St Andrew's Academy

Mathematics **Department**

National 5 Mathematics

PRACTICE EXAM REVISION PACK

Table of Contents

Scientific Notation 1 4
Similarity 1 5
Similarity 2 6
Positive and Negative Numbers 7
Pythagoras 1 8
Pythagoras 2 9
Pythagoras 3 10
Brackets And Equations 1 11
Brackets And Equations 2 12
Brackets And Equations 3 13
Brackets And Equations 4 14
Statistics 1 15
Statistics 2 16
Statistics 3 17
Statistics 4 18
Trigonometry 1 19
Trigonometry 2 20
Trigonometry 3 21
Trigonometry 4 22
Simultaneous Equations 1 23
Simultaneous Equations 2 24
Area 1 25
Area 2 26
Area 3 27
Factorisation 1 28
Changing the Subject of a Formula 29
Gradient & Equation of a Line 30
Functions & Graphs 1 31
The Circle 1 32
The Circle 2 33
The Circle 3 34
The Circle 4 35
Inequations 36
Trigonometry 5 37
Solving Quadratic Equations 1 38
Solving Quadratic Equations 2 39
Solving Quadratic Equations 3 40

Standard Deviation *41*
Equations Involving Fractions 1 ..... *42*
Equations Involving Fractions 2 ..... *43*
Fractional Expressions *44*
Surds 1 ..... *45*
Surds 2 ..... *47*
Indices *48*
ANSWERS *49*

Scientific Notation 1

1. Write each of the following numbers in scientific notation.

(a) 1200 (b) 4 125 000 (c) 225 (d) 67 000

(e) 9 (f) 41 000 000 (g) 92 (h) 240 000 000 000

2. For each of the following numbers i) write it out in figures ; ii) write it in scientific notation.

(a) 5 million (b) 32 thousand (c) $52 \cdot 1$ million (d) 243 thousand

3. Write each of the following numbers in scientific notation.

(a) $0 \cdot 057$ (b) $0 \cdot 0021$ (c) $0 \cdot 84$ (d) $0 \cdot 00000000915$

(e) $0 \cdot 0007$ (f) $0 \cdot 08004$ (g) $0 \cdot 0000012$ (h) $0 \cdot 6$

4. Write each of the following numbers out in full.

(a) $1 \cdot 6 \times 10^5$ (b) $2 \cdot 78 \times 10^3$ (c) $1 \cdot 22 \times 10^8$

(d) 4×10^4 (e) $2 \cdot 003 \times 10^2$ (f) $5 \cdot 7 \times 10^0$

(g) 6×10^{-3} (h) $4 \cdot 52 \times 10^{-6}$ (i) $1 \cdot 003 \times 10^{-4}$

(j) $7 \cdot 2 \times 10^{-5}$ (k) 23×10^{-2} (l) $6 \cdot 0004 \times 10^{-3}$

5. Calculate each of the following expressing your answer in standard form:

(a) $(2 \times 10^3) \times (3 \times 10^5)$ (b) $(4 \times 10^4) \times (2 \times 10^{-6})$

(c) $(5 \times 10^2) \times (3 \times 10^4)$ (d) $(9 \times 10^7) \div (1 \cdot 5 \times 10^2)$

(e) $(3 \cdot 6 \times 10^2) \div (0 \cdot 2 \times 10^5)$ (f) $(24 \times 10^4) \div (48 \times 10^{-3})$

(g) $\dfrac{1 \cdot 28 \times 10^6}{0 \cdot 4 \times 10^2}$ (h) $\dfrac{4 \cdot 17 \times 10^2}{3 \times 10^{-3}}$ (i) $\dfrac{18 \times 10^{-2}}{0 \cdot 2 \times 10^5}$

6. Answer each of the following questions leaving your answers in standard form and correct to 3 s.f. where necessary.

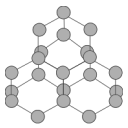
(a) Light travels at $1 \cdot 85 \times 10^5$ miles per second. How far will it travel in an hour?

(b) The radius of the earth is $6 \cdot 45 \times 10^6$ metres. What is its circumference (in km)?

(c) If a heart beats 70 times a minute, how many times will it beat in a lifetime of 80 years?

(d) 100 grams of water contains 2000 drops. How many drops would there be in a tank containing 1 tonne of water?

(e) In 1 gram of carbon there are 6×10^{26} atoms. How many carbon atoms are there in 5kg of pure carbon?

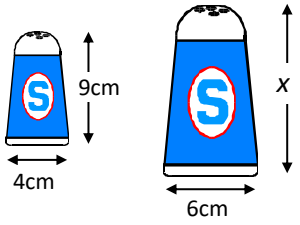


Similarity 1

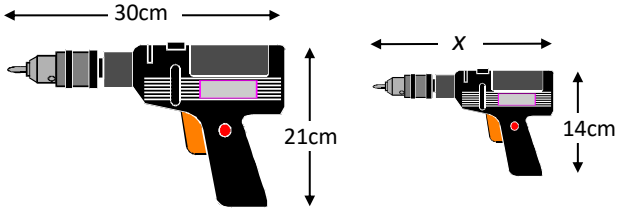
1. Each diagram below shows a pair of similar shapes or objects. For each pair …….

   i) state the scale factor (from left to right) ii) calculate the length marked x .

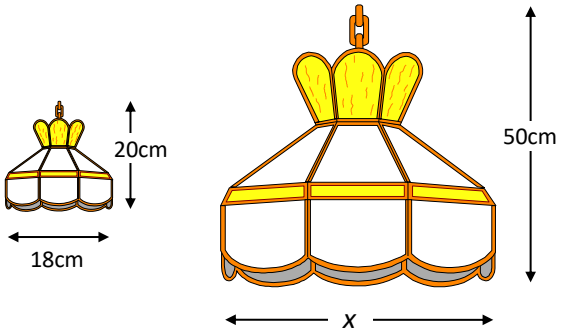
(a)



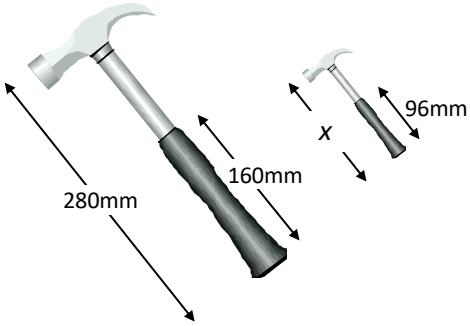
(b)



(c)



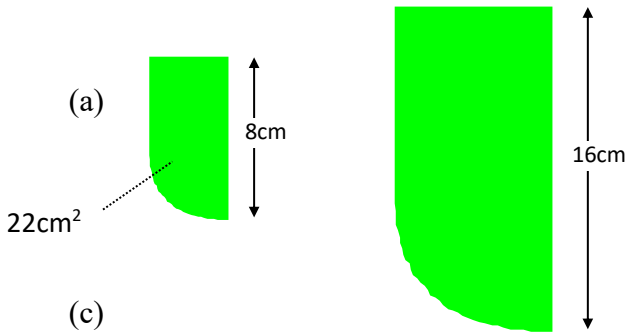
(d)



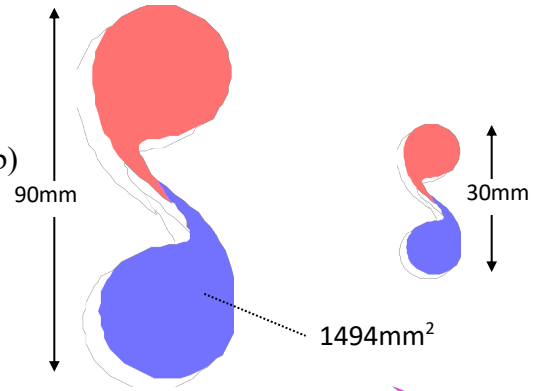
2. Each pair of shapes below is mathematically similar.

   Calculate the area of each right-hand shape.

(a)

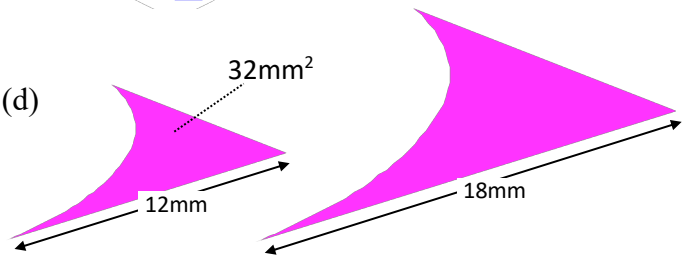


(b)



(c)

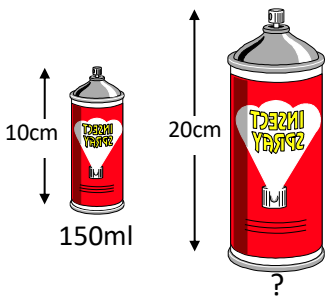
(d)



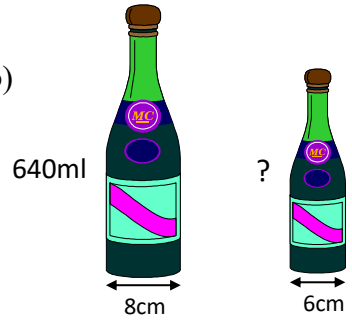
3. Each pair of containers below is mathematically similar.

   Calculate the volume of each right-hand container.

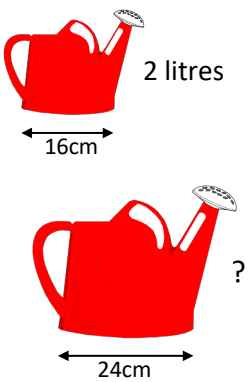
(a)



(b)



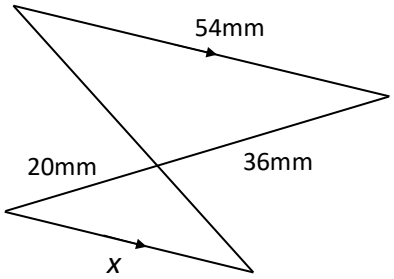
(c)



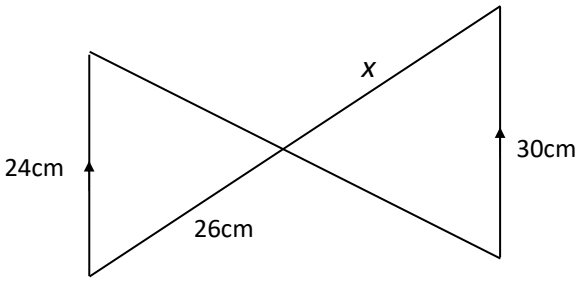
Similarity 2

1. Calculate the length of the side marked x in each diagram below.

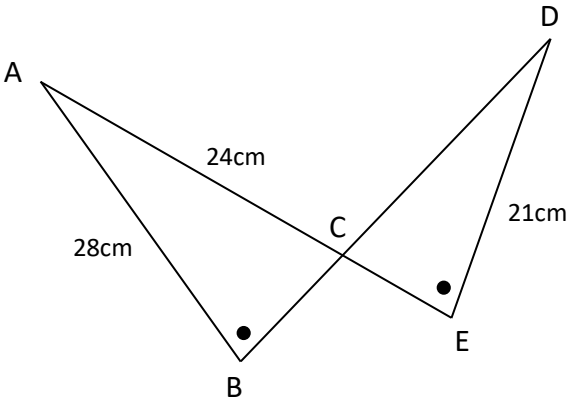
(a)



(b)



2. In the diagram $\angle ABC = \angle CED$, AB = 28cm, AC = 24cm and ED = 21cm.



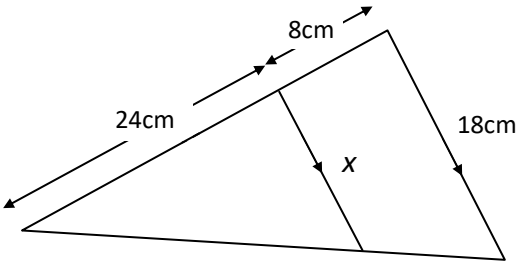
(a) Explain why the triangles ABC and CDE are similar.

(b) Calculate the length of CD.

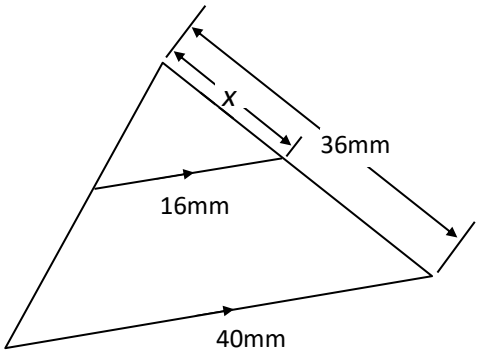
(c) Given that the area of triangle ABC is 144 square centimetres, calculate the area of triangle CDE.

3. Calculate the length of the side marked x in each diagram below.

(a)



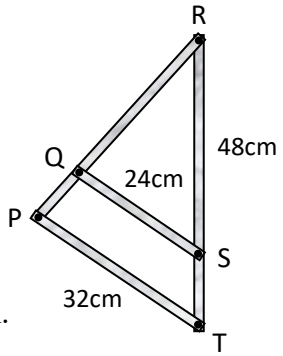
(b)



4. The digram opposite shows an aluminium pipe frame. The cross members QS and PT are parallel.

RS = 48cm, QS = 24cm and PT = 32cm as shown.

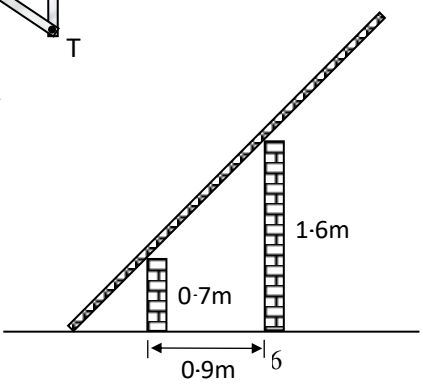
Calculate the length of ST



5. In the diagram a ladder is laid against two walls as shown.

The higher wall is $1 \cdot 6$ metres high, and the lower wall is $0 \cdot 7$ metres. The distance between the two left hand faces of the walls is $0 \cdot 9$ metres.

Calculate the distance between the foot of the ladder and the lower wall.



Positive and Negative Numbers

1. Calculate each of the following.

(a)	$4-7$	(b)	$-3+8$	(c)	$5+(-3)$	(d)	$2+(-7)$
(e)	$-3-6$	(f)	$-1-4$	(g)	$-9+5$	(h)	$-2+(-5)$
(i)	$2-(-4)$	(j)	$-6-(-3)$	(k)	$-2-(-4)$	(l)	$-7-(-7)$

2. Simplify:

(a)	$2x-5x$	(b)	$-3a+a$	(c)	$7x-4x$	(d)	$5p+(-8p)$
(e)	$-2e+7e$	(f)	$-d-3d$	(g)	$4h+(-2h)$	(h)	$-9a+(-a)$
(i)	$4k-(-2k)$	(j)	$-4p-(-2p)$	(k)	$-m-m$	(l)	$-5y-(-8y)$

3. Simplify:

(a)	-6×5	(b)	$-2\times(-7)$	(c)	$3\times(-4)$	(d)	-8×2
(e)	$-a\times 5$	(f)	$6\times(-4p)$	(g)	$-2y\times 7$	(h)	$-3d\times(-9d)$

4. Solve each of the following equations.

(a)	$3x+8=2$	(b)	$2t+3=-7$	(c)	$4m+1=-3$
(d)	$4y-7=-3$	(e)	$6a-1=-13$	(f)	$7d-2=-2$
(g)	$5y=3y-16$	(h)	$3a=20-2a$	(i)	$7d=-2d-18$
(j)	$7h+4=4h-5$	(k)	$12p-6=8p-2$	(l)	$8x+5=14-x$
(m)	$2p+3=p-4$	(n)	$7h-6=2h-21$	(o)	$5x+9=8x+33$
(p)	$4y-7=8y-23$	(q)	$7k+2=4k-25$	(r)	$16a-4=6a-34$

5. Evaluate each of the following expressions when $a=2$, $b=-4$ and $c=-3$.

(a)	$a+b$	(b)	$a-b$	(c)	$2a+c$	(d)	ab
(e)	bc	(f)	$b-c$	(g)	$a+2c$	(h)	$3b+6a$
(i)	$2c-2b$	(j)	b^2	(k)	$3c^2$	(l)	$(2b)^2$
(m)	a^2-c^2	(n)	$7a+3c$	(o)	$2c-3b$	(p)	$(2b-4c)^2$

6. Evaluate each of the following expressions when $p=-2$, $q=4$ and $r=-6$.

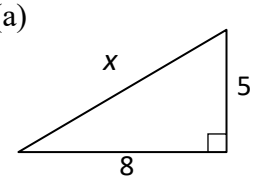
(a)	$\frac{q}{p}$	(b)	$\frac{r}{p}$	(c)	$\frac{3q}{r}$	(d)	$\frac{2r}{q}$
(e)	$\frac{2q+r}{p}$	(f)	$\frac{q-p}{r}$	(g)	$\frac{2p+2r}{-q}$	(h)	$\frac{r^2+q}{2p}$

Pythagoras 1

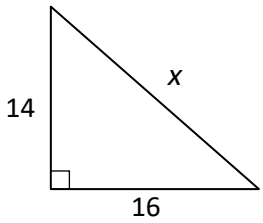
You need a calculator for this worksheet.
Round your answers to one decimal place where necessary.

1. Calculate the length of the side marked x in each triangle below

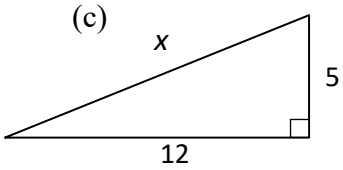
(a)



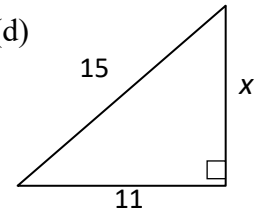
(b)



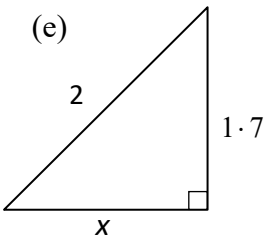
(c)



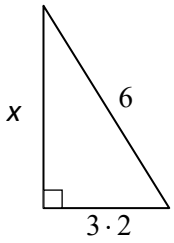
(d)



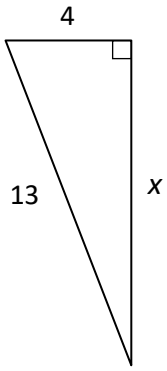
(e)



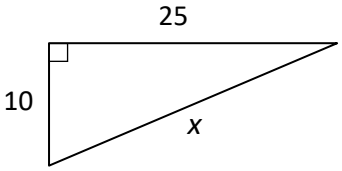
(f)



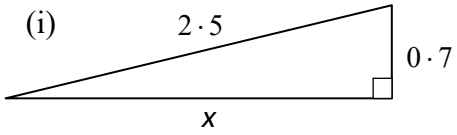
(g)



(h)



(i)

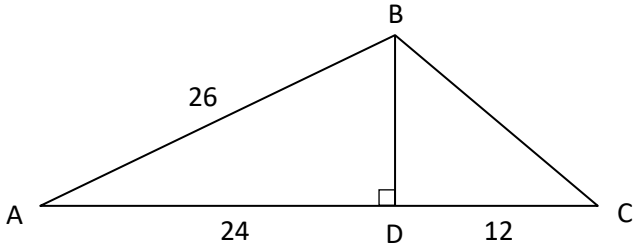


2. Consider the framework opposite.

(a) Calculate the length of BD.

(b) Hence calculate the length of BC.

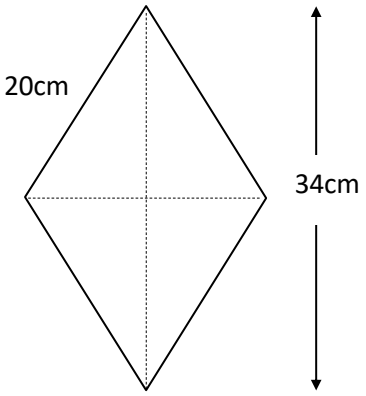
(c) Calculate the area of triangle ABC.



3. A rhombus has sides of 20cm and its longest diagonal measuring 34cm.

(a) Calculate the length of the shorter diagonal.

(b) Calculate the area of the rhombus



4. Calculate the distance between each pair of points below.

(a) A(2 , 5) , B(7 , 10)

(b) P(1 ,8) , Q(12 ,2)

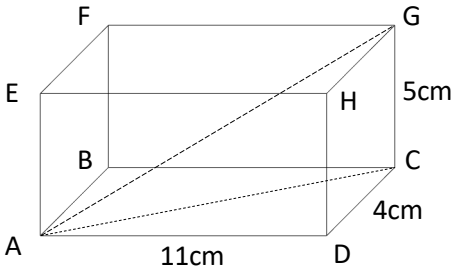
(c) E(– 2 , 3) , F(2 , – 4)

(d) R(– 7 , – 3) , F(3 , – 1)

Pythagoras 2

You need a calculator for this worksheet.
Round your answers to one decimal place where necessary.

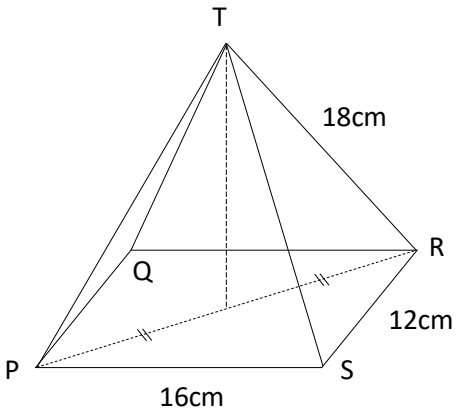
1. Consider the cuboid opposite.



   (a) Calculate the length of the face diagonal AC.

   (b) Hence calculate the length of the space diagonal AG.

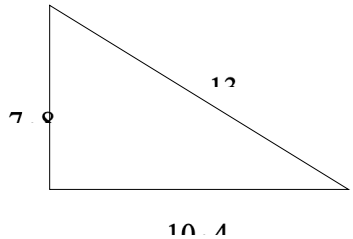
2. The pyramid opposite has a rectangular base.



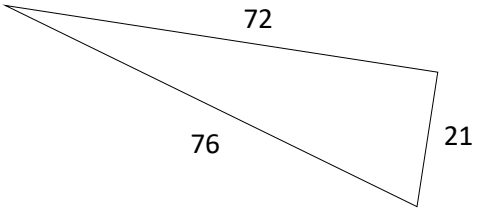
   (a) Calculate the length of the base diagonal PR.

   (b) Given that edge TR = 18cm, calculate the vertical height of the pyramid.

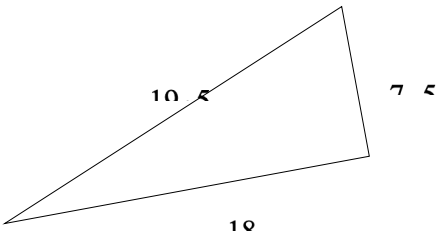
3. Which of the following triangles are right-angled?



(i)

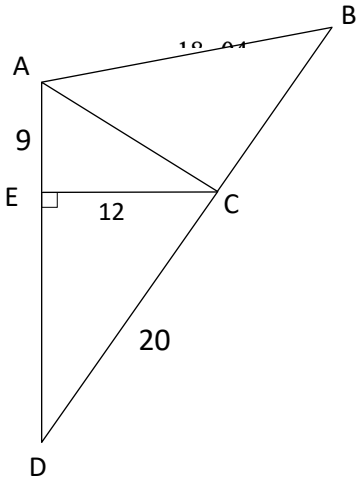


(ii)



(iii)

4. Consider the diagram opposite. All lengths are centimetres.



   (a) Calculate the length of AC.

   (b) Calculate the length of ED.

   (c) Prove that triangle ACD is right-angled at C.

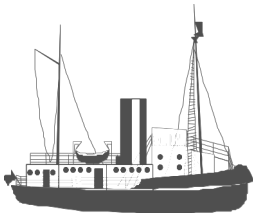
   (d) Hence calculate the length of BC and the area of triangle ABC correct to the nearest whole number.

Pythagoras 3

You need a calculator for this worksheet.
Round your answers to one decimal place where necessary.

Begin questions 1 to 8 by drawing a clear and well labelled diagram. Let x be the length to be found.

1. A ship sails 9km due North and then a further 17km due East.
   How far is the ship from its starting point?



2. An aircraft flies 400km due West and then a further 150km due South.
   How far is the aircraft from its starting point?

3. A ship sailed $8 \cdot 42$ km due East followed by $4 \cdot 7$km due South.
   How far would it have sailed if it had followed a direct course?

4. A ship sails 9km due North and then a further distance x km due West.
   The ship is now 12km from its starting point. Calculate x.

5. How long is the diagonal of a square of side 11mm?

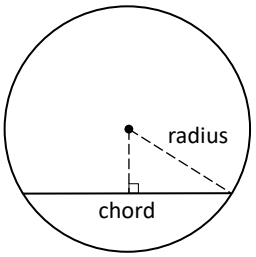
6. A rectangle measures 14cm by 9cm. Calculate the length of its diagonals.

7. A ladder of length 5 metres leans against a vertical wall with the foot of the ladder 2 metres from the base of the wall. How high up the wall does the ladder reach?

8. A ladder is placed against a vertical wall. If the distance between the foot of the ladder and the wall is $1 \cdot 8$ metres, and the ladder reaches 4 metres up the wall, calculate the length of the ladder.

9. A circle has a diameter of 20cm.
   A chord is drawn which is 6cm from the centre of the circle.
   Calculate the length of the chord.

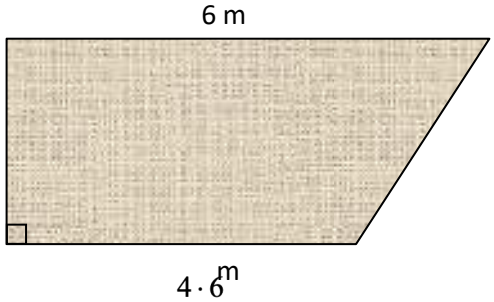
10. A circle has a diameter of 12cm.
    A chord is drawn which is 5cm from the centre of the circle.
    Calculate the length of the chord.



This diagram may help you with questions 9 and 10

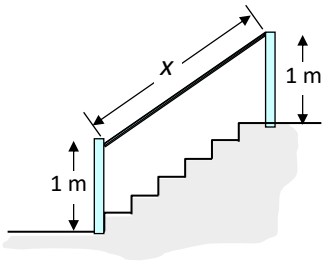
11. The room shown opposite has two parallel sides.

    Using the given dimensions calculate the perimeter of the room.



12. Calculate the length of the banister rail shown in the diagram if there are 6 stairs, and if each tread measures 25cm and each riser 20cm.

    Give your answer in metres.



Brackets And Equations 1

1. Expand each of the following:

a)	$3(c+5)$	*b*)	$2(w-4)$	*c*)	$2(3f+1)$	*d*)	$3(t+8)$
e)	$5(g-3)$	*f*)	$7(w+x)$	*g*)	$6(y-3)$	*h*)	$7(p+2q)$
i)	$4(1+2y)$	*j*)	$8(p+9k)$	*k*)	$5(1+2a)$	*l*)	$4(7f+2g)$
m)	$8(1+3e)$	*n*)	$5(2+3w)$	*o*)	$h(h+2)$	*p*)	$a(a+5)$
q)	$c(c-5)$	*r*)	$e(e-2)$	*s*)	$f(1+4f)$	*t*)	$2t(t+4)$
u)	$p(p+q)$	*v*)	$p(3p+1)$	*w*)	$5a(h+a)$	*x*)	$3r(p-2r)$

2. Expand:

a)	$-4(d+3)$	*b*)	$-2(x-3)$	*c*)	$-5(d+2)$	*d*)	$-3(a-4)$
e)	$-7e(e+5)$	*f*)	$-9(x+9)$	*g*)	$-6p(p-7)$	*h*)	$-8(k+7)$
i)	$-3y(1-2y)$	*j*)	$-7(1+6h)$	*k*)	$-5v(5-2v)$	*l*)	$-4p(1-8p)$

3. Solve each of the following equations:

a)	$3(x+2)=24$	*b*)	$5(2p-3)=15$	*c*)	$4(2+x)=40$
d)	$7(2p-1)=21$	*e*)	$2(3m-1)=16$	*f*)	$8(2v-1)=24$
g)	$-3(x+5)=-27$	*h*)	$-4(y-1)=-16$	*i*)	$-3(p+4)=6$
j)	$-(a+2)=-9$	*k*)	$-5(2a-3)=5$	*l*)	$-4(3x-2)=-16$
m)	$3(m+4)=11$	*n*)	$2(7+y)=17$	*o*)	$6(2x-1)=-3$
p)	$-2(x+5)=3$	*q*)	$-3(2p-1)=-4$	*r*)	$-12(d-3)=-12$

4. Expand each of the following:

a)	$3(a+b+2c)$	*b*)	$5(x^2-2x+3)$	*c*)	$a(a+b-c)$
d)	$2p(3p-q+1)$	*e*)	$-3(y^2-2y+5)$	*f*)	$-x(x^2+3x-1)$

Brackets And Equations 2

1. Expand and simplify :

a)	$3(2a - 1) + a$	b)	$2(3x + 1) - 2x$	c)	$5(b + 1) - 11$
d)	$5(2g - 1) + 3$	e)	$3(3 - 4y) + 7y$	f)	$3(4c + 1) - 6$
g)	$4(3h + 1) - 10h$	h)	$a(b + 2) + 2ab$	i)	$7(2 - 3m) - 8$
j)	$6 + 2(4y - 3)$	k)	$5a + 2(2a - 3)$	l)	$7 - 2(2p - 3)$
m)	$6 + 5(3y - 2)$	n)	$7b - 3(2b - 3)$	o)	$8 - 2(5y - 3)$
p)	$2x - 3(2x - 5)$	q)	$3c + 2(1 - 3c)$	r)	$9 - 2(6g - 1)$

2. Expand each of the following :

a)	$(x + 1)(x + 3)$	b)	$(y + 3)(y + 1)$	c)	$(a + 2)(a + 5)$
d)	$(b + 2)(b + 4)$	e)	$(x + 2)(x + 6)$	f)	$(s + 1)(s + 6)$
g)	$(y + 5)(y + 4)$	h)	$(b + 6)(b + 4)$	i)	$(c + 9)(c + 8)$
j)	$(x - 3)(x - 5)$	k)	$(b - 2)(b - 3)$	l)	$(c - 15)(c - 3)$
m)	$(a - 4)(a - 9)$	n)	$(y - 7)(y - 8)$	o)	$(x - 1)(x - 1)$
p)	$(s - 7)(s - 7)$	q)	$(d - 2)(d - 12)$	r)	$(b - 11)(b - 2)$

3. Expand each of the following :

a)	$(x - 2)(x + 5)$	b)	$(a + 3)(a - 4)$	c)	$(t - 6)(t + 3)$
d)	$(y + 7)(y - 4)$	e)	$(c + 2)(c - 5)$	f)	$(x - 5)(x + 1)$
g)	$(b - 3)(b + 9)$	h)	$(p - 10)(p + 1)$	i)	$(y - 7)(y + 6)$
j)	$(z + 2)(z - 6)$	k)	$(x + 1)(x - 2)$	l)	$(a + 1)(a - 1)$
m)	$(c - 5)(c + 3)$	n).	$(p - 7)(p + 2)$	o)	$(b + 12)(b - 6)$
p)	$(x - 2)(x + 5)$	q)	$(a + 3)(a - 6)$	r)	$(t - 8)(t + 3)$
s)	$(y + 1)(y - 4)$	t)	$(c + 2)(c - 8)$	u)	$(x - 4)(x + 7)$
v)	$(b - 1)(b + 9)$	w)	$(p - 10)(p + 3)$	x)	$(y - 1)(y + 4)$

4. Expand each of the following :

a)	$(3x - 3)(x - 5)$	b)	$(a + 1)(2a + 4)$	c)	$(t - 5)(5t - 3)$
d)	$(y - 7)(2y - 2)$	e)	$(3c + 2)(c + 7)$	f)	$(2x + 5)(x + 2)$
g)	$(b - 1)(3b - 8)$	h)	$(5p + 11)(p + 1)$	i)	$(3y - 6)(3y - 6)$
j)	$(4z + 2)(z - 3)$	k)	$(2x + 1)(2x - 3)$	l)	$(4a + 1)(3a - 1)$
m)	$(c - 4)(2c + 3)$	n).	$(5p - 7)(p + 4)$	o)	$(b + 2)(7b - 6)$
p)	$(3x - 2)(2x + 1)$	q)	$(a + 1)(7a + 6)$	r)	$(2t - 8)(3t + 1)$
s)	$(y - 1)(3y - 1)$	t)	$(3c + 2)(3c - 2)$	u)	$(3x - 1)(3x - 7)$
v)	$(2b + 1)(4b + 2)$	w)	$(2p - 3)(p + 3)$	x)	$(2y - 1)(7y + 3)$

5. Expand :

a)	$(x + 1)^2$	b)	$(w - 3)^2$	c)	$(a - 4)^2$	d)	$(c + 6)^2$
e)	$(y - 8)^2$	f)	$(a + 7)^2$	g)	$(b + 2)^2$	h)	$(k + 9)^2$
i)	$(b - 9)^2$	j)	$(x - 10)^2$	k)	$(c - 1)^2$	l)	$(y - 5)^2$
m)	$(p - 10)^2$	n)	$(c - 12)^2$	o)	$(p - 6)^2$	p)	$(x + 4)^2$
q)	$(2g - 1)^2$	r)	$(5y + 3)^2$	s)	$(3q + 2)^2$	t)	$(4a - 1)^2$
u)	$(3y - 6)^2$	v)	$(4h + 1)^2$	w)	$(3x + 4)^2$	x)	$(4b - 5)^2$
y)	$(2d - 8)^2$	z)	$(5a + 4)^2$				

Brackets And Equations 3

1. Expand, simplify and solve each of the following equations :

a)	$5-3(x-2)=-1$	*b*)	$2(3x-1)+3=31$
c)	$4(x+2)+3(x+4)=-1$	*d*)	$5(x+5)-(2x+1)=6$
e)	$2(x+1)+3(x+4)+1=0$	*f*)	$3(x+6)-2(x+9)=31$
g)	$2-x-(3x-2)=4$	*h*)	$7(1-x)-2(4-3x)=4$
i)	$2(3-2x)-5(3x-4)=45$	*j*)	$2(3-x)-3(5-2x)=-17$
k)	$2(4x+1)-3(3x-7)=23$	*l*)	$3(5-x)-2(7-3x)+8=0$
m)	$4(2x+1)-(x+2)=16$	*n*)	$3(4-x)+5=19-x$

2. Expand and simplify each of the following expressions :

a)	$3(x-4)+(x+2)^2$	*b*)	$(2x-1)(x+3)+2x(x-3)$
c)	$(2x+3)^2-4(x+1)$	*d*)	$-(x+2)^2+4x$
e)	$-3(2x-1)^2+12x^2$	*f*)	$(x-3)(x+1)-(x+4)^2$
g)	$3x(x-4)-(x+2)(x-4)$	*h*)	$(x+2)^2+(2x-1)^2-(x+3)$
i)	$(2x-3)^2-4(x-3)(2x+1)$	*j*)	$3x(x+3)^2+2x(x-3)$
k)	$2x(x^2-x+2)+(x-3)^2$	*l*)	$(x-1)^2-x(x+1)^2$

3. Solve each of the following equations :

a)	$x^2+7x-2=x^2+5x+8$	*b*)	$10x+x^2+9=x^2+7x+30$
c)	$(x+4)(x+2)=x^2+x+28$	*d*)	$(x+1)^2=x(x-7)+19$
e)	$(2x-1)^2-1=4(x+3)(x-1)$	*f*)	$(x-7)(x-3)=(x+2)^2+3$
g)	$3(x+5)(x-1)=3(x+6)^2-27$	*h*)	$(2x+1)(x+1)=2(x-4)^2+7$
i)	$(3x-1)(x+1)=3x(x+1)+4$	*j*)	$(2x+1)^2-3x(x+5)=(x+3)(x+6)+3$

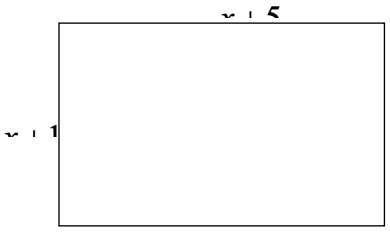
Brackets And Equations 4

1. (a) For the rectangle opposite write down, in its simplest, an expression for:

   i) its perimeter (P);

   ii) its area (A).

   (b) Calculate P when $x = 4$ cm.

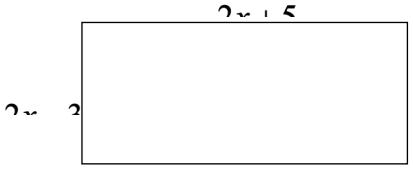


2. (a) For the rectangle opposite write down, in its simplest, an expression for:

   i) its perimeter (P);

   ii) its area (A).

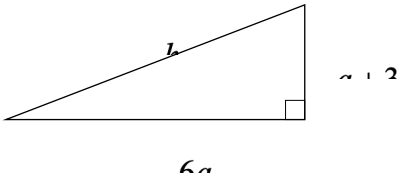
   (b) Calculate A when $x = 6$ cm.



3. Consider the triangle opposite.

   (a) Write down an expression for h^2 in its simplest form.

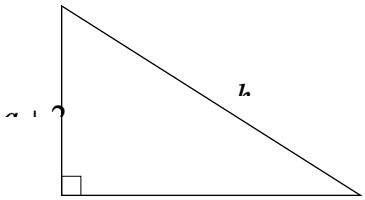
   (b) Hence calculate h when $a = 2$.



4. Consider the triangle opposite.

   (a) Write down an expression for h^2 in its simplest form.

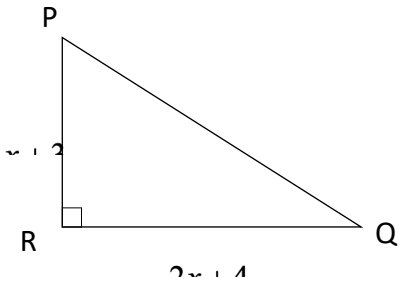
   (b) Hence calculate h when $a = 7$.



5. For the triangle opposite, write down simplified expressions for:

   (a) its area (A);

   (b) the length of PQ.

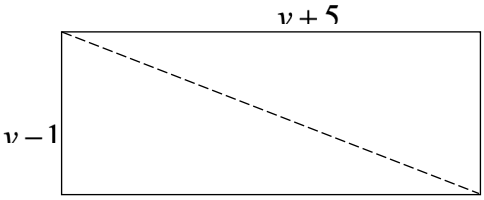


6. For the rectangle opposite, write down simplified expressions for:

   (a) P , its perimeter.

   (b) A , its area.

   (c) The length, d , of its diagonal.



7. Repeat question 6. for rectangles measuring:

   (a) $(x+5)\ cm\ \ by\ \ (2x+2)\ cm$

   (b) $(x+3)\ mm\ \ by\ \ (3x-1)\ mm$

Statistics 1

1. For each set of numbers below, calculate : i) the range; ii) the mean.

   (a) 5 7 3 8 8 5 3 9

   (b) 23 53 21 34 87 64

   (c) 1·4 4·7 7·1 12·2 4·6 13·1 20·2 11·8 5·0

2. For each set of numbers below, establish the median and state the mode:

   (a) 2 3 3 3 4 4 5 7 7 8 8

   (b) 32 45 33 17 22 54 45

   (c) 6·3 1·7 8·8 1·2 8·6 4·1 10·7 6·3 6·3

   (d) 8 12 56 24 36 12 24 24

   (e) 11 11 7 12 16 17

   (f) 23 26 38 65 43 75 75 62 86 22

3. For each set of numbers in Q2, calculate the mean value, rounding your answers to 1d.p.

4. (a) Calculate the mean of the numbers 5 12 7 3 2 5 1

   (b) Calculate the new mean when a 9 is added.

5. Seven women have weights of 44kg , 51kg , 57kg , 63kg , 48kg , 49kg and 45kg.

   (a) Find the mean weight of the seven women.

   (b) Find the mean weight of the remaining five women after the lightest and the heaviest women leave.

6. The average weight of 12 boxes is $2 \cdot 4$kg.

   (a) What is the total weight of all 12 boxes?

   (b) If an extra box is added weighing $1 \cdot 1$kg , what is the average weight of the thirteen boxes?

7. The mean of six numbers is $4 \cdot 7$. The mean of a different four numbers is $6 \cdot 5$.
   Calculate the mean of all ten numbers together.

8. The mean height of eight tomato plants is 42cm. A ninth plant is added to the group and the mean height of all nine plants is 43cm. Establish the height of the ninth plant.

9. The following are the heights (in metres) of a group of people:

   1·6 , 1·7 , 1·9 , 1·8 , 1·6 , 1·7 , 1·5 , 1·9 , 1·6 , 1·8

   (a) Find the mean, median and modal height of the group.

   (b) When a new member joined the group the mean height became $1 \cdot 7$m exactly.
   What height was the new member?

Statistics 2

1. Calculate the mean and determine the median and mode for each frequency table below.

Apple Weight (g)	f
70	2
71	6
72	9
73	11
74	8
75	3
76	1

Eggs in Nest	f
1	5
2	15
3	25
4	30
5	15
6	10

Test Marks /10	f
3	1
4	0
5	2
6	8
7	9
8	13
9	9
10	8

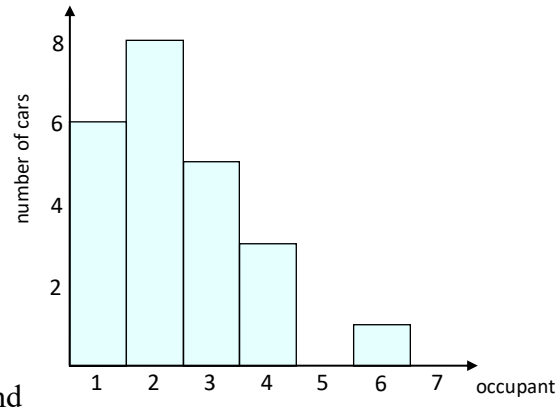
2. Twenty-five children were measured and their heights are shown in the frequency table below.

height (metres)	1.4	1.44	1.48	1.52	1.56
frequency	3	5	6	8	3

Calculate the mean height of the 25 children correct to 1 decimal place.

3. In a survey the number of occupants in the cars passing a school was recorded.

The results have been shown in the histogram opposite.

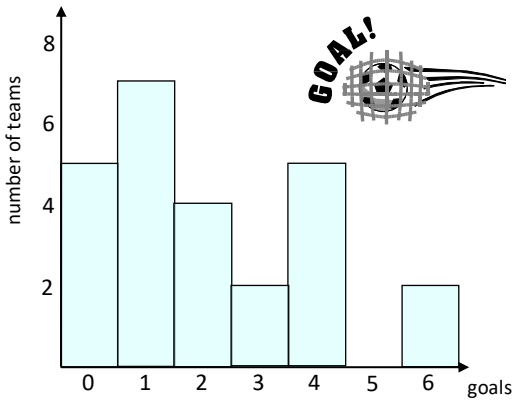


(a) How many cars were in the survey?

(b) What is the modal number of occupants?

(c) Construct a frequency table from the diagram and use it to calculate the mean number of occupants per car correct to 1d.p.

4. The graph opposite shows the number of goals scored by 25 football teams on a particular Saturday.



(a) What is the range of goals scored?

(b) State the median and modal number of goals.

(c) What percentage of the teams scored 2 goals?

(d) Construct a frequency table from the graph and use it to calculate the mean number of goals scored.

5. (Extension) Construct your own frequency table to fit the following criteria:

Range = 5 , $\sum f = 15$, mode = 7 , median = 6 , mean = 6

Statistics 3

1. For each data set below establish the value of the median (Q_2) and the quartiles Q_1 and Q_3.
Hence calculate the semi-interquartile range for each set.

(a) 4 4 5 6 8 10 10 10 12 13 18

(b) 23 32 32 34 35 40 41 47 50

(c) 4 4 5 7 8 9 9 9 12 14

(d) 23 34 38 46 58 71

(e) 10 12 12 13 15 20 21 21 26 32 38 41

(f) 43 28 27 32 50 19 24 47

2. For each frequency table below : i) Copy the table and complete the cumulative frequency column.

ii) Work out the two quartiles, Q_1 and Q_3 and the median (Q_2).

iii) Calculate the semi-interquartile range.

(a)

Cats in litter	*f*	Cum. *f*
6	2	
7	3	
8	4	
9	6	
10	3	
11	1	

(b)

Hours of Sunshine (day)	*f*	Cum. *f*
8	4	
9	5	
10	8	
11	5	
12	6	
13	1	
14	1	

(c)

Matches in Box	*f*	Cum. *f*
48	3	
49	3	
50	6	
51	7	
52	10	
53	7	
54	9	
55	5	

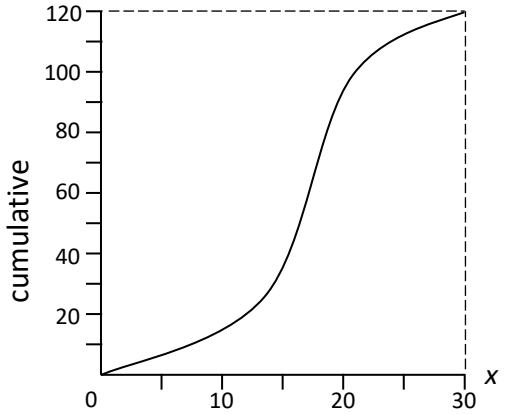
(d)

Plant Height (cm)	*f*	Cum. *f*
120	5	
121	17	
122	18	
123	14	
124	24	
125	14	
126	8	

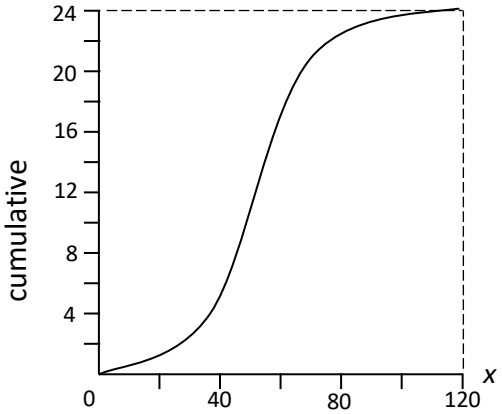
3. Draw a cumulative frequency curve (an ogive) for each distribution in question 2.
Mark the median and the upper and lower quartiles, as accurately as you can, on each curve.

4. Two cumulative frequency curves are shown below.
For each curve estimate the median and the upper (Q_3) and lower (Q_1) quartiles.
Use your quartile estimates to calculate the semi-interquartile range for each distribution.

(a)



(b)

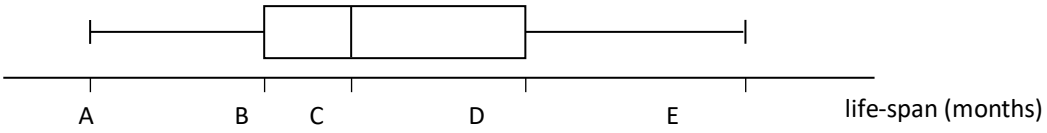


Statistics 4

1. The life-span (in months) of a sample of eleven lightbulbs is shown below.

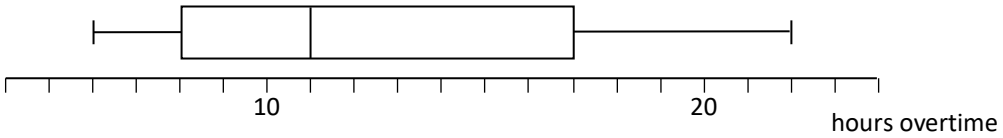
2 3 6 7 8 8 9 11 12 14 17

These results are now illustrated using a boxplot.



Make a five-figure summary to find the values of A, B, C, D and E.

2. The boxplot below shows the number of hours overtime worked in a small factory in a particular month.



(a) What is the greatest and least number of overtime hours worked?

(b) What is the median of this distribution?

(c) What percentage of the workforce completed between 8 and 17 hours overtime?

(d) Calculate the range and the semi-interquartile range for this data.

3. For each data set below ..... i) make a five-figure summary;
ii) draw a boxplot;
iii) calculate the semi-interquartile range.

(a) 5 6 7 7 8 8 12 12 12 13 15 20 21

(b) 16 18 18 20 26 27 39 40

(c) 1 1 5 6 6 8 9 9 9 9 12 20 24 40 40

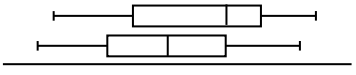
4. In a particular French holiday resort the number of hours sunhine over a twelve day period in June and over a similar period in July were recorded. The results are shown below.

June - 8 6 9 7 4 2 12 13 1 7 9 6

July - 10 12 9 9 15 14 2 3 9 8 16 4

(a) Make a five-figure summary for both June and July's data.

(b) Draw a composite boxplot.
(i.e. draw a boxplot for each set on the same diagram)



(c) State the median and calculate the range and semi-interquartile range for each set.

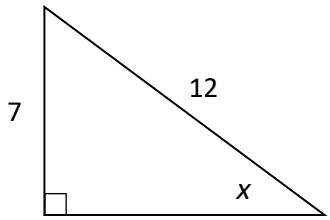
(d) Compare and comment on the two sets of data.

Trigonometry 1

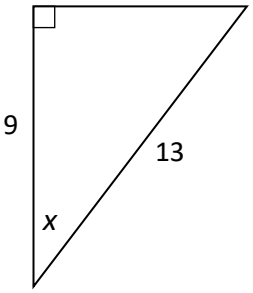
You need a scientific calculator for this worksheet.
Round all answers to 1 d.p. where necessary.

1. Find the size of angle x in each diagram.

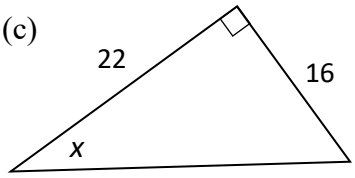
(a)



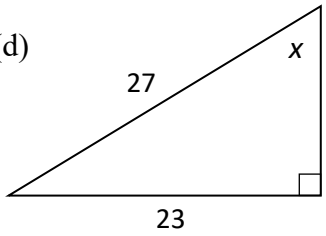
(b)



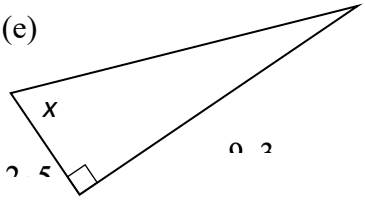
(c)



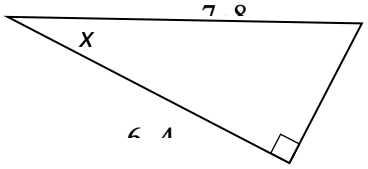
(d)



(e)

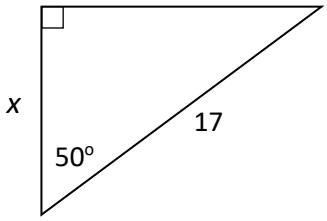


(f)

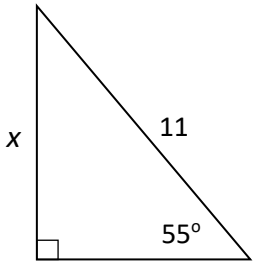


2. Calculate the length of the side marked x in each triangle below.

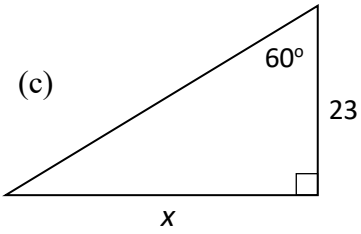
(a)



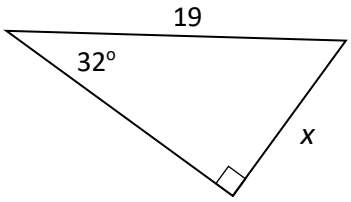
(b)



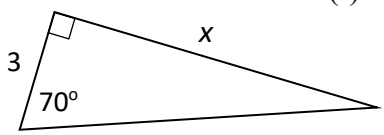
(c)



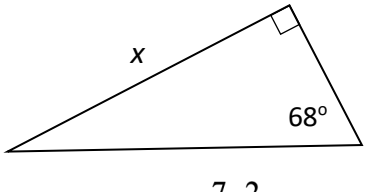
(d)



(e)

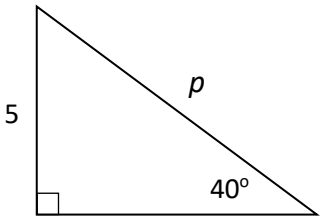


(f)

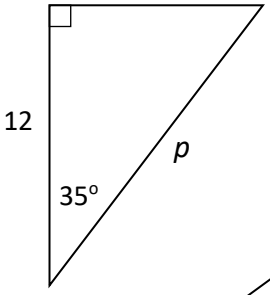


3. Calculate the length of the side marked p in each triangle below.

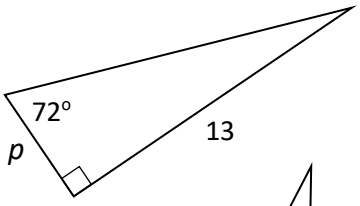
(a)



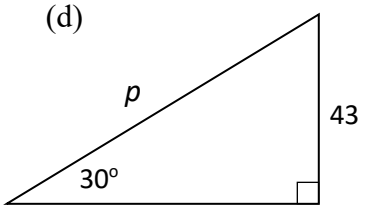
(b)



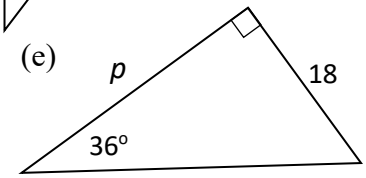
(c)



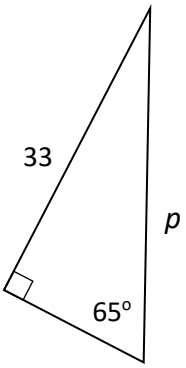
(d)



(e)



(f)

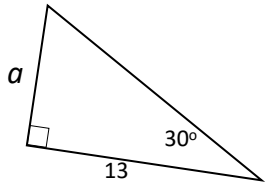


Trigonometry 2

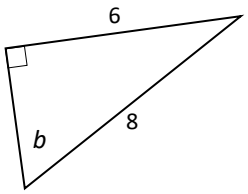
You need a scientific calculator for this worksheet.

Find the angles and sides marked with letters.

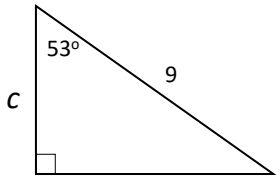
1.



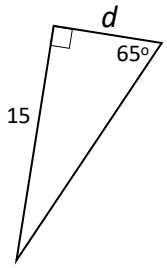
2.



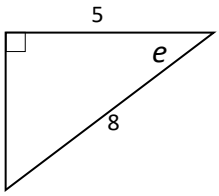
3.



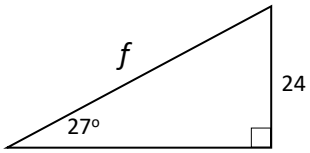
4.



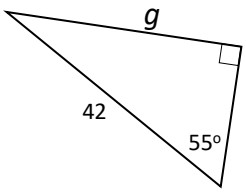
5.



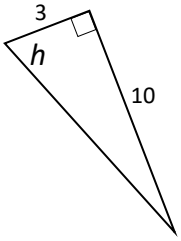
6.



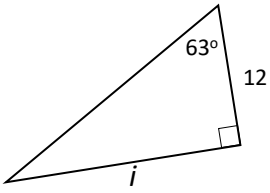
7.



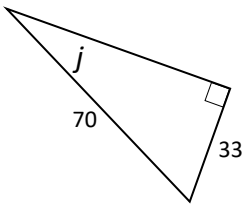
8.



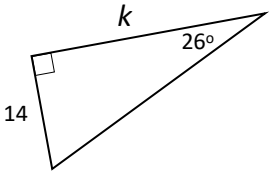
9.



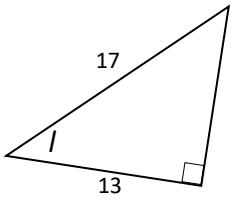
10.



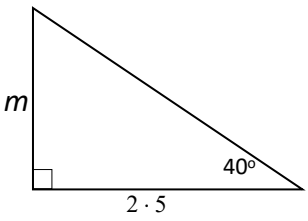
11.



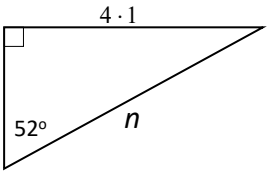
12.



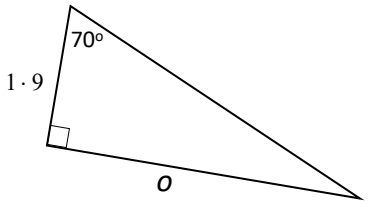
13.



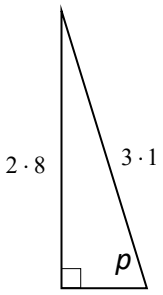
14.



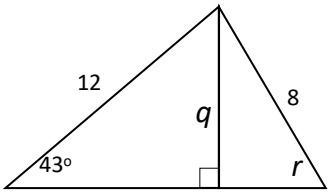
15.



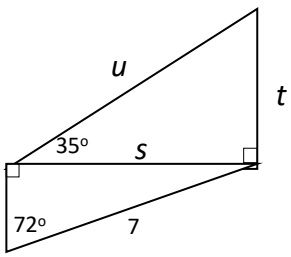
16.



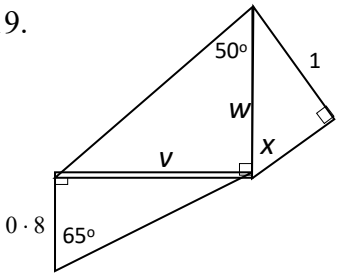
17.



18.

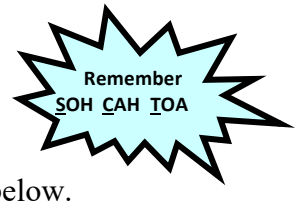


19.



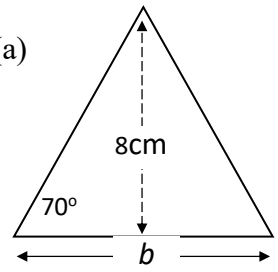
Trigonometry 3

You need a scientific calculator for this worksheet.

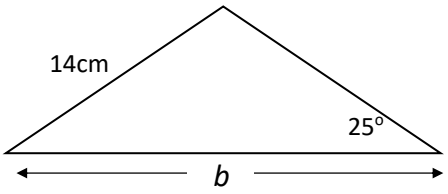


1. Calculate the length of the base, b , of each isosceles triangle below.

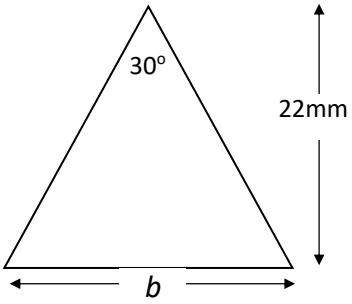
(a)



(b)

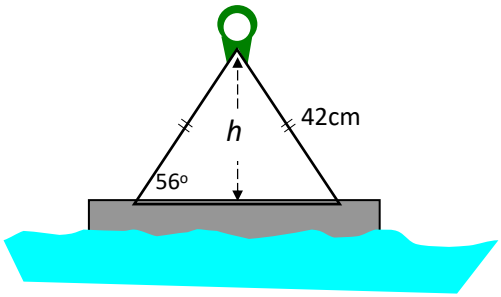


(c)



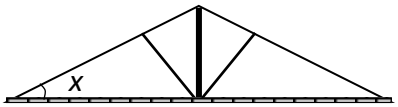
2. The diagram opposite represents a buoy used for tying-up small boats.

Calculate the vertical height (h) of its triangular frame.



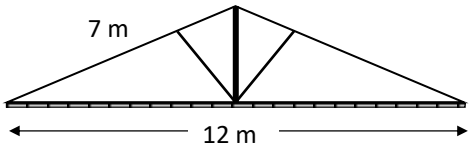
3. To comply with building regulations a roof must have an angle of between 21° and 28° to the horizontal (see diagram).

Which, if any, of the two roofs below comply with the building regulations?

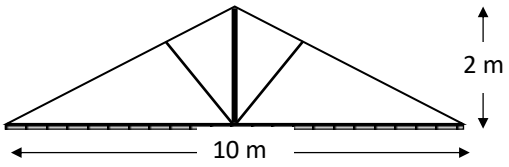


x must lie between 21° and 28°

(a)



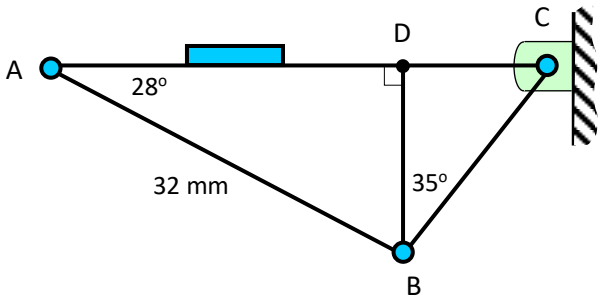
(b)



4. The diagram opposite shows part of the framework for a small hinged bracket.

(a) Calculate the length of DB.

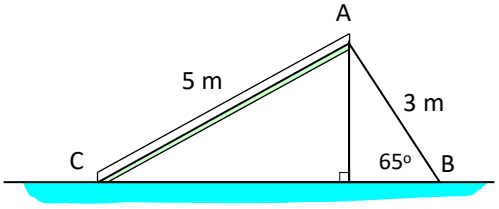
(b) Hence calculate the length of BC.



5. The diagram opposite represents a playground chute. AC represents the slide and AB the stairs.

A local council ruling states " *for a slide to be safe the maximum permissible angle between the slide and the ground is 35°* ".

Does this diagram represent a "safe" slide?



Trigonometry 4

You need a scientific calculator for this worksheet.

Most of the problems below will require you to draw a neat sketch before attempting to answer the question.

1. A ladder of length 4m rests against a vertical wall so that the base of the ladder is $1 \cdot 5$ m from the wall.

   Calculate the angle between the ladder and the ground.

2. A ladder of length 5m leans against a vertical wall so that the base of the ladder is 2m from the wall.

   Calculate the angle between the ladder and the wall.

3. A vertical telegraph pole has a wire support of length 9m stretching from the top of the pole to the ground so that the angle between the wire support and the ground is 65°.

   How far is the end of the wire support from the base of the pole?

4. A vertical aerial mast has a wire support of length 12m stretching from the top of the mast to the ground so that the angle between the wire support and the ground is 78°.

   Calculate the height of the mast.

5. A ladder of length $4 \cdot 8$ m rests against a vertical wall so that it reaches up the wall to a height of $4 \cdot 3$ m.

   Calculate the angle between the ladder and the ground.

6. A tall thin tree has a height of 15m. A rope support stretches from the top of the tree to a point on the ground out from the base of the tree.

   If the angle between the rope and the ground is 62°, calculate the length of the rope support.

7. From a distance of 20m from the base of a tower the angle of elevation to the top of the tower is 38°. How high is the tower?

8. P is a point 30m from the base of a building. The building has a height of 18m.

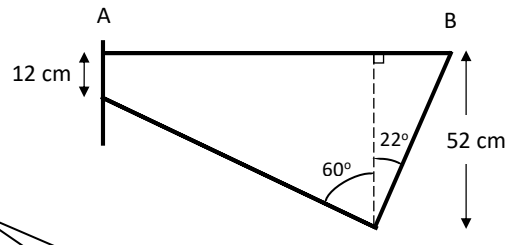
   Calculate the angle of elevation to the top of the building from P.

9. A girl is flying a kite from a string of length 46m.
   The string is taut, and is being held 1m above the ground.

   Calculate the height of the kite above the ground if the angle of elevation is 36° between the string and the horizontal.

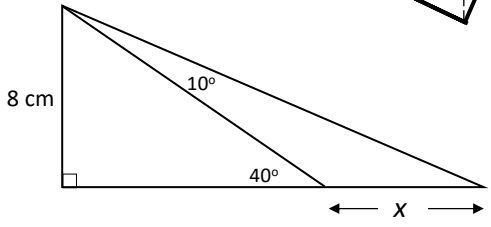
10. The frame of a bicycle is shown in the diagram opposite.

    Find the length of the cross bar, AB.



11. Consider the diagram opposite.

    Calculate the length marked *x*.



Simultaneous Equations 1

1. Solve the following systems of equations by "elimination".

(a) $\begin{aligned} 2x+4y &= 24 \\ 7x-2y &= 4 \end{aligned}$ (b) $\begin{aligned} 4a-3b &= 18 \\ 2a+6b &= -8 \end{aligned}$ (c) $\begin{aligned} 2e+7f &= 26 \\ 8e-5f &= 38 \end{aligned}$

(d) $\begin{aligned} 5x+y &= -2 \\ 3x+2y &= 3 \end{aligned}$ (e) $\begin{aligned} 2x-3y &= 10 \\ 4x-6y &= 20 \end{aligned}$ (f) $\begin{aligned} 4p+3q &= 1 \\ 8p+5q &= -1 \end{aligned}$

(g) $\begin{aligned} 2g+3h &= 1 \\ 5g-2h &= -26 \end{aligned}$ (h) $\begin{aligned} -2x+3y &= 6 \\ 9x-7y &= -1 \end{aligned}$ (i) $\begin{aligned} 2u+4v &= -16 \\ 11u-7v &= -1 \end{aligned}$

(j) $\begin{aligned} 2x-8y &= 0 \\ 5x-5y &= 15 \end{aligned}$ (k) $\begin{aligned} 3p+2q &= -11 \\ 4p+3q &= -14 \end{aligned}$ (l) $\begin{aligned} 10a-3b &= 46 \\ 6a-8b &= 40 \end{aligned}$

2. Solve the following systems of equations by "substitution".

(a) $\begin{aligned} x+3y &= 17 \\ 3x-2y &= -4 \end{aligned}$ (b) $\begin{aligned} a-3b &= 6 \\ 3a+b &= 8 \end{aligned}$ (c) $\begin{aligned} 2e+f &= 1 \\ 5e-2f &= -20 \end{aligned}$

(d) $\begin{aligned} 5x+3y &= 7 \\ 4x+y &= 0 \end{aligned}$ (e) $\begin{aligned} 2x-5y &= -14 \\ x-2y &= -5 \end{aligned}$ (f) $\begin{aligned} 2p+3q &= 6 \\ 4p+q &= -8 \end{aligned}$

(g) $\begin{aligned} 2g+h &= 11 \\ 7g-8h &= 96 \end{aligned}$ (h) $\begin{aligned} 3x-2y &= 25 \\ x+5y &= -3 \end{aligned}$ (i) $\begin{aligned} u-4v &= 10 \\ 9u-2v &= 22 \end{aligned}$

(j) $\begin{aligned} 2x &= 3y+5 \\ x+5y &= 9 \end{aligned}$ (k) $\begin{aligned} 3p-2q+7 &= 0 \\ 4p+q &= -2 \end{aligned}$ (l) $\begin{aligned} 4a+b-30 &= 0 \\ 6a+5b-38 &= 0 \end{aligned}$

3. Solve the following simultaneous equations "graphically".

(a) $\begin{aligned} x+y &= 6 \\ 2x+y &= 8 \end{aligned}$
Draw axes with x and y from 0 to 8

(b) $\begin{aligned} x+2y &= 8 \\ 3x+y &= 9 \end{aligned}$
Draw axes with x and y from 0 to 9

(c) $\begin{aligned} x+3y &= 6 \\ x-y &= 2 \end{aligned}$
Draw axes with x from 0 to 8 and y from –2 to 4

(d) $\begin{aligned} 2x+3y &= 12 \\ x+y &= 5 \end{aligned}$
Draw axes with x and y from 0 to 7

(e) $\begin{aligned} 3x+4y &= 24 \\ 3x+2y &= 18 \end{aligned}$
Draw axes with x and y from 0 to 9

(f) $\begin{aligned} 5x+y &= 10 \\ x-y &= -4 \end{aligned}$
Draw axes with x from -4 to 4 and y from 0 to 10

Simultaneous Equations 2

Problems Leading to Simultaneous Equations

Note: each question must begin with the construction of two separate equations each with two <u>stated</u> unknowns.

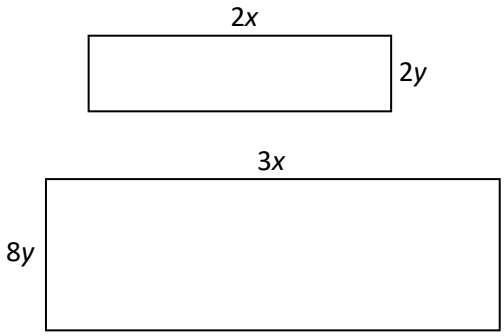
1. Find two numbers whose sum is 56 and whose difference is 16.

2. Find two numbers whose sum is 22 and where twice the big one minus three times the small one is 24.

3. Two numbers are such that twice the smaller plus the larger is equal to 18 and the difference between twice the larger and the smaller is 11.
Find the two numbers.

4. Two numbers are such that three times the larger plus twice the smaller is equal to 31 and the sum of twice the smaller plus the larger is 13.
Find the two numbers.

5. Consider the two rectangles opposite.

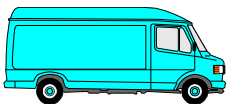


The smaller one has a perimeter of 60cm.
The larger one has a perimeter of twice the smaller.

(a) Form two equations and solve them simultaneously to find the values of x and y.

(b) Hence calculate the area of the smaller rectangle.

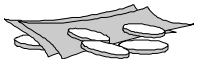
6. A van is carrying eight identical boxes and five identical parcels.



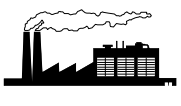
(a) If 3 boxes and 2 parcels weigh a total of 22kg and 4 boxes and 3 parcels weigh 30kg, find the weight of an individual box and a single parcel.

(b) What is the total weight carried by the van?

7. 3 pounds of butter and 4 pints of milk costs £3.84.
5 pounds of butter and 7 pints of milk costs £6.48.
Find the cost of a pound of butter and a single pint of milk.



8. In a certain factory, the basic rate of pay is £4.50 per hour, with overtime at £6.40.
His total wage for a certain week was £215.80.
If he worked a total of 45 hours in all, how many hours did he work at the basis rate?

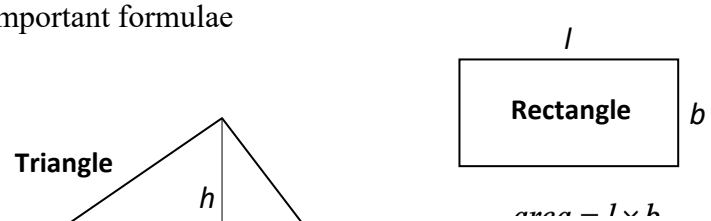


9. At a concert 500 tickets were sold. Cheap tickets cost £5 whereas more expensive ones cost £9.
If the total receipts were £3 220, how many cheap tickets were sold?

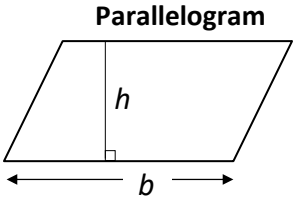
10. John saves money by putting every 50p and every 20p coin he recieves in a box. After a while he discover's that he has 54 coins amounting to £17.10. How many 50p coins does he have?

Area 1

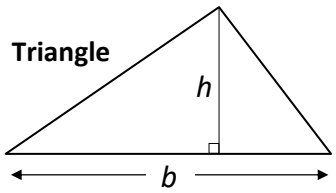
Important formulae



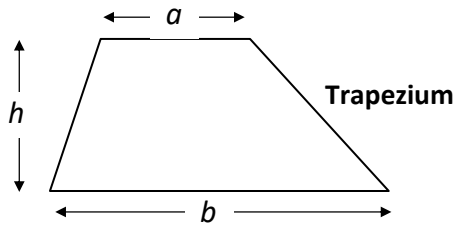
$area = l \times b$



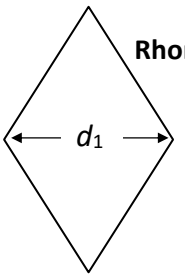
$area = b \times h$



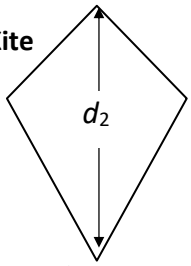
$area = \frac{1}{2}bh$



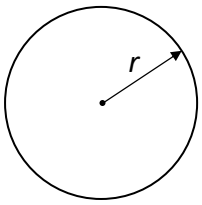
$area = \frac{1}{2}h(a+b)$



or



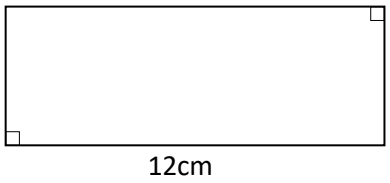
$area = \frac{1}{2} \times d_1 \times d_2$



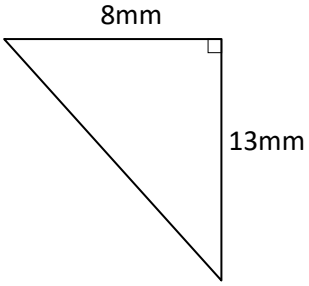
$area = \pi r^2$

Calculate the area of each shape below:

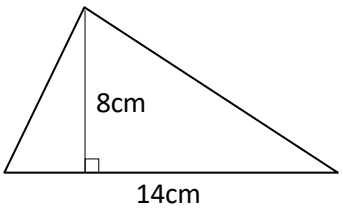
(a)



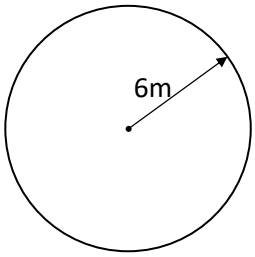
(b)



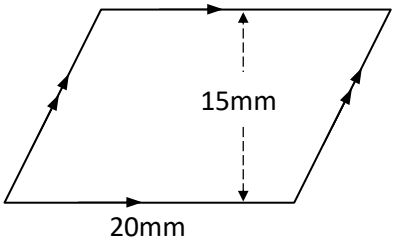
(c)



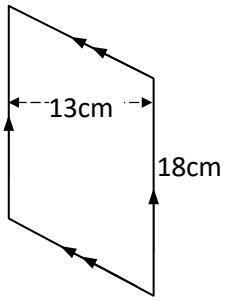
(d)



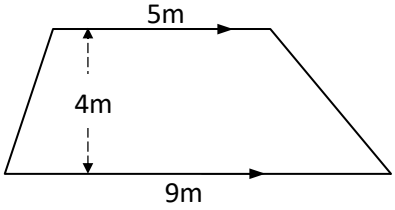
(e)



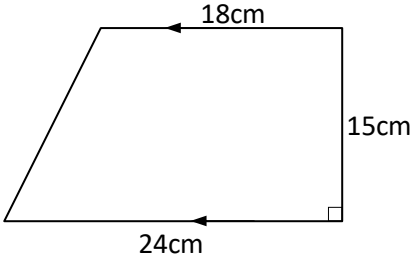
(f)



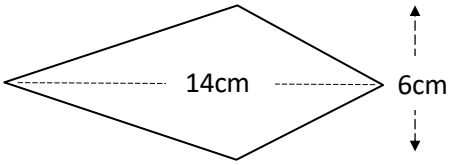
(g)



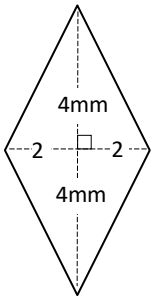
(h)



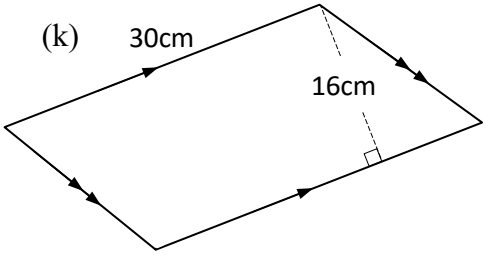
(i)



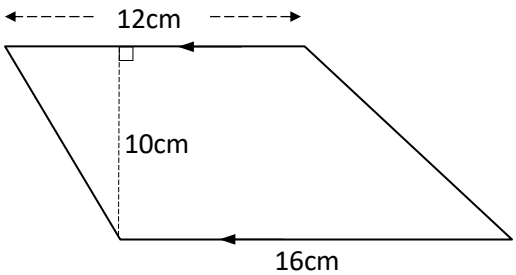
(j)



(k)



(l)

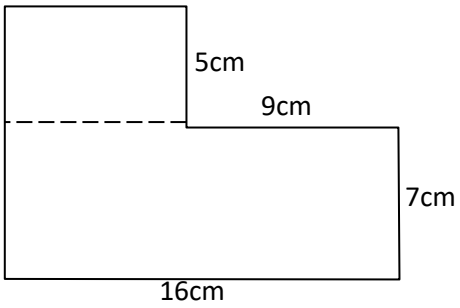


Area 2

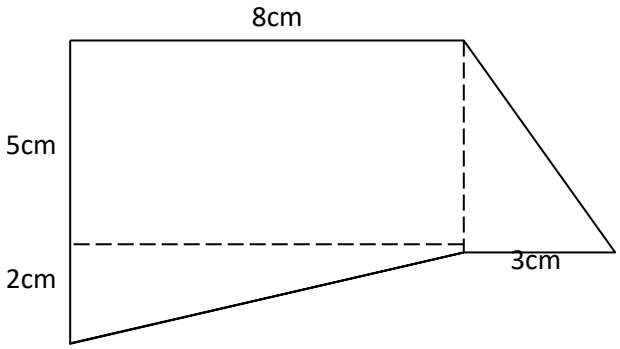
Calculate the area of each composite shape below:
(*note.... assume right-angles where obvious*)

Round your answers to 1 decimal place where necessary.

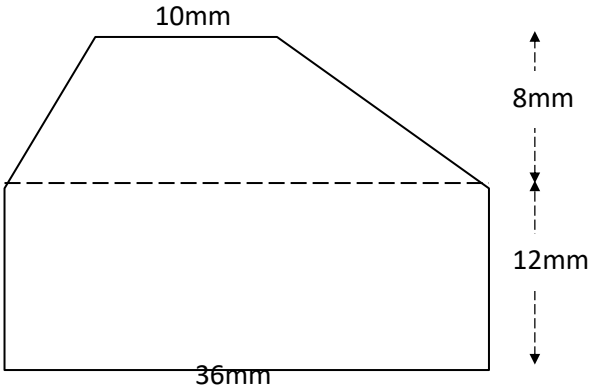
(a)



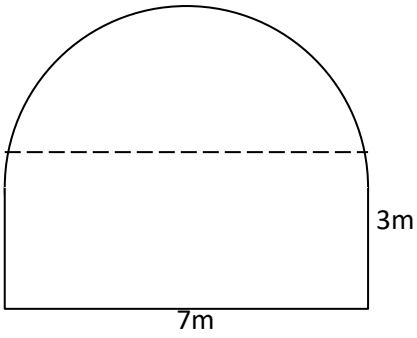
(b)



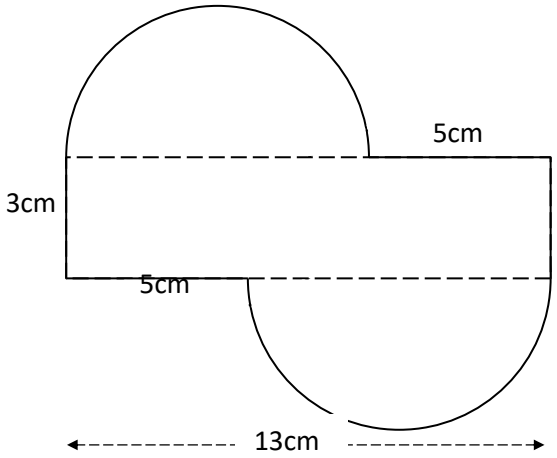
(c)



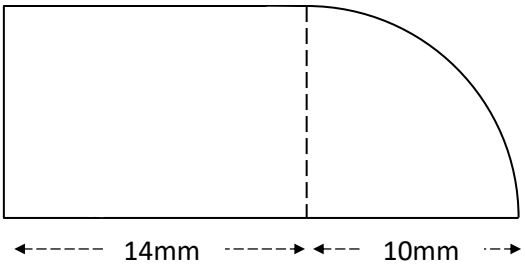
(d)



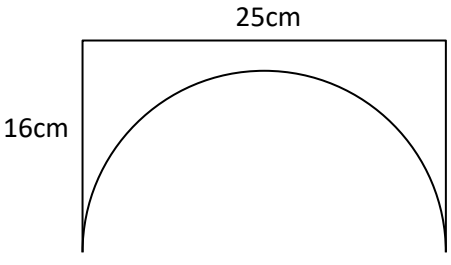
(e)



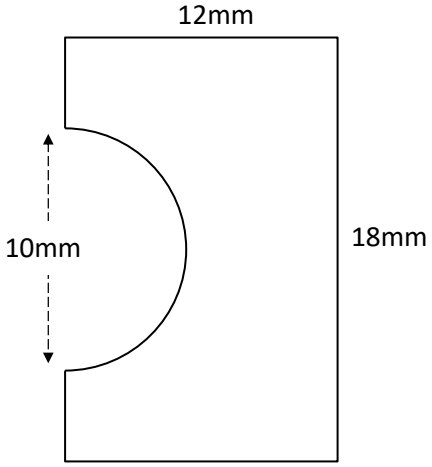
(f)



(g)



(h)

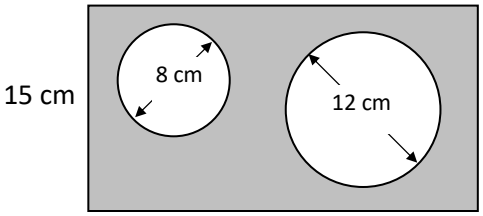


Area 3

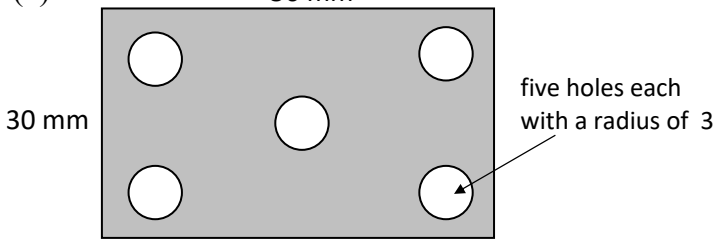
Round your answers to 1 decimal place where necessary.

1. Calculate the shaded area in each diagram below.

(a)



(b)



2. A rectangular steel plate measures 40cm by 25cm.
Four holes, each with a diameter of 10cm, have been drilled through the plate.

   (a) Calculate the area of metal remaining, after the holes have been drilled.

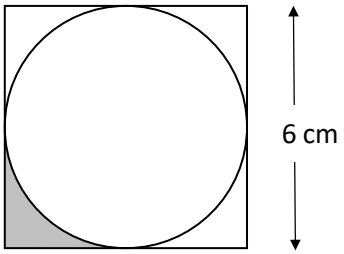
   (b) What percentage of metal has been wasted?

3. A piece of thin plastic is in the shape of a square of side 18cm.

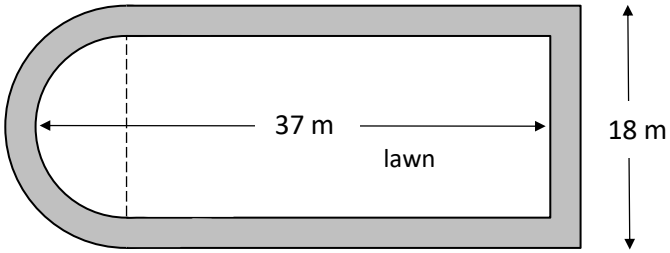
   (a) Calculate the area of the largest circular hole which can be drilled through the plastic.

   (b) What percentage of the plastic has been lost to create this circular disc?

4. Calculate the shaded area in the diagram opposite.



5. The diagram below shows a lawn (unshaded) surrounded by a path of uniform width (shaded).
The curved end of the lawn is a semi-circle of diameter 14 metres.



   (a) Calculate the area of the lawn.

   (b) Calculate the area of the path.

6. A rectangular sheet of metal measures 60cm by 20cm. It is melted down and recast into circular discs of the same thickness as the original sheet and with radius 5cm.
How many complete discs can be cast?

Factorisation 1

1. Factorise each of the following by first removing a common factor.

(a)	$3x-15$	(b)	$5y+35$	(c)	$8a+48$	(d)	$18+6t$
(e)	x^2+9x	(f)	$3y-y^2$	(g)	b^2-4b	(h)	$5p+p^2$
(i)	$ab+ac$	(j)	x^2-xy	(k)	$pq-pr$	(l)	a^2+ax
(m)	$8a+20$	(n)	$21y-28$	(o)	$24x+22$	(p)	$36c-63$

2. Factorise each of the following by first removing the highest common factor.

(a)	$2a^2+6a$	(b)	$5x^2-40x$	(c)	$30y-y^2$	(d)	$3t^2+18t$
(e)	$6x^2-27x$	(f)	$14y-10y^2$	(g)	$12b^2-32b$	(h)	$25x^2+20x$

3. Factorise (each expression contains a difference of squares):

(a)	a^2-3^2	(b)	x^2-2^2	(c)	p^2-9^2	(d)	c^2-5^2
(e)	b^2-1	(f)	y^2-16	(g)	m^2-25	(h)	a^2-9
(i)	$36-d^2$	(j)	$4-q^2$	(k)	$49-w^2$	(l)	x^2-64
(m)	$81-4g^2$	(n)	$36w^2-y^2$	(o)	$4a^2-1$	(p)	g^2-81h^2
(q)	$49x^2-y^2$	(r)	$9c^2-16d^2$	(s)	$4p^2-9q^2$	(t)	b^2-100c^2

4. Factorise each of the following quadratic expressions:

(a)	$b^2+7b+12$	(b)	$x^2+14x+45$	(c)	$s^2+11s+24$	(d)	$y^2+11y+28$
(e)	b^2+6b+9	(f)	$c^2+13c+42$	(g)	$a^2+12a+32$	(h)	y^2+6y+8
(i)	x^2-6x+5	(j)	c^2-6c+8	(k)	$y^2-10y+21$	(l)	$b^2-14b+48$
(m)	$x^2-7x+10$	(n)	$s^2-13s+40$	(o)	$y^2-11y+18$	(p)	$a^2-8a+16$

5. Factorise:

(a)	x^2+4x-5	(b)	$a^2-4a-21$	(c)	t^2-t-20	(d)	$y^2+4y-32$
(e)	$c^2-5c-14$	(f)	x^2-5x-6	(g)	$b^2+7b-18$	(h)	$p^2-8p-20$
(i)	y^2-y-56	(j)	$z^2-2z-24$	(k)	$x^2-3x-28$	(l)	$a^2-13a-30$
(m)	c^2+c-20	(n)	p^2-6p-7	(o)	$b^2+5b-50$	(p)	$x^2+3x-18$

Changing the Subject of a Formula

1. Change the subject of each formula to x.

a.	$y = x + 3$	b.	$y = x - 5$	c.	$y = x + a$
d.	$y = x - b$	e.	$y = 3x$	f.	$y = 10x$
g.	$y = kx$	h.	$y = ax$	i.	$y = 3p + x$
j.	$y = x - 5t$	k.	$y = 2x + 1$	l.	$y = 3x - 7$
m.	$y = 7x + 4a$	n.	$y = 3b + 4x$	o.	$y = 8 + 10x$

2. Make x the subject of each formula below.

a.	$y = ax + b$	b.	$y = mx + c$	c.	$t = sx - r$
d.	$p = qx + 2r$	e.	$m = fx - 3n$	f.	$a = b + cx$
g.	$k = h - mx$	h.	$d = 3b + cx$	i.	$g = kc - hx$

3. Change the subject of each formula to the letter shown in brackets.

a.	$P = 4l$	(l)	b.	$V = IR$	(I)	c.	$S = DT$	(T)
d.	$A = lb$	(b)	e.	$C = \pi d$	(d)	f.	$G = UT$	(U)
g.	$v = u + at$	(t)	h.	$P = 2l + 2b$	(l)	i.	$H = xy + 5m$	(y)

4. Make x the subject of each formula.

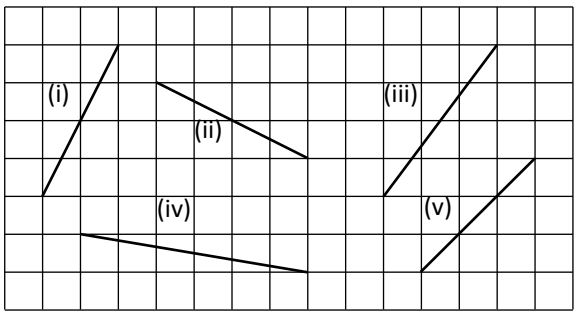
a.	$y = \frac{3}{x}$	b.	$d = \frac{c}{x}$	c.	$m = \frac{y}{x}$
d.	$s = \frac{a+2}{x}$	e.	$w = \frac{z-1}{x}$	f.	$a = \frac{b+c}{x}$
g.	$a = \frac{x+8}{9}$	h.	$k = \frac{x-5}{2}$	i.	$p = \frac{3-x}{4}$
j.	$y = \frac{2}{x} + 1$	k.	$z = \frac{6}{x} - 7$	l.	$h = \frac{m}{x} + k$

5. Change the subject of each formula to the letter shown in brackets.

a.	$v^2 = u^2 + 2as$	(s)	b.	$v^2 = u^2 + 2as$	(u)			
c.	$V = \pi r^2 h$	(h)	d.	$V = \pi r^2 h$	(r)			
e.	$r = \sqrt{\frac{A}{\pi}}$	(A)	f.	$L = 3 + \sqrt{6a}$	(a)			
g.	$2k = \sqrt{(p+4)}$	(p)	h.	$x^2 = \frac{4yz}{t}$	(y)			
i.	$ar = \frac{1}{2}\sqrt{\frac{x}{b}}$	(b)	j.	$st = A^2(x - 3y)$	(A)			
k.	$R = A^2(x - 3y)$	(x)	l.	$na = \sqrt{(1-n^2)}$	(n)			
m.	$d = \frac{t(n-1)}{n}$	(n)	n.	$\frac{1}{R} = \frac{1}{r_1} + \frac{1}{r_2}$	(R)			

Gradient & Equation of a Line

1. (a) Calculate the gradient of each line in the diagram opposite.



(b) Copy and complete each statement below :

The gradient of any horizontal line is _____ .

The gradient of any vertical line is _____ .

2. Calculate the gradient of the line joining each pair of points below.

(a)	A(4,3) , B(8,11)	(b)	C(1,9) , D(3,1)	(c)	E(-2,6) , F(8,8)
(d)	G(5,-9) , H(8,-15)	(e)	I(0,6) , J(5,11)	(f)	K(-1,-3) , L(7,-9)
(g)	M(-4,0) , N(-1,5)	(h)	P(2,2) , Q(-3,4)	(i)	R(5,-1) , S(-2,10)

3. Draw each of the following lines on a coordinate diagram *(you should manage 3 lines on each diagram)*.

(a)	$y = x + 3$	(b)	$y = -2x - 1$	(c)	$y = \frac{1}{2}x$
(d)	$y = -\frac{1}{2}x + 2$	(e)	$x + y = 6$	(f)	$2y = x - 4$
(g)	$3y = x + 12$	(h)	$4x + 5y = 20$	(i)	$3x - 2y = 12$

4. State the gradient and the *y*-intercept point for each line in question 3.

5. State the gradient and the *y*-intercept point for each line below.

(a)	$y = x - 7$	(b)	$y = -5x + 3$	(c)	$5y = 3x - 10$
(d)	$y = -4x$	(e)	$2x + y = 11$	(f)	$2y = x - 5$
(g)	$3y - x = 18$	(h)	$3x + 7y - 21 = 0$	(i)	$4x - 5y = 20$

6. Write down the equation of the line:
   (a) with gradient 4, passing through the point (0,5)
   (b) with gradient -2, passing through the point (0,1)
   (c) with gradient $\frac{3}{4}$, passing through the point (0,-3)

7. Establish the equation of the line passing through each pair of points below.

(a)	A(2,1) , B(6,13)	(b)	C(3,4) , D(5,-4)	(c)	E(-2,-1) , F(6,3)
(d)	G(4,-13) , H(-2,-1)	(e)	I(2,8) , J(10,12)	(f)	K(-3,2) , L(9,-2)

8. *(extension & extra practice)* Find the equation of each line in question 2 using … $y - b = m(x - a)$.

Functions & Graphs 1

1. A function is given as $f(x) = 6x - 5$.

   Find: (a) $f(3)$ (b) $f(-1)$ (c) $f(\frac{1}{2})$ (d) $f(a)$

2. A function is given as $f(x) = x^2 + 4$.

   Find: (a) $f(2)$ (b) $f(4)$ (c) $f(-3)$ (d) $f(p)$

3. A function is given as $h(a) = 12 - 2a$.

   Find: (a) $h(4)$ (b) $h(6)$ (c) $h(-2)$ (d) $h(m)$

4. A function is defined as $g(x) = x^2 + 3x$.

   Find: (a) $g(a)$ (b) $g(2p)$ (c) $g(m+1)$ (d) $g(2-e)$

5. A function is defined as $f(x) = x^2 - 4x$.

   Find: (a) $f(4)$ (b) $f(3a)$ (c) $g(a-2)$ (d) $g(2p+1)$

6. A function is given as $f(x) = 5x + 3$. For what value of x is :

   (a) $f(x) = 23$ (b) $f(x) = -2$ (c) $f(x) = 5$?

7. A function is given as $h(t) = 20 - 6t$. For what value of t is :

   (a) $h(t) = 2$ (b) $h(t) = -16$ (c) $h(t) = 32$?

8. A function is given as $g(a) = a^2 - 16$. For what value(s) of a is :

   (a) $g(a) = 9$ (b) $g(a) = -15$ (c) $g(a) = 0$?

9. A function is defined as $f(x) = x^2 + 2x$.

   (a) Evaluate: i) $f(3)$ ii) $f(-2)$.

   (b) Find $f(a+3)$ in its simplest form.

10. A function is defined as $h(a) = 33 - 6a$.

    (a) Evaluate: i) $h(4)$ ii) $h(-1)$.

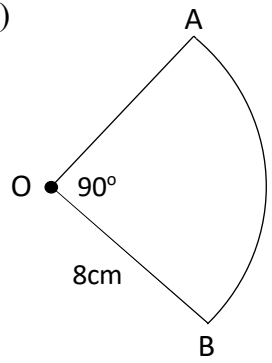
    (b) Given that $h(t) = 0$, find the value of t.

    (c) Express $h(p-2)$ in its simplest form.

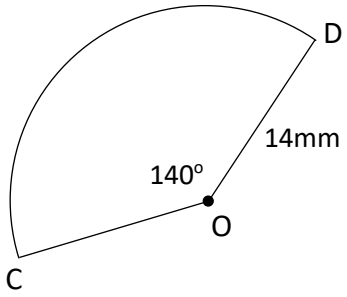
The Circle 1

1. Calculate the length of the arc in each diagram below, giving your answer correct to 1d.p.

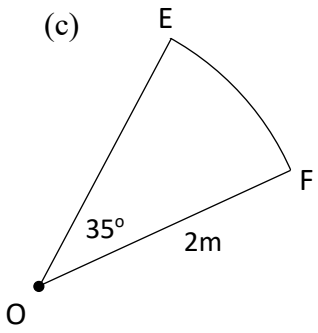
(a)



(b)



(c)



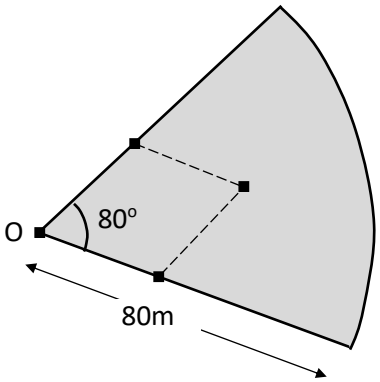
2. Calculate the perimeter of each sector in question1.

3. Calculate the area of each sector in question 1.

4. A school baseball field is in the shape of a sector of a circle as shown.
Given that O is the centre of the circle, calculate:

(a) the perimeter of the playing field;

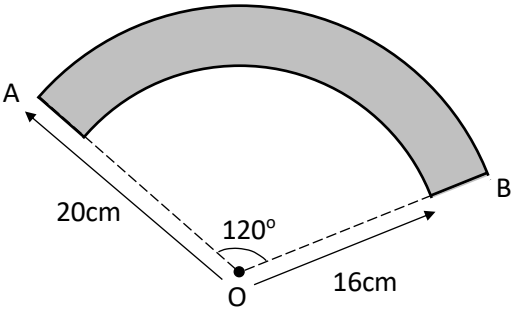
(b) the area of the playing field.



5. In the diagram opposite, O is the centre of two concentric circles with radii 16cm and 20cm as shown.
Angle $AOB = 120^o$.

Calculate: (a) The perimeter of the shaded shape.

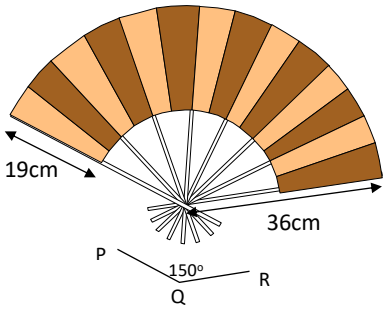
(b) The shaded area.



6. A Japanese paper fan is fully opened when angle $PQR = 150^o$ as shown.

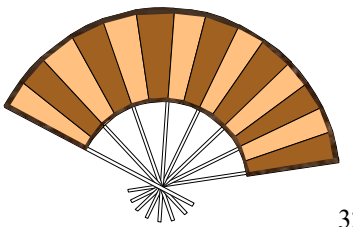
(a) Using the dimensions shown in *diagram 1*, calculate the approximate area of paper material in the fan.

diagram 1



(b) Decorative silk bands are placed along the edges as shown in *diagram 2*, calculate the approximate total length of this silk edging strip.

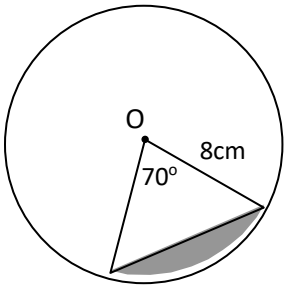
diagram 2



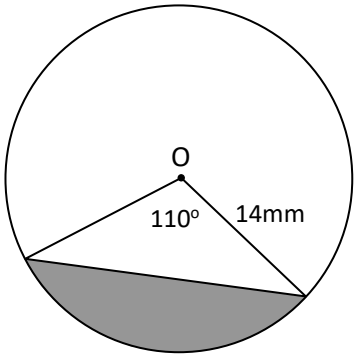
The Circle 2

1. Calculate the area of each shaded segment in the diagrams below.

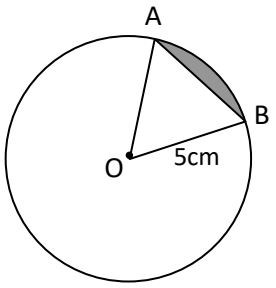
(a)



(b)



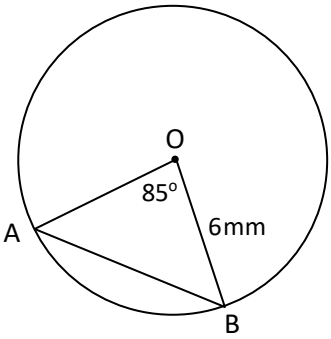
(c)



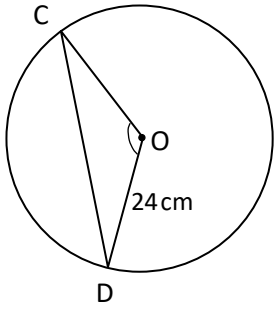
$\angle AOB = 60^o$

2. Calculate the length of the chord in each diagram below.

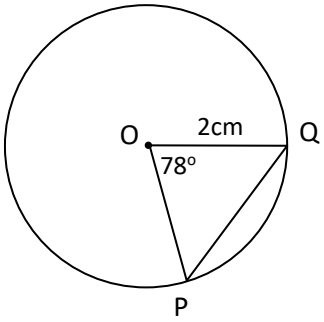
(a)



(b)



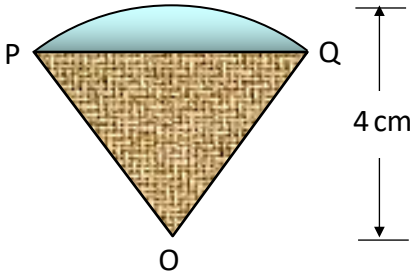
(c)



$\angle COD = 130^o$

3. Calculate the perimeter of each segment in question 2.

4. The logo for a small ice-cream company is shown opposite. It is simply a sector of a circle with its centre at O.



(a) Calculate the perimeter of the logo.

(b) Calculate the area of the ice-cream part.

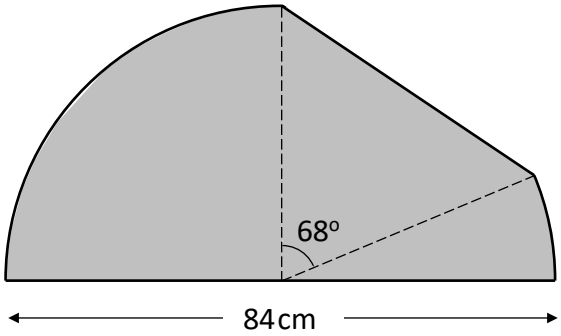
$\angle POQ = 72^o$

5. A designer table-top is shaped as a semi-circle with a segment removed as shown in the diagram.

From the information supplied calculate:

(a) the perimeter of the table-top;

(b) the area of the table-top.



The Circle 3

1. (a) A wafer biscuit consists of a sector of a circle with a triangular part removed as shown in *figure 1*.

The radius of the circle PQ is 6cm and PS = 2cm.
Angle QPR = 100°.

Calculate the area of the biscuit.

figure 1

(b) A smaller version of the wafer is produced.

In this smaller biscuit PQ = $4 \cdot 4$ cm .

Given that the arc length QR = $6 \cdot 9$ cm , calculate the size of angle QPR, correct to the nearest degree, for this version of the biscuit.

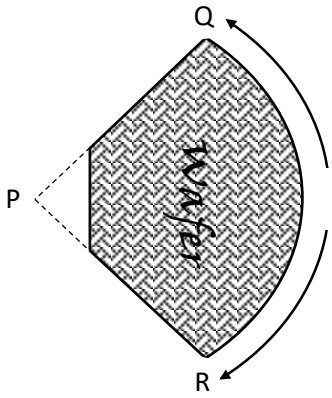


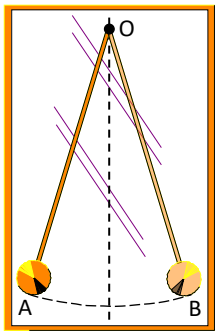
figure 2

2. A grandfather clock has a pendulum which travels along an arc of a circle, centre O.

The arm length of the pendulum is 60cm.

The pendulum swings from position OA to OB.
The length of the arc AB is 21cm.

Calculate the size of angle AOB to the nearest degree.



3. (a) A circle, centre O, has an arc PQ of length 40cm.
If the diameter of the circle is 80cm, calculate the size of angle POQ correct to 1 d.p.

(b) A circle, centre O, has a sector EOF with an area of 50cm^2.
If the radius of the circle is 8cm, calculate the size of angle EOF correct to 1 d.p.

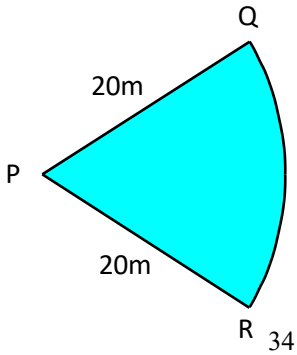
(c) An arc AB on a circle, centre O, has a length of 16mm.
If angle AOB = 75° , calculate the radius of this circle.

(d) A sector of a circle has an area of 12cm^2. If the angle at the centre is 60°, calculate the diameter of the circle correct to 2-decimal places.

4. The shape opposite is the sector of a circle, centre P, radius 20m.

The area of the sector is $251 \cdot 2$ square metres.

Find the length of the arc QR.



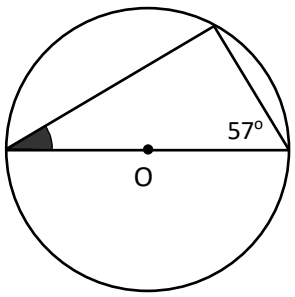
The Circle 4

Copy and learn the following .....

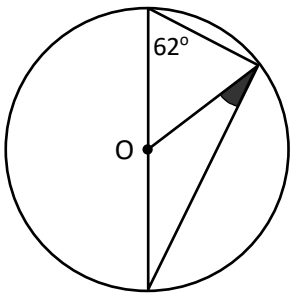
1. *Angles in a semi-circle equal 90°.*
2. *The angle between a tangent and a radius is 90°.*
3. *Look for isosceles triangles in all diagrams.*
4. *The angles in any triangle add up to 180°.*
5. *Two angles in a straight line add up to 180°.*
6. *Be aware of the tangent kite.*

Exercise1 : Find the size of the shaded angles in each diagram.
(O is the centre of each circle, PS and PT are tangents)

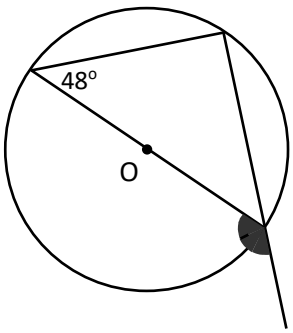
1.



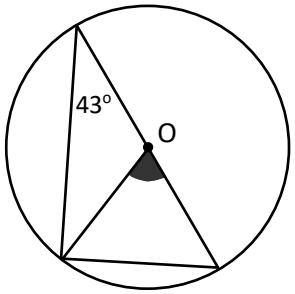
2.



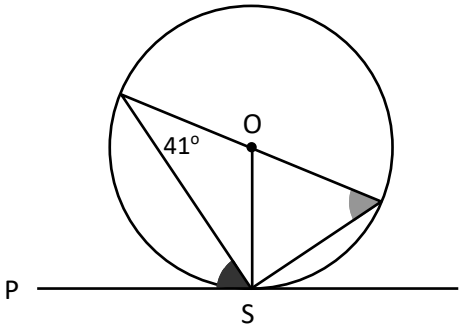
3.



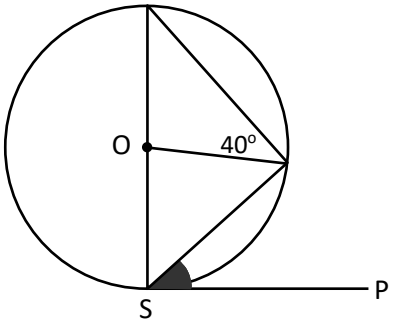
4.



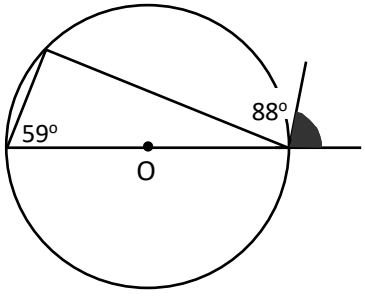
5.



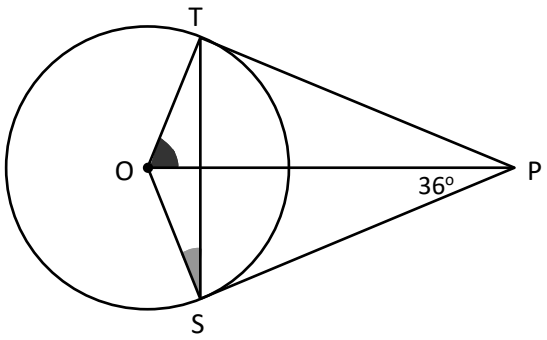
6.



7.

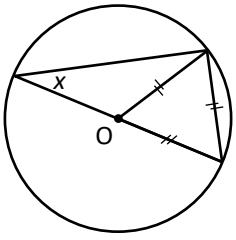


8.

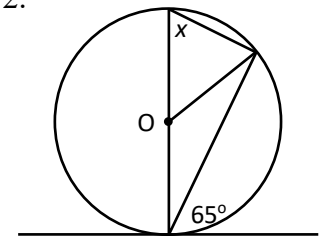


Exercise 2 : Calculate the size of angle *x* in each diagram below.

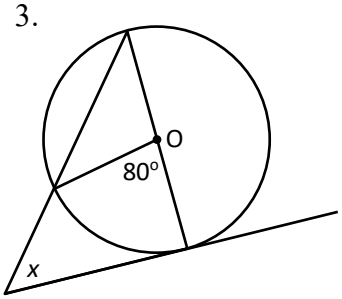
1.



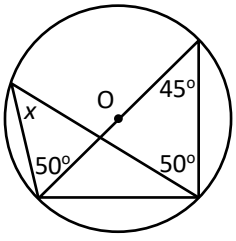
2.



3.



4.



Inequations

1. Solve each of the following inequations where x can only take values from the set of numbers ….. $\{-2, -1, 0, 1, 2, 3, 4, 5\}$.

(a) $6x+2 \le 3x+5$ (b) $7x-1 > 3x+3$

(c) $3(2x+1) \ge 5x+8$ (d) $2(6+5x) < 8x+12$

(e) $14-2(3-x) \le 8$ (f) $5+3(2-x) \ge 14-6x$

(g) $2x-(4-x) < x+2$ (h) $3-4(2+x) > 6(2-x)-17$

Example .....

$$\begin{aligned} 3x-2 &\ge x+4 \\ 3x-x &\ge 4+2 \\ 2x &\ge 6 \\ \therefore x &\ge 3 \end{aligned}$$

answer … { 3 , 4 , 5 }

2. Solve each of the following inequations.

(a) $3a+2 \le 17-2a$ (b) $7(2x+3) > 8x+27$

(c) $2(5p-12) \ge 7p-18$ (d) $40+3k < 28-k$

(e) $1-5(2-m) \le 2(m+7)$ (f) $3(2y-4)-1 > 4(4-y)$

(g) $2(3-4h) < 12-15h$ (h) $2-3(2-x) > 2(1-x)-5$

Example .....

$$\begin{aligned} 4(2a-1) &\le 3(a+1) \\ 8a-4 &\le 3a+3 \\ 8a-3a &\le 3+4 \\ 5a &\le 7 \\ \therefore a &\le \tfrac{7}{5} \end{aligned}$$

3. Solve each of the following inequations.

(a) $2a+18 \le 12+4a$ (b) $14-3x > x+6$

(c) $3(p-2) \ge 5p-10$ (d) $16-3k < 20-k$

(e) $7(2-d) \le 2(d-12)$ (f) $2(2y-1)-8 > 10(1+y)$

(g) $4(3-4h) < 12+h$ (h) $3(2-y) > 2(1+3y)-7$

(i) $w(w-3) > 5(w+2)+w^2$ (j) $4d(1+d) < 2d(2d+3)-20$

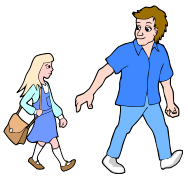
Example .....

$$\begin{aligned} 3(4-p) &< 2(p-1) \\ 12-3p &< 2p-2 \\ 12+2 &< 2p+3p \\ 14 &< 5p \\ \tfrac{14}{5} &< p \\ \therefore p &> \tfrac{14}{5} \end{aligned}$$

4. I think of a <u>whole</u> number, treble it and subtract 3. The answer must be less than or equal to 12. Form an inequation and solve it to find the possible starting whole numbers.

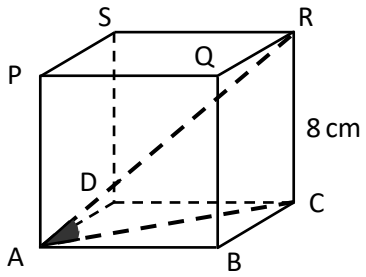
5. I subtract a whole number from 8 and double the answer. The result must be greater than 10. Form an inequation and solve it to find the possible starting whole numbers.

6. Fred and Jane are brother and sister. Fred is 3 years older than twice Jane's age. The sum of their ages is less than 36 years. Taking Jane's age to be x years form an inequation. What can you say about Jane's age?



Trigonometry 5

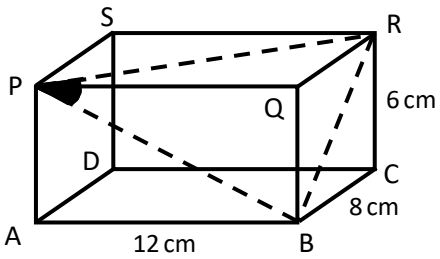
1. The diagram opposite is a cube of side 8cm.



   (a) Calculate the length of AC.

   (b) Hence calculate the size of angle CAR.

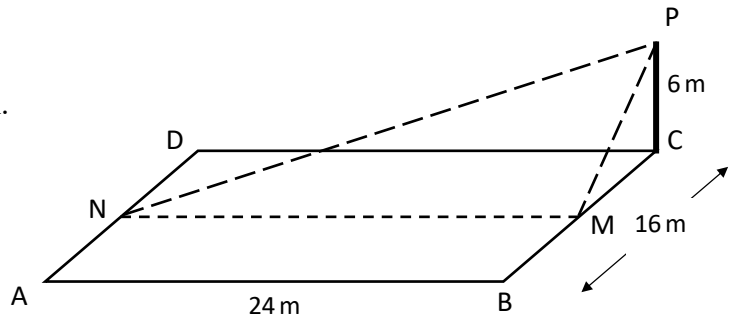
2. The cuboid opposite has dimensions 12cm by 8cm by 6cm as shown.



   (a) Calculate the lengths of PB and BR.

   (b) Hence calculate the size of $\angle BPR$

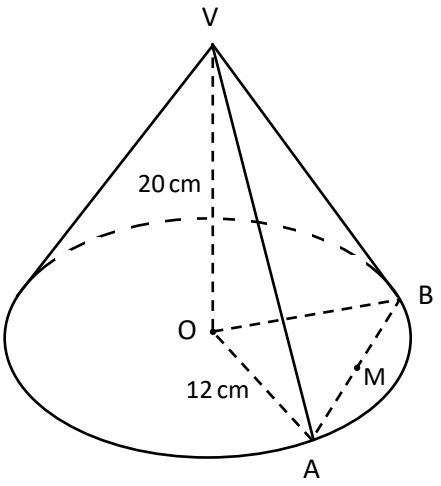
3. ABCD is a rectangle resting on a horizontal plane with AB = 24 m and BC = 16 m as shown.
CP is a vertical post of length 6 m.
M and N are the mid-points of BC and AD respectively.



   (a) Calculate the size of angle CMP.

   (b) Calculate the length of PM and hence calculate the size of angle MNP.

4. A cone of base radius 12 cm has a vertical height of 20 cm as shown.



   (a) Calculate the slant height of the cone.

   (b) Calculate the size of angle OBV.

   (c) i) Given that M is the mid-point of AB and $\angle$ AOB = 90°, calculate the length of the chord AB.

   ii) Hence calculate the size of $\angle$ MBV

   iii) Calculate the area of triangle ABV.

Solving Quadratic Equations 1

1.

Examples …….. Common Factor

Solve

$(a)\quad x^2-5x=0$

$x(x-5)=0$

$\therefore\ x=0\ \ or\ \ x-5=0$

$x=0\ \ or\ \ x=5$

$(b)\quad 4x^2+18x=0$

$2x(2x+9)=0$

$\therefore\ 2x=0\ \ or\ \ 2x+9=0$

$x=0\ \ or\ \ x=-\frac{9}{2}$

Exercise 1: Solve the following quadratic equations.

(a)	$x^2+6x=0$	(b)	$y^2-9y=0$
(c)	$z^2-z=0$	(d)	$a^2+7a=0$
(e)	$b^2+11b=0$	(f)	$3x^2-9x=0$
(g)	$4y^2-28y=0$	(h)	$5z^2-60z=0$
(i)	$7m^2+35m=0$	(j)	$9n^2-54n=0$
(k)	$6p^2-15p=0$	(l)	$4q^2-14q=0$
(m)	$15r^2+25r=0$	(n)	$12u^2+16u=0$
(o)	$18v^2+21v=0$	(p)	$28l^2-35l=0$
(q)	$16m^2-18m=0$	(r)	$9n^2+16n=0$
(s)	$8b^2-10b=0$	(t)	$10c^2-45c=0$

2.

Examples .. Difference of Two Squares

Solve

$(a)\quad y^2-9=0$

$(y+3)(y-3)=0$

$\therefore\ y+3=0\ \ or\ \ y-3=0$

$y=-3\ \ or\ \ y=3$

$(b)\quad 25a^2-49=0$

$(5a+7)(5a-7)=0$

$\therefore\ 5a+7=0\ \ or\ \ 5a-7=0$

$a=-\frac{7}{5}\ \ or\ \ a=\frac{7}{5}$

Exercise 2: Solve the following quadratic equations.

(a)	$x^2-36=0$	(b)	$y^2-100=0$
(c)	$z^2-49=0$	(d)	$a^2-1=0$
(e)	$b^2-64=0$	(f)	$x^2-121=0$
(g)	$4y^2-25=0$	(h)	$9z^2-16=0$
(i)	$25m^2-64=0$	(j)	$9n^2-25=0$
(k)	$25p^2-1=0$	(l)	$4q^2-9=0$
(m)	$49r^2-144=0$	(n)	$36u^2-25=0$
(o)	$81v^2-1=0$	(p)	$4l^2-1=0$
(q)	$16m^2-9=0$	(r)	$1-16p^2=0$
(s)	$25-4g^2=0$	(t)	$4-(p+1)^2=0$

3.

Examples .. Tri-nomials

Solve

$(a)\quad x^2-x-6=0$

$(x-3)(x+2)=0$

$\therefore\ x-3=0\ \ or\ \ x+2=0$

$x=3\ \ or\ \ x=-2$

$(b)\quad 2a^2-7a+6=0$

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

$\therefore\ 2a-3=0\ \ or\ \ a-2=0$

$a=\frac{3}{2}\ \ or\ \ a=2$

Exercise 3: Solve the following quadratic equations.

(a)	$x^2-9x+20=0$	(b)	$y^2-12y+27=0$
(c)	$z^2-6z+5=0$	(d)	$a^2-8a+15=0$
(e)	$b^2+14b+40=0$	(f)	$x^2+10x+9=0$
(g)	$y^2+18y+81=0$	(h)	$z^2+2z-48=0$
(i)	$m^2+7m-60=0$	(j)	$n^2+5n-36=0$
(k)	$p^2+p-56=0$	(l)	$q^2-4q-21=0$
(m)	$r^2-6r-72=0$	(n)	$u^2-7u-8=0$
(o)	$3v^2+10v+7=0$	(p)	$2l^2-11l+5=0$
(q)	$12m^2-31m+7=0$	(r)	$3n^2-19n+28=0$
(s)	$4b^2-20b+25=0$	(t)	$9c^2+18c+8=0$
(u)	$3q^2+14q-5=0$	(v)	$6a^2+a-12=0$
(w)	$8b^2-2b-15=0$	(x)	$2c^2-5c-18=0$
(y)	$12m^2-8m-15=0$	(z)	$2n^2-n-28=0$

Solving Quadratic Equations 2

1. Solve each of the following quadratic equations by first removing a common factor and then factorising further.

(a)	$2x^2+8x-10=0$	(b)	$4y^2+20y+24=0$
(c)	$5z^2-5z-60=0$	(d)	$2a^2-6a-56=0$
(e)	$7b^2-70b+63=0$	(f)	$10x^2-20x-150=0$
(g)	$2y^2-18=0$	(h)	$6z^2-6=0$
(i)	$6m^2+21m+9=0$	(j)	$12n^2+20n+8=0$
(k)	$5p^2-45=0$	(l)	$48q^2+8q-16=0$
(m)	$10r^2-60r-720=0$	(n)	$28u^2-63=0$
(o)	$36v^2+120v+84=0$	(p)	$80l^2+40l-400=0$
(q)	$27m^2-12=0$	(r)	$6n^2-38n+56=0$
(s)	$18b^2+24b+8=0$	(t)	$60c^2+75c-90=0$
(u)	$24q^2-22q+4=0$	(v)	$54a^2+9a-108=0$
(w)	$18b^2-39b+18=0$	(x)	$250c^2-10=0$
(y)	$60m^2-21m-18=0$	(z)	$36n^2-30n-24=0$

Examples .. Mixed Factors

Solve

(a) $3x^2-6x-24=0$

$3(x^2-2x-8)=0$

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

$\therefore\ x-4=0 \ \ or \ \ x+2=0$

$x=4 \ \ or \ \ x=-2$

(b) $80a^2-20=0$

$20(4a^2-1)=0$

$20(2a-1)(2a+1)=0$

$\therefore\ 2a-1=0 \ \ or \ \ 2a+1=0$

$a=\frac{1}{2} \ \ or \ \ a=-\frac{1}{2}$

2. Use the quadratic formula, $x=\dfrac{-b\pm\sqrt{(b^2-4ac)}}{2a}$, to solve the following quadratic equations rounding your answers to 1-decimal place.

[useful tip ……. *calculate* $b^2-(4ac)$, *separately*, *away from the equation*, *and bring the final number back in ….. why have we introduced the extra brackets*?]

(a)	$x^2+4x+1=0$	(b)	$x^2+6x+4=0$	(c)	$x^2+7x+5=0$
(d)	$x^2+3x-1=0$	(e)	$x^2-6x+3=0$	(f)	$x^2-4x-7=0$
(g)	$2x^2+x-4=0$	(h)	$2x^2-3x-4=0$	(i)	$2x^2+12x+9=0$
(j)	$4x^2-12x+3=0$	(k)	$3x^2+x-5=0$	(l)	$7x^2+3x-1=0$

3. Solve each of the following quadratic equations by "completing the square".
Round your answers to 2-decimal places.

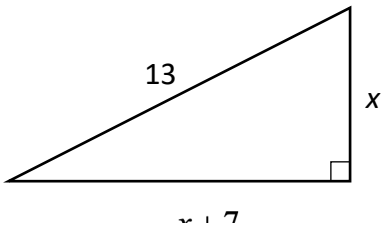
(a)	$x^2+4x+2=0$	(b)	$x^2+6x-2=0$	(c)	$x^2+2x-1=0$
(d)	$x^2+8x+3=0$	(e)	$x^2-6x-4=0$	(f)	$x^2-12x+21=0$
(g)	$2x^2+4x-3=0$	(h)	$2x^2-8x+5=0$	(i)	$x^2+5x-2=0$?

4. *Extension* …… Solve the following equations using the most appropriate method.

(a)	$(x+1)(x+2)=12$	(b)	$x(x-1)=3(x+1)$	(c)	$x(x+1)+3(x-2)=4(2x-1)$
(d)	$2(a^2-3)=a(a+1)$	(e)	$(x+3)+\dfrac{6}{(x-4)}=0$	(f)	$(2x-1)^2-3=6$

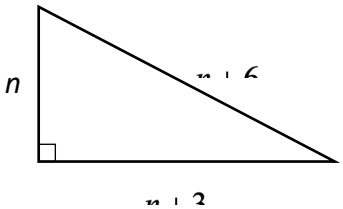
Solving Quadratic Equations 3

1. The diagram opposite shows a right-angled triangle with sides measuring 13, $x+7$ and x centimetres.



   (a) Form an equation and solve it to find x.

   (b) Hence calculate the perimeter of the triangle.

2. 

The sides of a right angled triangle are n, $n+3$ and $n+6$ centimetres long.

Find n by solving an equation, and hence calculate the area of this triangle.

3. Repeat question 2. for a right angled triangle with short sides measuring n and $2n+4$ and the hypotenuse measuring $3n-4$ millimetres.

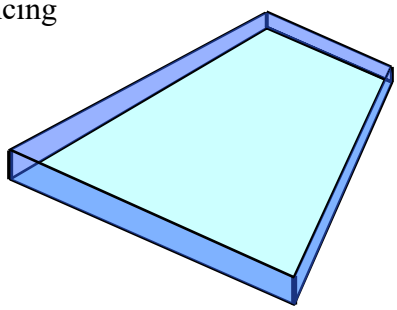
4. A rectangular sheet of glass has an area of $1500\,\text{cm}^2$ and a perimeter of $160\,\text{cm}$.

   (a) Taking the length of the glass sheet as x, write down an expression for the width of the sheet in terms of x.

   (b) Form an equation in x for the area of the sheet and solve it to find x.

   Hence state the dimensions of the glass sheet.

5. A farmer has 260 metres of clear plastic fencing. He uses all the fencing to create a rectangular holding pen.



   (a) Taking x as the length of the pen, write down an expression for the width of the pen in terms of x.

   (b) Given that the area of the pen is 4000 square metres, form an equation and solve it to find x, the length of the pen.

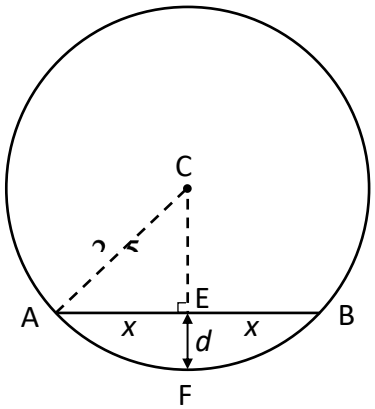
6. The perimeter of a rectangular lawn is 42 metres and its area is 80 square metres.

   Find the length and breadth of the lawn.

7. The diagram opposite shows the cross section of a cylindrical oil tank of radius 2·5 metres.

   The width AB of the exposed oil surface is $2x$ metres.

   The maximum depth of the oil is d metres, as shown.



   (a) Write down the length of CE in terms of d.

   (b) By applying Pythagoras' Theorem, show that …

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

   (c) Find d when $x = \frac{3}{2}$, and $d < 1$.

Standard Deviation

All of the following questions refer to chosen samples.

The recommended formulae for mean and standard deviation of a sample is shown opposite although alternative formulae may be used for this worksheet.

$$\text{(mean)}\quad \bar{x} = \frac{\sum x}{n} \quad , \quad s = \sqrt{\frac{\sum x^2 - \frac{(\sum x)^2}{n}}{n-1}}$$

---

1. The heights, in centimetres, of a sample of ten tomato plants were recorded.

   The data gave the following summary totals:

   $$\sum x = 320 \qquad \sum x^2 = 11526$$

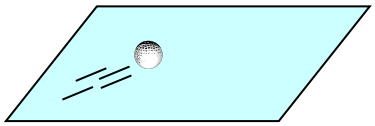
   (a) Calculate the mean and standard deviation, giving your answer correct to 1-decimal place where necessary.

   (b) Another sample of ten plants has a mean height of 28cm and a standard deviation of 6·3. How does this second sample compare with the first?

2. A sample of twelve golf balls were artificially tested by rolling them across a flat area. The distance travelled, in metres, by each ball, was recorded.

   The data gave the following summary totals:

   $$\sum x = 48 \qquad \sum x^2 = 192 \cdot 38$$



   (a) Calculate the mean and standard deviation, giving your answer correct to 2-decimal places where necessary.

   (b) Another sample of twelve balls has a mean distance of 4·3m and a standard deviation of 0·81.

   How, with consistency in mind, does this second sample compare with the first?

3. A group of students took part in an end of year assessment. The marks out of fifty for a sample of these students are listed below.

   35 38 21 44 48 32 45 45 39 31 40

   (a) Calculate, correct to 3 significant figures, the mean and standard deviation of this sample.

   (b) A "highly commended" certificate is to be given to any student who has a mark that is more than one standard deviation above the mean.

   How many students in this sample would receive this certificate?

4. A sample of fifteen matchboxes was chosen from an assembly line. The number of matches in each box was recorded. The results are shown below.

   65 63 66 62 61 61 62 62
   63 64 59 61 60 63 64

   (a) Calculate, correct to 3 significant figures, the mean and standard deviation of this sample.

   (b) Boxes which contain less than one standard deviation of matches below the mean are to be discarded and refilled. How many boxes in this sample would be discarded?

Equations Involving Fractions 1

1. Solve the following equations.

$(a)\ \frac{x}{8}=3$ $(b)\ \frac{5a}{2}=10$ $(c)\ \frac{3p}{4}=9$ $(d)\ \frac{w}{6}=\frac{5}{2}$

$(e)\ \frac{3x}{4}=\frac{9}{2}$ $(f)\ \frac{4x}{7}=\frac{3}{2}$ $(g)\ \frac{5h}{8}=\frac{1}{2}$ $(h)\ \frac{7p}{3}=\frac{4}{5}$

$(i)\ 6=\frac{30}{x}$ $(j)\ 14=\frac{42}{m}$ $(k)\ 8=\frac{32}{3g}$ $(l)\ \frac{3}{2}=\frac{24}{x}$

$(m)\ \frac{6}{5}=\frac{12}{5k}$ $(n)\ \frac{9}{h}=\frac{3}{4}$ $(o)\ \frac{4}{3x}=\frac{2}{15}$ $(p)\ \frac{5}{4v}=\frac{2}{9}$

2 Solve each of the following equations.

$(a)\ \frac{x}{2}+3=11$ $(b)\ \frac{3p}{2}+1=4$ $(c)\ 1+\frac{5d}{2}=16$

$(d)\ 7+\frac{3q}{4}=13$ $(e)\ \frac{2y}{3}-8=2$ $(f)\ \frac{7e}{5}-4=10$

$(g)\ \frac{1}{2}a+6=14$ $(h)\ \frac{3}{4}x-7=11$ $(i)\ 12+\frac{2}{3}y=16$

$(j)\ \frac{x}{4}+\frac{1}{3}=2$ $(k)\ \frac{p}{2}-\frac{3}{7}=1$ $(l)\ \frac{2w}{5}+3=\frac{7}{2}$

$(m)\ \frac{3y}{8}-1=\frac{2}{3}$ $(n)\ \frac{2h}{3}=1-\frac{h}{6}$ $(o)\ \frac{a}{4}=\frac{5}{2}-\frac{a}{3}$

$(p)\ \frac{2p}{3}-\frac{p}{4}=\frac{7}{12}$ $(q)\ \frac{4d}{9}-\frac{2}{3}=\frac{d}{2}$ $(r)\ \frac{2}{x}-\frac{1}{3}=\frac{1}{x}$

$(s)\ \frac{3}{4}-\frac{4}{y}=1$ $(t)\ \frac{1}{3e}+\frac{1}{e}=\frac{1}{3}$ $(u)\ \frac{1}{4k}+\frac{1}{3}=\frac{2}{5}$

3. Solve each of the following equations.

$(a)\ \frac{x+1}{4}+\frac{x+2}{5}=2$ $(b)\ \frac{2p+1}{3}+\frac{p+4}{5}=2$ $(c)\ \frac{x-1}{5}+2=\frac{2x-3}{3}$

$(d)\ \frac{2x+1}{4}+\frac{1}{2}=\frac{6x-1}{2}$ $(e)\ \frac{3y+4}{2}-y=\frac{2y+8}{3}$ $(f)\ \frac{d-1}{3}+\frac{3d-2}{4}=\frac{4}{3}$

$(g)\ \frac{3x+1}{5}+\frac{2x+5}{2}=-\frac{1}{2}$ $(h)\ 3+\frac{3a+2}{3}=\frac{9a+5}{2}$ $(i)\ 2w+\frac{w-1}{2}=\frac{5w+3}{3}$

Equations Involving Fractions 2

1. Solve each of the following equations.

(a) $\frac{2}{5}x + 5 = 13$ (b) $\frac{1}{4} + \frac{4}{3}p = \frac{33}{4}$ (c) $\frac{2}{7}y - \frac{1}{2} = \frac{7}{2}$

(d) $2d + \frac{5}{8} = \frac{1}{2}$ (e) $\frac{8}{3} + 3h = \frac{5}{6}$ (f) $4c - \frac{11}{4} = \frac{7}{6}$

(g) $3(x+\frac{1}{2}) = \frac{5}{4}$ (h) $2(3p-\frac{5}{3}) + \frac{1}{6} = 1$ (i) $3k + \frac{4}{9} = \frac{1}{2}k + \frac{22}{3}$

2. Solve the following equations.

(a) $\frac{2}{3}(x+12) = 10$ (b) $\frac{3}{4}(3p+2) = 15$ (c) $\frac{7}{8}(5k-3) = 28$

(d) $\frac{4}{5}(2d+5)+3 = 23$ (e) $\frac{3}{5}(3p-1)-7 = 5$ (f) $\frac{5}{6}(h+5)-\frac{1}{2} = \frac{27}{2}$

(g) $\frac{1}{2}(x+1) + 2x = \frac{2}{3}(4x+1)$ (h) $\frac{1}{6}a + \frac{2}{3}(a+3) = \frac{1}{2}(a+12)$

(i) $\frac{5}{3}(d+1) + \frac{1}{2}d = \frac{3}{4}(d+8) + 7$ (j) $\frac{3}{7}y + \frac{1}{2}(y-2) = \frac{3}{4}(3y-26)$

3. (a) I think of a number x. If I divide the number by 7 and then add 10, the result equals half of the original number. Form an equation and solve it to find x.

(b) I think of a number p. If I find two-thirds of the number and subtract 4, the result is the same as halving the original number. Form an equation and solve it to find p.

(c) I think of a number n. I double this number and add on seven. If this total is then divided by three the result is one less than the original number.
Form an equation and solve it to find n.

(d) A number y is doubled and subtracted from 40. When this result is halved the answer is found to be one-and-a-half times the original number. Form an equation and solve it to find y.

4. My petrol tank hold x litres of petrol when full.
I syphon off 6 litres to put in my lawn-mower and use half of what is left on a journey.
If there are then 16 litres left, how many litres were in the full tank?

5. A roll of wire was x metres long. A 4 metre length is cut-off and used to rewire a junction box. Half of what is left is used on another job. If there is one third of the roll still unused establish the value of x.

6. A small bush, when planted, had an original height of x centimetres. After a month it had grown a further half of its original height. The height of the bush was then reduced by 21 centimetres. After this pruning the bush was found to be three quarters of its original height.

Find the original height of the bush.

Fractional Expressions

1. Simplify the following.

(a) $\frac{4a}{2a^2}$ (b) $\frac{10x^2}{12xy}$ (c) $\frac{3v^2t}{9vt^2}$ (d) $\frac{10ab^3}{2a^2b}$

(e) $\frac{3ab^2c}{4a^2c}$ (f) $\frac{4k^2m}{28km^3}$ (g) $\frac{5efg^2}{10e^2fg^3}$ (h) $\frac{21xy^2}{36x^3}$

2. Simplify the following.

(a) $\frac{3a}{b}\times\frac{b^2}{6}$ (b) $\frac{8b}{a}\times\frac{3a}{16}$ (c) $\frac{24x^2}{5y}\times\frac{10y}{6x}$ (d) $\frac{p^3}{24q^2}\times\frac{36q}{p^2}$

(e) $\frac{a}{2b}\div\frac{1}{b^2}$ (f) $\frac{2x}{3y}\div\frac{8x^2}{9}$ (g) $\frac{5xy}{3}\div\frac{10y^2}{9}$ (h) $\frac{6m^2}{7n}\div\frac{12m}{49n^2}$

(i) $\frac{4(a+1)}{b}\times\frac{b^2}{a+1}$ (j) $\frac{p}{3q-2}\times\frac{2(3q-2)}{3p}$ (k) $\frac{x-4}{y^2}\div\frac{3(x-4)}{y}$

(l) $\frac{2a+6}{5}\times\frac{10}{a+3}$ (m) $\frac{4r}{t+1}\times\frac{5t+5}{2r^2}$ (n) $\frac{e}{6f-12}\div\frac{2e^2}{3f-6}$

3. Write each of the following as a single fraction in its simplest form.

(a) $\frac{a}{2}+\frac{b}{3}$ (b) $\frac{k}{4}-\frac{m}{5}$ (c) $\frac{x}{3}+\frac{4y}{6}$ (d) $\frac{3h}{4}-\frac{k}{12}$

(e) $\frac{3}{a}+\frac{1}{b}$ (f) $\frac{4}{x}-\frac{2}{y}$ (g) $\frac{5}{3d}+\frac{1}{e}$ (h) $\frac{2}{5f}-\frac{2}{10g}$

(i) $\frac{7}{2b}+\frac{3}{4c}$ (j) $\frac{3}{2w}+\frac{8}{5x}$ (k) $\frac{1}{x}+\frac{2}{y}-\frac{1}{z}$ (l) $\frac{1}{2a}+\frac{2}{3b}+\frac{3}{c}$

4. Simplify the following.

(a) $\frac{x+2}{3}+\frac{x+3}{6}$ (b) $\frac{a+6}{4}+\frac{a-2}{3}$ (c) $\frac{d-3}{2}-\frac{d+2}{6}$

(d) $\frac{2a-1}{4}-\frac{a+2}{5}$ (e) $\frac{a+3b}{2}+\frac{a-2b}{4}$ (f) $\frac{2u+v}{3}-\frac{u-v}{4}$

(g) $\frac{a+2}{b}+\frac{a-1}{2b}$ (h) $\frac{3x+y}{2x}+\frac{x-2y}{3x}$ (i) $\frac{4p-q}{5p}-\frac{2p-3q}{3p}$

Surds 1

1. Express each of the following in its simplest form.

(a) $\sqrt{8}$ (b) $\sqrt{12}$ (c) $\sqrt{50}$ (d) $\sqrt{20}$ (e) $\sqrt{24}$ (f) $\sqrt{108}$
(g) $\sqrt{60}$ (h) $\sqrt{72}$ (i) $\sqrt{300}$ (j) $\sqrt{27}$ (k) $\sqrt{96}$ (l) $\sqrt{48}$
(m) $\sqrt{45}$ (n) $\sqrt{98}$ (o) $5\sqrt{8}$ (p) $3\sqrt{32}$ (q) $5\sqrt{40}$ (r) $2\sqrt{12}$
(s) $4\sqrt{18}$ (t) $3\sqrt{24}$ (u) $3\sqrt{27}$

2. Simplify:

(a) $5\sqrt{2} + 3\sqrt{2}$ (b) $3\sqrt{7} - \sqrt{7}$ (c) $4\sqrt{3} + 2\sqrt{3} - 3\sqrt{3}$ (d) $5\sqrt{6} - 2\sqrt{6} + \sqrt{3}$
(e) $\sqrt{8} + 5\sqrt{2}$ (f) $5\sqrt{3} - \sqrt{12}$ (g) $4\sqrt{5} + \sqrt{20} + \sqrt{45}$
(h) $3\sqrt{2} + 2\sqrt{8} - \sqrt{18}$
(i) $\sqrt{50} - \sqrt{8}$ (j) $3\sqrt{12} + \sqrt{27}$ (k) $\sqrt{75} + \sqrt{108} - \sqrt{3}$ (l) $\sqrt{5} + \sqrt{20} + \sqrt{80}$

3. Simplify:

(a) $\sqrt{5} \times \sqrt{5}$ (b) $\sqrt{2} \times \sqrt{2}$ (c) $\sqrt{3} \times \sqrt{5}$ (d) $\sqrt{6} \times \sqrt{2}$
(e) $\sqrt{3} \times \sqrt{6}$ (f) $\sqrt{x} \times \sqrt{y}$ (g) $\sqrt{8} \times \sqrt{2}$ (h) $3\sqrt{2} \times \sqrt{2}$
(i) $2\sqrt{5} \times 3\sqrt{5}$ (j) $3\sqrt{2} \times 2\sqrt{7}$ (k) $4\sqrt{3} \times 2\sqrt{3}$ (l) $\sqrt{5} \times 3\sqrt{2}$
(m) $2\sqrt{6} \times 3\sqrt{3}$ (n) $8\sqrt{2} \times \sqrt{12}$ (o) $5\sqrt{3} \times 3\sqrt{5}$ (p) $4\sqrt{8} \times 2\sqrt{2}$

4. Expand and simplify:

(a) $\sqrt{2}(1 - \sqrt{2})$ (b) $\sqrt{3}(\sqrt{3} + 1)$ (c) $\sqrt{5}(\sqrt{5} - 1)$ (d) $\sqrt{2}(5 + \sqrt{2})$
(e) $\sqrt{2}(3 + \sqrt{6})$ (f) $2\sqrt{3}(\sqrt{8} + 1)$ (g) $\sqrt{3}(\sqrt{6} - 2\sqrt{8})$ (h) $\sqrt{5}(\sqrt{5} + 2)$
(i) $4\sqrt{6}(2\sqrt{6} - \sqrt{8})$ (j) $\sqrt{8}(\sqrt{2} + 4)$ (k) $2\sqrt{12}(\sqrt{3} + \sqrt{6})$ (l) $\sqrt{5}(\sqrt{200} + \sqrt{50})$

5. Expand and simplify:

(a) $(\sqrt{2} + 3)(\sqrt{2} - 1)$ (b) $(\sqrt{5} + 1)(2\sqrt{5} - 4)$ (c) $(2\sqrt{2} + 3)(\sqrt{2} + 4)$
(d) $(\sqrt{3} + 1)(\sqrt{3} - 1)$ (e) $(2 + \sqrt{5})(2 - \sqrt{5})$ (f) $(\sqrt{3} + \sqrt{2})(\sqrt{3} - \sqrt{2})$
(g) $(\sqrt{2} - 4)(3\sqrt{2} - 1)$ (h) $(\sqrt{8} + 2)(\sqrt{8} + 1)$ (i) $(2\sqrt{3} + \sqrt{2})(\sqrt{3} + 3\sqrt{2})$
(j) $(\sqrt{2} + 3)^2$ (k) $(\sqrt{2} + \sqrt{3})^2$ (l) $(2\sqrt{3} - 1)^2$
(m) $(2\sqrt{7} - \sqrt{2})^2$ (n) $(5 - 2\sqrt{3})^2$

6. Express each of the following with a *rational denominator*.

(a) $\frac{1}{\sqrt{2}}$ (b) $\frac{1}{\sqrt{3}}$ (c) $\frac{1}{\sqrt{5}}$ (d) $\frac{6}{\sqrt{3}}$ (e) $\frac{10}{\sqrt{5}}$ (f) $\frac{2}{\sqrt{3}}$ (g) $\frac{3}{\sqrt{5}}$
(h) $\frac{20}{\sqrt{2}}$ (i) $\frac{3}{2\sqrt{5}}$ (j) $\frac{4}{5\sqrt{2}}$ (k) $\frac{2}{3\sqrt{2}}$ (l) $\frac{12}{5\sqrt{6}}$ (m) $\frac{\sqrt{4}}{\sqrt{3}}$ (n) $\frac{\sqrt{5}}{\sqrt{2}}$
(o) $\frac{\sqrt{8}}{3\sqrt{2}}$ (p) $\frac{2\sqrt{3}}{3\sqrt{2}}$ (q) $\frac{1}{\sqrt{50}}$ (r) $\frac{10}{\sqrt{12}}$ (s) $\frac{4}{\sqrt{8}}$ (t) $\frac{3\sqrt{2}}{\sqrt{24}}$ (u) $\frac{2\sqrt{3}}{\sqrt{54}}$

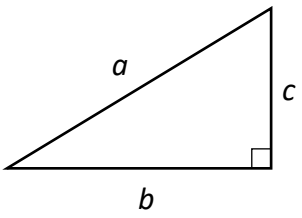
7. (extension) Rationalise the denominator, in each fraction, using the appropriate conjugate surd.

(*a*) $\frac{1}{\sqrt{2}-1}$ (*b*) $\frac{4}{\sqrt{5}+1}$ (*c*) $\frac{12}{2-\sqrt{3}}$ (*d*) $\frac{2-\sqrt{3}}{2+\sqrt{3}}$

(*e*) $\frac{1}{\sqrt{3}-\sqrt{2}}$ (*f*) $\frac{2}{\sqrt{5}+\sqrt{3}}$ (*g*) $\frac{\sqrt{2}}{\sqrt{5}+3}$ (*h*) $\frac{3\sqrt{2}}{\sqrt{8}+1}$

Surds 2

1. A right angled triangle has sides a, b and c as shown.
For each case below calculate the length of the third side, expressing your answer as a surd in its simplest form.



(a) Find a if $b = 6$ and c = 3. (b) Find c if $a = 2$ and $b = 1$.

(c) Find c if $a = 18$ and $b = 12$ (d) Find b if $a = 2\sqrt{8}$ and $c = 2\sqrt{6}$.

2. Given that $x = 1 + \sqrt{2}$ and $y = 1 - \sqrt{2}$, simplify:

(a) $5x + 5y$ (b) $2xy$ (c) $x^2 + y^2$ (d) $(x + y)(x - y)$

3. Given that $p = \sqrt{5} + \sqrt{3}$ and $q = \sqrt{5} - \sqrt{3}$, simplify:

(a) $2p - 2q$ (b) $4pq$ (c) $p^2 - q^2$

4. A rectangle has sides measuring $(2 + \sqrt{2})$ cm and $(2 - \sqrt{2})$ cm.

Calculate the exact value of i) its area; ii) the length of a diagonal.

5. A curve has as its equation $y = 2 + \frac{1}{2}x^2$.

(a) If the point P($\sqrt{2}$, k) lies on this curve find the exact value of k.

(b) Find the exact length of OP where O is the origin.

6. In ΔABC, AB = AC = 12cm and BC = 8cm. Express the length of the altitude from A to BC as a surd in its simplest form.

7. An equilateral triangle has each of its sides measuring $2a$ metres.

(a) Find the exact length of an altitude of the triangle in terms of a.

(b) Hence find the exact area of the triangle in terms of a.

8. The exact area of a rectangle is $2(\sqrt{6} + \sqrt{3})$ square centimetres. Given that the breadth of the rectangle is $\sqrt{6}$ cm, show that the length is equal to $(2 + \sqrt{2})$ cm.

9. (extension) Express $\dfrac{6}{\sqrt{7} + 1}$ in the form $a + b\sqrt{c}$.

10. (extension) Given that $\tan 75^\circ = \dfrac{\sqrt{3} + 1}{\sqrt{3} - 1}$, show that $\tan 75^\circ = 2 + \sqrt{3}$.

Indices

You must be aware of the laws of indices and all the other information shown in this box to successfully complete this worksheet

$x^a \times x^b = x^{a+b}$, $x^a \div x^b = x^{a-b}$, $(x^a)^b = x^{ab}$

$(xy)^n = x^n y^n$, $x^{-a} = \frac{1}{x^a}$, $x^{\frac{m}{n}} = \sqrt[n]{x^m}$, $x^0 = 1$

1. Simplify the following expressing your answers with positive indices.

(a) $y \times y \times y$ (b) $p \times p \times p \times p \times q \times q$ (c) $a \times a \times b \times b \times a$ (d) $2^3 \times 2^4$

(e) $p^3 \times p^7$ (f) $a^3 \times a^{-4}$ (g) $3 \times y^2 \times 2 \times y$ (h) $2 \times a^2 \times b^3 \times a^{-1}$

(i) $y^4 \div y^2$ (j) $4r^8 \div 2r^3$ (k) $d^4 \div d^{-3}$ (l) $a^0 \times 6a^3 \div 2a^{-2}$

(m) $\frac{h^5}{h^2}$ (n) $\frac{10e^{-3}}{5e^3}$ (o) $\frac{2p^{-2}}{p^{-6}}$ (p) $\frac{a^2 \times 2a^5}{a^4}$ (q) $\frac{w \times w \times w}{p^2 w^4}$ (r) $\frac{3a^4b^3}{6a^2b^5}$

2. Simplify the following expressing your answers with positive indices.

(a) $(3^2)^5$ (b) $(4^{-3})^2$ (c) $(a^3)^7$ (d) $(p^4)^{-3}$ (e) $(d^{-5})^{-2}$

(f) $(a^{\frac{1}{4}})^8$ (g) $(y^{\frac{2}{3}})^{\frac{3}{4}}$ (h) $2(p^{\frac{4}{5}})^{-\frac{5}{2}}$ (i) $3(c^{-2})^0$ (j) $(k^{-\frac{1}{3}})^{-\frac{2}{5}}$

(k) $(ab)^3$ (l) $(xy^2)^4$ (m) $(2m^3)^3$ (n) $(2xy^2)^4$ (o) $3(a^2b^4)^{\frac{1}{2}}$

3. Express without root signs.

(a) $\sqrt[4]{a}$ (b) $\sqrt{p^3}$ (c) $\sqrt[3]{x^5}$ (d) $\sqrt[5]{r^2}$ (e) $\sqrt[a]{b^3}$ (f) $\sqrt[3]{h^2}$

4. Express with root signs (write with positive indices first where necessary).

(a) $p^{\frac{1}{5}}$ (b) $w^{\frac{3}{4}}$ (c) $x^{\frac{1}{2}}$ (d) $a^{-\frac{3}{4}}$ (e) $y^{-\frac{1}{5}}$ (f) $q^{-\frac{4}{3}}$

5. Evaluate each of the following without the use of a calculator.

(a) $25^{\frac{1}{2}}$ (b) $8^{\frac{1}{3}}$ (c) $4^{-\frac{1}{2}}$ (d) $16^{-\frac{1}{4}}$ (e) 13^0 (f) 7^{-1}

(g) $16^{\frac{3}{2}}$ (h) $27^{\frac{2}{3}}$ (i) $8^{-\frac{4}{3}}$ (j) $(-8)^{\frac{1}{3}}$ (k) $64^{\frac{2}{3}}$ (l) $100^{-\frac{3}{2}}$

(m) $(\frac{1}{2})^{-1}$ (n) $(\frac{1}{8})^{\frac{4}{3}}$ (o) $(\frac{2}{3})^3$ (p) $(\frac{1}{2})^{-5}$ (q) $(\frac{3}{4})^{-2}$ (r) $(\frac{8}{27})^{-\frac{4}{3}}$

6. Simplify each of the following by …. i) changing root signs to fractional powers;
ii) moving x's onto the numerators;
iii) expanding brackets …… where necessary.

(a) $x^{\frac{1}{2}}(x^4+1)$ (b) $x^{-\frac{1}{2}}(x^{\frac{3}{2}}-x^2)$ (c) $\frac{1}{x^2}\left(x^{\frac{1}{2}}+x\right)$

(d) $\frac{2}{x^{-3}}\left(x^2+\frac{1}{x}\right)$ (e) $\frac{1}{\sqrt{x}}\left(x^2-\sqrt{x}\right)$ (f) $\left(x^2+\frac{1}{x}\right)^2$

(g) $\frac{1}{x}\left(\sqrt{x}+x\right)$ (h) $\left(x+\frac{1}{\sqrt{x}}\right)^2$ (i) $x^{-2}\left(\frac{1}{x}-\sqrt[3]{x}\right)$

(j) $\frac{x^2+3}{x}$ (k) $\frac{\sqrt{x}\ -\ x}{x^2}$ (l) $\frac{(2x+1)^2}{x^{\frac{3}{2}}}$

ANSWERS

Scientific Notation

1. (a) $1\cdot2 \times 10^{3}$ (b) $4\cdot125 \times 10^{6}$ (c) $2\cdot25 \times 10^{2}$ (d) $6\cdot7 \times 10^{4}$
   (e) 9×10^{0} (f) $4\cdot1 \times 10^{7}$ (g) $9\cdot2 \times 10^{1}$ (h) $2\cdot4 \times 10^{11}$

2. (a) 5000000 , 5×10^{6} (b) 32000 , $3\cdot2 \times 10^{4}$
   (c) 52100000 , $5\cdot21 \times 10^{7}$ (d) 243000 , $2\cdot43 \times 10^{5}$

3. (a) $5\cdot7 \times 10^{-2}$ (b) $2\cdot1 \times 10^{-3}$ (c) $8\cdot4 \times 10^{-1}$ (d) $9\cdot15 \times 10^{-9}$
   (e) 7×10^{-4} (f) $8\cdot004 \times 10^{-2}$ (g) $1\cdot2 \times 10^{-6}$ (h) 6×10^{-1}

4. (a) 160000 (b) 2780 (c) 122000000 (d) 40000
   (e) $200\cdot3$ (f) $5\cdot7$ (g) $0\cdot006$ (h) $0\cdot00000452$
   (i) $0\cdot0001003$ (j) $0\cdot000072$ (k) $0\cdot23$ (l) $0\cdot0060004$

5. (a) 6×10^{8} (b) 8×10^{-2} (c) $1\cdot5 \times 10^{7}$ (d) 6×10^{5}
   (e) $1\cdot8 \times 10^{-2}$ (f) 5×10^{6} (g) $3\cdot2 \times 10^{4}$ (h) $1\cdot39 \times 10^{5}$
   (i) 9×10^{-6}

6. (a) $6\cdot66 \times 10^{8}$ miles (b) $4\cdot05 \times 10^{4}$ km (c) $2\cdot94 \times 10^{9}$ times
   (d) 2×10^{7} drops (e) 3×10^{30} atoms

Similarity 1

1. (a) i) $k = \frac{3}{2}$ *or* $1\cdot5$ ii) $13\cdot5$ *cm* (b) i) $k = \frac{2}{3}$ *or* $0\cdot666..$ ii) 20 *cm*
   (c) i) $k = \frac{5}{2}$ *or* $2\cdot5$ ii) 45 *cm* (d) i) $k = \frac{3}{5}$ *or* $0\cdot6$ ii) 168 *mm*

2. (a) 88 cm^2 (b) 166 mm^2 (c) 49cm^2 (d) 72 mm^2

3. (a) 1200 ml (b) 270 ml (c) $6\cdot75$ litres

Similarity 2

1. (a) $x = 30$mm (b) $x = 32\cdot5$cm

2. (a) Because they are equiangular (b) CD = 18cm (c) 81 cm^2

3. (a) $x = 13\cdot5$cm (b) $x = 14\cdot4$mm

4. ST = 16cm

5. distance = $0 \cdot 7$ m

Positive & Negative Numbers

1. (a) -3 (b) 5 (c) 2 (d) -5
   (e) -9 (f) -5 (g) -4 (h) -7
   (i) 6 (j) -3 (k) 2 (l) 0

2. *(a)* $-3x$ *(b)* $-2a$ (c) $3x$ (d) $-3p$
   (e) $5e$ (f) $-4d$ (g) $2h$ (h) $-10a$
   (i) $6k$ (j) $-2p$ (k) $-2m$ (l) $3y$

3. (a) -30 (b) 14 (c) -12 (d) -16
   (e) $-5a$ (f) $-24p$ (g) $-14y$ (h) $27d^2$

4. (a) $x = -2$ (b) $t = -5$ (c) $m = -1$
   (d) $y = 1$ (e) $a = -2$ (f) $d = 0$
   (g) $y = -8$ (h) $a = 4$ (i) $d = -2$
   (j) $h = -3$ (k) $p = 1$ (l) $x = 1$
   (m) $p = -7$ (n) $h = -3$ (o) $x = -8$
   (p) $y = 4$ (q) $k = -9$ (r) $a = -3$

5. (a) -2 (b) 6 (c) 1 (d) -8
   (e) 12 (f) -1 (g) -4 (h) 0
   (i) 2 (j) 16 (k) 27 (l) 64
   (m) -5 (n) 5 (o) 6 (p) 16

6. (a) -2 (b) 3 (c) -2 (d) -3
   (e) -1 (f) -1 (g) 4 (h) -10

Pythagoras 1

1. (a) $x = 9 \cdot 4$ (b) $x = 21 \cdot 3$ (c) $x = 13$

   (d) $x = 10 \cdot 2$ (e) $x = 1 \cdot 1$ (f) $x = 5 \cdot 1$

   (g) $x = 12 \cdot 4$ (h) $x = 26 \cdot 9$ (i) $x = 2 \cdot 4$

2. (a) BD = 10

   (b) BC = $15 \cdot 6$

   (c) Area = 180 cm^2

3. (a) 21 or $21 \cdot 1$cm

   (b) Area $\approx$ 357 cm^2

4. (a) $7 \cdot 1$ (b) $12 \cdot 5$

   (c) $8 \cdot 1$ (d) $10 \cdot 2$

Pythagoras 2

1. (a) $11 \cdot 7$ cm (b) $12 \cdot 7$

2. (a) 20 cm (b) 15 cm

3. (i) Yes (ii) No (iii) Yes

4. (a) 15 cm (b) 16 cm (c) Proof (d) BC = 10 cm , Area = 225 cm^2

Pythagoras 3

1. $19 \cdot 2$ km
2. $427 \cdot 2$ km
3. $9 \cdot 6$ km
4. $7 \cdot 9$ km
5. $15 \cdot 6$ mm
6. $16 \cdot 6$ cm
7. $4 \cdot 6$ m
8. $4 \cdot 4$ m
9. 16 cm
10. $6 \cdot 6$ cm
11. P = $16 \cdot 9$ m
12. $1 \cdot 9\,(2)$ m

Brackets & Equations 1

1.

a)	$3c+15$	*b*)	$2w-8$	*c*)	$6f+2$	*d*)	$3t+24$
e)	$5g-15$	*f*)	$7w+7x$	*g*)	$6y-18$	*h*)	$7p+14q$
i)	$4+8y$	*j*)	$8p+72k$	*k*)	$5+10a$	*l*)	$28f+8g$
m)	$8+24e$	*n*)	$10+15w$	*o*)	h^2+2h	*p*)	a^2+5a
q)	c^2-5c	*r*)	e^2-2e	*s*)	$f+4f^2$	*t*)	$2t^2+8t$
u)	p^2+pq	*v*)	$3p^2+p$	*w*)	$5ah+5a^2$	*x*)	$3rp-6r^2$

2.

a)	$-4d-12$	*b*)	$-2x+6$	*c*)	$-5d-10$	*d*)	$-3a+12$
e)	$-7e^2-35e$	*f*)	$-9x-81$	*g*)	$-6p^2+42p$	*h*)	$-8k-56$
i)	$-3y+6y^2$	*j*)	$-7-42h$	*k*)	$-25v+10v^2$	*l*)	$-4p+32p^2$

3.

a)	$x=6$	*b*)	$p=3$	*c*)	$x=8$
d)	$p=2$	*e*)	$m=3$	*f*)	$v=2$
g)	$x=4$	*h*)	$y=5$	*i*)	$p=-6$
j)	$a=7$	*k*)	$a=1$	*l*)	$x=2$
m)	$m=-\frac{1}{3}$	*n*)	$y=\frac{3}{2}$	*o*)	$x=\frac{3}{12}=\frac{1}{4}$
p)	$x=-\frac{13}{2}$	*q*)	$p=\frac{7}{6}$	*r*)	$d=4$

4.

a)	$3a+3b+6c$	*b*)	$5x^2-10x+15$	*c*)	$a^2+ab-ac$
d)	$6p^2-2pq+2p$	*e*)	$-3y^2+6y-15$	*f*)	$-x^3-3x^2+x$

Brackets & Equations 2

1.

a)	$7a-3$	*b*)	$4x+2$	*c*)	$5b-6$
d)	$10g-2$	*e*)	$9-5y$	*f*)	$12c-3$
g)	$2h+4$	*h*)	$3ab+2a$	*i*)	$6-21m$
j)	$8y$	*k*)	$9a-6$	*l*)	$13-4p$
m)	$15y-4$	*n*)	$b+9$	*o*)	$14-10y$
p)	$-4x+15$	*q*)	$-3c+2$	*r*)	$11-12g$

2.

a)	x^2+4x+3	*b*)	y^2+4y+3	*c*)	$a^2+7a+10$
d)	b^2+6b+8	*e*)	$x^2+8x+12$	*f*)	s^2+7s+6
g)	$y^2+9y+20$	*h*)	$b^2+10b+24$	*i*)	$c^2+17c+72$
j)	$x^2-8x+15$	*k*)	x^2-5b+6	*l*)	$c^2-18c+45$
m)	$a^2-13a+36$	*n*)	$y^2-15y+56$	*o*)	x^2-2x+1
p)	$s^2-14s+49$	*q*)	$d^2-14d+24$	*r*)	$b^2-13b+22$

3.

a)	$x^2+3x-10$	*b*)	a^2-a-12	*c*)	$t^2-3t-18$
d)	$y^2+3y-28$	*e*)	$c^2-3c-10$	*f*)	x^2-4x-5
g)	$b^2+6b-27$	*h*)	$p^2-9p-10$	*i*)	y^2-y-42
j)	$z^2-4z-12$	*k*)	x^2-x-2	*l*)	a^2-1
m)	$c^2-2c-15$	*n*)	$p^2-5p-14$	*o*)	$b^2+6b-72$
p)	$x^2+3x-10$	*q*)	$a^2-3a-18$	*r*)	$t^2-5t-24$
s)	y^2-3y-4	*t*)	$c^2-6c-16$	*u*)	$x^2+3x-28$
v)	b^2+8b-9	*w*)	$p^2-7p-30$	*x*)	y^2+3y-4

4. *a*) $3x^2-18x+15$ *b*) $2a^2+6a+4$ *c*) $5t^2-28t+15$
d) $2y^2-16y+14$ *e*) $3c^2+23c+14$ *f*) $2x^2+9x+10$
g) $3b^2-11b+8$ *h*) $5p^2+16p+11$ *i*) $9y^2-36y+36$
j) $4z^2-10z-6$ *k*) $4x^2-4x-3$ *l*) $12a^2-a-1$
m) $2c^2-5c-12$ *n*) $5p^2+13p-28$ *o*) $7b^2+8b-12$
p) $6x^2-x-2$ *q*) $7a^2+13a+6$ *r*) $6t^2-22t-8$
s) $3y^2-4y+1$ *t*) $9c^2-4$ *u*) $9x^2-24x+7$
v) $8b^2+8b+2$ *w*) $2p^2+3p-9$ *x*) $14y^2-y-3$

5. *a*) x^2+2x+1 *b*) w^2-6w+9 *c*) $a^2-8a+16$ *d*) $c^2+12c+36$
e) $y^2-16y+64$ *f*) $a^2+14a+49$ *g*) b^2+4b+4 *h*) $k^2+18k+81$
i) $b^2-18b+81$ *j*) $x^2-20x+100$ *k*) c^2-2c+1 *l*) $y^2-10y+25$
m) $p^2-20p+100$ *n*) $c^2-24c+144$ *o*) $p^2-12p+36$ *p*) $x^2+8x+16$
q) $4g^2-4g+1$ *r*) $25y^2+30y+9$ *s*) $9q^2+12q+4$ *t*) $16a^2-8a+1$
u) $9y^2-36y+36$ *v*) $16h^2+8h+1$ *w*) $9x^2+24x+16$ *x*) $16b^2-40b+25$
y) $4d^2-32d+64$ *z*) $25a^2+40a+16$

Brackets & Equations 3

1.
a) $x=4$ *b*) $x=5$ *c*) $x=-3$ *d*) $x=-6$
e) $x=-3$ *f*) $x=31$ *g*) $x=0$ *h*) $x=-5$
i) $x=-1$ *j*) $x=-2$ *k*) $x=0$ *l*) $x=-3$
m) $x=2$ *n*) $x=-1$

2.
a) x^2+7x-8 *b*) $4x^2-x-3$ *c*) $4x^2+8x+5$
d) $-x^2-4$ *e*) $12x-3$ *f*) $-10x-19$
g) $2x^2-10x+8$ *h*) $5x^2-x+2$ *i*) $-4x^2+8x+21$
j) $3x^3+20x^2+21x$ *k*) $2x^3-x^2-2x+9$ *l*) $-x^3-x^2-3x+1$

3.
a) $x=5$ *b*) $x=7$ *c*) $x=4$ *d*) $x=2$
e) $x=1$ *f*) $x=1$ *g*) $x=-4$ *h*) $x=2$
i) $x=-5$ *j*) $x=-1$

Brackets & Equations 4

1. (a) i) $P = 4x + 12$ ii) $A = x^2 + 6x + 5$

   (b) 28 cm

2. (a) i) $P = 8x + 4$ ii) $A = 4x^2 + 4x - 15$

   (b) 153 cm^2

3. (a) $h^2 = 37a^2 + 6a + 9$

   (b) $h = 13$

4. (a) $h^2 = 5a^2 - 4a + 8$

   (b) $h = 15$

5. (a) $A = x^2 + 5x + 6$

   (b) $PQ = \sqrt{(5x^2 + 22x + 25)}$

6. (a) $P = 4y + 8$ (b) $A = y^2 + 4y - 5$ (c) $d = \sqrt{(2y^2 + 8y + 26)}$

7. (a) $P = 6x + 14$, $A = 2x^2 + 12x + 10$, $d = \sqrt{(5x^2 + 18x + 29)}$

   (a) $P = 8x + 4$, $A = 3x^2 + 8x - 3$, $d = \sqrt{(10x^2 + 10)}$

Statistics 1

1. (a) i) range = 6 ii) mean = 6

   (b) i) range = 66 ii) mean = 47

   (c) i) range = $18 \cdot 8$ ii) mean = $8 \cdot 9$

2. (a) median = 4 mode = 3 (b) median = 33 mode = 45

   (c) median = $6 \cdot 3$ mode = $6 \cdot 3$ (d) median = 24 mode = 24

   (e) median = $11 \cdot 5$ mode = 11 (f) median = $52 \cdot 5$ mode = 75

3. (a) $4 \cdot 9$ (b) $35 \cdot 4$ (c) $6 \cdot 0$ (d) $24 \cdot 5$ (e) $12 \cdot 3$ (f) $51 \cdot 5$

4. (a) 5 (b) $5 \cdot 5$

5. (a) 51kg (b) 50kg

6. (a) $28 \cdot 8$kg (b) $2 \cdot 3$kg

7. $5 \cdot 42$

8. 51 cm

9. (a) mean = $1 \cdot 71$ m , median = $1 \cdot 7$ m , mode = $1 \cdot 6$ m

   (b) $1 \cdot 6$ m

Statistics 2

1. Table 1 : mean = $72 \cdot 25$, median = 73 , mode = 73

   Table 2 : mean = $3 \cdot 65$, median = 4 , mode = 4

   Table 3 : mean = $7 \cdot 78$, median = 8 , mode = 8

2. mean = $1 \cdot 5$ m

3. (a) 23 cars (b) 2 (c) frequency table , mean = $2 \cdot 4$ occupants/car

4. (a) range = 6 goals (b) median = 2 goals , mode = 1 goal

   (c) 16% (d) frequency table , mean = $2 \cdot 12$ goals

5. A possible answer .....

x	3	4	5	6	7	8
frequency	1	2	2	3	5	2

Statistics 3

1. (a) median (Q_2) = 10 , Q_1 = 5 , Q_3 = 12 , S.I.R. = $3 \cdot 5$

   (b) median (Q_2) = 35 , Q_1 = 32 , Q_3 = 44 , S.I.R. = 6

   (c) median (Q_2) = $8 \cdot 5$, Q_1 = 5 , Q_3 = 9 , S.I.R. = 2

   (d) median (Q_2) = 42 , Q_1 = 34 , Q_3 = 58 , S.I.R. = 12

   (e) median (Q_2) = $20 \cdot 5$, Q_1 = $12 \cdot 5$, Q_3 = 29 , S.I.R. = $8 \cdot 25$

   (f) median (Q_2) = 30 , Q_1 = $25 \cdot 5$, Q_3 = 45 , S.I.R. = $9 \cdot 75$

2. (a) i) column completed ii) median (Q_2) = 8 , Q_1 = 7 , Q_3 = 15 iii) S.I.R. = 4

   (b) i) column completed ii) median (Q_2) = 10 , Q_1 = 9 , Q_3 = 12 iii) S.I.R. = $10 \cdot 5$

   (c) i) column completed ii) median (Q_2) = 52 , Q_1 = 51 , Q_3 = 54 iii) S.I.R. = $1 \cdot 5$

   (d) i) column completed ii) median (Q_2) = 123 , Q_1 = 122 , Q_3 = 124 iii) S.I.R. = 1

3. Pupils own drawings

4. All these answers are approximate: (a) median (Q_2) = 17 , Q_1 = 14 , Q_3 = $19 \cdot 5$, S.I.R. = $2 \cdot 75$

(b) median (Q_2) = 52 , Q_1 = 41 , Q_3 = 62 , S.I.R. = $10 \cdot 5$

Statistics 4

1. A = 2 B = 6 C = 8 D = 12 E = 17

2. (a) 6 hours and 22 hours

(b) 11 hours

(c) 50%

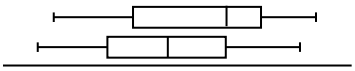
(d) range = 16 hours , S.I.R. = $4 \cdot 5$ hours

3. (a) i) L = 5 , Q_1 = 7 , Q_2 = 12 , Q_3 = 14 , H = 21 ii) boxplot iii) S.I.R. = $3 \cdot 5$

(b) i) L = 16 , Q_1 = 18 , Q_2 = 23 , Q_3 = 33 , H = 40 ii) boxplot iii) S.I.R. = $7 \cdot 5$

(c) i) L = 1 , Q_1 = 6 , Q_2 = 9 , Q_3 = 20 , H = 40 ii) boxplot iii) S.I.R. = 7

4. (a) June : L = 1 , Q_1 = 5 , Q_2 = 7 , Q_3 = 9 , H = 13
July : L = 2 , Q_1 = 6 , Q_2 = 9 , Q_3 = 11 , H = 15

(b) boxplot 

(c) June : range = 12 , S.I.R. = 2 July : range = 13 , S.I.R. = $3 \cdot 5$

(d) comments ..... (July's median higher also a bigger spread, etc.)

Trigonometry 1

1. (a) $x = 35 \cdot 7^\circ$ (b) $x = 46 \cdot 2^\circ$ (c) $x = 36 \cdot 0^\circ$

(d) $x = 58 \cdot 4^\circ$ (e) $x = 75 \cdot 0^\circ$ (f) $x = 34 \cdot 9^\circ$

2. (a) $x = 10 \cdot 9$ (b) $x = 9 \cdot 0$ (c) $x = 39 \cdot 8$

(d) $x = 10 \cdot 1$ (e) $x = 8 \cdot 2$ (f) $x = 6 \cdot 7$

3. (a) $p = 7 \cdot 8$ (b) $p = 14 \cdot 6$ (c) $p = 4 \cdot 2$

(d) $p = 86 \cdot 0$ (e) $p = 24 \cdot 8$ (f) $p = 36 \cdot 4$

Trigonometry 2

1. $a = 7 \cdot 5$ 2. $b = 48 \cdot 6^\circ$ 3. $c = 5 \cdot 4$ 4. $d = 7 \cdot 0$ 5. $e = 51 \cdot 3^\circ$

6. $f = 52 \cdot 9$ 7. $g = 34 \cdot 4$ 8. $h = 73 \cdot 3^\circ$ 9. $i = 23 \cdot 6$ 10. $j = 28 \cdot 1^\circ$

11. $k = 28 \cdot 7$ 12. $l = 40 \cdot 1^\circ$ 13. $m = 2 \cdot 1$ 14. $n = 5 \cdot 2$ 15. $o = 5 \cdot 2$

16. $p = 64 \cdot 6^\circ$ 17. $q = 8 \cdot 2$ $r = 55 \cdot 1^\circ$ 18. $s = 6 \cdot 7$ $t = 4 \cdot 7$ $u = 8 \cdot 2$

19 $v = 1 \cdot 7$ $w = 1 \cdot 4$ $x = 45 \cdot 6^\circ$

Trigonometry 3

1. (a) $5 \cdot 8$ cm (b) $25 \cdot 4$ cm (c) $11 \cdot 8$ mm

2. $34 \cdot 8$ cm

3. (a) 31^o - No (b) $21 \cdot 8^o$ - Yes

4. (a) DB = $15 \cdot 0$ mm (b) BC = $18 \cdot 3$ mm

5. AB = $2 \cdot 7$ m $\therefore \angle ACB = 32 \cdot 7^\circ$ $(32 \cdot 9^\circ)$ - It is a safe chute.

Trigonometry 4

1. 68.0° 2. 41.8° 3. 3.8 m 4. 11.7 m

5. 63.6° 6. 17.0 m 7. 15.6 m 8. 40.0°

9. 28.0 m 10. 88.8 cm 11. 4.4 cm

Simultaneous Equations 1

1. (a) $x = 2$, $y = 5$ (b) $a = 3$, $b = -2$ (c) $e = 6$, $f = 2$ (d) $x = -1$, $y = 3$

(e) $x = 2$, $y = -2$ (f) $p = -2$, $q = 3$ (g) $g = -4$, $h = 3$ (h) $x = 3$, $y = 4$

(i) $u = -2$, $v = -3$ (j) $x = 4$, $y = 1$ (k) $p = -5$, $q = 2$ (l) $a = 4$, $b = -2$

2. (a) $x = 2$, $y = 5$ (b) $a = 3$, $b = -1$ (c) $e = -2$, $f = 5$ (d) $x = -1$, $y = 4$

(e) $x = 3$, $y = 4$ (f) $p = -3$, $q = 4$ (g) $g = 8$, $h = -5$ (h) $x = 7$, $y = -2$

(i) $u = 2$, $v = -2$ (j) $x = 4$, $y = 1$ (k) $p = -1$, $q = 2$ (l) $a = 8$, $b = -2$

3. (a) (2,4) (b) (2,3) (c) (3,1) (d) (3,2)

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

Simultaneous Equations 2

1. 36 and 20 2. 18 and 4 3. 8 and 5

4. 9 and 2 5. (a) $x = 12$, $y = 3$ (b) 144 cm^2

6. (a) box = 6 kg , parcel = 2 kg (b) 58 kg 7. butter = 96p , milk = 24p

8. 38 hours 9. 320 cheaper tickets 10. 21 fifty pence coins

Area 1

(a) $38 \cdot 4\,cm^2$ (b) $52mm^2$ (c) $56cm^2$ (d) $113 \cdot 04\,m^2$

(e) $300mm^2$ (f) $234cm^2$ (g) $28m^2$ (h) $315cm^2$

(i) 42cm*2* (j) $16mm^2$ (k) $480cm^2$ (l) $140cm^2$

Area 2

1. $147\,cm^2$ 2. $55 \cdot 5\,cm^2$ 3. $616\,mm^2$

4. $40 \cdot 2\,m^2$ 5. $89 \cdot 2\,cm^2$ 6. $218 \cdot 5\,mm^2$

7. $154 \cdot 7\,cm^2$ 8. $176 \cdot 8\,mm^2$

Area 3

1. (a) $196 \cdot 8\,\text{cm}^2$ (b) $1538 \cdot 7\,\text{mm}^2$

2. (a) $686\,\text{cm}^2$ (b) $31 \cdot 4\,\%$

3. (a) $254 \cdot 3\,\text{cm}^2$ (b) $21 \cdot 5\,\%$

4. $1 \cdot 9\,\text{cm}^2$

5. (a) $496 \cdot 9\,\text{m}^2$ (b) $206 \cdot 3\,\text{m}^2$

6. 15

Factorisation

1. (a) $3\,(x-5)$ (b) $5\,(y+7)$ (c) $8\,(a+6)$ (d) $6\,(3+t)$
   (e) $x\,(x+9)$ (f) $y\,(3-y)$ (g) $b\,(b-4)$ (h) $p\,(5+p)$
   (i) $a\,(b+c)$ (j) $x\,(x-y)$ (k) $p\,(q-r)$ (l) $a\,(a+x)$
   (m) $4\,(2a+5)$ (n) $7\,(3y-4)$ (o) $2\,(12x+11)$ (p) $9\,(4c-7)$

2. (a) $2a\,(a+3)$ (b) $5x\,(x-8)$ (c) $10y\,(3-y)$ (d) $3t\,(t+6)$
   (e) $3x\,(2x-9)$ (f) $2y\,(7-5y)$ (g) $4b\,(3b-8)$ (h) $5x\,(5x+4)$

3. (a) $(a-3)(a+3)$ (b) $(x-2)(x+2)$ (c) $(p-9)(p+9)$ (d) $(c-5)(c+5)$
   (e) $(b-1)(b+1)$ (f) $(y-4)(y+4)$ (g) $(m-5)(m+5)$ (h) $(a-3)(a+3)$
   (i) $(6-d)(6+d)$ (j) $(2-q)(2+q)$ (k) $(7-w)(7+w)$ (l) $(x-8)(x+8)$
   (m) $(9-2g)(9+2g)$ (n) $(6w-y)(6w+y)$ (o) $(2a-1)(2a+1)$ (p) $(g-9h)(g+9h)$
   (q) $(7x-y)(7x+y)$ (r) $(3c-4d)(3c+4d)$ (s) $(2p-3q)(2p+3q)$ (t) $(b-10c)(b+10c)$

4. (a) $(b+3)(b+4)$ (b) $(x+9)(x+5)$ (c) $(s+3)(s+8)$ (d) $(y+7)(y+4)$
   (e) $(b+3)(b+3)$ (f) $(c+6)(c+7)$ (g) $(a+8)(a+4)$ (h) $(y+4)(y+2)$
   (i) $(x-1)(x-5)$ (j) $(c-4)(c-2)$ (k) $(y-3)(y-7)$ (l) $(b-6)(b-8)$
   (m) $(x-5)(x-2)$ (n) $(s-8)(s-5)$ (o) $(y-2)(y-9)$ (p) $(a-4)(a-4)$

5. (a) $(x-1)(x+5)$ (b) $(a+3)(a-7)$ (c) $(t-5)(t+4)$ (d) $(y+8)(y-4)$
   (e) $(c+2)(c-7)$ (f) $(x-6)(x+1)$ (g) $(b-2)(b+9)$ (h) $(p-10)(p+2)$
   (i) $(y-8)(y+7)$ (j) $(z+4)(z-6)$ (k) $(x+4)(x-7)$ (l) $(a+2)(a-15)$
   (m) $(c+5)(c-4)$ (n) $(p-7)(p+1)$ (o) $(b+10)(b-5)$ (p) $(x-3)(x+6)$

Changing the Subject

1. a. $x = y - 3$ b. $x = y + 5$ c. $x = y - a$ d. $x = y + b$
   e. $x = \frac{y}{3}$ f. $x = \frac{y}{10}$ g. $x = \frac{y}{k}$ h. $x = \frac{y}{a}$
   i. $x = y - 3p$ j. $x = y + 5t$ k. $x = \frac{y-1}{2}$ l. $x = \frac{y+7}{3}$
   m. $x = \frac{y-4a}{7}$ n. $x = \frac{y-3b}{4}$ o. $x = \frac{y-8}{10}$

2. a. $x = \frac{y-b}{a}$ b. $x = \frac{y-c}{m}$ c. $x = \frac{t+r}{s}$ d. $x = \frac{p-2r}{q}$
   e. $x = \frac{m+3n}{f}$ f. $x = \frac{a-b}{c}$ g. $x = \frac{h-k}{m}$ h. $x = \frac{d-3b}{c}$ i. $x = \frac{kc-g}{h}$

3. a. $l = \frac{P}{4}$ b. $I = \frac{V}{R}$ c. $T = \frac{S}{D}$ d. $b = \frac{A}{l}$ e. $d = \frac{C}{\pi}$
   f. $U = \frac{G}{T}$ g. $t = \frac{v-u}{a}$ h. $l = \frac{P-2b}{2}$ i. $y = \frac{H-5m}{x}$

4. a. $x = \frac{3}{y}$ b. $x = \frac{c}{d}$ c. $x = \frac{y}{m}$ d. $x = \frac{a+2}{s}$
   e. $x = \frac{z-1}{w}$ f. $x = \frac{b+c}{a}$ g. $x = 9a - 8$ h. $x = 2k + 5$
   i. $x = 3 - 4p$ j. $x = \frac{2}{y-1}$ k. $x = \frac{6}{z+7}$ l. $x = \frac{m}{h-k}$

5. a. $s = \frac{v^2 - u^2}{2a}$ b. $u = \sqrt{v^2 - 2as}$ c. $h = \frac{V}{\pi r^2}$
   d. $r = \sqrt{\frac{V}{\pi h}}$ e. $A = \pi r^2$ f. $a = \frac{(L-3)^2}{6}$
   g. $p = 4k^2 - 4$ h. $y = \frac{x^2 t}{4z}$ i. $b = \frac{x}{(2ar)^2}$
   j. $A = \sqrt{\frac{st}{(x-3y}}$ k. $x = \frac{R + 3A^2 y}{A^2}$ l. $n = \sqrt{1 - (na)^2}$
   m. $n = \frac{t}{t-d}$ n. $R = \frac{r_1 r_2}{r_1 + r_2}$

Gradient & Equation of a Line

1. (a) (i) $m = 2$ (ii) $m = -\frac{1}{2}$ (iii) $m = \frac{4}{3}$ (iv) $m = -\frac{1}{6}$ (v) $m = 1$

   (b) *zero* (0) , *undefined*

2. (a) $m = 2$ (b) $m = -4$ (c) $m = \frac{1}{5}$ (d) $m = -2$ (e) $m = 1$

   (f) $m = -\frac{3}{4}$ (g) $m = \frac{5}{3}$ (h) $m = -\frac{2}{5}$ (i) $m = -\frac{11}{7}$

3. Students own drawings.

4. (a) $m = 1$, (0,3) (b) $m = -2$, (0,-1) (c) $m = \frac{1}{2}$, (0,0)

   (d) $m = -\frac{1}{2}$, (0,2) (e) $m = -1$, (0,6) (f) $m = \frac{1}{2}$, (0,-2)

   (g) $m = \frac{1}{3}$, (0,4) (h) $m = -\frac{4}{5}$, (0,4) (i) $m = \frac{3}{2}$, (0,-6)

5. (a) $m = 1$, (0,-7) (b) $m = -5$, (0,3) (c) $m = \frac{3}{5}$, (0,-2)

   (d) $m = -4$, (0,0) (e) $m = -2$, (0,11) (f) $m = \frac{1}{2}$, $(0, -\frac{5}{2})$

   (g) $m = \frac{1}{3}$, (0,6) (h) $m = -\frac{3}{7}$, (0,3) (i) $m = \frac{4}{5}$, (0,-4)

6. (a) $y = 4x + 5$ (b) $y = -2x + 1$ (c) $y = \frac{3}{4}x - 3$

7. (a) $y = 3x - 5$ (b) $y = -4x + 16$ (c) $y = \frac{1}{2}x$

   (d) $y = -2x - 5$ (e) $y = \frac{1}{2}x + 7$ (f) $y = -\frac{1}{3}x + 1$

8. (a) $y = 2x - 5$ (b) $y = -4x + 13$ (c) $5y = x + 32$

   (d) $y = -2x + 1$ (e) $y = x + 6$ (f) $4y = -3x - 15$

   (g) $3y = 5x + 20$ (h) $5y = -2x + 14$ (i) $7y = -11x + 48$

Functions & Graphs 1

1. (a) 13 (b) -11 (c) -2 (d) $6a - 5$
2. (a) 8 (b) 20 (c) 13 (d) $p^2 + 4$
3. (a) 4 (b) 0 (c) 16 (d) $12 - 2m$
4. (a) $a^2 + 3a$ (b) $4p^2 + 6p$ (c) $m^2 + 5m + 4$ (d) $e^2 - 7e + 10$

5. (a) 0 (b) $9a^2 - 12a$ (c) $a^2 - 8a + 12$ (d) $4p^2 - 4p - 3$

6. (a) $x = 4$ (b) $x = -1$ (c) $x = 0 \cdot 4$ *or* $\frac{2}{5}$

7. (a) $t = 3$ (b) $t = 6$ (c) $t = -2$

8. (a) $a = \pm 5$ (b) $a = \pm 1$ (c) $a = \pm 4$

9. (a) i) 15 ii) 0 (b) $a^2 + 8a + 15$

10. (a) i) 9 ii) 39 (b) $t = 5 \cdot 5$ $(5\frac{1}{2})$ (c) $45 - 6p$

The Circle 1

1. (a) 12·6 cm (b) 34·2mm (c) 1·2m

2. (a) 28·6cm b) 62·2mm (c) 5·2m

3. (a) 50·2cm^2 (b) 239·3mm^2 (c) 1·2m^2

4. (a) 271·6m (b) 4465·8m^2

5. (a) 83·4cm (b) 150·7cm^2

6. (a) 1317·5cm^2 (b) 176·7cm

The Circle 2

1. (a) 9cm^2 (b) 96mm^2 (c) 2·3cm^2

2. (a) 8·1mm (b) 43·5cm (c) 2·5cm

3. (a) 17mm (b) 97·9cm (c) 5·2cm

4. (a) 13cm (b) 2·4cm^2

5. (a) 213cm (b) 2541cm^2

The Circle 3

1. (a) 29·4cm^2 (b) 90^o

2. 20^o

3. (a) 57·3^o (b) 89·6^o

   (c) 12·2cm (d) 4·8cm^2

4. 25·1m^2

The Circle 4

Exercise 1

1. 33^o 2. 28^o 3. 138^o

4. 86^o 5. 49^o, 49^o` 6. 40^o

7. 61^o 8. 36^o, 54^o

Exercise 2

1. 30^o 2. 65^o

3. 50^o 4. 45^o

Inequations

1. (a) $\{-2, -1, 0, 1\}$ (b) $\{2, 3, 4, 5\}$

   (c) $\{5\}$ (d) $\{-2, -1\}$

   (e) $\{-2, -1, 0\}$ (f) $\{1, 2, 3, 4, 5\}$

   (g) $\{-2, -1, 0, 1, 2\}$ (h) $\{1, 2, 3, 4, 5\}$

2. (a) $a \leq 3$ (b) $x > 1$

   (c) $p \geq 2$ (d) $k < -3$

   (e) $m \leq \frac{23}{3}$ $(7\frac{2}{3})$ (f) $y > -\frac{29}{10}$ $(-2\frac{9}{10})$

   (g) $h < \frac{6}{7}$ (h) $x > \frac{1}{5}$

3. (a) $a \geq 3$ (b) $x < 2$

   (c) $p \leq 2$ (d) $k > -2$

   (e) $d \geq \frac{38}{9}$ $(4\frac{2}{9})$ (f) $y < -\frac{10}{3}$ $(-3\frac{1}{3})$

   (g) $h > 0$ (h) $y < \frac{11}{9}$ $(1\frac{2}{9})$

   (i) $w < \frac{5}{4}$ - $(-1\frac{1}{4})$ (j) $d > 10$

4. $\{0, 1, 2, 3, 4, 5\}$

5. {0,1,2}

6. Jane must be younger than 11 years.

Trigonometry 5

1. (a) 11·3cm (b) 35·3°

2. (a) 13·4cm, 10cm (b) 36·7°

3. (a) 36·9° (b) 10m, 22·6°

4. (a) 23·3cm (b) 59° (c) (i) 17cm
(ii) 68·6°
(iii) 184·4cm^2

Solving Quadratic Equations 1

Exercise 1

(a)	-6, 0	(b)	0, 9	(c)	0, 1	(d)	-7, 0
(e)	-11, 0	(f)	0, 3	(g)	0, 7	(h)	0, 12
(i)	-5, 0	(j)	0, 6	(k)	$0, \frac{5}{2}$	(l)	$0, \frac{7}{2}$
(m)	$-\frac{5}{3}, 0$	(n)	$-\frac{4}{3}, 0$·	(o)	$-\frac{7}{6}, 0$	(p)	$0, \frac{5}{4}$
(q)	$0, \frac{9}{8}$	(r)	$-\frac{16}{9}, 0$	(s)	$0, \frac{5}{4}$	(t)	$0, \frac{9}{2}$

Exercise 2

(a)	-6, 6	(b)	-10, 10	(c)	-7, 7	(d)	-1, 1
(e)	-8, 8	(f)	-11, 11	(g)	$-\frac{5}{2}, \frac{5}{2}$	(h)	$-\frac{4}{3}, \frac{4}{3}$
(i)	$-\frac{8}{5}, \frac{8}{5}$	(j)	$-\frac{5}{3}, \frac{5}{3}$	(k)	$-\frac{1}{5}, \frac{1}{5}$	(l)	$-\frac{3}{2}, \frac{3}{2}$
(m)	$-\frac{12}{7}, \frac{12}{7}$	(n)	$-\frac{5}{6}, \frac{5}{6}$	(o)	$-\frac{1}{9}, \frac{1}{9}$	(p)	$-\frac{1}{2}, \frac{1}{2}$
(q)	$-\frac{3}{4}, \frac{3}{4}$	(r)	$-\frac{1}{4}, \frac{1}{4}$	(s)	$-\frac{5}{2}, \frac{5}{2}$	(t)	-3, 1

Exercise 3

(a)	4, 5	(b)	3, 9	(c)	1, 5	(d)	3, 5
(e)	-10, -4	(f)	-9, -1	(g)	-9 (twice)	(h)	-8, 6
(i)	-12, 5	(j)	-9, 4	(k)	-8, 7	(l)	-3, 7
(m)	-6, 12	(n)	-1, 8	(o)	$-\frac{7}{3}$, -1	(p)	$\frac{1}{2}$, 5
(q)	$\frac{1}{4}$, $\frac{7}{3}$	(r)	$\frac{7}{3}$, 4	(s)	$\frac{5}{2}$ (twice)	(t)	$-\frac{4}{3}$, $-\frac{2}{3}$
(u)	-5, $\frac{1}{3}$	(v)	$-\frac{3}{2}$, $\frac{4}{3}$	(w)	$-\frac{5}{4}$, $\frac{3}{2}$	(x)	-2, $\frac{9}{2}$
(y)	$-\frac{5}{6}$, $\frac{3}{2}$	(z)	$-\frac{7}{2}$, 4				

Solving Quadratic Equations 2

1.	(a)	-5, 1	(b)	-5, -1	(c)	-3, 4
	(d)	-4, 7	(e)	1, 9	(f)	5, -3
	(g)	-3, 3	(h)	-1, 1	(i)	-3, $-\frac{1}{2}$
	(j)	-1, $-\frac{2}{3}$	(k)	-3, 3	(l)	$-\frac{2}{3}$, $\frac{1}{2}$
	(m)	-6, 12	(n)	$-\frac{3}{2}$, $\frac{3}{2}$	(o)	$-\frac{7}{3}$, -1
	(p)	$-\frac{5}{2}$, 2	(q)	$-\frac{2}{3}$, $\frac{2}{3}$	(r)	$\frac{7}{3}$, 4
	(s)	$-\frac{2}{3}$ (twice)	(t)	-2, $\frac{3}{4}$	(u)	$\frac{1}{4}$, $\frac{2}{3}$
	(v)	$-\frac{3}{2}$, $\frac{4}{3}$	(w)	$\frac{2}{3}$, $\frac{3}{2}$	(x)	$-\frac{1}{5}$, $\frac{1}{5}$
	(y)	$-\frac{2}{5}$, $\frac{3}{4}$	(z)	$-\frac{1}{2}$, $\frac{4}{3}$		
2.	(a)	-3·7, -0·3	(b)	-5·2, -0·8	(c)	-6·2, -0·8
	(d)	-3·3, 0·3	(e)	0·6, 5·4	(f)	-1·3, 5·8
	(g)	-1·7, 1·2	(h)	-0·9, 2·3	(i)	-0·9, -5·1
	(j)	0·3, 2·7	(k)	-1·5, 1·1	(l)	-0·6, 0·2

3. (a) -0·59, -3·4 (b) -6·32, 0·32 (c) -2·41, 0·41

(d) -7·61, 0·39 (e) -0·61, 6·61 (f) 2·13, 9·87

(g) -2·58, 0·58 (h) 0·78, 3·22 (i) -5·37, 0·37

4. (a) -5,2 (b) -0·65, 4·65 (c) -0·45, 4·45

(d) -2, 3 (e) -2, 3 (f) -1, 2

Solving Quadratic Equations 3

1. (a) $(x + 7)^2 + x^2 = 13^2$, 5 (b) 34cm

2. 9 $54cm^2$

3. 10 $120cm^2$

4. (a) $80 - x$ (b) $x(80 - x) = 1500$ 30, 50 Dimensions are 30m x 50m

5. (a) $130 - x$ (b) $x(130 - x) = 4000$ 80m/50m

6. 5m, 16m

7. (a) $2·5 - d$ (b) proof (c) 0·5

Standard Deviation

1. (a) 32, 12 (b) Mean of second sample is slightly lower but the heights are closer together.

2. (a) 4·8, 0·19 (b) Second sample is less consistent than the first.

3. (a) 38, 7·22 (b) 1

4. (a) 62·4, 1·89 (b) 2

Equations Involving Fractions 1

1. (a) 24 (b) 4 (c) 12 (d) 15

(e) 6 (f) $\frac{21}{8}$ (g) $\frac{4}{5}$ (h) $\frac{12}{35}$

(i) 5 (j) 3 (k) $\frac{4}{3}$ (l) 16

(m) 2 (n) 12 (o) 10 (p) $\frac{45}{8}$

2. (a) 16 (b) 2 (c) 6

(d) 8 (e) 15 (f) 10

(g) 16 (h) 24 (i) 6

(j) $\frac{20}{3}$ (k) $\frac{20}{7}$ (l) $\frac{5}{4}$

(m) $\frac{40}{9}$ (n) $\frac{6}{5}$ (o) $\frac{30}{7}$

(p) $\frac{7}{5}$ (q) -12 (r) 3

(s) -16 (t) 4 (u) $\frac{15}{4}$

3. (a) 3 (b) 1 (c) 6

(d) $\frac{1}{2}$ (e) -4 (f) 2

(g) -2 (h) $\frac{1}{3}$ (i) $\frac{9}{5}$

Equations Involving Fractions 2

1. (a) 20 (b) 6 (c) 14

(d) $\frac{-1}{16}$ (e) $\frac{-11}{18}$ (f) $\frac{47}{48}$

(g) $\frac{-1}{12}$ (h) $\frac{25}{36}$ (i) $\frac{124}{45}$

2. (a) 3 (b) 6 (c) 7

(d) 10 (e) 7 (f) $\frac{59}{5}$

(g) -1 (h) 12 (i) 8 (j) 14

3. (a) 28 (b) 24 (c) 10 (d) 8

4. 38 litres 5. 12 6. 28 cm.

Fractional Expressions

1. (a) $\frac{2}{a}$ (b) $\frac{5x}{6y}$ (c) $\frac{v}{3t}$ (d) $\frac{5b^2}{a}$

(e) $\frac{3b^2}{4a}$ (f) $\frac{k}{7m^2}$ (g) $\frac{1}{2eg}$ (h) $\frac{7y^2}{12x^2}$

2. (a) $\frac{ab}{2}$ (b) $\frac{3b}{2}$ (c) $8x$ (d) $\frac{3p}{2q}$

(e) $\frac{ab}{2}$ (f) $\frac{3}{4xy}$ (g) $\frac{3x}{5y}$ (h) $\frac{7mn}{2}$

(i) $4b$ (j) $\frac{2}{3}$ (k) $\frac{1}{3y}$ (l) 4

(m) $\frac{10}{r}$ (n) $\frac{1}{4e}$

3. (a) $\frac{3a+2b}{6}$ (b) $\frac{5k-4m}{20}$ (c) $\frac{x+2y}{3}$ (d) $\frac{9h-k}{12}$

(e) $\frac{3b+a}{ab}$ (f) $\frac{4y-2x}{xy}$ (g) $\frac{5e+3d}{3de}$ (h) $\frac{2g-f}{5fg}$

(i) $\frac{14c+3b}{4bc}$ (j) $\frac{15x+16w}{10xw}$ (k) $\frac{yz+2xz-xy}{xyz}$ (l) $\frac{3bc+4ac+18ab}{6abc}$

4. (a) $\frac{3x+7}{6}$ (b) $\frac{7a+10}{12}$ (c) $\frac{2d-11}{6}$ (d) $\frac{6a-13}{12}$

(e) $\frac{3a+4b}{4}$ (f) $\frac{5u+7v}{12}$ (g) $\frac{3a+3}{2b}$ (h) $\frac{11x-y}{6x}$

(i) $\frac{2p+12q}{15p}$

Surds 1

1. (a) $2\sqrt{2}$ (b) $2\sqrt{3}$ (c) $5\sqrt{2}$ (d) $2\sqrt{5}$ (e) $2\sqrt{6}$ (f) $6\sqrt{3}$

(g) $2\sqrt{15}$ (h) $6\sqrt{2}$ (i) $10\sqrt{3}$ (j) $3\sqrt{3}$ (k) $4\sqrt{6}$ (l) $4\sqrt{3}$

(m) $3\sqrt{5}$ (n) $7\sqrt{2}$ (o) $10\sqrt{2}$ (p) $12\sqrt{2}$ (q) $10\sqrt{10}$ (r) $4\sqrt{3}$

(s) $12\sqrt{2}$ (t) $6\sqrt{6}$ (u) $9\sqrt{3}$

2. (a) $8\sqrt{2}$ (b) $2\sqrt{7}$ (c) $3\sqrt{3}$ (d) $4\sqrt{6}$ (e) $7\sqrt{2}$ (f) $3\sqrt{3}$

(g) $9\sqrt{5}$ (h) $4\sqrt{2}$ (i) $3\sqrt{2}$ (j) $9\sqrt{3}$ (k) $10\sqrt{3}$ (l) $7\sqrt{5}$

3. (a) 5 (b) 2 (c) $\sqrt{15}$ (d) $2\sqrt{3}$ (e) $3\sqrt{2}$ (f) $\sqrt{(xy)}$

(g) 4 (h) 6 (i) 30 (j) $6\sqrt{14}$ (k) 24 (l) $3\sqrt{10}$

(m) $18\sqrt{2}$ (n) $16\sqrt{6}$ (o) $15\sqrt{15}$ (p) 32

4. (a) $\sqrt{2} - 2$ (b) $3 + \sqrt{3}$ (c) $5 - \sqrt{5}$ (d) $5\sqrt{2} + 2$

(e) $3\sqrt{2} + 2\sqrt{3}$ (f) $4\sqrt{6} + 2\sqrt{3}$ (g) $3\sqrt{2} - 4\sqrt{6}$ (h) $5 + 2\sqrt{5}$

(i) $48 - 16\sqrt{3}$ (j) $4 + 8\sqrt{2}$ (k) $12 + 12\sqrt{2}$ (l) $15\sqrt{10}$

5. (a) $2\sqrt{2} - 1$ (b) $6 - 2\sqrt{5}$ (c) $11\sqrt{2} + 16$ (d) 2

(e) -1 (f) 1 (g) $10 - 13\sqrt{2}$ (h) $10 + 3\sqrt{8}$

(i) $12 + 7\sqrt{6}$ (j) $11 + 6\sqrt{2}$ (k) $5 + 2\sqrt{6}$ (l) $13 - 4\sqrt{3}$

(m) $30 - 4\sqrt{14}$ (n) $37 - 20\sqrt{3}$

6. (a) $\frac{\sqrt{2}}{2}$ (b) $\frac{\sqrt{3}}{3}$ (c) $\frac{\sqrt{5}}{5}$ (d) $2\sqrt{3}$

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

(i) $\frac{3\sqrt{5}}{10}$ (j) $\frac{2\sqrt{2}}{5}$ (k) $\frac{\sqrt{2}}{3}$ (l) $\frac{2\sqrt{6}}{5}$

(m) $\frac{2\sqrt{3}}{3}$ (n) $\frac{\sqrt{10}}{2}$ (o) $\frac{2}{3}$ (p) $\frac{\sqrt{6}}{3}$

(q) $\frac{\sqrt{2}}{10}$ (r) $\frac{5\sqrt{3}}{3}$ (s) $\sqrt{2}$ (t) $\frac{\sqrt{3}}{2}$ (u) $\frac{\sqrt{2}}{3}$

7. (a) $\sqrt{2} + 1$ (b) $\sqrt{5} - 1$ (c) $12(2 + \sqrt{3})$ (d) $7 - 4\sqrt{3}$

(e) $\sqrt{3} + \sqrt{2}$ (f) $\sqrt{5} - \sqrt{3}$ (g) $\frac{\sqrt{2}(\sqrt{5}-3)}{-4}$ (h) $\frac{12-3\sqrt{2}}{7}$

Surds 2

1. (a) $3\sqrt{5}$ (b) $\sqrt{3}$ (c) $6\sqrt{5}$ (d) $2\sqrt{2}$

2. (a) 10 (b) -2 (c) 6 (d) $4\sqrt{2}$

3. (a) $4\sqrt{3}$ (b) 8 (c) $4\sqrt{15}$

4. (i) 2 (ii) $2\sqrt{3}$

5. (a) 3 (b) $\sqrt{11}$

6. $8\sqrt{2}$

7. (a) $\sqrt{3}a$ (b) $\sqrt{3}a^2$

8. Proof. 9. $-1 + \sqrt{7}$ 10. Proof.

Indices

1. (a) y^3 (b) p^4q^2 (c) a^3b^2 (d) 2^7 (e) p^{10} (f) a^{-1}

(g) $6y^3$ (h) $2ab^3$ (i) y^2 (j) $2r^5$ (k) d^7 (l) $3a^5$

(m) h^3 (n) $\frac{2}{e^6}$ (o) $2p^4$ (p) $2a^3$ (q) $\frac{1}{wp^2}$ (r) $\frac{a^2}{2b^2}$

2. (a) 3^{10} (b) $\frac{1}{4^6}$ (c) a^{21} (d) $\frac{1}{p^{12}}$ (e) d^{10} (f) a^2

(g) $y^{\frac{1}{2}}$ (h) $\frac{2}{p^2}$ (i) 3 (j) $k^{\frac{2}{15}}$ (k) a^3b^3 (l) x^4y^8

(m) $8m^9$ (n) $16x^4y^8$ (o) $3ab^2$

3. (a) $a^{\frac{1}{4}}$ (b) $p^{\frac{3}{2}}$ (c) $x^{\frac{5}{3}}$ (d) $r^{\frac{2}{5}}$ (e) $b^{\frac{3}{a}}$ (f) $h^{\frac{2}{3}}$

4. (a) $\sqrt[5]{p}$ (b) $\sqrt[4]{w^3}$ (c) $\sqrt{x}$ (d) $\frac{1}{\sqrt[4]{a^3}}$ (e) $\frac{1}{\sqrt[5]{y}}$ (f) $\frac{1}{\sqrt[3]{q^4}}$

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

(g) 64 (h) 9 (i) $\frac{1}{16}$ (j) -2 (k) 16 (l) $\frac{1}{1000}$

(m) 2 (n) $\frac{1}{16}$ (o) $\frac{8}{27}$ (p) 32 (q) $\frac{16}{9}$ (r) $\frac{81}{16}$

6. (a) $x^{\frac{9}{2}} + x^{\frac{1}{2}}$ (b) $x - x^{\frac{3}{2}}$ (c) $x^{\frac{-3}{2}} + x^{-1}$ (d) $2x^5 + 2x^2$

(e) $x^{\frac{3}{2}} - 1$ (f) $x^4 + 2x + x^{-2}$ (g) $x^{\frac{-1}{2}} + 1$ (h) $x^2 + 2x^{\frac{1}{2}} + x^{-1}$

(i) $x^{-3} - x^{\frac{-5}{3}}$ (j) $x + 3x^{-1}$ (k) $x^{\frac{-3}{2}} - x^{-1}$ (l) $4x^{\frac{1}{2}} + 4x^{\frac{-1}{2}} + x^{\frac{-3}{2}}$