Year 8
Mathematics
Unit 3 – Student

Name: _____

Class: _____

Contents

1 Changing the Subject

A formula is a mathematical equation containing two or more variables.

Suppose that you have the formula such as $2x = 3a$

We could write this formula as $x = \frac{3a}{2}$ in which case we would say that x is the subject of the formula, or that x is given/written in terms of a.

Note: x is the subject of the formula above as it appears on its own on one side of an equals sign.

1.1 Subject of a Formula

The subject of a formula is the variable that is being worked out. It can be recognised as the letter on its own on one side of the equals sign.

Is a the subject?

$a = 3x + 1$	$\boldsymbol{a}$ is the subject	$\boldsymbol{a}$ is the NOT subject
$a + 1 = 3b + 2$	$\boldsymbol{a}$ is the subject	$\boldsymbol{a}$ is the NOT subject
$4a = 3b + 2$	$\boldsymbol{a}$ is the subject	$\boldsymbol{a}$ is the NOT subject
$4b + 2 = a$	$\boldsymbol{a}$ is the subject	$\boldsymbol{a}$ is the NOT subject
$a = 5a - 7b + 3$	$\boldsymbol{a}$ is the subject	$\boldsymbol{a}$ is the NOT subject
$a^2 = 3b + 2$	$\boldsymbol{a}$ is the subject	$\boldsymbol{a}$ is the NOT subject
$a = \frac{1}{2}b$	$\boldsymbol{a}$ is the subject	$\boldsymbol{a}$ is the NOT subject
$a = \frac{7b + 55c}{2}$	$\boldsymbol{a}$ is the subject	$\boldsymbol{a}$ is the NOT subject
$\sqrt{b} = a$	$\boldsymbol{a}$ is the subject	$\boldsymbol{a}$ is the NOT subject
$\sqrt{a} = b$	$\boldsymbol{a}$ is the subject	$\boldsymbol{a}$ is the NOT subject
$a + 0 = b$	$\boldsymbol{a}$ is the subject	$\boldsymbol{a}$ is the NOT subject

Fluency Practice

Formula	Is a the subject?
$a = b + 3$	
$b + 3 = a$	
$a + 3 = b$	
$a + c = b$	
$ac = b$	
$a = bc$	
$a = bc - 6$	
$a = bc - x$	
$a = bc - a$	
$a = bc - a^2$	
$-a = b + 3$	
$\frac{1}{a} = b + 3$	
$a^2 = b + 3$	
$a = b^2 + 3$	
$2a = b^2 + 3$	
$\sqrt{a} = b^2 + 3$	
$a = \sqrt{\frac{b^2 + 3}{2}}$	
$\sqrt{\frac{b^2 + 3}{2}} = a$	
$\sqrt{\frac{b^2 + 3}{2a}} = a$	

1.2 Addition and Subtraction

Worked Example	Your Turn
Make x the subject of the following formulae: (a) $y = x + z$ (b) $y = x - w$ (c) $y = x + \sqrt{rs}$	Make x the subject of the following formulae: (a) $y = x + k$ (b) $y = x - q$ (c) $y = x - \sqrt{ab}$

Intelligent Practice

Make x the subject for each of the following formulae:

1) $y = x + a$

2) $y = b + x$

3) $y = x + abc$

4) $y = def + x$

5) $y = x - a$

6) $y = -b + x$

7) $y = x - abc$

8) $y = -def + x$

1.3 Multiplication and Division

Worked Example	Your Turn
Make x the subject of the following formulae: (a) $y = ax$ (b) $y = \frac{x}{pq}$ (c) $y = -\frac{x}{\sqrt{z}}$	Make x the subject of the following formulae: (a) $y = bx$ (b) $y = \frac{x}{abc}$ (c) $y = -\frac{x}{\sqrt{w}}$

Intelligent Practice

Make x the subject for each of the following formulae:

1) $y = ax$

2) $y = -ax$

3) $y = bcx$

4) $y = -bcx$

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

6) $y = -\frac{x}{\sqrt{a}}$

7) $y = \frac{x}{bc}$

8) $y = -\frac{x}{\sqrt{bc}}$

1.4 Addition or Subtraction then Division

Worked Example	Your Turn
Make x the subject of the following formulae: $y = mx + c$	Make x the subject of the following formulae: $y = abx + c$

Intelligent Practice

Make x the subject for each of the following formulae:

1) $y = ax + b$

2) $y = b^2 + ax$

3) $y = ax + bcd$

4) $y = d^2ef + ax$

5) $y = ax - b$

6) $y = -\sqrt{b} + ax$

7) $y = ax - bcd$

8) $y = -\sqrt{bcd} + ax$

1.5 Addition or Subtraction then Multiplication

Worked Example	Your Turn
Make x the subject of the following formulae: (a) $y = \frac{x}{m} + c$ (b) $y = -\frac{x}{ef} + c^2$	Make x the subject of the following formulae: (a) $y = \frac{x}{ab} + c$ (b) $y = -\frac{x}{cd} + e^2$

Intelligent Practice

Make x the subject for each of the following formulae:

1) $y = \frac{x}{a} + c$

2) $y = -\frac{x}{a} + c$

3) $y = \frac{x}{a^2} - c$

4) $y = -\frac{x}{a^2} - c$

5) $y = \frac{x}{bc} + \sqrt{qrs}$

6) $y = -\frac{x}{bc} - \sqrt{qrs}$

1.6 Brackets

Worked Example	Your Turn
Make x the subject of the following formulae: $y = p(x + q)$	Make x the subject of the following formulae: $y = p(x - q)$

Fluency Practice

Make x the subject of these equations.

There are two ways to rearrange each equation so there are two sets of answer boxes. You only need to fill in your answer once. Use the boxes where your answer fits best.

$a(x + b) = c$ $\quad x = \frac{\square}{\square} - \square$ or $x = \frac{\square}{\square}$

$2(x + a) = b$ $\quad x = \frac{\square}{\square} - \square$ or $x = \frac{\square}{\square}$

$a(x - 6) = b$ $\quad x = \frac{\square}{\square} + \square$ or $x = \frac{\square}{\square}$

$c(7 + x) = 2$ $\quad x = \frac{\square}{\square} - \square$ or $x = \frac{\square}{\square}$

Extension:

The following formula can be used to convert temperatures from Fahrenheit (F) into Celsius (C):

$$C = \frac{5(F - 32)}{9}$$

Find a formula to convert temperatures from Celsius (C) into Fahrenheit.

1.7 Powers and Roots

Worked Example	Your Turn
Make a the subject of the following formulae: (a) $2a^2 = c$ (b) $2\sqrt{a} = c$	Make a the subject of the following formulae: (a) $2(a+b)^2 = c$ (b) $2\sqrt{a-b} = c$

Intelligent Practice

Make a the subject for each of the following formulae:

1) $2a^2 + b = c$
2) $2a^2 - b = c$
3) $6a^2 - b = c$
4) $2(a - 2b)^2 + b = c$
5) $2(a + 2b)^2 - b = c$
6) $6(a + 2b)^2 - b = c$

1) $2\sqrt{a} + b = c$
2) $2\sqrt{a} - b = c$
3) $6\sqrt{a} - b = c$
4) $2\sqrt{a - 2b} + b = c$
5) $2\sqrt{a + 2b} - b = c$
6) $6\sqrt{a + 2b} - b = c$

1.8 Review and Problem Solving

Fluency Practice

Question 1: Make y the subject of each of the following

(a) $y + w = c$ (b) $y - p = m$ (c) $m + y = s$

(d) $y - 2g = n$ (e) $3y = c$ (f) $ay = w$

(g) $\frac{y}{c} = w$ (h) $\frac{y}{a} = 2c$ (i) $a = y + p$

(j) $c = y - k$ (k) $y^2 = s$ (l) $y^3 = x$

(m) $\sqrt{y} = g$ (n) $\pi y = c$ (o) $n - y = t$

(p) $ry = c$ (q) $4\pi y = b$ (r) $y + 7t = c + r$

(s) $\frac{r}{y} = w$ (t) $y^2 = k + x$ (u) $A = xy$

Question 2: Make x the subject of the following formulae

(a) $4x + c = w$ (b) $dx - t = 8$ (c) $x^2 + 3 = h$

(d) $2x + 2y = P$ (e) $s = x^2 - 3$ (f) $y = xz + s$

(g) $\frac{x}{n} + 2 = w$ (h) $\frac{x}{6} - 5 = w$ (i) $\frac{x + 3}{c} = h$

(j) $3y = 4x + 1$ (k) $x^2 + a = v$ (l) $x^3 - 4 = 5y$

(m) $\frac{x + t}{m} = 2c$ (n) $\frac{w + x}{u} = 3z$ (o) $A = \pi x^2$

(p) $A = \frac{1}{2}bx$ (q) $V = abx$ (r) $v^2 = u^2 + 2ax$

(s) $\frac{a + b}{x} = r$ (t) $\frac{5cx}{b} = a$ (u) $\sqrt[3]{\frac{x}{k}} = w$

Question 3: Make c the subject of the following

(a) $(a + c)^2 = t$ (b) $v = u + ac$ (c) $v = \pi c^2 h$

Fluency Practice

Question 1: Make x the subject of each of the following

(a) $A = \frac{1}{2}(x + y)$

(b) $A = \pi r^2 + 2\pi rx$

(c) $T = 3x^2 - y$

(d) $s = \frac{m}{ax}$

(e) $s = uy + \frac{1}{2}xy^2$

(f) $\frac{1}{3}w = \frac{1}{4}x + t$

(g) $j = \frac{x + 3}{d}$

(h) $g = \frac{t}{x - 2}$

(i) $p = 3(y + 2x)^2$

(j) $12w = \frac{3}{4}(2x + a)$

Intelligent Practice

Make a the subject of the following formulae:

1) $2a = b$

2) $\frac{a}{2} = b$

3) $a + 2 = b$

4) $a - 2 = b$

5) $\frac{a}{c} = b$

6) $\frac{a}{c} + 2 = b$

7) $ac = b$

8) $ac - 2 = b$

9) $ac - d = b$

10) $\frac{a+2}{c} = b$

11) $\frac{2a}{c} = b$

12) $\frac{d(a+2)}{c} = b$

Extension

Question 1: The circumference of a circle is given as $c = 2\pi r$
Make the radius, r, the subject of the formula.

Question 2: The formula to convert degrees Fahrenheit to degree Celsius is $\frac{5}{9}(F - 32) = C$

Find the formula to convert from degrees Celsius to degrees Fahrenheit by making F the subject.

Question 3: Can you spot any mistakes below?

Make *y* the subject of the formula:

$k = y^2 + a$

$\sqrt{k} = y + a$

$\sqrt{k} - a = y$

$y = \sqrt{k} - a$

Express *v* in terms of *t*

$t = \frac{v}{4} + 1$

$t - 1 = \frac{v}{4}$

$\frac{t-1}{4} = v$

rearrangement: linear rules which go together?

each of these are all one of two linear relations
group them into two sets: rearrangements of the same linear relationship

(1) $2x = 10 - 5y$

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

(3) $x = -5 - \frac{5}{2}y$

(4) $5y = 10 - 2x$

(5) $5y - 2x = -10$

(6) $y = 2 - \frac{2}{5}x$

(7) $x = 5 - \frac{5}{2}y$

(8) $2x + 5y = 10$

(9) $2x = -10 - 5y$

(10) $2x + 5y - 10 = 0$

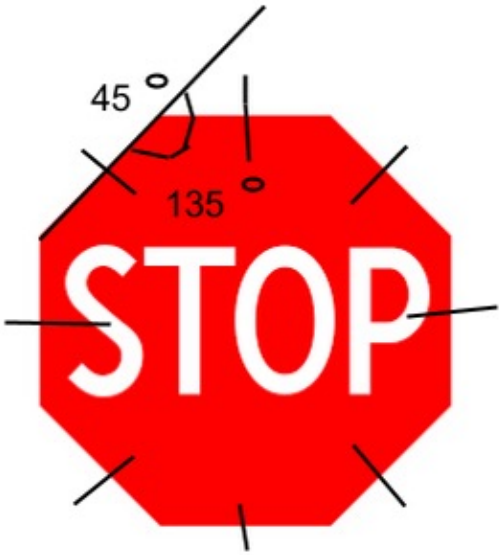
(11) $y = -2 - \frac{2}{5}x$

(12) $5y = -10 - 2x$

Change the Subject – Science Formulae

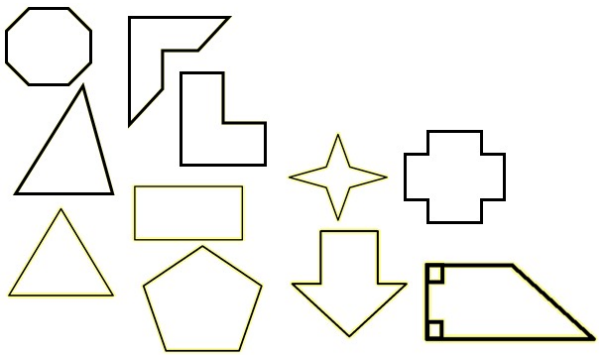
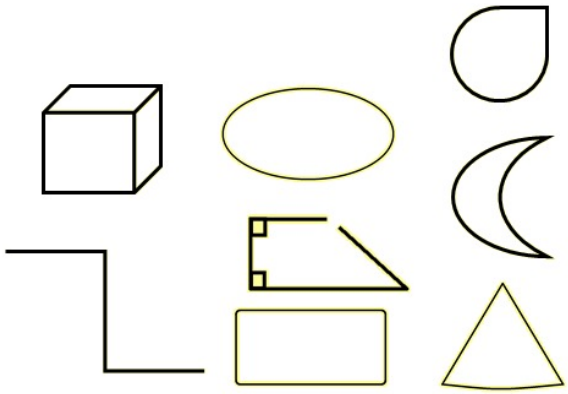
1	weight = mass × gravitational field strength	$W = m\,g$	Make m the subject	
2	work done = force × distance	$W = Fs$	Make s the subject	
3	force = spring constant × extension	$F = ke$	Make e the subject	
4	pressure = $\frac{\text{force normal to a surface}}{\text{area of that surface}}$	$p = \frac{F}{A}$	Make F the subject	
5	distance travelled = speed × time	$s = vt$	Make v the subject	
6	acceleration = $\frac{\text{change in velocity}}{\text{time taken}}$	$a = \frac{\Delta v}{t}$	Make Δv the subject	
7	resultant force = mass × acceleration	$F = ma$	Make a the subject	
8	momentum = mass × velocity	$p = mv$	Make m the subject	
9	power = $\frac{\text{work done}}{\text{time taken}}$	$P = \frac{W}{t}$	Make W the subject	
10	density = $\frac{\text{mass}}{\text{volume}}$	$\rho = \frac{m}{V}$	Make m the subject	
11	time period = $\frac{1}{\text{frequency}}$	$T = \frac{1}{f}$	Make f the subject	
12	power = (current)^2 × resistance	$P = I^2R$	Make I the subject	

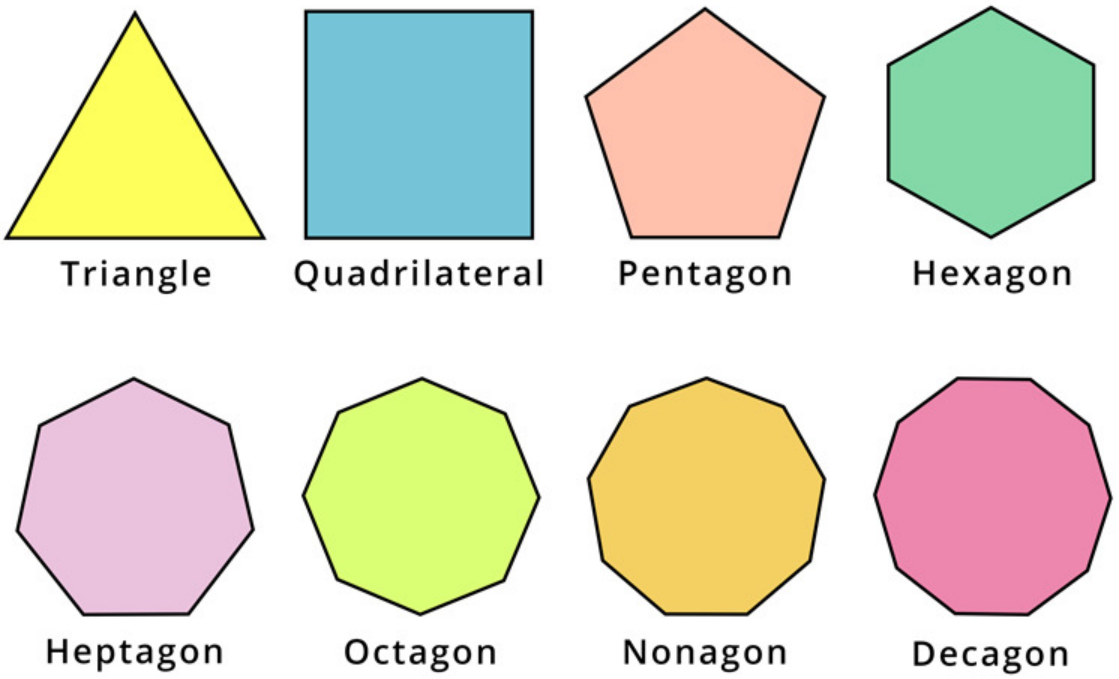
2 Angles in Polygons



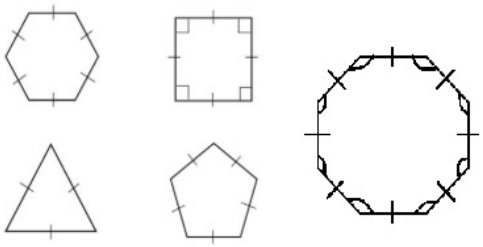
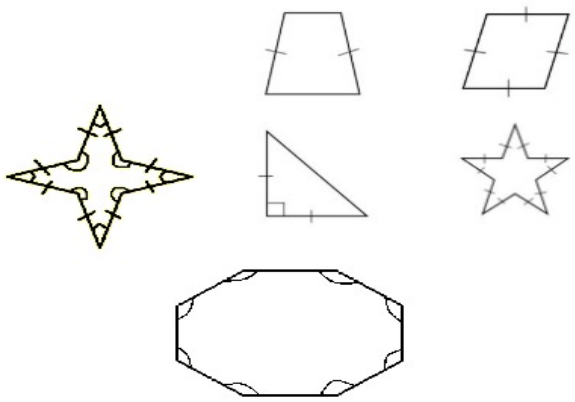
2.1 Polygons

Frayer Model – Polygon

Definition	**Characteristics**
Literally translates to “many angles”. Generally recognised as a 2D shape made up of 3 or more connected straight lines.	• Made of connected straight lines (no gaps) • Flat shape
Examples 	**Non Examples** 

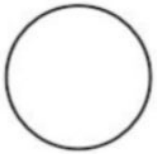
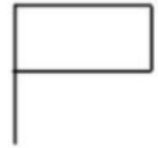
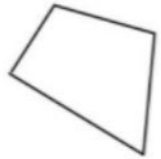
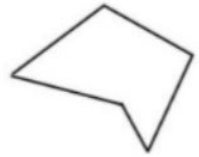


Frayer Model – Regular Polygon

Definition	**Characteristics**
A polygon with all sides equal sized and all interior angles equal sized.	• All connected straight sides • All sides equal sized • All angles equal sized
Examples	**Non Examples**
	

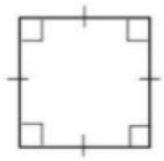
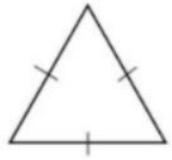
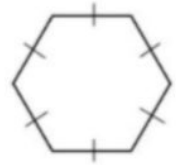
Polygons – Example or Non-Example

In each of the following diagrams decide whether the shape is a polygon or not. Label them 'Example' or 'Non-example'. For those that ARE polygons, give the name of the polygon.

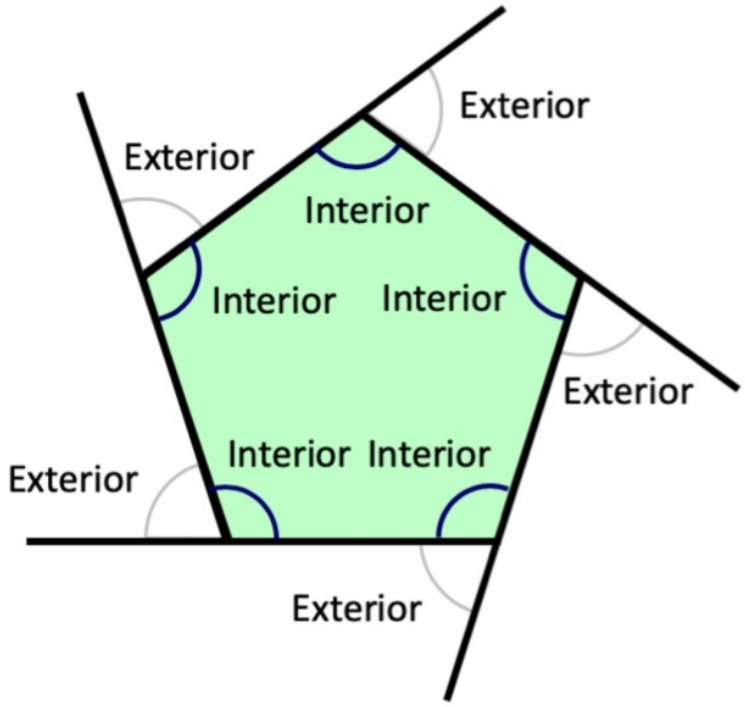
A 	B 	C 	D 	E 
F 	G 	H 	I 	J 

Polygons – Regular or Irregular

Which of the following are regular and which are irregular – how do you know?

A 	B 	C 	D 	E 	F 

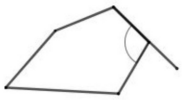
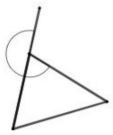
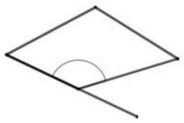
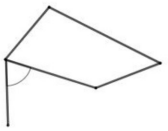
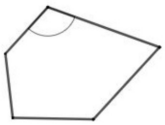
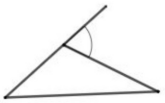
2.2 Interior and Exterior Angles



- The interior angles of a polygon are on the inside.
- The exterior angles of a polygon are on the outside.
- The interior and exterior angles form a straight line.

$$\text{Interior Angle} + \text{Exterior Angle} = 180°$$

2.3 Interior Angles

Examples	Nonexamples
	
	
	

Sum of Interior Angles

Number of Sides	Name of Shape	Interior Angle Sum
3	Triangle	$180°$
4	Quadrilateral	$360°$
5	Pentagon	$540°$
6	Hexagon	$720°$
7	Heptagon	$900°$
8	Octagon	$1080°$

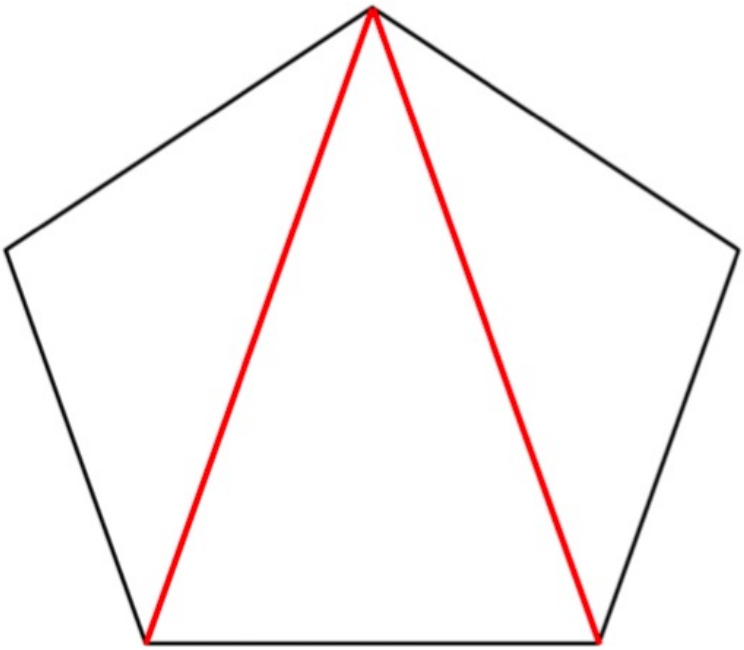
Note: The polygon can be regular or irregular.

Sum of interior angles of a polygon $= (n - 2) \times 180°$
where n is the number of sides on the polygon

Why?

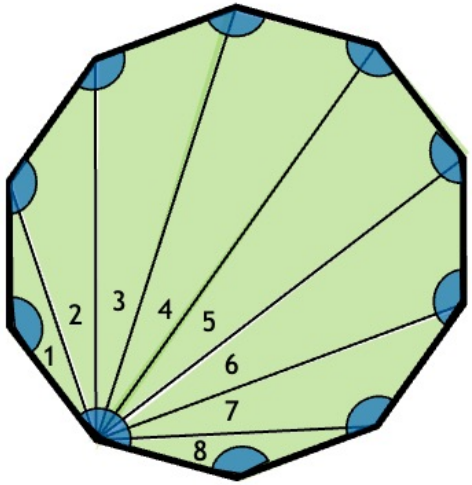
A polygon with n sides can be split into $n - 2$ triangles (with all triangle angles in the corners), and each triangle's angles add up to $180°$.

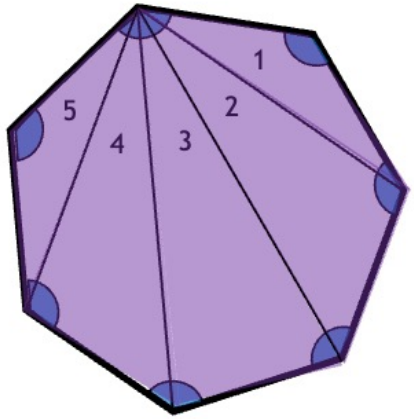
e.g.

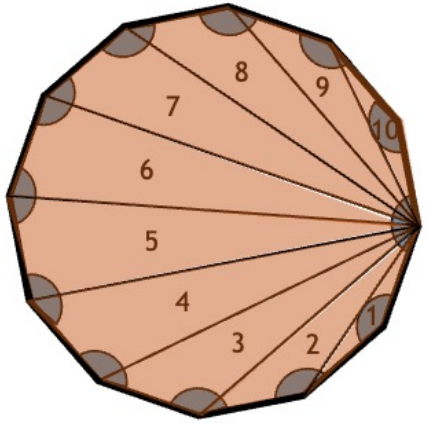


5 sides
3 triangles
$3 \times 180° = 540°$
So the interior angles in a pentagon sum (add up) to $540°$

Interior Angles of Polygons: Derivation 1





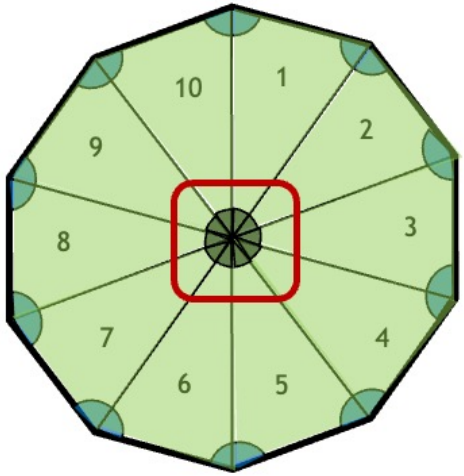


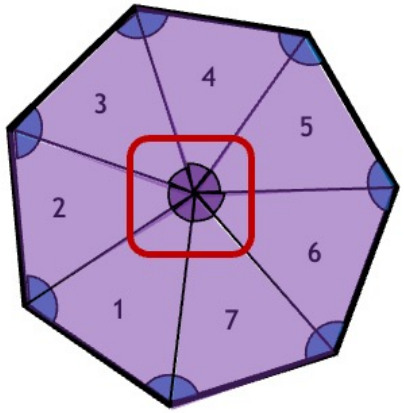
10 sides	7 sides	12 sides
8 triangles	5 triangles	10 triangles

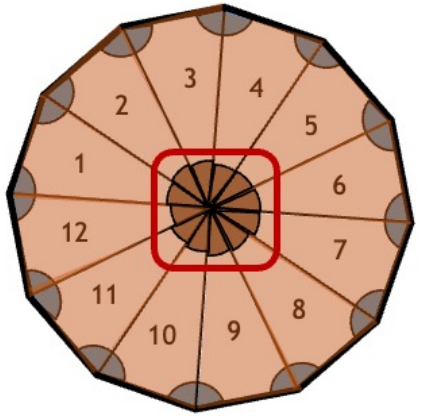
Angle sum: $8\times180° = 1440°$	Angle sum: $5\times180° = 900°$	Angle sum: $10\times180° = 1800°$
Each angle: $\frac{1440°}{10} = 144°$	Each angle: $\frac{900}{7} \approx 128.57°$	Each angle: $\frac{1800}{12} = 150°$

n sides → $n-2$ triangles → Angle sum $180(n-2)$ → Each angle $\frac{180(n-2)}{n}$

Interior Angles of Polygons: Derivation 2





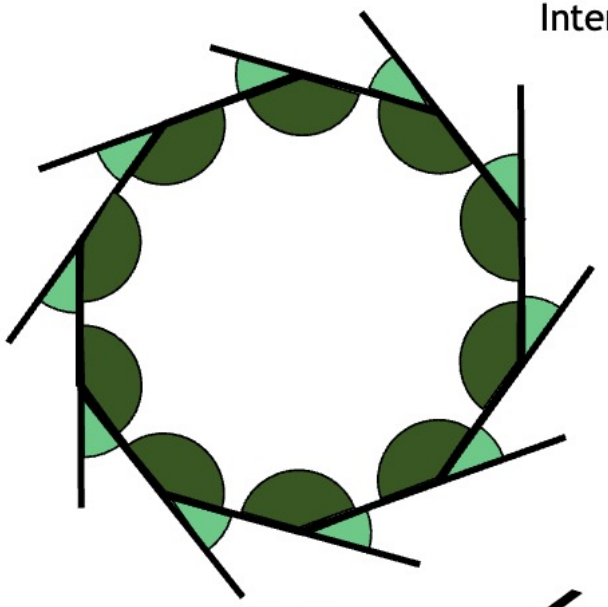


10 sides	7 sides	12 sides
10 triangles	7 triangles	12 triangles

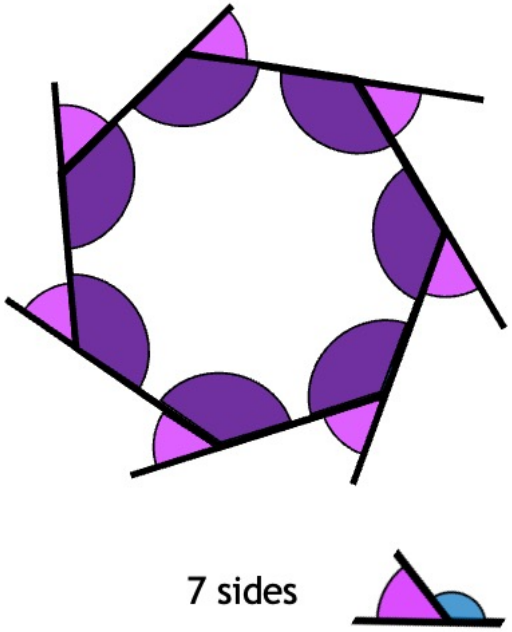
Angle sum: $10\times180° = 1800°$ $1800° - 360° = 1440°$	Angle sum: $7\times180° = 1260°$ $1260° - 360° = 900°$	Angle sum: $12\times180° = 2160°$ $2160° - 360° = 1800°$
Each angle: $\frac{1440°}{10} = 144°$	Each angle: $\frac{900}{7} \approx 128.57°$	Each angle: $\frac{1800°}{12} = 150°$

n sides → n triangles and an extra complete turn → Angle sum $180n - 360$ → Each angle $\frac{180n - 360}{n}$

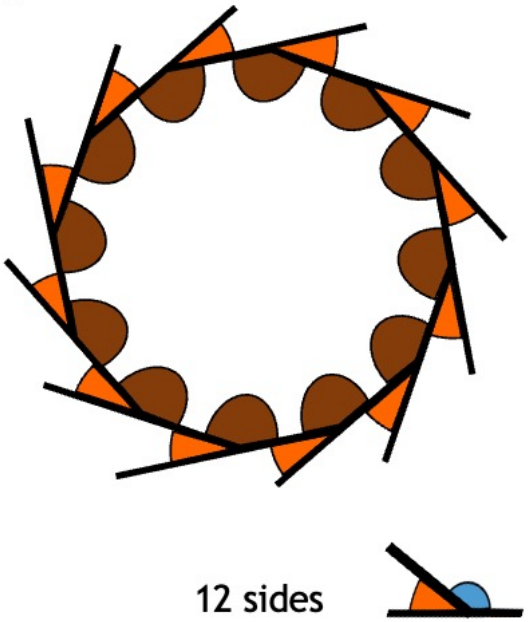
Interior Angles of Polygons: Derivation 3



10 sides



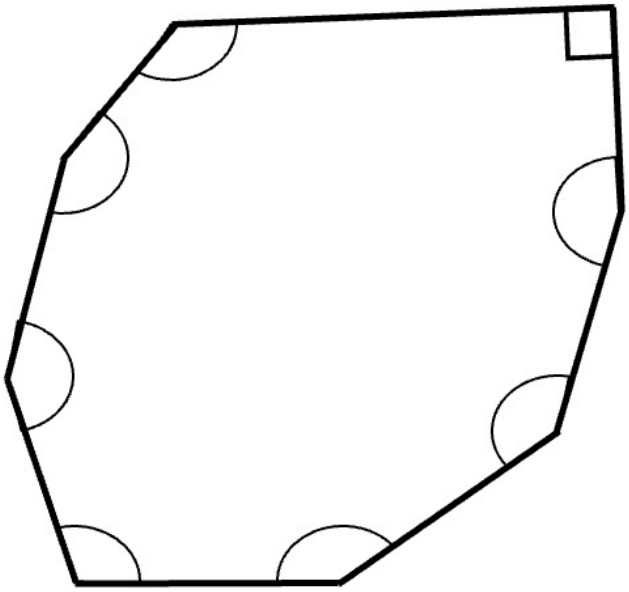
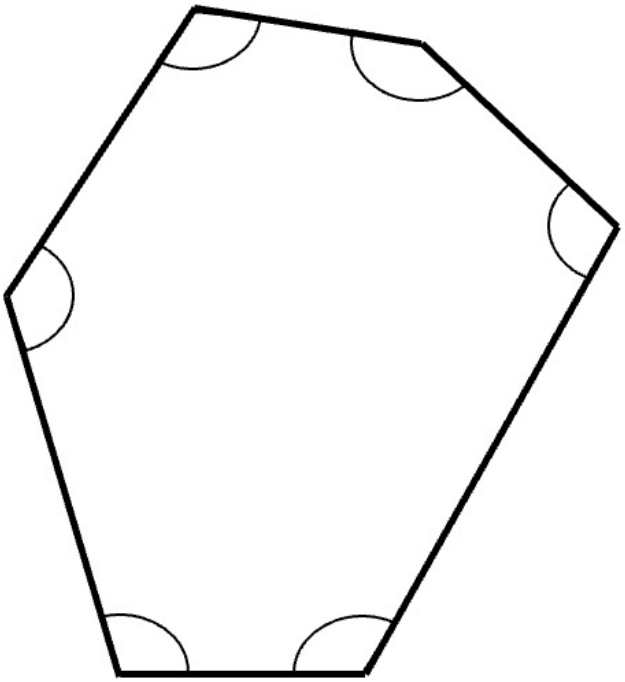
7 sides



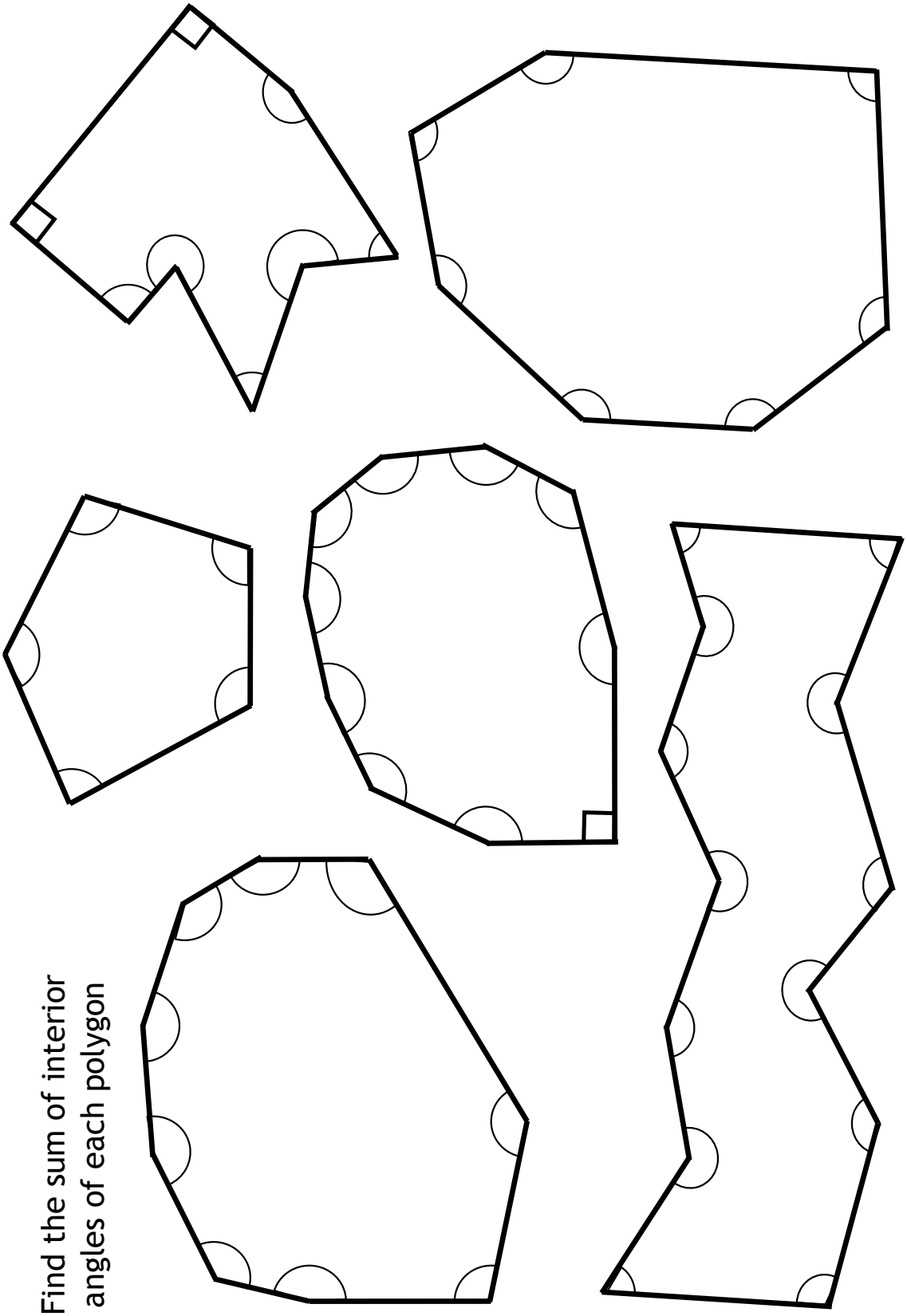
12 sides

Exterior angle:	$\frac{360°}{10} = 36°$	Exterior angle:	$\frac{360°}{7} \approx 51.43°$	Exterior angle:	$\frac{360°}{12} = 30°$
Each angle:	$180° - 36° = 144°$	Each angle:	$180° - 51.43° = 128.57°$	Each angle:	$180° - 30° = 150°$
Angle sum:	$144°\times 10 = 1440°$	Angle sum:	$128.57°\times 7 \approx 900°$	Angle sum:	$150°\times 12 = 1800°$

n sides ⇒ Exterior angle: $\frac{360}{n}$ ⇒ Each angle: $180 - \frac{360}{n}$ ⇒ Angle sum: $n\left(180 - \frac{360}{n}\right)$

Worked Example	Your Turn
Find the sum of interior angles of this polygon. 	Find the sum of interior angles of this polygon. 

Fluency Practice



Find the sum of interior angles of each polygon

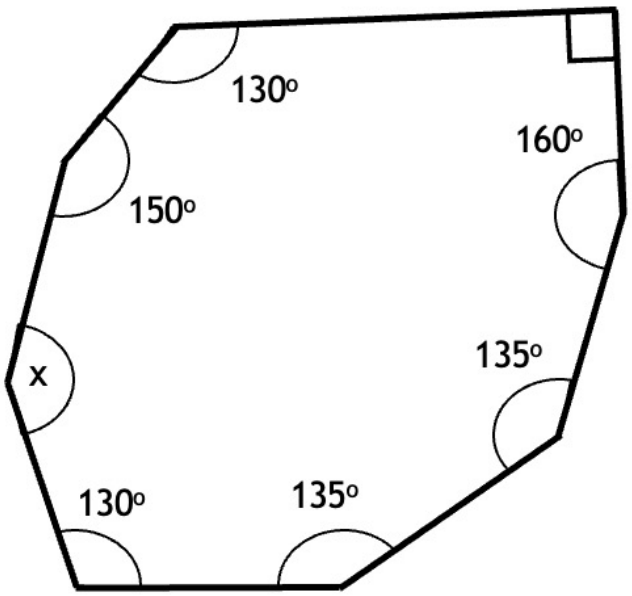
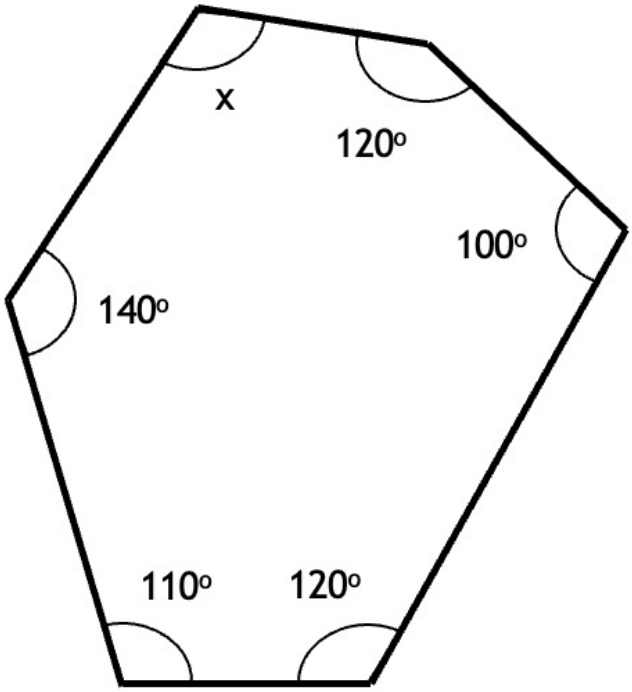
Worked Example	Your Turn
Find the sum of the interior angles of a polygon with 30 sides.	Find the sum of the interior angles of a polygon with 60 sides.

Fluency Practice

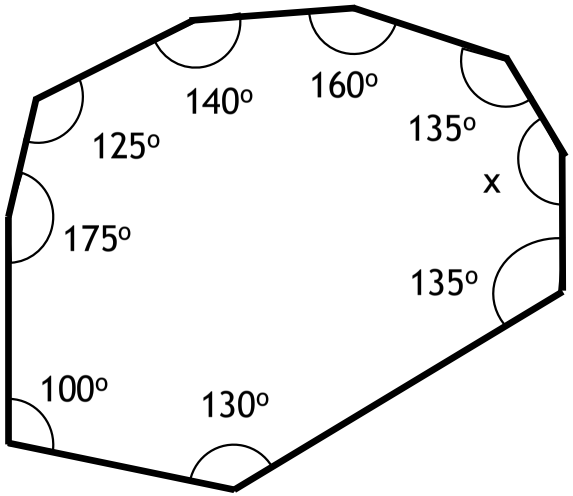
Question 2: Work out the sum of the interior angles for polygons with

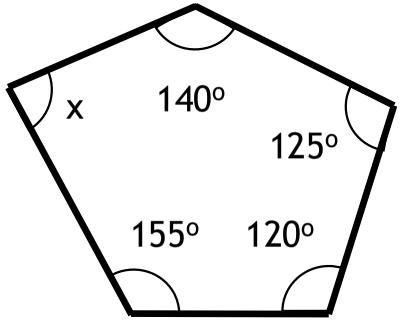
(a) 10 sides (b) 14 sides (c) 20 sides (d) 45 sides

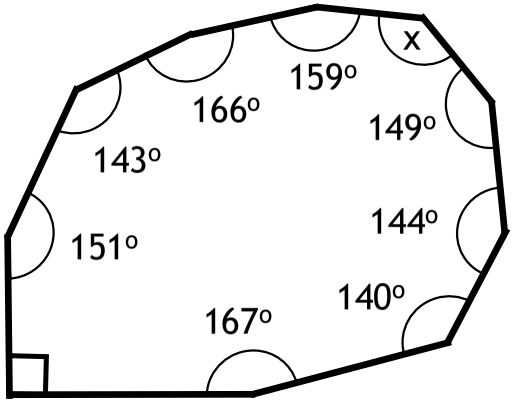
(e) 50 sides (f) 80 sides (g) 100 sides (h) 200 sides

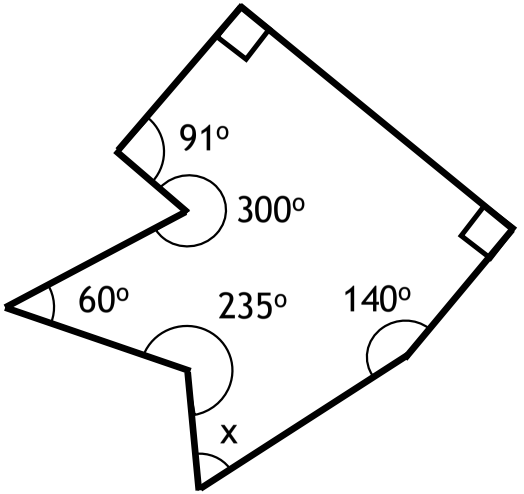
Worked Example	Your Turn
Find angle x. 	Find angle x. 

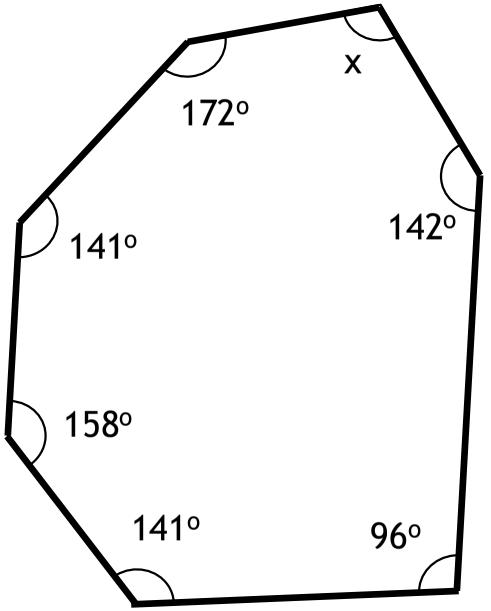
Find the angle marked x in each shape

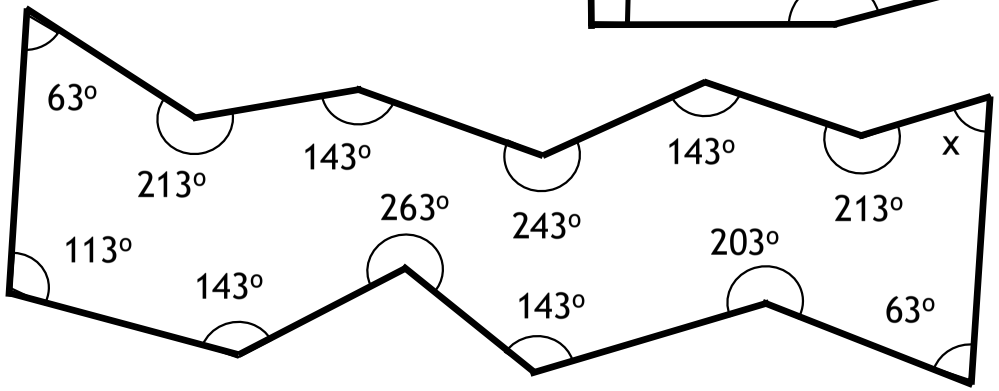








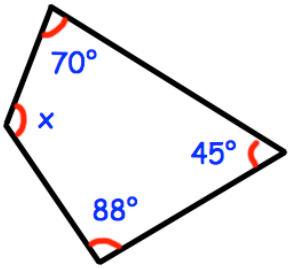




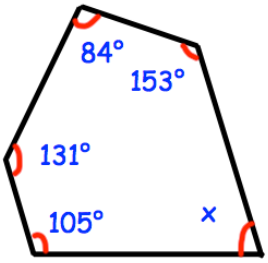
Fluency Practice

Question 1: Find the missing angle in each irregular polygon

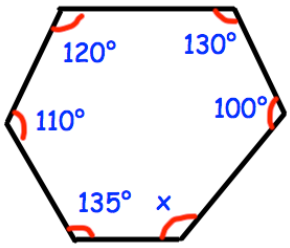
(a)



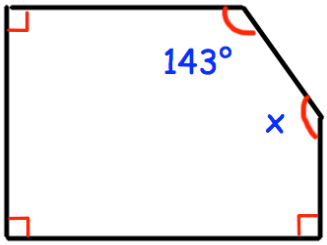
(b)



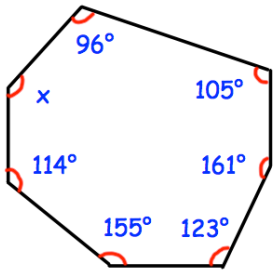
(c)



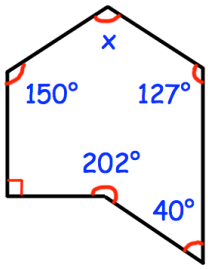
(d)



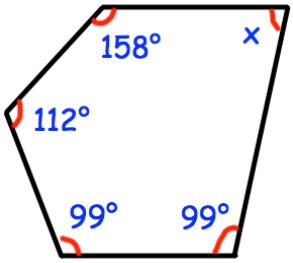
(e)



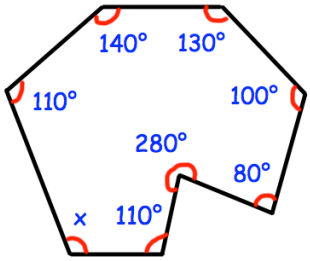
(f)



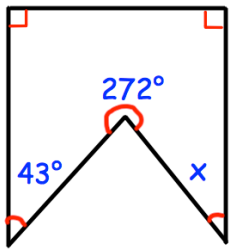
(g)



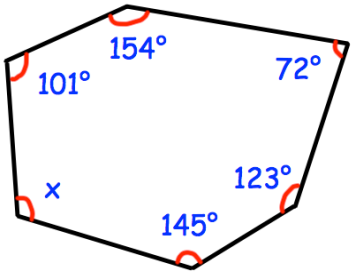
(h)



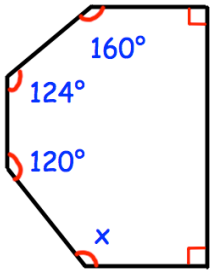
(i)



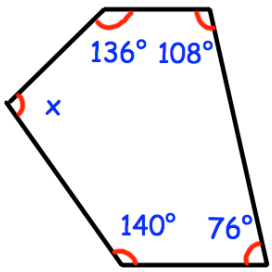
(j)



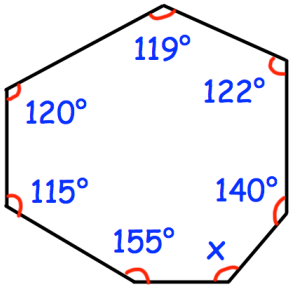
(k)



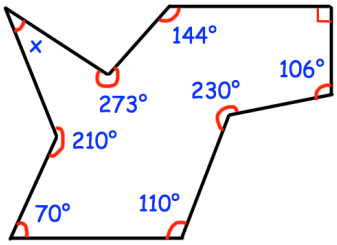
(l)



(m)



(n)



Worked Example	Your Turn
The sum of the interior angles of a polygon is $3240°$. How many sides does the polygon have?	The sum of the interior angles of a polygon is $6840°$. How many sides does the polygon have?

Fluency Practice

Question 3: Work out the number of sides of polygons with these sum of interior angles

(a) 1260° (b) 2880° (c) 3960° (d) 5040°

(e) 12240° (f) 15840° (g) 2340° (h) 89640°

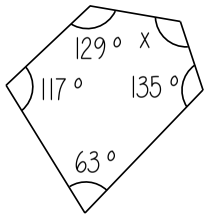
The diagrams are not drawn accurately

1. Find the sum of the interior angles in each polygon

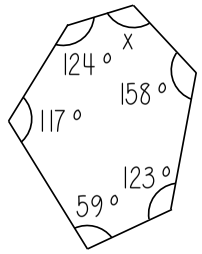
a. 12 sides b. 15 sides c. 18 sides d. 22 sides e. 25 sides f. 30 sides g. 52 sides h. 120 sides

2. Find the value of x

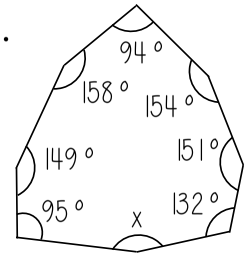
a.



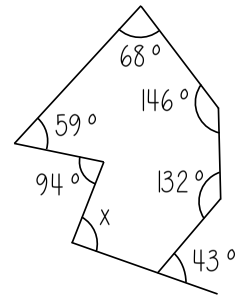
b.



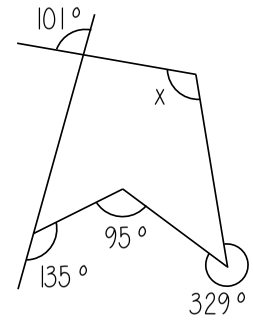
c.



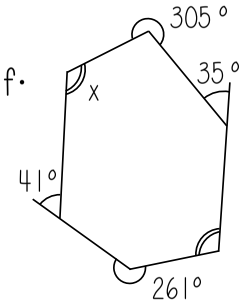
d.



e.



f.

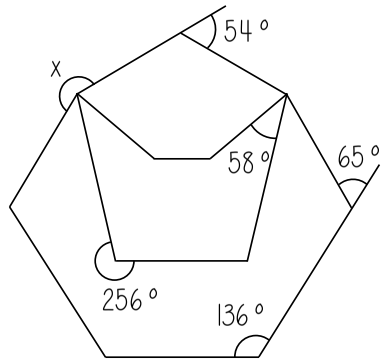


3. Find the number of sides each polygons has, given the sum of the interior angles

a. 1800° b. 1980° c. 3060° d. 3240° e. 3780° f. 5940° g. 9720° h. 14220°

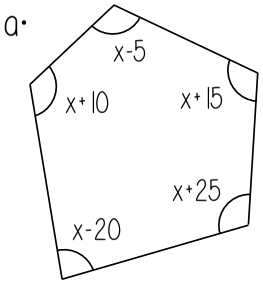
4.

The polygon has one line of symmetry.
Find the value of x.

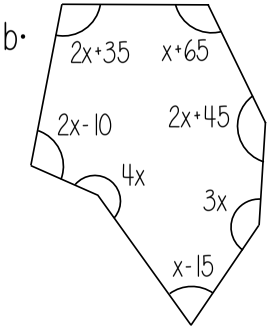


5. Find the value of x (and y)

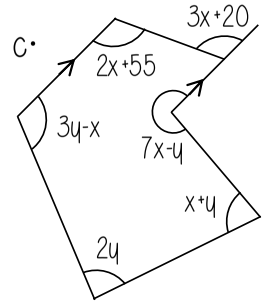
a.



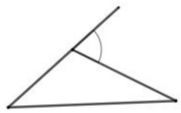
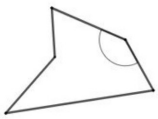
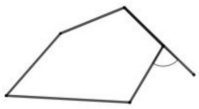
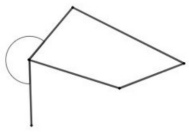
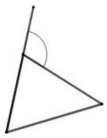
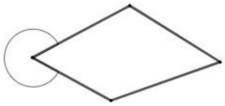
b.



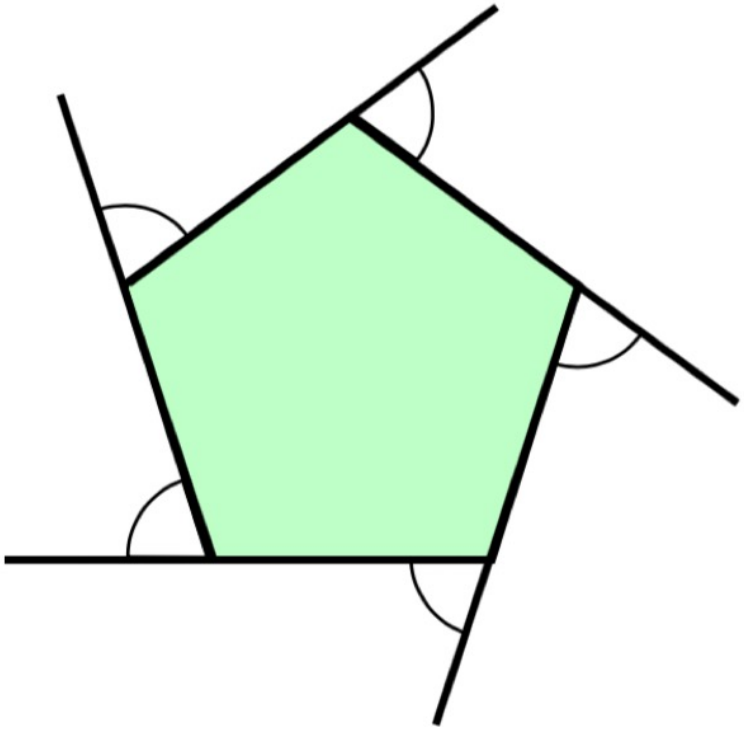
c.



2.4 Exterior Angles

Examples	Nonexamples
	
	
	

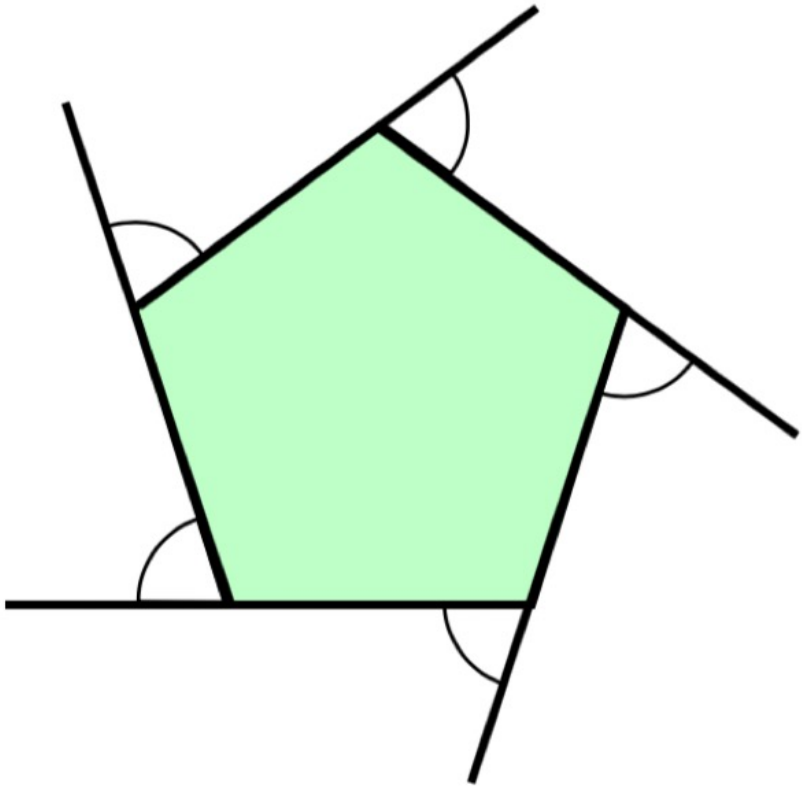
Sum of Exterior Angles



Note: The polygon can be regular or irregular.

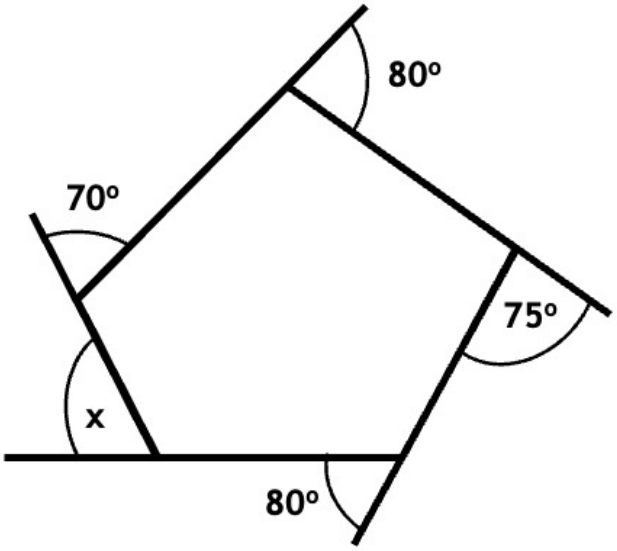
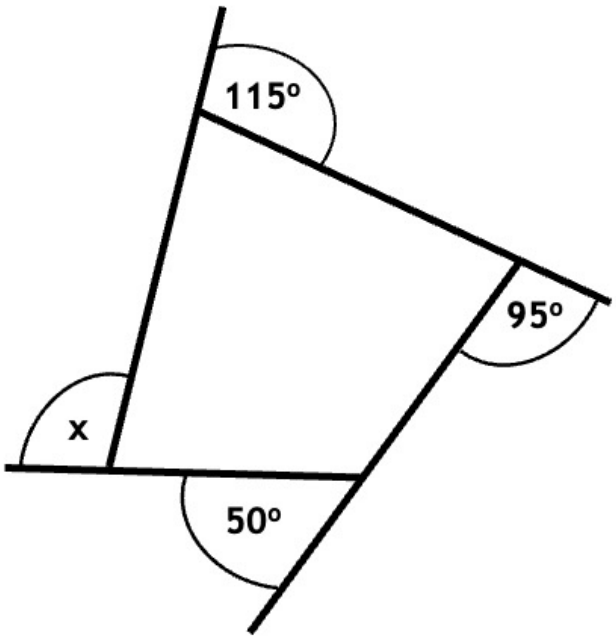
$$\text{Sum of exterior angles of a polygon} = 360°$$

Why?



<u>Why?</u>

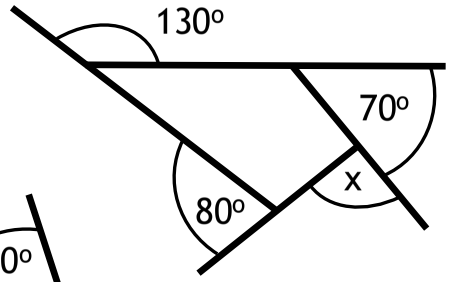
All the exterior angles can fit around a point, and angles around a point add up to 360°.

Worked Example	Your Turn
Find angle x 	Find angle x 

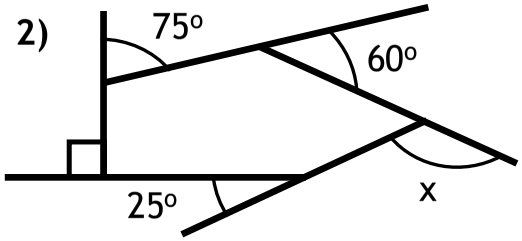
Fluency Practice

Find the angle marked x in each question

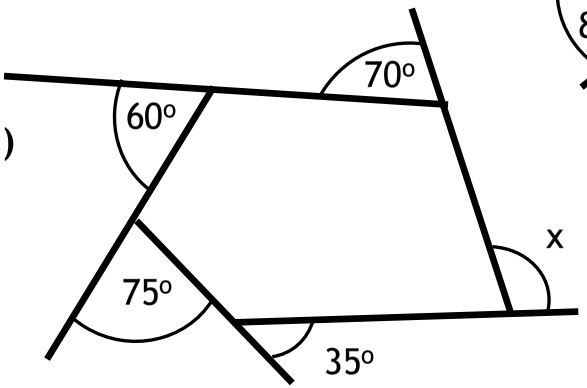
1)



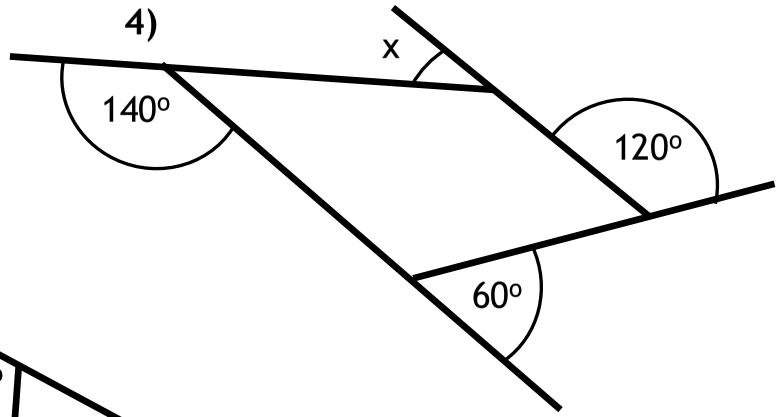
2)



3)



4)



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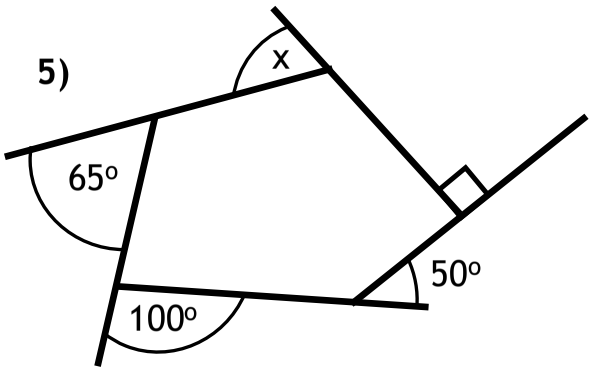

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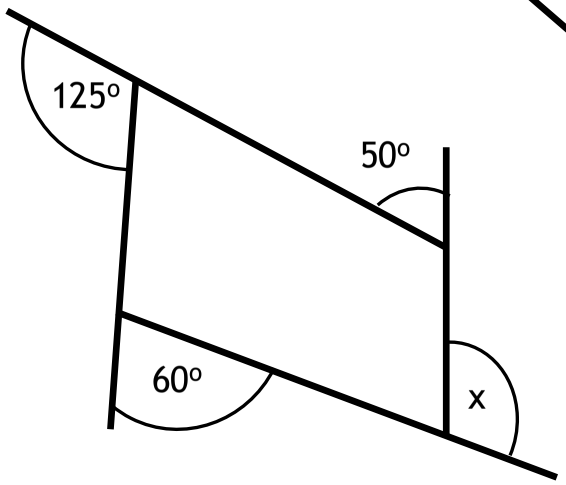
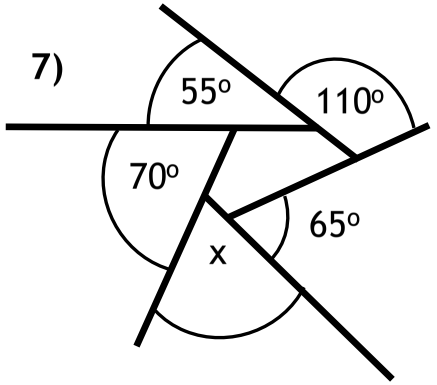
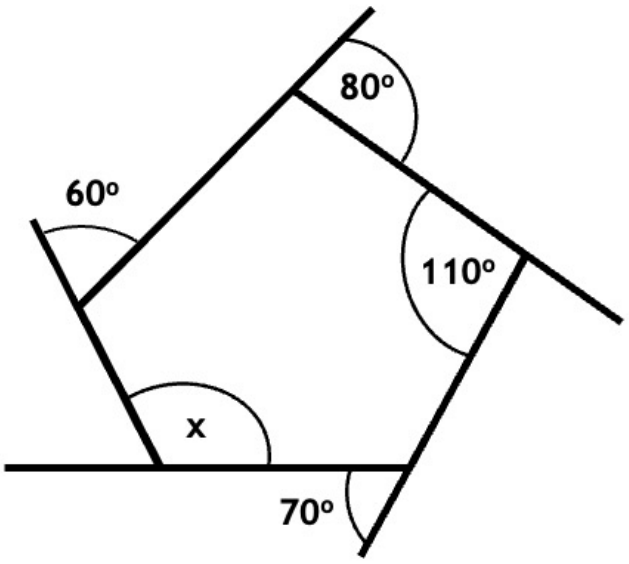
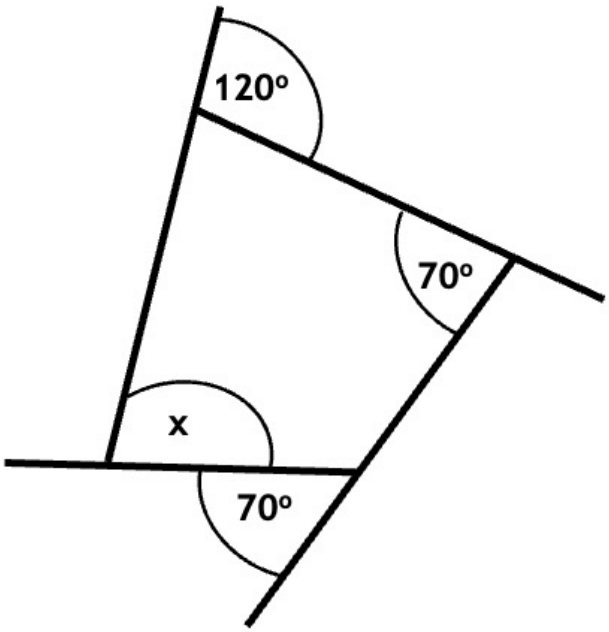


7)



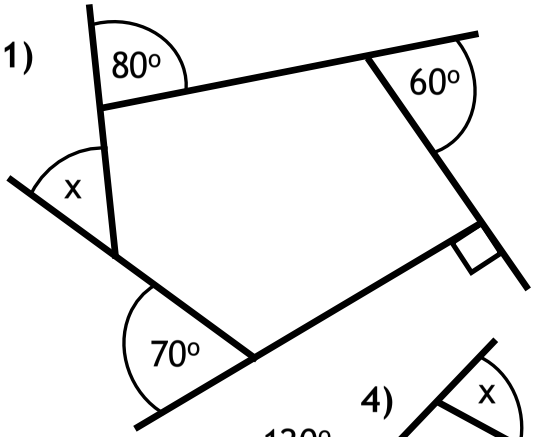
Worked Example	Your Turn
Find angle x 	Find angle x 

Fluency Practice

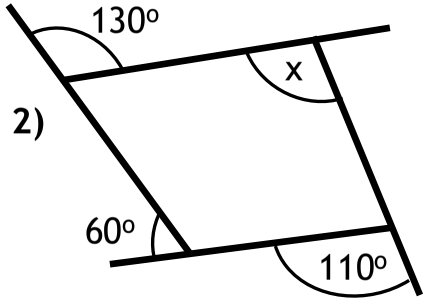
Find the angle marked x in each question

Diagrams not to scale

1)



2)



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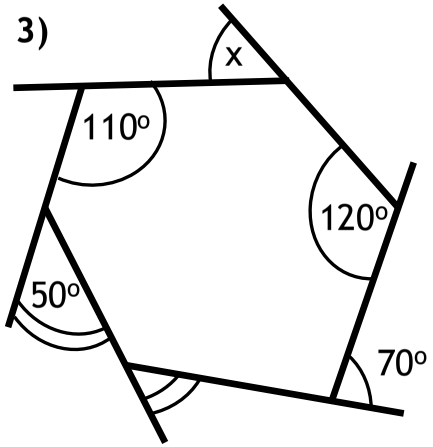

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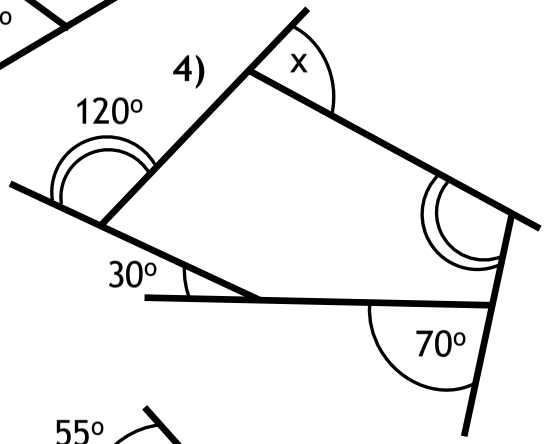
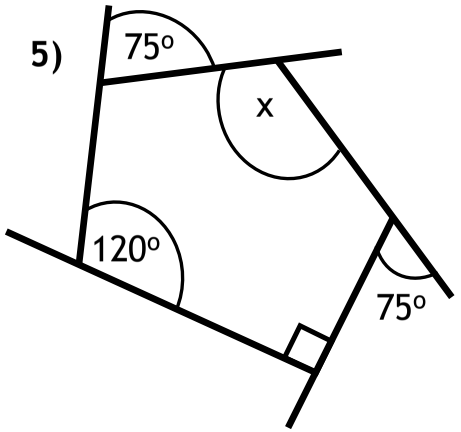
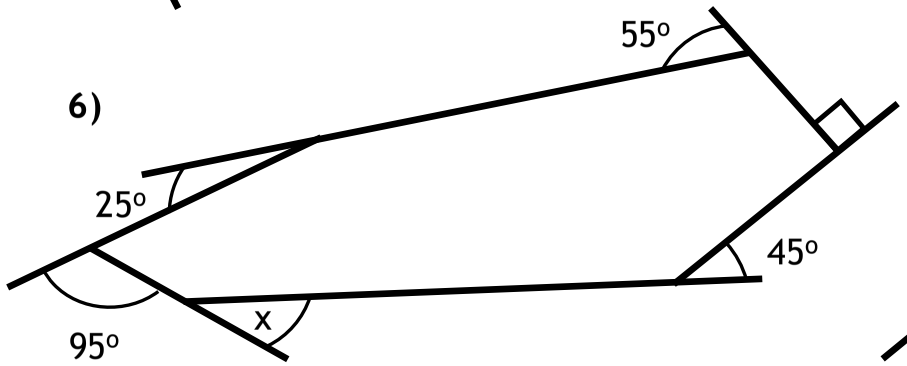


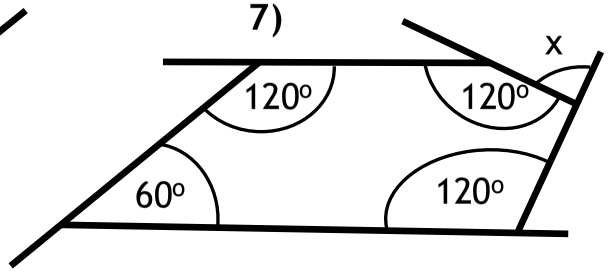
5)



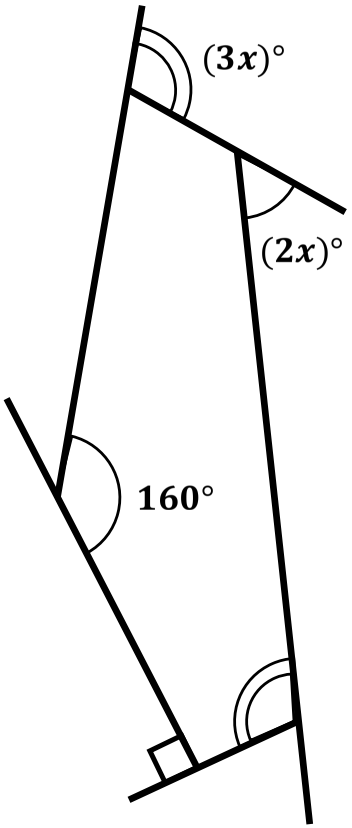
6)

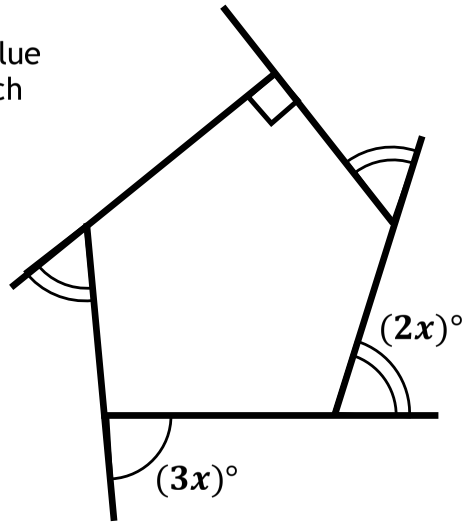


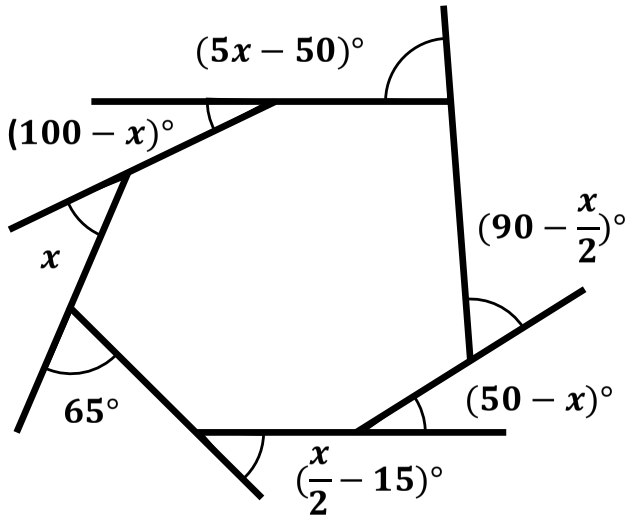
7)

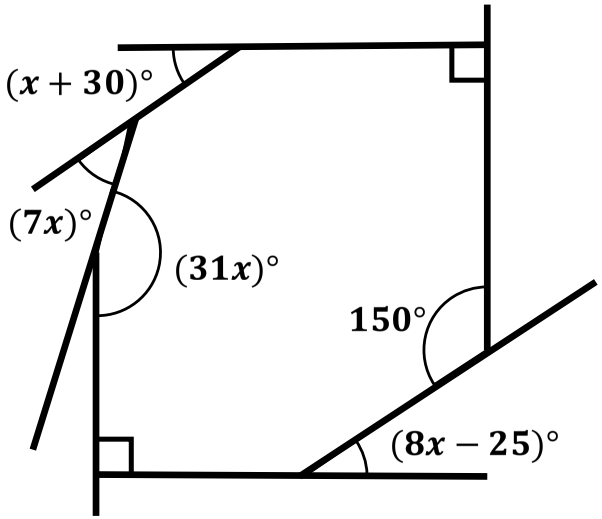


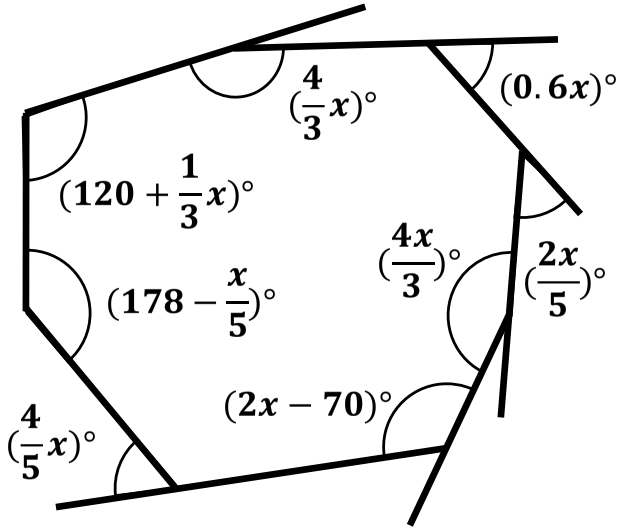
Find the value of x in each question









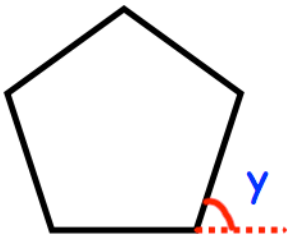


Worked Example	Your Turn
A regular polygon has 12 sides. Find the size of each exterior angle.	A regular polygon has 48 sides. Find the size of each exterior angle.

Fluency Practice

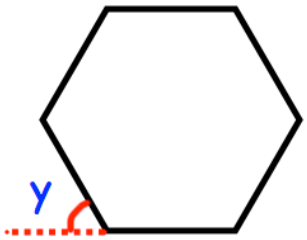
Question 6: Each of the polygons below are regular.
Calculate the size of each exterior angle, y.

(a)



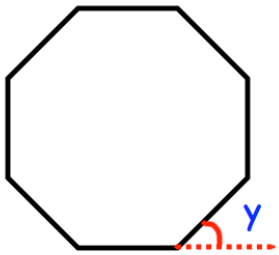
regular pentagon

(b)



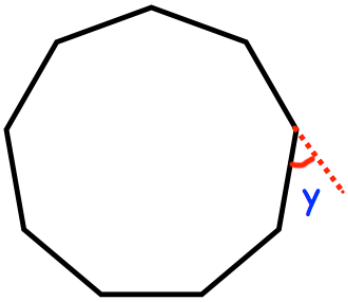
regular hexagon

(c)



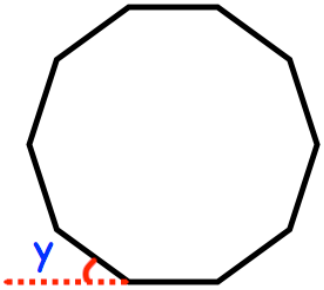
regular octagon

(d)



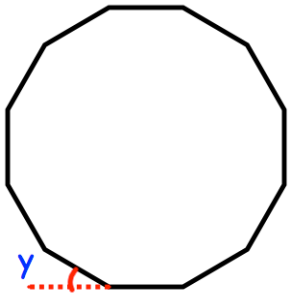
regular nonagon

(e)



regular decagon

(f)



regular dodecagon

Fluency Practice

Question 7: Calculate the size of each exterior angle in regular polygons with

(a) 15 sides (b) 18 sides (c) 20 sides (d) 24 sides

(e) 30 sides (f) 36 sides (g) 40 sides (h) 45 sides

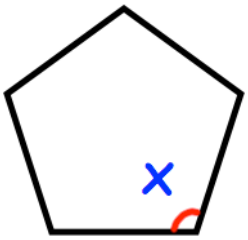
(i) 60 sides (j) 72 sides (k) 90 sides (l) 200 sides

Worked Example	Your Turn
A regular polygon has 12 sides. Find the size of each interior angle.	A regular polygon has 48 sides. Find the size of each interior angle.

Fluency Practice

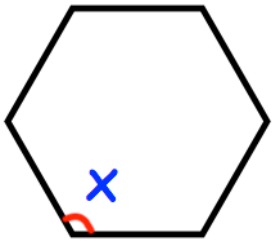
Question 4: Each of the polygons below are regular.
Calculate the size of each interior angle, x.

(a)



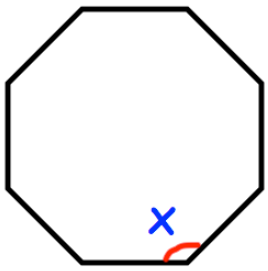
regular pentagon

(b)



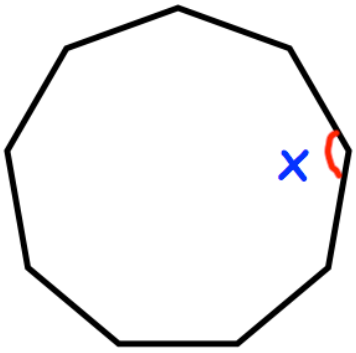
regular hexagon

(c)



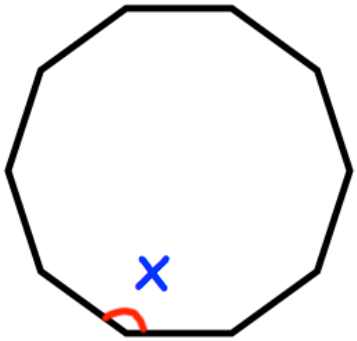
regular octagon

(d)



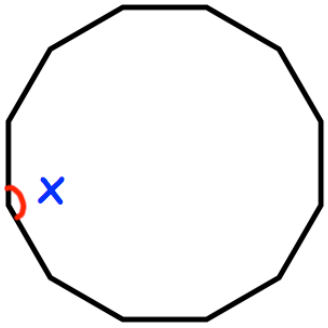
regular nonagon

(e)



regular decagon

(f)



regular dodecagon

Fluency Practice

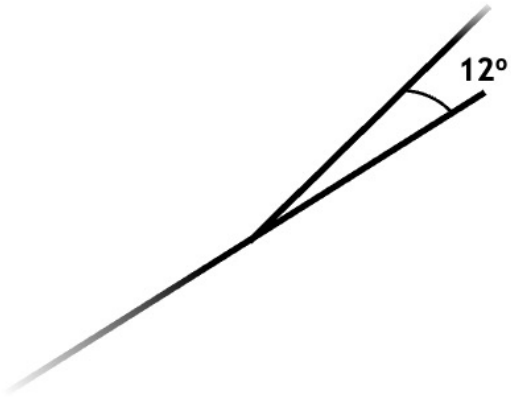
Question 5: Calculate the size of each interior angle in regular polygons with

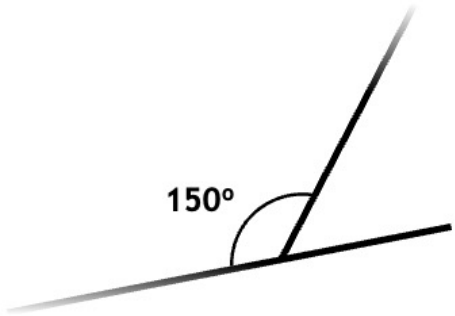
(a) 15 sides (b) 20 sides (c) 24 sides (d) 30 sides

(e) 36 sides (f) 40 sides (g) 50 sides (h) 60 sides

(i) 72 sides (j) 80 sides (k) 90 sides (l) 100 sides

Worked Example	Your Turn
A section of a two different regular polygons are show below. How many sides do they each have?	A section of a two different regular polygons are show below. How many sides do they each have?





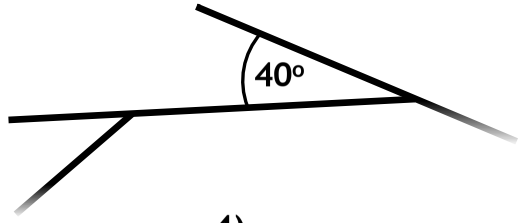
Each question shows part of a regular polygon and an interior or exterior angle.

For questions 1 to 6, find the number of sides. For questions 7 to 10, find the perimeter of the shape in cm.

There is one question that is an ambiguous case. Which question is it and why is it the only possible ambiguous case?

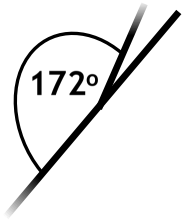
Diagrams not to scale

1)

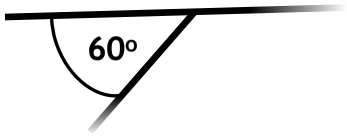


2)

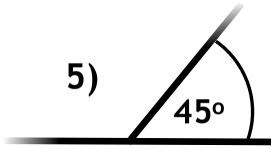
3)



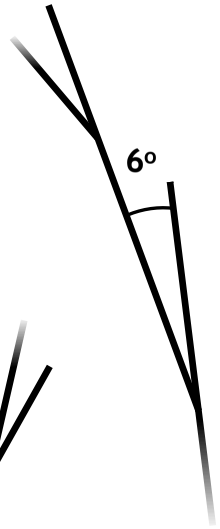
4)



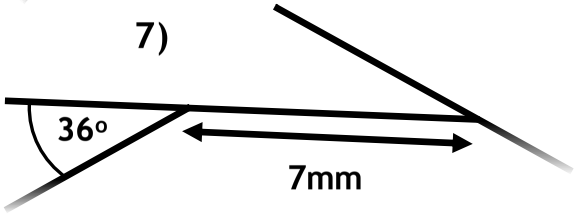
5)



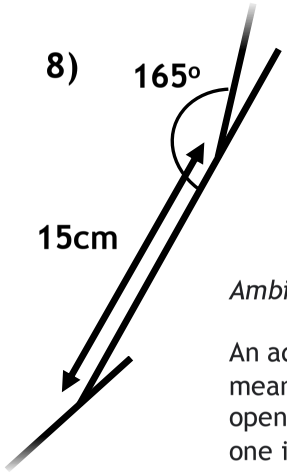
6)



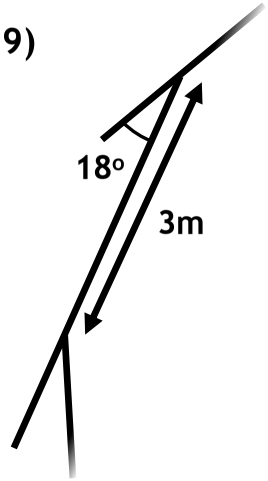
7)



8)



9)



10) A regular polygon that has an edge length of 2mm and an interior angle of 186°

11) A regular polygon has a perimeter of 180cm and an exterior angle of 10°. How long is each edge in cm?

12) A regular polygon has a perimeter of 12m and an interior angle of 171°. How long is each edge in cm?

Ambiguous

An adjective that means something is open to more than one interpretation.

From the Latin: ambi (both ways) and agere (to drive).

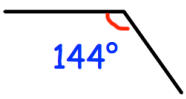
Fluency Practice

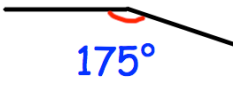
In each question, find missing angle x.

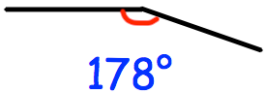
Worked Example	Your Turn
The interior angle of a regular polygon is $160°$. How many sides does the polygon have?	The interior angle of a regular polygon is $140°$. How many sides does the polygon have?

Fluency Practice

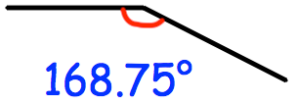
Question 8: Shown below is one interior angle from regular polygons.
Calculate how many sides the polygons have.

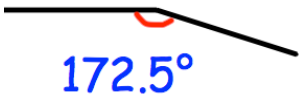
(a) 

(b) 

(c) 

(d) 

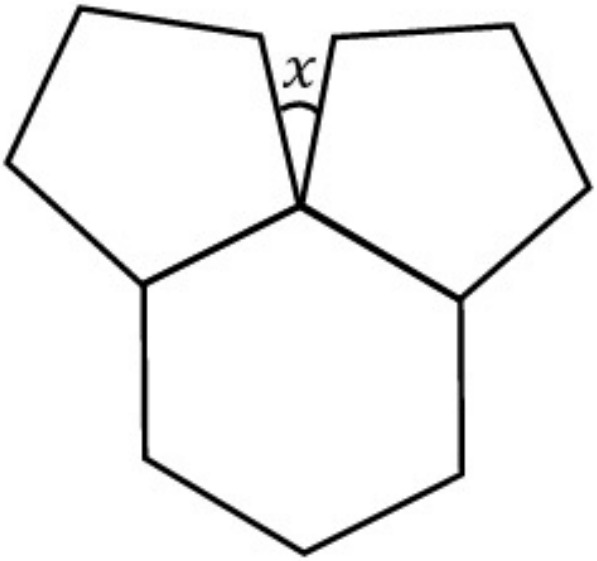
(e) 

(f) 

Worked Example	Your Turn
The size of each interior angle of a regular polygon is 9 times the size of each exterior angle. How many sides does the polygon have?	The size of each interior angle of a regular polygon is 11 times the size of each exterior angle. How many sides does the polygon have?

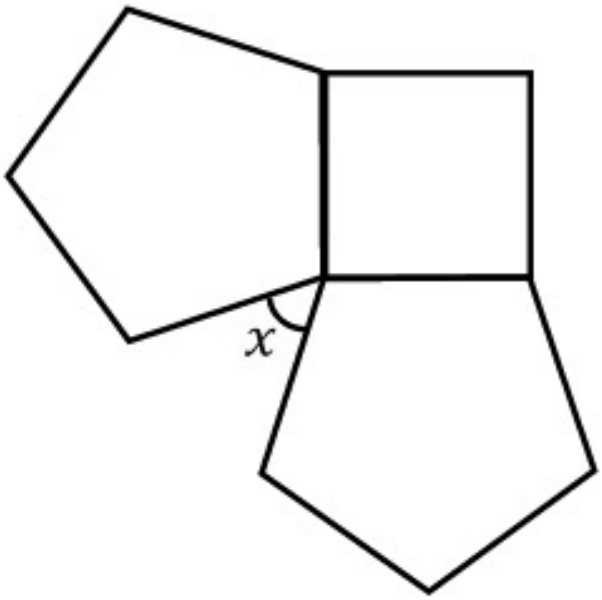
Worked Example

These are regular polygons.
Find x



Your Turn

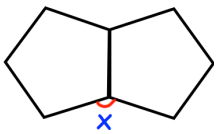
These are regular polygons.
Find x



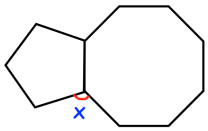
Extension

Question 1: In each diagram below, two regular polygons are shown.
Calculate x.

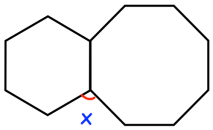
(a)



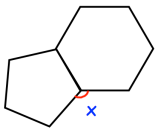
(b)



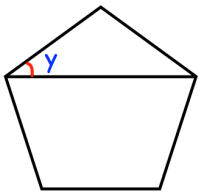
(c)



(d)



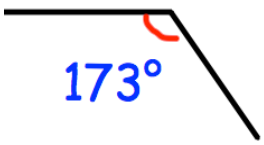
Question 2: Shown is a regular pentagon.
Find y.



Question 3: A regular polygon has 18 sides.
Calculate the size of each interior angle.

Question 4: A regular polygon has 30 sides.
Calculate the size of each interior angle.

Question 5: Explain why this cannot be an interior angle from regular polygons.



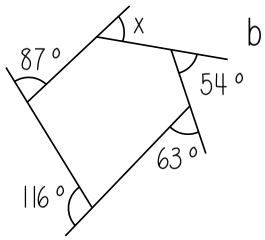
Question 6: A polygon has an interior angle that is five times larger than the exterior angle.
How many sides does it have?

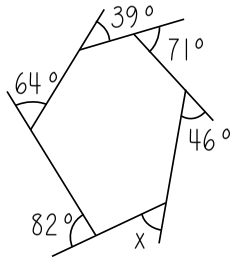
Question 7: Explain why regular hexagons tessellate.

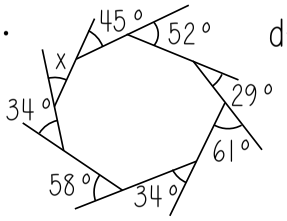
Question 8: Explain why regular pentagons do not tessellate.

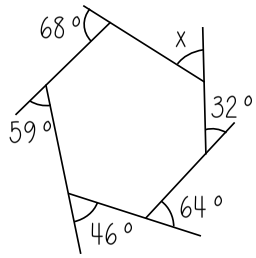
The diagrams are not drawn accurately

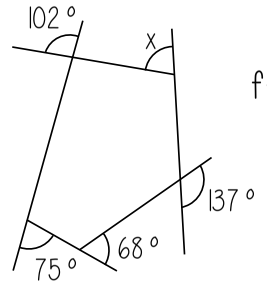
1. Find the value of x

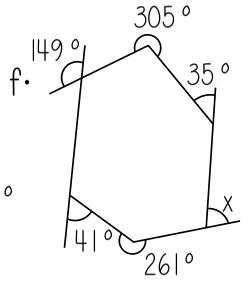
a. 

b. 

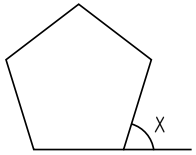
c. 

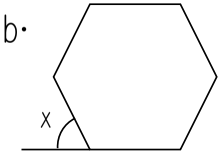
d. 

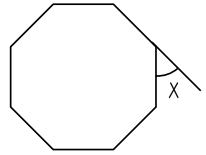
e. 

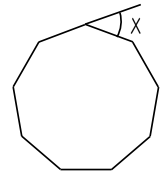
f. 

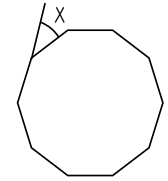
2. Calculate the size of one exterior angle in each regular polygon

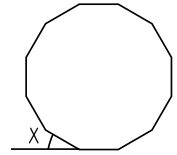
a. 

b. 

c. 

d. 

e. 

f. 

g. 15 sides h. 18 sides i. 20 sides j. 24 sides k. 30 sides l. 60 sides m. 120 sides n. 180 sides

3. Calculate the number of sides in each regular polygon

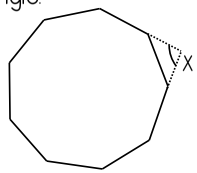
a. Exterior angle = 15° a. Exterior angle = 60° c. Exterior angle = 5° d. Exterior angle = 12° e. Exterior angle = 4° f. Exterior angle = 45°

g. Exterior angle = 7·5° h. Exterior angle = 11·25° i. Interior angle = 168° j. Interior angle = 156° k. Interior angle = 108° l. Interior angle = 175·5°

4.

The diagram shows a regular nonagon and an isosceles triangle.

Find the value of x.



5.

a. A regular polygon has interior angles 4 times larger than its exterior angles. Calculate the number of sides.

b. A regular polygon has interior angles 6·5 times larger than its exterior angles. Calculate the number of sides.

6.

a. Regular polygon A has 12 sides and exterior angles of 6x. Regular polygon B has exterior angles of 4x. Find the number of sides polygon B has.

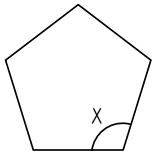
b. Regular polygon C has 20 sides and exterior angles of 2x. Regular polygon D has exterior angles of 5x. Find the number of sides polygon D has.

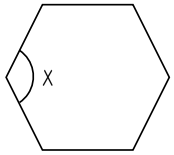
The diagrams are not drawn accurately

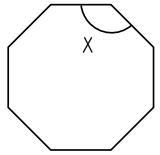
1. Calculate the sum of the interior angles in each polygon

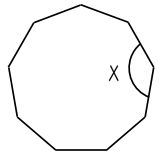
a. 7 sides b. 11 sides c. 17 sides d. 23 sides e. 50 sides f. 95 sides

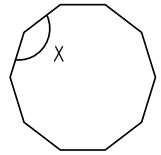
2. Calculate the size of one interior angle in each regular polygon

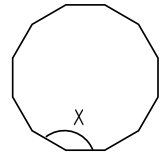
a. 

b. 

c. 

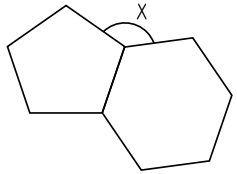
d. 

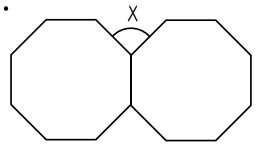
e. 

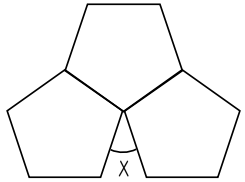
f. 

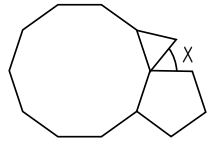
g. 15 sides h. 18 sides i. 20 sides j. 24 sides k. 30 sides l. 60 sides m. 120 sides n. 360 sides

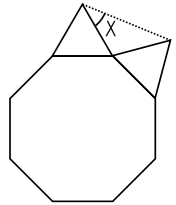
3. All the polygons are regular and meet at a point. Find the value of x

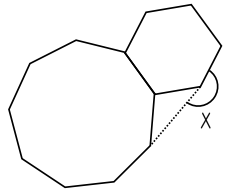
a. 

b. 

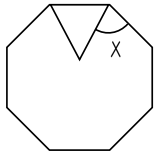
c. 

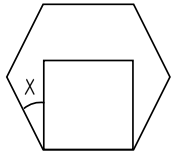
d. 

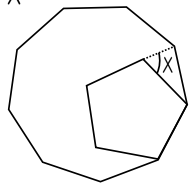
e. 

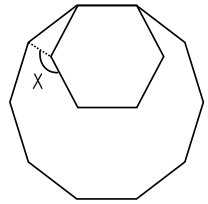
f. 

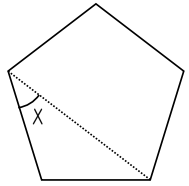
4. All the polygons are regular. Find the value of x

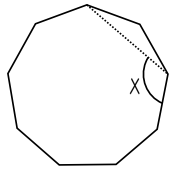
a. 

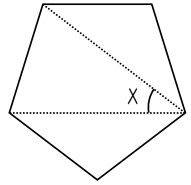
b. 

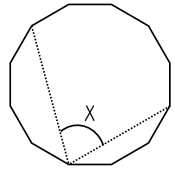
c. 

d. 

e. 

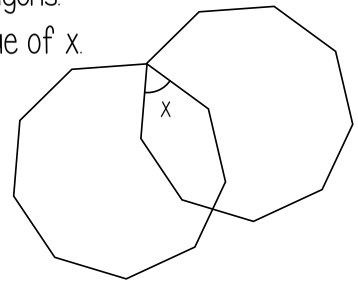
f. 

g. 

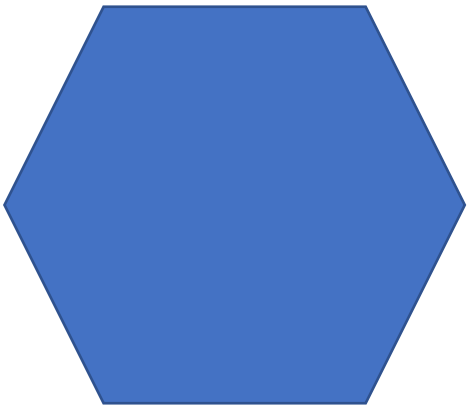
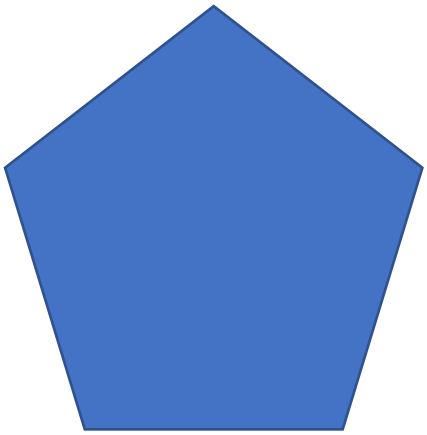
h. 

5.

The diagram shows two overlapping, regular nonagons.
Find the value of x.



2.5 Review and Problem Solving

Worked Example	Your Turn
a) Calculate the sum of the interior angles of a hexagon. 	a) Calculate the sum of the interior angles of a pentagon. 
b) Calculate the size of one interior angle of a regular hexagon.	b) Calculate the size of one interior angle of regular pentagon.
c) The sum of the interior angles of a polygon is 2700°. Calculate the number of sides.	c) The sum of the interior angles of a polygon is 2160°. Calculate the number of sides.

Fill in the Gaps

Number of sides	Sum of interior angles	Size of one interior angle in a regular polygon
3	180°	
	360°	
7		
9		
10		144°
	1800°	150°
13	1980°	
14		
	2700°	

Worked Example	Your Turn
a) What is the total of the interior angles of a 9- sided shape?	a) What is the total of the interior angles of a 14- sided shape?
b) Calculate the size of an interior angle in a regular octagon.	b) Calculate the size of an interior angle in a regular pentagon.
c) A regular polygon has an exterior angle of 12°. How many sides does it have?	c) A regular polygon has an exterior angle of 10°. How many sides does it have?

Fill in the Gaps

Name	Number of Angles	Sum of Interior Angles	Size of One Interior Angle in a Regular Polygon	Size of One Exterior Angle in a Regular Polygon
	3			
		$360°$	$90°$	
Octagon				$45°$
Hexadecagon		$2520°$		
Pentadecagon	15		$156°$	
				$72°$
		$720°$	$120°$	
	12			
		$1620°$		$\frac{360°}{11}$

Ratio and Polygon Angles

a regular polygon

(1) exterior angle : interior angle = 1 : 2
how many sides does the polygon have?

(2) exterior angle : interior angle = 2 : 7
how many sides does the polygon have?

(3) exterior angle : interior angle is 2 : 13
how many sides does the polygon have?

(4) exterior angle : total of the interior angles = 1 : 40
how many sides does the polygon have?

(5) exterior angle : total of the interior angles = 1 : 24
how many sides does the polygon have?

two regular polygons

(1) the numbers of sides are the ratio 1 : 2
the interior angles are in the ratio 2 : 3
how many sides do they have?

(2) the numbers of sides are the ratio 2 : 3
the interior angles are in the ratio 12 : 13
how many sides do they have?

(3) the numbers of sides are the ratio 3 : 5
the interior angles are in the ratio 20 : 21
how many sides do they have?

(4) the interior angles are in the ratio 7 : 6
the exterior angles are in the ratio 1 : 3
how many sides do they have?

(5) the interior angles are in the ratio 5 : 6
the exterior angles are in the ratio 5 : 2
how many sides do they have?

regular polygons

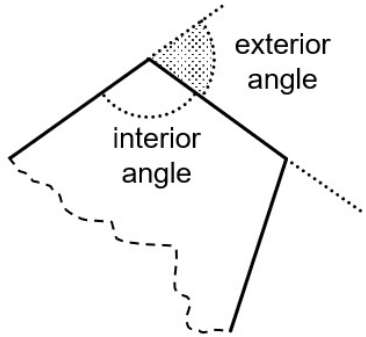
(1) a polygon has n sides
the interior angle is $12n + 12$ degrees
the exterior angle is $12n + 48$ degrees
how many sides does it have?

(2) a polygon has n sides
the interior angle is $12n + 24$ degrees
how many sides does it have?
try to find more than one answer

(3) a polygon has n sides
the interior angle is $12n + 6$ degrees
how many sides does it have?

regular polygon questions

(1) work out the size of an exterior angle of a regular nonagon (9 sides)



(2) work out the interior angle of a regular dodecagon (12 sides)

(3) calculate the size of an interior angle of a regular 20-sided polygon (an 'icosagon')

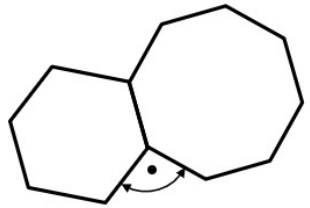
(4) the size of each exterior angle of a regular polygon is 15^o
work out the number of sides of the polygon

(5) the size of each interior angle of a regular polygon is 156^o
work out the number of sides of the polygon

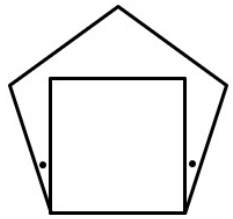
(6) how many times bigger is the interior angle of a regular nonagon to an exterior angle?

(7) which regular polygon has an interior angle three times an exterior angle?

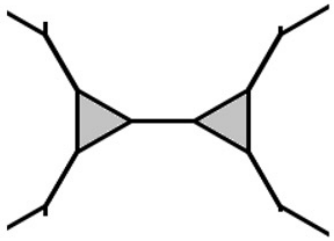
(8) what is the angle shown between a regular octagon and a regular hexagon?



(9) what is the angle between a regular pentagon and a square?

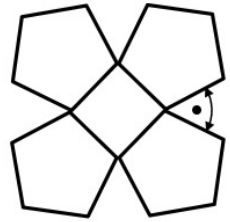


(10) what is the angle between a regular nonagon and a regular decagon if they share a common side?

(11) 

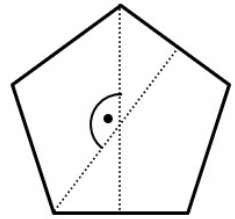
when four of the same regular polygon meet they form two equilateral triangles as shown how many sides do the regular polygons have?

(12) a square is surrounded by four regular pentagons what is the angle shown?

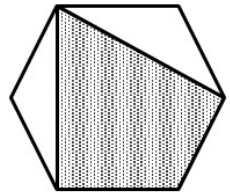


(13) the size of each interior angle of a regular polygon is 11 times the size of each exterior angle how many sides does the polygon have?

(14) find the obtuse angle between two lines of symmetry of a regular pentagon



(15) what are the angles in the kite, shown inside a regular hexagon?

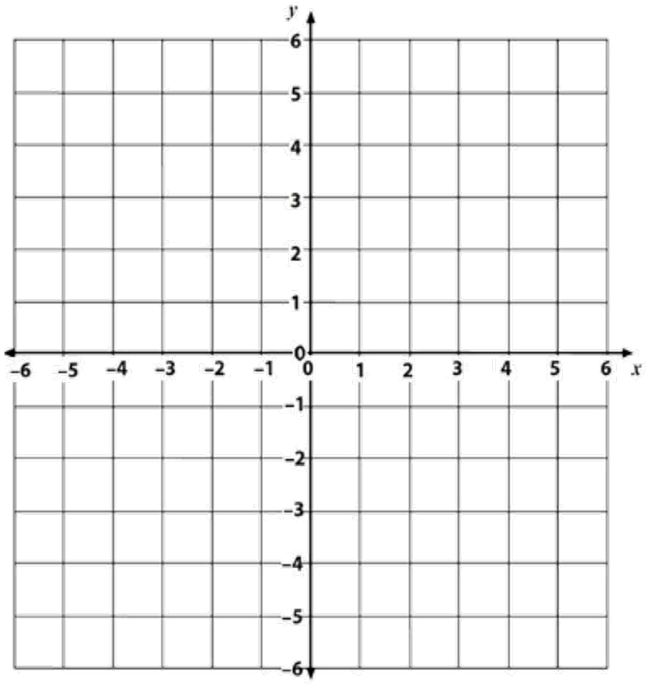
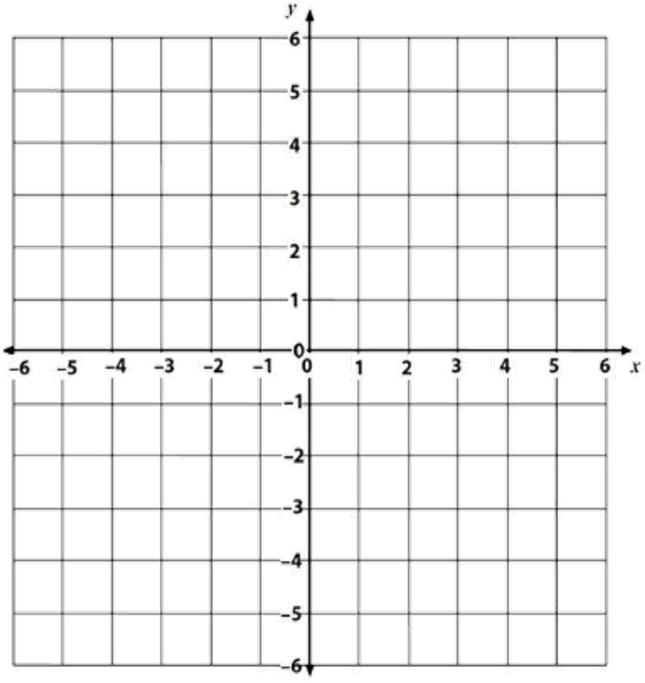


what are the angles in this type of kite inside other regular polygons that have an even number of sides?

3 Straight Line Graphs

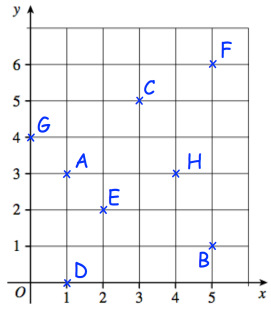
3.1 Coordinates

Coordinates are pair of numbers written in the form (x, y) where x is the amount moved horizontally, and y the amount moved vertically from the origin on a graph. The two values are referred to, in order, as the x-coordinate and the y-coordinate.

Worked Example	Your Turn
Plot the coordinates: $(2, 5)$ $(2, -5)$ $(-2, 5)$ $(-2, -5)$ 	Plot the coordinates: $(3, 4)$ $(3, -4)$ $(-3, 4)$ $(-3, -4)$ 

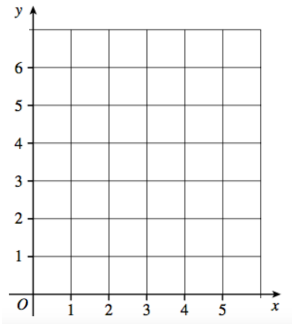
Fluency Practice

Question 1: Write down the coordinates of the points A, B, C, D, E, F, G and H.

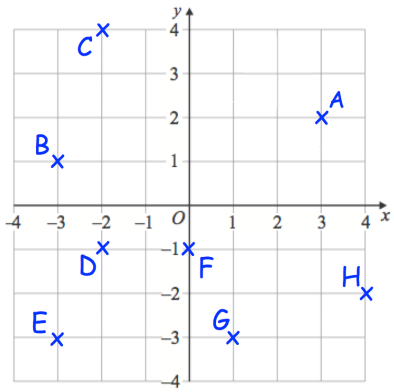


Question 2: Make a copy of the grid shown and then plot the points:

(a) A (3, 1)
(b) B (2, 5)
(c) C (5, 4)
(d) D (1, 1)
(e) E (4, 0)
(f) F (0, 1)
(g) G (3, 3)
(h) H (0, 0)

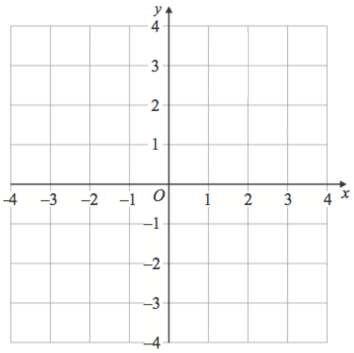


Question 3: Write down the coordinates of the points A, B, C, D, E, F, G and H.



Question 4: Make a copy of the grid shown and then plot the points:

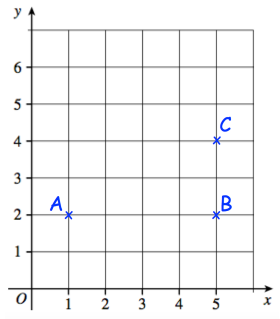
(a) A (1, 4)
(b) B (−1, 1)
(c) C (−3, −4)
(d) D (2, −1)
(e) E (−2, 0)
(f) F (−1, −2)
(g) G (3, −2)
(h) H (0, −4)
(i) I (−2, 2)
(j) J (−4, −1)
(k) K (0, 1)



Extension

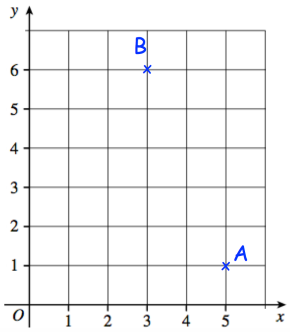
Question 1: Three points are shown on a grid.
ABCD is a rectangle.

(a) Plot D
(b) Write down the coordinates of the point D



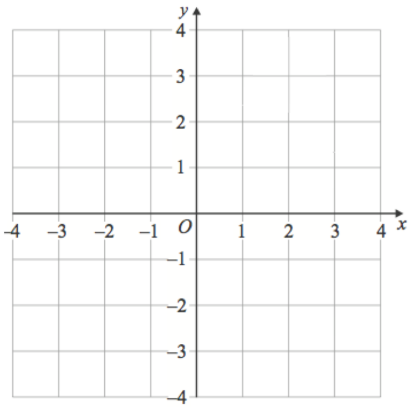
Question 2: Two points are shown on a grid
ABC is an isosceles triangle.

(a) Plot C
(b) Write down the coordinates of the point C



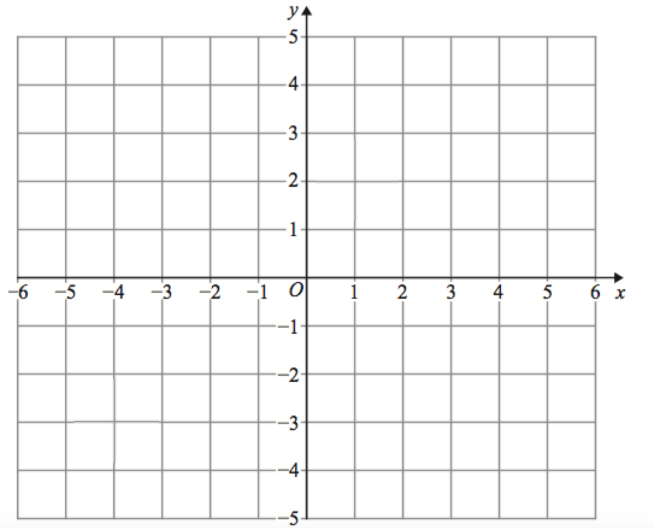
Question 3: Make a copy of the grid shown.

(a) Plot the point A (−3, −2)
(b) Plot the point B (1, −2)
(c) Plot the point C (3, 1)
(d) Plot the point D (−1 , 1)
(e) What type of quadrilateral is ABCD?



Extension

For each question 4-5 below, you will need copies of this grid.



Question 4: (a) Plot the following coordinates

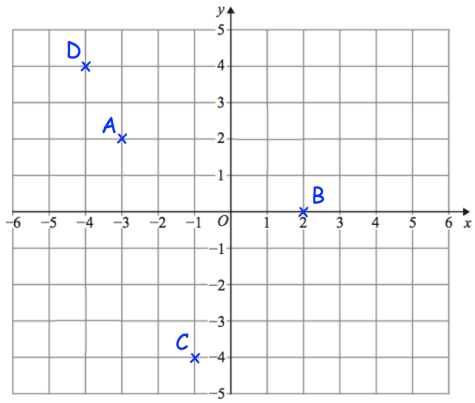
(3, 0) (−3, −2) (1, −4) (1, 2) (−3, 0) (−1, −4) (3, −2) (−1, 2)

(b) Join the shapes to make a polygon.
(c) Name the polygon that you have drawn.

Question 5: (a) Plot the coordinates A (−4, 1), B (1, −2) and C (2, 1)
(b) ABCD is a kite.
(c) Plot D
(d) Write down the coordinates of the point D.

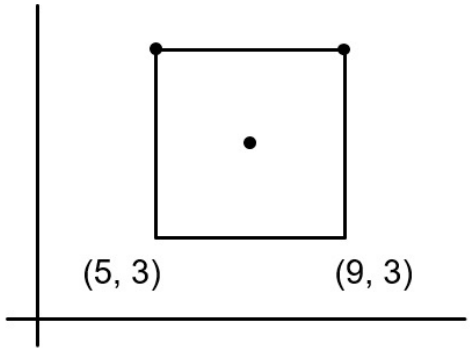
Question 6: James has been asked to plot the coordinates A (−3, 2), B (0, 2), C (−1, −4) and D (4, −4)

Can you spot any mistakes?

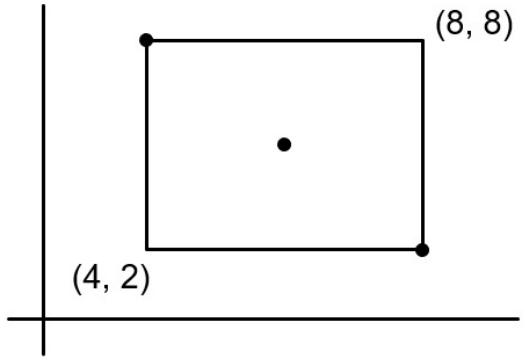


find the missing coordinates of the given shapes (i)

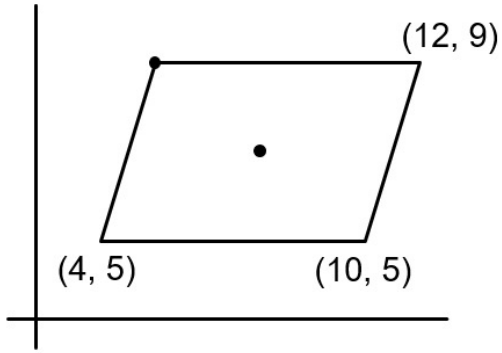
(1) a square



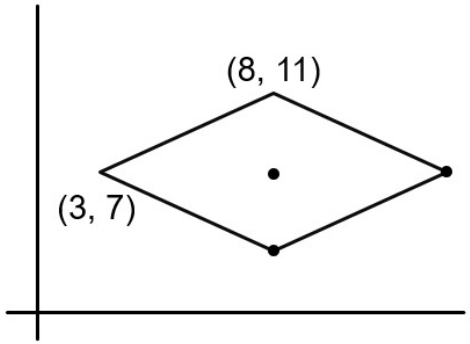
(2) a rectangle



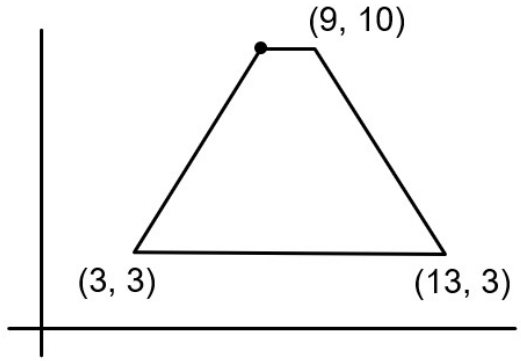
(3) a parallelogram



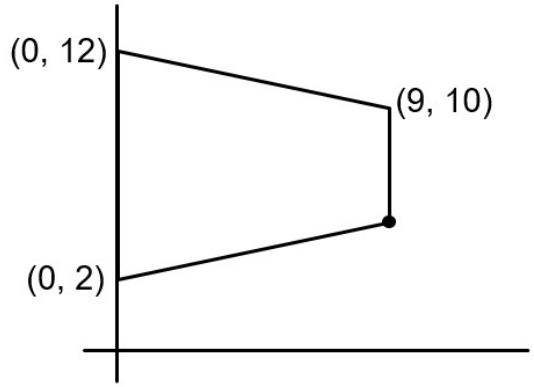
(4) a rhombus



(5) an isosceles trapezium

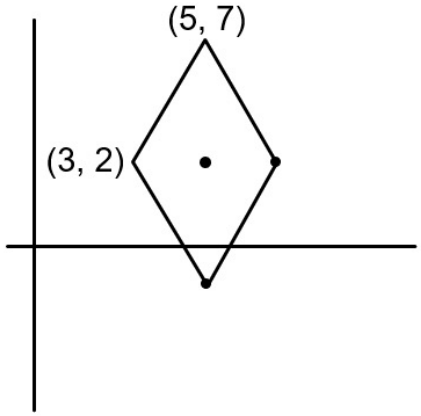


(6) an isosceles trapezium

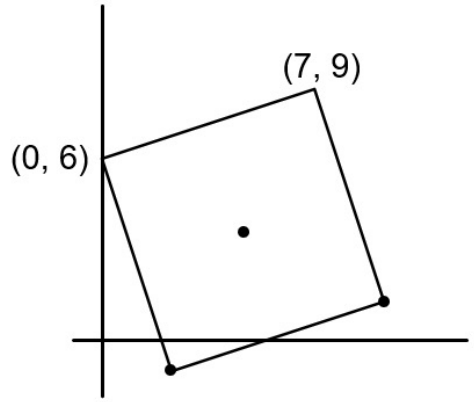


find the missing coordinates of the given shapes (ii)

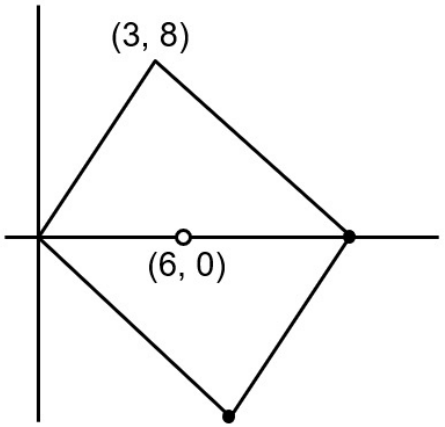
(7) a rhombus



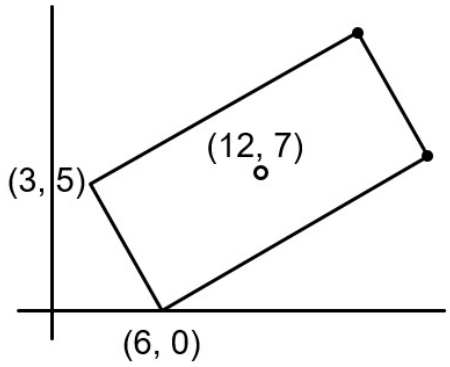
(8) a square



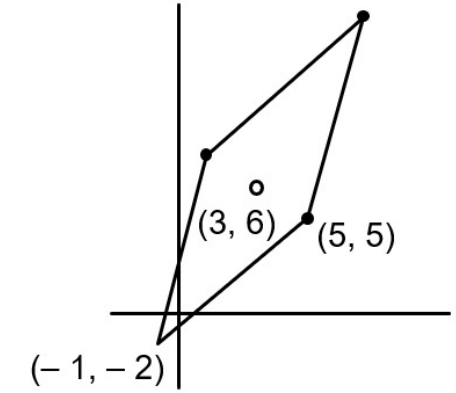
(9) a parallelogram



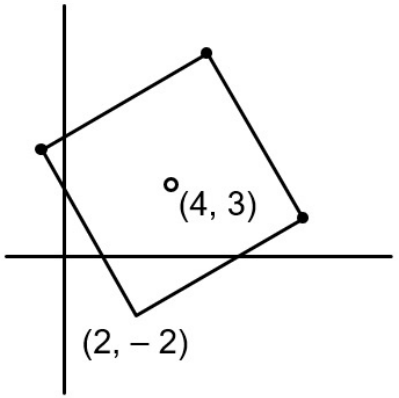
(10) a rectangle



(11) a rhombus



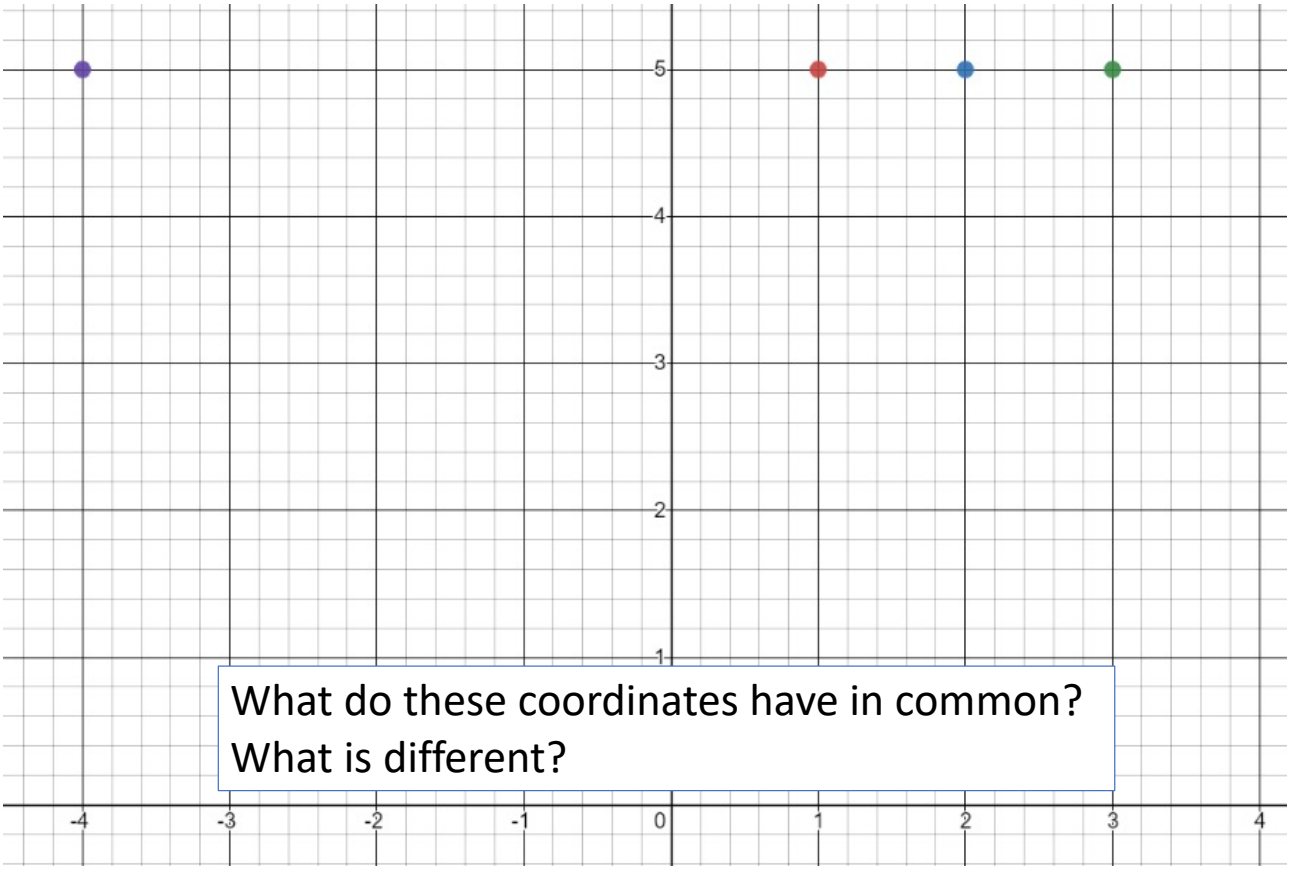
(12) a square



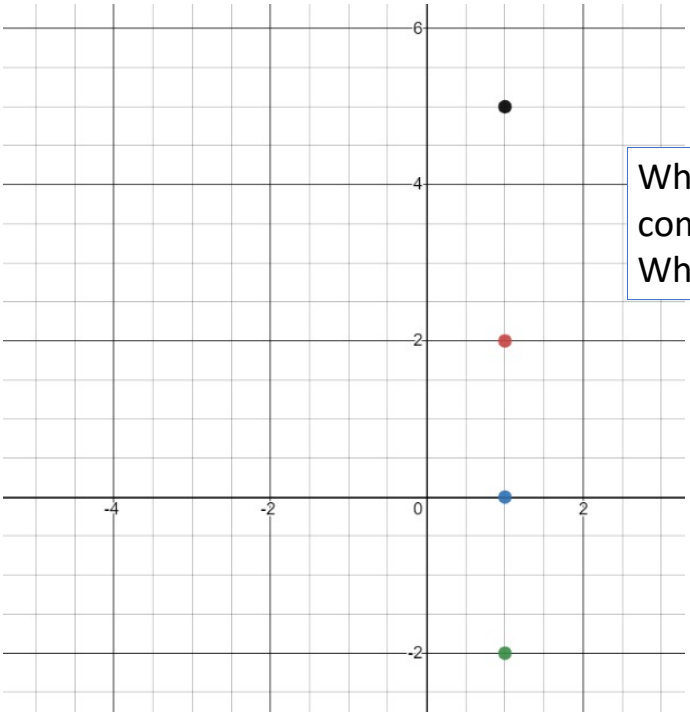
3.2 Horizontal and Vertical Lines

Graphs of the form $y = c$ and $x = c$, will either be a horizontal or vertical line.

Horizontal and Vertical Lines



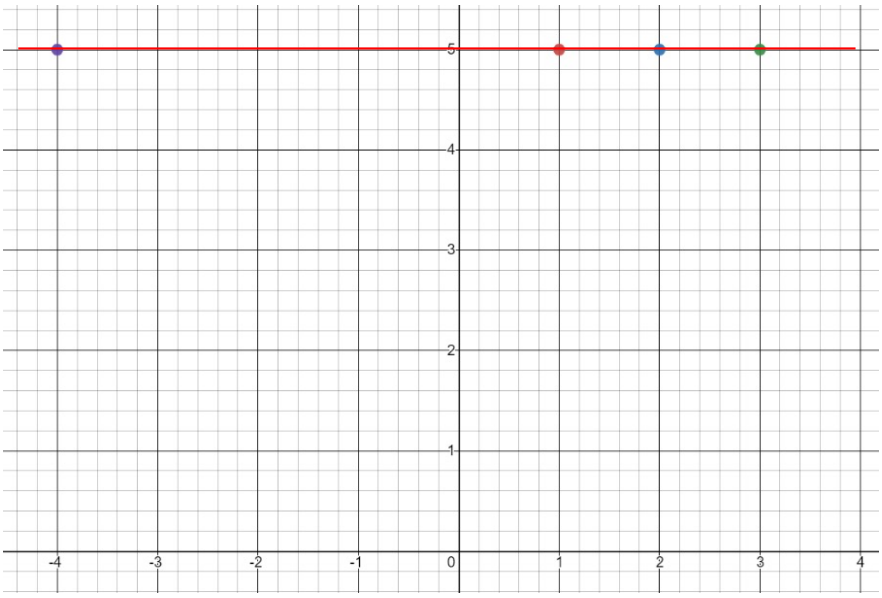
What do these coordinates have in common?
What is different?



What do these coordinates have in common?
What is different?

Horizontal and Vertical Lines

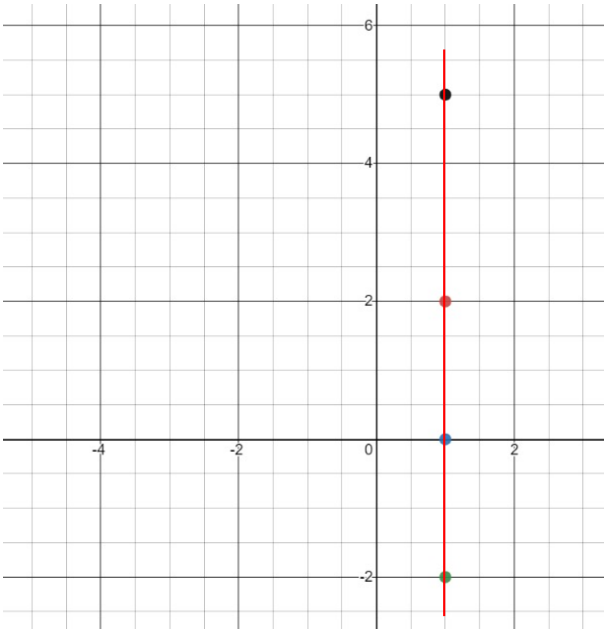
The relationship of the shared characteristic between points can be written as an equation.



All of these points have a y coordinate of 5.

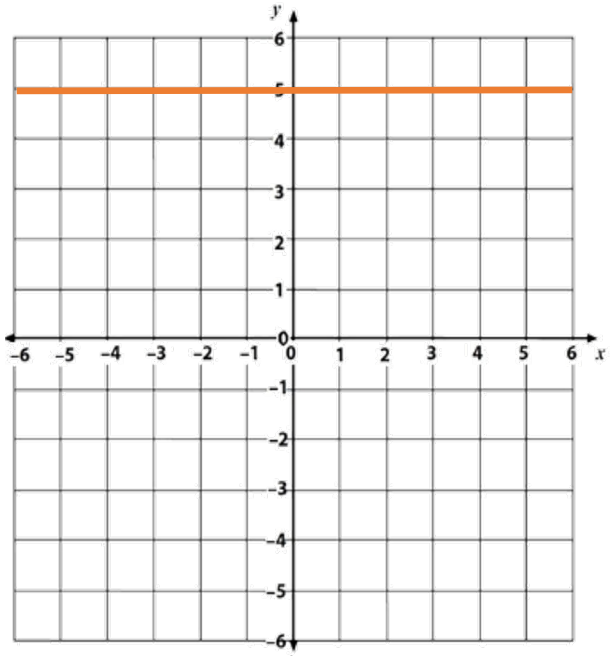
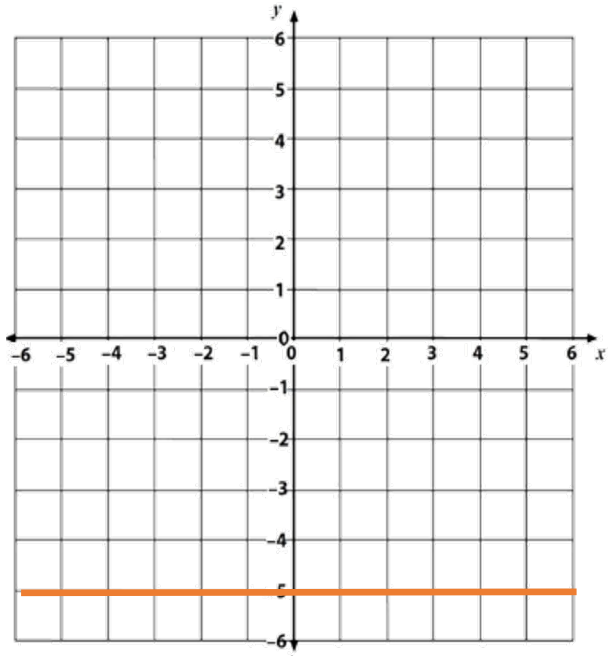
The straight line can be described as y = 5 because this is true for every point on the line.

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

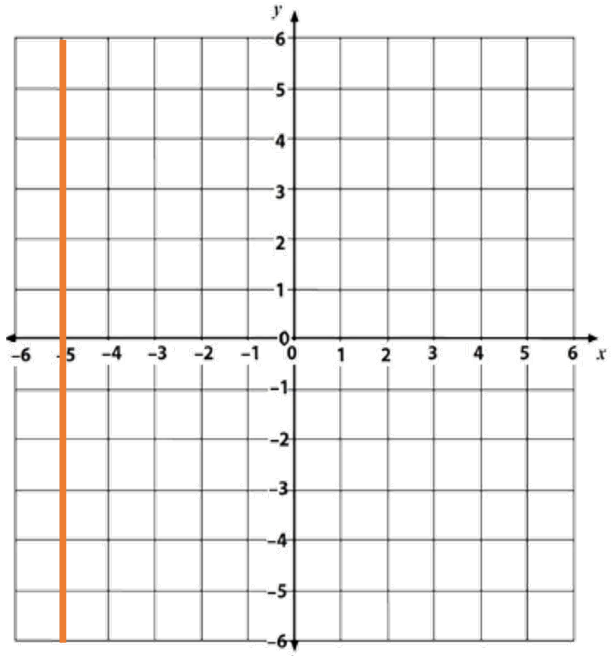


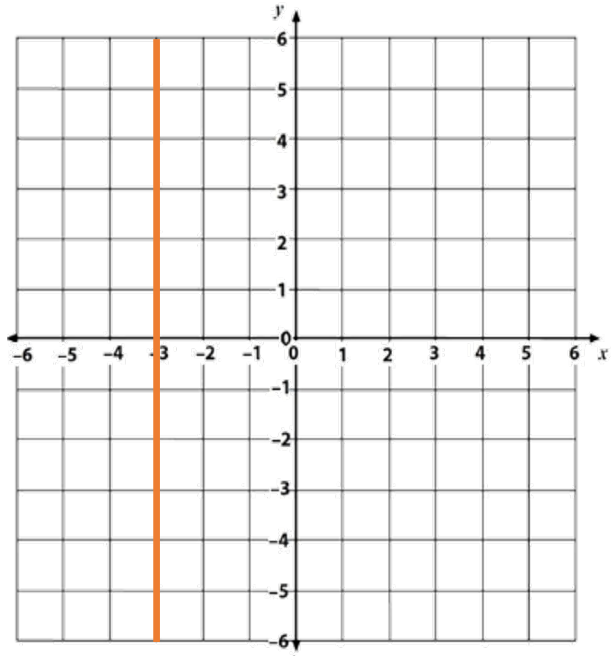
All of these points have an x coordinate of 1.

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

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

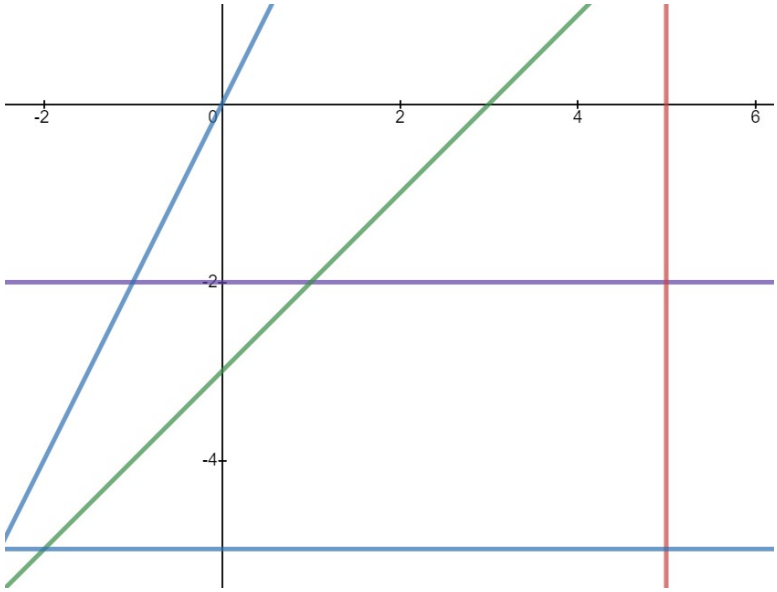
Worked Example	Your Turn
Find the equation of the line:	Find the equation of the line:





Horizontal and Vertical Lines

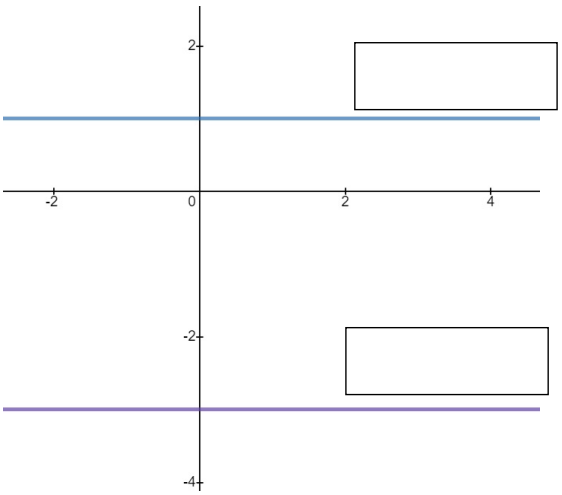
Which of these lines can be described as ‘x = ___’ or ‘y = ___’?
How many can you ‘name’?
Why can’t some of the lines be written as ‘x = ___’ or ‘y = ___’?

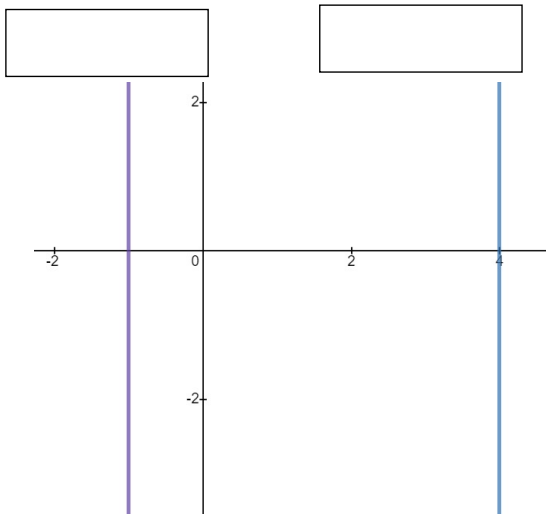


Fluency Practice

Vertical and horizontal lines.

1) Fill in the boxes with the equations of the straight lines.





2) Write the equation of the line that all of the following points will fall on.

(a) (4, 5), (4, 9), (4,0), (4,-3)

(b) (-10, 2), (173, 2), (10,2), (-0.3,2)

(c) (4.3, 0.1), (0, 0.1), (-9, 0.1)

(d) $(-\frac{1}{3}, 10)$, $(-\frac{1}{3}, -3)$, $(-\frac{1}{3}, 0.5)$, $(-\frac{1}{3}, -0.1)$

3) Thinking carefully about the coordinates can you find the equation of…

(a) The x-axis

(b) The y-axis

4) A point has the coordinates of (3, -5).

(a) What are the equations of the horizontal and vertical lines that this point is on?

(b) The line is vertical. Which of those two equations from (a) will it be?

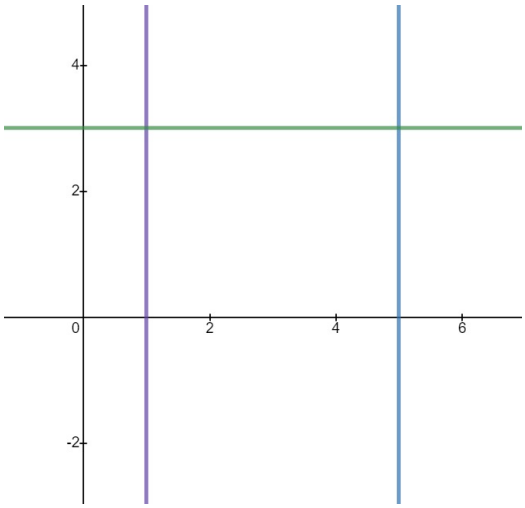
5) A shape is made by the area enclosed by the lines x = 1, x = 9, y = 2 and y = 5.

(a) What is the shape?

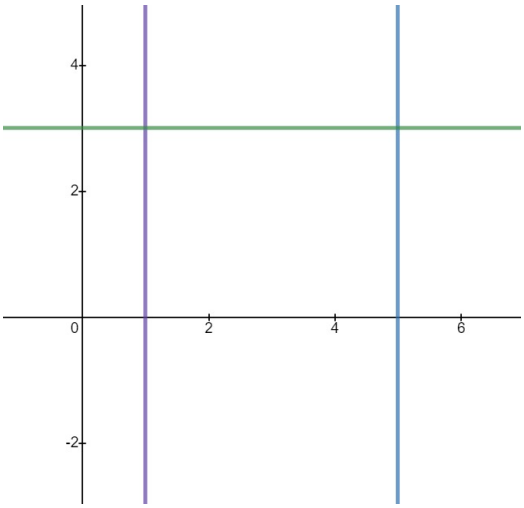
(b) What is the area of the shape?

Fluency Practice

6) Write down the equation of the straight line that would make the enclosed shape a square.



7) There is a rectangle below with a side missing. If the area of the rectangle is 24cm^2, what will be the equation of the missing line?



3.3 Drawing Straight Line Graphs

A linear equation is drawn as a straight line on a set of axes.

To draw the graph we need coordinates.

We generate these coordinates by substituting values into the linear equation.

Worked Example

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

x					
y					

Your Turn

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

x					
y					

Worked Example

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

x					
y					

Your Turn

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

x					
y					

Fluency Practice

1) y = 2x + 3

x	-2	-1	0	1	2
y					

2) y = 2x + 4

x	-2	-1	0	1	2
y					

3) y = 2x + 5

x	-2	-1	0	1	2
y					

4) y = 3x + 5

x	-2	-1	0	1	2
y					

5) y = 3x + 1

x	-2	-1	0	1	2
y					

6) y = 3x - 1

x	-2	-1	0	1	2
y					

7) y = 3x - 2

x	-2	-1	0	1	2
y					

8) y = 3x - 3

x	-2	-1	0	1	2
y					

9) y = 3x - 5

x	-2	-1	0	1	2
y					

10) y = 4x - 5

x	-2	-1	0	1	2
y					

11) y = -4x - 5

x	-2	-1	0	1	2
y					

12) y = -2x - 5

x	-2	-1	0	1	2
y					

13) y = -½x - 5

x	-2	-1	0	1	2
y					

14) y = ½x + ¾

x	-2	-1	0	1	2
y					

Worked Example

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

x					
y					

Your Turn

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

x					
y					

Worked Example

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

x					
y					

Your Turn

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

x					
y					

Fluency Practice

Question 6: For each equation, complete the table of values and draw its graph for values of x from −1 to 3.

(a) $x + y = 3$

x	-1	0	1	2	3
y					

(b) $2x + y = 4$

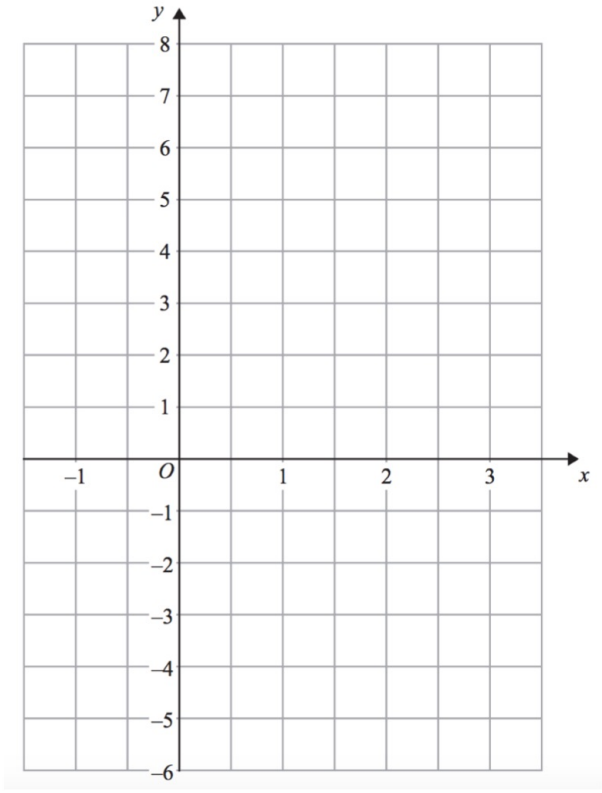
x	-1	0	1	2	3
y					

(c) $x + 2y = -2$

x	-1	0	1	2	3
y					

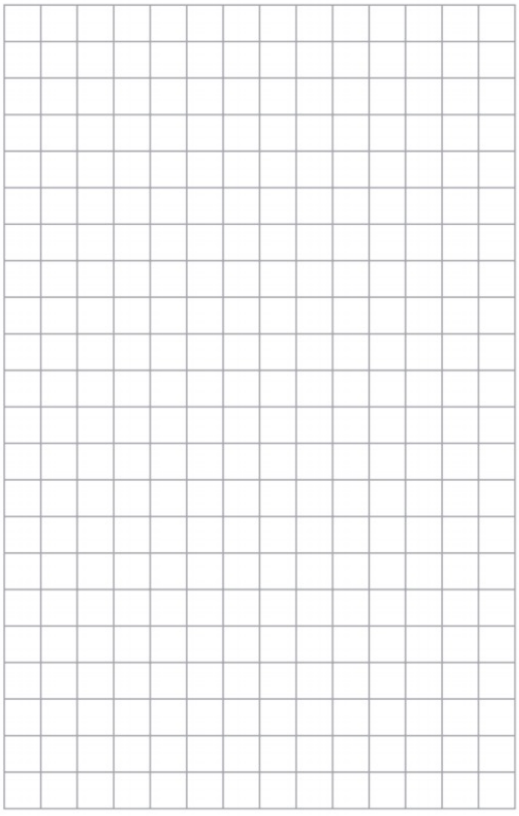
(d) $2x - y = 4$

x	-1	0	1	2	3
y					



Extension

Question 7: For each equation, draw its graph for values of x from −2 to 3.



(g) $x + y = 8$

(h) $2x + y = 12$

(i) $x + 2y = 10$

(j) $2x + 3y = 12$

(k) $2x + 5y - 20 = 0$

Intelligent Practice

Plot each pair of linear graphs on the axes given.
Write a sentence about what you notice about each pair of lines.

1) On the axes on the right, plot the graphs of
$y = 2x + 1$ and
$y = 3x + 1$

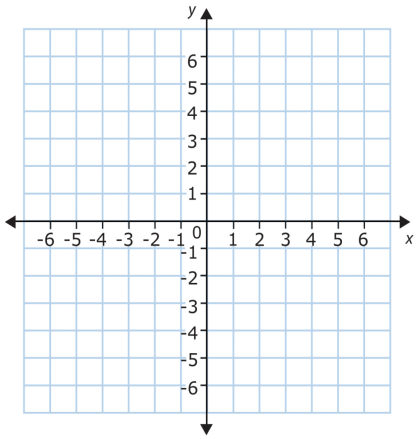


Table of values of $\boldsymbol{y = 2x + 1}$

x	-2	-1	0	1	2
y					

Table of values of $\boldsymbol{y = 3x + 1}$

x	-2	-1	0	1	2
y					

2) On the axes on the right, plot the graphs of
$y = 2x - 1$ and
$y = 2x - 2$

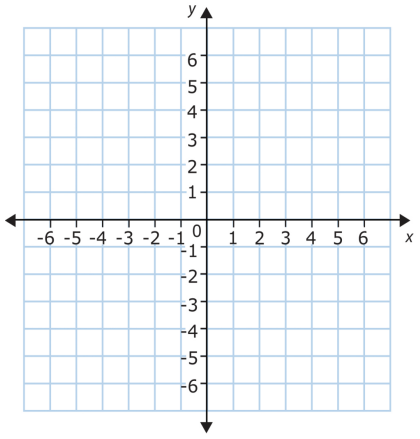


Table of values of $\boldsymbol{y = 2x - 1}$

x	-2	-1	0	1	2
y					

Table of values of $\boldsymbol{y = 2x - 2}$

x	-2	-1	0	1	2
y					

3) On the axes on the right, plot the graphs of
$y = -2x$ and
$y = -2x + 1$

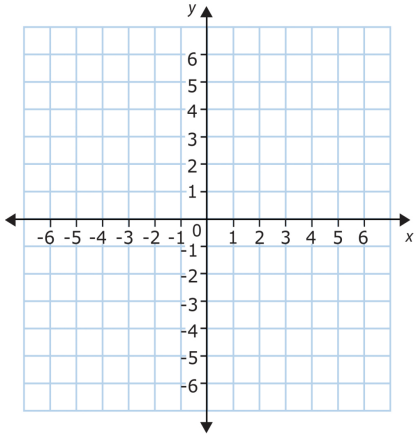


Table of values of $\boldsymbol{y = -2x}$

x	-2	-1	0	1	2
y					

Table of values of $\boldsymbol{y = -2x + 1}$

x	-2	-1	0	1	2
y					

Intelligent Practice

4) On the axes on the right, plot the graphs of
$y = \frac{1}{2}x$ and
$y = 2x$

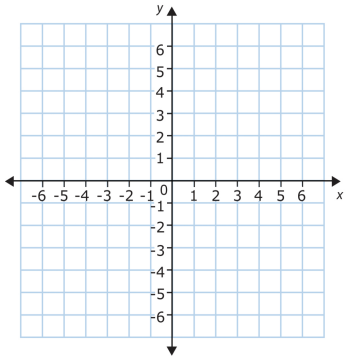


Table of values of $\boldsymbol{y = \frac{1}{2}x}$

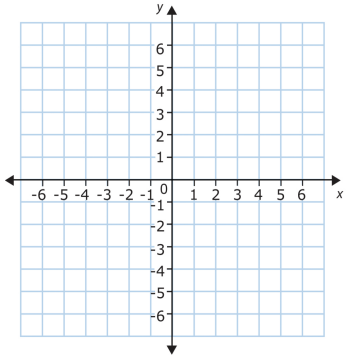
x	-2	-1	0	1	2
y					

Table of values of $\boldsymbol{y = 2x}$

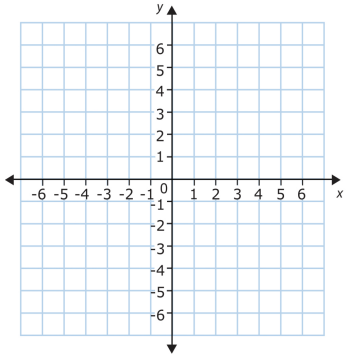
x	-2	-1	0	1	2
y					

5) On the axes on the right, plot the graphs of
$\boldsymbol{y = -\frac{1}{2}x}$ and
$\boldsymbol{y = -2x}$

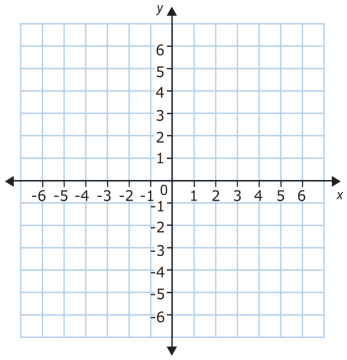
You need to draw your own tables of values form now on.



6) On the axes on the right, plot the graphs of
$y = \frac{1}{2}x + 1$ and
$y = -2x + 3$



7) On the axes on the right, plot the graphs of
$y = \frac{3}{4}x + 1$ and
$y = -\frac{4}{3}x + 3$



EXTENSION:
Generalise the conclusions you have made from the questions above. What do you notice? Can you give another pair of equations that follow the same rule?

3.4 Gradient

The gradient tells us how steep a line is, therefore the bigger the gradient the steeper the line is.

A positive gradient is a straight line which slopes up to the right.

A negative gradient is a straight line which slopes down to the right.

Possible answers:

$\frac{1}{5}, 5, -\frac{1}{5}, -5$

$\frac{50}{10} =$

$-50 \div 10 =$

$-50 \div -10 =$

$\frac{10}{-50} =$

$\frac{-10}{50} =$

$-10 \div -50 =$

$-10 \div 50 =$

$\frac{-50}{10} =$

$\frac{50}{-10} =$

$-\frac{50}{10} =$

$50 \div 10 =$

$50 \div -10 =$

$\frac{-10}{-50} =$

$10 \div -50 =$

$10 \div 50 =$

$\frac{10}{50} =$

$\frac{-50}{-10} =$

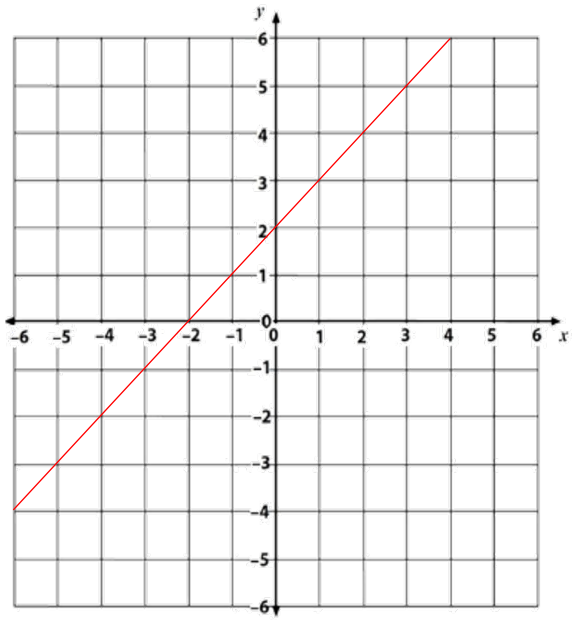
$-\frac{10}{50} =$

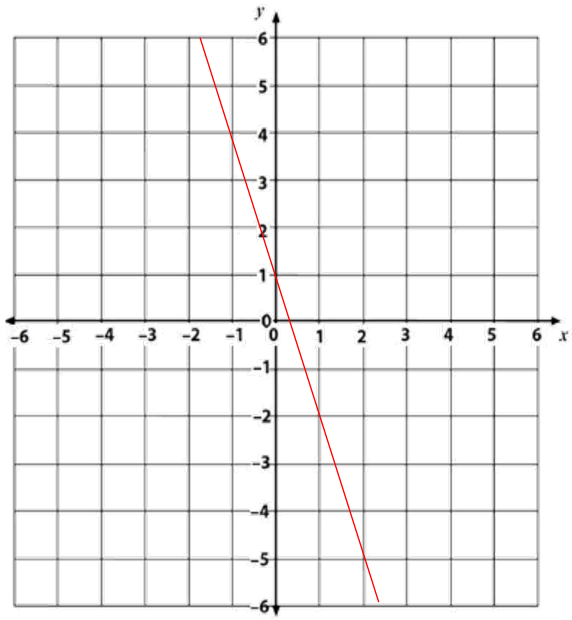
Gradient

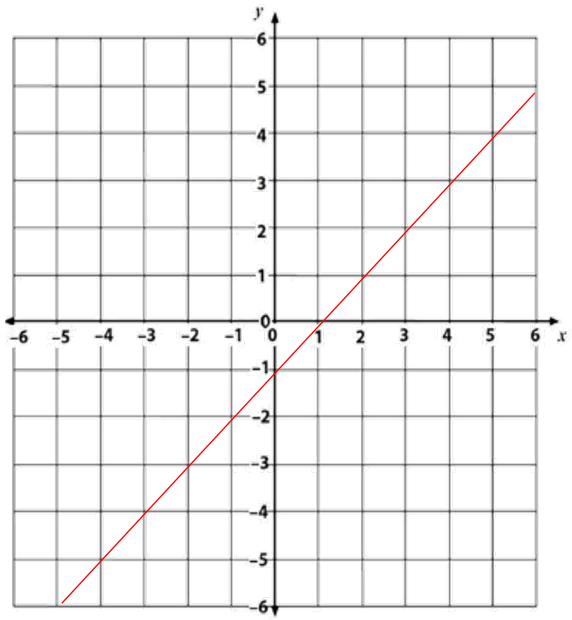
Word	**Gradient**
Word class	Noun
Definition	1. an inclined part of a road or railway; a slope. 2. an increase or decrease in the magnitude of a property (e.g. temperature, pressure, or concentration) observed in passing from one point or moment to another.
Example	*“The car has fail-safe brakes for use on steep gradients.*
Synonyms	Slope, incline
Origins	From the Latin *‘gradus’*, meaning step.

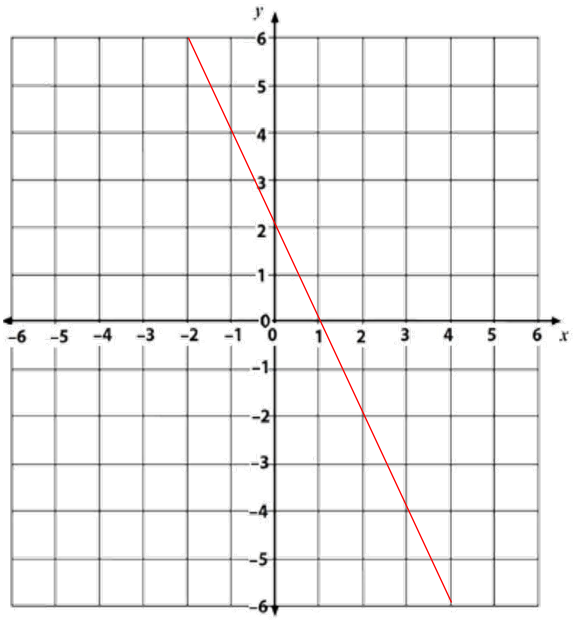
Worked Example	Your Turn
Calculate the gradient between the coordinates: a) $(-2, -1)$ and $(5, 7)$ b) $(2, -1)$ and $(-5, -7)$	Calculate the gradient between the coordinates: a) $(-4, 2)$ and $(6, 8)$ b) $(-4, 2)$ and $(-6, -8)$

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



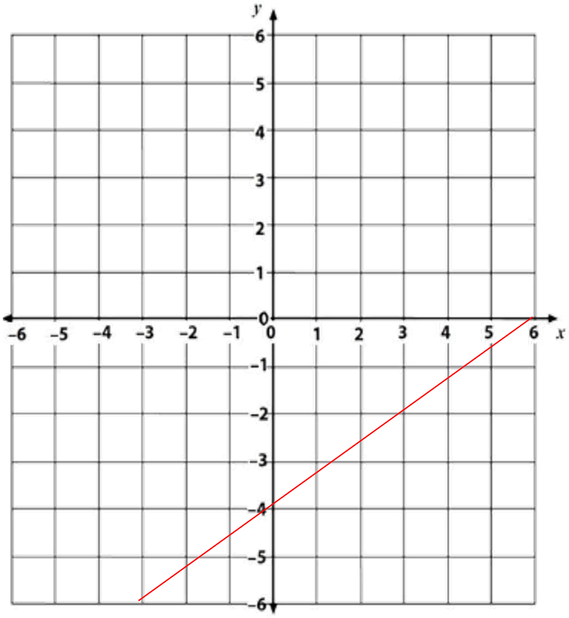


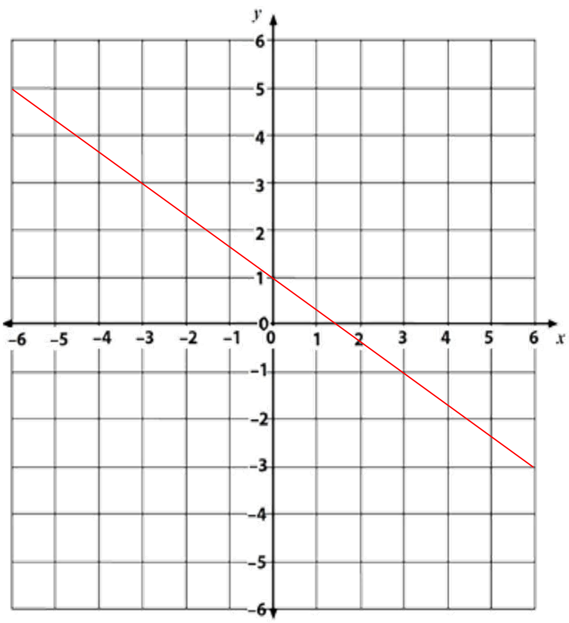




Worked Example

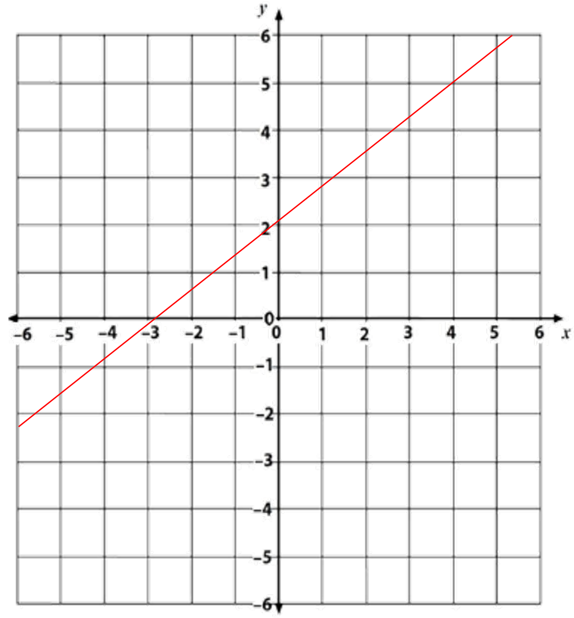
Find the gradient of:

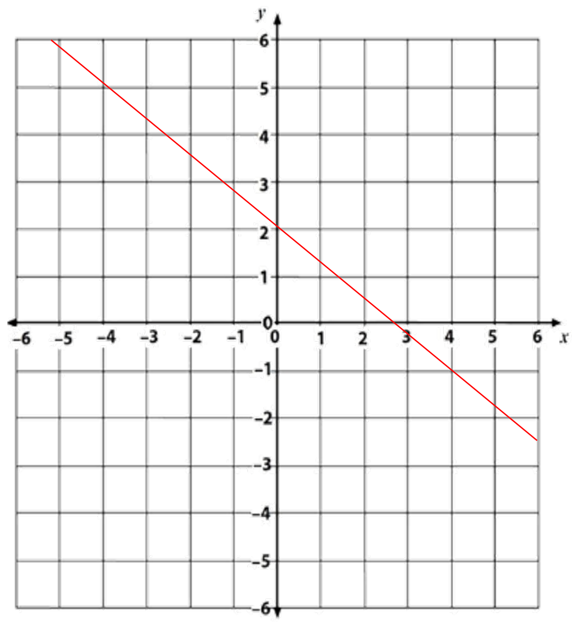


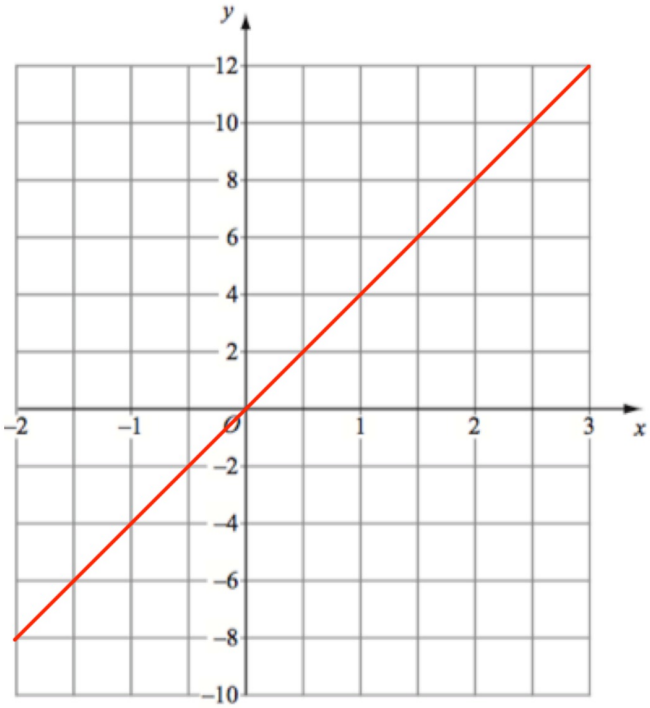
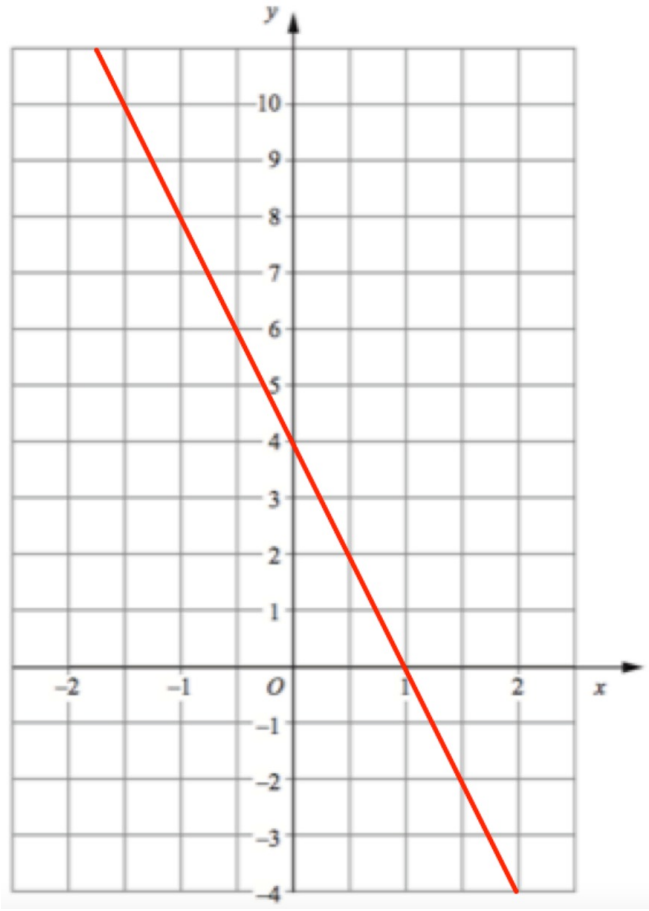


Your Turn

Find the gradient of:



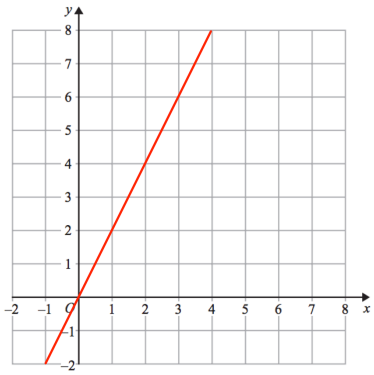


Worked Example	Your Turn
Find the gradient of:  	Find the gradient of: 

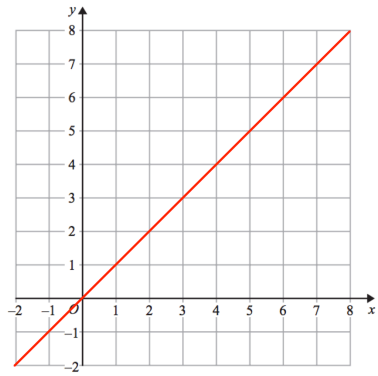
Fluency Practice

Question 1: Find the gradient of each of these lines

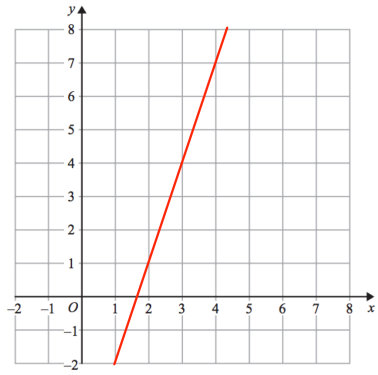
(a)



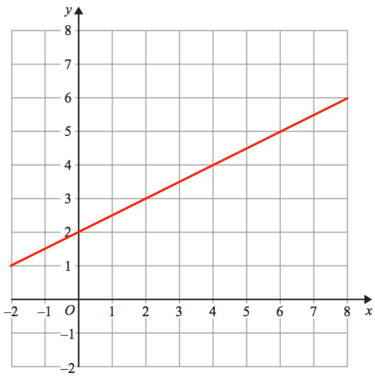
(b)



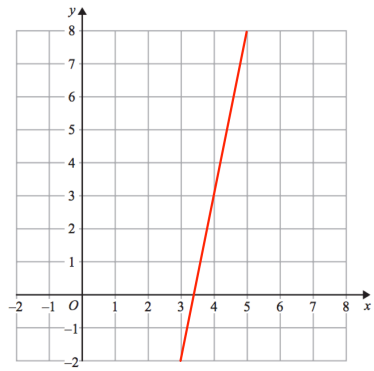
(c)



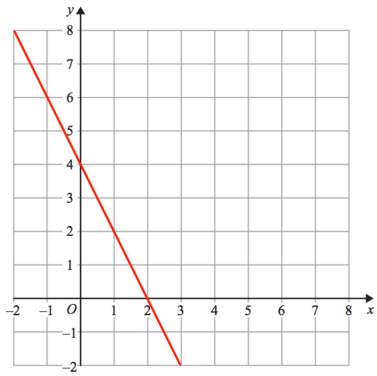
(d)



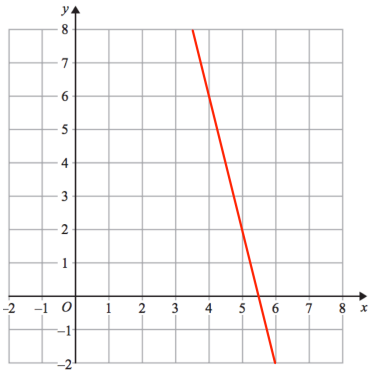
(e)



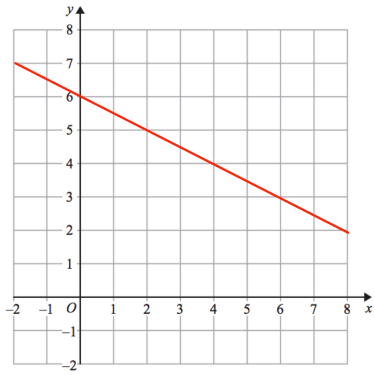
(f)



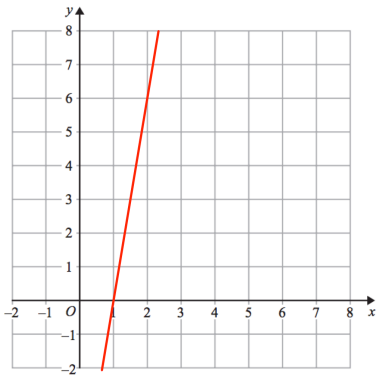
(g)



(h)



(i)

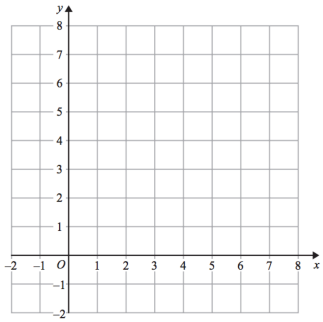


Fluency Practice

Question 2: Draw lines with the following gradients

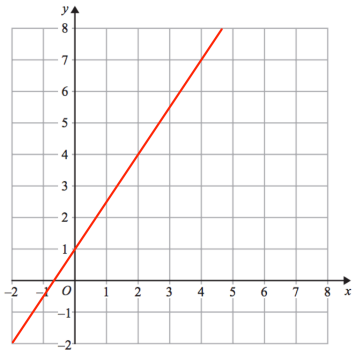
(a) 2 (b) 4 (c) 7 (d) −1

(e) −3 (f) −5 (g) $\frac{1}{2}$ (h) 10

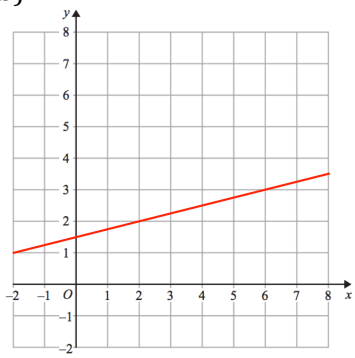


Question 3: Find the gradient of each of these lines

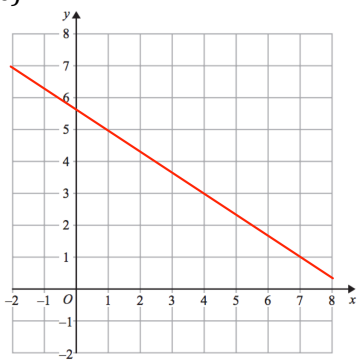
(a)



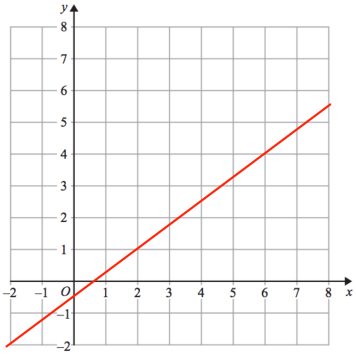
(b)



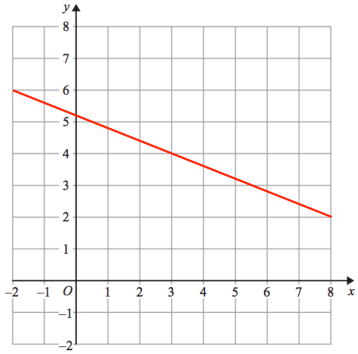
(c)



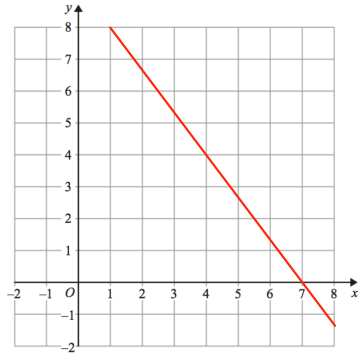
(d)



(e)



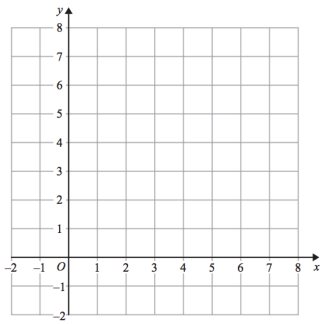
(f)



Question 4: Draw lines with the following gradients

(a) $2\frac{1}{2}$ (b) $\frac{1}{3}$ (c) $\frac{1}{5}$ (d) $-\frac{1}{6}$

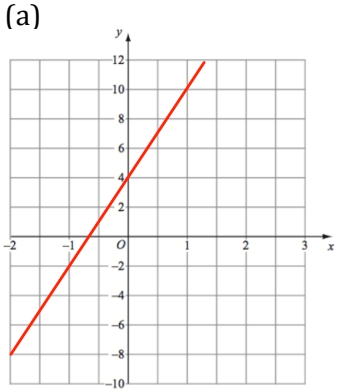
(e) $\frac{3}{10}$ (f) $\frac{4}{5}$ (g) $1\frac{1}{3}$ (h) $-\frac{3}{5}$



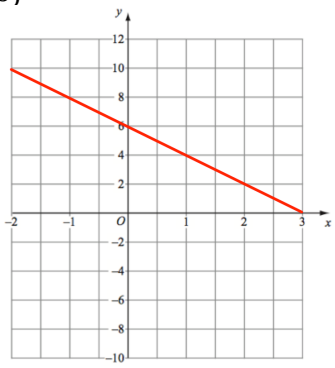
Fluency Practice

Question 5: Find the gradient of each of these lines

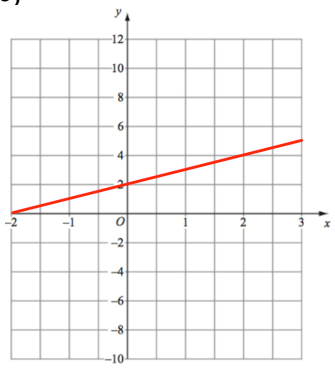
(a)



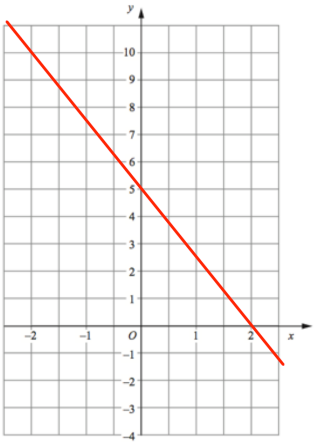
(b)



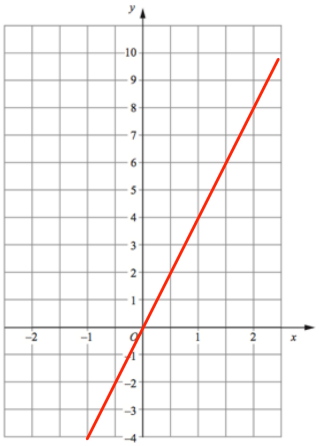
(c)



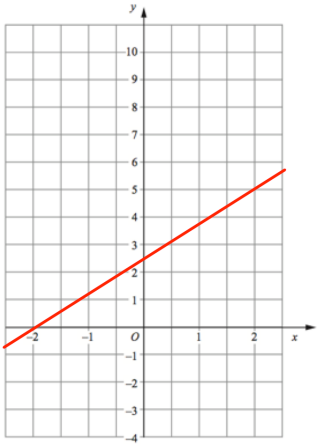
(d)



(e)

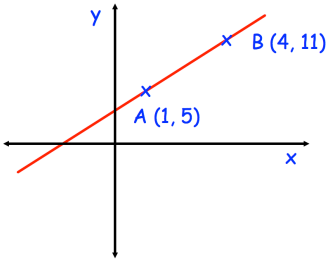


(f)

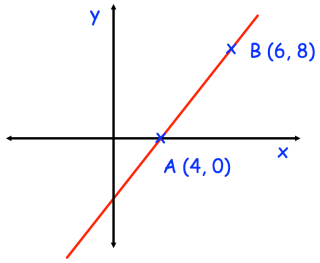


Question 6: Find the gradient of each line shown below

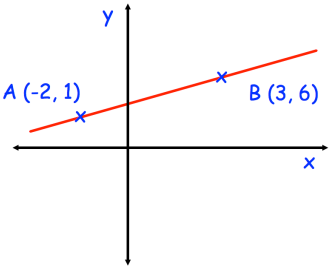
(a)



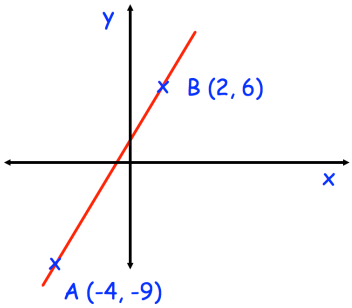
(b)



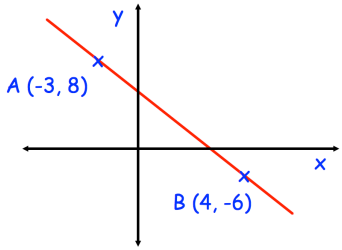
(c)



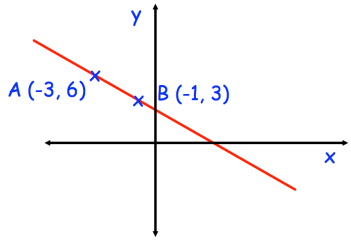
(d)



(e)

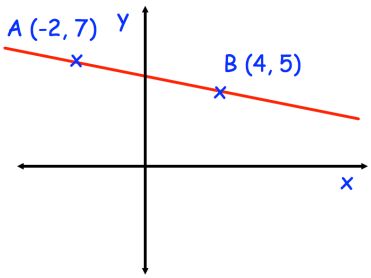


(f)

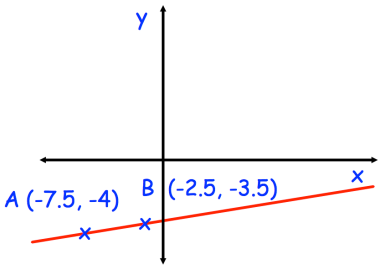


Fluency Practice

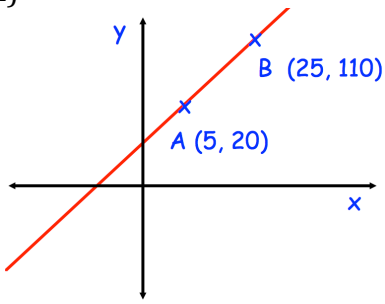
(g)



(h)



(i)



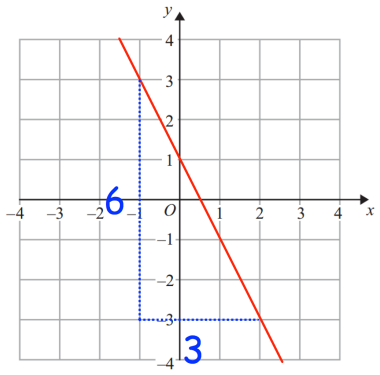
Question 7: Work out the gradient of the line passing through these pairs of points

(a) (1, 4) and (3, 10)
(b) (0, 0) and (3, 12)
(c) (5, −2) and (9, 14)
(d) (−8, 6) and (0, −2)
(e) (−5, −9) and (1, 3)
(f) (−7, −2) and (1, −4)
(g) (−2, 1) and (8, −7)
(h) (−2, 9) and (4, 7)
(i) (−4.5, 3) and (6, −7.5)

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

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

Fluency Practice



Question 1: Alisha says that the gradient of the line is 2.
Explain her mistake.

Question 2: Find the gradient of the line passing through the points (4a, −a) and (6a, 5a)

Question 3: The line passing through (5, −2) and (8, c) has a gradient of 3.
Find c.

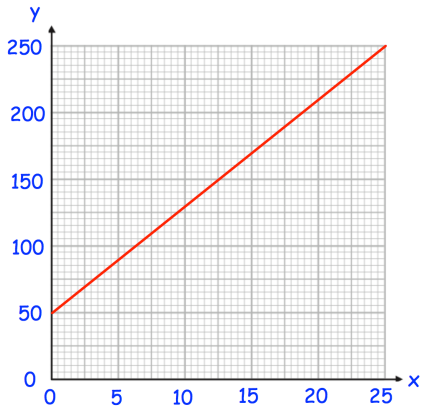
Question 4: The line passing through (−8, −9) and (−2, h) has a gradient of 4.
Find h.

Question 5: The line passing through (3, −4) and (m, 10) has a gradient of 2.
Find m.

Question 6: The line passing through (−2, 5) and (2, n) has a gradient of −½
Find n.

Question 7: The line passing through (1, p) and (5, 1) has a gradient of 0.75
Find p.

Question 8: Find the equation of the line shown



3.5 Equation of Straight Line Graphs

Straight line graphs can be written in the form $y = mx + c$, where m is the gradient, or steepness of the graph and c is the y-intercept of the graph, where the graph cuts through the y-axis.

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

$+m$

$y = mx + c$

Gradient

$\boldsymbol{y = 2x + 3}$

Let us look at different ways to present information about the **gradient**.

- …goes through $(0, 3)$ and has a **gradient of $\mathbf{2}$**
- …goes through $(0, 3)$ and **each time you move $\mathbf{1}$ unit to the right, you need to move $\mathbf{2}$ units up to find the line again**
- …goes through $(0, 3)$ and **each time you move $\mathbf{2}$ units to the right, you need to move $\mathbf{4}$ units up to find the line again**
- …goes through $(0, 3)$ and **each time you move $\mathbf{5}$ units to the right, you need to move $\mathbf{10}$ units up to find the line again**
- …goes through $(0, 3)$ and $(\mathbf{1}, \mathbf{5})$
- …goes through $(0, 3)$ and $(\mathbf{2}, \mathbf{7})$
- …goes through $(0, 3)$ and $(\mathbf{5}, \mathbf{13})$
- …goes through $(0, 3)$ and $(\mathbf{-8}, \mathbf{-13})$

y-intercept

$\boldsymbol{y = 2x + 3}$

Let us look at different ways to present information about the **y-intercept**.

- …has a gradient of 2 and **y-intercept of 3**
- …has a gradient of 2 and **crosses the y-axis at 3**
- …has a gradient of 2 and **goes through $(0, 3)$**
- …has a gradient of 2 and **$y = 3$ when $x = 0$**
- …has a gradient of 2 and **goes through $(1, 5)$**
- …has a gradient of 2 and **goes through $(-1, 1)$**
- …has a gradient of 2 and **goes through $(-2, -1)$**
- …has a gradient of 2 and **goes through $(17, 37)$**

Equation

$\boldsymbol{y = 2x + 3}$

Let us look at more abstract ways to present information about the line.

- …goes through $(2,7)$ and $(6,15)$
- …goes through $(-4,-5)$ and $(6,15)$
- …goes through $(-4,-5)$ and $(-10,-17)$
- …goes through $(0,3)$, (a,b) and $(a+3,b+6)$
- …goes through $(4,7)$, $(a-2,b+1)$ and $(a+1,b+7)$

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

Fluency Practice

Question 1: Write down the gradient of each of these lines.

(a) y = 3x + 1 (b) y = 2x − 5 (c) y = 7x + 4 (d) y = 10x + 5

(e) y = x − 2 (f) y = 6x (g) y = −4x + 3 (h) y = −3x − 7

(i) $y = \frac{1}{2}x + 3$ (j) $y = -\frac{4}{5}x - 9$

Question 2: Write down where each of these lines cross the y-axis (y-intercept)

(a) y = 2x + 3 (b) y = 7x + 1 (c) y = 3x − 2 (d) y = x − 5

(e) y = 2x (f) y = −4x + 6 (g) y = −5x − 3 (h) y = −3x

(i) $y = \frac{4}{3}x + \frac{2}{5}$ (j) $y = -\frac{2}{3}x - \frac{1}{2}$

Question 12: Find the gradients and the y-intercepts of each of these lines

(a) x + y = 10 (b) x − y = 4 (c) 2x + y = 6

(d) 3x − y = −1 (e) 8x + 2y + 9 = 0 (f) 5x − 2y − 4 = 0

(g) 7x = 1 − 2y (h) 15y − 6x = 8 (i) ⅔x + 2y = 5

(j) ⅕y − ½x = 1 (k) ⅔x + ¾y = 1½

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

Discussion

What about the equation of a straight line with gradient ∞?

Fluency Practice

Question 3: Write down the equation of the lines below

(a) gradient of 3 and y–intercept of 6

(b) gradient of 2 and y–intercept of –1

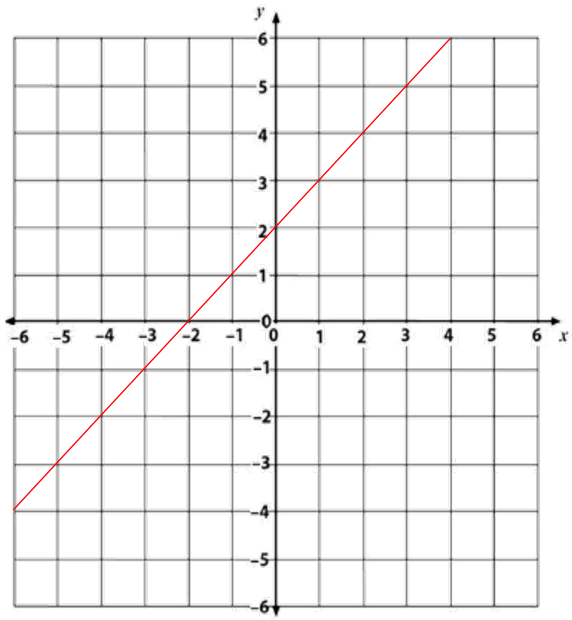
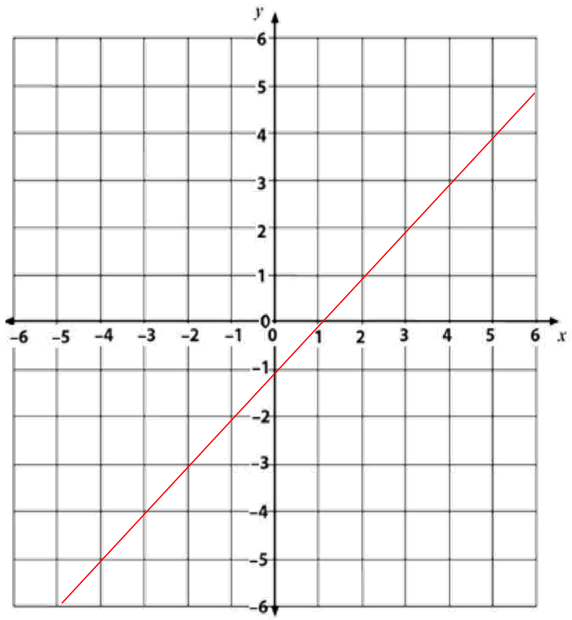
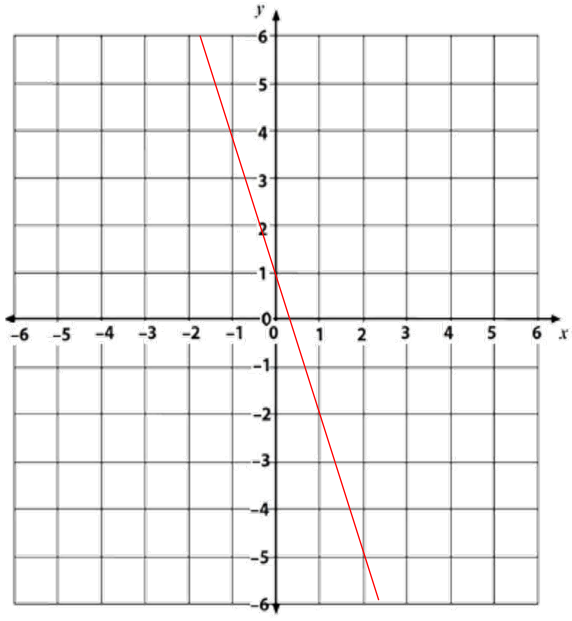
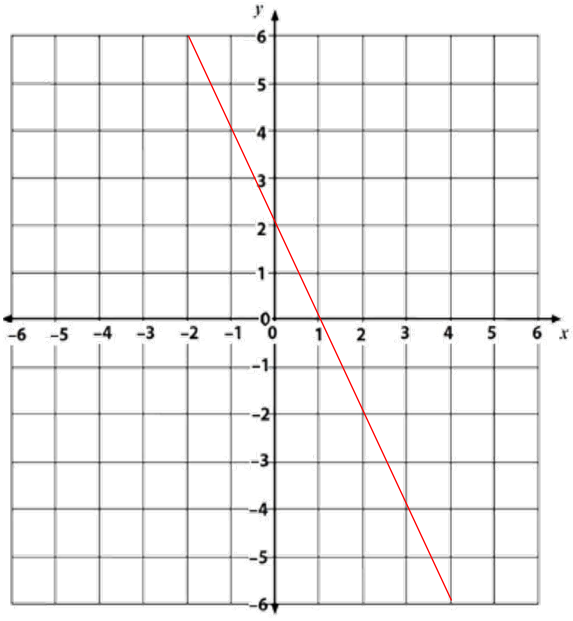
(c) gradient of –4 and y–intercept of 3

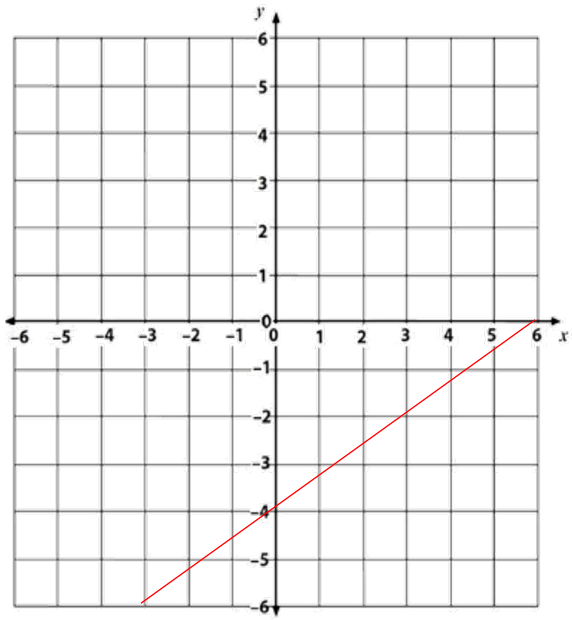
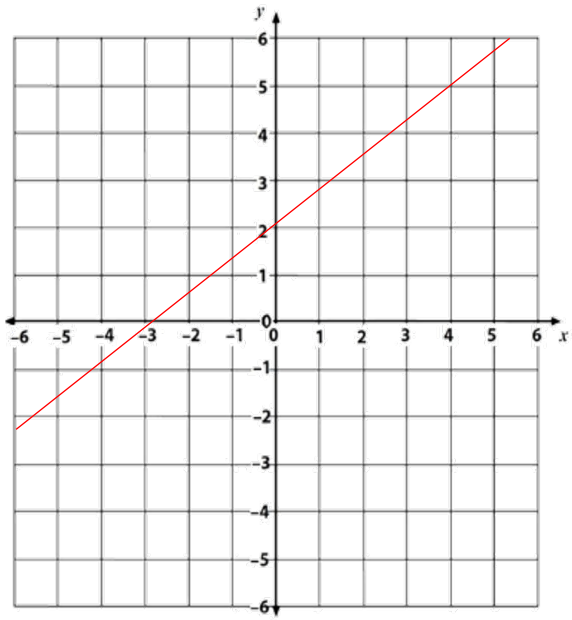
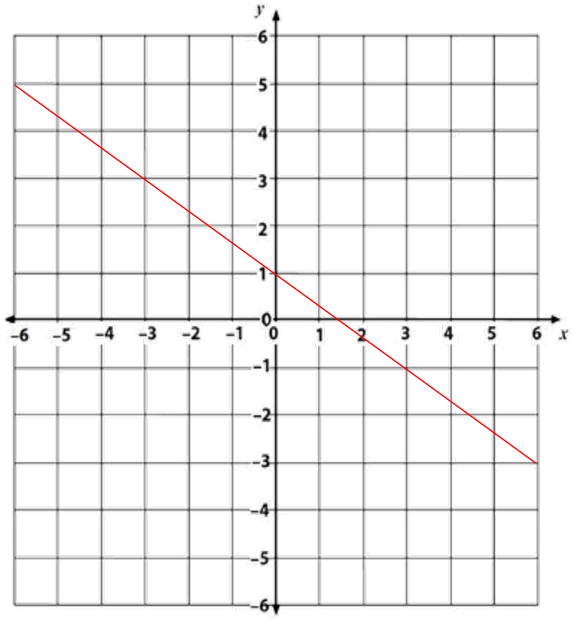
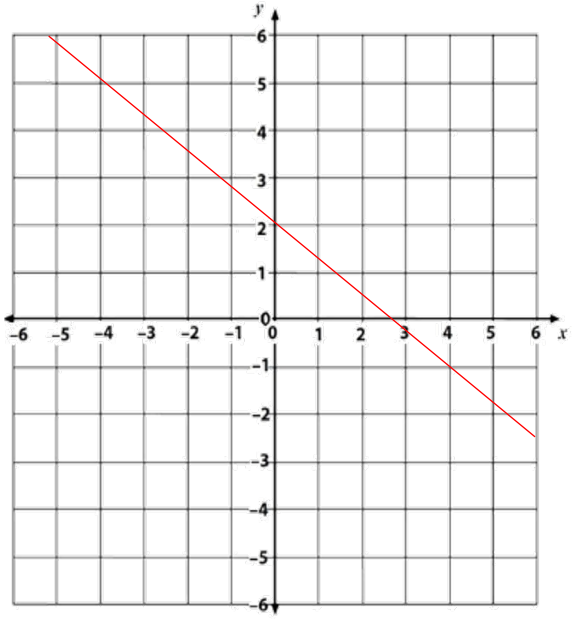
(d) gradient of 8 and y–intercept of 4

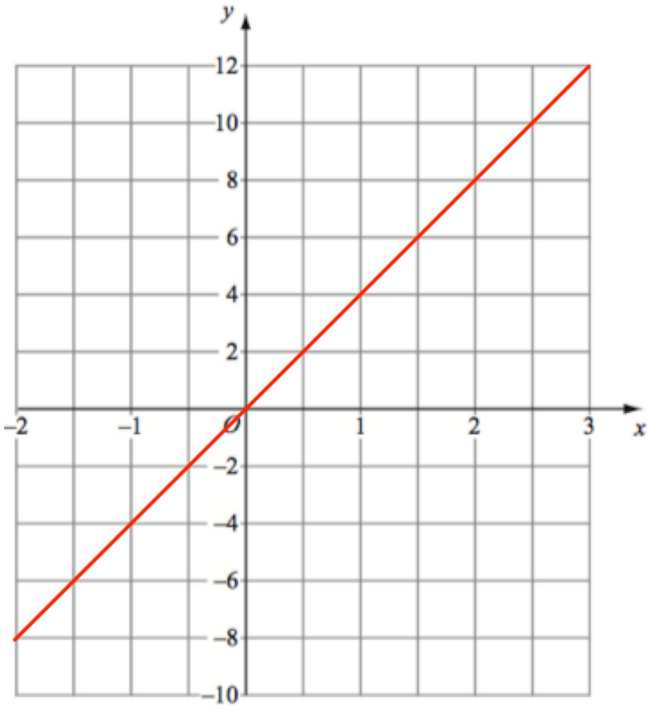
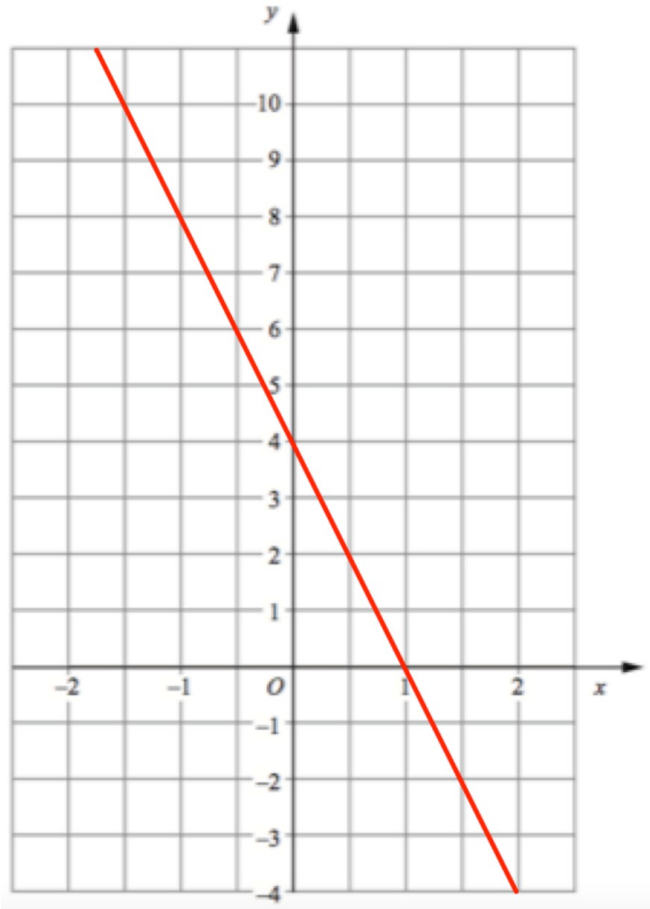
(e) gradient of 1 and passing though (0, 4)

(f) passing through (0, –2) with gradient 4

(g) gradient of –5 and passing through the origin.

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

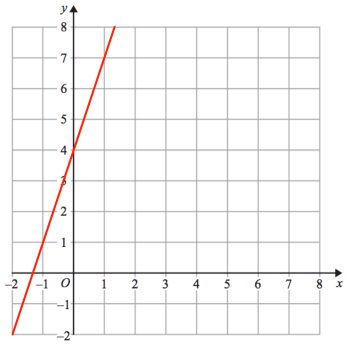
Worked Example	Your Turn
Find the equation of:	Find the equation of:
	
	

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

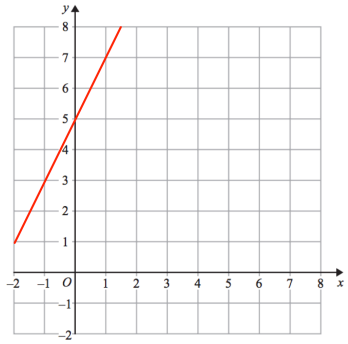
Fluency Practice

Question 5: Find the equation of each line

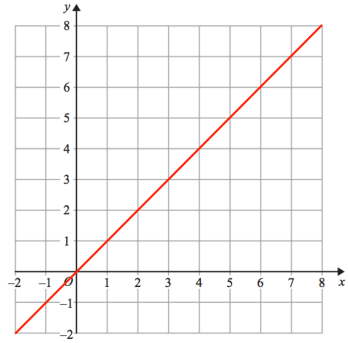
(a)



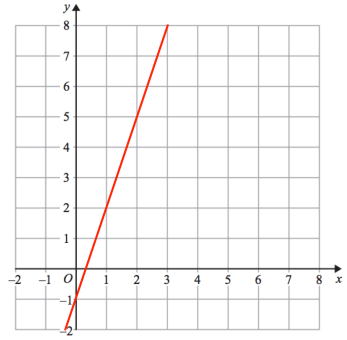
(b)



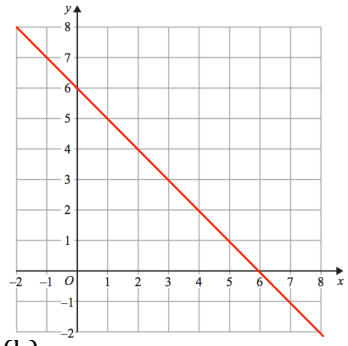
(c)



(d)



(e)



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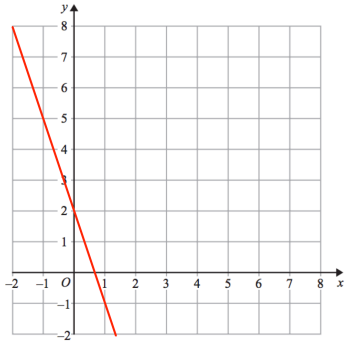
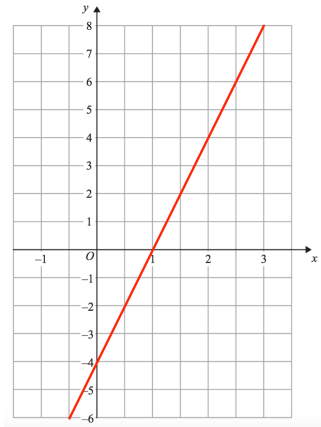
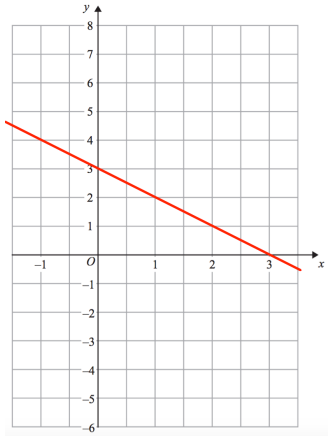


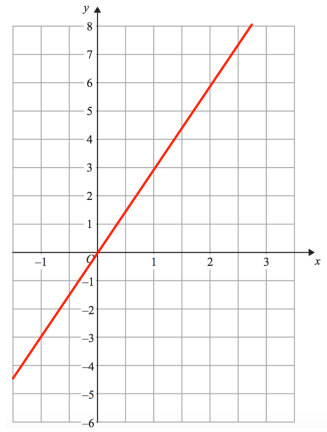
(g)



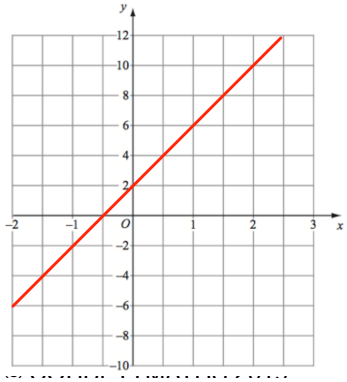
(h)



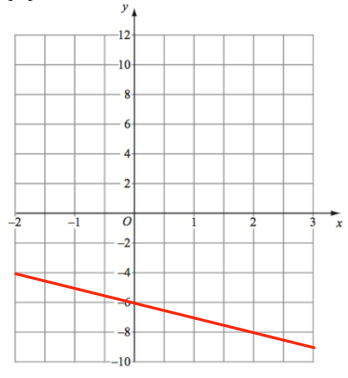
(i)



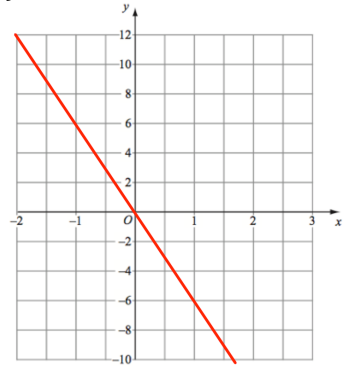
(j)



(k)



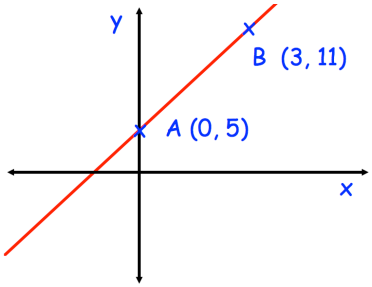
(l)



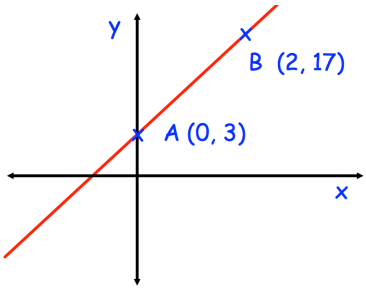
Fluency Practice

Question 6: Find the equation of each line below.

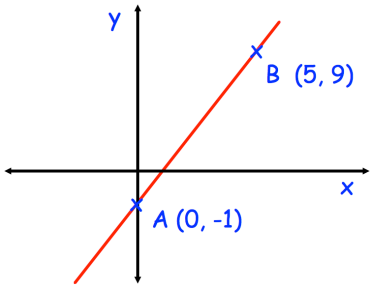
(a)



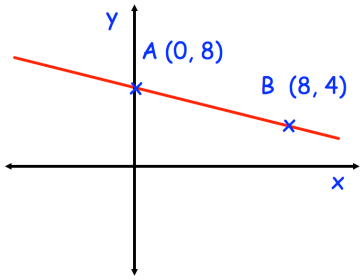
(b)



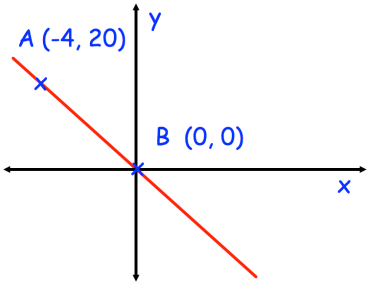
(c)



(d)



(e)



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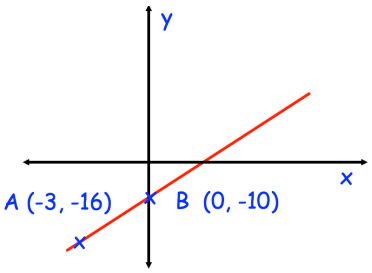


Question 7: Find the equation of the straight line that passes through the points

(a) (0, 3) and (4, 19)

(b) (0, 2) and (6, 20)

(c) (0, 0) and (1, 4)

(d) (0, −9) and (9, 0)

(e) (0, −6) and (7, 8)

(f) (−8, −10) and (0, 14)

(g) (0, 2) and (10, 7)

(h) (−4, 1) and (0, 7)

(i) (−4, 0) and (0, 18)

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

Fluency Practice

Question 8: Find the equation of the straight line that:

(a) has a gradient of 4 and passes through the point (1, 10)

(b) has a gradient of 2 and passes through the point (−3, 3)

(c) has a gradient of 1 and passes through the point (5, 2)

(d) has a gradient of −3 and passes through the point (−2, 8)

(e) has a gradient of −5 and passes through the point (3, −1)

(f) has a gradient of ½ and passes through the point (4, 5)

(g) has a gradient of ⅖ and passes through the point (−5, −5)

(h) has a gradient of −⅔ and passes through the point (9, 15)

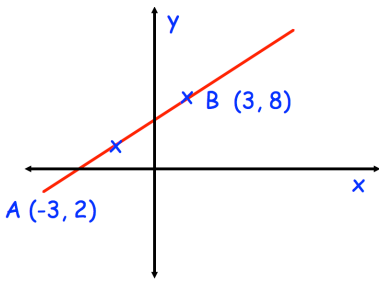
Worked Example	Your Turn
Write the equation of the line in the form $y = mx + c$ which passes through the points $(2, 3)$ and $(5, -9)$	Write the equation of the line in the form $y = mx + c$ which passes through the points $(3, 10)$ and $(-5, 18)$

Worked Example	Your Turn
Write the equation of the line in the form $y = mx + c$ which passes through the points $(2, -3)$ and $(7, -5)$	Write the equation of the line in the form $y = mx + c$ which passes through the points $(3, -2)$ and $(-7, 5)$

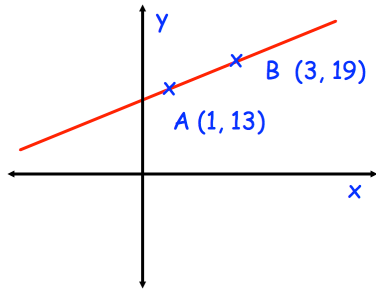
Fluency Practice

Question 9: Find the equations of the lines below

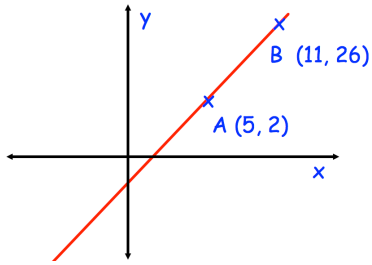
(a)



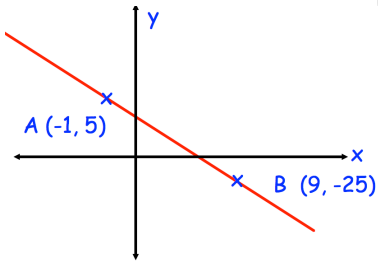
(b)



(c)



(d)



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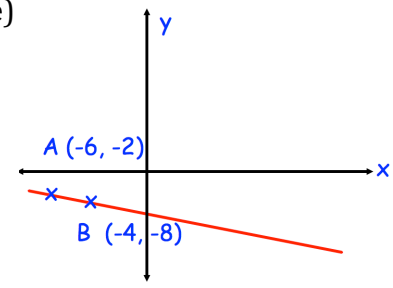
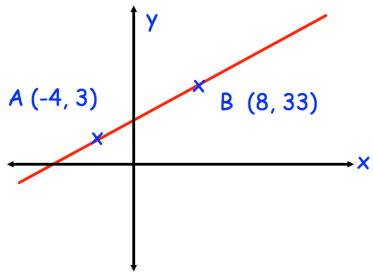


(f)



Question 10: Find the equation of the straight line that passes through these pairs of points

(a) (2, 5) and (4, 11)

(b) (−4, 2) and (1, 7)

(c) (−5, −8) and (−4, −4)

(d) (−1, −2) and (−6, 3)

(e) (−6, −4) and (−3, 2)

(f) (3, 5) and (4, 1)

(g) (−5, 4) and (5, 2)

(h) (1, 6) and (5, 4)

(i) (−10, −5) and (−7, 4)

Worked Example

Find where the line intercepts the axes:

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

Your Turn

Find where the line intercepts the axes:

Line	x-intercept	y-intercept
$y = 4x + 5$		
$y = 5x + 4$		
$y = 5x - 4$		
$y = 4x - 5$		
$y = 5 - 4x$		
$y = 4 - 5x$		
$4x + 5y = 20$		
$5x + 4y = 20$		
$ax + by = c$		

Fluency Practice

Question 11: Find the coordinates where the following lines cross the x-axis

(a) $y = 2x + 6$

(b) $y = -x + 4$

(c) $y = 3x + 9$

(d) $y = x - 5$

(e) $y = 4x + 1$

(f) $y = -2x + 10$

(g) $y = -4x - 10$

(h) $y = 5x + 3$

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

(j) $x + y = 8$

(k) $4x + 2y + 7 = 0$

(l) $3x + 2y - 8 = 0$

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

Fluency Practice

Question 4:

(a) Does the point (2, 5) lie on the line $y = 3x - 1$?

(b) Does the point (4, 1) lie on the line $y = 3x + 1$?

(c) Does the point (3, 1) lie on the line $y = x - 3$?

(d) Does the point (5, 7) lie on the line $y = -3x + 22$?

(e) Does the point $(-4, -8)$ lie on the line $y = -2x$?

(f) Does the point $(-1, 8)$ lie on the line $y = 2x + 11$?

(g) Does the point (12, 60) lie on the line $y = 7x - 18$?

Extension

Question 1: The point (5, −2) lies on which lines below

Line A $y = x + 7$

Line B $y = -3x + 13$

Line C $y = 4x - 18$

Line D $y = -2x - 8$

Line E $y = 2x - 12$

Question 2: Do the points (1, 4), (4, 10) and (9, 20) lie in a straight line?

Question 3: A line has equation y = 2x + 6
The line crosses the x−axis at the point A
The line crosses the y−axis at the point B
The point C has coordinates (1, 8)

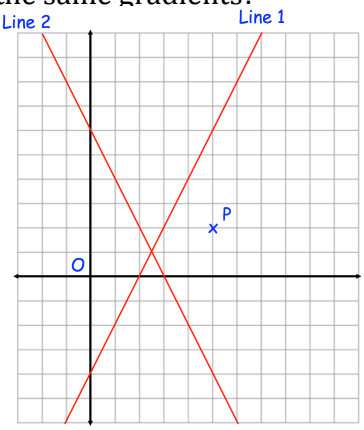
(a) Find the coordinates of the point A
(b) Find the coordinates of the point B
(c) Find the equation of the straight line passing through the points A and C.

Question 4: Do the lines y = 3x + 1 and 4x − 2y + 3 = 0 have the same gradients?

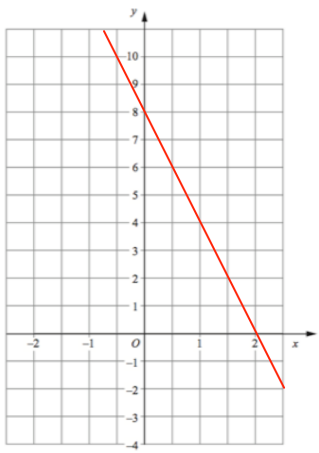
Question 5: Line 1 has equation y = 3x − 12

(a) Find the coordinates of P

(b) Find the equation of Line 2



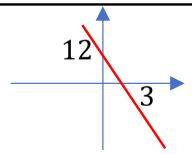
Question 6: Lexi says the line below has an equation of y = −2x +8
Explain her mistake.



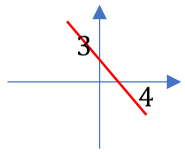
3.6 Review and Problem Solving

Worked Example	Your Turn
$y = 5x + 10$ $ax + by = d$ Gradient: x intercept: y intercept: Sketch:	$y = 5x + 15$ $ax + by = d$ Gradient: x intercept: y intercept: Sketch:

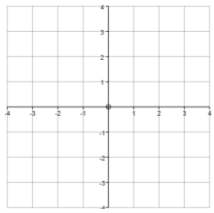
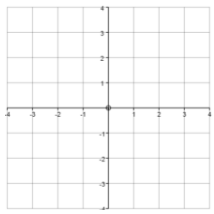
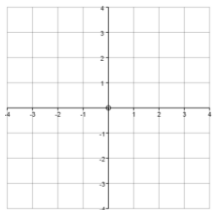
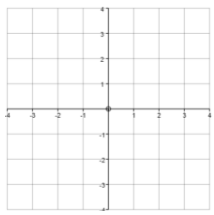
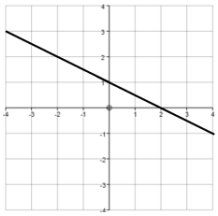
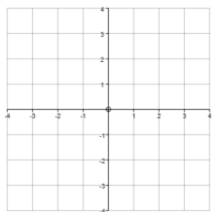
Fill in the Gaps

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

Fill in the Gaps

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

Fill in the Blanks

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

Maths Venns

y-intercept is positive
If you think a region is impossible to fill, convince me why!
x-intercept is an integer
Positive gradient
A
B
C
D
E
F
G
H
Write the equation of a line that could belong in each of the regions

Maths Venns

x-intercept is negative
If you think a region is impossible to fill, convince me why!
y-intercept is positive
Positive gradient
Write the equation of a line that could belong in each of the regions
A
B
C
D
E
F
G
H

Maths Venns

Passes through (6, 9)
If you think a region is impossible to fill, convince me why!
Passes through (−2, 13)
Passes through (2, 1)
Write the equation of a line that could belong in each of the regions
A
B
C
D
E
F
G
H