)**

Plot the graph of  $y = -\frac{5}{x}$   
from  $x = -5$  to  $x = 5$

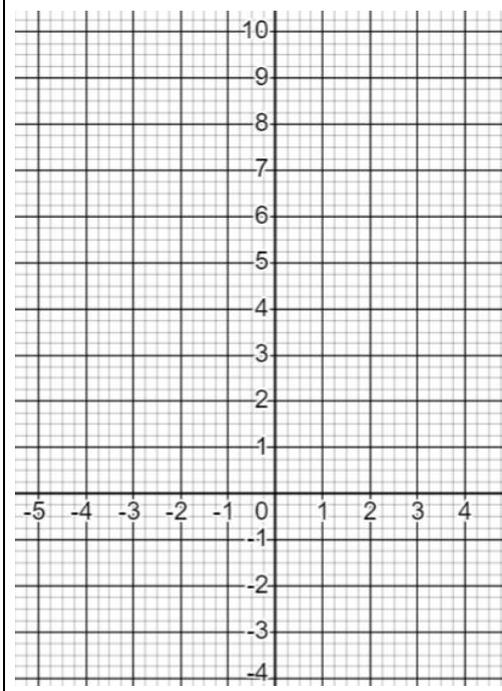
x	-5	-2	-1	0	1	2	5
y							



**(c)**

Plot the graph of  $y = \frac{10}{x^2}$   
from  $x = -2$  to  $x = 3$

x	-5	-2	-1	0	1	2	5
y							

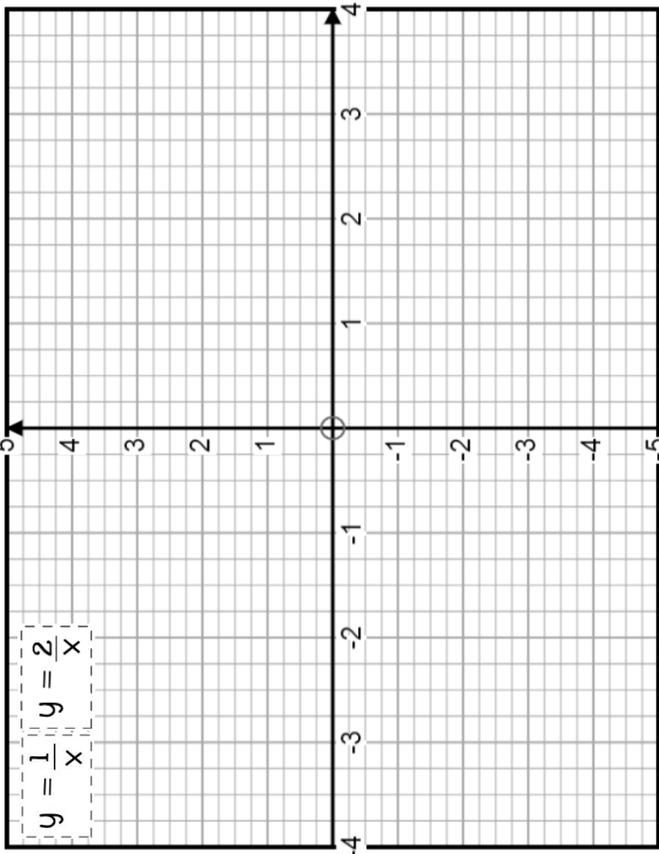


# Fluency Practice

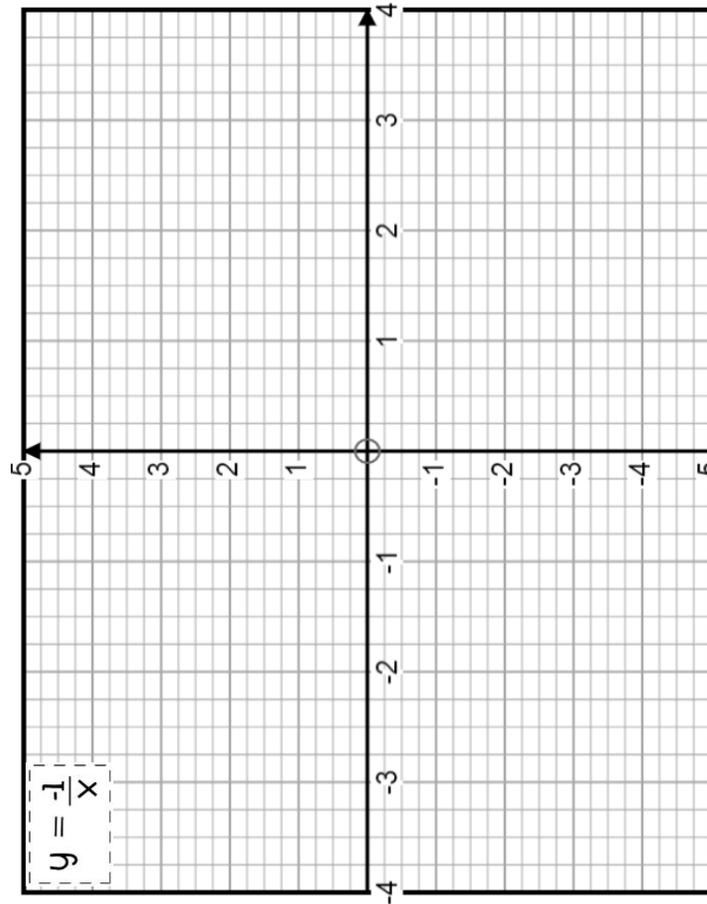
## reciprocal functions

These functions involve **dividing by x**.  
 What shape do their graphs make?  
 Draw two graphs on the first set of axes.

x	$y = \frac{1}{x}$	$y = \frac{2}{x}$
-4		
-3		
-2		
-1		
-0.5		
-0.25		
0		
0.25		
0.5		
1		
2		
3		
4		



x	y
-4	
-3	
-2	
-1	
-0.5	
-0.25	
0	
0.25	
0.5	
1	
2	
3	
4	



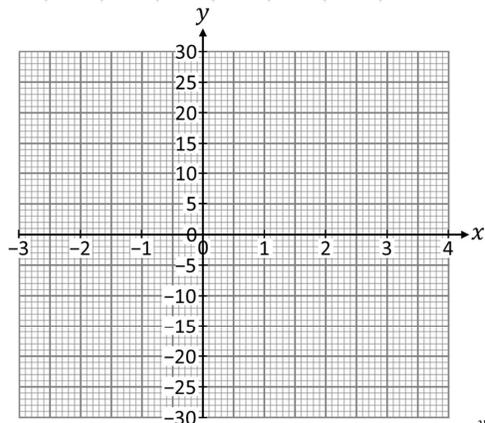
# Fluency Practice

## Plotting Cubic & Reciprocal Graphs

Plot the graph of  $y = x^3$  for values of  $x$  from  $-3$  to  $3$

A)

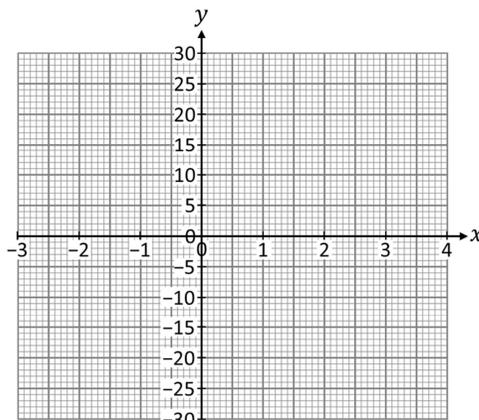
$x$	-3	-2	-1	0	1	2	3
$y$	-27						



Plot the graph of  $y = x^3 - 4$  for  $-2 \leq x \leq 3$

B)

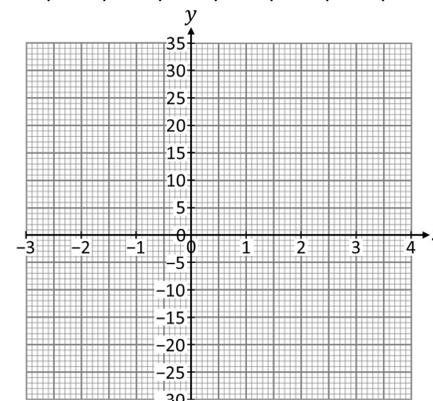
$x$	-2	-1	0	1	2	3
$y$						



Plot the graph of  $y = 5 - x^3$  for  $-3 \leq x \leq 3$

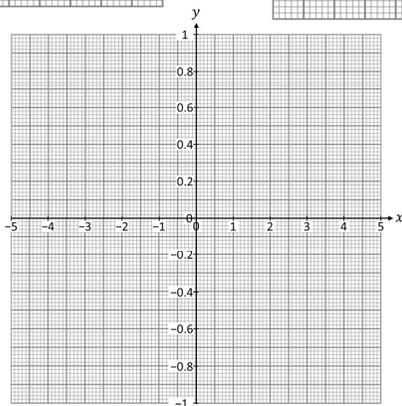
C)

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



D) Plot the graph of  $y = \frac{1}{x}$  for  $-5 \leq x \leq 5$

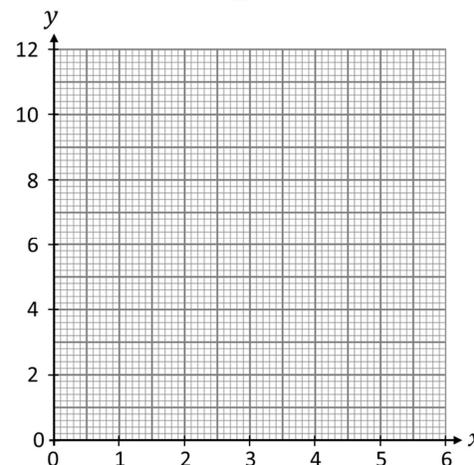
Why is there no value when  $x = 0$ ?



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

E) Plot the graph of  $y = \frac{12}{x}$  for  $0 \leq x \leq 6$

For your table of values, choose values for  $x$  that produce integer answers.

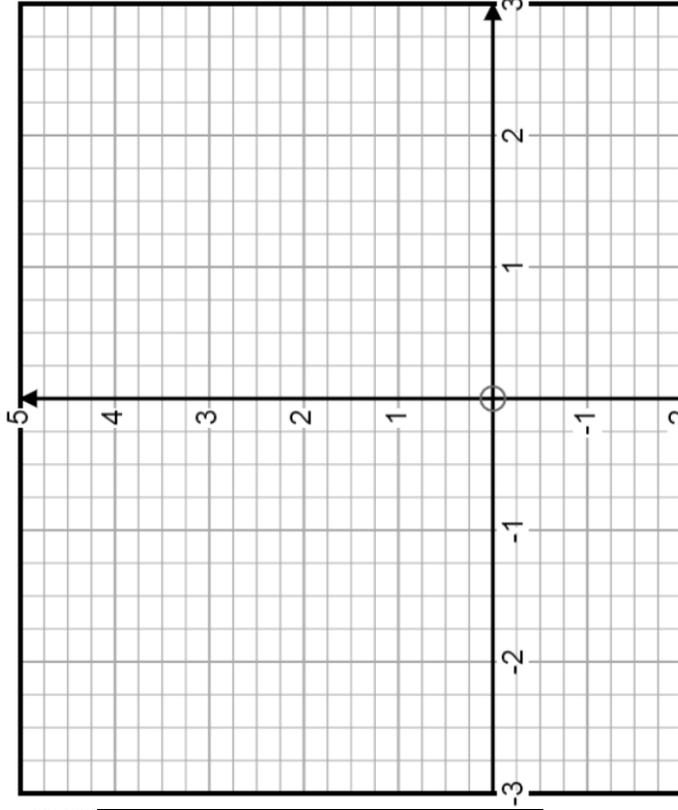


# Fluency Practice

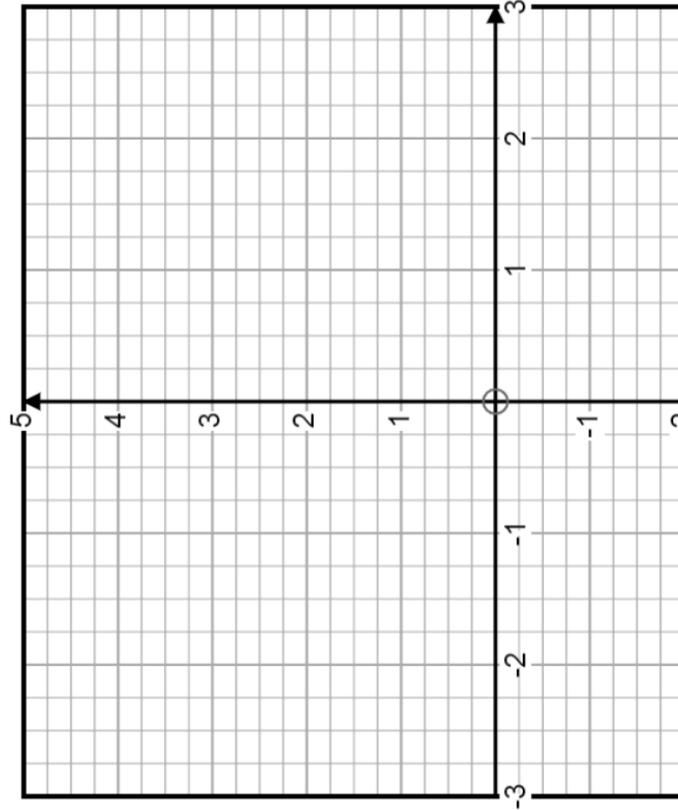
## exponential functions

These functions have **x as a power**.  
 What shape do their graphs make?  
 Draw two functions on each set of axes.

$y = 2^x$		$y = 4^x$	
x	y	x	y
-3		-3	
-2		-2	
-1		-1	
-0.5		-0.5	
0		0	
0.5		0.5	
1		1	
2		2	



$y = 0.5^x$		$y = 4^{-x}$	
x	y	x	y
-2		-2	
-1		-1	
-0.5		-0.5	
0		0	
0.5		0.5	
1		1	
2		2	



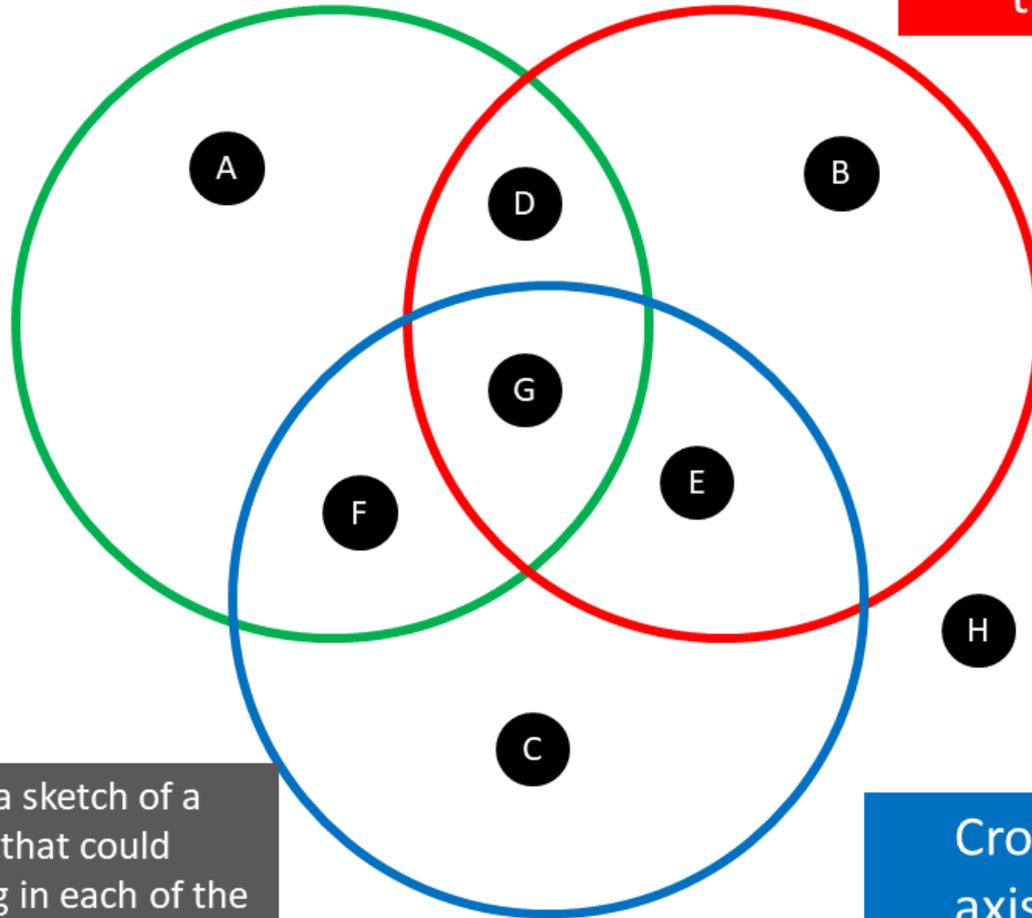
### extension

All of these graphs pass through (0, 1). Why?

# Problem Solving

Is symmetrical about the y-axis

Passes through the origin



If you think a region is impossible to fill, convince me why!

BONUS:  
Can you give the equations?

Draw a sketch of a graph that could belong in each of the regions.

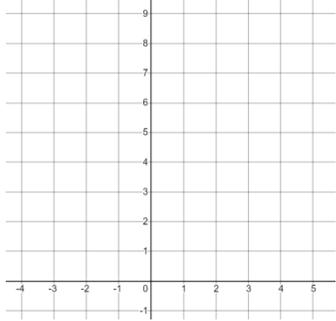
Crosses the x-axis twice

# Fluency Practice

**(a)**

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

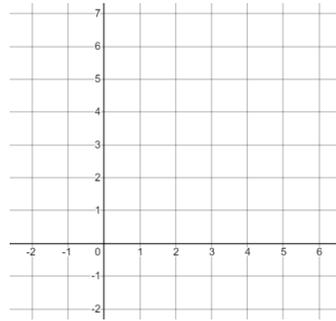
$x$	-2	-1	0	1	2	3
$y$						



**(c)**

Plot the graph of  $y = x^2 - 4x + 2$

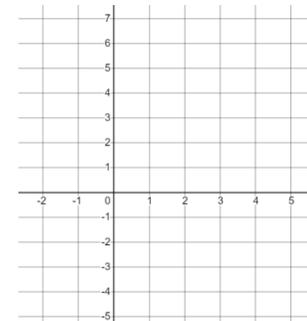
$x$	-1	0	1	2	3	4	5
$y$							



**(e)**

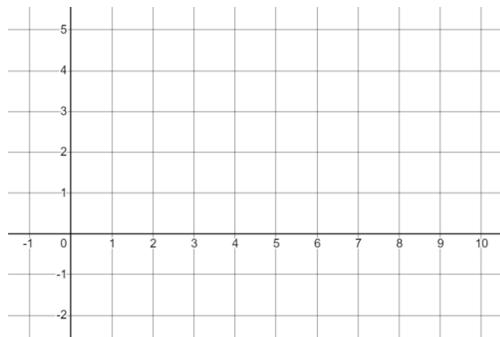
Plot the graph of  $y = x^3 - 4x^2 + 5$

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



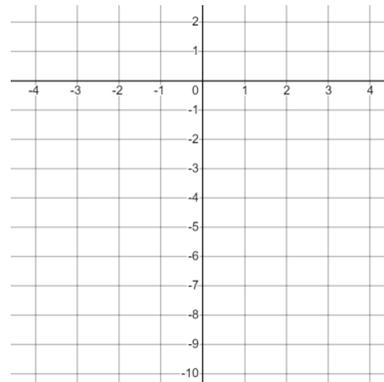
**(b)**

On the grid, plot the graph of  $2x - 3y = 6$  from  $x = 0$  to  $x = 9$



**(d)**

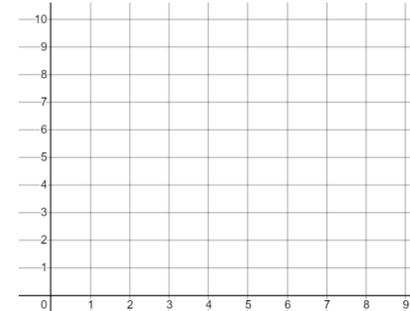
Plot the graph of  $y = 2 + x - x^2$  for  $x = -3$  to  $x = 3$



**(f)**

Plot the graph of  $y = x + \frac{8}{x}$

$x$	1	2	3	4	6	8
$y$						



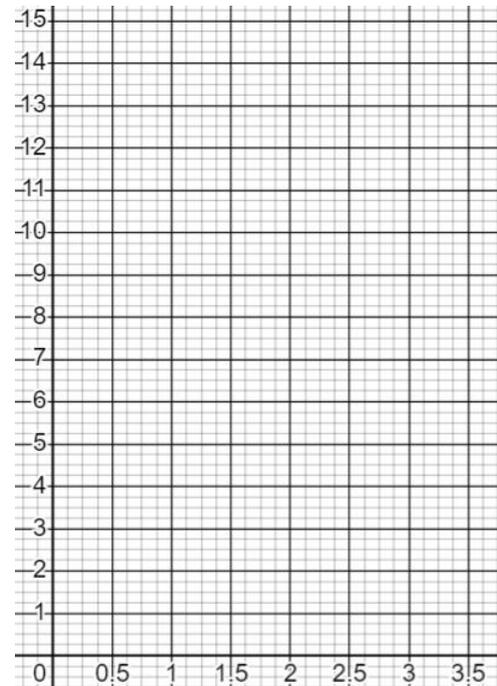
# Fluency Practice

## Plotting Harder Non-Linear Graphs

**(a)**

Plot the graph of  $y = x^2 + \frac{2}{x^2}$   
between  $x = 0.5$  and  $x = 3.5$

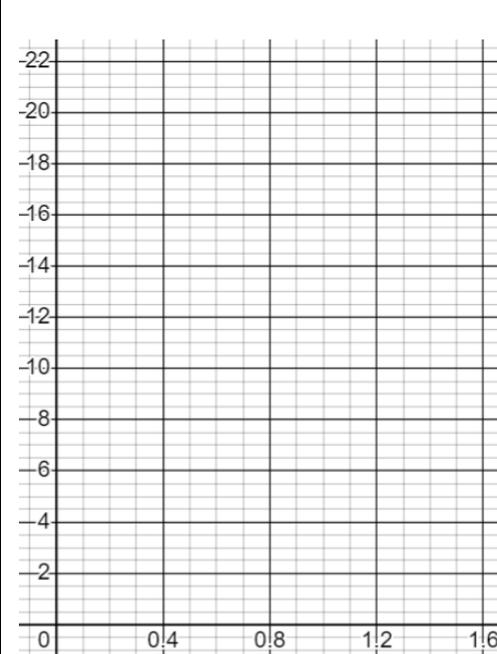
$x$	0.5	1	1.5	2	2.5	3	3.5
$y$							



**(b)**

Plot the graph of  $y = x^3 + 3x + \frac{2}{x}$   
from  $x = 0.1$  to  $x = 1.5$

$x$	0.1	0.2	0.4	0.7	1	1.2	1.5
$y$							



**(c)**

Plot the graph of  $y = x \left( \frac{x}{2} - \frac{1}{x^2} \right)$   
from  $x = -4$  to  $x = -0.5$

$x$	-4	-3	-2	-1	-0.5	-0.25
$y$						

