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These workbooks have been developed for the children of South Africa under the leadership of the Minister of Basic Education, Mrs Angie Motshekga, and the Deputy Minister of Basic Education, Mr Enver Surty.

The Rainbow Workbooks form part of the Department of Basic Education's range of interventions aimed at improving the performance of South African learners in the first six grades. As one of the priorities of the Government's Plan of Action, this project has been made possible by the generous funding of the National Treasury. This has enabled the Department to make these workbooks, in all the official languages, available at no cost.

We hope that teachers will find these workbooks useful in their everyday teaching and in ensuring that their learners cover the curriculum. We have taken care to guide the teacher through each of the activities by the inclusion of icons that indicate what it is that the learner should do.

We sincerely hope that children will enjoy working through the book as they grow and learn, and that you, the teacher, will share their pleasure.

We wish you and your learners every success in using these workbooks.

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**MATHEMATICS IN ENGLISH
GRADE 9 – BOOK 2
TERMS 3 & 4**
ISBN 978-1-4315-0228-8
**THIS BOOK MAY
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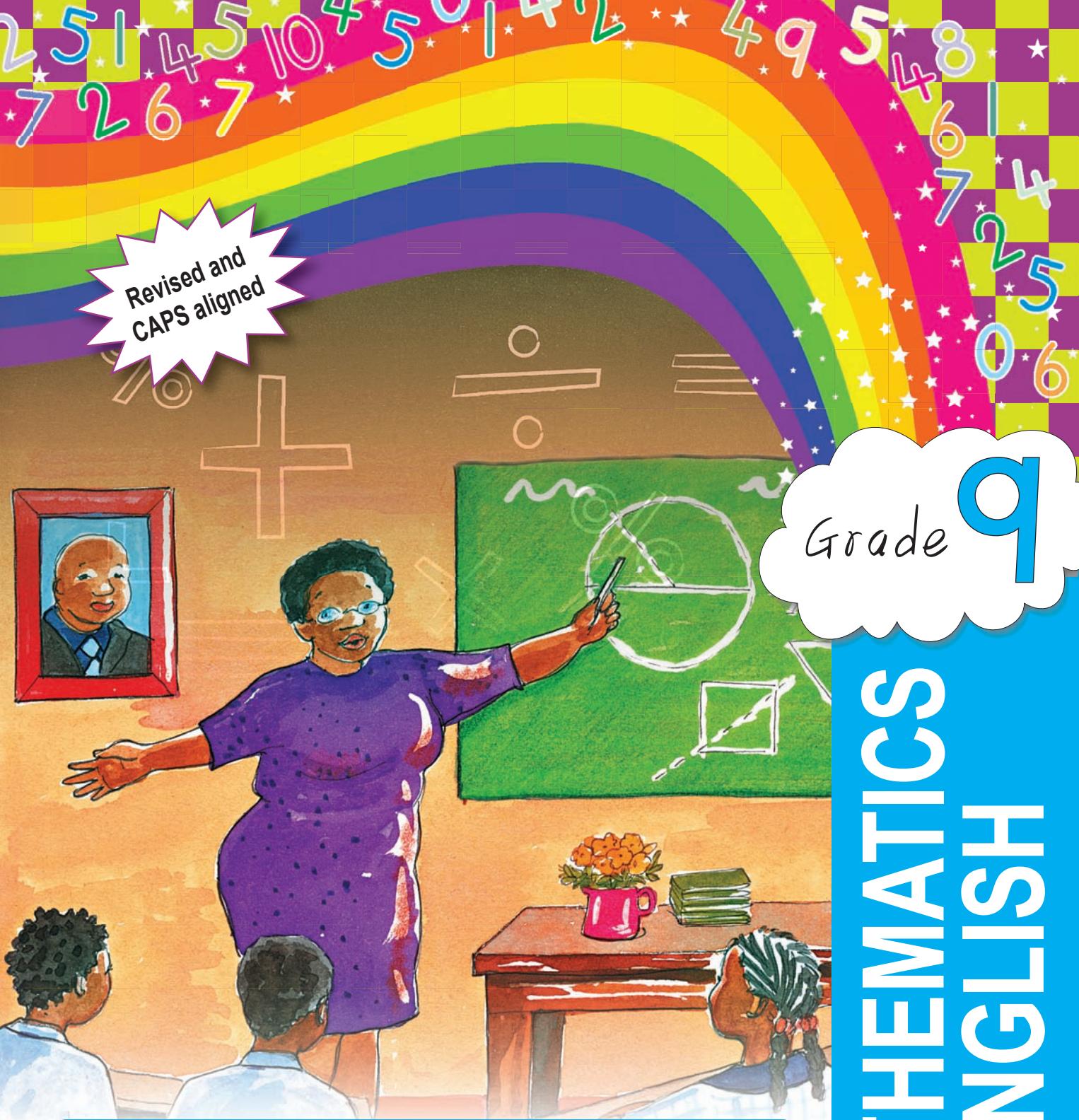
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MATHEMATICS IN ENGLISH – Grade 9 Book 2

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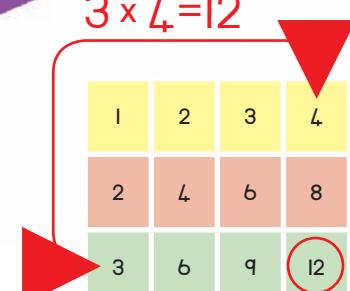
MATHEMATICS IN ENGLISH
Book 2
TERMS
3 & 4

Contents

No.	Title	Pg.
65	Number patterns	2
66	Number sequences	4
67	More number sequences	6
68	Geometric patterns	8
69	Number sequences and equations	10
70	Algebraic expressions	12
71	Operations with algebraic expressions	14
72a	The product of a monomial and polynomial	16
72b	The product of a monomial and polynomial (continued)	18
73a	The product of two binomials	20
73b	The product of two binomials (continued)	22
73c	The product of two binomials (continued)	24
73d	The product of two binomials (continued)	26
74	Divide a trinomial and polynomial by a monomial	28
75a	Algebraic expressions and substitution	30
75b	Algebraic expressions and substitution (continued)	32
76	Factorise algebraic expressions	34
77	Factorise algebraic expressions	36
78	Factorise more algebraic expressions	38
79	Factorise more algebraic expressions	40
80	Factorise even more algebraic expressions	42
81	More algebraic equations	44
82	Even more algebraic equations	46
83	More and more algebraic equations	48
84	Algebraic equations and volume	50
85	Algebraic equations: Substitutions	52
86a	Using algebraic equations to solve practical problems	54
86b	Using algebraic equations to solve practical problems (continued)	56
87	Some more algebraic expressions	58
88a	Interpreting graphs	60
88b	Interpreting graphs (continued)	62
89	x-intercept and y-intercept	64
90a	Interpreting graphs: gradient	66
90b	Interpreting graphs: gradient (continued)	68
91	Use tables of ordered pairs	70
92	More graphs	72
93	Yet more graphs	74
94	Yet more graphs	76
95	Sketch and compare graphs	78
96a	Compare and sketch graphs	80
96b	Compare and sketch graphs (continued)	82
97	Graphs	84
98	More graphs	86
99a	Graphs	88
99b	Graphs (continued)	90
100a	Surface area, volume and capacity of a cube	92
100b	Surface area, volume and capacity of a cube (continued)	94
101	Surface area, volume and capacity of a rectangular prism	96
102	Surface area, volume and capacity of a hexagonal prism	98
103a	Surface area, volume and capacity of a triangular prism	100
103b	Surface area, volume and capacity of a triangular prism (continued)	102
104a	Surface area, volume and capacity of a cylinder	104
104b	Surface area, volume and capacity of a cylinder (continued)	106
105	Reflecting over axes	108
106	Reflecting over lines	110
107	Reflecting over any line	112

No.	Title	Pg.
I08	Rotations	114
I09	Translation	116
I10	Transformation	118
I11a	More transformations	120
I11b	More transformations (continued)	122
I12a	Enlargement and reduction	124
I12b	Enlargement and reduction (continued)	129
I13a	More enlargement and reduction	128
I13b	More enlargement and reduction (continued)	130
I14	Polyhedra	132
I15	Polyhedra and non-polyhedra	134
I16	Regular and non-regular polyhedra and non-polyhedra	136
I17	Polyhedra and non-polyhedra all around us	138
I18	Visualise geometric objects	140
I19	Geometric solid game	142
I20a	Perspective	144
I20b	Perspective (continued)	146
I20c	Perspective (continued)	148
I21a	Constructing nets	150
I21b	Constructing nets (continued)	152
I22a	More constructing nets	154
I22b	More constructing nets (continued)	156
I22c	More constructing nets (continued)	158
I23a	Data collection	160
I23b	Data collection (continued)	162
I24a	Organise data	164
I24b	Data collection (continued)	166
I25a	Summarise data	168
I25b	Summarise data (continued)	170
I26a	Bar graphs	172
I26b	Bar graphs (continued)	174
I27a	More bar graphs	176
I27b	More bar graphs (continued)	178
I28a	Histograms	180
I28b	Histograms (continued)	182
I29a	More on histograms	184
I29b	More on histograms (continued)	186
I30a	Pie charts	188
I30b	Pie charts (continued)	190
I31a	Broken line graph	192
I31b	Broken line graph (continued)	194
I32a	Scatter plots	196
I32b	Scatter plots (continued)	198
I33	Select the right graph	200
I34a	Report data	202
I34b	Report data (continued)	204
I35	Data handling cycle	206
I36	More of the data handling cycle	208
I37a	Another data handling cycle	210
I37b	Another data handling cycle (continued)	212
I38	Probability of a single event and its relative frequency	214
I39a	Fundamental counting principle	216
I39b	Fundamental counting principle (continued)	218
I40	Probability of compound independent events	220
I41	Probability of dependent events	222
I42	Probability of compound mutually exclusive events	224
I43	Probability of compound mutually inclusive events	226
I44	Revision sheet	228

$3 \times 4 = 12$



Multiplication table

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40
3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
4	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80
5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120
7	14	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140
8	16	24	32	40	48	56	64	72	80	88	96	104	112	120	128	136	144	152	160
9	18	27	36	45	54	63	72	81	90	99	108	117	126	135	144	153	162	171	180
10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
11	22	33	44	55	66	77	88	99	110	121	132	143	154	165	176	187	198	209	220
12	24	36	48	60	72	84	96	108	120	132	144	156	168	180	192	204	216	228	240
13	26	39	52	65	78	91	104	117	130	143	156	169	182	195	208	221	234	247	260
14	28	42	56	70	84	98	112	126	140	154	168	182	196	210	224	238	252	266	280
15	30	45	60	75	90	105	120	135	150	165	180	195	210	225	240	255	270	285	300
16	32	48	64	80	96	112	128	144	160	176	192	208	224	240	256	272	288	304	320
17	34	51	68	85	102	119	136	153	170	187	204	221	238	255	272	289	306	323	340
18	36	54	72	90	108	126	144	162	180	198	216	234	252	270	288	306	324	342	360
19	38	57	76	95	114	133	152	171	190	209	228	247	266	285	304	323	342	361	380
20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340	360	380	400

Multiplication table



Grade

9

Mathematics

PART
3

WORKSHEETS
65 to 144

Name:

Book

2

ENGLISH

Number patterns

Give a **rule** to describe the **constant difference** between consecutive value of term in order to extend the pattern.

$-1; -1,5; -2; -2,5; \dots$

"adding $-0,5$ "

"counting in $-0,5$ "

"adding $-0,5$ to the previous number in the pattern."

Give a **rule** to describe the **constant ratio** between consecutive terms.

$2; -1; 0,5; -0,25; 0,125; \dots$

"multiplying the previous number by $-0,5$ "

Describe the pattern that has **neither a constant difference** nor a **constant ratio**.

$1, 0, -2, -5, -9, -14$

"subtracting by one more than what was subtracted to get the previous term"

Using this rule, the next three terms will be $-20, -27, -35$.

1. Describe the pattern by giving the rule and then extend it by three value of term.

a. $36, 43, 50, 57, \dots$

b. $29, 17, 5, -7, \dots$

c. $63, 45, 27, 9, \dots$

d. $59, 60, 61, 62, \dots$

e. $18, 43, 68, 93, \dots$

f. $48, 61, 74, 87, \dots$

g. $1, 8, 27, 64, \dots$

h. $1, 4, 16, 25, \dots$

i. $36, 19, 2, -15, \dots$

j. $22, -16, -54, -92, \dots$

2. Describe the pattern by giving the rule and then extend it by three value of term.

a. $6, -12, 24, -48, \dots$

b. $-17, -102, -612, -3\,672, \dots$

c. 16, 112, 784, 5 488, ...

d. 28, 140, 700, 3 500, ...

e. 25, 75, 225, 675, ...

f. 52, -208, 832, -3 328, ...

g. 37, 333, 2 997, 26 973, ...

h. -39, -156, -624, -2 496, ...

i. 43, -129, 387, -1 161, ...

j. 49, 294, 1 764, 10 584, ...

3. Describe the pattern by giving the rule and then extend it by three value of value of term.

a. 66, 58, 51, 45, ...

b. 32, 38, 31, 39, ...

c. 25, 34, 46, 61, ...

d. 72, 55, 37, 18, ...

e. 14, 28, 84, 336, ...

f. 16, 32, 128, 1 024, ...

g. 21, 23, 19, 25, ...

h. 87, -3, 77, 7, 67, ...

i. 27, 38, 50, 63, ...

j. 44, 66, 132, 330, ...

Problem solving

Create your own sequences as follows:

- Constant difference between the consecutive value of term
- Constant ratio between the consecutive value of term
- Neither a constant difference nor a constant ratio



Sign:

Date:

Number sequences

Look at the example. Determine the 10th term.

n (Position in sequence)	1	2	3	4	10	n
Value of term	-3	-7	-11	-14	-39	

Number sentences

First term: $-4(1) + 1 = -3$

The difference between the terms is -4.

Second term: $-4(2) + 1 = -7$

" n " is any natural number.

Third term: $-4(3) + 1 = -11$

Fourth term: $-4(4) + 1 = -14$

Tenth term: $-4(10) + 1 = -39$

n^{th} term: $-4(n) + 1$

1. Determine the tenth and n^{th} terms using a table and number sentence.

a. n^{th} term is:

n (Position in sequence)	1	2	3	4	10	n
Value of term	13	23	33	43		

b. n^{th} term is:

n (Position in sequence)	1	2	3	4	10	n
Value of term	11	17	23	29		

c. n^{th} term is:

n (Position in sequence)	1	2	3	4	10	n
Value of term	17	20	23	26		

d. n^{th} term is:

n (Position in sequence)	1	2	3	4	10	n
Value of term	-16	-23	-30	-37		

e. n^{th} term is:

n (Position in sequence)	1	2	3	4	10	n
Value of term	-3	6	15	24		

f. n^{th} term is:

n (Position in sequence)	1	2	3	4	10	n
Value of term	13	17	21	25		

g. n^{th} term is:

n (Position in sequence)	1	2	3	4	10	n
Value of term	-6	10	26	42		

2. Make notes on how you solved the sequences.

[Large empty box for notes]

Problem solving

Determine the tenth and n^{th} terms using a table and a number sentence.

n^{th} term is:

n (Position in sequence)	3	6	9	10	12	n
Value of term	13	40	85	?	148	?

n^{th} term is:

n (Position in sequence)	18	12	10	6	n
Value of term	5 815	1 711	?	199	?



Sign: _____
Date: _____

More number sequences



Give the next three terms

$$2^2; 3^2; 4^2; 5^2; \dots$$

$$\sqrt{4}; \sqrt{9}; \sqrt{16}; \sqrt{25}; \dots$$

$$2^3; 3^3; 4^3; 5^3; \dots$$

$$\sqrt[3]{8}; \sqrt[3]{27}; \sqrt[3]{64}; \sqrt[3]{125}; \dots$$



1. Complete the tables.

Example:

n (Position in sequence)	1	2	3	4	10	n
Value of term	2	5	10	17	?	?

The bottom row of terms for each position in sequence (n) is obtained by using the formula or rule:
square the position number (n) in the top row and add 1 = $n^2 + 1$.

First term: $2 = (1)^2 + 1$

Second term: $5 = (2)^2 + 1$

Third term: $10 = (3)^2 + 1$

Fourth term: $17 = (4)^2 + 1$

Tenth term: $101 = (10)^2 + 1$

n^{th} term : $= n^2 + 1$

a.

n (Position in sequence)	3	4	5	6	10	n
Value of term	7	14	23	34	?	?

Third term: $7 = \underline{\hspace{2cm}}$

Fourth term: $14 = \underline{\hspace{2cm}}$

Fifth term: $23 = \underline{\hspace{2cm}}$

Sixth term: $34 = \underline{\hspace{2cm}}$

Tenth term: $\underline{\hspace{2cm}} = \underline{\hspace{2cm}}$

n^{th} term: $\underline{\hspace{2cm}} = \underline{\hspace{2cm}}$

Make notes on how you solved the sequences

b.

n (Position in sequence)	2	4	6	8	10	n
Value of term	11	67	219	515	?	?

Second term: 11 = _____

Fourth term: 67 = _____

Sixth term: 219 = _____

Eighth term: 515 = _____

Tenth term: ____ = _____

n^{th} term: ____ = _____

c.

n (Position in sequence)	-5	0	5	10	15	n
Value of term	$-10\frac{1}{2}$	$\frac{1}{2}$?	$19\frac{1}{2}$	$29\frac{1}{2}$?

Minus Fifth term: $-10\frac{1}{2}$ = _____

Zero term: $\frac{1}{2}$ = _____

Fifth term: ____ = _____

Tenth term: $19\frac{1}{2}$ = _____

Fifteenth term: $29\frac{1}{2}$ = _____

n^{th} term: ____ = _____

d.

n (Position in sequence)	2	4	6	8	10	n
Value of term	8	?	216	512	?	?

Second term: 8 = _____

Fourth term: ____ = _____

Sixth term: 216 = _____

Eighth term: 512 = _____

Tenth term: ____ = _____

n^{th} term: ____ = _____

e.

n (Position in sequence)	1	2	4	8	10	n
Value of term	2	5	17	65	?	?

First term: 2 = _____

Second term: 5 = _____

Fourth term: 17 = _____

Eighth term: 65 = _____

Tenth term: ____ = _____

n^{th} term: ____ = _____

Sharing

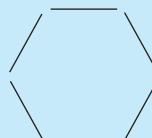
Share your answers with a friend. Do you have the same rules for the n^{th} value of term?



Sign: _____

Date: _____

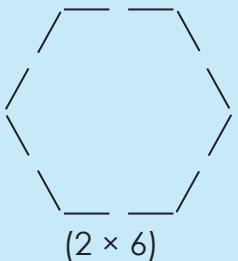
Geometric patterns



(1×6)

What will the next pattern be?

The rule: add one section to each side.



(2×6)

How will you determine the next pattern?

n (Position in sequence)	1	2	3	4	5	10	n
Value of term	6	12	18	24	30	60	?

First term: $6(1) = 6$

Second term: $6(2) = 12$

Third term: $6(3) = 18$

Fourth term: $6(4) = 24$

Fifth term: $6(5) = 30$

Tenth term: $6(10) = 60$

n^{th} term: $6(n) = 6n$

1. Do the following: (You may need to use a separate sheet of paper.)

- Draw the first four terms in each of the following geometric patterns.
- Write them in a table determining the first, second, third, fourth, tenth and n^{th} terms.
- Write number sentences for each table.

a. Heptagon

i.

ii.

iii.

b. Pentadecagon

i.

ii.

iii.

c. Icosagon

i.

ii.

iii.

Sharing

Do the same with an icosekaipentagon.



Sign: _____
Date: _____

Number sequences and equations

Look at the example. Discuss. What will the 10th term be?

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

x	-2	-1	0	1	2	5	10
y	$-5\frac{3}{4}$	$-2\frac{3}{4}$	$\frac{1}{4}$	$3\frac{1}{4}$	$6\frac{1}{4}$	$15\frac{1}{4}$	

$$\begin{array}{llllll} y = 3(-2) + \frac{1}{4} & y = 3(-1) + \frac{1}{4} & y = 3(0) + \frac{1}{4} & y = 3(1) + \frac{1}{4} & y = 3(2) + \frac{1}{4} & y = 3(5) + \frac{1}{4} \\ y = -6 + \frac{1}{4} & y = -3 + \frac{1}{4} & y = 0 + \frac{1}{4} & y = 3 + \frac{1}{4} & y = 6 + \frac{1}{4} & y = 15 + \frac{1}{4} \\ y = -5\frac{3}{4} & y = -2\frac{3}{4} & y = \frac{1}{4} & y = 3\frac{1}{4} & y = 6\frac{1}{4} & y = 15\frac{1}{4} \end{array}$$

1. Complete the tables using the equations.

a.

x	-2	-1	0	1	2	5	10
y							

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

b.

x	-2	-1	0	1	2	10	50
y							

$$y = x^2 - 1$$

c.

x	-3	-2	-1	0	1	13	25
y							

$$y = x^3 - 2$$



d.

x	0	2	3	50	75	100
y						

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



e.

x	1	3	5	7	27	47
y						

$$y = -4x - 3$$



2. Complete the tables. What is the value of m and n?

a.

x	-2	-1	0	1	2	5	n
y						m	

$$y = x^2 - \frac{1}{4}$$

c.

x	-3	5	13	21	29	37	n
y					m		

$$y = 2x^2 + \frac{1}{4}$$

b.

x	1	2	3	4	n	6	7
y				m			

$$y = -x - 4$$

d.

x	3	6	9	n	15	21	24
y						m	

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

How did you solve for m?

Describe in your own words how you solved for m.



Sign: _____

Date: _____

Variables: a number that can have different values as compared to a constant that has a fixed value.

b, x, p, z, y and c are variables.

$$7b$$

$$\frac{x}{4}$$

$$13z$$

$$4c$$

$$-\frac{4}{p}$$

$$\sqrt{y}$$

Constant: a constant is a number on its own whose value does not change.

-1, 5, 4 and $\frac{1}{2}$ are constants, as their values do not change.

$$-1$$

$$5$$

$$4$$

$$\frac{1}{2}$$

Coefficient: a constant attached to the front of a variable or group of variables. The variable is multiplied by the coefficient.

Here are examples of a coefficient.

In $4x + 3y$ there are two terms, $4x$ and $3y$, and the coefficient of x in $4x$ is 4 and the coefficient of y in $3y$ is 3.

Algebraic expression: a collection of quantities made up of constants and variables joined by the four fundamental operations.

Here are some examples of algebraic expressions.

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

$$x + 4$$

$$\frac{z}{4}$$

$$3z + 6$$

$$y - 3$$

Term: parts of an algebraic expression linked to each other by the + or - symbols.

Expressions with one term.

$$3x$$

$$\frac{x}{3}$$

Expressions with two terms.

$$3x + y$$

$$4x^2 + 3$$

Expressions with three terms.

$$x - 3y + 3$$

Monomial: an algebraic expression that has only one term, for example:

$$4x$$

Binomial: an algebraic expression that has two terms, for example:

$$4x - 3y$$

Trinomial: an algebraic expression that has three terms, for example:

$$2x - 3y + z$$

1. Identify the variables, constants and coefficients in the following.

a. $5x^2$

x is a variable, 5 is a constant and also a coefficient.

c. $\frac{x^2}{4}$

e. $9x^2 + 5$

g. $100xy + x$

b. $2x^2 + 4x$

d. $\frac{x^2}{4x^4}$

f. $xy^2 + x$

h. $4x^2 + 2x + 3$

i. $\frac{9x^2 + 4}{7x}$

j. $\frac{6x^2 + 4x + 3}{2x^2}$

2. Write down the terms and coefficients of the variables in the following algebraic expressions:

a. $3x^2 - 4y$

b. $\frac{2}{3}x + y$

c. $3x + 4y - \frac{5}{2}y$

d. $x^2 + 2xy + y^2$

e. $\frac{x}{7} - \frac{8}{y}$

3. Circle the like terms in the following algebraic expressions, and then add them together.

a. $3x^2 - 4xy + 5x^2 - 9$

$3x^2 + 5x^2 = 8x^2$

b. $xyz - 5xy + 6zx + 15xyz - 1$

c. $x^3 + y^3 - 3xy + 6yx - 4y^3$

d. $abc + bcd + cda$

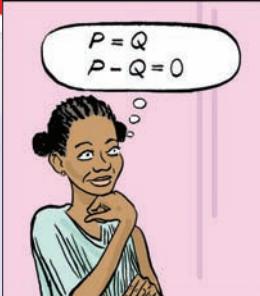
4. Give five examples of each.

Monomial

Binomial

Trinomial

Create an algebraic expression with variables, constants and using all the basic operations. Simplify the expression.



Revise

Like terms are **monomials** that contain the same variables and are raised to the same powers. They can be combined to form a single term.

$4a^2b$ and $10a^2b$ are like terms.

In the expression:

$3x^2 + 2xy - 5y^3 - 4xy + 9$, the like terms are $2xy$ and $-4xy$.

1. Add the following algebraic expressions.

Example:

Add $-3x + 4$ and $2x^2 - 7x - 2$

$$(-3x + 4) + (2x^2 - 7x - 2)$$

$$= 2x^2 + (-3x - 7x) + (4 - 2)$$

$$= 2x^2 - 10x + 2$$

a. $\frac{3}{2}x^2 + x + 1$ and $\frac{3}{7}x^2 + \frac{1}{4}x + 5$

b. $\frac{7}{5}x^3 - x^2 + 1$ and $2x^2 + x - 3$

c. $xy + \frac{z}{y} + zx$ and $3xy - \frac{z}{y}$

d. $\frac{3y}{xz} + \frac{x}{2y} + z$ and $-\frac{4y}{xz} + \frac{3x}{2y} - z$

2. Subtract the following algebraic expressions:

Example:

Subtract $2x^2 - 7x - 2$ from $-3x + 4$

$$\begin{aligned}(-3x + 4) - (2x^2 - 7x - 2) \\= -2x^2 + [-3x - (-7x)] + [(4 - (-2))] \\= -2x^2 + (-3x + 7x) + (4 + 2) \\= -2x^2 + 4x + 6\end{aligned}$$

a. $7x^3 - 3x^2 + 2$ from $x^2 - 5x + 2$

b. $\frac{x}{y} + \frac{y}{z} - 3$ from $\frac{3x}{y} - \frac{2y}{z} + 7 + x^2$

c. $ax^2 + 2hxy + by^2$ from $cx^2 + 2gxy + dy^2$

Problem solving

Create an algebraic expression with variables and constants using all the basic operations. Simplify the expression.



Sign: _____
Date: _____

The product of a monomial and polynomial

Monomials multiplied by polynomials (Applying the distributive property)

$$\begin{aligned} a(b + c) \\ = a \times b + a \times c \\ = ab + ac \end{aligned}$$

or

a	b	c
ab		ac

$$\begin{aligned} 3(a + b) \\ = (3 \times a) + (3 \times b) \\ = 3a + 3b \end{aligned}$$

or

3	a	b
3a		3b

$$\begin{aligned} x(2 + 4) \\ = (x \times 2) + (x \times 4) \\ = 2x + 4x \\ = 6x \end{aligned}$$

or

x	2	4
2x		4x

$$\begin{aligned} 2a(3a^2 - 4a + 5) \\ (2a \times 3a^2) - (2a \times 4a) + (2a \times 5) \\ = 6a^{1+2} - 8a^{1+1} + 10a \\ = 6a^3 - 8a^2 + 10a \end{aligned}$$

or

$2a$	$3a^2$	$-4a$	5
	6a ³	-8a ²	10a

$$\begin{aligned} -2a(3a^2 - 4a + 5) \\ = (-2a \times 3a^2) + (-2a \times -4a) + (-2a \times 5) \\ = -6a^{1+2} + 8a^{1+1} - 10a \\ = -6a^3 + 8a^2 - 10a \end{aligned}$$

or

$-2a$	$3a^2$	$-4a$	5
	-6a ³	8a ²	-10a

1. Revision: calculate.

Example: $2(3 + 4)$

$$\begin{aligned} &= (2 \times 3) + (2 \times 4) \\ &= 6 + 8 \\ &= 14 \end{aligned} \quad \left. \right\}$$

Both ways are correct.
Sometimes it is easier to write it in brackets.

or

$$\begin{aligned} &2(3 + 4) \\ &= 2(7) \\ &= 14 \end{aligned}$$

a. $3(6 + 9)$

b. $8(3 + 7)$

c. $5(2 + 1)$

2. Revision: Simplify.

Example: $a(b + c)$

$$\begin{aligned} &= (a \times b) + (a \times c) \\ &= ab + ac \end{aligned}$$

a. $b(c + d)$

b. $s(r + p)$

c. $z(e + c)$

3. Revision: Simplify.

Example: $3(a + b)$

$$\begin{aligned} &= (3 \times a) + (3 \times b) \\ &= 3a + 3b \end{aligned}$$

a. $7(b + c)$

b. $8(p + q)$

c. $4(x + y)$



Sign: _____
Date: _____

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The product of a monomial and polynomial continued

4. Revision: Simplify.

Example: $x(2 + 4)$ or $x(2 + 4)$

$$\begin{aligned}
 &= (x \times 2) + (x \times 4) && = x(6) \\
 &= 2x + 4x && = 6x \\
 &= 6x
 \end{aligned}$$

a. $x(6 + 3)$

b. $m(9 + 2)$

c. $y(5 + 7)$

5. Simplify.

Example: $2x(3x^2 - 4x + 5)$

$$\begin{aligned}
 &= 6x^{1+2} - 8x^{1+1} + 10x \\
 &= 6x^3 - 8x^2 + 10x
 \end{aligned}$$

a. $2x(x^2 - 11x + 12)$

b. $2x(x^2 - x + 12)$

c. $4x(3x^2 - 9x + 15)$

6. Simplify.

Example: $-2x(3x^2 - 4x + 5)$

$$\begin{aligned}
 &= (-2x)(3x^2) + (-2x)(-4x) + (-2x)(+5) \\
 &= -6x^{1+2} - 8x^{1+1} + 10x \\
 &= -6x^3 + 8x^2 - 10x
 \end{aligned}$$

$$-2x(3x^2 - 4x + 5)$$

a. $-2x(2x^2 - x + 4)$

b. $-4x(x^2 - x + 12)$

c. $-2x(x^2 - 6x + 8)$

7. If $x = -3$, then: $4x^2 + 3x + 2 =$

a. $5x^2 + 6x + 7$

b. $9x^2 + 6x + 5$

c. $2x^2 + 7x + 6$

8. Simplify and then substitute $x = -2$

a. $2x(4x^2 + 5x + 6)$

b. $4x(x^2 - 3x + 2)$

c. $5x(x^2 + 12x + 20)$

Problem solving

The $a \times$ can be "distributed" across the $2 + 4$ into $a \times 2$ plus $a \times 4$. What did the original sum look like?

Determine the value of $x^2 - 3$ if $x = \frac{-3}{2}$.

Create your own monomial multiplied by a trinomial and simplify it.

Create your own monomial multiplied by a trinomial and simplify it using the distributive property.

Create your own trinomial and divide it by a monomial which is a factor of all three terms in the trinomial.



Sign: _____
Date: _____



The product of two binomials

$$(3 + 4)(3 + 5)$$

$$\begin{aligned} &= (3 \times 3) + (3 \times 5) + (4 \times 3) + (4 \times 5) \\ &= 9 + 15 + 12 + 20 \\ &= 56 \end{aligned}$$

or

$$\begin{aligned} &(3 + 4)(3 + 5) \\ &= 7 \times 8 \\ &= 56 \end{aligned}$$

or

	3	5
3	9	15
4	12	20

Remember:

positive number \times positive number = positive number

negative number \times negative number = positive number

positive number \times negative number = negative number

1. Multiply.

Example: $(x + 2)(x + 3)$

$$\begin{aligned} &= (x + 2)(x + 3) \\ &= (x \times x) + (x \times 3) + (2 \times x) + (2 \times 3) \\ &= x^{1+1} + 3x + 2x + 6 \\ &= x^2 + 3x + 2x + 6 \\ &= x^2 + 5x + 6 \end{aligned}$$

	x	3
x	x^2	$3x$
2	$2x$	6

a. $(x + 2)(x + 2)$

b. $(x + 3)(x + 4)$

c. $(x + 1)(x + 1)$

2. Multiply.

Example: $(x - 2)(x - 3)$

$$= \underbrace{(x - 2)}_{\text{green}} \times \underbrace{(x - 3)}_{\text{green}}$$

$$\begin{aligned} &= (x \times x) + (x \times -3) + (-2 \times x) + (-2 \times -3) \\ &= x^{1+1} - 3x - 2x + 6 \\ &= x^2 - 5x + 6 \end{aligned}$$

	x	-3
x	x^2	-3x
-2	-2x	6

a. $(x - 3)(x - 4)$

b. $(x - 5)(x - 7)$

c. $(x - 2)(x - 4)$

3. Multiply.

Example: $(x + 2)(x - 3)$

$$= \underbrace{(x + 2)}_{\text{green}} \times \underbrace{(x - 3)}_{\text{green}}$$

$$\begin{aligned} &= (x \times x) + (x \times -3) + (-2 \times x) + (-2 \times -3) \\ &= x^{1+1} - 3x + 2x - 6 \\ &= x^2 - x - 6 \end{aligned}$$

	x	-3
x	x^2	-3x
2	2x	-6



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73b

The product of two binomials continued

Term 3

a. $(x + 5)(x - 5)$

b. $(x + 2)(x - 8)$

c. $(x + 7)(x - 8)$

4. Multiply.

Example: $(x - 2)(x + 3)$

$$\begin{aligned}
 &= (x - 2) \times (x + 3) \\
 &= (x \times x) + (x \times 3) + (-2 \times x) + (-2 \times 3) \\
 &= x^{1+1} + 3x - 2x - 6 \\
 &= x^2 + x - 6
 \end{aligned}$$

	x	+3
x	x^2	$3x$
-2	$-2x$	-6

a. $(x - 4)(x + 5)$

b. $(x - 2)(x + 8)$

c. $(x - 5)(x + 4)$

5. Multiply.

Example: $(x \pm 2)^2$

$$\begin{aligned}&= (x + 2)(x + 2) \text{ and } (x - 2)(x - 2) \\&= x^2 + 2x + 2x + 4 \text{ and } x^2 - 2x - 2x + 4 \\&= x^2 + 4x + 4 \text{ and } x^2 - 4x + 4 \\&= x^2 \pm 4x + 4\end{aligned}$$

x	2
x	x^2
2	$2x$

x	-2
x	x^2
-2	$-2x$

a. $(x \pm 3)^2$

b. $(x \pm 4)^2$

c. $(x \pm 6)^2$

6. Simplify.

Example: $2(x - 3)^2$

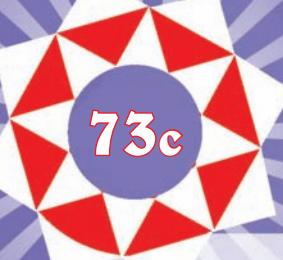
$$\begin{aligned}&= 2[(x - 3)(x - 3)] \\&= 2[x^2 - 3x - 3x + 9] \\&= 2[x^2 - 6x + 9] \\&= 2x^2 - 12x + 18\end{aligned}$$



Sign: _____

Date: _____

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The product of two binomials continued

Term 3

a. $2(x - 6)^2$

b. $6(x - 7)^2$

c. $3(x - 2)^2$

d. $-4(x - 1)^2$

e. $-7(x - 6)^2$

f. $2(x - 5)^2$

7. Revision: simplify.

Example: see previous worksheet for example.

a. $2(x + 3)^2$

b. $6(x + 2)^2$

c. $3(x + 3)^2$

d. $3(x + 2)^2$

e. $-1(x + 2)^2$

f. $-3(x + 3)^2$

8. Simplify.

Example: $(x + 1)(2x - 5)$

$$\begin{aligned} &= 2x^2 - 5x + 2x - 5 \\ &= 2x^2 - 3x - 5 \end{aligned}$$

a. $(x + 2)(x - 3)$

b. $(x + 2)(x - 4)$

c. $(x + 1)(x - 5)$

9. Simplify.

Example: $3(x + 1)(2x - 5)$

$$\begin{aligned} &= (3x + 3)(2x - 5) \\ &= (3x \times 2x) + (3x \times -5) + (3 \times 2x) + (3 \times -5) \\ &= 6x^2 - 15x + 6x - 15 \\ &= 6x^2 - 9x - 15 \end{aligned}$$

or

$$\begin{aligned} &3(x + 1)(2x - 5) \\ &= 3(2x^2 + 2x - 5x - 5) \\ &= 3(2x^2 - 3x - 5) \\ &= 6x^2 - 9x - 15 \end{aligned}$$

a. $3(x + 2)(3x - 1)$

b. $2(2x - 5)(3x + 1)$

c. $5(2x + 7)(3x - 5)$



Sign:

Date:

continued

The product of two binomials continued

10. Simplify.

a. $2(x + 1)^2 + 4(x + 2)(x - 3)$

b. $3(a - 2)^2 + (2a - 3)(a - 4)$

Multiplying algebraic expressions together

In order to multiply two algebraic expressions, each of the terms of one algebraic expression is multiplied by each of the terms of the other algebraic expression and the result is simplified by adding the like terms.

11. Multiply these algebraic expressions and simplify (delete together).

Example: Multiply $2n + 3$ by $n^2 - 3n + 4$

$$\begin{aligned}
 & (2n + 3)(n^2 - 3n + 4) \\
 &= 2n(n^2 - 3n + 4) + 3(n^2 - 3n + 4) \\
 &= 2n \times n^2 + 2n(-3n) + 2n \times 4 + 3 \times n^2 + 3(-3n) + 3 \times 4 \\
 &= 2n^3 - 6n^2 + 8n + 3n^2 - 9n + 12 \\
 &= 2n^3 - 3n^2 - n + 12 \\
 &\therefore (2n + 3)(n^2 - 3n + 4) = 2n^3 - 3n^2 - n + 12
 \end{aligned}$$

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

b. $(b + 6)(b^2 - 12b + 2) =$

12. Multiply.

Example: Multiply $2x^2 - 3x - \frac{9}{x}$ by $-x + \frac{7}{x}$

Solution:
$$\begin{aligned} & (2x^2 - 3x - \frac{9}{x})(-x + \frac{7}{x}) \\ &= 2x^2(-x + \frac{7}{x}) - 3x(-x + \frac{7}{x}) - \frac{9}{x}(-x + \frac{7}{x}) \\ &= 2x^2 \times (-x) + 2x^2 \times \frac{7}{x} - 3x \times (-x) - 3x \times \frac{7}{x} - \frac{9}{x} \times (-x) - \frac{9}{x} \times \frac{7}{x} \\ &= -2x^3 + 14x + 3x^2 - 21 + 9 - \frac{63}{x^2} \\ &= -2x^3 + 3x^2 + 14x - 12 - \frac{63}{x^2} \\ \therefore & (2x^2 - 3x - \frac{9}{x})(-x + \frac{7}{x}) = -2x^3 + 3x^2 + 14x - 12 - \frac{63}{x^2} \end{aligned}$$

a. $c^2 + 7c - 14$ by $-c + \frac{7}{c}$

b. $2b^2 - 5b - \frac{5}{b}$ by $-b + \frac{2}{b}$



Sign:

Date:

Problem solving

Create two binomial expressions (with coefficients that are positive or negative integers). Multiply them together and simplify the product.

Divide a trinomial and polynomial by a monomial

Compare the examples.

Example 1:

$$\begin{aligned} & \frac{4x^4 - 2x^3}{2x^2} \\ &= \frac{4x^4}{2x^2} - \frac{2x^3}{2x^2} \\ &= 2x^{4-2} - x^{3-2} \\ &= 2x^2 - x \end{aligned}$$

Example 2:

$$\begin{aligned} & \frac{x^3}{x^2} \\ &= \frac{x \cdot x \cdot x}{x \cdot x} \\ &= x \end{aligned}$$

Example 3:

$$\begin{aligned} & \frac{6x^3 - 8x^2}{2x} \\ &= \frac{6x^3}{2x} - \frac{8x^2}{2x} \\ &= 3x^{3-1} - 4x^{2-1} \\ &= 3x^2 - 4x \end{aligned}$$

1. Revision: simplify using examples 1 and 2 above to guide you.

a. $\frac{2x^2 - 2x}{2x}$

b. $\frac{3x^2 - 6x}{3x}$

c. $\frac{10x^2 - 10x}{5x}$

2. Simplify.

Example: $\frac{6x^3 - 8x^2 + 2x + 10}{2x}$

$$\begin{aligned} &= \frac{6x^3}{2x} - \frac{8x^2}{2x} + \frac{2x}{2x} + \frac{10}{2x} \\ &= 3x^{3-1} - 4x^{2-1} + 1 + \frac{5}{x} \\ &= 3x^2 - 4x + 1 + \frac{5}{x} \end{aligned}$$

a. $\frac{6x^3 + 2x^2 + 2x}{2x}$

b. $\frac{12x^3 + 6x^2 + 6x}{3x}$

c. $\frac{15x^3 + 10x^2 + 30x}{5x}$

d. $\frac{6x^3 + 8x^2 + 2x + 8}{2x}$

e. $\frac{12x^3 + 6x^2 + 9x + 9}{3x}$

f. $\frac{20x^3 + 16x^2 - 8x - 8}{4x}$

3. Divide and test.

Example: $(2x^2 + 5x + 3) \div (2x + 3)$

$$\begin{array}{r} x+1 \\ 2x+3 \overline{)2x^2+5x+3} \\ -(2x^2+3x) \\ \hline 2x+3 \\ -(2x+3) \\ \hline \end{array}$$

Test
 $(2x+3)(x+1)$
 $= 2x^2 + 3x + 2x + 3$
 $= 2x^2 + 5x + 3$

a. $(3x^2 + 7x + 4) \div (3x + 4) =$

b. $(5x^2 + 21x + 18) \div (5x + 6) =$

c. $(2x^2 + 18x + 16) \div (x + 2) =$

Problem solving

Create a polynomial divided by a monomial.

Find the remainder when $x^2 - x + 1$ is divided by $x + 1$.

Find the quotient and remainder when $x^4 + 2x^3 + \frac{2}{3}x - \frac{1}{3}$ is divided by $x^2 + \frac{1}{3}$.



Algebraic expressions and substitution



Look at this example:

Find the value of $3x^2 - x + 2$ when $x = 2$

Let us understand the steps involved.

First, substitute the given variable with the given value, i.e.

$$3 \times (2^2) - (2) + 2$$

And then simplify the numerical result obtained in the first step.

$$\begin{aligned} 3 \times 2^2 - 2 + 2 &= 3 \times 4 - 2 + 2 \\ &= 12 - 2 + 2 \\ &= 12 \end{aligned}$$

therefore

$$3x^2 - x + 2 = 12 \text{ when } x = 2$$

We can evaluate any algebraic expression for Given values(s) of the variable(s) occurring in it.

Take two other examples:

$$(3x^2 - 3x + 1)(x - 1) \text{ when } x = 3$$

Substitute x with 3 and we get

$$\begin{aligned} (3 \times 3^2 - 3 \times 3 + 1)(3 - 1) \\ = (3 \times 9 - 9 + 1)(2) \\ = 2(19) = 38 \end{aligned}$$

$$(3x^2 - 1) + (4x^3 - 4x - 3) \text{ when } x = -1$$

Substitute with $x = -1$ and we get

$$\begin{aligned} [3 \times (-1)^2 - 1] + [4(-1)^3 - 4(-1) - 3] \\ = 3 - 1 + [-4 + 4 - 3] \\ = 2 - 3 \\ = -1 \end{aligned}$$

- 1. Evaluate each of the following algebraic expressions for the indicated value of the variable: $x = 4$**

Example: $x^2 + 3x - 5$

$$\begin{aligned} (4)^2 + 3(4) - 5 \\ = 16 + 12 - 5 \\ = 28 - 5 \\ = 23 \end{aligned}$$

a. $x^2 + 2x - 8$

b. $x^2 + 3x - 5$

c. $x^2 - 3x - 8$

d. $x^2 - 4x + 2$

e. $x^2 + 2x - 4$

f. $x^2 - 5x - 10$

- 2. Evaluate each of the following algebraic expressions for the indicated value of the variable: $x = -1$**

Example: $\frac{2}{3}x^3 + \frac{4}{5}x^2 - \frac{7}{5}$

$$\begin{aligned}
 &= \frac{2}{3}(-1)^3 + \frac{4}{5}(-1)^2 - \frac{7}{5} \\
 &= -\frac{2}{3} + \frac{4}{5} - \frac{7}{5} \\
 &= -\frac{2}{3} - \frac{3}{5} \\
 &= \frac{-10-9}{15} \\
 &= \frac{-19}{15} \\
 &= -1\frac{4}{15}
 \end{aligned}$$

a. $\frac{1}{2}x^2 + \frac{3}{4}x - \frac{2}{4}$

b. $\frac{3}{4}x^3 + \frac{1}{2}x - \frac{1}{4}$

c. $\frac{1}{2}x^2 + \frac{1}{2}x - \frac{1}{10}$

d. $\frac{3}{4}x^2 - \frac{1}{2}x + \frac{1}{5}$

e. $\frac{1}{8}x^3 + \frac{1}{4}x + \frac{1}{3}$

f. $\frac{1}{3}x^2 + \frac{1}{4}x + \frac{1}{12}$

- 3. Evaluate each of the following algebraic expressions for the indicated value of the variable: $x = \frac{1}{3}$**

Example: $\frac{2}{3x} + \frac{x^2}{4} - \frac{7}{x^2}$

$$\begin{aligned}
 &= \frac{2}{3(\frac{1}{3})} + \frac{\frac{1}{3}}{4} - \frac{7}{(\frac{1}{3})^2} \\
 &= \frac{2}{1} + \frac{\frac{1}{9}}{4} - \frac{7}{\frac{1}{9}} \\
 &= 2 + (\frac{1}{9} \div \frac{4}{1}) - (\frac{7}{1} \div \frac{1}{9}) \\
 &= 2 + (\frac{1}{9} \times \frac{1}{4}) - (\frac{7}{1} \times \frac{9}{1}) \\
 &= 2 + \frac{1}{36} - \frac{63}{1} \\
 &= 2 - 63 + \frac{1}{36} \\
 &= -61\frac{1}{36}
 \end{aligned}$$



Sign:

Date:

continued

Algebraic expressions and substitution

continued

a. $\frac{4}{5}x^2 + \frac{1}{5}x - \frac{1}{6}$

b. $\frac{1}{4}x^3 - \frac{1}{7}x - \frac{1}{5}$

c. $\frac{1}{8}x - \frac{3}{4}x - \frac{4}{5}$

4. Evaluate each of the following algebraic expressions for the indicated values of the variables: $x = 2$ and $y = 1$

Example: if $x = 2$ and $y = 1$

$$\begin{aligned} \text{then } \frac{x^2}{y} + 3xy - 11 \\ &= \frac{2^2}{1} + (3)(2)(1) - 11 \\ &= (\frac{4}{1}) + 6 - 11 \\ &= 4 + 6 - 11 \\ &= -1 \end{aligned}$$

a. $\frac{x^2}{y} + 2xy + 5 =$

b. $\frac{x^2}{y} + 3xy + 11 =$

c. $\frac{x^2}{y^2} - 3xy - 7 =$

d. $\frac{x^2}{y^2} - 2xy - 3 =$

e. $\frac{x^2}{y} + 4xy + 10 =$

f. $\frac{x^3}{y^2} + 4xy + 2 =$

5. Evaluate each of the following algebraic expressions for the indicated values of the variables: $x = 2$, $y = 1$ and $z = -3$

Example: If $x = 2$, $y = 1$, $z = -3$

$$\begin{aligned} \text{then } & xyz - x^3 - y^3 + z^3 \\ &= (2)(1)(-3) - (2)^3 - (1)^3 + (-3)^3 \\ &= -6 - 8 - 1 - 27 \\ &= -42 \end{aligned}$$

a. $xyz + x^2 + y^2 + 2^3 =$

b. $xyz + x^3 - y^2 - 2^3 =$

c. $xyz - x^3 - y^3 + 2^2 =$

d. $x^2yz^3 - x^2 + y^2 - 2^2 =$

e. $xyz + x^3 + y^3 - 2^3 =$

f. $xyz - x^2 - y^2 + 2^2 =$

Problem solving

Explain in your own words what it means to evaluate an algebraic expression for the indicated values. You can make use of an example to explain this.



Sign: _____
Date: _____

Factorise algebraic expressions

Expand: $2x(x + 3)$
 $= 2x^2 + 6x$

2x	x	3
	$2x^2$	$6x$

Factorising is the reverse of expanding an expression through multiplication.

Factorise: $2x^2 + 6x$
 $= 2x(x + 3)$

Factorise: $a - 4b$
 $= 1(a - 4b)$

Factorise: $4b - a$
 $= -1(a - 4b)$

Note that 1 and -1 are common factors of every expression.

1. Multiply a monomial by a binomial and factorise your answer.

Example: Expand: $2x(x + 3)$
 $= 2x^2 + 6x$

Factorise: $2x^2 + 6x$
 $= 2x(x + 3)$

a. $2(x - 3)$

b. $4x(x - 1)$

c. $x(y + 1)$

d. $p(q + 3)$

e. $2a(a + 1)$

f. $abc(ab - abc)$

2. Factorise the following (always start by looking for a common factor, do not forget 1 or -1 and write the terms in the factor in alphabetical order).

Example: Factorise: $a - 4b$

$$= 1(a - 4b)$$

Factorise: $4b - a$

$$= -1(a - 4b)$$

a. $y - x^2 =$

b. $2x^2 - c =$

c. $-x^2 + 1 =$

d. $p^2q^2 - n =$

Problem solving

Expand the following and prove your answer by factorising. $2(p^3 + 8p^2 - 5p)$



Sign: _____
Date: _____

Factorise more algebraic expressions

Remember: Factorising is the reverse of expanding.

Revise how to factorise.

Look for the largest number that can divide into each term of the given expression. Look for any common factors.

$$\begin{aligned} 12x + 20xy \\ = 4x(3 + 5y) \end{aligned}$$

This is because $4x$ is the largest factor of both $12x$ and $20xy$.

To factorise, rewrite the expression as factors multiplied together.

Check by expanding your answer.

$$\begin{aligned} 4x(3 - 5y) \\ = 12x + 20xy \end{aligned}$$

1. Factorise.

Example: $6a^4 - 4a^2$
 $= 2a^2 (3a^2 - 2)$

Check your answer by multiplication:
 $2a^2 (3a^2 - 2)$
 $= 2a^2 \times 3a^2 + 2a^2 (-2) = 6a^4 - 4a^2$

a. $8y^4 - 4y^2$

b. $10a^4 - 6a^2$

c. $18x^4 - 36x^2$

d. $12m^4 - 15m^2$

2. Factorise (group terms together).

Example: $ax - bx + 2a - 2b$
 $= x(a - b) + 2(a - b)$
 $= (a - b)(x + 2)$

Check your answer:
 $(a - b)(x + 2)$
 $= ax - bx + 2a - 2b$

a. $bx - cx + 3b - 3c$

b. $cd - ce + 2d - 2e$

c. $cy - dy + 2c - 2d$

d. $mx - my + 5x - 5y$

3. Factorise (group terms together).

Example: $2x(a - b) - 3(a - b)$
 $= (a - b)(2x - 3)$

Check your answer:
 $(a - b)(2x - 3)$
 $= 2ax - 3a - 2bx + 3b$

and

$$2x(a - b) - 3(a - b) = 2ax - bx - 3a + 3b$$

a. $3x(m - n) - 2(-n + m) =$

b. $3q(d - e) - 1(-e + d) =$

c. $2a(x - y) - 5(-y + x) =$

d. $2d(a - c) - 3(-c + a) =$

4. Factorise. (Remember to look for a common factor first.)

Example: $2x(a - b) - 3(b - a)$
 $= 2x(a - b) - 3(-a + b)$
 $= 2x(a - b) + 3(a - b)$
 $= (a - b)(2x + 3)$

Check your answer:
 $(a - b)(2x + 3)$
 $= 2ax - 2bx + 3a - 3b$

and

$$2x(a - b) - 3(b - a) = 2ax - 2bx - 3b + 3a$$

a. $5d^2 + 20d + 2d + 8$

b. $3a^2bc - 4abc + 6a^2 + 8a$

c. $6b^4 - 2b^2 =$

d. $3m(p - q) - 3(-q + p) =$

5. Factorise.

Example: $(a + b)^2 - 5(a + b)$
 $= (a + b)[(a + b) - 5]$
 $= (a + b)(a + b - 5)$

a. $7(x^2 - xy) + (y - x) =$

b. $ab^2 - ac^2 =$

c. $121b^2 + 11b =$

d. $9(a^2 - ab) - 6(a - b) =$

Factorise

a. $am - bm + 2a - 2b$

b. $k(2k - 4m) + (7k - 14m)$

c. $4x^4 - 16y^2 =$

d. $mn - pn + 2m - 2p$

e. $4p(c - d) - 7(-d + c)$



Sign:

Date:

Look at the examples. Describe what happens in them

Example 1:

$$25a^2 - 1 \\ = (5a - 1)(5a + 1)$$

Example 2:

$$a^4 - b^4 \\ = (a^2 - b^2)(a^2 + b^2) \\ = (a - b)(a + b)(a^2 + b^2)$$

Example 3: $3x^2 - 27$

$$= 3(x^2 - 9) \\ = 3(x + 3)(x - 3)$$

Example 4:

$$9(a + b)^2 - 1 \\ = [3(a + b) - 1][3(a + b) + 1] \\ = (3a + b - 1)(3a + 3b + 1)$$

1. Factorise.

Example: See example 1 above.

a. $36x^2 - 1$

b. $16y^2 - 1$

c. $64p^2 - 1$

d. $49m^2 - 1$

e. $100a^2 - 1$

f. $9q^2 - 1$

2. Factorise.

Example: See example 2 above.

a. $d^4 - g^4 =$

b. $x^{16} - y^{16} =$

c. $m^8 - m^8 =$

d. $p^4 - q^4 =$

e. $v^4 - w^4 =$

f. $s^8 - t^8 =$

3. Factorise.

Example: See example 3 on the previous page.

a. $4x^2 - 64$

b. $2x^2 - 2$

c. $3x^2 - 39$

d. $7x^2 - 56$

e. $6x^2 - 42$

f. $9x^2 - 90$

4. Factorise.

Example: See example 4 on the previous page.

a. $36(x + y)^2 - 4 =$

b. $4(m + n)^2 - 49 =$

c. $16(d + e)^2 - 81 =$

d. $25(o + p)^2 - 81 =$

e. $49(v + w)^2 - 16 =$

f. $(q + r)^2 - 16 =$

Problem solving

Is 12 a factor of 48?

Is $3p^2$ a factor of $6p^4$?

Is $12x^3y^2z^5$ a factor of $24x^4y^5z^6$? How do you know?

If $-x^3 + 5x^2 - 4x + 5$ is a polynomial, what is the common factor?



Sign:

Date:

Look at the examples. Discuss them.

Example 1:

$$\begin{aligned} & \frac{2x + 6y}{x + 3y} \\ &= \frac{2(x + 3y)}{(x + 3y)} \\ &= 2 \end{aligned}$$

Example 2:

$$\begin{aligned} & \frac{3x - 3y}{6x - 6y} \\ &= \frac{3(x - y)}{6(x - y)} \\ &= \frac{1}{2} \end{aligned}$$

Example 3:

$$\begin{aligned} & \frac{9a^2 - 1}{3a + 1} \\ &= \frac{(3a - 1)(3a + 1)}{3a + 1} \\ &= 3a - 1 \end{aligned}$$

1. Factorise.

Example: See example 1 above.

a. $\frac{3x + 6y}{x + 2y}$

b. $\frac{2x + 8y}{x + 4y}$

c. $\frac{2x + 12y}{x + 6y}$

d. $\frac{3x + 9y}{x + 3y}$

e. $\frac{2x + 10y}{x + 5y}$

f. $\frac{5x + 10y}{x + 2y}$

2. Factorise.

Example: See example 2 above.

a. $\frac{2x - 2y}{5x - 5y}$

b. $\frac{3x - 3y}{9x - 9y}$

c. $\frac{5x - 5y}{10x - 10y}$

d. $\frac{4x - 4y}{8x - 8y}$

e. $\frac{2x - 2y}{6x - 6y}$

f. $\frac{4x - 4y}{12x - 12y}$

3. Factorise.

Example: See example 3 on the previous page.

a. $\frac{81a^2 - 1}{9a + 1}$

b. $\frac{36a^2 - 1}{6a + 1}$

c. $\frac{16a^2 - 1}{4a - 1}$

d. $\frac{121a^2 - 1}{11a + 1}$

e. $\frac{25a^2 - 1}{5a + 1}$

f. $\frac{100a^2 - 1}{10a - 1}$

Problem solving

Factorise:

a. $\frac{25x + 25y}{30x + 30y}$

b. $\frac{7a - 7b}{14a - 14b}$

c. $\frac{4x + 28y}{x + 7y}$

d. $\frac{256a^2 - 1}{16a + 1}$

e. $\frac{27x - 27y}{81x - 81y}$

f. $\frac{12x - 108y}{x - 9y}$

g. $\frac{225a^2 - 1}{15a + 1}$

h. $\frac{169a^2 + 1}{13a + 1}$

i. $\frac{8x + 56y}{x + 7y}$

j. $\frac{16x - 16y}{42x - 42y}$



Sign: _____
Date: _____

Factorise even more algebraic expressions

Revise.

$$\begin{array}{l}
 x^2 + 5x + 6 \\
 = x^2 + 5x + 6 \\
 = (x+3)(x+2)
 \end{array}$$

Both operations are positive.
3 + 2 = 5 3 × 2 = 6

$$\begin{array}{r}
 (x+3) \\
 \overline{x} \\
 + \\
 2 \\
 \hline
 \end{array}
 \quad
 \begin{array}{|c|c|c|} \hline & x^2 & 3x \\ \hline x & & \\ \hline + & & \\ \hline 2 & 2x & 6 \\ \hline \end{array}$$

$$x^2 - 5x + 6$$

$$(x-3)(x-2)$$

$$\begin{array}{r}
 (x-2) \\
 \overline{x} \\
 - \\
 3 \\
 \hline
 \end{array}
 \quad
 \begin{array}{|c|c|c|} \hline & x^2 & -2x \\ \hline x & & \\ \hline - & & \\ \hline 3 & -3x & 6 \\ \hline \end{array}$$

$$x^2 - x - 6$$

$$(x-3)(x+2)$$

$$\begin{array}{r}
 (x+2) \\
 \overline{x} \\
 - \\
 3 \\
 \hline
 \end{array}
 \quad
 \begin{array}{|c|c|c|} \hline & x^2 & 2x \\ \hline x & & \\ \hline - & & \\ \hline 3 & -3x & -6 \\ \hline \end{array}$$

1. Factorise.

Example: $x^2 + 5x + 6$

$$\begin{aligned}
 &= x^2 + 5x + 6 \\
 &= (x+3)(x+2)
 \end{aligned}$$

$(x+3)$

$$\begin{array}{r}
 (x+3) \\
 \overline{x} \\
 + \\
 2 \\
 \hline
 \end{array}
 \quad
 \begin{array}{|c|c|c|} \hline & x^2 & 3x \\ \hline x & & \\ \hline + & & \\ \hline 2 & 2x & 6 \\ \hline \end{array}$$

a. $x^2 + 3x + 2$

b. $x^2 + 4x + 3$

c. $x^2 + 6x + 5$

d. $x^2 + 8x + 12$

e. $x^2 + 4x + 4$

f. $x^2 + 12x + 20$

2. Factorise.

Example: $x^2 - 5x + 6$
 $= (x - 3)(x - 2)$

$$(x - 2)$$

$$\begin{array}{r} \overline{x} \\ - \\ 3 \\ \hline \end{array} \quad \begin{array}{|c|c|} \hline x^2 & -2x \\ \hline -3x & 6 \\ \hline \end{array}$$

a. $x^2 - 6x + 9$

b. $x^2 - 4x + 3$

c. $x^2 - 6x + 8$

d. $x^2 - 9x + 8$

e. $x^2 - 12x + 20$

f. $x^2 - 7x + 6$

3. Factorise.

Example: $x^2 - x - 6$
 $= (x - 3)(x + 2)$

$$(x + 2)$$

$$\begin{array}{r} \overline{x} \\ - \\ 3 \\ \hline \end{array} \quad \begin{array}{|c|c|} \hline x^2 & 2x \\ \hline -3x & -6 \\ \hline \end{array}$$

a. $x^2 - x - 12$

b. $x^2 - 3x - 10$

c. $x^2 - x - 2$

d. $x^2 - 2x - 24$

e. $x^2 - 2x - 15$

f. $x^2 - 2x - 8$

Problem solving

Factorise

$x^2 + 15x + 56$

$x^2 - 2x - 45$

$x^2 + 14x + 48$

$x^2 - x + 132$

$x^2 + 13x + 42$

$x^2 - 16x + 63$

$x^2 + 13x + 42$

$x^2 - 10x - 24$

$x^2 + 13x + 40$

$x^2 - x - 72$



Sign:
Date:

Look at the examples. Discuss.

Example 1:

$$-2x = 8$$

$$\frac{-2x}{-2} = \frac{8}{-2}$$

$$x = -4$$

Example 2:

$$3x + 1 = 7$$

$$3x + 1 - 1 = 7 - 1$$

$$3x = 6$$

$$\frac{3x}{3} = \frac{6}{3}$$

$$x = 2$$

1. Solve for x .

Example: $x - 3 = 4$

$$x - 3 + 3 = 4 + 3$$

$$x = 7$$

a. $x - 4 = 7$

b. $x - 4 = 9$

c. $x - 4 = 15$

d. $x - 3 = 8$

e. $x - 2 = 12$

f. $x - 5 = 9$

2. Solve for x .

Example: $-6x = -12$

$$\frac{-6x}{-6} = \frac{-12}{-6}$$

$$x = 2$$

a. $-4x = -16$

b. $-x = -15$

c. $-7x = -28$

d. $-3x = -9$

e. $-3x = -21$

f. $-9x = -90$

g. $-3x = -18$

h. $-2x = -30$

i. $-5x = -25$

3. Solve for x .

Example: $4x - 3 = 9$
 $4x - 3 + 3 = 9 + 3$
 $4x = 12$
 $\frac{4x}{4} = \frac{12}{4}$
 $x = 3$

a. $4x - 4 = 4$

b. $2x - 15 = 1$

c. $8x - 8 = 8$

d. $2x - 15 = 1$

e. $5x - 10 = 10$

f. $12x - 9 = 27$

g. $6x - 15 = 15$

h. $7x - 5 = 9$

i. $2x - 3 = 3$

Problem solving

Write an equation for each of these and solve it.

Gugu is 9 years older than Sam. In 3 years' time Gugu will be twice as old as Sam. How old is Gugu now?

Peter has five computer games. Sarah has twice as many as Peter. Thoko has two more than Sarah and Peter together. How many games does Thoko have?

Thapelo has six sweets more than Palesa. In total they have 24 sweets. How many sweets does Palesa have?

Melissa starts to save money in her piggy bank. She starts with R5 in January and saves double the amount in each consecutive month. How much money did she save after 6 months?



Sign:

Date:

Look at the example. Discuss.

Solve for x .

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

$x(x - 3) = 0$ (Make sure the right hand side is zero then factorise left-hand side)

$x = 0$ or $x - 3 = 0$ (at least one factor = 0)

Therefore $x = 0$ or $x = 3$ (add 3 to both sides to solve the equation)

1. Solve the following equations:

Example: $x^2 + 4x = 0$

$$x(x + 4) = 0$$

$$x = 0 \text{ or } x + 4 = 0$$

$$x = 0 \text{ or } x = -4$$

a. $a^2 + 8a = 0$

b. $t^2 + 9t = 0$

c. $x^2 + 7x = 0$

d. $x^2 + 5x = 0$

e. $q^2 + 12q = 0$

f. $q^2 + 10q = 0$

g. $b^2 + 6b = 0$

h. $m^2 + 2m = 0$

i. $s^2 + 4s = 0$

j. $y^2 + 2y = 0$

2. Solve for x .

Example: $2x^2 + 4x = 0$

$$2x(x + 2) = 0$$

$$2x = 0 \text{ or } x + 2 = 0$$

$$\frac{2x}{2} = \frac{0}{2} \text{ or } x + 2 - 2 = -2$$

$$\therefore x = 0 \text{ or } x = -2$$

a. $5x^2 + 10x = 0$

b. $2a^2 + 2a = 0$

c. $12p^2 + 24p = 0$

d. $6a^2 + 12a = 0$

e. $8b^2 + 8b = 0$

f. $7x^2 + 28x = 0$

g. $3x^2 + 9x = 0$

h. $4x^2 + 12x = 0$

i. $9b^2 + 27b = 0$

j. $2x^2 + 8x = 0$

How fast can you solve for x ?

Do the inverse operation.

a. $9x^2 + 15x = 0$

f. $x^2 - 4 = 0$

b. $x^3 + x^2 = 0$

g. $x^2 - 11x = 0$

c. $x^2 - 121 = 0$

h. $4x^2 + 100x = 0$

d. $12x^2 + 9x = 0$

i. $7x^2 + 49x = 0$

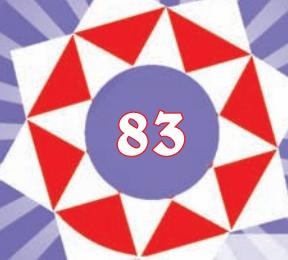
e. $3x^2 - 27x = 0$

j. $5x^2 - 225x = 0$



Sign: _____
Date: _____

More and more algebraic equations



Look at the example. Discuss.

Solve for x if $x^2 - 25 = 0$

At least one factor = 0

$$(x + 5)(x - 5) = 0$$

[Factorise the difference of two squares on the left-hand side.]

Add -5 to both sides of the equation.

$$x + 5 = 0 \text{ or } x - 5 = 0$$

Add 5 to both sides of the equation.

$$\text{Therefore } x = -5 \text{ or } x = 5$$

1. Solve for x :

Example: Solve for x if $x^2 - 16 = 0$

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

$$x = -4 \text{ or } x = 4$$

a. $x^2 - 9 = 0$

b. $x^2 - 36 = 0$

c. $x^2 - 25 = 0$

d. $x^2 - 169 = 0$

e. $x^2 - 4 = 0$

f. $x^2 - 100 = 0$

g. $x^2 - 64 = 0$

h. $x^2 - 144 = 0$

i. $x^2 - 16 = 0$

j. $x^2 - 225 = 0$

2. Solve for x : $x^2 - 6,25 = 0$



3. Expand:

Example: $(x + 4)(x - 4) = 0$

$$x^2 - 16 = 0$$

a. $(x + 2)(x - 2) = 0$

b. $(x + 7)(x - 7) = 0$

c. $(x + 5)(x - 5) = 0$

d. $(x + 9)(x - 9) = 0$

e. $(x + 3)(x - 3) = 0$

f. $(x + 8)(x - 8) = 0$

g. $(x + 11)(x - 11) = 0$

h. $(x + 12)(x - 12) = 0$

i. $(x + 10)(x - 10) = 0$

j. $(x + 14)(x - 14) = 0$

4. Calculate: $(x + 1,2)(x - 1,2) = 0$

How fast can you solve this?

Solve for x if:

$$x^2 - 1 = 0$$

$$x^2 - 16 = 0$$

$$x^2 - 400 = 0$$

$$x^2 - 81 = 0$$

$$x^2 - 256 = 0$$



Look at the example. Discuss.

A rectangular prism with the following measurements:

$$\text{Length} = (2x) \text{ cm}$$

$$\text{Breadth} = (x - 1) \text{ cm}$$

$$\text{Height} = (2x + 2) \text{ cm}$$



$$\text{Volume} = \text{length} \times \text{breadth} \times \text{height}$$

$$l \times b \times h$$

$$= (2x) \text{ cm} \times (x - 1) \text{ cm} \times (2x + 2) \text{ cm}$$

$$= (2x)(x - 1) \times (2x + 2) \text{ cm}^3$$

$$= (2x^2 - 2x) \times (2x + 2) \text{ cm}^3$$

$$= 4x^3 + 4x^2 - 4x^2 - 4x \text{ cm}^3$$

$$= 4x^3 + 4x \text{ cm}^3$$

1. Find the volume of these prisms by using the above formula.

a. $l = 4x \text{ cm}$

$b = 4x \text{ cm}$

$h = 5x \text{ cm}$

b. $l = 3x \text{ cm}$

$b = x + 3 \text{ cm}$

$h = x + 1 \text{ cm}$

c. $l = 2x + 2 \text{ cm}$

$b = x + 3 \text{ cm}$

$h = x \text{ cm}$

d. $l = 4x \text{ cm}$

$b = x + 2 \text{ cm}$

$h = 3x + 1 \text{ cm}$

e. $l = 4x \text{ cm}$

$b = x + 1 \text{ cm}$

$h = x + 2 \text{ cm}$

f. $l = 2x \text{ cm}$

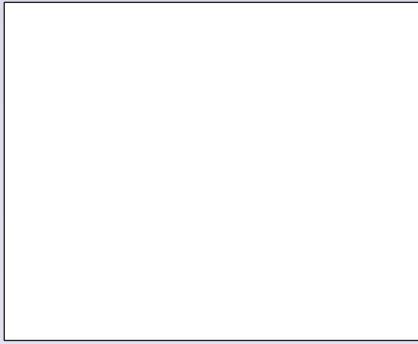
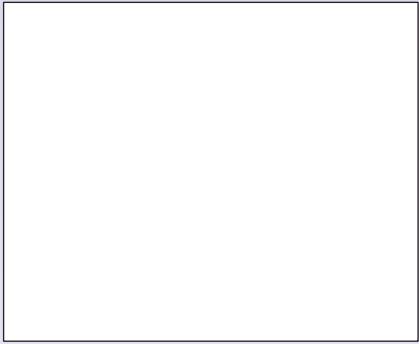
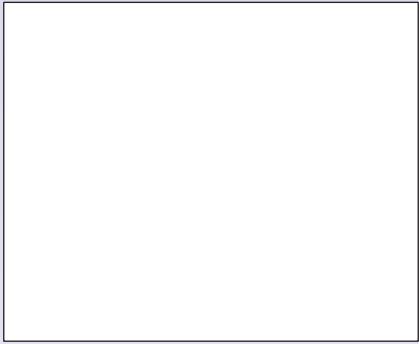
$b = 2x + 3 \text{ cm}$

$h = 3x + 1 \text{ cm}$

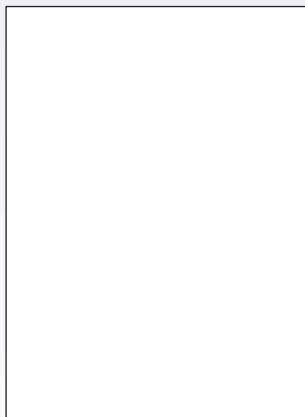
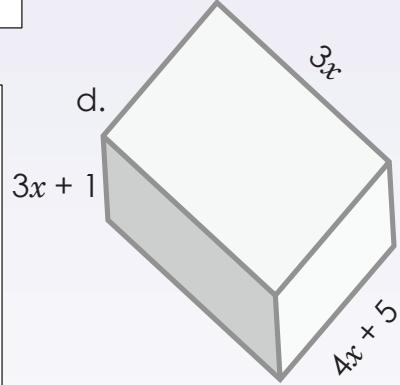
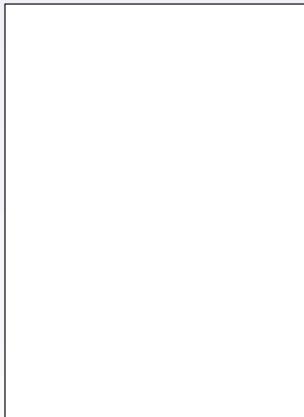
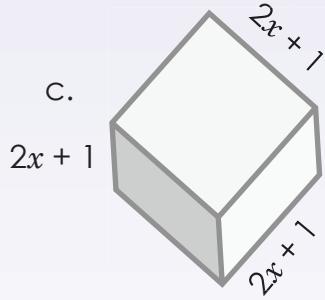
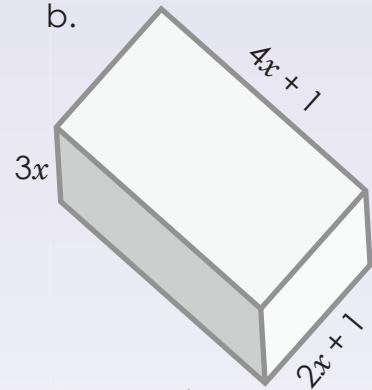
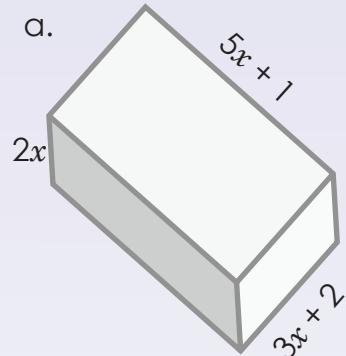
g. $l = 8x \text{ cm}$
 $b = 5x \text{ cm}$
 $h = 10x \text{ cm}$

h. $l = (3x + 2) \text{ cm}$
 $b = (4x + 1) \text{ cm}$
 $h = 5x \text{ cm}$

i. $l = (3x + 4) \text{ cm}$
 $b = (2x + 3) \text{ cm}$
 $h = 5x \text{ cm}$



2. Calculate the volume of these prisms in terms of x .



Problem solving

- Look around the classroom or your home and create your own problems by measuring items such as boxes and rectangular prism containers (tissue boxes, lunch tins, pencil cases, etc.)
- If $x = 3$, calculate the actual volumes in question 2 above.



Sign:

Date:

Look at the examples. Discuss.

$y = 2x^2 + 4x + 3$. Calculate y if $x = -2$:

$$\begin{aligned}y &= 2(-2)^2 + 4(-2) + 3 \\&\text{or} \\&= 8 - 8 + 3 \\&= 3\end{aligned}$$

$$\begin{aligned}y &= 2x(x + 2) + 3 \\&= 2(-2)(-2 + 2) + 3 \\&= 2(-2)(0) + 3 \\&= 0 + 3 \\&= 3\end{aligned}$$

1. Calculate the value of y if $x = -1$ using both methods.

Example: $y = 3x^2 + 6x + 2$

$$\begin{aligned}y &= 3(-1)^2 + 6(-1) + 2 \\&= 3 - 6 + 2 \\&= -1\end{aligned}$$

or

$$\begin{aligned}y &= 3x^2 + 6x + 2 \\&= 3x(x + 2) + 2 \\&= 3(-1)(-1 + 2) + 2 \\&= 3(-1)(1) + 2 \\&= -3 + 2 \\&= -1\end{aligned}$$

a. $y = 2x^2 + 8x + 3$

b. $y = 7x^2 + 14x + 1$

c. $y = 2b^2 + 4b + 5$

d. $y = 3x^2 + 9x + 5$

e. $y = 3x^2 + 6x + 5$

f. $y = 6x^2 + 12x + 4$

g. $y = 5x^2 + 10x + 2$

h. $y = 4a^2 + 8a + 2$

i. $y = 3n^2 + 6x + 3$

j. $y = 2x^2 + 6x + 5$

Problem solving

Substitute with the given value for the variable and calculate.

$y = x^2 + 5x + 3; x = -2$

$y = 4x^2 + 10x + 15; x = 3$

$y = 2x^2 + 7x - 14; x = 3$

$y = x^2 + 9x - 7; x = 4$

$y = 5x^2 + 6x + 12; x = -6$



Sign:

Date:

Using algebraic equations to solve practical problems

Read and discuss before solving the problems.

Try to understand and not just memorise.

Yes, sometimes we need to memorise formulae and methods, but then make sure you can explain to yourself and to other learners how they work.

If you get stuck when trying to solve an equation, try to approach the problem from a **different point of view**. Is there another way of looking at the problem? Is there another way of doing it? Can you solve part of the problem first?

For example, if you need to show whether an expression is positive or negative, and you cannot do it algebraically, a graphical method might help.

1. Write an equation for each of these and solve them.

- a. 331 students went on a field trip. Six buses were filled and seven students travelled in cars. How many students were in each bus?

- b. Bongiwe had R24 to spend on seven pencils. After buying them she had R10 left. How much did each pencil cost?

c. The sum of three consecutive numbers is 72. What is the smallest of these numbers?

d. The sum of three consecutive even numbers is 48. What is the smallest of these numbers?

e. You bought a magazine for R5 and four erasers. You spent a total of R25. How much did each eraser cost?



Sign: _____
Date: _____

continued ➔

Using algebraic equations to solve practical problems continued

- f. Suzanne had many boxes. She bought seven more. A week later half of all her boxes were damaged. There were only 22 undamaged boxes left. How many boxes did she start off with?

- g. Riana spent half of her monthly allowance on cell phone airtime. To help her earn more money, her parents let her wash and vacuum their car for R40. What is her monthly allowance if she ended up with R120?

- h. Rebecca had some sweets to give to her four friends. She kept 10 sweets for herself and then divided the rest evenly among her friends. Each friend received two sweets. With how many sweets did she start?

i. How old am I if 400 reduced by two times my age is 244?

j. Mpho sold half of her books and then bought 16 more. She now has 36 books. With how many did she begin?

k. For a field trip, four learners travelled by car and the rest in nine buses. How many learners were in each bus if 472 students went on the trip?

Problem solving

Write five of your own problems and solve them. Write down the rule that solves them.



Sign: _____
Date: _____

Some more algebraic expressions

Look at the example. Discuss.

Example: Complete the table below for x and y values for the equation: $y = 2x^2 - 3$.

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

$$\begin{aligned}y &= 2(-2)^2 - 3 \\&= 2(4) - 3 \\&= 8 - 3 \\&= 5\end{aligned}$$

$$\begin{aligned}y &= 2(-1)^2 - 3 \\&= 2(1) - 3 \\&= 2 - 3 \\&= -1\end{aligned}$$

$$\begin{aligned}y &= 2(0)^2 - 3 \\&= 0 - 3 \\&= -3\end{aligned}$$

$$\begin{aligned}y &= 2(1)^2 - 3 \\&= 2 - 3 \\&= -1\end{aligned}$$

$$\begin{aligned}y &= 2(2)^2 - 3 \\&= 8 - 3 \\&= 5\end{aligned}$$

1. Complete the table below for x and y values for the equation.

a. $y = 3x^2 - 4$

x	-2	-1	0	1	2
y					

b. $y = 4x^2 - 3$

x	-2	-1	0	1	2
y					

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

x	-2	-1	0	1	2
y					

d. $y = 5x^2 - 7$

x	-2	-1	0	1	2
y					

e. $y = 5x^2 - 3$

x	-2	-1	0	1	2
y					

f. $y = 2x^2 - 2$

x	-2	-1	0	1	2
y					

g. $y = 3x^2 - 6$

x	-2	-1	0	1	2
y					

h. $y = 4x^2 - 2$

x	-2	-1	0	1	2
y					

i. $y = 2x^2 - 6$

x	-2	-1	0	1	2
y					

2. Complete the table below for x and y values for the equation.

Example: $y = x^2 - 2$

x	-3	-2	0	1	3
y	7	2	-2	-1	7

$$\begin{aligned}y &= (-3)^2 - 2 \\&= 9 - 2 \\&= 7\end{aligned}$$

$$\begin{aligned}y &= (-2)^2 - 2 \\&= 4 - 2 \\&= 2\end{aligned}$$

$$\begin{aligned}y &= (0)^2 - 2 \\&= 0 - 2 \\&= -2\end{aligned}$$

$$\begin{aligned}-1 &= x^2 - 2 \\x^2 &= 1 \\x &= 1\end{aligned}$$

$$\begin{aligned}7 &= x^2 - 2 \\x^2 &= 9 \\x &= 3\end{aligned}$$

a. $y = x^2 - 3$

x	-5	-3	0		
y				1	13

b. $y = x^2 - 10$

x	-4	-2	0		
y				15	26

c. $y = x^2 - 4$

x	-7	-5	0		
y				21	96

d. $y = x^2 - 1$

x	-2	-1	0		
y				48	63

e. $y = x^2 - 7$

x	-2	-1	0		
y				74	93

f. $y = x^2 - 9$

x	-2	-1	0		
y				16	27

g. $y = x^2 - 5$

x	-2	-1	0		
y				-1	4

h. $y = x^2 - 8$

x	-2	-1	0		
y				-4	8

i. $y = x^2 - 6$

x	-2	-1	0		
y				-5	3

More equations...

Choose your own values for the variable. Draw tables and solve for y .

$y = 3x^2 - 4$

$y = 2x^2 - 6$

$y = 5p^2 - 10$

$y = 6x^2 - 5$

$y = q^2 - 1$



Sign:

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A **linear equation** is an equation with one or more variables which can be represented by a straight line on a graph. The equation is never squared or square rooted. Example: $y = x + 2$.

$$x \quad y = x + 2$$

Ordered pair (coordinates)

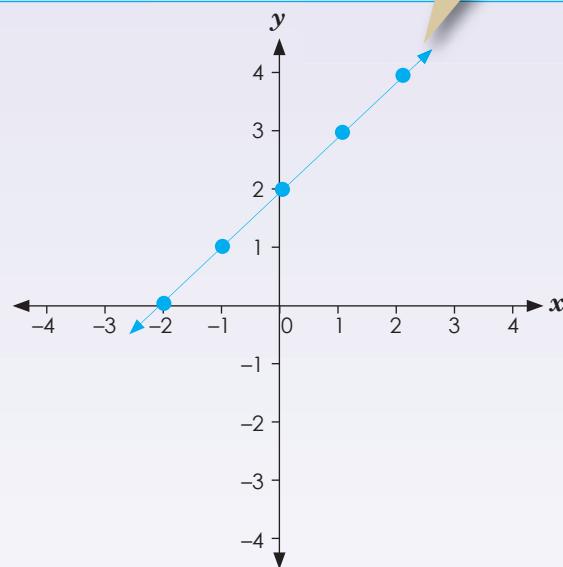
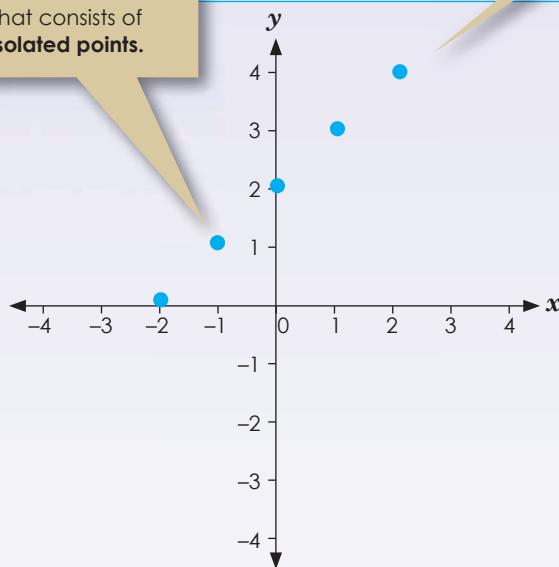
Choose some values for x .

-2	$-2 + 2 = 0$	(-2, 0)
-1	$-1 + 2 = 1$	(-1, 1)
0	$0 + 2 = 2$	(0, 2)
1	$1 + 2 = 3$	(1, 3)
2	$2 + 2 = 4$	(2, 4)

You plot these chosen points on the set of axes.

If we draw a line through all the points and extend the line in both directions, we get a **continuous function**

This is a
discrete function
that consists of
isolated points.



1. Answer the following questions.

- a. What does linear mean?

b. Is $y = x + 3$ linear or non-linear? Draw it.

c. Is $y = x^2 + 2$ linear or non-linear? Draw it.

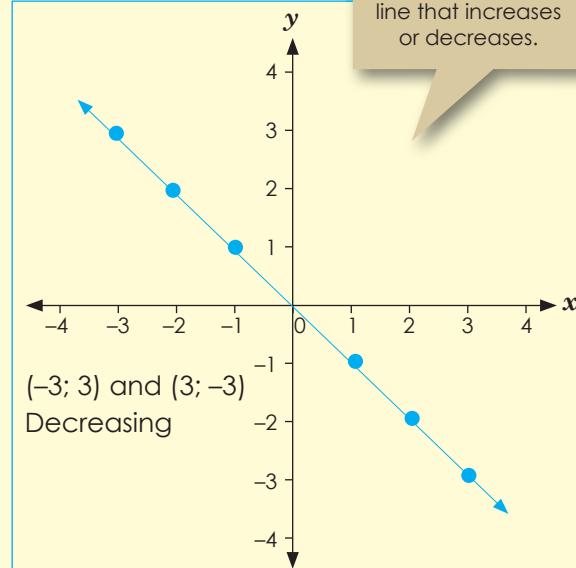
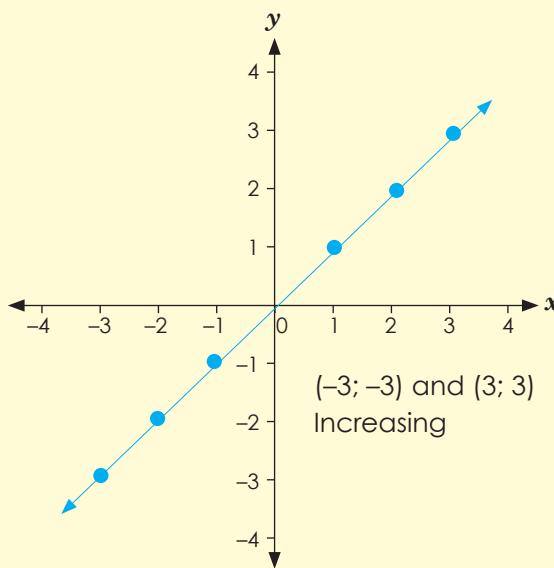
d. Compare your answers to b and c. Do exponents make an equation linear or non-linear?

continued ➔

Interpreting graphs continued

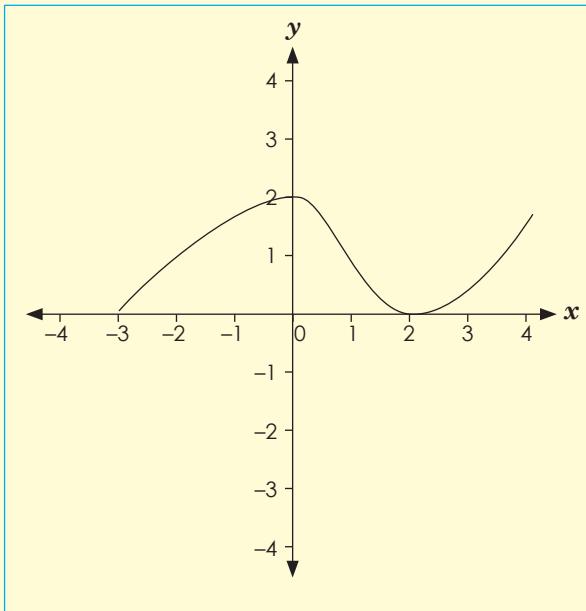
Look at the examples. Discuss.

Example:



A linear graph

means a straight line that increases or decreases.

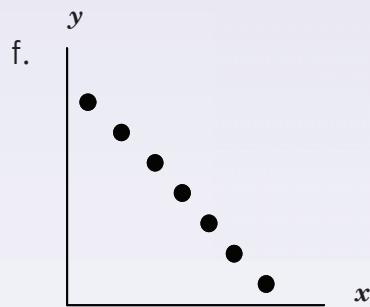
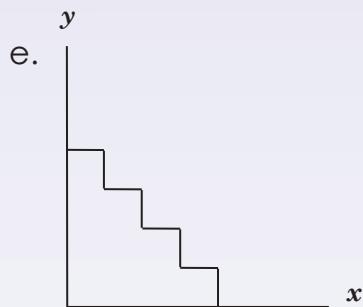
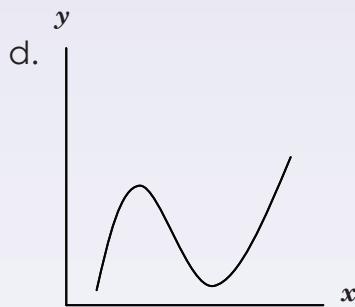
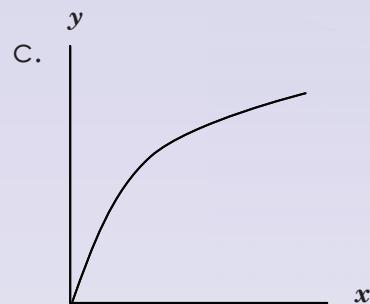
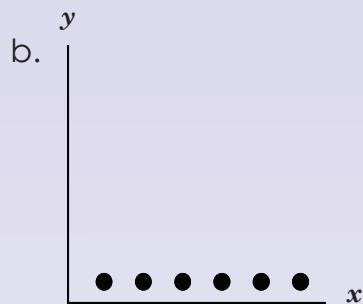
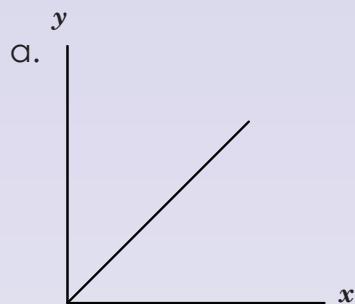


If a graph increases or decreases in a curved line it is a

non-linear graph.

A non-linear graph is not a straight line graph.

2. Describe each graph using the words highlighted in green in this worksheet.



Problem solving

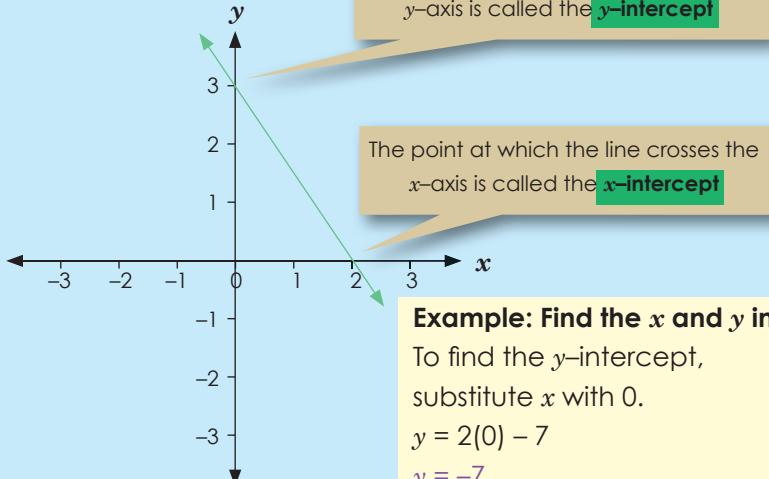
Draw a graph that includes four of the features learned in this worksheet.



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x-intercept and y-intercept

Read and discuss.



Example: Find the x and y intercepts of the graph of $y = 2x - 7$

To find the y -intercept,
substitute x with 0.

$$y = 2(0) - 7 \\ y = -7$$

To find the x -intercept,
substitute y with 0.

$$0 = 2x - 7 \\ 2x = 7 \\ x = \frac{7}{2}$$

The y -intercept is at point $(0, -7)$ and the x -intercept is at point $(\frac{7}{2}, 0)$

Term 3

Think back:

THEN

Think back to when you were in primary school: your worksheets contained statements like

+ 3 = 4 and you had to fill in the box.

NOW

Now you can say " $x + 3 = 4$ "

Using function notation

These $y =$ equations are **functions**. $f(x)$ is the symbol for a function involving a single variable (in this case x).

Previously we would have said:
 $y = 2x + 5$; solve for y if $x = -2$.

Now you can say:

$$f(x) = 2x + 5, \text{ find } f(-2).$$

Example: $f(x) = 2x + 5$, find $f(-2)$

$$\begin{aligned} f(-2) &= 2(-2) + 5 \\ &= -4 + 5 \\ &= 1 \end{aligned}$$

Let us proceed with x - and y -intercepts.

Find x - and y -intercepts of $y = f(x) = x^2 + x - 2$.

To find the x -intercepts, we solve

$$f(x) = x^2 + x - 2$$

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

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

$$x = 1 \text{ or } x = -2$$

So x -intercepts are $(1, 0)$ and $(-2, 0)$ and the y -intercept is $(0, -2)$

To find the y -intercept, we substitute $x = 0$

$$f(0) = (0)^2 + (0) - 2.$$

$$y = 0^2 + 0 - 2$$

$$y = -2$$

$$y = -2$$

1. Find the x - and y -intercepts.

Example: To find the y -intercept, substitute x with 0

$$y = 2(0) - 7$$

$$y = -7$$

To find the x -intercept, substitute y with 0

$$0 = 2x - 7$$

$$2x = 7$$

$$x = \frac{7}{2} = 3.5$$

a. $y = 2x + 4$

b. $y = 2x + 7$

c. $y = 2x - 5$

d. $y = 3x - 6$

e. $y = -4x - 1$

f. $y = -3x - 2$

2. Find the x - and y -intercepts.

a. $y = x^2 + 2x + 1$

b. $y = x^2 + 3x - 2$

c. $y = x^2 + 4x - 2$

d. $y = x^2 + 5x - 4$

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

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

Problem solving

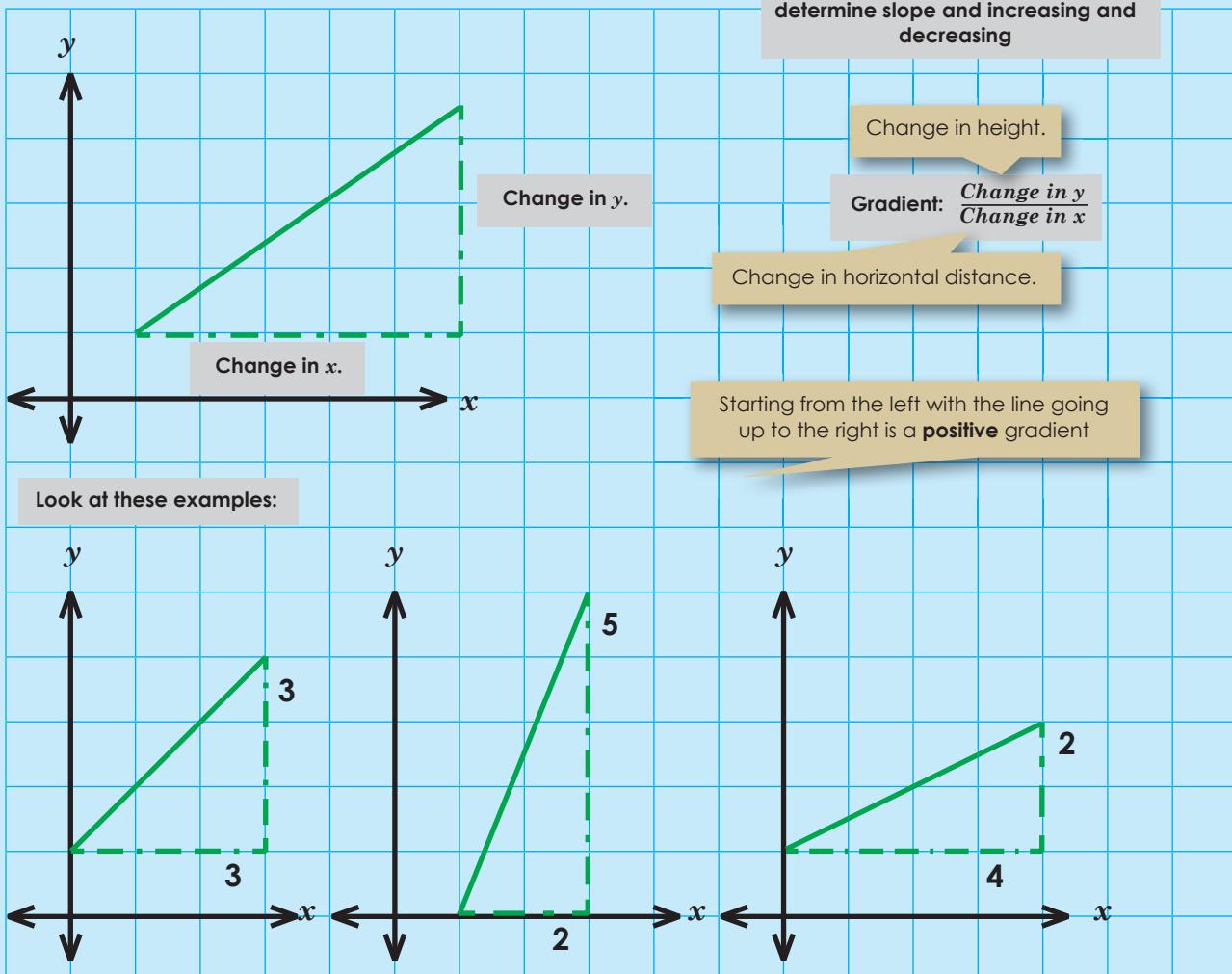
If the x -intercept is 4, what could the y -intercept be?



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Interpreting graphs: gradient



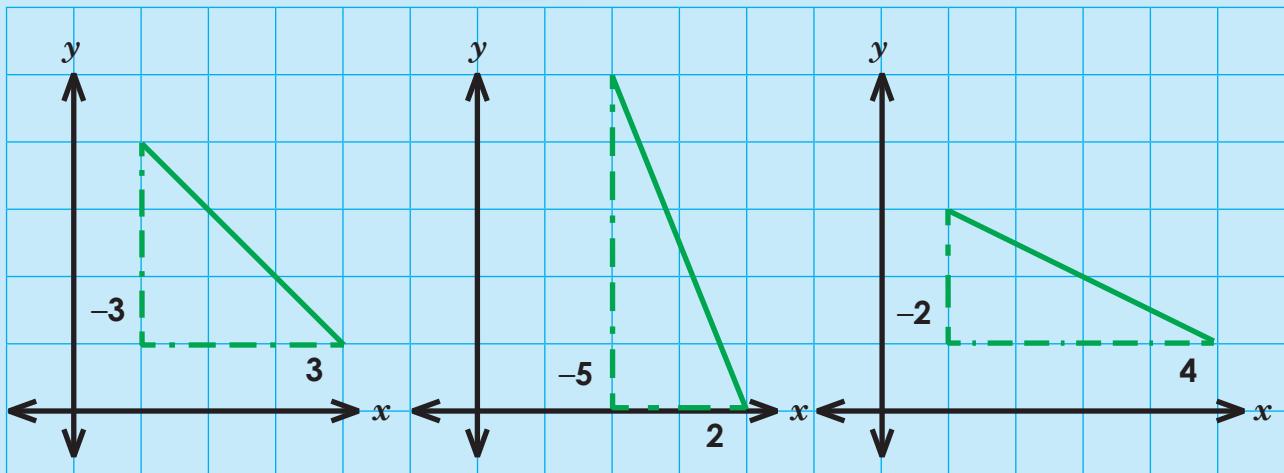
The gradient of the line is $\frac{3}{3} = 1$.

$\frac{5}{2} = 2\frac{1}{2} = 2,5$
The line is steeper so the gradient is larger.

$\frac{2}{4} = \frac{1}{2} = 0,5$
The line is less steep, so the gradient is smaller.

Negative gradient:

Starting from the left with the line going down to the right is a **negative** gradient.



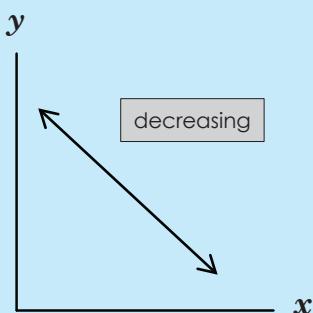
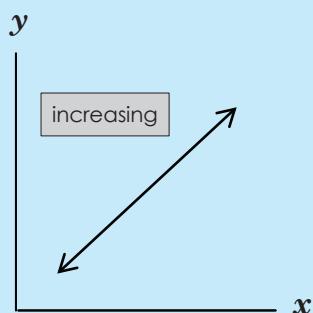
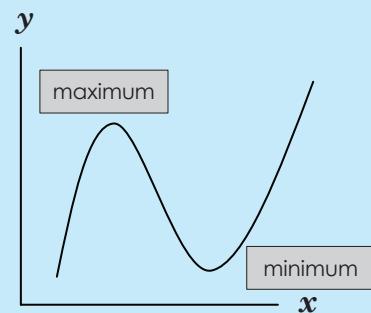
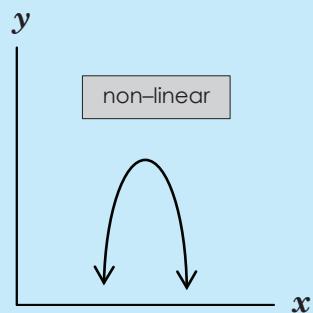
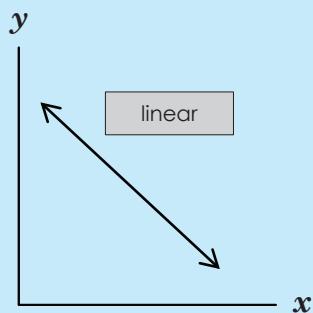
The gradient is:

$$\frac{-3}{3} = -1$$

$$\frac{-5}{2} = -2\frac{1}{2} = -2,5$$

$$\frac{-2}{4} = -\frac{1}{2} = -0,5$$

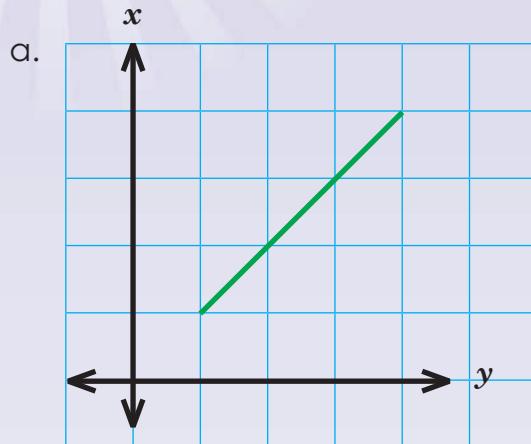
Remember these terms that we use when we talk about linear and non-linear graphs:

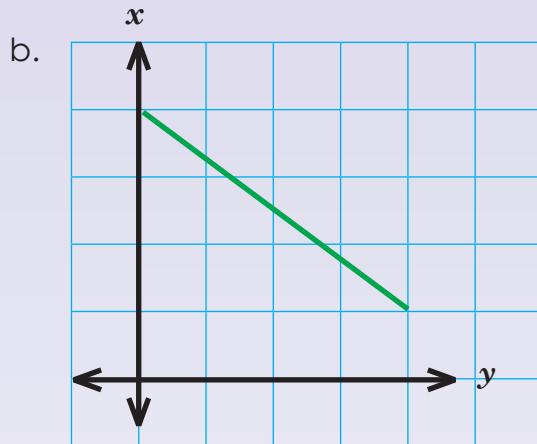


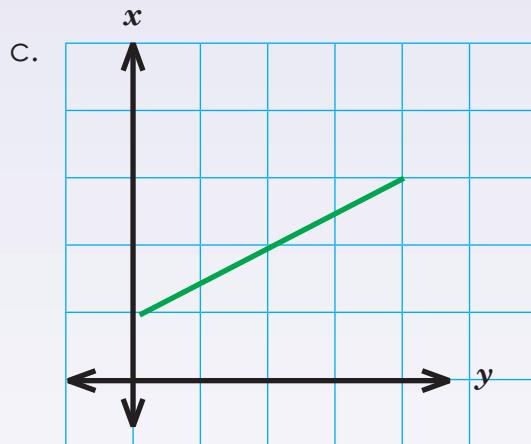
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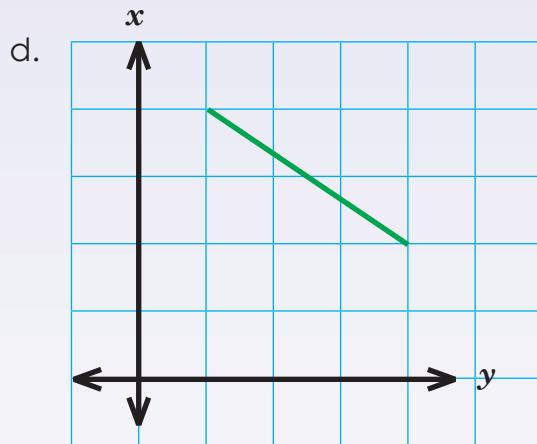
Interpreting graphs: gradient continued

1. What are the gradients of these lines?

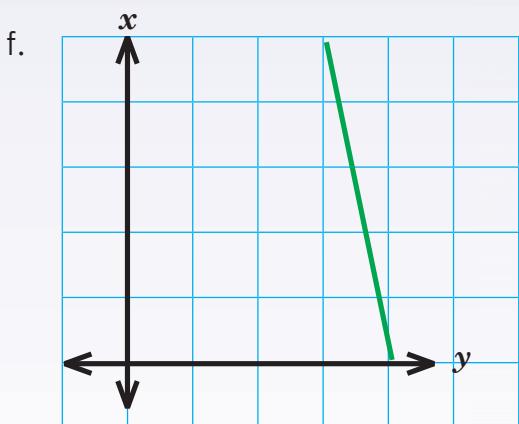
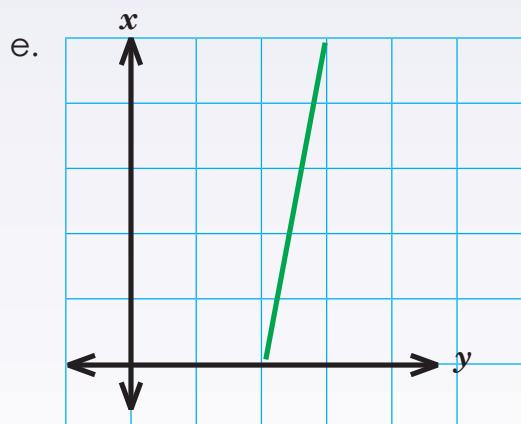
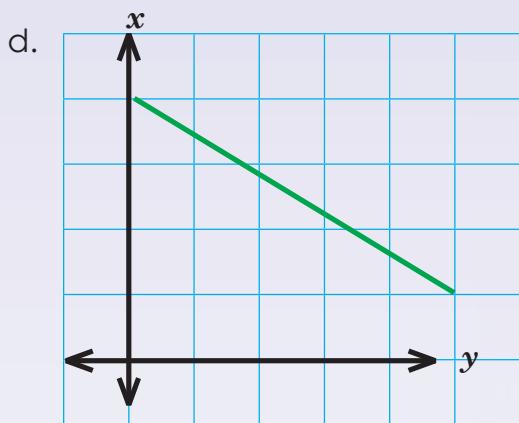
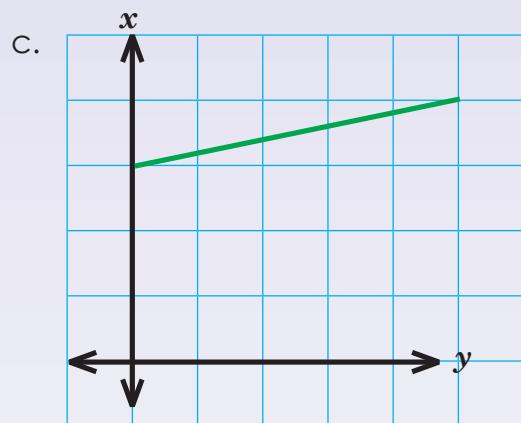
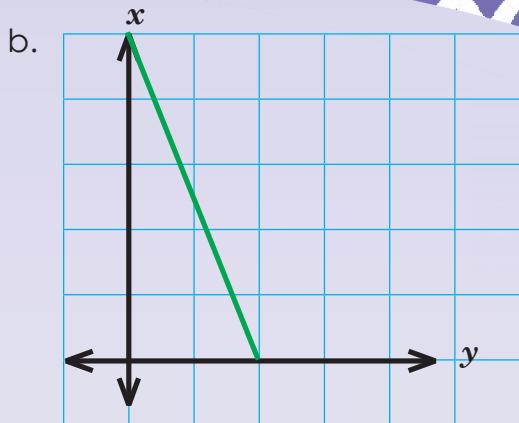
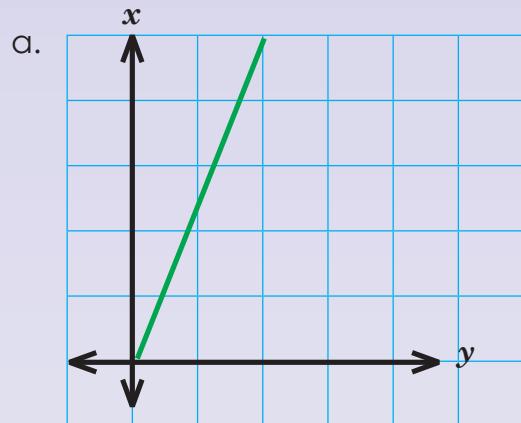








2. What are the gradients of these lines?



Problem solving

How would you determine the gradient of any object in your home.

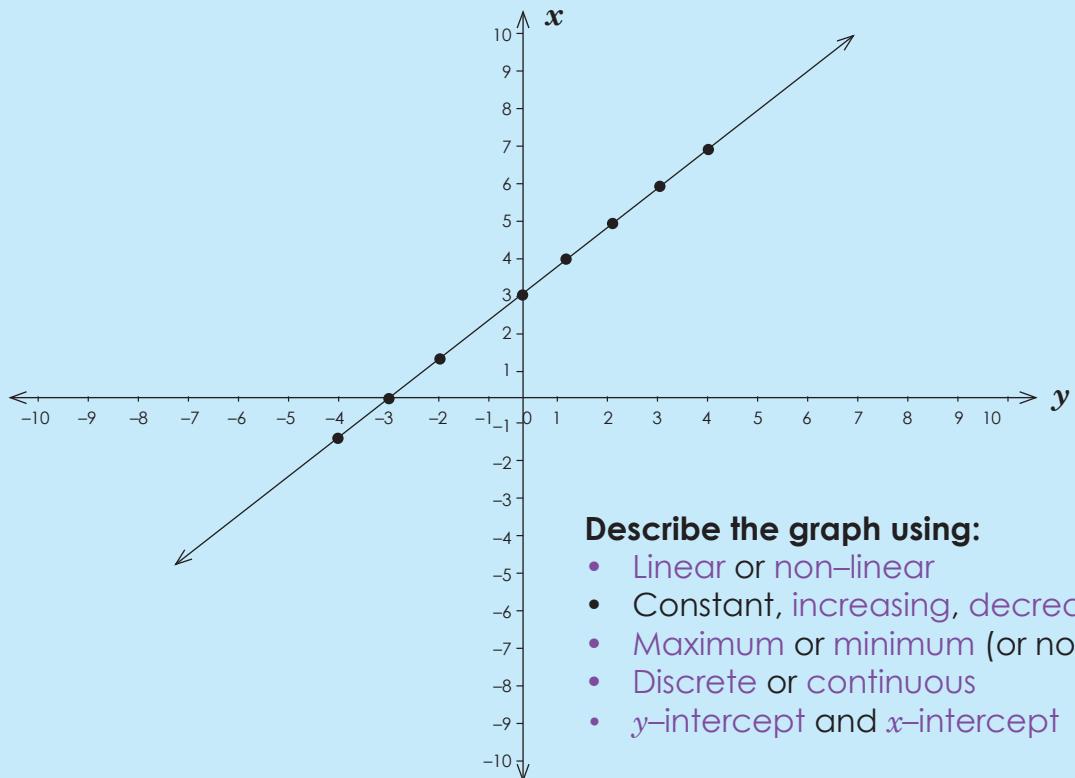


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91

Use tables of ordered pairs

x	-4	-3	-2	-1	0	1	2	3	4
y	-1	0	1	2	3	4	5	6	7



Describe the graph using:

- Linear or non-linear
- Constant, increasing, decreasing
- Maximum or minimum (or not applicable)
- Discrete or continuous
- y -intercept and x -intercept

1. Plot the following on the Cartesian plane. Use some of the above words to describe the graphs.

a.

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

b.

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

c.

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

d.

x	-4	-3	-2	-1	0	1	2	3	4
y	1	0	1	2	3	4	5	6	7

e.

x	-4	-3	-2	-1	0	1	2	3	4
y	18	11	6	3	0	3	6	11	18

f.

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

Problem solving

Create your own table with ordered pairs and a graph showing a linear graph intercepting the x -axis and y -axis.



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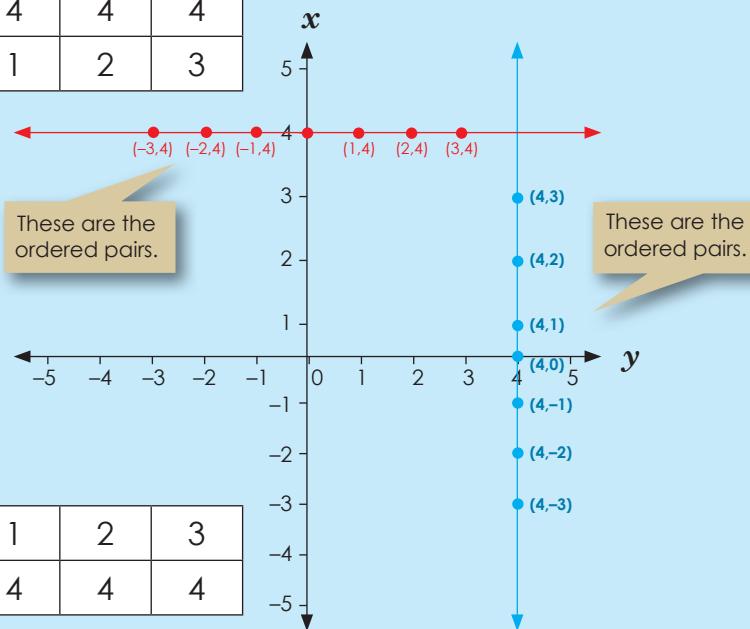
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$x = 4$

In this equation for all the values of y , $x = 4$ and it is plotted as a straight vertical line. We can say that the equation is independent from y .

If you write it in a table, it looks like this:

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



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

 $y = 4$

This equation is independent from x , so for all values of x , $y = 4$, it is plotted as a straight horizontal line.

1. Sketch and compare the graphs of:

a. $x = 3$
 $y = 3$

x					
y					

b. $x = -2$
 $y = -2$

x					
y					

c. $x = 5$
 $y = 5$

x						
y						

d. $x = 7$
 $y = 7$

x						
y						

e. $x = -6$
 $y = 6$

x						
y						

f. $x = -8$
 $y = 8$

x						
y						

Problem solving

Sketch and compare the graphs of $y = 2,5$ and $x = 2,5$.



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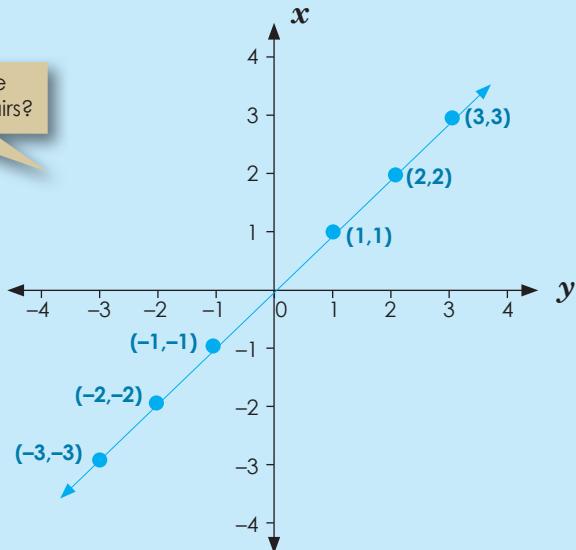
Date:

$x = y$

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

Is this graph linear or non-linear?

What are ordered pairs?



Is this graph constant, increasing or decreasing?

What will the graph look like if it is decreasing?

1. Sketch and compare the graphs. Use the graph paper on the next page. Use colour and label each graph.

- a. $x = y$ b. $x = -y$
 c. $-x = y$ d. $-x = -y$

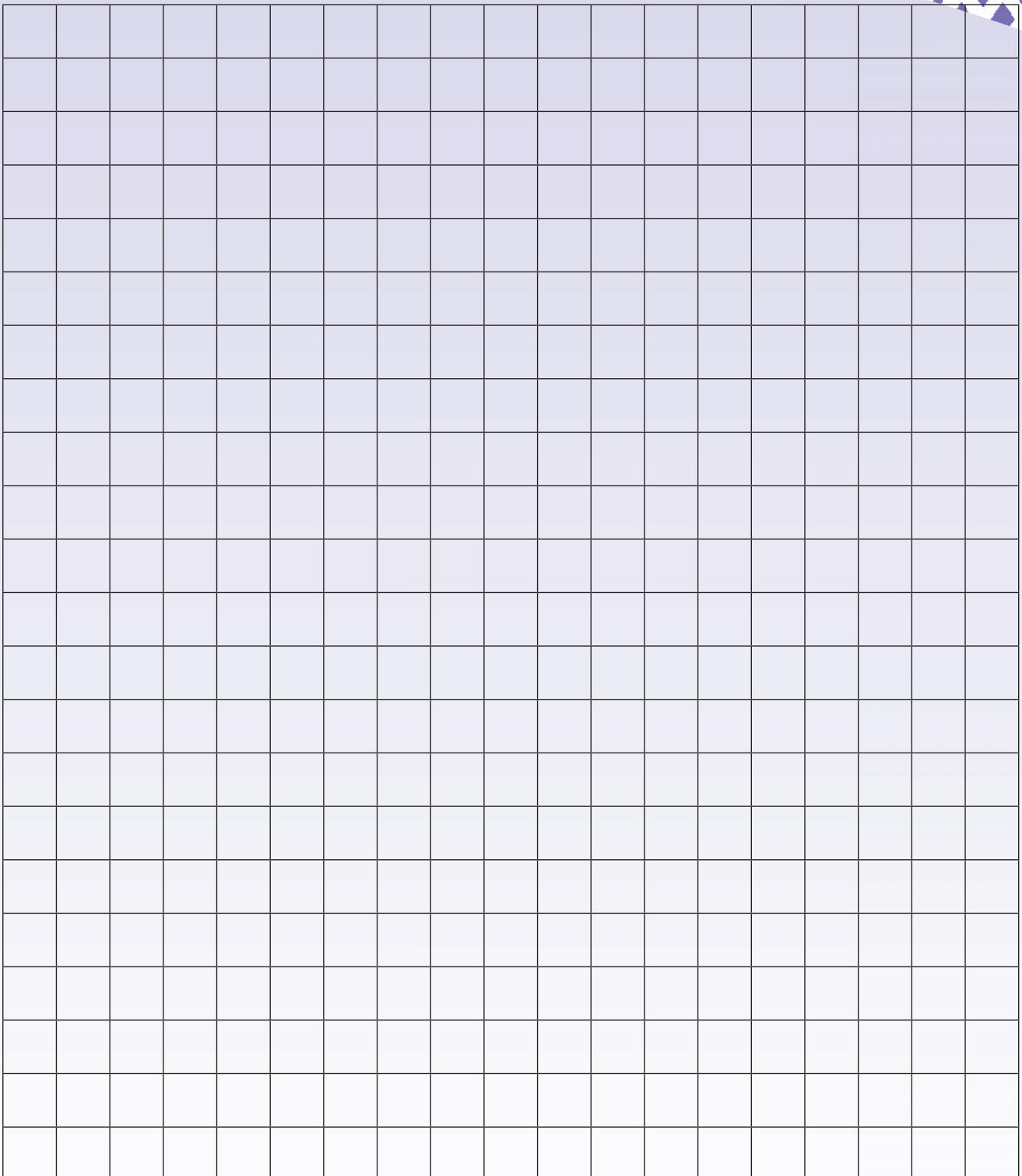
2. Describe each graph.

- a. Is the graph linear or non-linear?

a.	b.	c.	d.
----	----	----	----

- b. Is the graph constant, increasing or decreasing?

a.	b.	c.	d.
----	----	----	----



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Date: _____

Problem solving

Compare the graphs a, b, c and d.

Sketch and compare the graphs: $y = 2x$; $y = 2x + 1$; $y = 2x - 1$

$$y = 2x$$

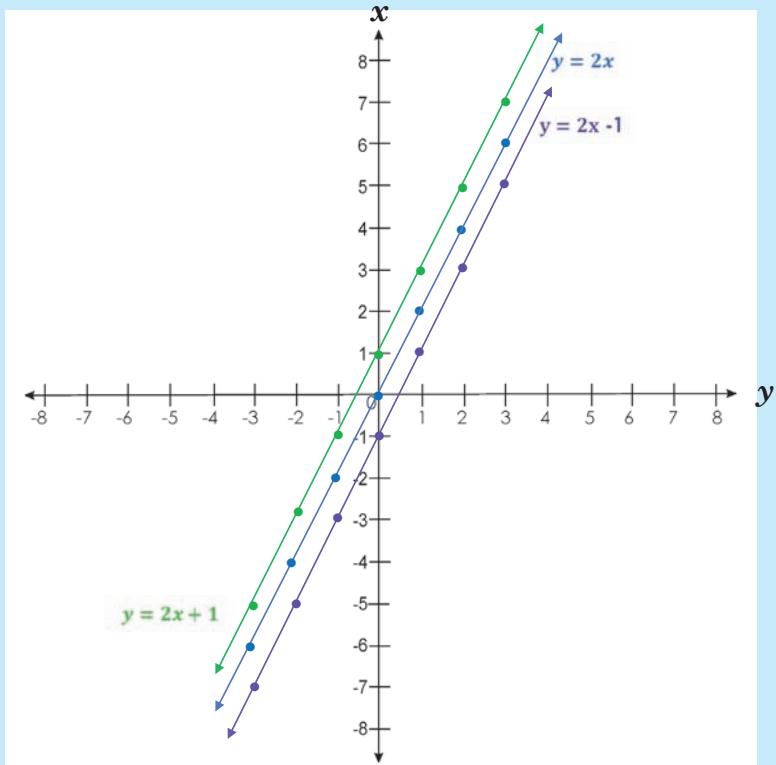
x	-3	-2	-1	0	1	2	3
y	-6	-4	-2	0	2	4	6

$$y = 2x + 1$$

x	-3	-2	-1	0	1	2	3
y	-5	-3	-1	1	3	5	7

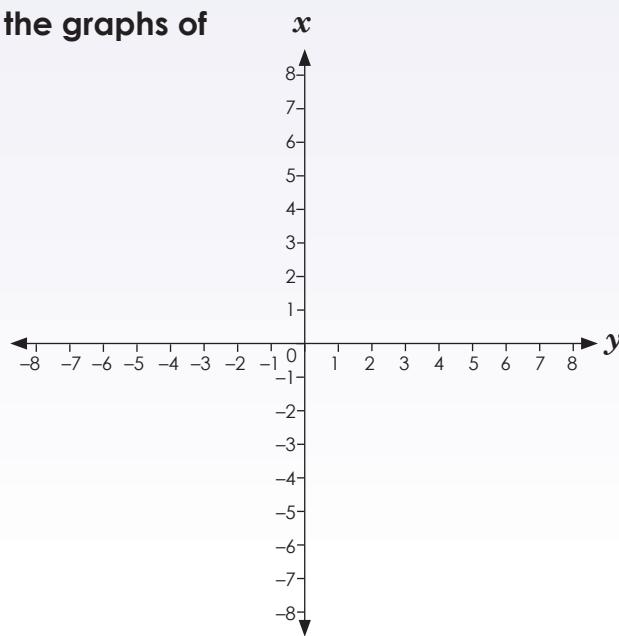
$$y = 2x - 1$$

x	-3	-2	-1	0	1	2	3
y	-7	-5	-3	-1	1	3	5

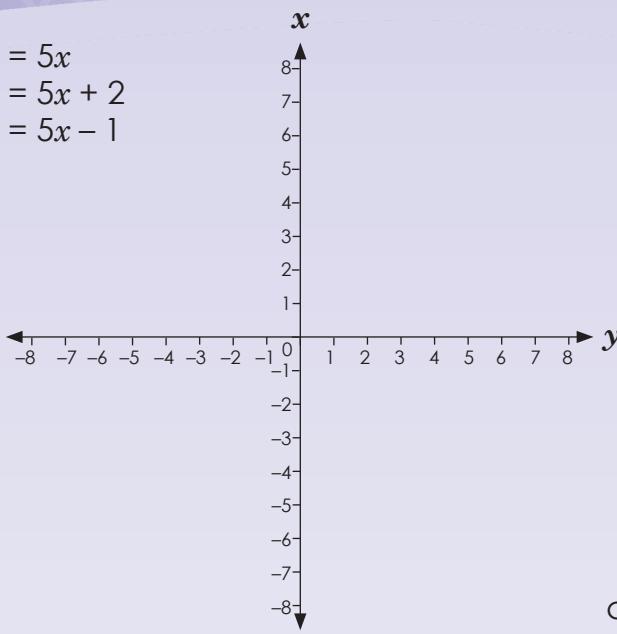


1. Sketch and compare the graphs of

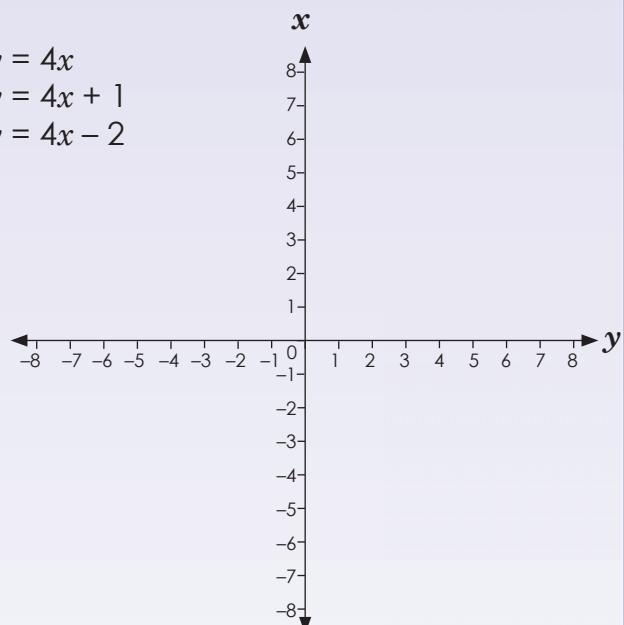
- a. $y = 3x$
 $y = 3x + 1$
 $y = 3x - 1$



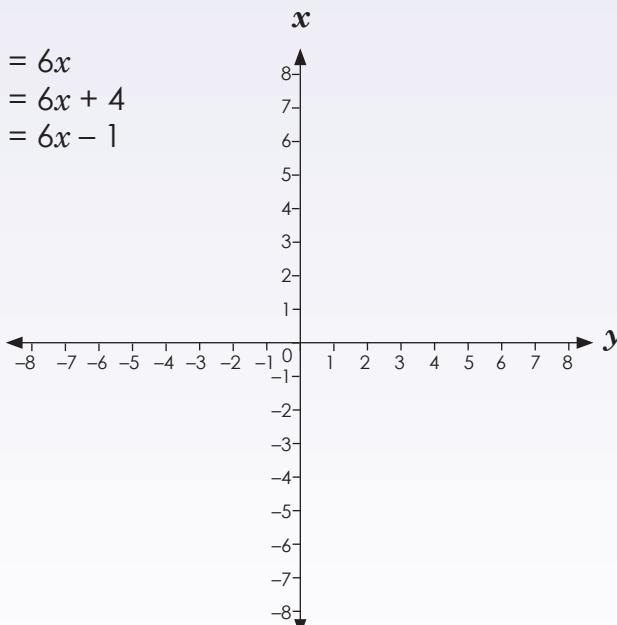
- b. $y = 5x$
 $y = 5x + 2$
 $y = 5x - 1$



- c. $y = 4x$
 $y = 4x + 1$
 $y = 4x - 2$



- d. $y = 6x$
 $y = 6x + 4$
 $y = 6x - 1$



Problem solving.

Sketch and compare the graphs of $y = 6x$, $y = 6x + 1$ and $y = 6x - 1$



Sign:

Date:

Sketch and compare graphs

 $y = 3x$

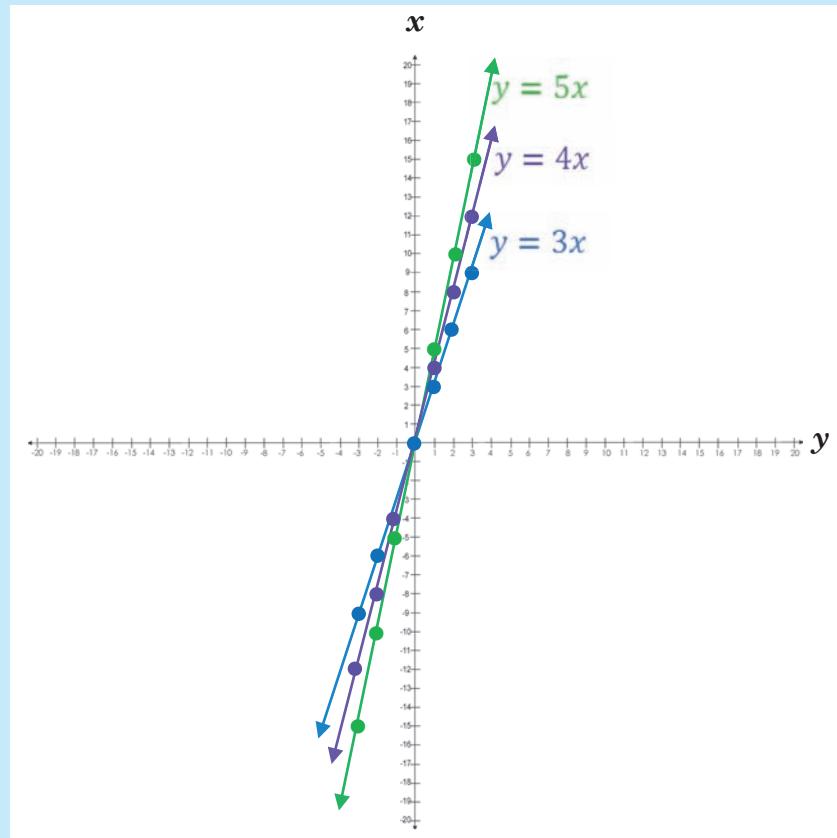
x	-3	-2	-1	0	1	2	3
y	-9	-6	-3	0	3	6	9

 $y = 4x$

x	-3	-2	-1	0	1	2	3
y	-12	-8	-4	0	4	8	12

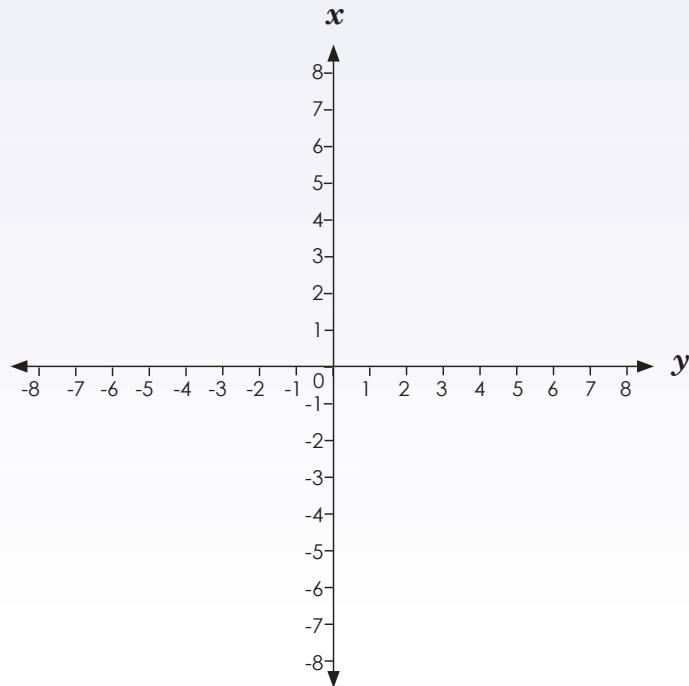
 $y = 5x$

x	-3	-2	-1	0	1	2	3
y	-15	-10	-5	0	5	10	15

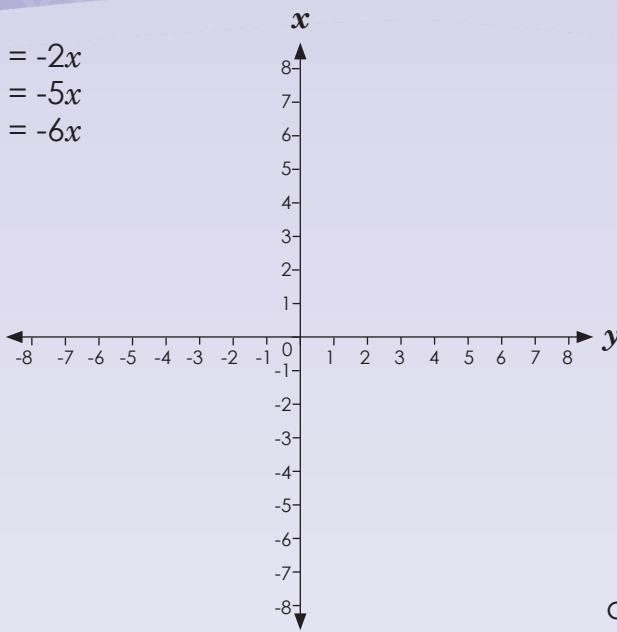


1. Sketch, label and compare the graphs.

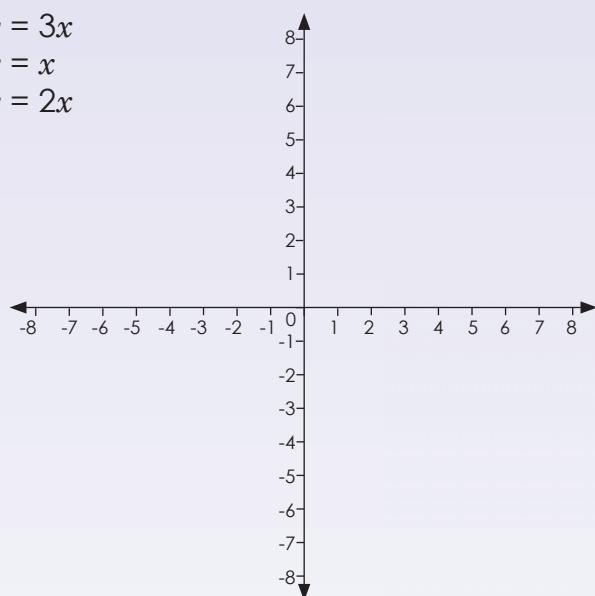
- a. $y = 2x$
 $y = 5x$
 $y = 6x$



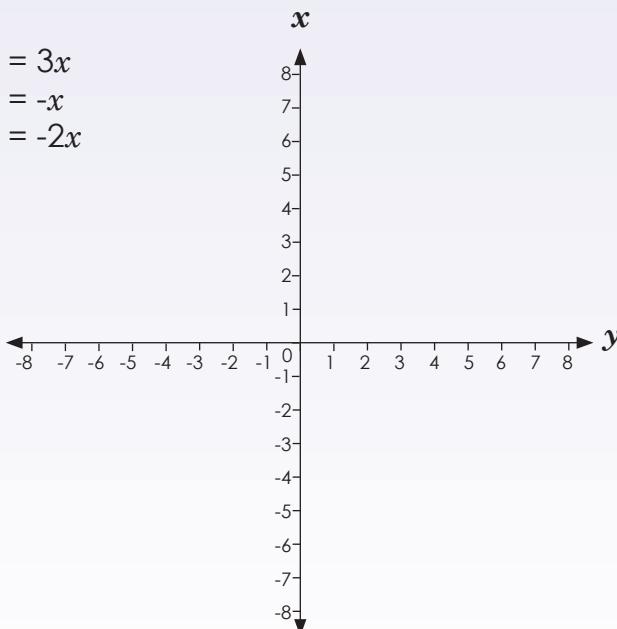
- b. $y = -2x$
 $y = -5x$
 $y = -6x$



- c. $y = 3x$
 $y = x$
 $y = 2x$



- d. $y = 3x$
 $y = -x$
 $y = -2x$



Problem solving

Compare the graphs in a, b, c and d.



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96a

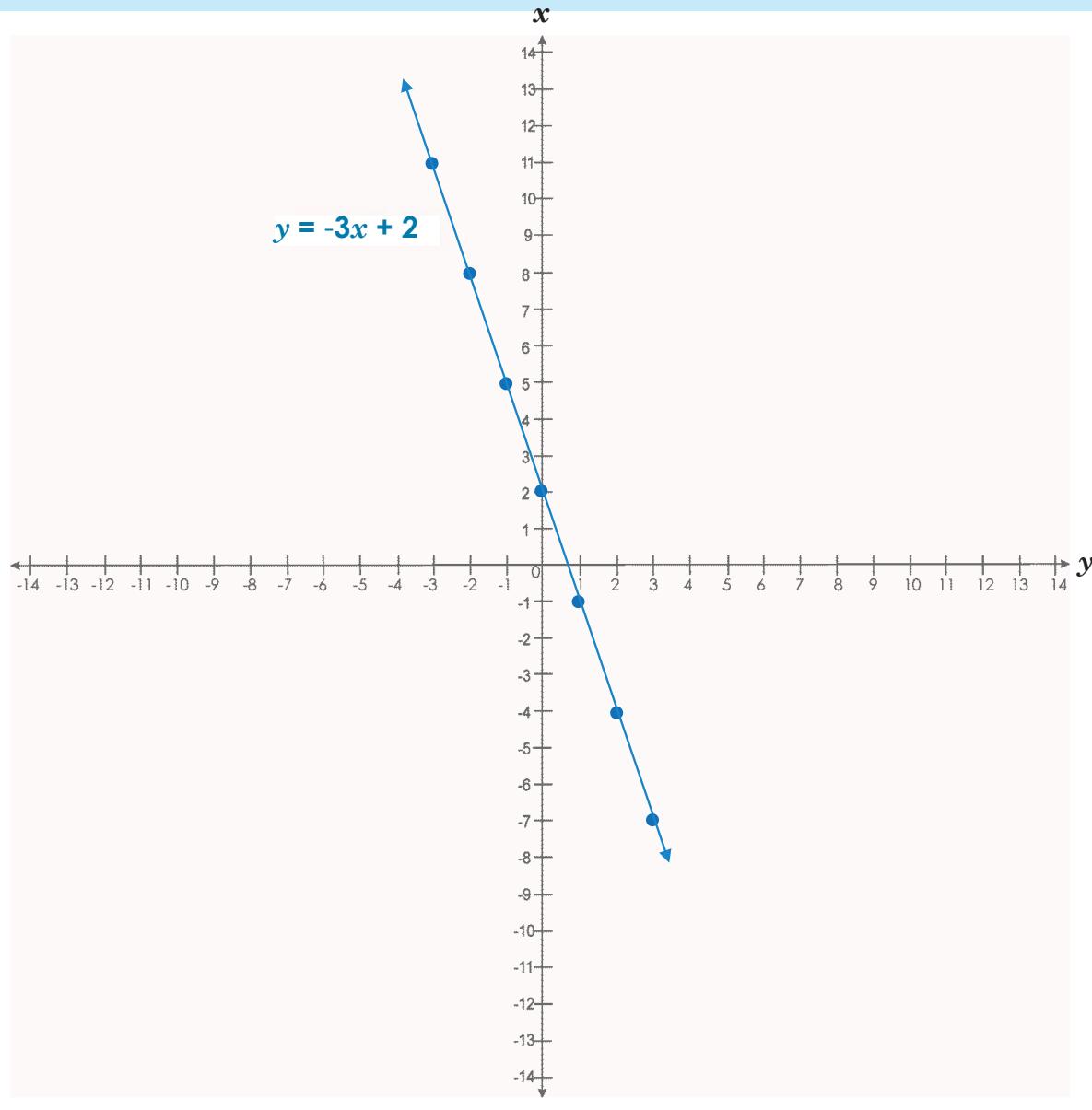
Compare and sketch graphs



$$y = -3x + 2$$

x	-3	-2	-1	0	1
y	11	8	5	2	-1

Plot it on the graph and join the points.



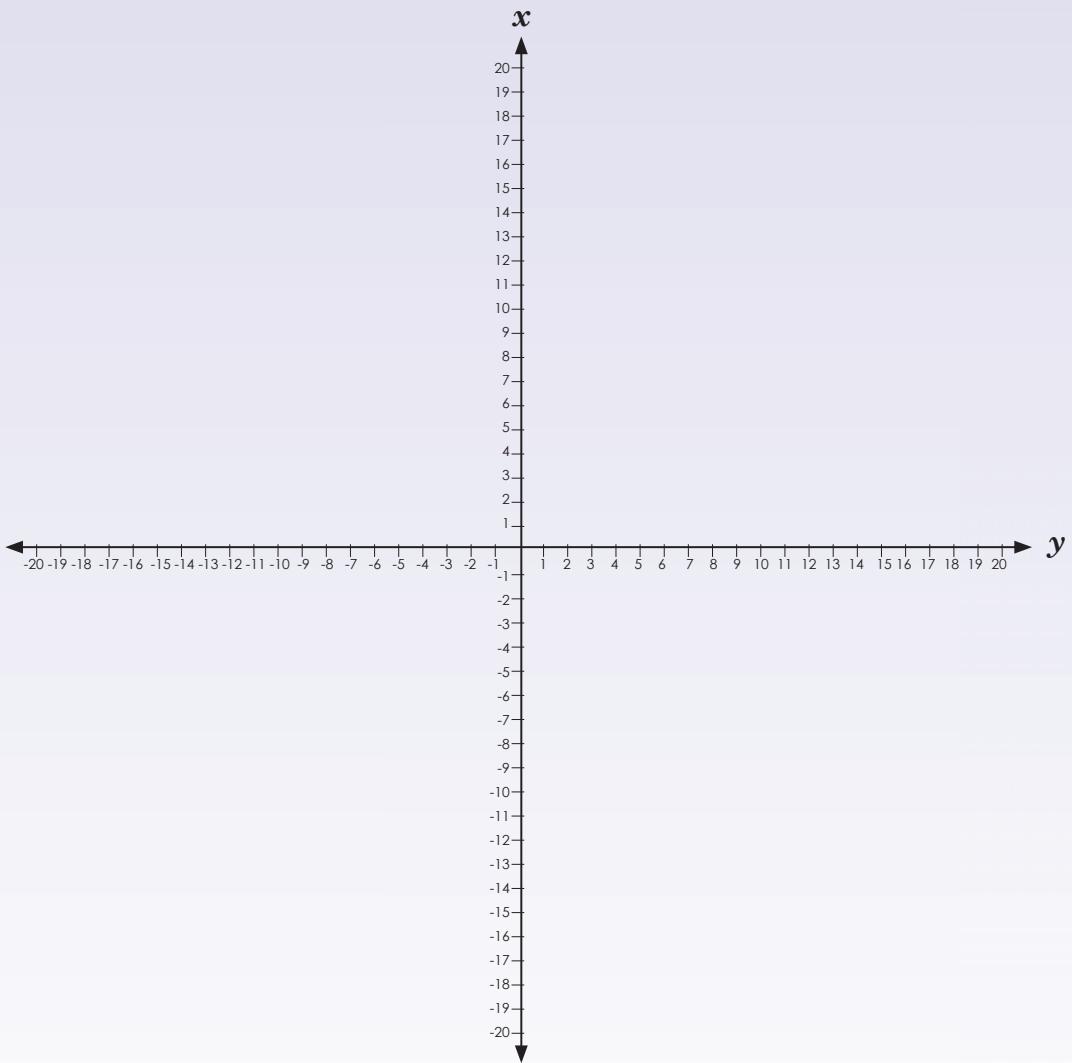
Term 3

80

1. Complete the table and sketch the graph.

a. $y = 4x + 3$

x							
y							



Sign:

Date:

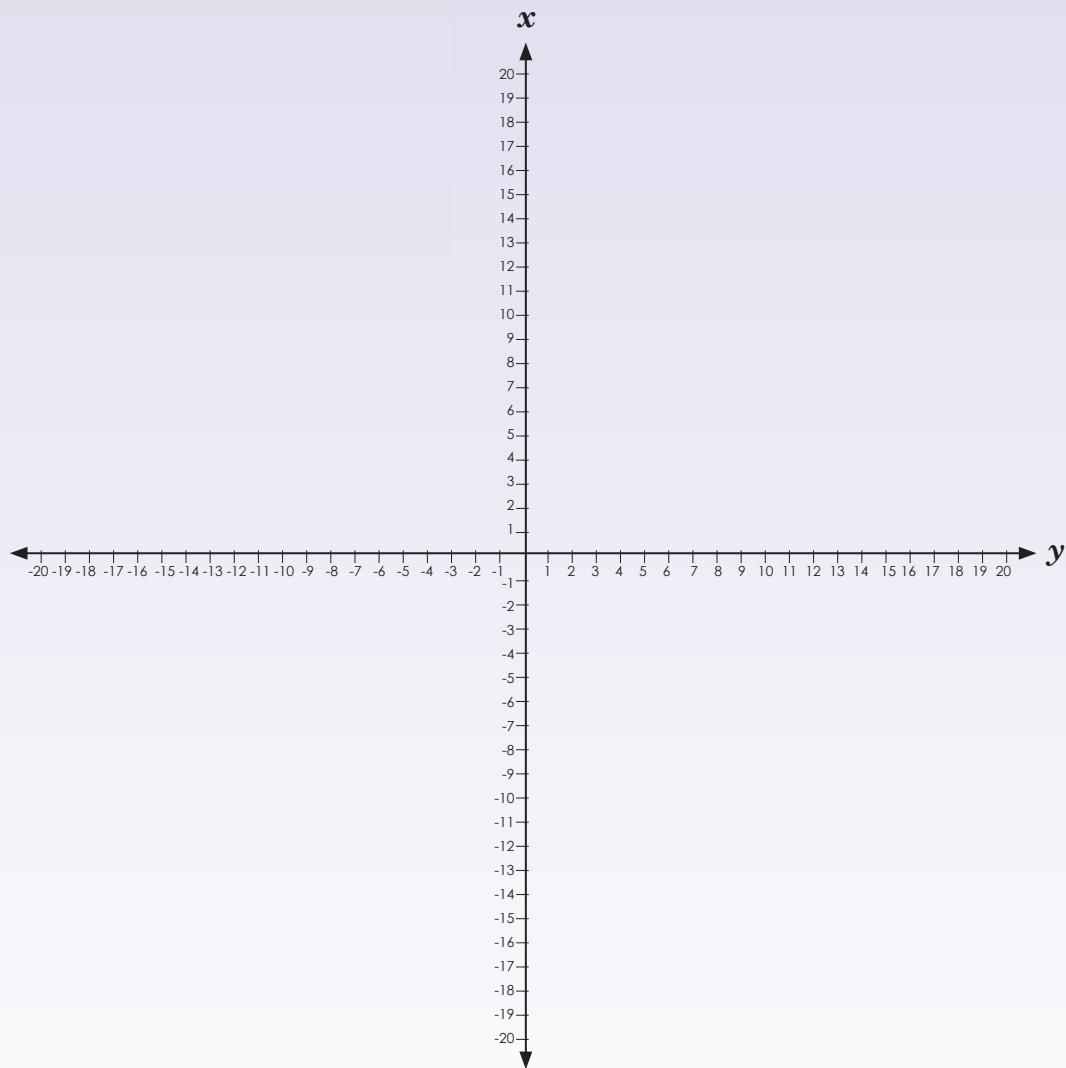
continued

96b

Compare and sketch graphs continued

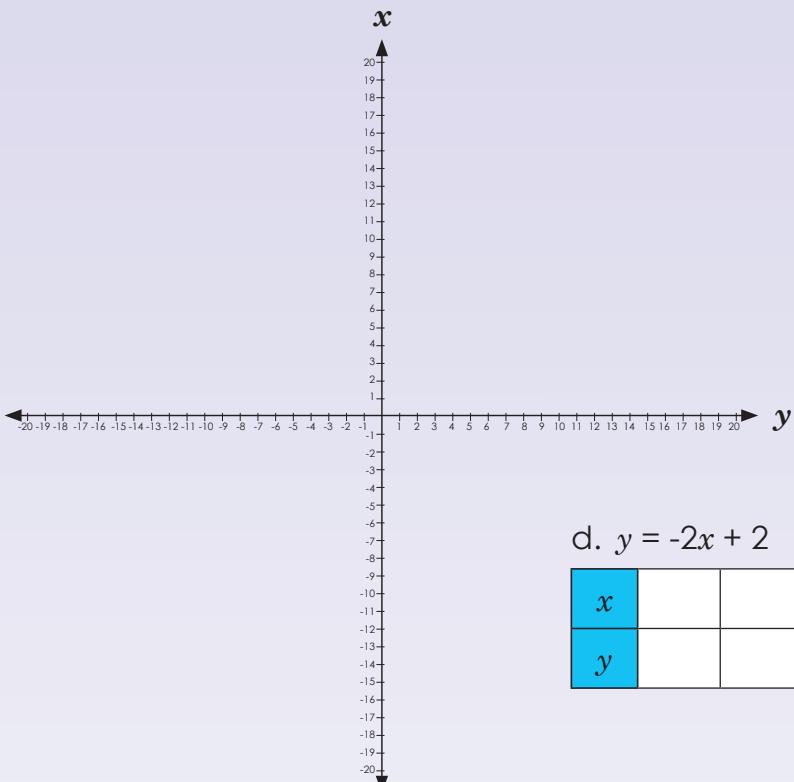
b. $y = 2x + 4$

x						
y						



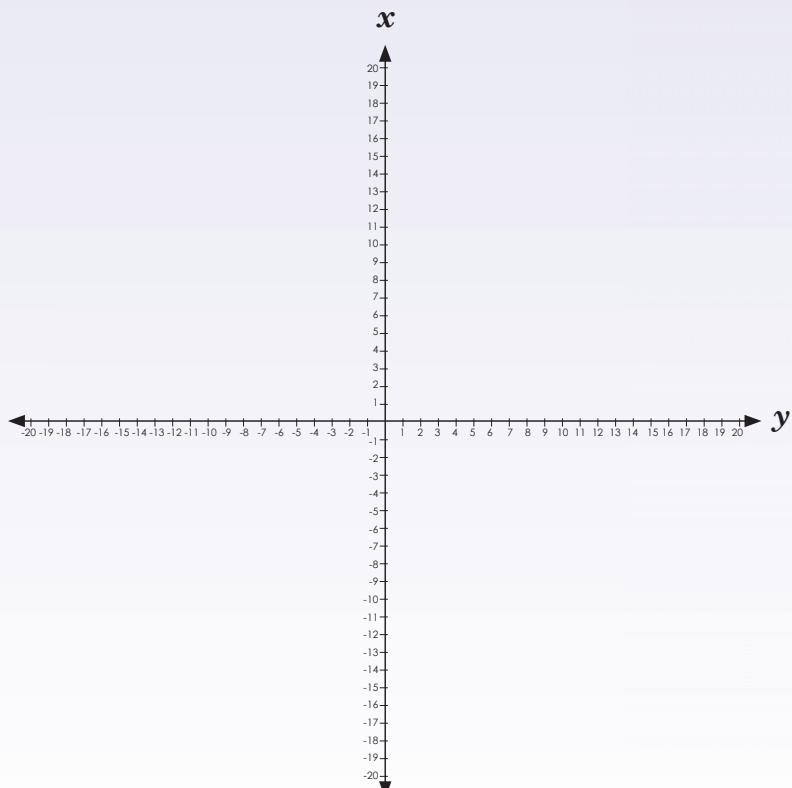
C. $y = -3x + 1$

x						
y						



d. $y = -2x + 2$

x						
y						



Problem solving

Compare graphs a and b.

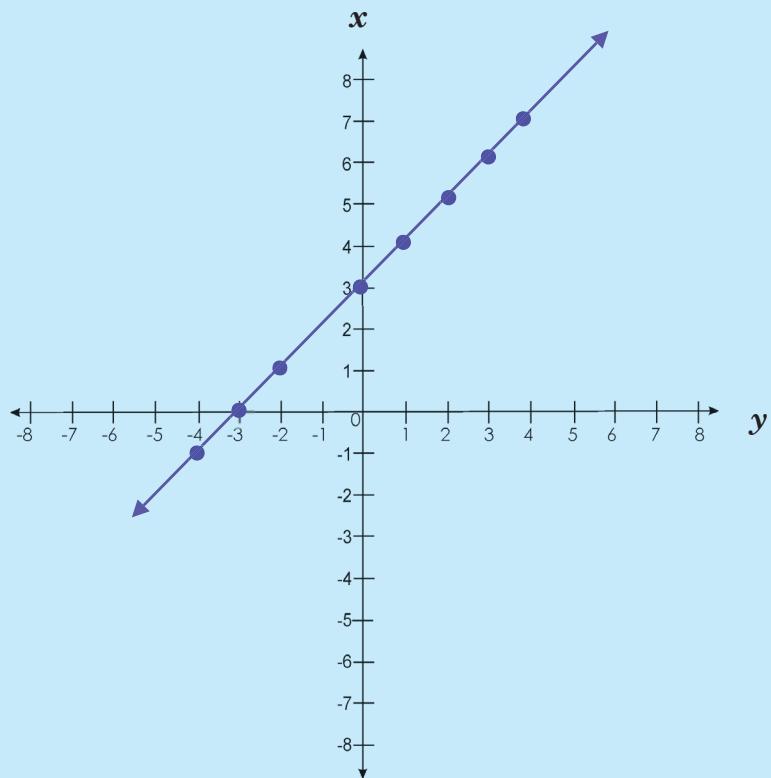


Sign: _____
Date: _____



Equation: $y = x + 3$

x	-4	-3	-2	-1	0	1	2	3	4
y	-1	0	1	2	3	4	5	6	7



1. Draw a graph using the equation and the given table. If the graph increases or decreases, what must you change to make it increase or decrease more?

a.

x	-3	-2	-1	0	1	2	3
y	-13	-8	-3	2	7	12	17

Equation: $y = 5x + 2$

b.

x	-3	-2	-1	0	1	2	3
y	-18	-12	-6	0	6	12	18

Equation: $y = 6x$

c.

x	-3	-2	-1	0	1	2	3
y	-14	-10	-6	-2	2	6	10

Equation: $y = 4x - 2$

d.

x	-3	-2	-1	0	1	2	3
y	7	5	3	1	-1	-3	-5

Equation: $y = 2x + 1$

e.

x	-3	-2	-1	0	1	2	3
y	8	5	2	-1	-4	-7	-10

Equation: $y = -3x - 2$

Problem solving

Determine the equation of the straight line passing through some points given by you.



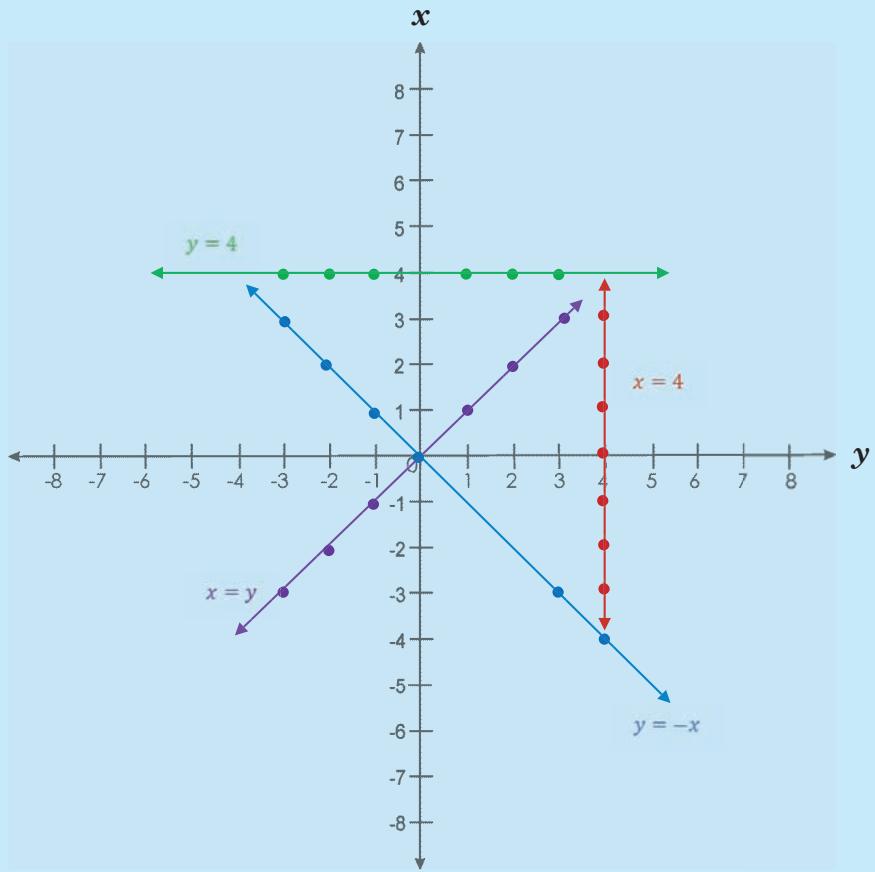
Sign:

Date:

More graphs

Look at the graph and write the ordered pairs in the tables. We have done the first one for you.

Term 3



1. a. $y = 4$

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

b. $x = 4$

x						
y						

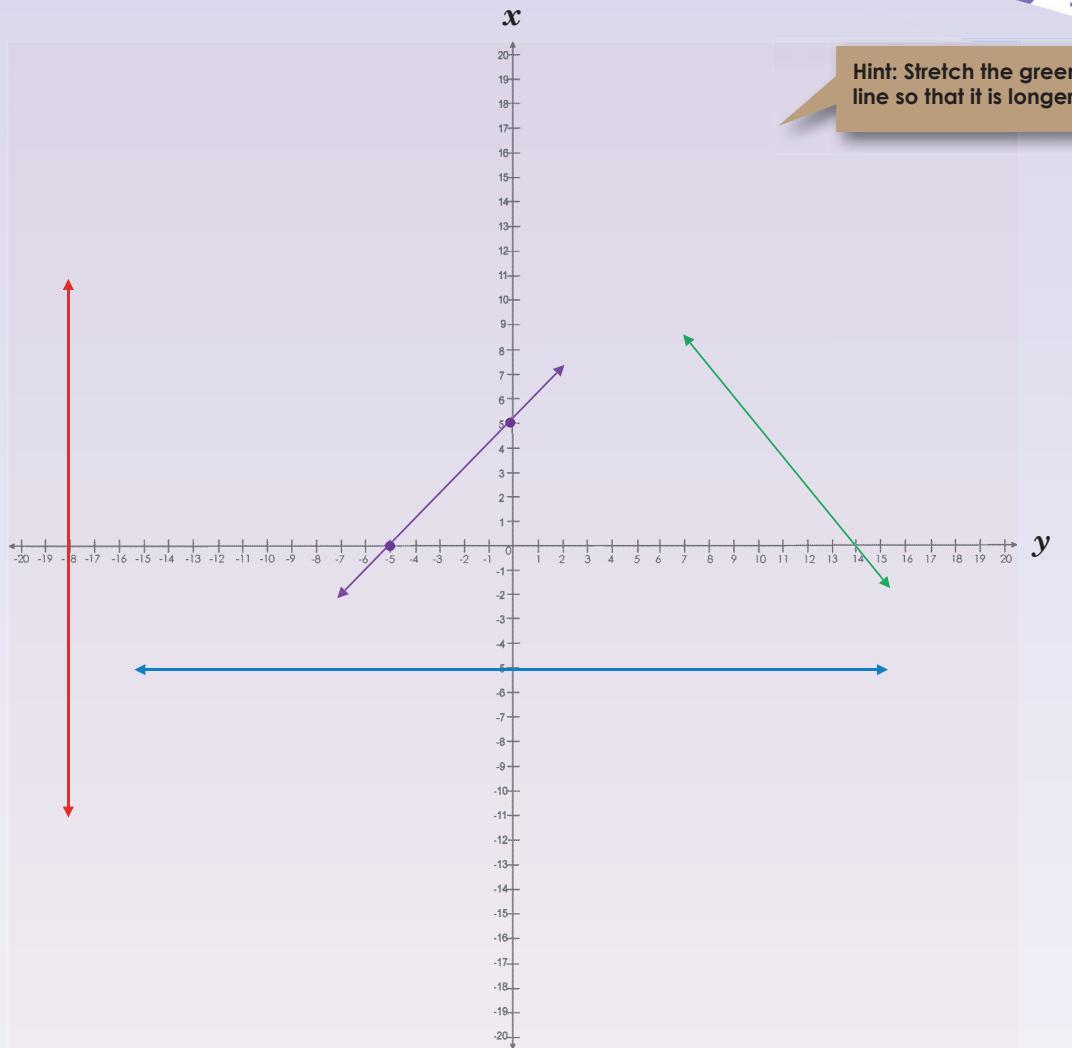
c. $x = y$

x						
y						

d. $y = -x$

x						
y						

2. Look at the coloured lines on this graph.
What will the ordered pairs and equations be?



x						
y						

x						
y						

x						
y						

x						
y						

Problem solving

Determine the equation of a linear graph by drawing your own graph first.

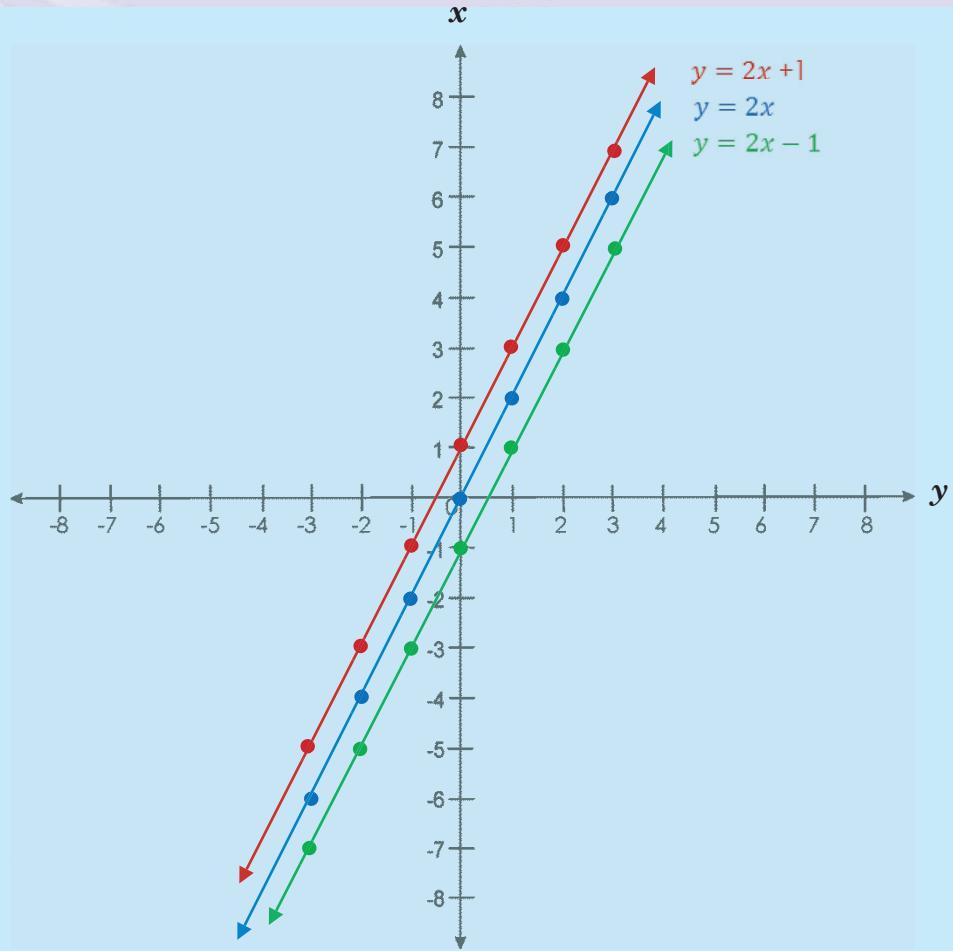


Sign:
Date:

99a

Yet more graphs

Term 3



What is the rule?

a. $y = 2x$

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

b. $y = 2x + 1$

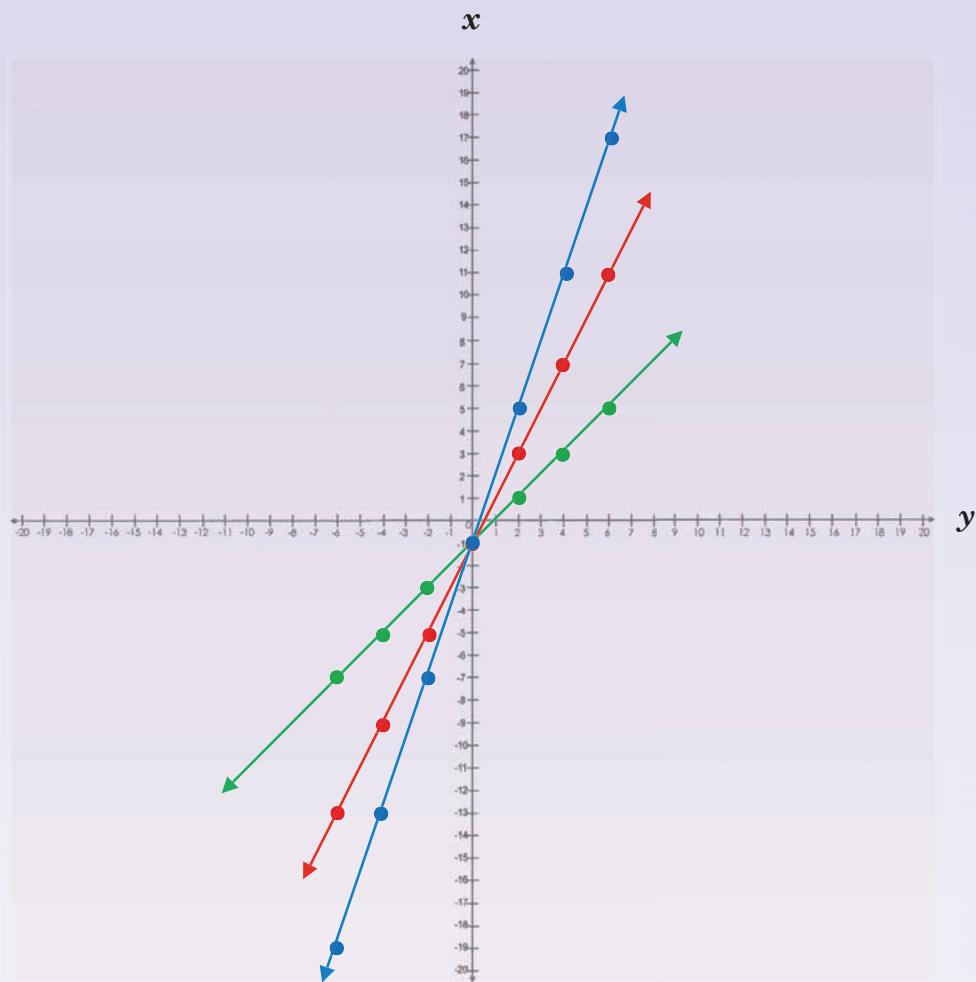
x	-3	-2	-1	0	1	2	3
y	-5	-3	-1	1	3	5	7

c. $y = 2x - 1$

x	-3	-2	-1	0	1	2	3
y	-7	-5	-3	-1	1	3	5

1. Determine the equation.

a.



Equation:

x						
y						

Equation:

x					
y					

Equation:

x					
y					



Sign:
Date:

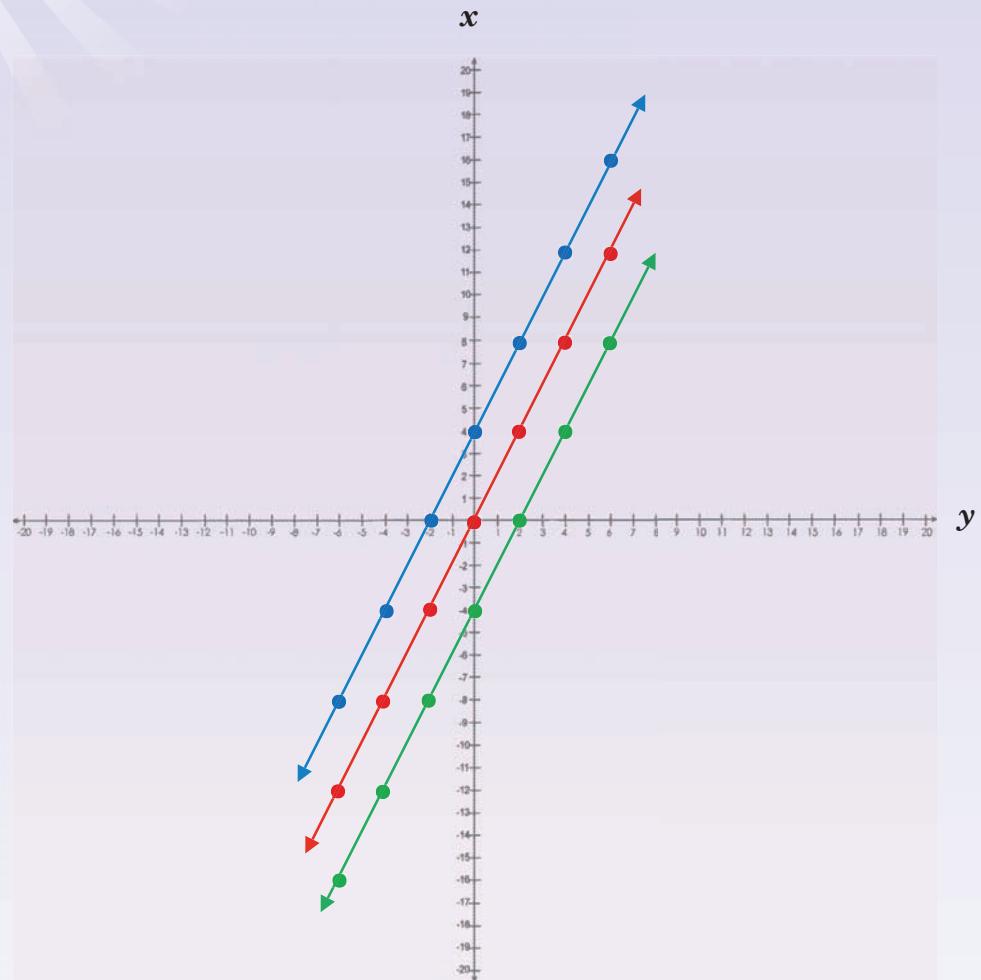
continued ➔

99b

Yet more graphs continued

Term 3

b.



Equation:

x							
y							

Equation:

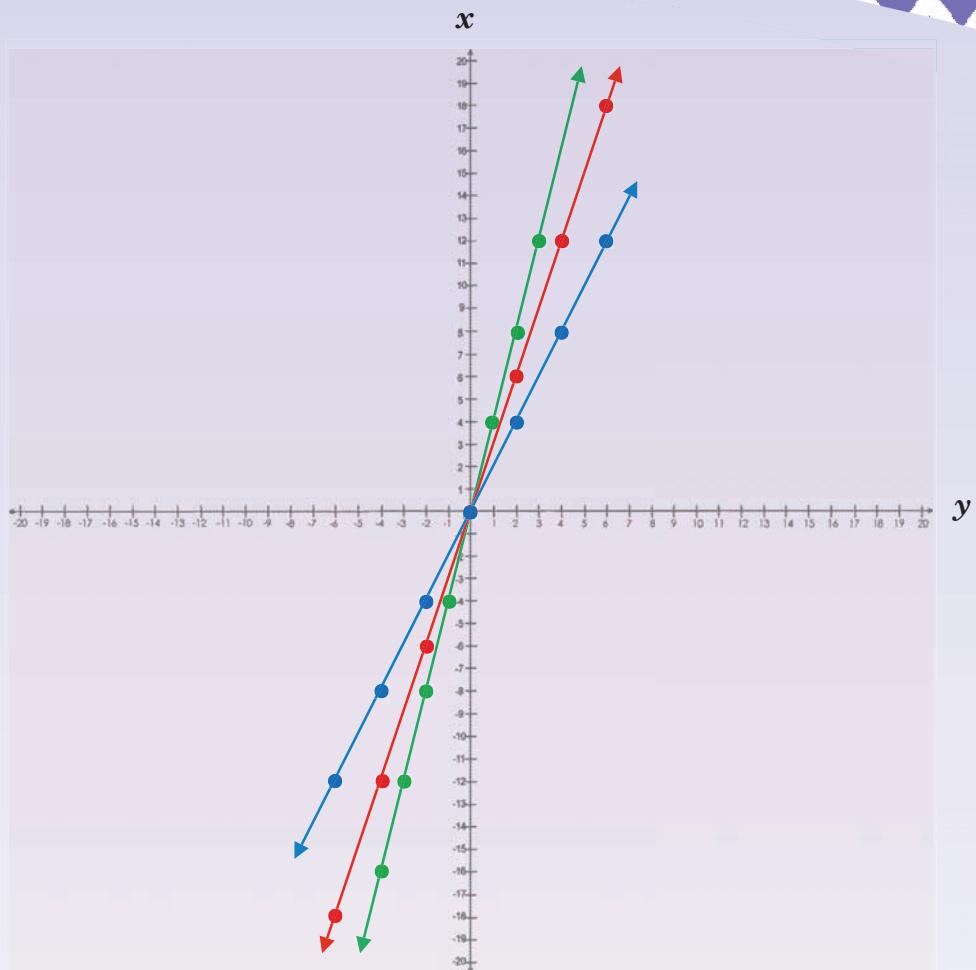
x							
y							

Equation:

x							
y							

90

C.



Equation:

x						
y						

Equation:

x						
y						

Equation:

x						
y						

Problem solving

Determine the equation of three straight lines by drawing any three lines on a graph (use this worksheet to guide you).



Sign:
Date:



Surface area, volume and capacity of a cube

100a

1. Calculate the volume, capacity (filled with water) and surface area of the following cubes. The one side equals ____.

a. 5 cm

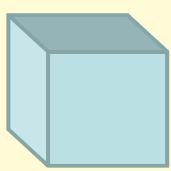
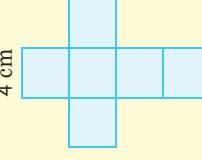
b. 2.8 cm

c. 4.3 cm

d. 5.25 cm

e. 40 cm

f. 55 cm

Perimeter of a square	Area of a square	The volume of a cube	Surface area of a cube	Capacity
$P = 4l$ ($l = \text{length}$)	$A = l^2$	$V = l^3$	$A = \text{the sum of the area of all the faces}$	An object with a volume of 1 cm^3 will displace exactly 1 ml of water. • An object with a volume of 1 m^3 will displace exactly 1 kl of water.
If 1 cm = 10 mm, then $1 \text{ cm}^2 = 100 \text{ mm}^2$				
If 1 m = 100 cm, then $1 \text{ m}^2 = 10\,000 \text{ cm}^2$				
If 1 cm = 10 mm, then $1 \text{ cm}^3 = 1\,000 \text{ mm}^3$				
If 1 m = 100 cm, then $1 \text{ m}^3 = 1\,000\,000 \text{ cm}^3$ or 10^6 cm^3				
			Where in real life do we use the volume and surface area of a cube?	
Volume	Capacity	Surface area	Surface area	
Volume of a solid is the amount of space it occupies.	Capacity is the amount of liquid a container holds when it is full.	This is the total area of the surface of a geometric solid.		
	Note: An object with a volume of 1 cm^3 will displace 1 ml of water. ∴ an object that is 64 cm^3 will displace 64 ml water or 0.064 l.	Net of the cube; how many faces are there? 		Area = sum of the area of all the faces. $= 6 (\text{area of a face})$ $= 6l^2$ $= 6(4 \text{ cm})^2$ $= 6 \times 16 \text{ cm}^2$ $= 96 \text{ cm}^2$
$V = l^3$ $V = (4 \text{ cm})^3$ $V = 64 \text{ cm}^3$				
Cubic mm	Cubic cm	Cubic m	Litre	
1 000 000 000	1 000 000	1	1 000	
1 000 000	1 000	0.001	1	
1 000	1	0.000 001	0.001	

Term 3

Example:

Volume

Capacity

Surface area

Surface area

--

--

100b

Surface area, volume and capacity of a Cube continued



Term 3

Surface area, volume and capacity of a Cube continued

a. 216 cm^2

b. 150 cm^2

c. 294 cm^2

d. 24 cm^2

e. 486 cm^2

f. 388 cm^2

g. 8.2 cm

h. 3.75 cm

i. 100 cm

j. 82 cm

2. If the surface area is ___, what is the volume of the cube?

Example:

$$54 \text{ cm}^2 = 6(\text{length})^2$$

A cube has six faces $\therefore 54 \text{ cm}^2 \div 6 = 9 \text{ cm}^2 = 3 \text{ cm} \times 3 \text{ cm}$. $\therefore \text{length} = 3 \text{ cm}$

The formula for the volume of a cube is $(\text{length})^3$

$$\therefore 3 \text{ cm} \times 3 \text{ cm} \times 3 \text{ cm} = 27 \text{ cm}^3$$

The volume is 27 cm^3 .

Problem solving

All the sides of this geometric object with six faces are the same. One side equals 3.5 cm . What is the shape of this object.

Surface area, volume and capacity of a rectangular prism

Perimeter of a rectangle	Area of a rectangle	The volume of a rectangular prism	Surface area of a rectangular prism	Capacity
$P = 2(l+b)$ or $2l+2b$	$A = l \times b$	$V = l \times b \times h$	$A = \text{the sum of the area of all the faces.}$	An object with a volume of 1 cm^3 will displace exactly 1 ml of water.
If 1 cm = 10 mm, then $1 \text{ cm}^2 = 100 \text{ mm}^2$				• An object with a volume of 1 m^3 will displace exactly 1 kl of water.
If 1 m = 100 cm, then $1 \text{ m}^2 = 10000 \text{ cm}^2$				
If 1 cm = 10 mm, then $1 \text{ cm}^3 = 1000 \text{ mm}^3$				
If 1 m = 100 cm, then $1 \text{ m}^3 = 1000000 \text{ cm}^3$ or 10^6 cm^3				
				Where in real life will we use the volume and surface area of a rectangular prism?

Example:

$$\text{If } 1 \text{ cm} = 10 \text{ mm, then } 1 \text{ cm}^2 = 100 \text{ mm}^2$$

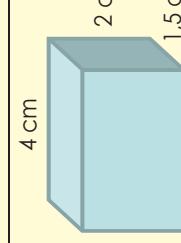
$$\text{If } 1 \text{ m} = 100 \text{ cm, then } 1 \text{ m}^2 = 10000 \text{ cm}^2$$

$$\text{If } 1 \text{ cm} = 10 \text{ mm, then } 1 \text{ cm}^3 = 1000 \text{ mm}^3$$

$$\text{If } 1 \text{ m} = 100 \text{ cm, then } 1 \text{ m}^3 = 1000000 \text{ cm}^3$$

Where in real life will we use the volume and surface area of a rectangular prism?

Volume	Capacity
4 cm	Note: An object with a volume of 1 cm^3 will displace 1 ml of water. ∴ an object that is 12 cm^3 will displace 12 ml.



$$V = l \times b \times h$$

$$V = 4 \text{ cm} \times 1.5 \text{ cm} \times 2 \text{ cm}$$

$$V = 12 \text{ cm}^3$$

Cubic mm	Cubic cm	Cubic m	Litre
1 000 000 000	1 000 000	1	1 000
1 000 000	1 000	0.001	1
1 000	1	0.000001	0.001

$$\begin{aligned}\text{Surface area:} \\ A &= 2bl + 2bh + 2hb \\ &= 2(1.5 \text{ cm} \times 4 \text{ cm}) + 2(4 \text{ cm} \times 2 \text{ cm}) + 2(2 \text{ cm} \times 1.5 \text{ cm}) \\ &= 12 \text{ cm}^2 + 16 \text{ cm}^2 + 6 \text{ cm}^2 \\ &= 34 \text{ cm}^2\end{aligned}$$

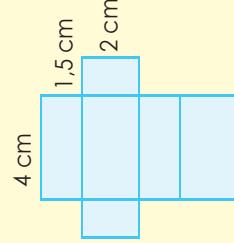
2. If the surface area is ___, what will the volume of the rectangular prism be?

Example:

$$52 \text{ cm}^2$$

Surface area

Describe the faces .



- a. 122 cm^2
- b. 118 cm^2
- c. 104 cm^2

$$\text{d. } 214 \text{ cm}^2$$

$$\text{e. } 220 \text{ cm}^2$$

Hint: Choose any two sides and determine the third or choose three sides and test your answer.

3. Calculate the volume, capacity (filled with water) and surface area of the following rectangular prisms:

length	breadth	height
a. 2 cm	1 cm	8 cm
b. 3.4 cm	2.2 cm	4 cm
c. 8 cm	4.3 cm	5 cm
d. 7.2 cm	6.5 cm	3.7 cm
e. 5.5 cm	3.5 cm	6 cm

1. Calculate the volume, capacity (filled with water) and surface area of the following rectangular prisms:

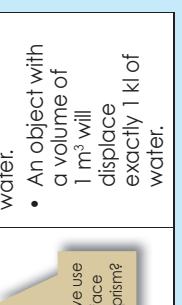
Problem solving

The length, breadth and height of this geometric object with six faces are 6 cm, 3 cm and 8 cm. What shape is the object? Draw it.

Sign _____ Date: _____

Surface area, volume and capacity of a hexagonal prism

1. Calculate the volume of a hexagonal prism.

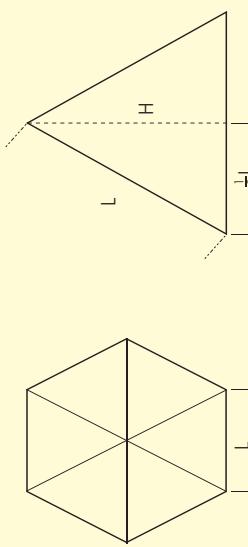
Perimeter of a hexagon	Area of a hexagon	The volume of hexagonal prisms	Surface area of a hexagonal prism	Capacity
$P = 6r$	See below	$V = 3 \text{ as} h$ $a = \text{apothem}$ $s = \text{side}$ $h = \text{height}$	$A = \text{the sum of the area of all the faces.}$  $\text{Where in real life do we use the volume and surface area of a hexagonal prism?}$	An object with a volume of 1 cm^3 will displace exactly 1 ml of water. <ul style="list-style-type: none"> An object with a volume of 1 m^3 will displace exactly 1 kl of water.

Investigate the volume and surface area of a hexagonal prism.

Information given

Regular hexagon

We can find the area of a regular hexagon by splitting it into six equilateral triangles.



L is the length. H is the height of each triangle.

Use Pythagoras' theorem for a right-angled triangle:

$$L^2 = (\frac{1}{2}L)^2 + H^2$$

$$\text{So: } H = \sqrt{L^2 - (\frac{1}{2}L)^2} = \frac{\sqrt{3}}{2}L$$

Now, look at one of the equilateral triangles:

$$\text{Area of triangle} = \frac{1}{2} \times \text{base} \times \text{height} = \frac{1}{2} \times L \times H = \frac{1}{2} \times L \times \frac{\sqrt{3}}{2}L = \frac{\sqrt{3}}{4}L^2$$

and:

$$\text{Area of regular hexagon} = 6 \times \text{area of triangle} = \frac{\sqrt{3}}{4}L^2 \times 6 = \frac{3\sqrt{3}}{2}L^2$$

In approximate numeric terms, the area of a regular hexagon is 2,598 times the square of its side length.

2. Calculate the surface area of a hexagonal prism.

Problem solving

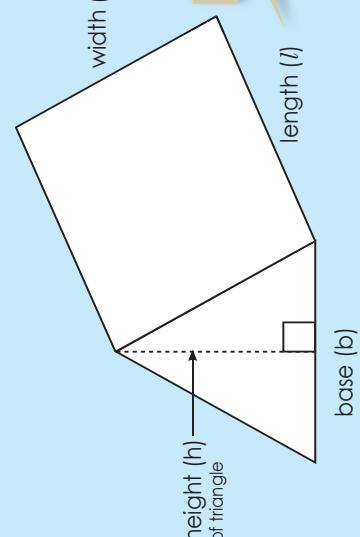
Summarise your investigation into the surface area of a hexagon.

Sign _____ Date: _____

99

Surface area, volume and capacity of a triangular prism

103a



Where in everyday life do we use the volume and surface area of a triangular prism?

Area of a rectangle	Area of a triangle	The volume of a triangular prism	Surface area of a triangular prism	Capacity
$A = l \times w$	$A = \frac{1}{2}b \times h$	$V = \frac{1}{2}b \times h \times l$	$A = \text{the sum of the area of all the faces.}$	An object with a volume of 1 cm^3 will displace exactly 1 ml of water. An object with a volume of 1 m^3 will displace exactly 1 kl of water.

If $1 \text{ cm} = 10 \text{ mm}$, then $1 \text{ cm}^2 = 100 \text{ mm}^2$
If $1 \text{ m} = 100 \text{ cm}$, then $1 \text{ m}^2 = 10000 \text{ cm}^2$
If $1 \text{ cm} = 10 \text{ mm}$, then $1 \text{ cm}^3 = 1000 \text{ mm}^3$
If $1 \text{ m} = 100 \text{ cm}$, then $1 \text{ m}^3 = 1000000 \text{ cm}^3$ or 10^6 cm^3

Example:

Volume	$V = \frac{1}{2}b \times h \times l$ $V = \frac{1}{2}(5 \text{ cm}) \times 3 \text{ cm} \times 2 \text{ cm}$ $V = 2.5 \text{ cm} \times 3 \text{ cm} \times 2 \text{ cm}$ $V = 15 \text{ cm}^3$	<p>Note: An object with a volume of 1 cm^3 will displace 1 ml of water. An object that is 15 cm^3 will displace 15 ml of water.</p>
Capacity		<p>Surface area</p> $A = 2(\text{area of triangle}) + (\text{area of the three rectangles})$ Area of triangles: $= 2(\frac{1}{2}(5 \text{ cm}) \times 3 \text{ cm}) = 15 \text{ cm}^2$ Area of middle rectangle $= b \times l = 5 \text{ cm} \times 2 \text{ cm} = 10 \text{ cm}^2$ Area of the other two rectangles $= (\text{length} \times \text{side of triangle}) \times 2$ $= (2 \text{ cm} \times \sqrt{3^2 + 2.5^2}) \times 2 = (2 \text{ cm} \times 3.9 \text{ cm}) \times 2 = 7.8 \text{ cm}^2 \times 2 = 15.6 \text{ cm}^2$ $A = 15 \text{ cm}^2 + 10 \text{ cm}^2 + 15.6 \text{ cm}^2 = 40.6 \text{ cm}^2$ <p>The two triangles are the same size.</p> <p>To find the length of two of the rectangles we need to use Pythagoras' theorem.</p>

Note that the two triangles are identical, but the three rectangles are different in size.

100

continued •
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

101



Surface area, volume and capacity of a triangular prism continued

1. Calculate the volume, capacity and the surface area of the following triangular prisms:

a. Base = 2 cm, Height = 1 cm and Length = 3 cm

b. Base = 10 cm, Height = 3 cm and Volume = 30 cm^3

2. If the surface area is _____, what is the volume of the triangular prism?

a. 110 cm^2 and length = 4 cm

b. 66 cm^2 and length = 5 cm

c. 177 cm^2 and length = 2 cm

d. 228 cm^2 and length = 3 cm

Problem solving

The geometric object has two triangular faces and three rectangular faces. The area of the triangle is 12 cm^2 , the height of each triangle is 4 cm and the length of the prism is 4cm. What is the surface area?

Surface area, volume and capacity of a cylinder

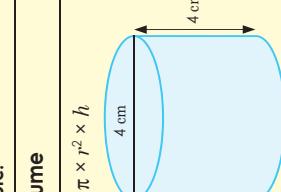
- Calculate the volume, capacity (if filled with water) and surface area of the cylinder.

Circumference of a circle	Area of a circle
$C = \pi d$ or $2\pi r$	$A = \pi r^2$

If 1 cm = 10 mm, then 1 cm^2 = 100 mm^2
 If 1 m = 100 cm, then 1 m^2 = 10 000 cm^2

The volume of a cylinder	Surface area of a cylinder
$V = \pi r^2 h$	$A = \text{sum of the areas of all the faces}$

Example:



Volume

$$V = \pi r^2 h$$

$$= \pi \times 2^2 \times 4$$

$$= 16\pi \text{ cm}^3$$

$$= 50,265 \text{ cm}^3$$

Capacity

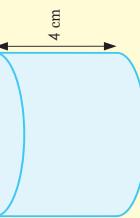
Note: An object with a volume of 1 cm^3 will displace 1 ml of water.
 \therefore an object that is 12 cm^3 will displace 12 ml of water.

Surface area

$$A = 2 \times \pi r \times (r + h)$$

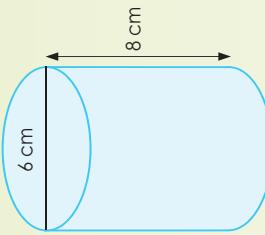
$$\begin{aligned} &\text{Area of one end} \\ &= \pi \times r^2 \end{aligned}$$

diameter = 4
 \therefore radius = 2
 $V = \pi \times (2)^2 \times 4$
 $= \pi \times 4 \times 4$
 $= 16\pi \text{ cm}^3$
 $= 50,265 \text{ cm}^3$

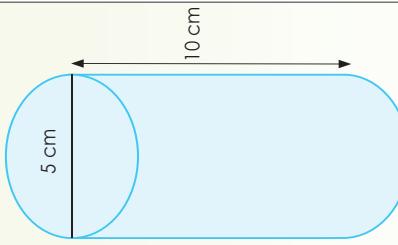


$$\begin{aligned} &\text{diameter} = 4 \\ &\therefore \text{radius} = 2 \\ A &= 2 \times \pi \times r \times (r + h) \\ &= 2 \times \pi \times 2 \times (2 + 4) \\ &= 2 \times \pi \times 2 \times (6) \\ &= 24\pi \\ &= 75,398 \text{ cm}^2 \end{aligned}$$

a.



b.

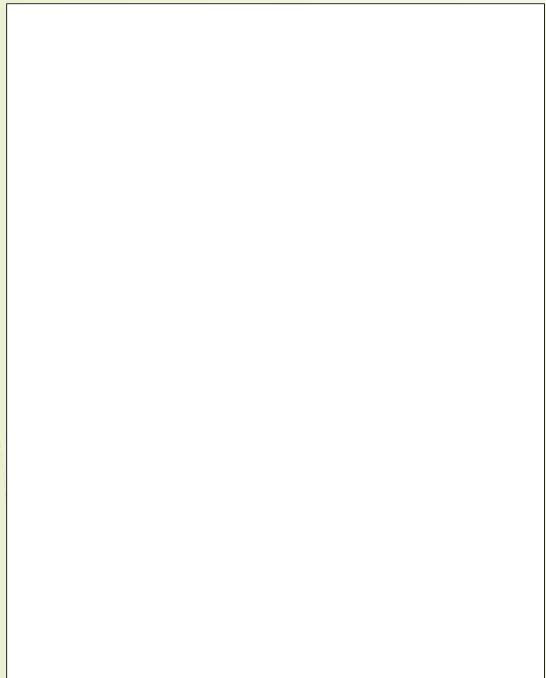


Term 3

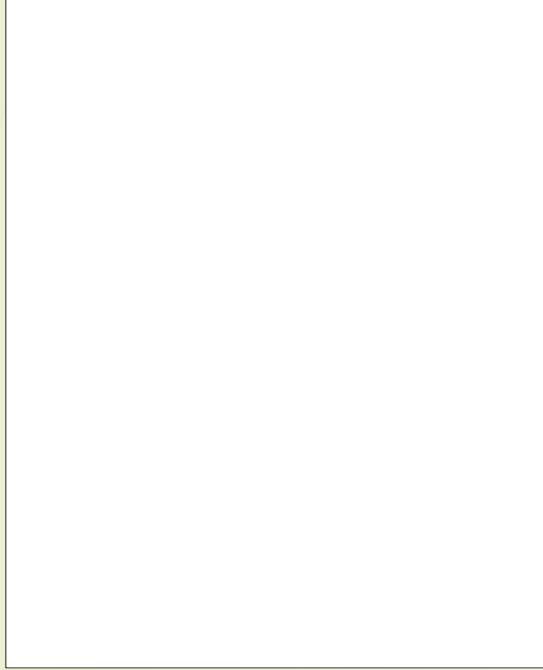
Term 3

Surface area, volume and capacity of a cylinder continued

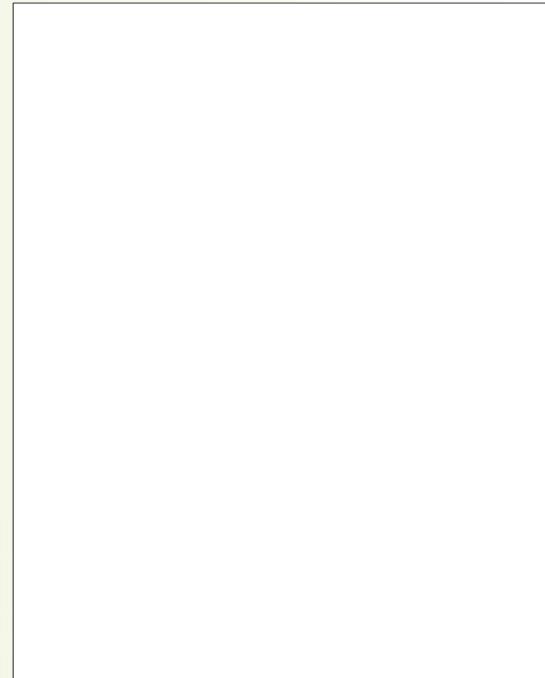
C. Diameter: 4 cm
Height: 10 cm



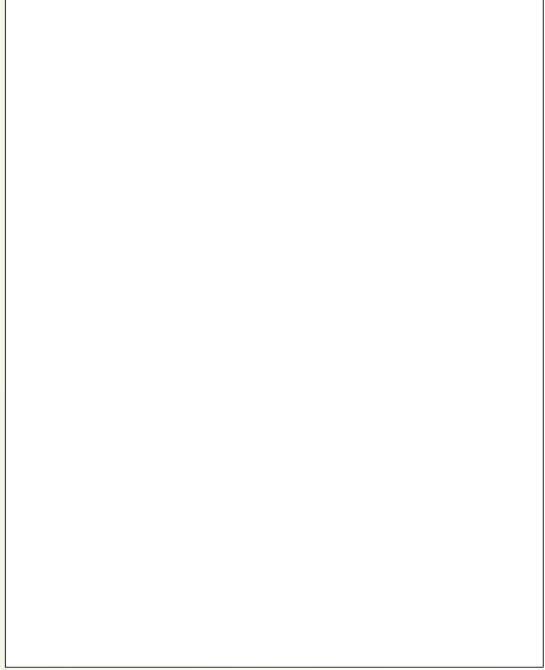
e. Diameter: 9 cm
Height: 13 cm



d. Diameter: 12 cm
Height: 14 cm

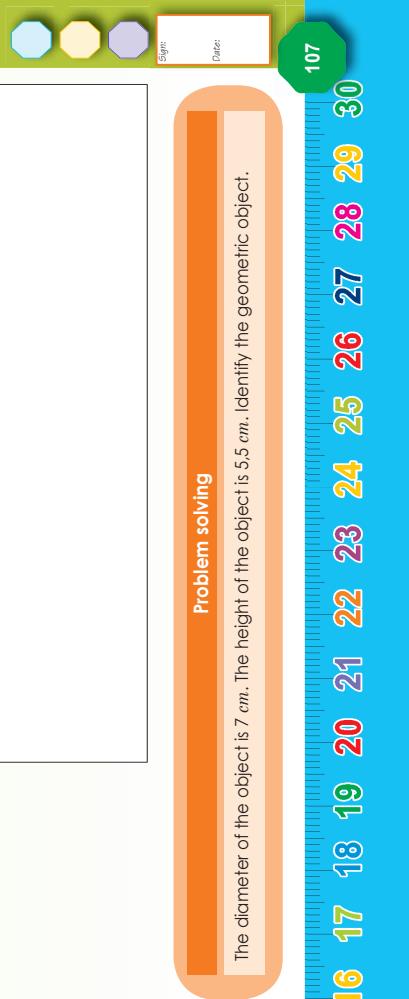


f. Diameter: 7 cm
Height: 11 cm



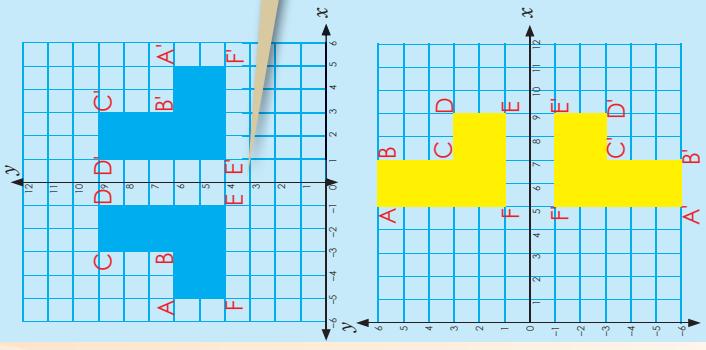
Problem solving

The diameter of the object is 7 cm. The height of the object is 5.5 cm. Identify the geometric object.



Reflecting over axes

Look at the figures and describe each one. Make use of words such as **mirror, shape, original shape, line of reflection** and **vertical**.



The coordinates of each figure are:

ABCDE: (-5, 6); (-3, 6); (-3, 9); (-1, 9); (-1, 4); (-5, 4)
ABC'D'E': (5, 6); (3, 6); (3, 9); (1, 9); (1, 4); (5, 4)

What do you notice? If a figure reflects over the y -axis the y -coordinates stay the same and the x -coordinates change to their opposite integers.

When a shape is reflected over a mirror line, the reflection is the same distance from the line of reflection as the original shape.

The coordinates of each figure are:

ABCDE: (5, 6); (7, 6); (7, 3); (9, 3); (9, 1); (5, 1)
ABC'D'E': (5, -6); (7, -6); (7, -3); (9, -3); (9, -1); (5, -1)

What do you notice? If a figure reflects over the x -axis the x -coordinates stay the same and the y -coordinates change to their opposite integers.

- i. Write down the coordinates for both figures:

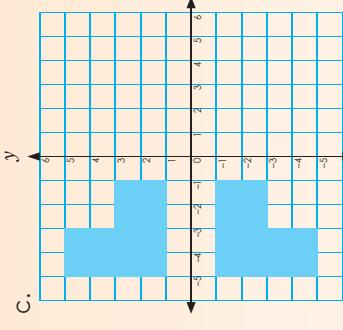
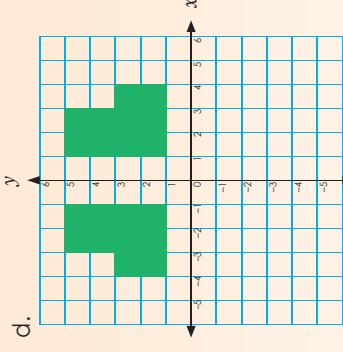
- ii. Reflects over ____ axis.

- iii. Compare x - and y -coordinates.

- i. Write down the coordinates for both figures:

- ii. Reflects over ____ axis.

- iii. Compare x - and y -coordinates.



- i. Write down the coordinates for both figures:

- ii. Reflects over ____ axis.

- iii. Compare x - and y -coordinates.

- i. Write down the coordinates for both figures:

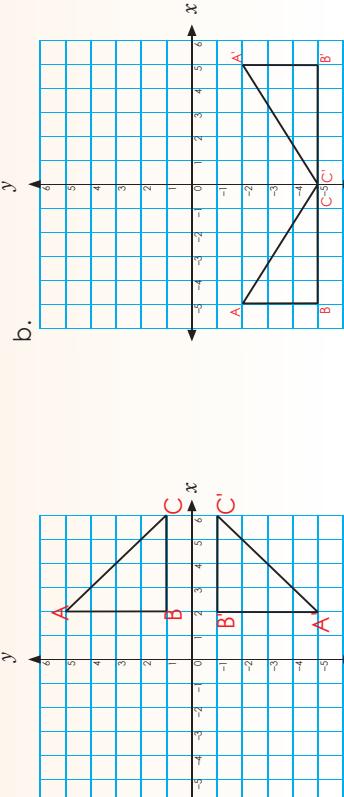
- ii. Reflects over ____ axis.

- iii. Compare x - and y -coordinates.

Problem solving

What are the two sets of new coordinates of the figure ABC $\{[-3, 4]; (-1, 1); (-5, 1)\}$ if it is reflected over the:

- x -axis
- y -axis



1. **Describe each reflection using the guidelines below each graph. Remember to label the figure before you describe it.**



- b.

- i. Reflects over ____ axis.

- ii. Reflects over ____ axis.

- iii. Compare x - and y -coordinates.



- i. Reflects over ____ axis.

- ii. Reflects over ____ axis.

- iii. Compare x - and y -coordinates.

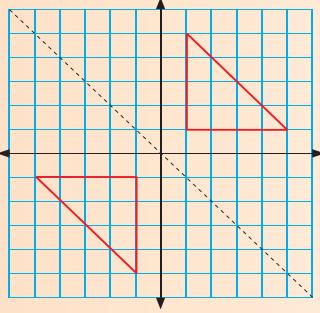
Sign: _____ Date: _____

Reflecting over lines

106

- 2. Describe each reflection. Remember to label your figures before you describe them.**

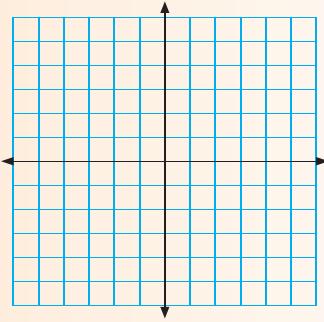
a.



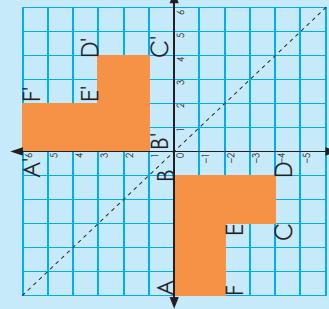
When you reflect a point across a line $x = -y$, the x -coordinate and the y -coordinate change places and the signs change (they are negated).

- 1. Draw the lines.**

a. $x = y$



Explain how you determine the line:



What do you notice about the line of reflection?

$$x = -y$$

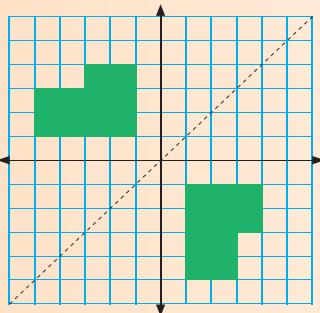
E.g. $(1, -1)$; $(2, -2)$

The coordinates for ABCDEF are:
 $(-6, 0)$; $(-1, 0)$; $(-1, -4)$; $(-3, -4)$; $(-3, -2)$; $(-6, -2)$

The coordinates for A'B'C'D'E'F' are:
 $(0, 6)$; $(1, 0)$; $(4, 1)$; $(4, 3)$; $(2, 3)$; $(2, 6)$

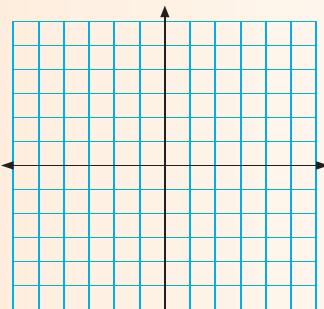
When you reflect a point across a line $x = -y$, the x -coordinate and the y -coordinate change places and the signs change (they are negated).

b.



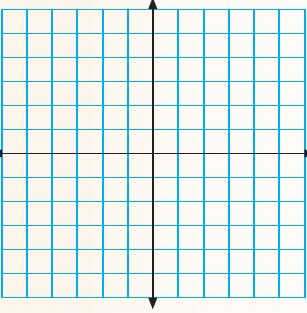
i. Write down the coordinates for both figures:

b. $-x = y$



Explain how you determine the line:

- 3. Draw figures reflecting over a line $x = y$.**



- i. What are the coordinates?
 ii. Reflects over the line ____.
 iii. Compare x- and y-coordinates.

Problem solving

Draw a figure reflecting over a line $-x = y$. Write down the coordinates.

Sign _____ Date: _____

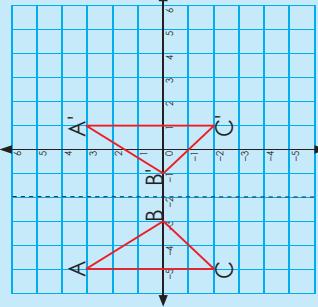
Reflecting over any line

107

Term 4

Describe the reflection.

The coordinates for ABC:
 $(-5, 3)$; $(-3, 0)$; $(-5, -2)$.



The line of reflection is in line with
 A and A' : $(1, 3)$; $(1, -2)$

A and A' is $(-2, 3)$
 B and B' is $(-2, 0)$
 C and C' is $(-2, 2)$.

Note that here the y-coordinates remain the same

A		Line of reflection	
$(-5, 3)$	$(1, 3)$	$(-2, 3)$	

B		Line of reflection	
$(-3, 0)$	$(-1, 0)$	$(-2, 0)$	

B'

$1 - (-2) = 1$

(Move 1 to the right.)

A'

$-3 - (-2) = -1$

(Move 1 to the left.)

C		Line of reflection	
$(-5, 2)$	$(1, -2)$	$(-2, 2)$	

C		Line of reflection	
$(-5, 2)$	$(1, -2)$	$(-2, 2)$	

C'

$1 - (-2) = 3$

(Move 3 to the right.)

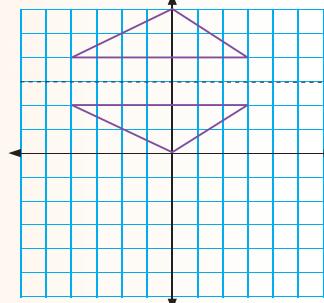
A'

$-5 - (-2) = -3$

(Move 3 to the left.)

1. **Describe the reflection using the example in the concept development to guide you. Remember to label your diagrams.**

a.

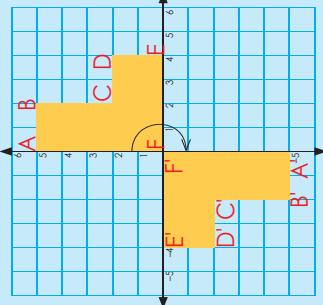


Problem solving

Show a figure reflecting over any line. Write down the coordinates.

Rotations

108



Explain this rotation.

Coordinates for ABCDEF are:
 $(0,5); (2,5); (2,2); (4,2); (4,0); (0,0)$

Coordinates for A'B'C'D'E'F' are:
 $(0,-5); (-2,-5); (-2,-2); (-4,-2); (-4,0); (0,0)$

The coordinates of corresponding vertices are opposite integers (just the + and - signs are different). This is always the same for 180° rotations about the origin.

1. Give two more examples of your own to show that the coordinates of corresponding vertices are opposite integers (with just the + and - signs being different).

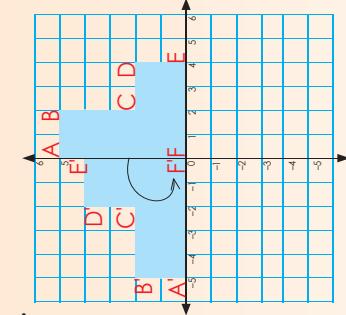
Term 4

- b. What do you notice about the coordinates of corresponding vertices?

- c. Give two more examples of rotating a figure 90° clockwise over the x-axis.

3. a. Write down the coordinates for:

A:	<input type="text"/>	A':	<input type="text"/>
B:	<input type="text"/>	B':	<input type="text"/>
C:	<input type="text"/>	C':	<input type="text"/>
D:	<input type="text"/>	D':	<input type="text"/>
E:	<input type="text"/>	E':	<input type="text"/>
F:	<input type="text"/>	F':	<input type="text"/>

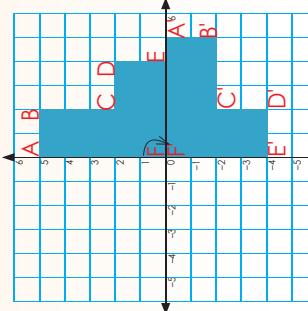


- b. What do you notice about the coordinates of corresponding vertices?

- c. Give two more examples of rotating a figure 90° anti-clockwise over the y-axis.

- a. Write down the coordinates for:

A:	<input type="text"/>	A':	<input type="text"/>
B:	<input type="text"/>	B':	<input type="text"/>
C:	<input type="text"/>	C':	<input type="text"/>
D:	<input type="text"/>	D':	<input type="text"/>
E:	<input type="text"/>	E':	<input type="text"/>
F:	<input type="text"/>	F':	<input type="text"/>



2. Rotation

Make use of words such as rotated or turned, clockwise, anti-clockwise, point of rotation and distance.

Problem solving

Show a figure that rotated on a Cartesian grid. Write down the coordinates.

Translation

109

Term 4

Two sets of coordinates are:

$$\begin{array}{l} \text{ABCDEF} \\ (-4,0); (-2,0); (-2,-3); (0,-3); (0,-5); (-4,-5) \end{array}$$

$$\begin{array}{l} \text{A'B'C'D'E'F'} \\ (-2,3); (0,3); (0,0); (2,0); (2,-2); (-2,-2) \end{array}$$

The translation vector is a vector that gives the length and direction of a particular translation.
3 up on the y-axis
2 right on the x-axis.

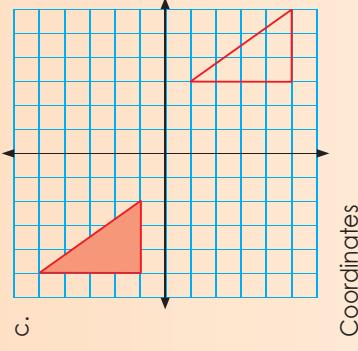
What is the translation vector for the figure?
2 right means +2 and 3 up means +3.

Work in pairs to prove this.

Write down the pairs of corresponding vertices.

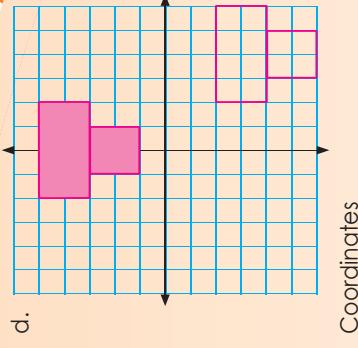
- $(-4,0)$ and $(-2,3)$
 - $(-2,0)$ and $(0,0)$
 - $(-2,-3)$ and $(0,3)$
 - $(0,-3)$ and $(2,0)$
 - $(0,-5)$ and $(2,-2)$
- $$\begin{array}{rcl} -4+2 = -2 & & -2+2 = 0 \\ \underline{0}+3 = 3 & & \underline{-3}+3 = \underline{0} \\ & & \end{array}$$
- $$\begin{array}{rcl} \underline{0}+2 = 2 & & -4+2 = -2 \\ -5+3 = \underline{-2} & & \underline{-5}+3 = \underline{-2} \end{array}$$

1. Describe the translation. Remember to label your diagrams.



Coordinates

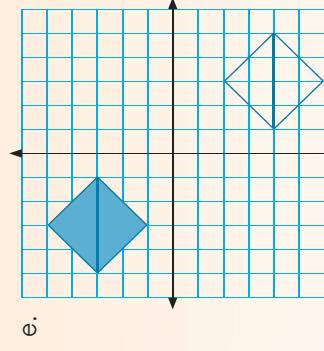
Translation vector



d.

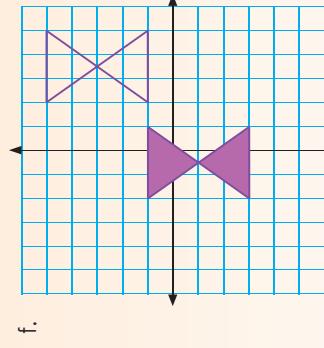
Coordinates

Translation vector



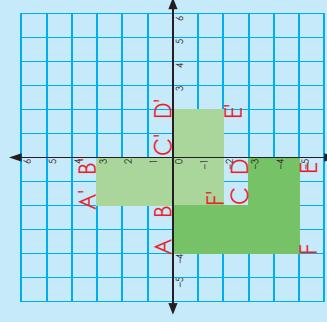
Coordinates

Translation vector



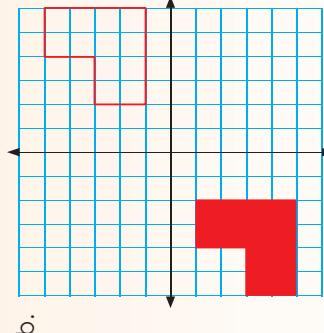
Coordinates

Translation vector



Coordinates

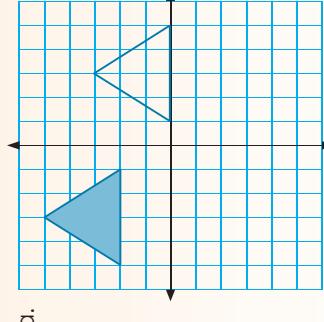
Translation vector



b.

Coordinates

Translation vector



c.

Coordinates

Translation vector

Problem solving

Show translation of a figure on the Cartesian plane. Write down the coordinates.

Transformation

110

In your own words describe these types of transformation:

Reflection

Over the x -axis

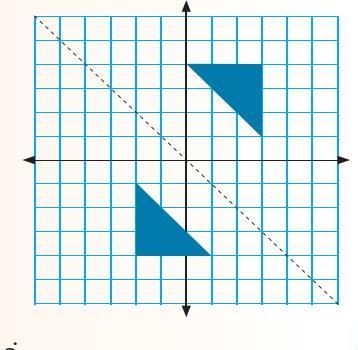
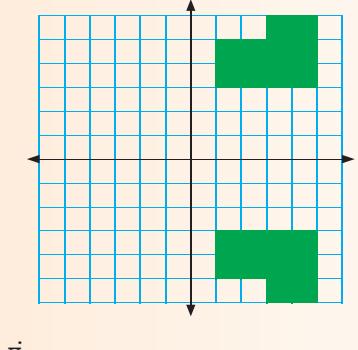
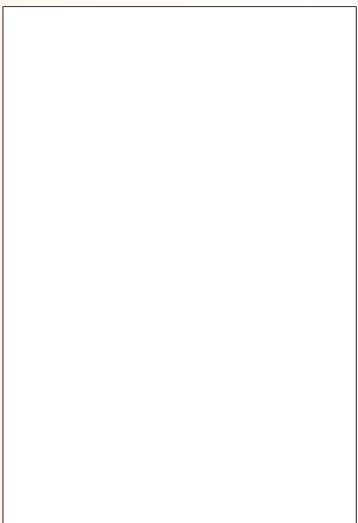
Over the y -axis

Over any line

Rotation

Translation

1. Describe the transformations. Remember to label your diagrams and axes.



Term 4

c.

d.

Write down notes on what to remember when working with transformations on the Cartesian plane.

Problem solving

Show reflection, rotation and translation of a shape on a Cartesian plane and write down the coordinates.

118

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

119

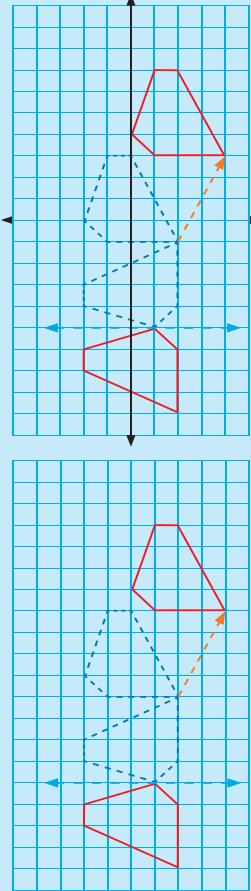
Date: _____

Sign: _____

More transformations

111a

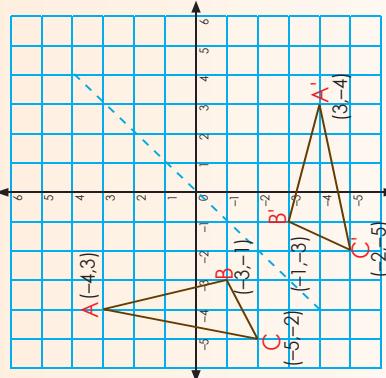
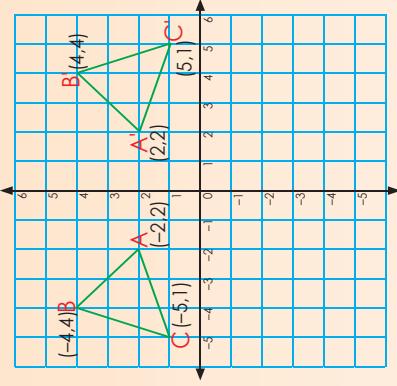
Show that the figures and its images are congruent by describing how the original figure has moved, using a combination of transformations.



The figure is:

- reflected, then
- rotated – clockwise by 90° , and then
- translated 5 blocks to the left and 2 blocks down.

Use coordinates to describe the transformation. You described the transformation from left to right; explain it now from right to left.



1a. Write down the coordinates of the geometric figures.

b. What do you notice?

c. What type of transformation is it?

Term 4

c. What type of transformation is it?

2a. Write down the coordinates of the geometric figures.

b. What do you notice?

c. What type of transformation is it?

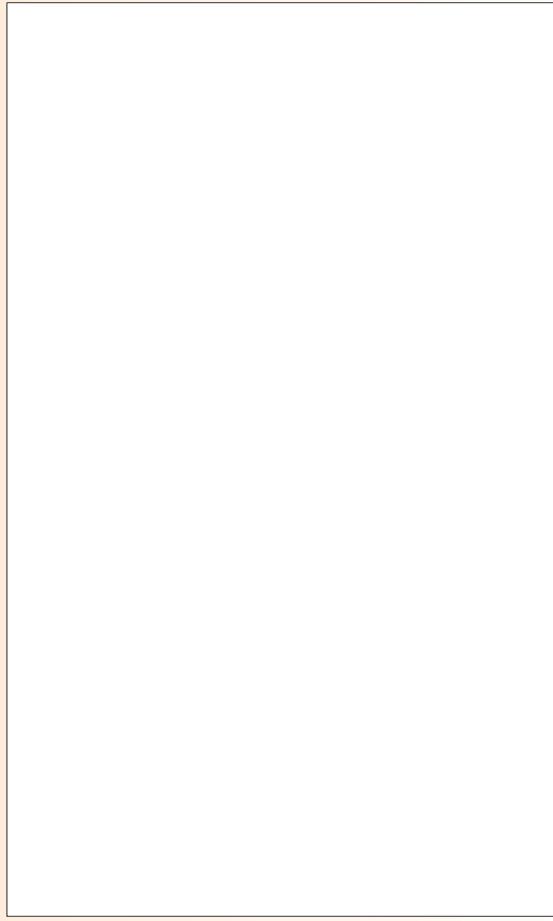
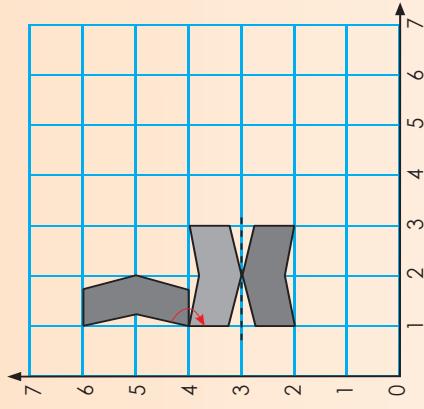
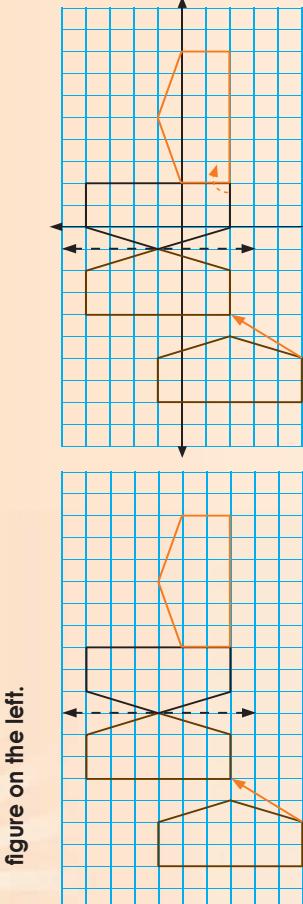
continued

More transformations continued

111b

4. Describe the transformation, starting from the figure at the top.

- Show congruent figures (a figure and its image), using rotation and reflection.
Example of an answer:



Problem solving

- Show a transformation on the Cartesian plane using reflection, rotation and translation. Write down the coordinates.

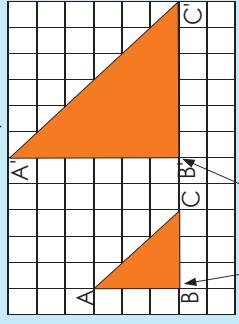
Date: _____

Enlargement and reduction

112a

In this worksheet you will enlarge figures by a given scale factor and make use of a centre of enlargement as your starting point.

Look at this example and discuss it.



Note how we write it. We put a single apostrophe ('l) after each point of the enlarged image.

Centre of enlargement

$$A'B' = 2 \times AB$$

$$B'C' = 2 \times BC$$

$$A'C' = 2 \times AC$$

Calculate the area and perimeter of the

- original triangle

- enlarged triangle

if one square = 1 cm \times 1 cm.

Original figure	Enlarged figure				
<table border="1"> <tr> <td>Perimeter 3 cm + 3 cm + 4.24 cm = 10.24 cm</td><td>Perimeter $\frac{1}{2} \times b \times h$ $= \frac{1}{2} \times 3 \text{ cm} \times 3 \text{ cm}$ $= \frac{9}{2} \text{ cm}^2$ because $AC = \sqrt{3^2 + 3^2}$ $= \sqrt{4 \times 3^2}$ $= \sqrt{4 \times 9}$ $= \sqrt{36}$ $= 6 \text{ cm}$</td></tr> </table>	Perimeter 3 cm + 3 cm + 4.24 cm = 10.24 cm	Perimeter $\frac{1}{2} \times b \times h$ $= \frac{1}{2} \times 3 \text{ cm} \times 3 \text{ cm}$ $= \frac{9}{2} \text{ cm}^2$ because $AC = \sqrt{3^2 + 3^2}$ $= \sqrt{4 \times 3^2}$ $= \sqrt{4 \times 9}$ $= \sqrt{36}$ $= 6 \text{ cm}$	<table border="1"> <tr> <td>Perimeter 6 cm + 6 cm + 8.48 cm = 20.48 cm</td><td>Area $\frac{1}{2} \times b \times h$ $= \frac{1}{2} \times 6 \text{ cm} \times 6 \text{ cm}$ $= 18 \text{ cm}^2$</td></tr> </table>	Perimeter 6 cm + 6 cm + 8.48 cm = 20.48 cm	Area $\frac{1}{2} \times b \times h$ $= \frac{1}{2} \times 6 \text{ cm} \times 6 \text{ cm}$ $= 18 \text{ cm}^2$
Perimeter 3 cm + 3 cm + 4.24 cm = 10.24 cm	Perimeter $\frac{1}{2} \times b \times h$ $= \frac{1}{2} \times 3 \text{ cm} \times 3 \text{ cm}$ $= \frac{9}{2} \text{ cm}^2$ because $AC = \sqrt{3^2 + 3^2}$ $= \sqrt{4 \times 3^2}$ $= \sqrt{4 \times 9}$ $= \sqrt{36}$ $= 6 \text{ cm}$				
Perimeter 6 cm + 6 cm + 8.48 cm = 20.48 cm	Area $\frac{1}{2} \times b \times h$ $= \frac{1}{2} \times 6 \text{ cm} \times 6 \text{ cm}$ $= 18 \text{ cm}^2$				

Area:

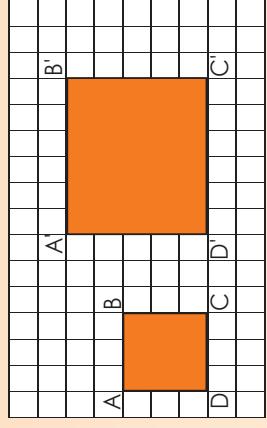
- Original triangle = $4\frac{1}{2}$ cm
- Enlarged triangle = 18 cm^2
- $18 \text{ cm}^2 \div 4.5 \text{ cm}^2 = 4$
- $\sqrt{4} = 2$ (because we work with area).

The scale factor is 2.

Therefore we say that the transformation is an **enlargement** with scale factor 2.

1. By what scale factor is the figure enlarged?

- a. Correct the enlarged square $A'D' = B'C'$ and It is 6 row high and make a perfect square. Each square of the grid paper = 1 cm by 1 cm.



What is the perimeter and the area of:

- the original figure?

Area:

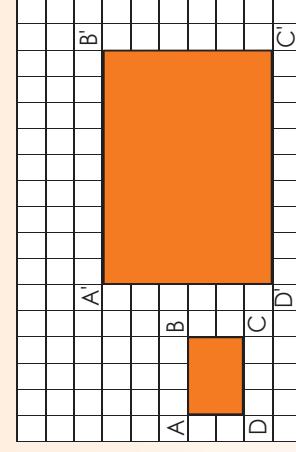
Perimeter:

Area:

Perimeter:

Therefore we say that the transformation is an **enlargement** with **scale factor** ____.

b. Each square of the grid paper = 1 cm by 1 cm.



What is the perimeter and the area of:

- the original figure?

Area:

Perimeter:

Area:

Perimeter:

Area:

Perimeter:

Area:

Perimeter:

Area:

Perimeter:

Area:

Perimeter:

continued

125

Enlargement and reduction continued

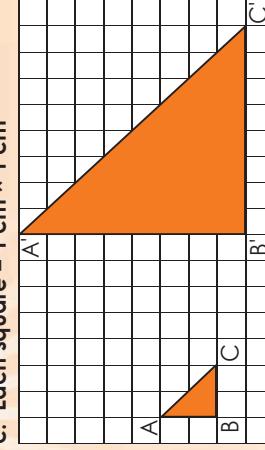
What is the perimeter and the area of:

- the original figure?

Area: _____

Perimeter: _____

c. Each square = 1 cm × 1 cm



$$A'B' = 4 \times AB$$

$$B'C' = 4 \times BC$$

$$A'C' = 4 \times AC$$

What is the perimeter and the area of:
 • the original figure?
 Area: _____ Perimeter: _____

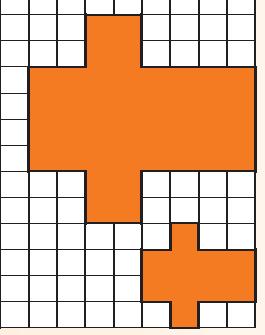
Term 4

- d. By what scale factor is the figure enlarged?



Therefore we say that the transformation is an enlargement with scale factor _____.

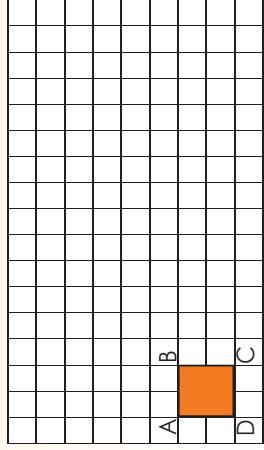
e. What is the perimeter and the area of:
 • the original figure?
 Area: _____ Perimeter: _____



Therefore we say that the transformation is an enlargement with scale factor _____.

f. Draw the enlargement.

g. An enlargement with scale factor 5



What is the perimeter and the area of:
 • the original figure?
 Area: _____ Perimeter: _____

Therefore we say that the transformation is an enlargement with scale factor _____.

b. An enlargement with scale factors $2\frac{1}{2}$

Area: _____ Perimeter: _____

What is the perimeter and the area of:
 • the original figure?
 Area: _____ Perimeter: _____

• the enlarged figure?
 Area: _____ Perimeter: _____

• the enlarged figure?
 Area: _____ Perimeter: _____

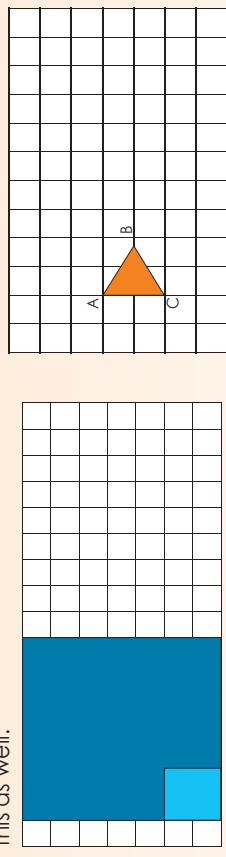
What is the perimeter and the area of:
 • the original figure?
 Area: _____ Perimeter: _____

• the enlarged figure?
 Area: _____ Perimeter: _____

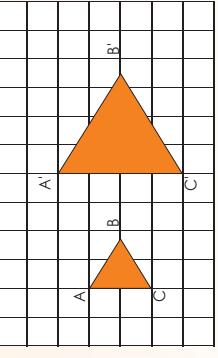
• the enlarged figure?
 Area: _____ Perimeter: _____

4. Draw an enlargement with scale factor 2

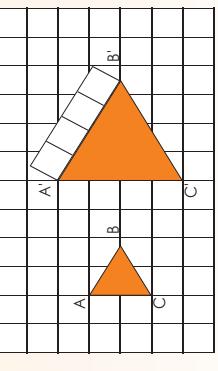
We can draw an enlargement like this as well:



Step 1:



Step 2:



A'B', B'C', and A'C', are all the same length as A'C'. How would I measure this without using a ruler? _____

Problem solving

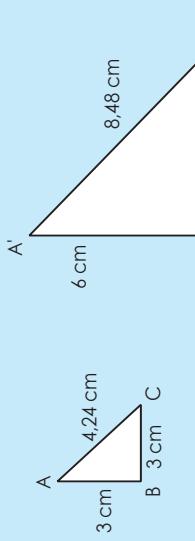
If I enlarge a triangle with sides that equal 3 units by a scale factor of 4, what will the length of the sides be? Each unit = 1 cm by 1 cm. What is the perimeter and area of:
 • the original figure?
 • the enlarged figure?

More enlargement and reduction

113a

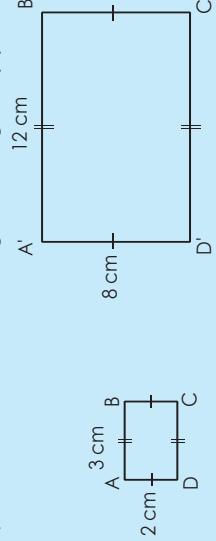
Look at the example. Discuss.

By what scale factor is the figure enlarged? (2).



- In pairs, calculate the area and perimeter of:
- the original figure
 - the enlarged figure

By what scale factor is the figure enlarged? (4).



- In pairs, calculate the area and perimeter of:
- the original figure
 - the enlarged figure

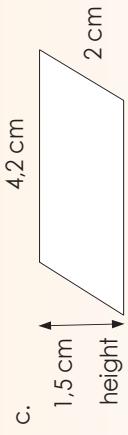
1. Complete the following.

a. 2.1 cm

- i. Enlarge by scale factor 2.



- iii. What do you notice?



- i. Enlarge by scale factor 2.

- ii. Calculate the perimeter and area of:
- the original figure
 - the enlarged figure

- iii. What do you notice?

b. 2.5 cm



- i. Enlarge by scale factor 2.

- ii. Calculate the perimeter and area of:
- the original figure
 - the enlarged figure

- iii. What do you notice?

Term 4

Sign:

Date:

128 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

129

continued

More enlargement and reduction

continued

113b

- ii. Calculate the perimeter and area of:
- the original figure
 - the enlarged figure

iii. What do you notice?

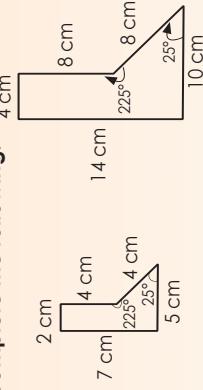
Term 4

ii. Calculate the perimeter and area of:

- the original figure
- the enlarged figure

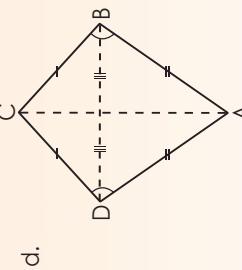
iii. What do you notice?

2. Complete the following:



Hint: Use Pythagoras's theorem

Diagonal AC = 22.5 cm
Diagonal BD = 16.5 cm



i. Enlarge by scale factor 3.

- a. By which scale factor is the figure enlarged?
b. Calculate the perimeter and area of:
- the original figure
 - the enlarged figure

iii. What do you notice?

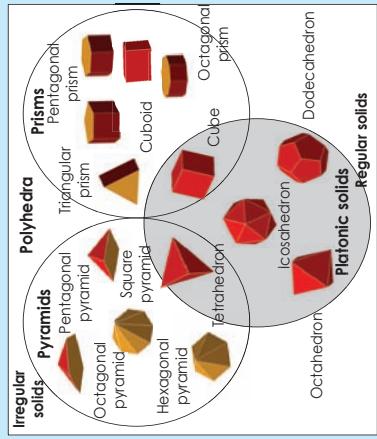
Problem solving

Enlarge your answer to question 1b by scale factor 3.
Reduce your answer to question 1b by scale factor 3.
What do you notice?

Polyhedra

114

Look at this Venn diagram of polyhedra. Discuss.



Platonic solids: A set of five regular convex polyhedrons which all have identical faces and the same number of edges meeting at each vertex: tetrahedron, cube, octahedron, dodecahedron and icosahedron (with 4, 6, 8, 12 and 20 faces respectively).

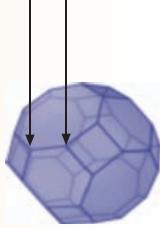
1. What is a regular polyhedron?

- a. How many regular polyhedra exist? _____
b. Which polygons are they made up of? What are they called?

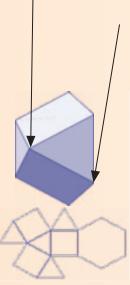


2. What is a semi-regular or Archimedean solid?

- a. Look at these examples of Archimedean solids. What do you notice?



3. What are Johnson solids? What do you notice about these examples?



- b. Why do you think they are named "semi-regular" solids?

Truncated tetrahedron		Cuboctahedron
-----------------------	--	---------------

Truncated cube		Truncated octahedron
----------------	--	----------------------

Square pyramid		Pentagonal pyramid
----------------	--	--------------------

Triangular cupola		Square cupola
-------------------	--	---------------

4. What is the difference between Platonic, Archimedean and Johnson solids?

Archimedean solids

Johnson solids

Problem Solving

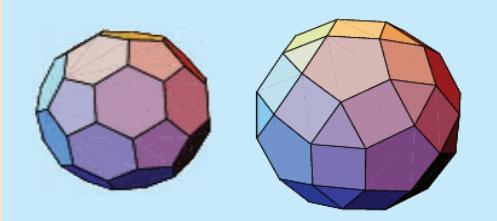
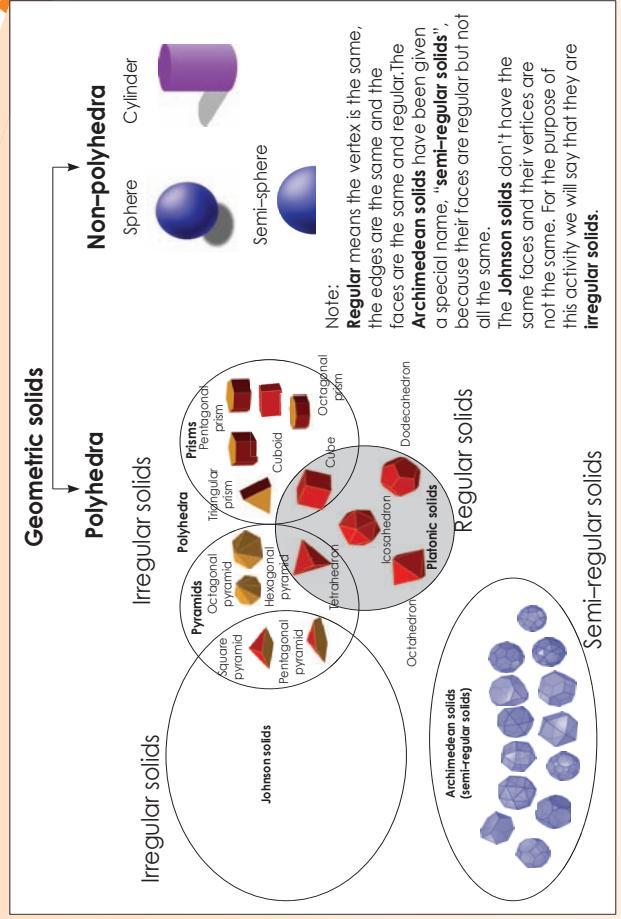
Find another two Archimedean and Johnson solids. Name and describe each.

Date: _____
Sign: _____

Polyhedra and non-polyhedra

115

3. Use the diagram to answer the questions.



Read more about the Archimedean and Johnson solids.
Summarise it in your own words.

Archimedean solids

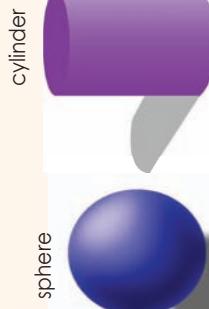
A set of 13 highly symmetric, semi-regular convex polyhedrons made up of two or more types of non-intersecting regular polygons meeting in identical vertices with all sides the same length (excluding regular prisms and anti-prisms and the elongated square gyrobicupola)

Johnson solids

A set of 92 convex polyhedrons with regular faces and equal edge lengths but whose regular polygonal faces do **not** meet in identical vertices (but excluding the completely regular Platonic solids and the semi-regular Archimedean solids and huge range of prisms and anti-prisms)

1. How can you tell that a surface is a plane surface?

2a. We know now that we can classify spheres, cylinders and hemispheres in their own category. Why?



b. What do you think a hemisphere is?



Term 4

a. Name five regular solids.

b. Name five irregular solids.

c. Name five semi-regular solids.

d. Name five polyhedra.

e. Name three non-polyhedra.

Problem solving

Give five examples of non-polyhedra in everyday life.



116 Regular and non-regular polyhedra and non-polyhedra

Describe each of the following:

Regular polyhedra

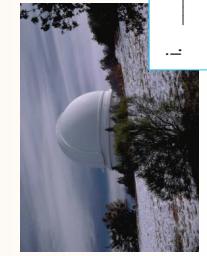
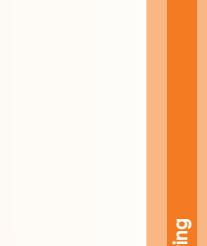
Non-regular polyhedra

Non-polyhedra

1. State whether the following are regular or irregular.

- a.  _____
- b.  _____
- c.  _____
- d.  _____
- e.  _____
- f.  _____
- g.  _____
- h.  _____
- i.  _____

2. i. Identify the following geometric solids in the photographs: cube, hemisphere, cylinder, triangular prism, and other others you find.
 ii. Identify also whether each is:
- a regular or irregular polyhedron
 - not a polyhedron

- a.  i. _____
ii. _____
- b.  i. _____
ii. _____
- c.  i. _____
ii. _____

Problem solving

Why do you think that a hemisphere and the solids above are not the same.



d.

i. _____
ii. _____



f.

i. _____
ii. _____



h.

i. _____
ii. _____



c.

i. _____
ii. _____



e.

i. _____
ii. _____



g.

i. _____
ii. _____



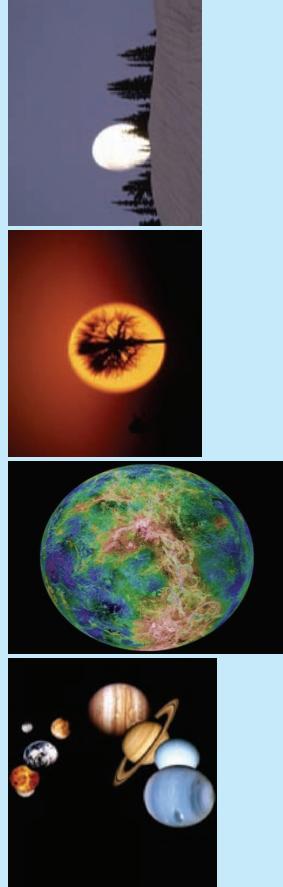
i.

i. _____
ii. _____

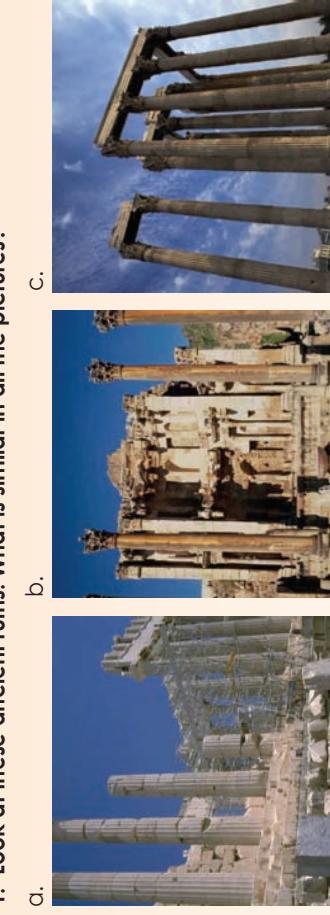
Polyhedra and non-polyhedra all around us

117

Look at the following pictures. Identify the geometric object and then name it.



1. Look at these ancient ruins. What is similar in all the pictures?



2.



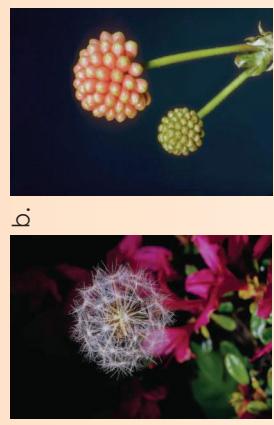
- Which building is this?
- What solid do you observe?

3. Nature provides us with the most beautiful patterns. Look at the following patterns in nature and see how you can create a polyhedron out of each one. You don't have to name the polyhedron.

Under the sea



Flowers



Under the sea

c.

Plants

f.



Rock

d.



4. Look at this architectural structure. Why do we say this is a concave polyhedron?



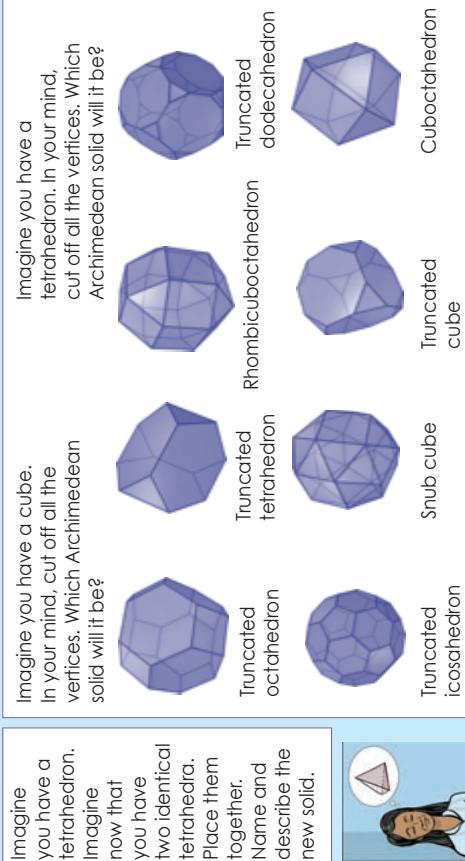
Problem solving

Concave means curved inwards and convex means curved outwards. Explain this using the pictures in this worksheet.

Visualise geometric objects

118

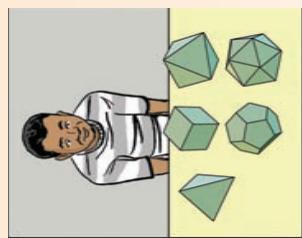
Read, close your eyes and visualise.



1. Write down the names of all the platonic solids'. Next to each give a description that you will read to a friend. The friend must then guess the geometric object.

	Triangles					Squares				
	Octahedron					Cubes				
	1	2	3	4	5	1	2	3	4	5
	6	7	8	9	10	11	12	13	14	15
Tetrahedron										
Octahedron										
Icosahedron										
Dodecahedron										

	Triangles					Squares				
	Octahedron					Cubes				
	1	2	3	4	5	1	2	3	4	5
	6	7	8	9	10	11	12	13	14	15
Tetrahedron										
Octahedron										
Icosahedron										
Dodecahedron										



	Triangles					Pentagons				
	Dodecahedron					Icosahedron				
	1	2	3	4	5	1	2	3	4	5
	6	7	8	9	10	11	12	13	14	15
Tetrahedron										
Dodecahedron										
Icosahedron										

	Triangles					Pentagons				
	Cubes					Icosahedron				
	1	2	3	4	5	1	2	3	4	5
	6	7	8	9	10	11	12	13	14	15
Tetrahedron										
Cubes										
Icosahedron										

Work in pairs

In pairs do the following activity:

Each of you make a regular and irregular solid cylinder, sphere and any other geometric solid.

Each of you places the geometric solid you have made into a bag.

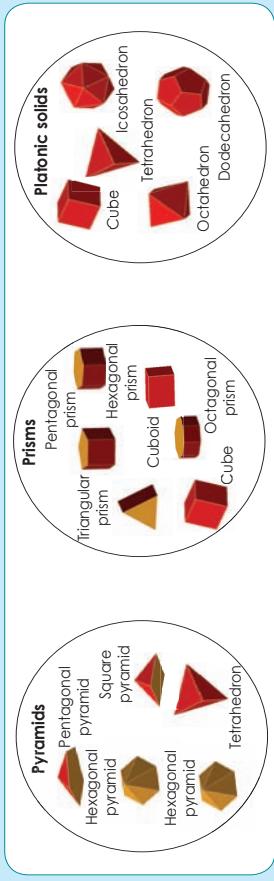
One of you then feels one of the objects in the bag and describes it to the other, who has to guess what it is.

Do this a few times by replacing the solid.

Geometric solid game

2

In this activity you are going to design the questions for this game. First, write down some key geometric solid words learned so far. Use these words to create your game cards on the next page.



1. Read the rules. Create your own game components.

Game rules

What you need:

- Two tokens to play with (use any small objects)
 - Markers to cover the numbers
 - Dice (make your own using a cube template)
 - Question cards (cut up a sheet of paper into 32 rectangular cards on which you will write questions to be asked)
 - Game board

How to play

Now, let's play.
Divide your group into two teams.
Each team has a token.

- Place your token on any empty square. You can move in any direction.
 - Throw the dice. The number on the dice will indicate to you how many places you can move.
 - Your aim is to land on a solid. When you land on a solid, take a card from the box. Read the question and answer it. Turn over the card to find the correct answer. If you have answered correctly, you can keep the card; otherwise place it at the back of Pack 1, Grade 9.
 - Also, if you answered correctly and kept the card, place a marker on the geometric shape or solid. This means that no-one can answer a question on this square again; it is now the same as a white square.
 - The next team plays.
 - You always wait for your turn once you have answered the previous question. If you land on an empty square you cannot take a card. You have to wait for your next turn to throw again.
 - The game is over once all the shapes or geometric solids are covered.
 - In the bottom corner of each card is a score. Add all of the scores of the cards you won.

The image shows a 10x10 grid for a geometric game. The grid consists of light blue squares. Several 3D geometric shapes are placed on the grid, primarily in the upper right quadrant. These include:

- A large blue octahedron at the top left.
- A blue cube in the middle row, second column from the left.
- A blue dodecahedron in the middle row, third column from the left.
- A blue tetrahedron in the middle row, fourth column from the left.
- A blue sphere in the middle row, fifth column from the left.
- A blue triangular prism in the middle row, sixth column from the left.
- A blue trapezoidal prism in the middle row, seventh column from the left.
- A blue cylinder in the middle row, eighth column from the left.
- A blue rectangular prism in the middle row, ninth column from the left.
- A blue triangular bipyramid in the middle row, tenth column from the left.
- A blue hexagonal prism in the bottom row, first column from the left.
- A blue dodecahedron in the bottom row, second column from the left.
- A blue triangular prism in the bottom row, third column from the left.
- A blue rectangular prism in the bottom row, fourth column from the left.
- A blue triangular bipyramid in the bottom row, fifth column from the left.
- A blue hexagonal prism in the bottom row, sixth column from the left.
- A blue dodecahedron in the bottom row, seventh column from the left.
- A blue rectangular prism in the bottom row, eighth column from the left.
- A blue triangular prism in the bottom row, ninth column from the left.
- A blue triangular bipyramid in the bottom row, tenth column from the left.

Family time:

110

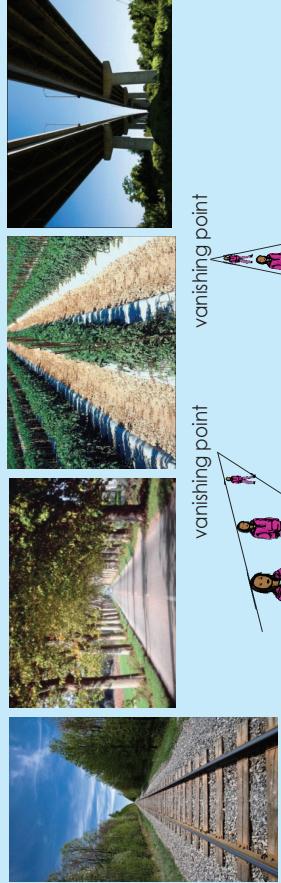
Family time:

Perspective

120a

Look at these photographs and answer the questions.
Are these railway tracks parallel?

If we were to view this from above, we would see parallel lines.



What is happening with this girl? Does she physically get smaller?

Before you carry on with Step 5, answer the following questions.

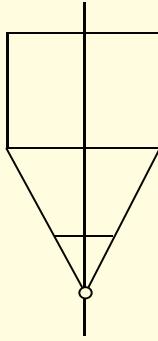
- Are the two connecting lines the same length?
- Why do you think we have one long and one short line?

Are these railway tracks parallel?

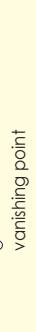
Note: The top perspective line goes past the connecting line. Erase the extended line, as it is not needed. When drawing objects in one-point perspective, drawing lines that are too long or too short are common, and we should adjust them accordingly.

Step 5: Form the front of the perspective object. Draw two horizontal lines of equal distance from the top and bottom of the closest part of the wall. Connect these two new lines with another vertical line.

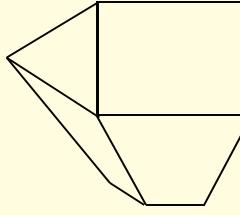
What you have done so far is to draw a cuboid. You might need to shade it to see it more clearly. This is what we call a **one-point perspective drawing** at its simplest.



Step 6: Draw the roof. Draw two diagonal lines from the top vertices of the front of the box (creating a triangle). Draw a line from where the lines meet towards the vanishing point. Draw another diagonal line that connects the far point of the box with the line you just created going towards the vanishing point. Try to make this diagonal line have the same angle as the line it matches up with at the front. These two lines should be parallel.



Step 7: Make the drawing neat. Remove any unwanted perspective lines, like the ones extending towards the vanishing point and horizon line.



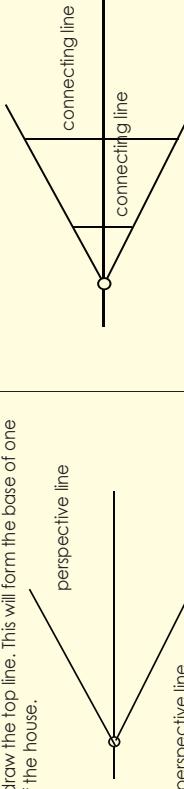
1. Use a pencil, a piece of paper, a ruler and an eraser. Follow the instructions, and draw the following.

Step 1: Draw a horizontal line.

Step 2: Choose a vanishing point. You can pick a point anywhere on this line; it doesn't really matter where. (Your results will just look different depending on where you put the point.)



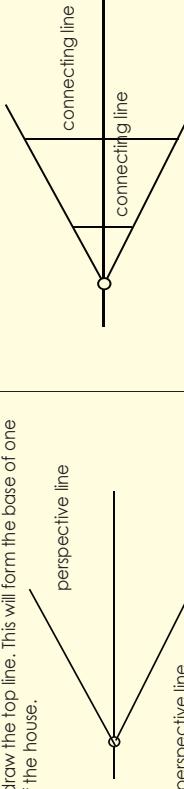
Step 3: Draw perspective lines. (Draw the perspective lines slightly so that you can easily erase them.) Make one line with your ruler from the vanishing point outward. This line will be the bottom of your building. Next, draw the top line. This will form the base of one wall of the house.



Step 4: Draw two vertical lines that connect the bottom and top lines. One wall of your structure is done.



Step 5: Draw perspective lines. (Draw the perspective lines slightly so that you can easily erase them.) Make one line with your ruler from the vanishing point outward. This line will be the bottom of your building. Next, draw the top line. This will form the base of one wall of the house.



Term 4

continued

144

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

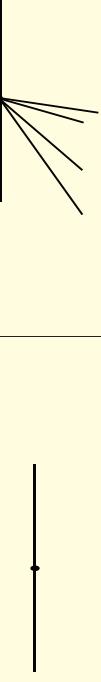
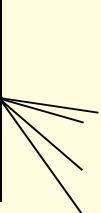
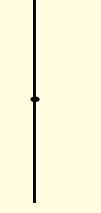
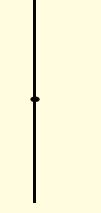
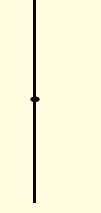
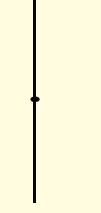
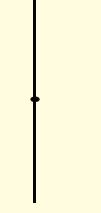
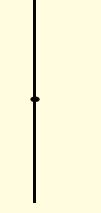
Perspective continued

120b

Remember in the previous activity we focused on one-point perspective. In this activity, we are going to look at two-point perspective.

- 2. Apply this knowledge (drawing method) to draw something amazing. (Remember, the more you apply this knowledge, the better your drawings will become.)**

- 4. Before looking at two-point perspective, we are going to draw a cube using one-point perspective.**

<p>Step 1: Draw the horizontal line and vanishing point.</p> 	<p>Step 2: Draw two pairs of perspective lines. Note that we have more than two perspective lines, but still only one vanishing point.</p> 
<p>Step 3: Draw a horizontal line joining three of the perspective lines, as shown in the drawing.</p> 	<p>Step 4: Draw a square using the horizontal line drawn in Step 3.</p> 
<p>Step 5: Estimate where you think the back edge of the cube is going to be, and draw that horizontal line.</p> 	<p>Step 6: Extend the perspective line on the right.</p> 
<p>Step 7: Draw a vertical line from the back edge (horizontal line) of the cube, to the perspective line on the far right.</p> 	<p>Step 8: Erase the lines that are not needed.</p> 

- 3. Look at the photographs. Indicate on the photographs the vanishing points and the perspective lines.**



Perspective continued

120c

5. Identify the vanishing point and lines of perspective.



b.



6. Look at these two photographs and identify the two vanishing points.

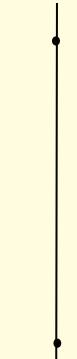


b.



7. Draw a cube using two-point perspective.

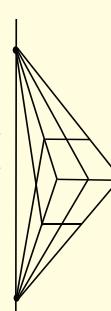
Step 1: Draw the horizontal line and two vanishing points.



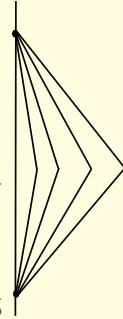
Step 3: Extend the first two perspective lines until they reach the second pair of perspective lines.



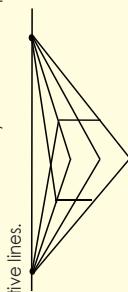
Step 5: Draw a line from where the second perspective lines meet to where the last perspective lines meet.



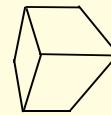
Step 2: Draw four perspective lines from each vanishing point, until they meet.



Step 4: From where the perspective lines stop in Step 3, draw vertical lines until they reach the last pair of perspective lines.



Step 6: Erase the unnecessary lines.

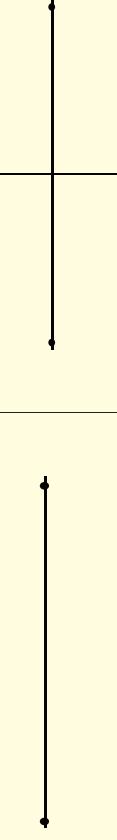


8. Look at this picture and do the following:

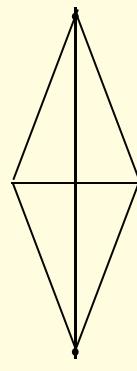
- Identify the vanishing points.
- Name all the geometric solids this building is made of.
- See if you can draw this castle using a horizontal line, vanishing points, perspective lines, vertical lines, etc.

9. Follow the steps to draw two cuboids that look like buildings.

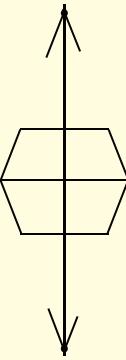
1. Draw a horizontal line. Add two vanishing points.
2. Make a vertical perpendicular to the horizontal line. Make sure it is in the middle of the line and shorter than the horizontal line.



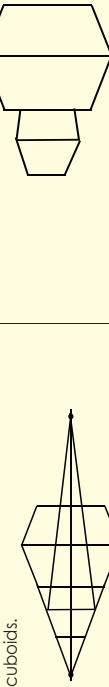
3. Draw perspective lines from the vertical line to the vanishing points. Use the diagram to guide you.



4. Now draw two lines parallel to the vertical line, one on the left and one on the right.
5. Erase the unnecessary lines as in the drawing below.



6. You have your first cuboid. Extend the left-hand perspective lines again. Decide where you want to place your second cuboid. It should be on the left. Draw a vertical line from the top to the bottom perspective line.
7. Extend the perspective lines on the right to where your second cuboid starts. Draw another vertical line on the left-hand side, showing the other edge of your cuboids.



Expanded opportunity: Add another 'building' to the drawing. Make sure it is in perspective.

Problem solving

Make a perspective drawing of your own, using perspective lines and a vanishing point.

Signt:	Date:	

Constructing nets

121a

2. Construct a square pyramid net.

Step 1: Construct two perpendicular lines. The lengths of AD and AB should be the same. Use your pair of compasses to measure them. From there, construct square ABCD.

Step 2:

- Using AB as a base, construct a triangle.
- Using DC as a base, construct a triangle.

Step 3:

- Using DA as a base, construct a triangle.
- Using BC as a base, construct a triangle.

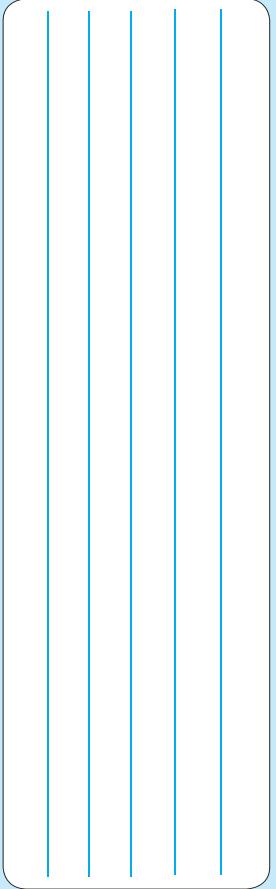
Step 2:

- Using AB as a base, construct a triangle.
- Using DC as a base, construct a triangle.

Step 3:

- Using DA as a base, construct a triangle.
- Using BC as a base, construct a triangle.

Write down the important points that you need to remember when constructing figures.



1. Construct a tetrahedron net

Step 1: Construct an equilateral triangle. Label it ABC.

Step 2: Construct another equilateral triangle with one base joined to base AB of the first triangle.

Step 3: Construct another triangle using BD as a base.

Step 4: Construct another triangle using AD as a base.

Term 4

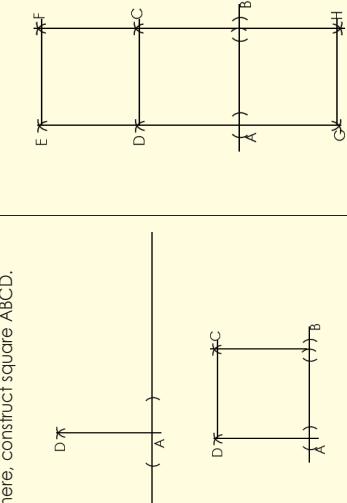
Constructing nets continued

121b

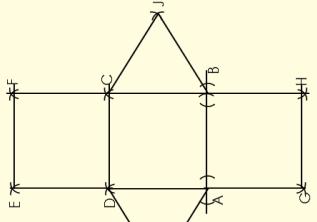
4. Construct a rectangular prism construction net.

3. Construct a triangular prism construction net.

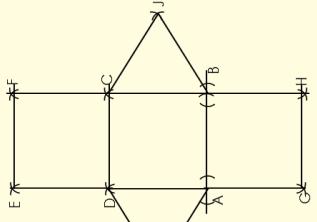
Step 1:
Construct two perpendicular lines. The lengths of AD and AB could be the same or one could be longer than the other. Use your pair of compasses to measure them. From there, construct square ABCD.



Step 2:
Using AB as a base, construct another square (or rectangle). Using DC as a base, construct a square (or rectangle).



Step 3:
Using DA as a base, construct a triangle.
Using BC as a base, construct a triangle.



<p>Step 1: Construct two perpendicular lines. The length between A and B should be longer than that between D and A. Use your compass to measure them. From there, construct rectangle ABCD.</p>	<p>Step 2:</p> <ul style="list-style-type: none"> • Use DC as base to construct another rectangle above. • Use AB as base to construct another rectangle below. Label the new points G and H. • Use GH as base to construct another rectangle. 	<p>Step 3:</p> <ul style="list-style-type: none"> • Use DA as base to construct a square. • Use CB as base to construct a square.

Making

Do all the construction on cardboard now, then cut it out and make the geometric object.

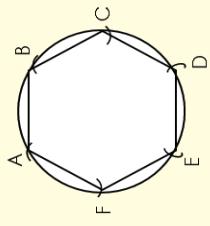
<p>Step 1: Construct two perpendicular lines. The length between A and B should be longer than that between D and A. Use your compass to measure them. From there, construct rectangle ABCD.</p>	<p>Step 2:</p> <ul style="list-style-type: none"> • Use DC as base to construct another rectangle above. • Use AB as base to construct another rectangle below. Label the new points G and H. • Use GH as base to construct another rectangle. 	<p>Step 3:</p> <ul style="list-style-type: none"> • Use DA as base to construct a square. • Use CB as base to construct a square.

More constructing nets

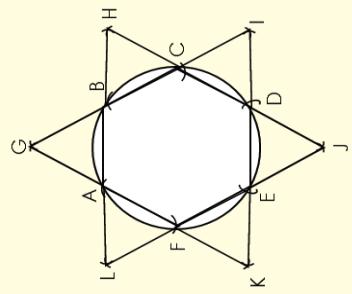
122a

2. Hexagonal pyramid construction

Step 1:
Construct hexagon ABCDEF.

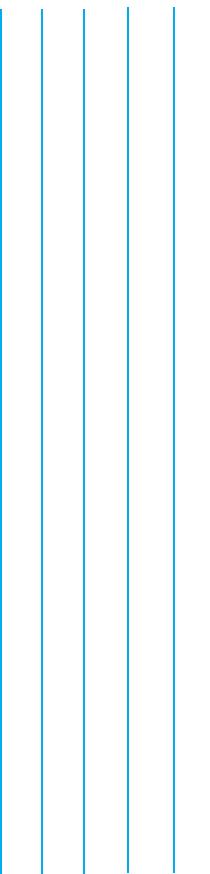


- Step 2:**
- Use AB as a base to construct a triangle.
 - Use BC as a base to construct a triangle.
 - Use CD as a base to construct a triangle.
 - Use DE as a base to construct a triangle.
 - Use EF as a base to construct a triangle.
 - Use FA as a base to construct a triangle.

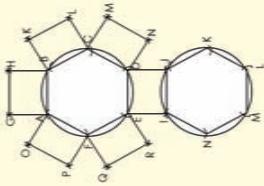


1. Construct a hexagonal prism.

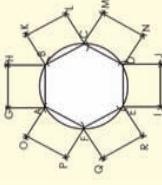
Step 1:
Construct hexagon ABCDEF.



- Step 2:**
- Use AB as a base to construct a rectangle.
 - Use BC as a base to construct a rectangle.
 - Use CD as a base to construct a rectangle.
 - Use DE as a base to construct a rectangle.
 - Use EF as a base to construct a rectangle.
 - Use FA as a base to construct a rectangle.
- Note:** The rectangles can also be squares.



- Step 3:**
- Use J as a base to construct another hexagon.

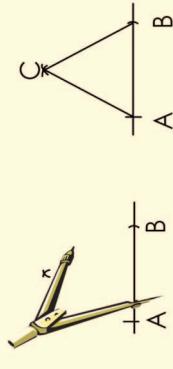


Term 4

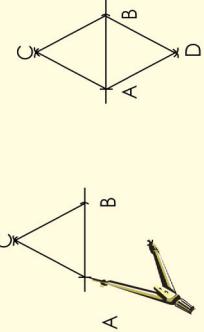
More Constructing nets continued

4. Construct an octahedron.

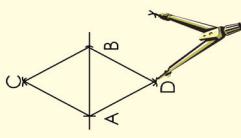
Step 1:
Construct an equilateral triangle. Label it ABC.



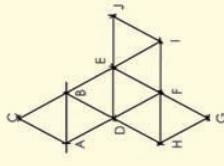
Step 2:
Construct another equilateral triangle with one base joined to base AB of the first triangle.



Step 3:
Construct another triangle using BD as a base.

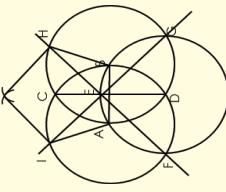


Step 4:
Carry on constructing triangles until you complete the net.

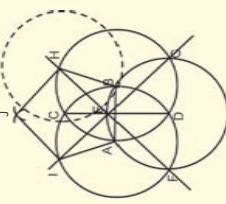


5. Construct an octahedron net.

Step 1:
Construct a pentagon.

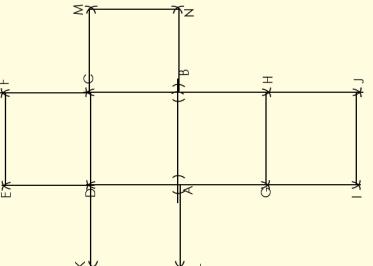


Step 2:
Let H be the middle of the next circle, for constructing the next pentagon.

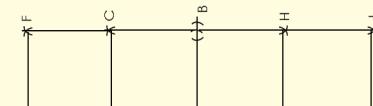


3. Construct a cube.

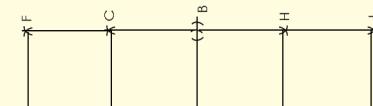
Step 1:
Construct two perpendicular lines. The length between A and B should be the same as the length between D and A. Use your compass to measure them. From there, construct square ABCD.



Step 2:
Use DC as base to construct another square.
Use AB as base to construct another square. Label the new points G and H.



Step 3:
Use DA as base to construct a square.
Use CB as base to construct a square.



More Constructing nets continued

122c

6. Project

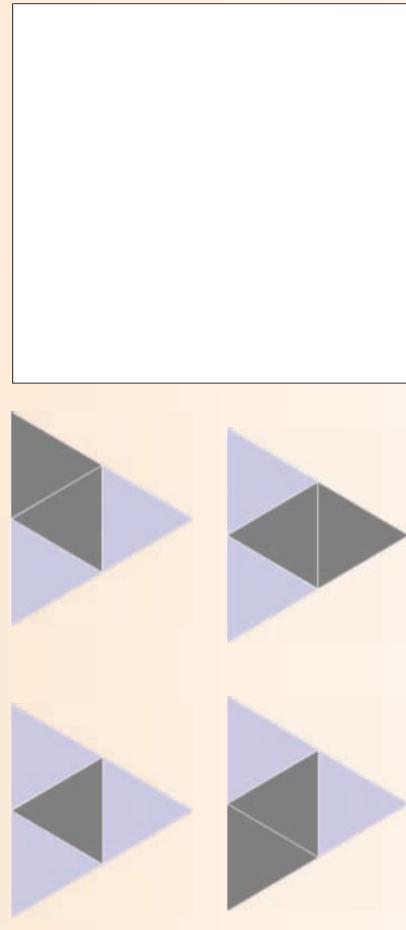
You have had various opportunities to work through constructions step by step. In this activity, you are going to choose your own geometric solid and design a net for it. Do not to choose solids that are too difficult or very easy to construct. You should:

- design and construct the net
- trace it on cardboard and cut it out
- fold it to make a solid

7. Quick activities

 (you may need to use extra paper.)

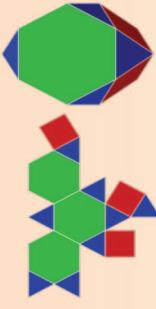
a. We know that a tetrahedron is a platonic solid. Platonic solid faces are all congruent. Use transformation Geometry to show that all the faces of this platonic solid are congruent.



b. Describe the net you made in Question 6. Support what you say with some drawings of your net.

Net description and drawings here.

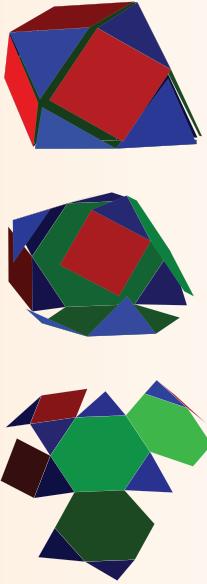
c. Look at this net of a Johnson solid.
Explain the faces in your own words.



d. Describe the shapes that make up your net in Question 6 in the same way as the example above.

Shapes description here.

e. Look what happens with the angles when the net is folded to form a geometric solid. Describe the vertices.



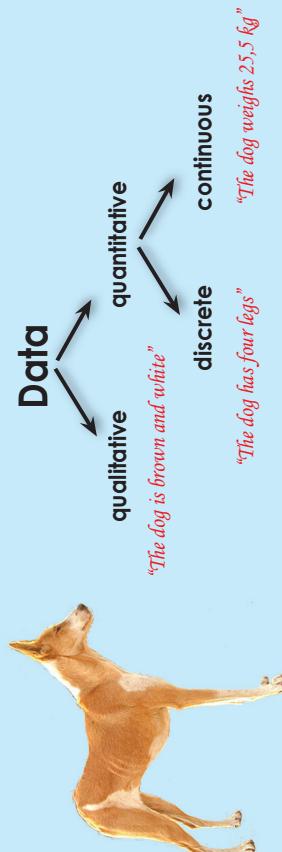
f. Describe the vertices of the net you created.

Vertices description here.

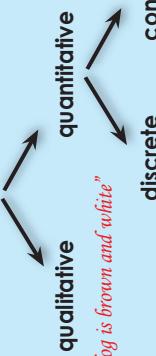
Data Collection

123

Data is a collection of facts, such as values or measurements, which we collect to solve a problem or to answer a research question or hypothesis.



Data



"The dog is brown and white"

"The dog has four legs"

"The dog weighs 25.5 kg"

Data can be qualitative or quantitative.

• **Qualitative data** is descriptive information (it describes something)

• **Quantitative data** is numerical information (numbers)

• Qualitative → **Quality**
• Quantitative → **Quantity**

In Grade 8 you learnt about discrete and continuous data. Classify the answers in the previous table as "continuous data" or "discrete data". What do you notice? What do you notice?
Answer:

Remember:
Discrete data is data that can only take certain values.
Continuous data is data that can take any value.

Qualitative	Quantitative
Appearance	• Grams of tea used
Smell	• Temperature served
Taste	• Cost per cup
Served in cup	• Size of cup

We can only classify **quantitative data** as being discrete or continuous.

Once a research hypothesis has been determined, the next step is to identify which method would be appropriate and effective.

Data can be collected from various sources using different methods.

Examples of sources of data:

Documents

- Historical (primary data)
- Diaries
- Literature review (secondary data)
- Content analysis

Observations

- Participant observer
- Case study

Survey

- Questionnaire
- Interview
- Focus group

Experimental

- True designs
 - Quasi-designs (simulation)
- Other field methods**
- Focus groups
- Multi-methods approach**
- Combination of methods



Example:

Qualitative data deals with descriptions. Data can be observed but not measured. Colours, textures, smells, tastes, appearance, beauty, etc.

Quantitative data Deals with numbers. Data that can be measured. Length, height, area, volume, weight, speed, time, temperature, humidity, sound levels, cost, members, ages, etc.

What data can you collect from a cup of tea? Classify the data into qualitative data and quantitative data.

Qualitative	Quantitative
Appearance	Grams of tea used
Smell	Temperature served
Taste	Cost per cup
Served in cup	Size of cup

Data Collection continued

123b

3. Identify the population or sample, and describe and justify your choice of source of data and method of data collection to determine the following:

1. Determine whether the data is qualitative or quantitative:

- a. The colours of motor cars in a used-car lot.

- b. The numbers on the shirts of a girls' soccer team.

- c. The number of seats in a movie theatre.

- d. A list of house numbers on your street.

- e. The ages of a sample of 350 employees of a large hospital.

2. Explain what bias there is in doing a research entirely online.

a. The number of households in South Africa with access to the internet.

- b. The average weight of the people visiting the local mall.

Design a survey

Your school decided to get involved in a paper recycling project.

Create a plan that tracks your school's paper recycling project.

Where and how will you get your information?

Make sure that each class sorts the paper collected as follows:

white paper, newspaper, cardboard and other.

You need to collect data per category per class to establish who collected the most during the campaign.

Organise data

124a

Revise:

Measure	Definition	How to calculate	Example Data set: 2, 2, 3, 5, 5, 7, 8
Mean	The mean is the total of the numbers divided by how many numbers there are.	To find the mean , you need to add up all the data, and then divide this total by the number of values in the data	Adding up the numbers gives: $2 + 2 + 3 + 5 + 5 + 7 + 8 = 32$ There are seven values, so you divide the total by 7: $32 \div 7 = 4.57\ldots$ So the mean is 4.57
Median	The median is the middle value in a series of numbers.	To find the median , you need to put the values in order, then find the middle value. If there are two values in the middle, then you find the mean of these two values.	The numbers in order: 2, 2, 3, (5), 5, 7, 8 The middle value is marked in brackets, and it is 5. So the median is 5.
Mode	The mode is the value that appears the most.	The mode is the value which appears most often in the data. It is possible to have more than one mode if there is more than one value which appears the most.	The data values: 2, 2, 3, 5, 5, 7, 8 The values that appear most often are 2 and 5. They both appear more times than any of the other data values. So the modes are 2 and 5
Range	The range is the difference between the biggest and the smallest number.	To find the range , you first need to find the lowest and highest values in the data. The range is found by subtracting the lowest value from the highest value	The data values: 2, 2, 3, 5, 5, 7, 8 The lowest value is 2 and the highest value is 8. Subtracting the lowest from the highest gives: $8 - 2 = 6$ So the range is 6.

Example:
a. (25, 24, 5, 25, 15, 1, 17)

Answer:

$$\text{Range} = 24$$

$$\text{Mean} = 16$$

$$\text{Median} = 17$$

$$\text{Mode}(s) = 25$$

The mean average is not always a whole number.

Remember to start by arranging the data from small to big.

b. (15, 24, 6, 9, 5, 7, 11)

Answer:

$$\text{Range} = 19$$

$$\text{Mean} = 11$$

$$\text{Median} = 9$$

$$\text{Mode}(s) = \text{none}$$

c. (17, 9, 26, 22, 26)

Answer:

$$\text{Range} = 17$$

$$\text{Mean} = 20$$

$$\text{Median} = 22$$

$$\text{Mode}(s) = 26$$

Note if there is an even amount of numbers, the median will be the value that would be halfway between the middle pair of numbers.

2. Calculate the interquartile range for the following data series:

a.

3	1	2	7	4	3	1	6
---	---	---	---	---	---	---	---

b.

26	65	80	12	15	3	7	99
----	----	----	----	----	---	---	----

The **interquartile range** is the range of the middle 50% of a distribution.

Both **variance** and **standard deviation** measure how far the average scores deviate or differ from the mean. The bigger the deviation the bigger the variance and standard deviation.

An **outlier** is an observation that lies an **abnormal distance** from other values in the data.

A large standard deviation may indicate that presence of outliers. The **interquartile method** may also be used to check for outliers.

Organise data continued

124b

4. Are there any outliers in the following data series. Explain your answer.

22	25	26	29	31	35	50
----	----	----	----	----	----	----

150	143	103	12	145	130	165	65	8	155
-----	-----	-----	----	-----	-----	-----	----	---	-----

Term 4

3. Calculate the variance and the standard deviation of the following data series.

150	143	103	12	145	130	165	65	8	155
-----	-----	-----	----	-----	-----	-----	----	---	-----

- Use the standard deviation to determine if there are any outliers in the following data series.
a. 40 50 40 30 170 -90 30 50 30 30
b. 12 25 36 107 8 15 -12 50 30 -30
c. 15 17 11 51 -3 20 5 16 14 12

- Use the interquartile to determine if there are any outliers in the following data series.
a. 5 20 6 5 7 8 15
b. 4 5 4 3 17 -9 3 5 3 3
c. 350 450 150 12 140 130 240 310 290 230

Now try it on your own.



Sign:

Date:

Summarise data

125d

We have looked at **measures of central tendency** and **measures of dispersion**.

We have also looked at how to group a set of data that is spread out.

Can you still remember what the measures of central tendencies are?

Describe what each mean.

Mode

Mean

Median

Range

What do we do when we have collected **more than one attribute** (criterion) about the same subject?

In this worksheet we are going to look at how to organise data according to more than one criterion.

	Right-handed	Left-handed	Total
Males	4	2	6
Females	5	1	6
Total	9	3	12

This is called a cross-tabulation (cross-table) or contingency table.

Was it easier to read?

Was it easier to read?

- Now answer the following questions.**
- How many males are there in the class?
 - How many females are there in the class?
 - How many males are right-handed and how many are left-handed?
 - How many females are right-handed and how many are left-handed?
 - How many learners are right-handed and how many are left-handed?

1. Suzanne is planting a new flower garden in her back yard. She got the soil ready for the new plants. Here is a table of what she planted in the new flower garden. Read the table and answer the questions.

Type of flower	Pink	White	Purple	Total
Daffodil	16	30	0	46
Iris	21	43	26	90
Day lily	14	12	0	26
Azalea	24	9	30	63
Roses	7	5	0	12
Total	82	99	56	

In this survey we collected two sets of data of 12 learners in our class. We know their gender and if they are right- or left-handed.

Answer the following questions:

- How many males are in the class?
- How many females are in the class?
- How many males are right-handed and how many are left-handed?
- How many females are right-handed and how many are left-handed?
- How many learners are right-handed and how many are left-handed?

Learner	Gender	Handedness
1	Female	Right-handed
2	Male	Left-handed
3	Male	Right-handed
4	Female	Right-handed
5	Female	Right-handed
6	Male	Right-handed
7	Male	Left-handed
8	Male	Right-handed
9	Female	Right-handed
10	Female	Left-handed
11	Male	Right-handed
12	Female	Right-handed

- What is the total number of iris bulbs Suzanne planted?
- How many roses did Suzanne plant altogether?
- What plant did Suzanne plant the most of?

125b Summarise data continued

d. How many more white daffodils did she plant than pink?

e. What is the total number of purple flowers Suzanne planted?

f. What is the total number of azaleas she placed in the garden?

g. How many more purple azaleas than pink azaleas are there?

h. What is the total number of day lily plants?

i. What is the total number of pink flowers?

j. What plant did she use the least in her garden?

2. Use the favourite colour table below to compile a cross tabulation of the data.

Learner	Gender	Colour	Learner	Gender	Colour
1	Female	Red	7	Male	Green
2	Male	Blue	8	Male	Blue
3	Male	Yellow	9	Female	Blue
4	Female	Red	10	Female	Red
5	Female	Green	11	Male	Yellow
6	Male	Blue	12	Female	Green

Healthcare worker	Gender	Type	Area
1	Female	Doctor	Rural
2	Male	Doctor	Urban
3	Male	Nurse	Rural
4	Female	Doctor	Urban
5	Female	Nurse	Urban
6	Male	Doctor	Urban
7	Male	Nurse	Urban
8	Male	Doctor	Rural
9	Female	Nurse	Rural
10	Female	Doctor	Urban
11	Male	Doctor	Rural
12	Female	Nurse	Rural

Complete a cross-tabulation table and answer the following questions.

- How many female doctors work in the urban area?
- How many doctors in total work in the rural area?
- How many of the rural doctors are male and how many female?
- How many male nurses are there?
- Where do these male nurses work?
- Where do the most female doctors work?

Sign:

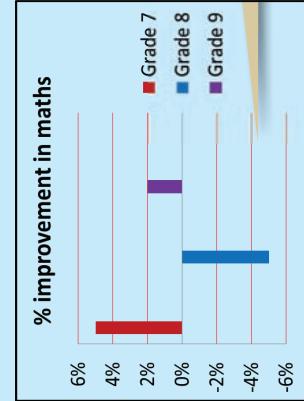
Date:

126 Bar graphs

Term 4

Analyse and interpret your graph and answer the following questions.

a. Where do you think this data came from?



Examples: Amount of rainfall on different days in a week, the favourite colours of Grade 8 learners, the number of students enrolled in different grades in a school in a particular academic year, etc

A bar graph can also have some negative values.

Bar graphs are used to compare categorical data using bars.

A **bar graph** is a visual display used to compare the amounts or frequency of occurrence of different characteristics of data.

1. In January I invested some money in gold, silver, platinum and palladium. I sold my investment in March. In the table below, find the price data in US dollar.

Price in US\$	January	February	March
Gold	1327	1427	1439
Silver	27.75	34.43	37.87
Platinum	1781	1828	1773
Palladium	806	811	766



Draw a bar graph to illustrate the percentage change in price from when I bought the investments to when I sold them.

b. How can this data and graph be useful for my investment decisions?

c. What scale did you use for your graph? Explain why.

d. Calculate the mean, median and mode.

e. What can these answers tell you about the data?

f. What is the data range?

g. What does the range tell you about the data?

Bar Graphs continued

126b

c. What scale did you use for your graph? Explain why.

h. Is there any extreme data (very small or large data)? Why do you think this data varies so much from the mean?

i. Which investment was the best? Explain.

Term 4

d. Calculate the mean, median and mode.

e. What can these answers tell you?

2. A scientist recorded the following earthquake data in the United States of America, using a seismograph to show the power of the earthquake on the 'Richter scale'.

Area	Reading on the Richter scale
William sound	8.2
Andrea of Islands	8.8
New Madrid	8.6
New Cape Yakatage	7.8
Gulf of Alaska	8.0



f. What is the data range?

Problem solving

Age of the drivers involved in fatal accidents									
28	27	27	26	30	31	30	31	29	28
27	26	24	22	19	19	22	23	24	24
26	27	28	29	30	30	29	28	27	27
27	17	21	26	39	42	65	16	40	53
65	42	52	26	25	25	24	56	52	27
27	28	29	30	30	29	28	22	28	35
36	53	33	36	37	26	26	41	19	
41	18	43	26	19	23	42	25	36	18
17	22	31	42	55	35	48	26	16	
22	36	18	26	35	31	45	22	19	

Age of the drivers involved in fatal accidents									
28	27	27	26	30	31	30	31	29	28
27	26	24	22	19	19	22	23	24	24
26	27	28	29	30	30	29	28	27	27
27	17	21	26	39	42	65	16	40	53
65	42	52	26	25	25	24	56	52	27
27	28	29	30	30	29	28	22	28	35
36	53	33	36	37	26	26	41	19	
41	18	43	26	19	23	42	25	36	18
17	22	31	42	55	35	48	26	16	
22	36	18	26	35	31	45	22	19	

- Group the data and draw a bar graph.
- Analyse and interpret your graph and answer the following questions.
 - What is the independent variable?
 - What is the dependent variable?
 - What are we comparing in this graph?
 - What range did you use for the class intervals?
 - Which class made the most accidents?
 - Calculate the mean, median and mode.
 - What can these answers tell you?
 - What is the data range?
 - What does the range tell you about the data?
 - Can we use this data as sample for the population of South Africa?
 - How can you avoid for any bias in your data?



b. How can this data and graph be useful to make future decisions?

a. Where was the earthquake the most severe?	b. How can this data and graph be useful to make future decisions?
--	--

More bar graphs

127a

Usually the x-axis is horizontal and its numbers represent time or some type or unit. The y-axis is usually vertical and its numbers measure how price or some other unit changes as a result of the change in the x variable. Sometimes to make the graph easier to read we make the x-axis vertical and the y-axis horizontal.

How to construct a double bar graph:

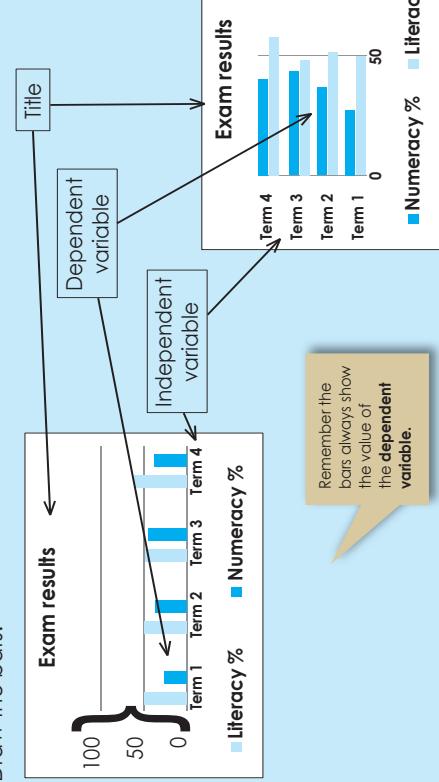
Decide what title you will give the graph.

Decide on your independent variable and dependent variable.

Choose a scale.

Put labels on the axes. Normally the x-axis represents the independent variable and y-axis dependent variable.

Draw the bars.



Analyse your data and answer the following questions.

a. What are we comparing in this graph?

b. In general, what can we say about the exam results?

2. Using the following data, construct a double bar graph and answer the questions.



The enrolment of Grades 8 and 9 learners from 2007 to 2010 were as follows:

2007: Grade 8 - 425, Grade 9 - 453
2008: Grade 8 - 431, Grade 9 - 419
2009: Grade 8 - 412, Grade 9 - 425
2010: Grade 8 - 380, Grade 9 - 414

1. The table below represents the test results of three of your subjects. Draw a bar graph with the independent variable on the horizontal x-axis. Then draw the same bar graph with the independent variable on the vertical y-axis.

	Exam results		
	Mathematics	Science	Languages
Term 2	56%	52%	58%
Term 4	65%	57%	51%

a. What scale did you use for your graph? Explain why.



More bar graphs continued

127b

3. A researcher followed 25 students from age 14 to age

18 to record how many of these students worked at each age level.

The following is the data that was collected:

14 yrs: 1 worked, 24 did not work

15 yrs: 3 worked, 22 did not work

16 yrs: 11 worked, 14 did not work

17 yrs: 19 worked, 6 did not work

18 yrs: 22 worked, 3 did not work

Construct a double bar graph. Interpret your graph and write a paragraph explaining your findings.



c. Compare the mean, median and mode for 2007 to 2010.

b. Calculate the mean, median and mode.

d. What can these answers tell you?

e. What is the data range?

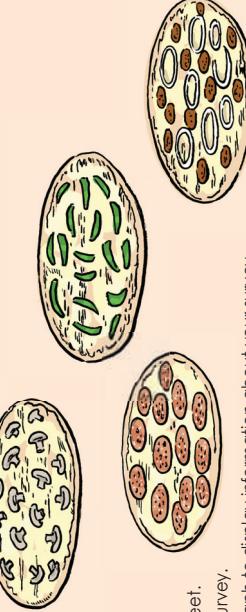
f. What does the range tell you about the data?

g. How can you avoid any bias in your data?

Problem solving

Ask family members, neighbours, classmates and friends what their favourite pizza toppings are. They are only allowed to select two from the list below. Rank them as the first choice and second choice.

List of pizza toppings:



Instructions:

- Design a recording sheet.
- Collect data using a survey.
- Make a double bar graph to display information about your survey.
- Analyse the results from the graph and write a paragraph about your findings.

Histograms

128a

1. Let us consider the following set of numbers.

57	66	73	92	77
31	60	32	22	25
45	36	49	42	56
37	88	41	54	42
57	63	59	15	62
3	32	82	48	37
78	18	39	77	97
92	73	66	77	93
22	32	60	25	19
42	49	36	56	54
54	41	88	42	45
15	59	63	62	40
48	82	32	37	66
77	39	18	97	91
47	55	27	69	69
46	55	21	73	71
46	55	15	76	74
45	56	9	79	77
44	56	2	82	79
44	56	-4	85	82

Revise how to compute the interval width.

The number of intervals influences the pattern, shape, or spread of your Histogram.

Here are two histograms of the following data set.

Histogram A with class interval of 10 and histogram B with class interval of 40

Histogram A

Class Intervals	Frequency
0-10	1
11-20	2
21-30	2
31-40	7
41-50	6
51-60	6
61-70	3
71-80	4
81-90	2
91-100	2

Histogram B

Class Intervals	Frequency
0-40	12
41-80	19
81-120	4

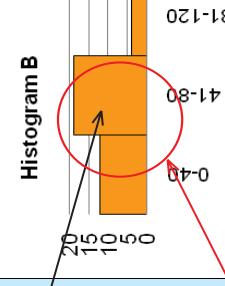
Remember to complete a frequency table first.

Term 4

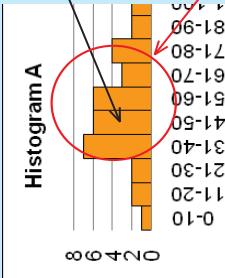
Mean seems to be about here

Spread seems to be about here

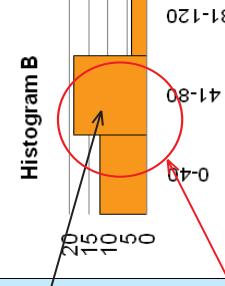
Histogram B



Histogram A



Histogram B



- Calculate the range.
- Decide on the number of intervals you want to have.
- Calculate the interval width and show your calculations.
- Determine the interval starting points and end points.

128b Histograms continued

- e. Count how many numbers fall into each interval and complete a frequency table.
f. Plot the data from the frequency table onto a histogram.

Term 4

- f. Add a title and legend.

2. Use the following data to draw a histogram and also find the mean, median and mode.

Resistance (ohms)	Frequency
46.0-46.2	3
46.2-46.4	5
46.4-46.6	6
46.6-46.8	9
46.8-47.0	5
47.0-47.2	6
47.2-47.4	5
47.4-47.6	2
47.6-47.8	3
47.8-48.0	1

A batch of resistors is tested to see how close they come to the manufacturer's specification of 47 ohms. Data is tabulated in bins of 0.2 ohm as follows:

Problem solving

Find out what an ohm is.

Make a histogram of this data. From the graph, estimate the median resistance. What can you say about the accuracy and the precision of the manufacturer's specified resistance of 47 ohms?

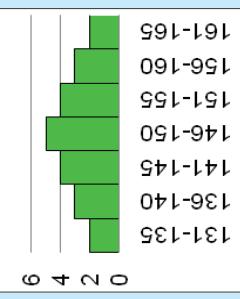


More on histograms

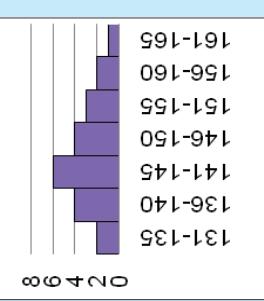
129a

Histograms can come in different shapes. The two most common shapes are the **bell-shaped curve** also known as the '**normal**' distribution and the **skewed** distribution.

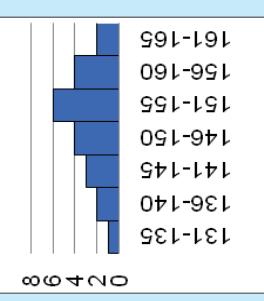
**Normal distribution
(Bell-shaped)**



**Skewed distribution
(Skewed to the left)**



**Skewed distribution
(Skewed to the right)**



Example:

A Histogram provides a visual representation so you can see where most of the measurements are located and how spread out they are.

What do you think a good spread or dispersion will be? Think about this question and develop your own definition of spread/dispersion.
Now look at this histogram.

In this histogram the distribution seems to be normal bell-shaped, but is that good or bad?

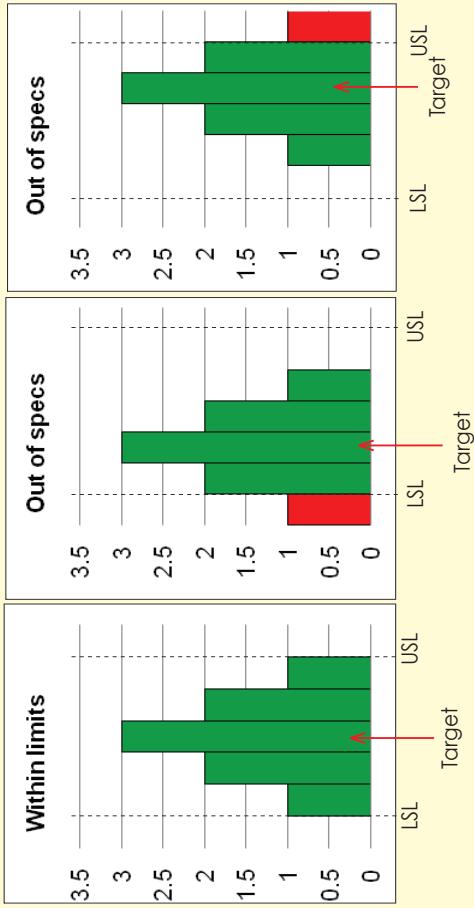
That will depend on your standard or target.

Let us say this histogram was the exam results of the first year engineering students and the pass rate is 50%.... Will this be a good distribution?

No! For this histogram shows that most of the student fail! It is not a good distribution at all.

The spread must always be measured against the **target** or **specification limits**.

Look at the following histograms to see whether they are within specification limits, and how close the spread is to the target.



LSL – Lower specification limit
USL – Upper specification limit

1. You are working at the gym. You are responsible for the semi-annual physical test screening for percentage body fat. You sampled 80 gym members randomly and this is the data you collected:

Body fat recorded	
11	22
10	15
9	7
8	13
7	20
6	25
5	12
4	16
3	17
2	10
1	16
0	17
8	23
7	14
6	16
5	10
4	5
3	21
2	26
1	10
0	17
23	12
24	10
11	15
14	20
17	11



More on histograms continued

129b

- g. If the target was not more than 15, what can you conclude from the histogram and data?

a. How many data points are there?

b. What is the data range?

c. Determine the number of intervals.

Problem solving

A skills trainer did an analysis of the scores of his students.

This is the data collected:

Average scores for the 9mm

160	190	155	300	280	185	250	285	200	165
175	190	210	225	275	240	170	185	215	220
270	265	255	235	170	175	185	195	200	260
180	245	270	200	200	220	265	270	250	230
255	180	260	240	245	170	205	260	215	185
255	245	210	225	225	235	230	230	195	225
230	255	235	195	220	210	235	240	200	220
195	235	230	215	225	235	225	200	245	230
220	215	225	250	220	245	195	235	225	230
210	240	215	230	220	225	200	235	215	240
220	230	225	215						

a. How many data points?

b. How many students in total did this instructor train?

c. What is the data range?

d. Determine the number of intervals.

e. Calculate the interval width – show your calculations.

f. Determine the interval points – show in a table.

g. Plot your data on a histogram and add titles and legend.

h. If the target was a score of not less than 240 to obtain a competency certificate, what can you conclude from the histogram and data?



Pie Charts

130a

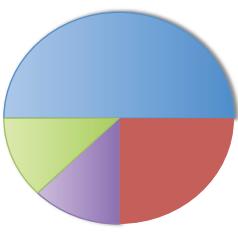
Revise the pie chart and how to draw it.

Steps:

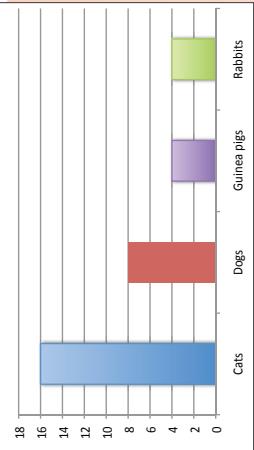
1. Convert all of your data points to percentages of the whole data set.
2. Convert the percentages into angles. Since a full circle is 360 degrees, multiply this by the percentages to get the angle for each section of the pie.
3. Draw a circle on a blank sheet of paper, using a pair of compasses. While a compass is not necessary, using one will make the chart much neater and clearer by ensuring the circle is even.
4. Draw a horizontal line, or radius, from the centre to the circumference of the circle, using the ruler or straight edge. This will be the first base line.
5. Measure the largest angle in the data with the protractor, starting at the baseline, and mark it on the circumference of the circle. Use the ruler to draw another radius to that point.
6. Use this new radius as a base line for your next largest angle and continue this process until you get to the last data point. You will only need to measure the last angle to verify its value since both lines will already be drawn.
7. Label and shade the sections of the pie chart to highlight whatever data is important for your use.

Term 4

Pets in the class



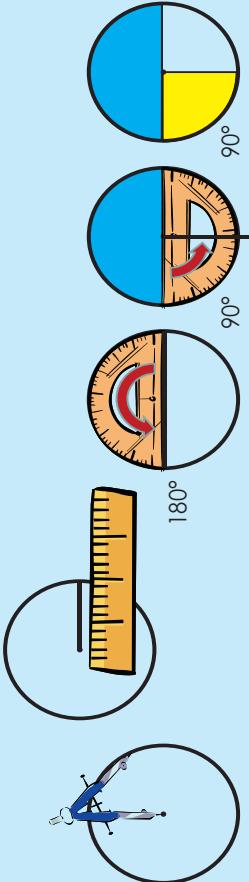
Pets in the class



The class produced two types of charts to present their data, but there are mistakes in both the pie chart and the bar chart. Try to find all the errors you can.

Draw the correct graphs.

Write a paragraph about the “story” of the graphs.



1. Class collected data about the numbers of certain pets owned by the pupils and completed the following table:

Pet	Cats	Dogs	Guinea pigs	Rabbits
Total number	16	8	4	4

Pie Charts continued

130b

2. In the 1800s, slaves were caught in Africa and transported to different countries.
The table below shows the destinations of slaves in percentages.

British Caribbean	25%
British North America	5%
Dutch Caribbean	5%
Spanish America	11%
Brazil	34%
French Caribbean	20%

- c. Write a brief summary based on the information from your chart.

- d. Explain what impact you think the slave trade had on the Africans remaining on the continent.

Term 4

- Use your chart to answer the following questions:
- a. Which area received the largest number of slaves?

- b. What was surprising about the statistics in the pie chart?

1. If a boy spends R225 a month, calculate how much he would spend on:

- a. Food
b. Clothes

2. If a girl spends R210 on clothes, calculate how much she would spend on:
a. Food
b. Entertainment



Problem solving

Teenage boy

Teenage girl

Sign _____ Date: _____

Broken line graph

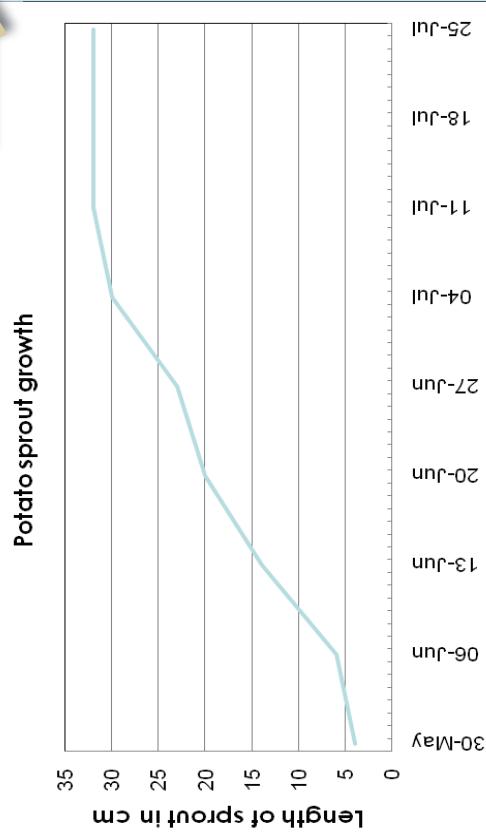
131a

Businesses often use line graphs to show information about profits

Meteorologists use line graphs to show monthly rainfall

Line graphs are useful as they show trends and can easily be extended

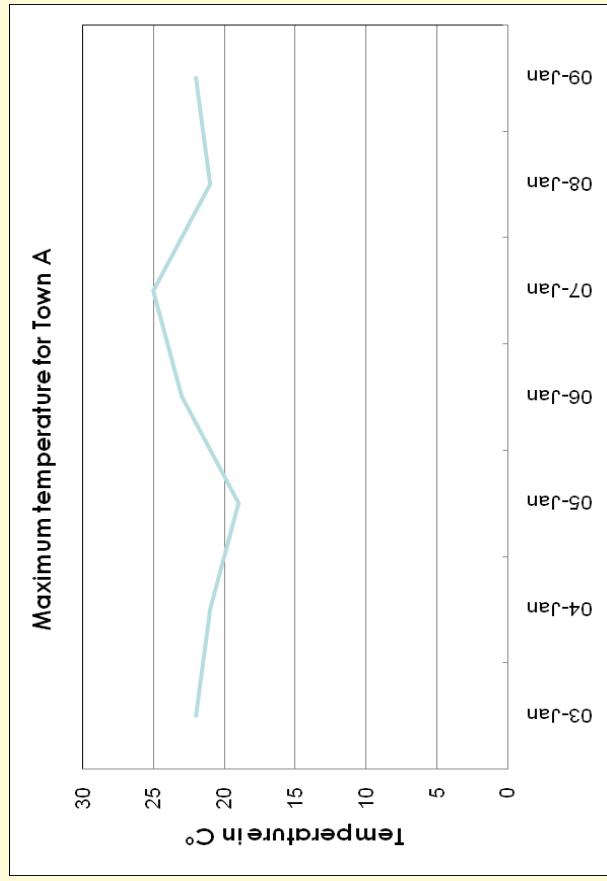
The line graph below shows the growth of a potato sprout over time.



A broken line graph will have numbers 'all over the place.'

It simply means it can go up without being a straight line.

Example: Drawing a broken line. We will use an example of temperature over one week. We will also describe each step.



On 3 January it was 22 degrees Celsius, on 4 January it decreased to 21 degrees Celsius and on 5 January it decreased further to 19 degrees Celsius.

On 6 January it increased to 23 degrees Celsius and on 7 January it increased further to 25 degrees Celsius.

On 8 January it decreased from 25 degrees Celsius to 21 degrees Celsius and on 9 January it increased to 22 degrees Celsius.

The graph goes up and down showing temperature rise and fall.

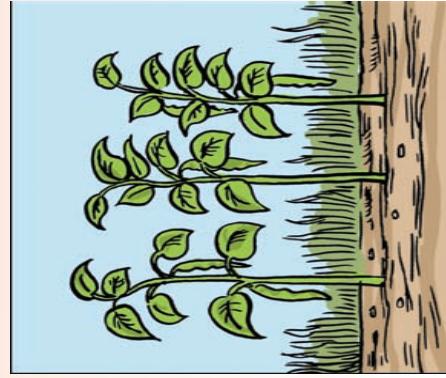
Ask the learners to predict the weather for the next week and then to draw a graph.

1. Keep record of the minimum and maximum temperature over two weeks. Draw a graph and interpret it.

--

2. Draw a broken line graph of a bean plant growth. Describe the graph.

Date	Plant Height (cm)
3 September	3
10 September	6
17 September	9
24 September	15
1 October	24
8 October	27
15 October	33
22 October	36
29 October	39



- a. How does this graph differ from the graph in Question 1?

- b. Interpret the graph.

Problem solving

Find a broken-line graph in a newspaper or the internet. Redraw it and then describe it.

Scatter plots

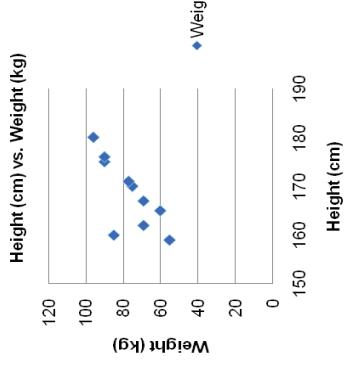
132a

A scatter plot diagram is a graph of plotted points that show the relationship between two sets of data.

Example:

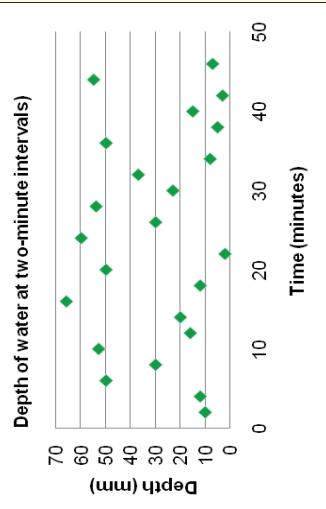
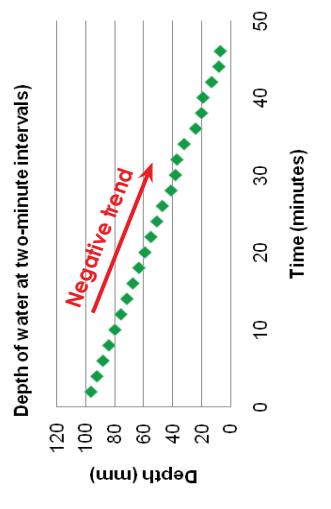
We surveyed the weight and height of the learners in our class. The data is represented in the table below.

Learner	Height (cm)	Weight (kg)
1	180	96
2	160	85
3	175	90
4	170	75
5	162	69
6	176	90
7	171	77
8	165	60
9	167	69
10	159	55



A scatter plot describes a **negative trend** if, as one set of values increases, the other set tends to decrease.

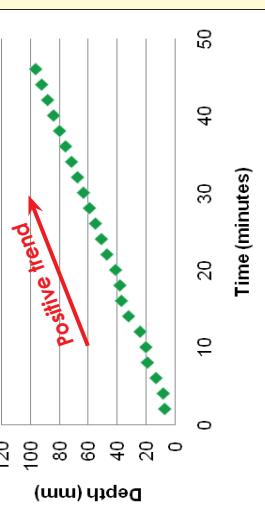
In the positive trend graph we can conclude that the tide is coming in (getting high tide) and in the negative trend graph we can conclude that the tide is going out (getting low tide).



1. Draw a scatter plot to determine the relationship between the age and the playing hours in a week

Age (x)	Playing hours (y)
6	20
7	17
8	18
9	17
10	17
11	13
12	16
14	14
15	13
16	12
17	5
18	9

A scatter plot describes a **positive trend** if, as one set of values increases, the other set tends to increase.



Problem solving

1. Determine the relationship between the average income of a family per annum (y) in thousand (R) and the percentage families (x) with that income. Plot a scatter diagram.



Percentage of number of families (x)	Average income (y)
5.8	10
4.3	15
10.7	25
12.0	35
17.2	50
22.3	75
12.5	100
9.6	150
2.7	200
2.9	250

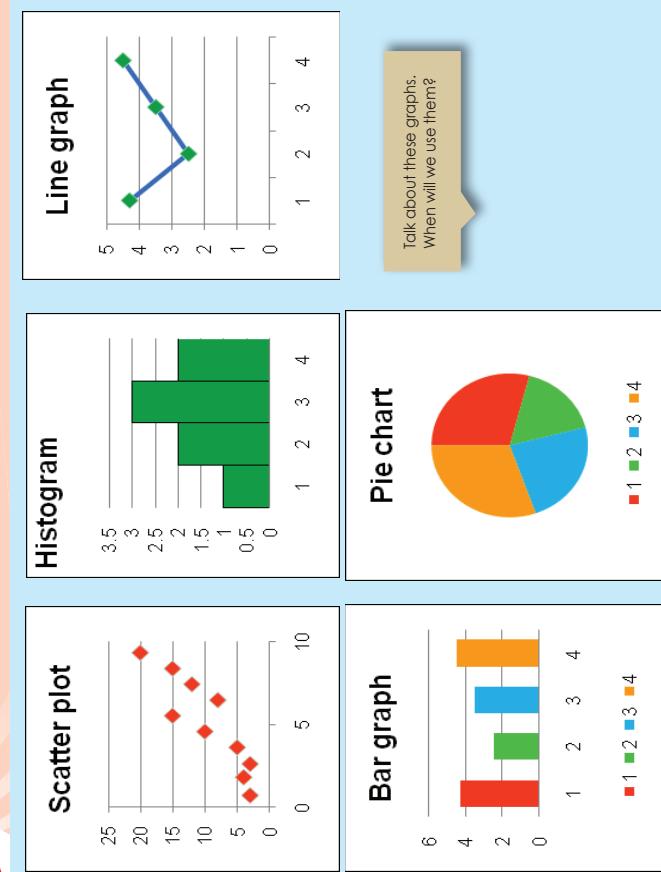
2. Plot the scattered diagram for the ordered pairs $\{(0,8), (1,10), (2,19), (3,8), (4,5), (5,13), (6,17), (7,7), (8,16), (9,18)\}$.

Number of workers (x)	Number of days (y)
2	60
3	46
4	30
5	22
6	20
7	25
8	15
9	18
10	12
11	16
12	10



Select the right graph

133



Term 4

- c. The number of boys and the number of girls who use the playground each day for one week.

- d. The percentage of chemical elements in seawater.

- e. The number of store customers per hour in one day.

Problem solving

Answer the following questions and then compile a frequency table and graph for each to demonstrate your answer.

Use your graphs to make at least two conclusions for each graph.

- What kind of graph might you use to show change over time?
- If you have data for Grade 7 and Grade 8 learners' favourite colours, what kind of graph might you use?
- If you have data for people's ages such as 0-9, 10-19, 20-29, and 30-39, what kind of graph should you use?
- What kind of graph might you use for data that shows parts of a whole?

Report data

134a

Revise the purpose and outline of a research report.

Here is a **suggested outline**:

1. Aim
This is the general aim of the research project.

2. Hypothesis
A specific statement or prediction that you can show to be true or false.

3. Plan
What questions are you asking?
What data do you need?
Who will you get the data from?
How will you collect it?
How will you record it?
How will you make sure the data is reliable?
Why? Give reasons for the choices you made.

Remember: for the conclusions to make sense to the reader, he or she must understand what the aim of the research was. Therefore always start the report by describing the aim of the research.

4. Analysis
This is where you start to make sense of the data.

You may need to do calculations.
Compare the mean and median of groups.

Look at the range – the measure of how spread out the group is.
You can draw frequency and other charts to summarise data.
Charts are good for representing data visually.

5. Interpretation
How do you interpret (explain the data)?
What does the data mean?

6. Conclusions

Do your results agree with the hypothesis?
How confident are you that your data and results are accurate?
What went wrong? How did you deal with it?
What would you do differently if you did the research again?

7. Appendices

It is good practice to include copies of any questionnaires or tests. The appendices may also include detailed tables related to data obtained, instructions to interviewers, and so on.

8. References

If you used any secondary data or research you must acknowledge your sources here.

Body fat percentage recorded												
11	22	15	7	13	20	25	12	16	19			
4	14	11	16	18	32	10	16	17	10			
8	11	23	14	16	10	5	21	26	10			
23	12	10	16	17	24	11	20	9	13			
24	10	16	18	22	15	13	19	15	24			
11	20	15	13	9	18	22	16	18	9			
14	20	11	19	10	17	15	12	17	11			
17	11	15	11	15	16	12	28	14	13			

1. Aim

2. Hypothesis

Do you still remember
the different terms
and how to calculate
them?



Term 4

Signt

Date:

1. Use the information from the this body fat research and write a report summarising the data and draw conclusions.

continued ↗
203

6. Conclusions

3. Plan

4. Analysis

5. Interpretation

7. Appendices

8. References

Data handling cycle

135



Data handling

Data handling is a process of collecting, organising, representing, analysing and interpreting data.

The visual representation of data is usually of major importance in research.

This assignment will go over two worksheets.

Do Grade 9 boys like action movies and girls like romance movies?

1. Choose your research team.



Names of your research team:

Term 4

f. How will you make sure the data is reliable?

g. Why? Give reasons for the choices you made.

- Your group will get an opportunity to present your aim, hypothesis and plan to the rest of the class.
- 5. Once all the research teams have presented their plans, you will get the opportunity to change your plans based on what they heard from the other teams.**

Our changes are:

6. Your revised plan is:

2. What is the aim of your research?

3. What is your hypothesis?

4. Questions that might help you to plan:

a. What questions will you ask?

b. What data do you need?

c. Who will you get it from?

d. How will you collect it?

e. How will you record it?

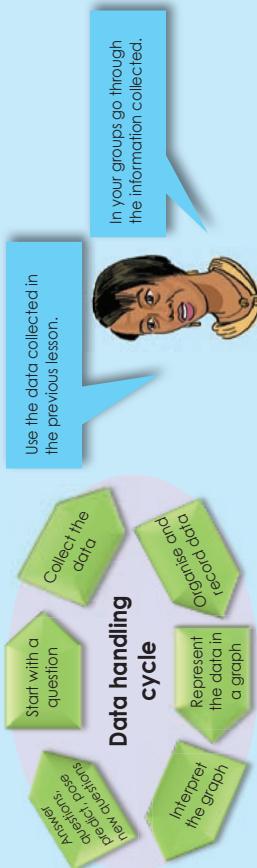
Preparing

Your plans are submitted now you should start collecting and recording the data.

Sign _____

Date: _____

In this worksheet you will continue with the data handling cycle.



Do Grade 9 boys like action movies and girls like romance movies?

1. Use the data you collected and recorded to:

a. Organise your data in a frequency table.

b. Calculate the mode, mean and median.

c. Calculate the data range.

d. Draw a stem-and-leaf display.

Interpreting your graphs.

Interpret your graphs and tables and write a report under the following headings:

1. Aim
2. Hypothesis
3. Plan
4. Analysis
5. Interpretation
6. Conclusions
7. Appendices
8. References

Another data handling cycle

137d



Data handling

Data handling is a process of collecting, organising, representing, analysing and interpreting data.

The visual representation of data is usually of major importance in research.

This assignment will go over two worksheets.

Is there a positive correlation between the height and weight of grade 9 boys.

1. Choose your research team.



Names of your research team:

2. What is the aim of your research?

3. What is your hypothesis?

4. Questions that might help you to plan:

a. What questions will you ask?

b. What data do you need?

c. Who will you get it from?

d. How will you collect it?

e. How will you record it?

f. How will you make sure the data is reliable?

g. Why? Give reasons for the choices you made.

- Your group will get an opportunity to present your aim, hypothesis and plan to the rest of the class.
5. Once all the research teams have presented their plans, you will get the opportunity to change your plans based on what they heard from the other teams.

Our changes are:

6. Your revised plan is:



Date:

d. Draw a stem-and-leaf display

5. Use the data you collected and recorded to:

a. Organise your data in a frequency table.

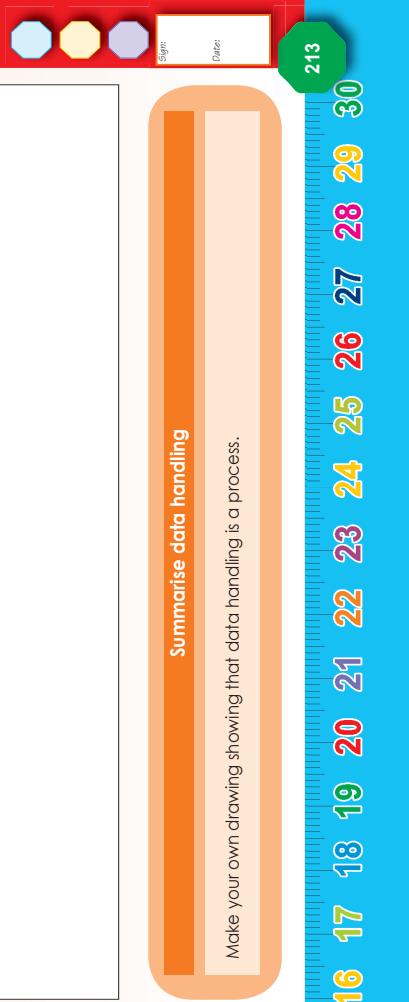
b. Calculate the mean, median and mode.

c. Calculate the data range.

e. Represent your data in a graph. You may use more than one type of graph.

Summarise data handling

Make your own drawing showing that data handling is a process.



Probability of a single event and its relative frequency

What is probability?

Probability is the chance that something will happen – how likely it is that some event will happen.

Example:

What is the probability of landing on 5 on a six-sided dice?

When rolling the dice there are 6 possible sides it can land on (1,2,3,4,5 or 6).

There is only one side that equals 5, therefore the probability to land on a 5 is one out of six or:

$$\frac{1}{6} = 16.6\%$$

Probability expressed as an equation will be:

$$\text{Probability} = \frac{\text{The number of ways of achieving success}}{\text{The total number of possible outcomes}}$$

What is relative frequency?

Relative frequency is based on a number of trials and is the observed number of successful events for a finite sample of trials.



What is the probability of landing on 5 on a six-sided dice?

When rolling the dice there are 6 possible sides it can land on (1,2,3,4,5 or 6).

There is only one side that equals 5, therefore the probability to land on a 5 is one out of six or:

$$\frac{1}{6} = 16.6\%$$

Term 4

1. There are 9 beads in a bag, 3 are red, 3 are yellow, 2 pink and 1 is blue. What is the probability of picking a yellow bead?

2. Your friend draws a bead 100 times, every time replacing the bead before drawing the next one. From the 100 trials, he picks a green bead 20 times.

- a. What is the relative frequency?
- b. What is the difference between the probability and the relative frequency?
- c. Why do you think the probability and relative frequency differ?

3. There is a bag full of coloured balls, red, blue, green and orange. Balls are picked out and replaced. John did this 1 000 times and obtained the following results:

Number of blue balls picked out: 300

Number of red balls: 200

Number of green balls: 450

Number of orange balls: 50

- a. What is the probability of picking a green ball?
- b. If there are 100 balls in the bag, how many of them are likely to be green?

The difference can be because we only rolled the 6-sided dice a 100 times - a very small sample of trials - if we increase the number of trials substantially the difference will decrease.

Problem solving

Jack asked 35 people whether they were left-handed or right-handed. 7 people said they were left-handed. Estimate the probability of any person chosen at random being left-handed.

Fundamental Counting principle

So let us look at this example:

- 3 choices of sandwiches
 - 3 choices of side dishes
 - 2 choices of drinks
- $3 \times 3 \times 2 = 18$ total outcomes

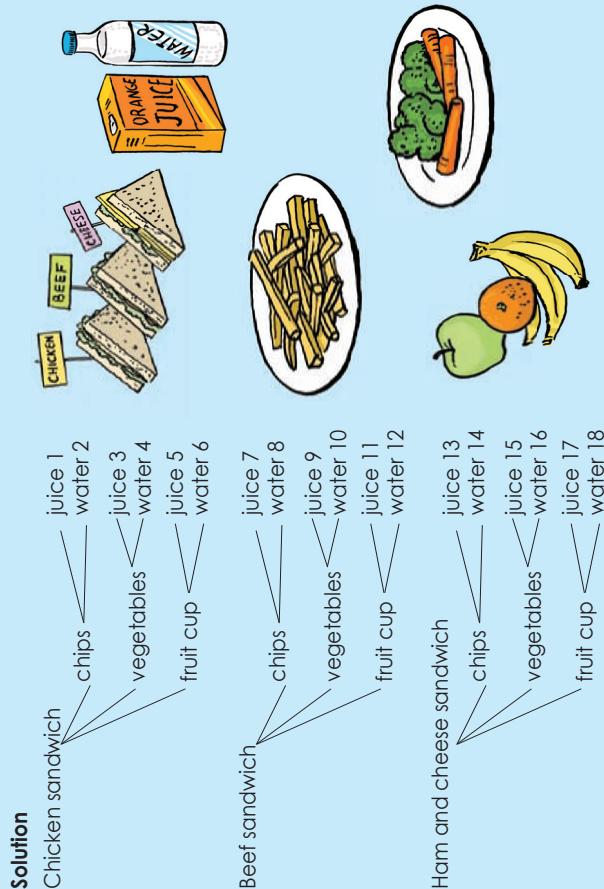
A new restaurant has opened and they offer lunch combos for R50.00. With the combo meal you get one sandwich, one side dish and one drink. The possible choices are below.

Sandwiches: chicken, beef, ham and cheese

Side dish: chips, vegetables, fruit cup

Drinks: juice, water

Draw a probability tree to find the total number of possible outcomes.



There are 18 possible combinations.

We were able to determine the total number of possible outcomes (18) by drawing a tree diagram. However, this technique can be very time-consuming. The fundamental counting principle will allow us to take the same information and find the total outcomes using a simple calculation.

This principle is difficult to explain in words.

1. How many combinations are there?

The sandwich inn offers 12 different kinds of sandwiches and four types of cheese. How many possible combinations of sandwiches and cheese are there?

2. What is the probability?

- How many possible outcomes are there?
- A pair of dice is rolled once.

- How many possible outcomes are there?

- What is the probability of rolling double?

- Find the probability of rolling doubles

Possibility Spaces

When working out what the probability of two things happening is, a probability/possibility space can be drawn.

For example, if you throw two dice, what is the probability that you will get: 8 or 9
Written as: P(8 or 9).

Solution:

		Dice 1					
		1	2	3	4	5	6
Dice 2	1						
	2						
	3						
	4						
	5						
	6						

Term 4

The probability space shows us that when throwing 2 dice, there are 36 different possibilities.

The blue circles indicate the ways of getting 8 (a 2 and a 6, a 3 and a 5, ...). There are 5 different ways.

The red circles indicate the ways of getting 9 (a 2 and a 6, a 4 and a 5, ...). There are 4 different ways.

So:

With 5 of these possibilities, you will get 8. Therefore $P(8) = \frac{5}{36}$

There are four ways, therefore $P(9) = \frac{4}{36} = \frac{1}{9}$

Therefore, you will get an 8 or a 9 in the following number of all the possible 36 cells of the table.

There are 9 altogether, so $P(8 \text{ or } 9) = \frac{5}{36} + \frac{4}{36} = \frac{9}{36} = \frac{1}{4}$

Do I understand?

Explain the fundamental counting principle in your own words.

3. Rolling two standard dice. Use a two-way table to determine the probability for rolling:
 a. P(3 or 8)
 b. P(7 or 9)
 c. P(6 or 5)

		Dice 1					
		1	2	3	4	5	6
Dice 2	1						
	2						
	3						
	4						
	5						
	6						

		Dice 1					
		1	2	3	4	5	6
Dice 2	1						
	2						
	3						
	4						
	5						
	6						

		Dice 1					
		1	2	3	4	5	6
Dice 2	1						
	2						
	3						
	4						
	5						
	6						

Probability of Compound Independent Events

In this worksheet, you will determine the probability of two events that are independent of one another. First we look at what the term independent means in terms of probability.

Two events, A and B, are independent if the outcome of A does not affect the outcome of B.

Do the following examples:

A coin is tossed and a six-sided dice is rolled. Find the probability of getting a tails on the coin and 4 on the dice.

These two events (the coin and dice) are independent events because the flipping of the coin does not affect rolling the dice. The events are independent of each other.

Solution: Let's us find the probability of each independent event:
 $P(\text{tails}) = \frac{1}{2}$

There is only one "tails" on a coin.

There are two total outcomes (heads and tails)

$P(4) = \frac{1}{6}$

There is only one 4 on a dice.

There are six total outcomes on a dice {1,2,3,4,5,6}

Now we need to find the probability of tossing a tails on the coin and rolling a 4 on the dice. So, we need to combine both events. There's a special rule for calculating the probability of independent events.

To find the probability of two or more independent events that occur in sequence, find the probability of each event separately, and then multiply the answers.
 $P(A \text{ and } B) = P(A) \cdot P(B)$

Now, let us apply our new rule:
 $P(\text{tails and a } 4) = \frac{1}{2} \cdot \frac{1}{6} = \frac{1}{12}$

The probability of flipping a tails on the coin and rolling a 4 on the dice is $\frac{1}{12}$.

Write your own probability of two events problem. Solve it.

1. Find the probability of independent events.

a. A jar of marbles contains three blue marbles, six red marbles, two green marble, and one black marble. A marble is chosen at random from the jar. After replacing it, a second marble is chosen. Find the probability for the following:



- You are given a standard deck of 52 cards that has been well shuffled. You want to choose an ace, a spade and a four, one after the other. You pick up three cards at random from anywhere in the pack. If they are not an ace, a spade or a four, you replace them at random. What is the probability of choosing an ace, a spade, and a four in this way?

Probability of Compound dependent events

Term 4

1. At the tyre store, five out of every 50 tyres are defective. If you purchase four tyres for your vehicle and they are randomly selected from a set of 50 newly shipped tyres, what is the probability that all four tyres will be defective?

Two events, A and B, are dependent if the outcome of the first event affects the outcome of the second event.

Dependent events are noted as: P(A, then B)

A card is chosen at random from a standard deck of 52 cards. Without replacing it, a second card is chosen. What is the probability that both cards chosen will be a king?

P(king, then king)

Formula used to find the probability of dependent events:



$$P(A \text{ and } B) = P(A) \cdot P(B \text{ after } A \text{ occurs})$$

Probability of A • Probability of B, given that A happened.

This means we multiply by the probability of event A times the probability of event B, given that A has happened.

Special note: when calculating probability of dependent events, you always assume that the first events happened as expected.

Calculate the probability of each event:

$$P(\text{pick one king}) = \frac{4}{52} = \frac{1}{13}$$

There are four kings in a deck of cards.

There are 52 cards in the sample space.

$$P(\text{pick a second king}) = \frac{3}{51} = \frac{1}{17}$$

If one king is chosen, there are three left.
If one king is chosen, there are only 51 cards left.

$$P(\text{king, then king}) = \frac{1}{13} \cdot \frac{1}{17} = \frac{1}{221}$$

The probability that a king is chosen, the card is not replaced, and then another king is chosen is $\frac{1}{221}$.

Problem solving

Explain in your own words what independent events are. Give an example.

Probability of Compound mutually exclusive events

- 1. You have a 10-sided dice. The dice is rolled. Find the probability of the following:**

- a. P(5 or an even number)
- b. P(4 or 7)
- c. P(6 or odd number)
- d. P(8 or 9)



Compound events can be classified as mutually exclusive or mutually inclusive. The probability is calculated differently for each, in this worksheet we are going to look at mutually exclusive events.

Compound events that are mutually exclusive:

When two events cannot happen at the same time, they are mutually exclusive events.

Example:

You have a dice and you are asked to find the probability of rolling a 1 or a 2. You know when you roll the dice, only one of those numbers can appear, not both. Therefore, these events are **mutually exclusive** of each other.

Mutually exclusive events (events that cannot happen at the same time)

$$P(A \text{ or } B) = P(A) + P(B)$$

Take note: with this formula, you are **adding** the probabilities of each event, not multiplying.

- 2. Find the probability. Using a standard deck of cards, find the probability of:**

- a. P(jack or a king)
- b. P(jack or a spade)

Do the following example on mutually exclusive events in your workbook.

You have a 10-sided dice.

The dice is rolled. Find the probability of the following events.

P(4 or 8)

Find the probability of rolling a 4 and 8. These two events cannot happen at the same time.

Step 1: Find the probability of each event independently.

$$P(4) = \frac{1}{10} \quad \text{There is one four on the dice}$$

There are 10 outcomes on the dice.

$$P(8) = \frac{1}{10} \quad \text{There is one eight on the dice.}$$

There are 10 outcomes on the dice.

Step 2: Add the probability of each individual event.

$$P(4 \text{ or } 8) = \frac{1}{10} + \frac{1}{10} = \frac{2}{10} = \frac{1}{5}$$

The probability of rolling a 4 or 8 on a 10-sided dice is $\frac{1}{5}$.

Give three examples of probability of compound mutually exclusive events.

Problem solving

Probability of Compound mutually inclusive events

Compound events can be further classified as mutually exclusive or mutually inclusive. The probability is calculated differently for each, in this worksheet we are going to look at mutually **inclusive** events.

Compound events that are mutually inclusive

This is an event that can happen at the same time another event occurs.

Example: Drawing a red king from a deck of cards.

We are drawing a single card from a standard deck of 52 cards. If we wanted to know the probability of drawing a king or a red card, it would be possible to pull a single card that meets both criteria since there are red kings in the deck. Therefore, these events are mutually inclusive of each other.

Mutually inclusive events (events that can happen at the same time)

$$P(A \text{ or } B) = P(A) + P(B) - P(\text{A and B})$$

Take note: This equation is different because we need to subtract $P(A \text{ and } B)$. When we find the probability of drawing a king we count the four kings into the probability.

When we find the probability of drawing a red card we include two of the kings in the 26 red cards in the deck.

We have counted the king of hearts and the king of diamonds twice.

Therefore, we must subtract one of the pair of kings counted in the outcomes.

Do the following example on mutually inclusive events in your workbook.

Step 1: Find the probability of each event independently.

$$P(\text{red}) = \frac{4}{52} \quad \begin{array}{l} \text{There are 26 red cards in the pack.} \\ \text{There are 52 cards in the pack.} \end{array}$$

$$P(\text{king}) = \frac{4}{52} \quad \begin{array}{l} \text{There are four kings in the pack.} \\ \text{There are 52 cards in the pack.} \end{array}$$

Step 2: Add the probability of each individual event.

$$P(\text{king or red}) = \frac{4}{52} + \frac{26}{52} = \frac{30}{52} = \frac{15}{26}$$

But we counted the king of hearts and the king of diamonds twice.

Step 3: Find the probability where both criteria occur.

$$P(\text{king}) = \frac{2}{52} \quad \begin{array}{l} \text{There are two red kings in the pack (king of hearts & diamonds)} \\ \text{There are 52 cards in the pack.} \end{array}$$

Step 4: Deduct the double count.

$$P(\text{kind of red}) = P(\text{king}) + P(\text{red}) - P(\text{king and red})$$

$$P(\text{kind of red}) = \frac{4}{52} + \frac{26}{52} - \frac{2}{52} = \frac{20}{52} = \frac{7}{13}$$

The probability of drawing a red king from a standard pack of cards is 7 out of 13 or $\frac{7}{13}$ or 53%.

- 1. You have a 10-sided dice. The dice is rolled. Find the probability of the following:**



- a. P(5 or an odd number)
- b. P(odd or prime number)
- c. P(8 or even number)

Problem solving

Directions: first determine if the event is exclusive or inclusive. Then find the probability. Using a standard deck of cards, find the probability of:
 $P(\text{jack or a spade})$

Revision sheet

144

These tables will give you information on where to go and revise your work.

Number operations and relationship concepts	Worksheet numbers	Do you need support? ✓ if Yes.
Whole numbers	R1, R10,77,78,79,80	
Exponents	21,22,23,24,25,26	
Integers	Integrated	
Fractions	Common fractions: R5,11,12,13,14,15 Decimal fractions: R6,16,18,19,20	
Multiples and Factors	R2,2	
Properties of numbers	1,10	
Financial Mathematics	6,7,8,9	
Ratio and rate	3,4	

Here we are going to revise **shape and space (geometry)**

Shape and space (geometry)	Worksheet numbers	Do you need support? ✓ if Yes.
Construction of geometric figures	R11,39,40,41,42,43,44,45,46	
Geometry of 2-D shapes	47,48,49,50,51,52	
Geometry of straight lines	53,54,55,56	
Transformation geometry	R12,57,105,106,107,108,109,110,111,112,113	
Geometry of 3-D objects	R13,114,115,116,117,118,119,120,121,122	

Here we are going to revise **measurement**

Measurement	Worksheet numbers	Do you need support? ✓ if Yes.
Area and perimeter of 2-D shapes	R14,60,61,62,63	
The theorem of Pythagoras	58,59	
Surface area and volume of 3-D objects	R15,100,101,102,103,104	

Here we are going to revise **data handling**

Data handling	Worksheet numbers	Do you need support? ✓ if Yes.
Collect, organize and summarise data	R16,123,124,125,137	
Represent data	126,127,128,129,130,131,132,137	
Analyze, interpret and report data	133,134,135,137	
Probability	138,139,140,141,142,143	

What do you understand now?

After revising this worksheet, share with your teacher and/or friends what you understand now that you didn't understand before.

Signt:

Date:

