Addition and Subtraction of Fractions (Without Calculator)

1. Calculate the following, showing all you working clearly (leave your answers as 'improper fractions' where necessary and write them in their lowest form).

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

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

(g) $\frac{1}{4}+\frac{5}{6}$ (h) $\frac{7}{8}+\frac{3}{4}$ (i) $\frac{1}{5}+\frac{3}{10}$

2. Calculate the following, showing all you working clearly (leave your answers as 'proper fractions' where necessary and write them in their lowest form).

(a) $2\frac{1}{7}+3\frac{1}{4}$ (b) $1\frac{1}{3}+2\frac{1}{5}$ (c) $3\frac{2}{5}+1\frac{3}{7}$

(d) $4\frac{1}{5}+2\frac{1}{4}$ (e) $3\frac{1}{3}+4\frac{2}{11}$ (f) $1\frac{2}{3}+1\frac{5}{6}$

3. Calculate the following, showing all you working clearly (leave your answers as 'improper fractions' where necessary and write them in their lowest form).

(a) $\frac{3}{4}-\frac{2}{3}$ (b) $\frac{5}{6}-\frac{1}{3}$ (c) $\frac{1}{3}-\frac{1}{6}$

(d) $\frac{3}{5}-\frac{1}{3}$ (e) $\frac{3}{7}-\frac{2}{9}$ (f) $\frac{5}{7}-\frac{4}{11}$

(g) $\frac{3}{7}-\frac{2}{5}$ (h) $\frac{3}{4}-\frac{1}{2}$ (i) $\frac{5}{6}-\frac{5}{12}$

4. Calculate the following, showing all you working clearly (leave your answers as 'improper fractions' where necessary and write them in their lowest form).

(a) $\frac{1}{4}+\frac{1}{2}$ (b) $\frac{1}{3}+\frac{5}{6}$ (c) $\frac{1}{5}+\frac{3}{10}$

(d) $\frac{1}{6}+\frac{1}{2}$ (e) $\frac{3}{4}+\frac{1}{5}$ (f) $\frac{1}{4}+\frac{2}{3}$

(g) $\frac{1}{12}+\frac{3}{4}$ (h) $\frac{5}{8}+\frac{1}{3}$ (i) $\frac{1}{7}+\frac{2}{5}$

5. Calculate the following, showing all you working clearly (leave your answers as 'proper fractions' and write them in their lowest form).

(a) $2\frac{1}{4}-1\frac{1}{3}$ (b) $3\frac{1}{2}-2\frac{1}{5}$ (c) $3\frac{2}{3}-2\frac{5}{6}$

(d) $7\frac{3}{7}-5\frac{2}{3}$ (e) $2\frac{3}{10}-1\frac{1}{5}$ (f) $4\frac{1}{7}-\frac{2}{5}$

(g) $4\frac{3}{5}-2\frac{3}{4}$ (h) $4\frac{1}{4}-3\frac{1}{2}$ (i) $5\frac{1}{11}-2\frac{7}{22}$

Addition and Subtraction of Fractions (Without Calculator)

1. Calculate the following, showing all you working clearly (leave your answers as 'improper fractions' where necessary and write them in their lowest form).

(a) $\frac{1}{4}+\frac{1}{2}$ (b) $\frac{2}{3}+\frac{1}{6}$ (c) $\frac{2}{5}+\frac{1}{4}$

(d) $\frac{2}{7}+\frac{1}{2}$ (e) $\frac{1}{4}+\frac{1}{6}$ (f) $\frac{4}{6}+\frac{5}{9}$

(g) $\frac{3}{8}+\frac{1}{6}$ (h) $\frac{5}{6}+\frac{1}{4}$ (i) $\frac{2}{15}+\frac{4}{9}$

2. Calculate the following, showing all you working clearly (leave your answers as 'proper fractions' where necessary and write them in their lowest form).

(a) $3\frac{1}{3}+2\frac{3}{5}$ (b) $5\frac{1}{3}+4\frac{1}{4}$ (c) $3\frac{7}{8}+2\frac{5}{12}$

(d) $6\frac{4}{9}+3\frac{5}{6}$ (e) $4\frac{3}{4}+1\frac{11}{12}$ (f) $5\frac{5}{12}+2\frac{17}{18}$

3. Calculate the following, showing all you working clearly (leave your answers as 'improper fractions' where necessary and write them in their lowest form).

(a) $\frac{4}{5}-\frac{1}{2}$ (b) $\frac{2}{3}-\frac{1}{6}$ (c) $\frac{3}{4}-\frac{5}{12}$

4. Calculate the following, showing all you working clearly (leave your answers as 'proper fractions' where necessary and write them in their lowest form).

(a) $2\frac{1}{2}-1\frac{3}{4}$ (b) $3\frac{1}{3}-2\frac{1}{2}$ (c) $5\frac{5}{8}-3\frac{3}{4}$

(d) $7\frac{3}{8}-5\frac{5}{6}$ (e) $7\frac{5}{12}-2\frac{13}{18}$ (f) $11\frac{1}{6}-1\frac{7}{9}$

5. Calculate the following, showing all you working clearly (leave your answers as 'proper fractions' where necessary and write them in their lowest form).

(a) $3\frac{3}{4}+2\frac{1}{2}+4\frac{5}{8}$ (b) $7\frac{2}{5}+4\frac{1}{2}+1\frac{1}{15}$

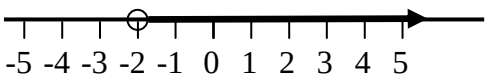
(c) $7\frac{2}{9}-3\frac{1}{3}-2\frac{5}{6}$ (d) $11\frac{1}{2}-2\frac{2}{3}+5\frac{1}{12}$

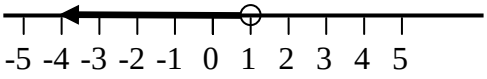
(e) $3\frac{1}{4}+2\frac{1}{6}-1\frac{1}{3}$ (f) $7\frac{2}{15}+3\frac{5}{6}-2\frac{2}{3}$

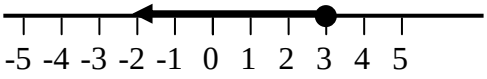
(g) $11\frac{1}{21}+4\frac{1}{7}-5\frac{2}{3}$ (h) $8\frac{1}{6}+5\frac{1}{9}-2\frac{11}{12}$

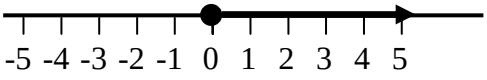
Linear Inequalities

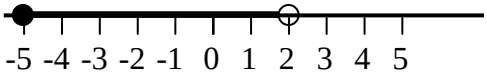
1. Write down the inequalities displayed below, using the variable n:

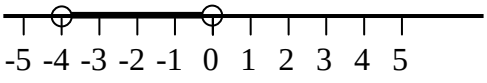
(a) 

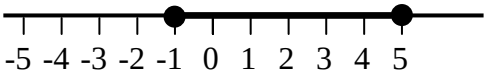
(b) 

(c) 

(d) 

(e) 

(f) 

(g) 

2. Display the following inequalities on a number line:

(a)	$x > 5$	(b)	$x < 7$
(c)	$x \geq -4$	(d)	$x \leq -1$
(e)	$x \geq 0$	(f)	$1 < x < 6$
(g)	$-1 < x \leq 6$	(h)	$-4 \leq x \leq -1$
(i)	$x > 0$	(j)	$-4 < x < 0$

3. Use some of the number lines you drew in question 2 to list all the whole number (or 'integer') solutions for the following inequalities:

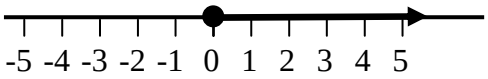
(a)	$1 < x < 6$	(b)	$-1 < x \leq 6$
(c)	$-4 \leq x \leq -1$	(d)	$-4 < x < 0$

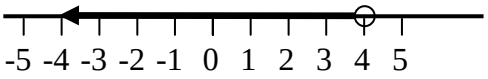
4. Represent the following inequalities on a number line:

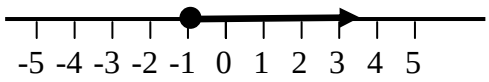
(a)	$n > 3$	(b)	$n \leq 0$	(c)	$-3 < n < -1$
(d)	$1 \leq n < 5$	(e)	$-4 \leq n \leq 0$	(f)	$5 < n \leq 7$

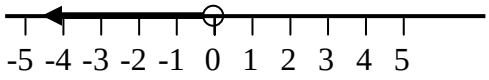
PTO

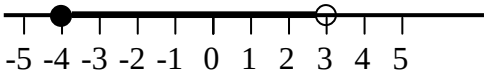
5. Write down the inequalities displayed below, using the variable *n*:

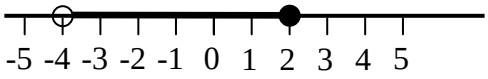
(a) 

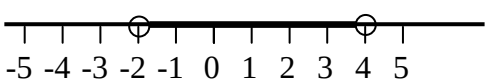
(b) 

(c) 

(d) 

(e) 

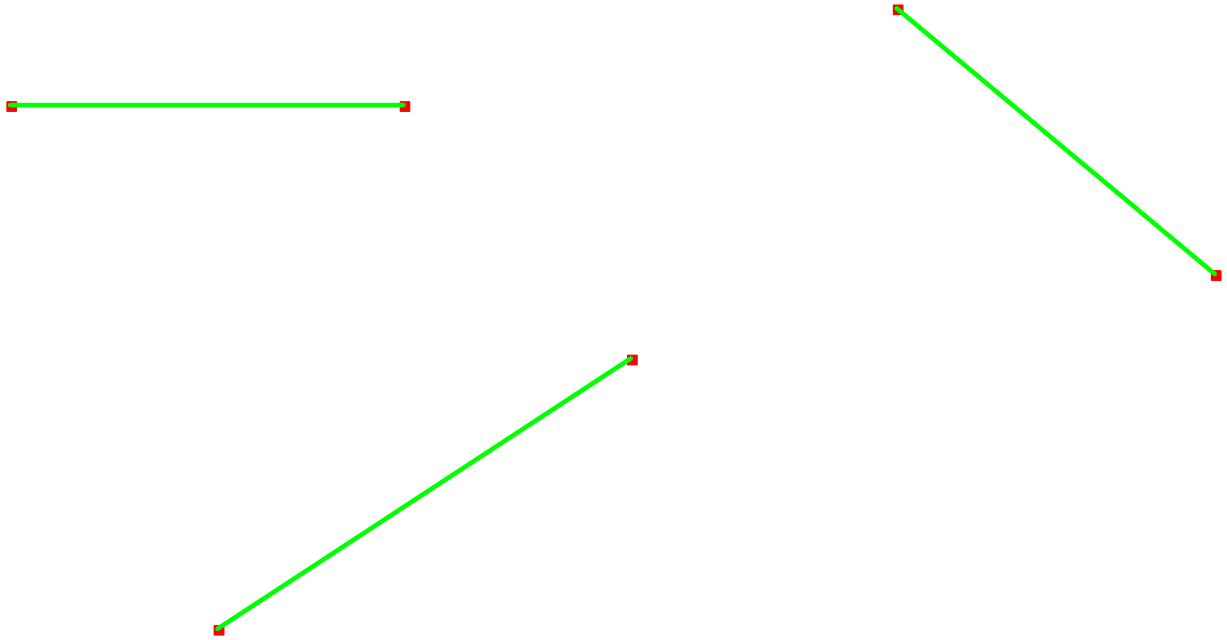
(f) 

(g) 

Constructions using a Straight Edge and a Compass

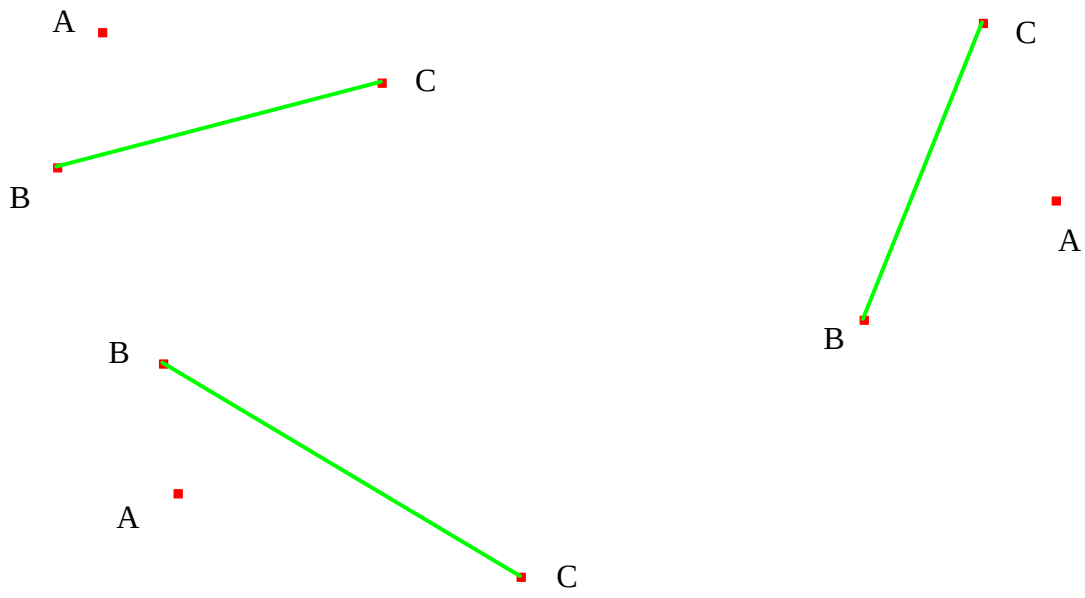
In the following use a compass and ruler, showing your working clearly.

1. Construct the perpendicular bisectors of the following solid lines.



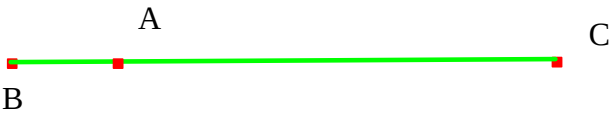
2. Check with a ruler whether you have cut the lines in half.

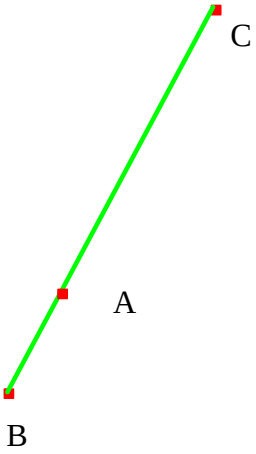
3. Construct the lines which are perpendicular to the line *BC* and which pass through the point *A*.

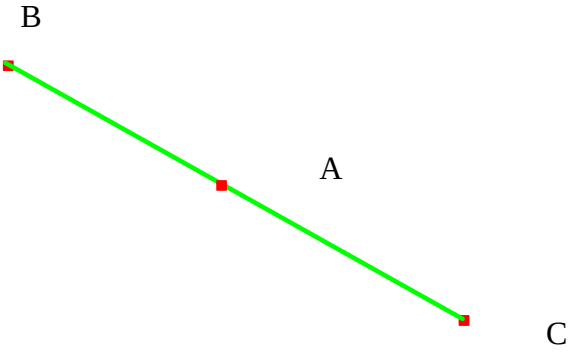


PTO

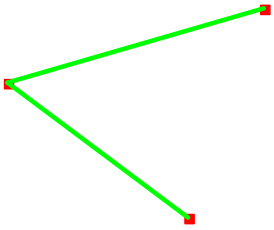
4. Construct the lines which are perpendicular to the line *BC* and which pass through the point *A*.

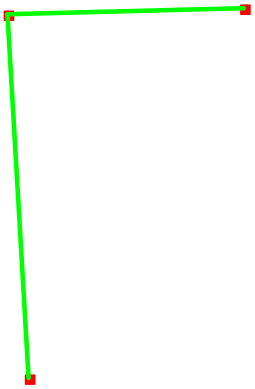


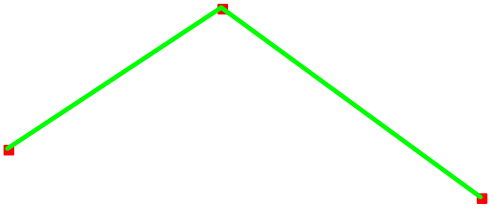




5. Construct the lines which bisect the angles enclosed between these pairs of lines:



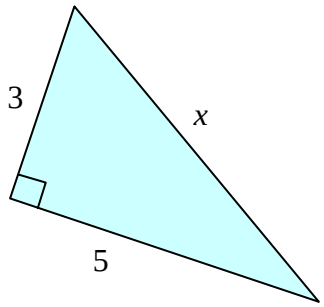




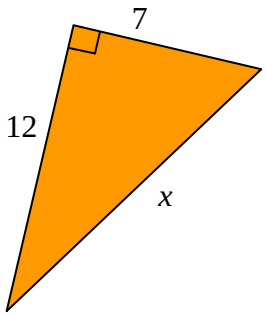
Pythagoras' Theorem

1. Find x in the following (to 3sf):

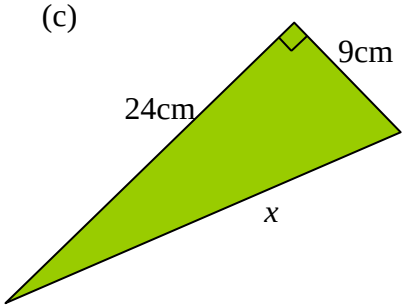
(a)



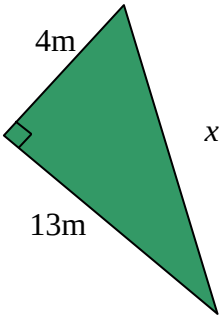
(b)



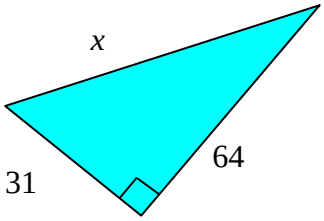
(c)



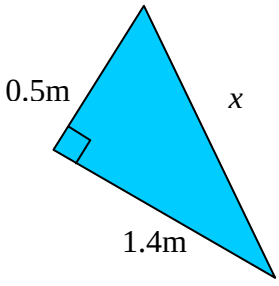
(d)



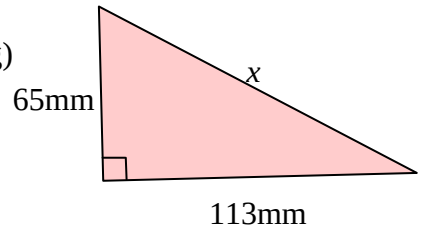
(e)



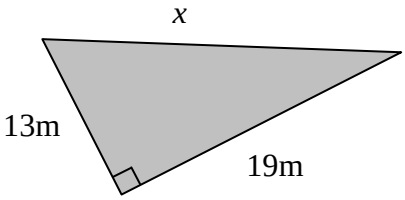
(f)



(g)



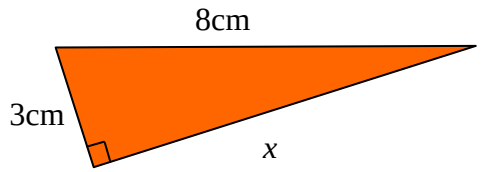
(h)



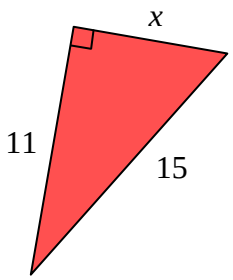
PTO

2. Find x in the following (to 3sf):

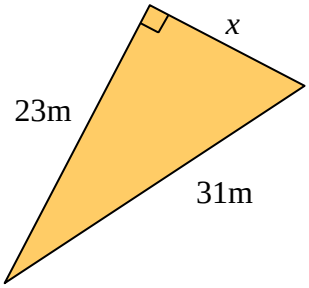
(a)



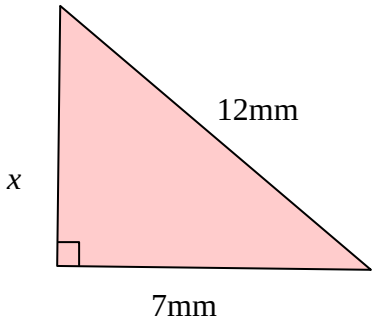
(b)



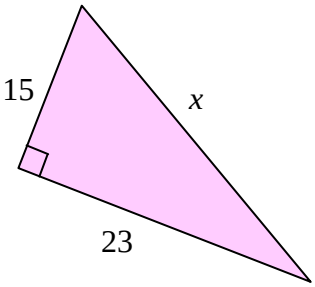
(c)



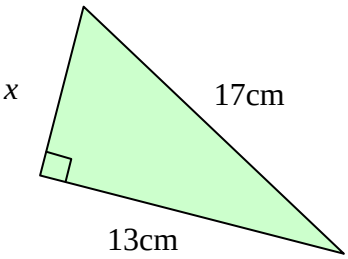
(d)



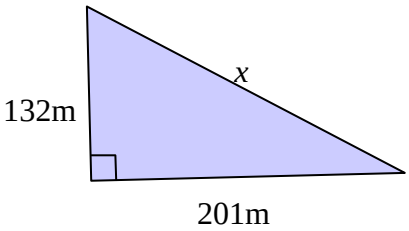
(e)



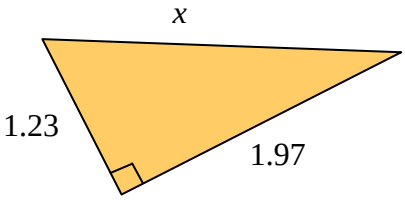
(f)



(g)



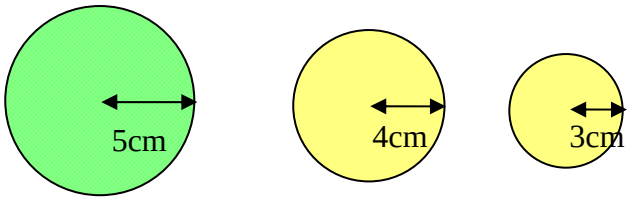
(h)



3. A rectangular field has length 75m and width 60m. How far is it from one corner to the one diagonally opposite it (to 3sf)?

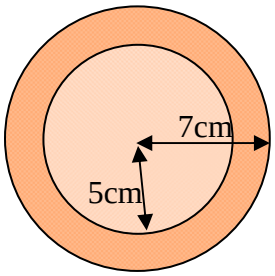
Area of Circles

1. (a) Show that a circle of radius 5cm has the same area as the combined area of a circle of radius 3cm and a circle of radius 4cm.

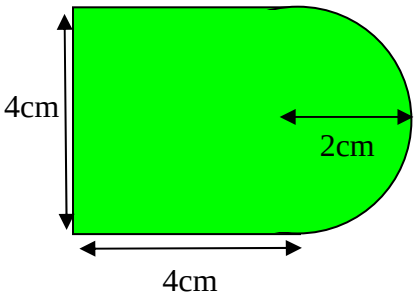


(b) Find (in terms of π) the area of a metal circle of radius 17cm.
(c) Find the area that remains when a circle of radius 8cm is cut out of it.
(d) Hence find the radius (it is a whole number) of the circle whose area is the same as the area that remains.

2. Find, in terms of π, the area which is enclosed between two circles with the same centre, one whose radius is 7cm and the other whose radius is 5cm.



3. Show that the area of a shape (shown opposite) consisting of a square of side length 4cm with a semicircle of radius 2cm added to one side is $16+2\pi$.



4. Find the radius of the circle which has the same area as the combined area of a circle of radius 12cm and a circle of radius 5cm.

5. Find the radius of the circle which has the same area as half of a semi-circle of radius 12cm.

6. A circle of radius 10cm has a circle of radius 5cm cut out of it.
(a) What is the remaining area (in terms of π)?
(b) What fraction of the initial circle is the remaining area?

7. Find, in terms of π, the area enclosed between a square of side length 6cm and the largest circle which can be drawn in this square.

PTO

8. Find the radius, r, of the circle whose area is equal to one quarter of the area of a circle of radius 8cm.

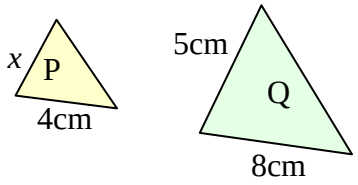
9. A rectangle measuring 5m by 4m has two semicircles of radius 2m attached to each of its smaller sides.
   (a) Find, in terms of π, the area of the shape.
   (b) Find, in terms of π, the area of the region which consists of all the points which are within 1m of this shape.

10. A circle of radius $2r$ cm has a circle of radius $r$cm cut out of it.
   (a) Find, in terms of r and π, the area of the shape that remains.
   (b) If that remaining area is exactly 75π cm^2 then find r.

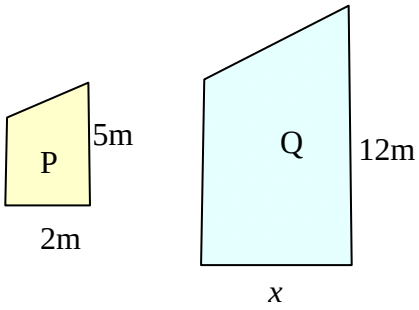
Similar Shapes

1. In each of the following, shape P is enlarged to a similar shape Q. Find the scale factor, *k*, for each enlargement. Find also the value of *x*.

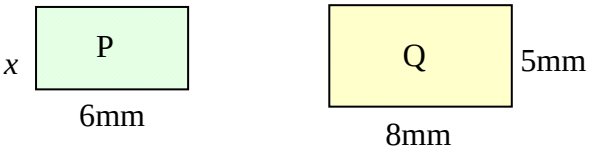
(a)



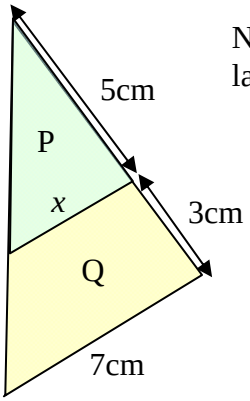
(b)



(c)

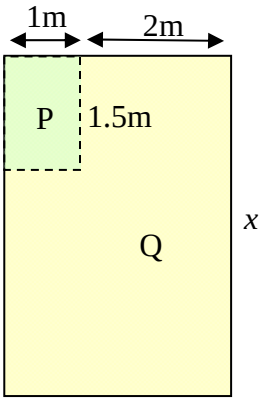


(d)



NB Q is the larger triangle.

(e)



NB Q is the larger rectangle.

2. A photocopier is set to reduce the lengths of copies to $\frac{2}{3}$ of the original size. If the original measured 12cm by 15cm what will be the dimensions of the copy?

3. A photography shop produces enlargements of photos. A 15cm x 10cm photo was enlarged so that its longest side was 24cm. What was the length of the shorter side?

4. A map is reduced to $\frac{3}{5}$ of its original size. A field on the original measured 25mm x 35mm. What will its dimensions on the image be?

PTO

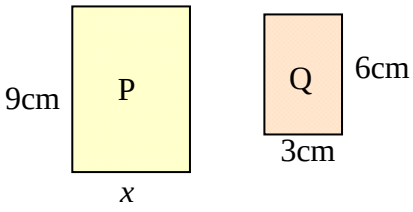
5. A rectangle P is enlarged to a rectangle Q. The dimensions of P are 5m by 12m. The shortest side of Q is 6m.
   (a) What is the scale factor of enlargement?
   (b) What is the length of the largest side of Q?

6. A right-angled triangle P is enlarged to a triangle Q. The hypotenuse of P is 12cm and the hypotenuse of Q is 15cm.
   (a) What is the scale factor of enlargement?
   (b) If the shortest side of P is 8cm find the shortest side of Q.

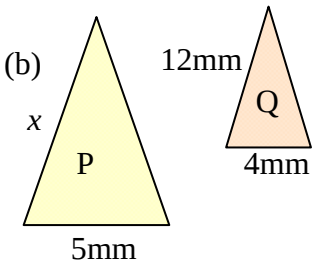
7. A map measures 24cm by 30cm and its dimensions are reduced to $\frac{2}{3}$ of its original size. What are the dimensions of the reduced map?

8. In each of the following, shape P is enlarged to a shape Q. Find the scale factor, *k*, for each enlargement. Find also the value of *x*.

(a)



(b)



9. The dimensions of a document are reduced to $\frac{3}{5}$ of their original lengths. If the reduced document has dimensions 12cm by 15cm then what was the size of the original document?

10. A photo has width 10cm and an area of $150\,\text{cm}^2$. Its length and width are enlarged by the same factor so that its width is 12cm. What is the area of the enlarged photo?

11. A photocopier is to reduce documents so that the area of the copy is ¼ of the area of the original. If the original had dimensions 112mm by 142mm what will the dimensions of the copy be?

Mean, Median and Mode

1. At a girls' school, a random sample of 130 pupils was taken and each pupil recorded her intake of milk (in ml) during a given day. The results are shown below:

Milk intake	10-	30-	60-	100-	150-	200-	300-500
No. of students	3	7	25	55	23	15	2

(a) Copy and complete the following table with midpoints against frequency.

Milk intake (Midpoint)	20				175		
No. of students	3	7	25	55	23	15	2

(b) Use this table to calculate an estimate of the mean (to 3sf).
(c) Find the class interval in which the median lies.
(d) Write down the modal class.

2. Summarised below are the prices of the goods (to the nearest £) sold by an electrical shop on a certain day.

Price of good (£)	Frequency
less than 20	2
20-	8
30-	19
40-	37
50-	62
60-	51
70-	29
90-	9
130-150	2

(a) Draw a table with midpoints against frequency.
(b) Use this table to find an estimate of the mean (to 3sf).

3. The table below shows the results of a multiple choice exam:

Number of Correct Answers (x)	11-15	16-20	21-25	26-30	31-35	36-40
Frequency	2	11	31	37	24	12

(a) Find the midpoint of the "11-15" class interval.
(b) Draw a table with midpoints against frequency.
(c) Use this table to find an estimate of the mean (to 3sf).
(d) Explain why this is only an estimate of the mean.
(e) To which value does the median correspond?
(f) Find the class interval in which the median lies.
(g) Write down the modal class.

PTO

4. The table below shows how many points were scored by a group of rugby players in a season:

Number of Points (x)	5-9	10-14	15-19	20-24	25-29	30-34
Frequency	18	12	7	5	2	3

(a) Find the midpoint of the "5-9" class interval.
(b) Draw a table with midpoints against frequency.
(c) Use this table to find an estimate of the mean (to 3sf).
(d) Find the class interval in which the median lies.
(e) Write down the modal class.

5. The table below shows the heights of a group of school children:

Height, h (cm)	140-	145-	150-	155-	160-	165-170
Frequency	40	45	94	97	85	57

(a) Find the midpoint of the "140-" class interval.
(b) Draw a table with midpoints against frequency.
(c) Use this table to find an estimate of the mean (to 3sf).
(d) State the modal class.

6. The table below shows the ages of 300 young people injured in car accidents in a certain month:

Age, x (year)	1-5	6-10	11-15	16-20	21-25	26-30
Frequency	87	71	51	43	26	22

(a) Explain why the class interval for "1-5" is can be written as $1 \le x < 6$.
(b) Find the midpoint of the "1-5" class interval.
(c) Find an estimate of the mean.
(d) Find the class interval in which the median lies.

Positive and Negative Indices (without calculators)

1. Express the following as powers of 2 (i.e. in the form 2^n):

(a) 4 (b) 16 (c) 64

(d) 2 (e) $\frac{1}{2}$ (f) 0.25

(g) 1 (h) $\frac{1}{32}$ (i) 128

2. Express the following as powers of the stated numbers:

(a) 32 as a power of 2 (b) 81 as a power of 3

(c) 625 as a power of 5 (d) $\frac{1}{16}$ as a power of 4

(e) $\frac{1}{7}$ as a power of 7 (f) $\frac{1}{25}$ as a power of 5

(g) $\frac{1}{144}$ as a power of 12 (h) $\frac{1}{1024}$ as a power of 2

3. Calculate the following:

(a) 2^6 (b) 3^4 (c) 5^3

(d) 11^2 (e) 2^{-3} (f) 10^{-2}

(g) 19^0 (h) 13^2 (i) 4^{-3}

(j) $\left(\frac{1}{2}\right)^3$ (k) $\left(\frac{2}{3}\right)^2$ (l) $\left(\frac{5}{3}\right)^4$

(m) $\left(\frac{1}{2}\right)^{-2}$ (n) $\left(\frac{2}{5}\right)^{-3}$ (o) $\left(\frac{2}{3}\right)^{-4}$

4. Find *x* in the following:

(a) $7^x = 49$ (b) $3^x = \frac{1}{81}$ (c) $2^x = 1$

(d) $9^x = 81$ (e) $5^x = \frac{1}{125}$ (f) $\left(\frac{2}{3}\right)^x = \frac{27}{8}$

(g) $\left(\frac{1}{4}\right)^x = 16$ (h) $\left(\frac{3}{4}\right)^x = \frac{16}{9}$ (i) $2^x = 1024$

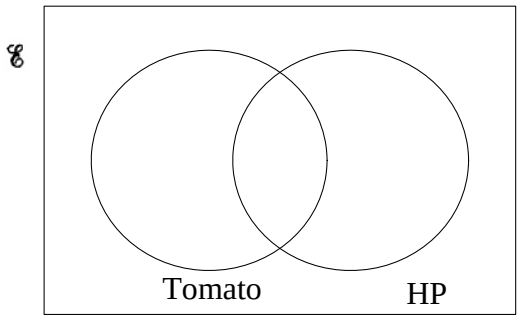
5. Express the following in the form 8^n where *n* is either an integer or a fraction:

(a) $\frac{1}{8}$ (b) 8 (c) 1

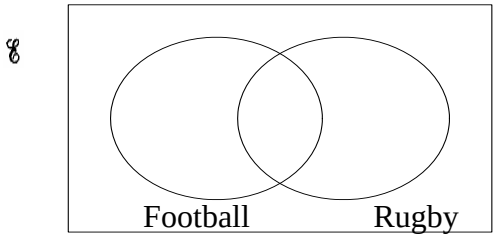
(d) 64 (e) $\frac{1}{64}$ (f) $\frac{1}{512}$

Sets

1. In a class of 20 pupils, 9 like tomato sauce but not HP sauce, 6 like HP sauce but not tomato sauce and 3 like neither. Copy and complete the following Venn diagram.



2. In a class of 30 pupils, 20 like football, 12 like rugby and 4 like neither.
Suppose n pupils like both football and rugby.
   (a) Write down an expression, in terms of n, for the number of pupils who:
      (i) like football but not rugby.
      (ii) like rugby but not football.
   (b) Copy and complete the following Venn diagram using n.



   (c) By adding up all four values, find n.

3. In a year of 100 pupils, 70 enjoy Maths, 50 enjoy French and 20 enjoy neither.
   (a) Set up a Venn diagram showing this information.
   (b) Use this to find the number of pupils who enjoy only one of the subjects.

4. In a shop there were 120 customers on a certain day. 60 paid using notes, 30 paid using coins and 50 paid using neither (cheques, cards etc.)
   (a) Set up a Venn diagram showing this information.
   (b) Use this to find the number of customers who used both notes and coins.

5. On an Athletics day 150 athletes are running. 60 are in the 100 metres, 50 are in the 200 metres and 80 are in neither.
   (a) Set up a Venn diagram showing this information.
   (b) Use this to find the number of athletes who ran in only one race.

6. A group of 200 adults were surveyed about holidays. 150 had been to Spain, 80 had been to France. Twice as many had been to both countries as had been to neither country.
Suppose n adults had been to neither country.
   (a) Write down an expression for the number of adults who had been to both countries.
   (b) Set up a Venn diagram using n.
   (c) Hence find n and set up a new Venn diagram without using n.

Quadratic Fractions

1. Simplify the following:

(a) $\dfrac{x^2+3x+2}{x+2}$ (b) $\dfrac{x^2+5x+6}{x+3}$

(c) $\dfrac{2x^2+3x+1}{x+1}$ (d) $\dfrac{x^2+x-12}{x+4}$

(e) $\dfrac{x^2-7x+10}{x-2}$ (f) $\dfrac{4x^2-8x+3}{2x-3}$

(g) $\dfrac{x^2-1}{x-1}$ (h) $\dfrac{25x^2-1}{5x+1}$

2. Simplify the following:

(a) $\dfrac{x^2+3x+2}{x^2+5x+4}$ (b) $\dfrac{x^2-1}{x^2+4x+3}$

3. Simplify $\dfrac{3}{x^2+5x+4}+\dfrac{2}{x^2+7x+6}$ by first factorising the denominators and finding the lowest common denominator.

4. Simplify the following

(a) $\dfrac{4}{x^2+6x+8}+\dfrac{7}{x^2+5x+6}$

(b) $\dfrac{5}{x^2+7x+12}+\dfrac{2}{x^2+9x+20}$

(c) $\dfrac{3}{x^2-1}+\dfrac{4}{x^2+4x+3}$

Functions

1. Given that $f(x) = 5x + 1$, find the following :
   (a) $f(1)$
   (b) $f(0)$
   (c) $f(-1)$
   (d) the value of x such that $f(x) = 11$.

2. Given that $g(x) = \frac{2x+1}{3}$, find the following :
   (a) $g(4)$
   (b) $g(7)$
   (c) $g(-2)$
   (d) the value of x such that $g(x) = 7$.

3. Given that $h(x) = x^2 + 1$ find the following :
   (a) $h(1)$
   (b) $h(-1)$
   (c) $h(2)$
   (d) the two values of x such that $h(x) = 101$.

4. Given that $f(x) = \frac{x+1}{x}$ find the following :
   (a) $f(-1)$
   (b) $f(2)$
   (c) $f\left(\frac{1}{2}\right)$
   (d) a value of x such that $f(x) = 2$.

5. Given that $f(x) = x^2 - 2x - 8$ calculate the following :
   (a) $f(2)$
   (b) $f(-3)$
   (c) $f\left(\frac{1}{2}\right)$
   (d) a value of x such that $f(x) = 0$

PTO

6. Given that the function $\mathrm{h}(x)$ is defined by $\mathrm{h}(x) = \dfrac{3x+2}{x-2}$, find the following :

(a) $\mathrm{h}(1)$

(b) the value of a such that $\mathrm{h}(a) = 11$

(c) the value of a such that $\mathrm{h}(a) = 7$

(d) the value of x such that $\mathrm{h}(x)$ has no value.

7. Given that $\mathrm{h}(z) = \dfrac{z^2-4}{2z-1}$ calculate the following :

(a) $\mathrm{h}(3)$

(b) $\mathrm{h}(-2)$

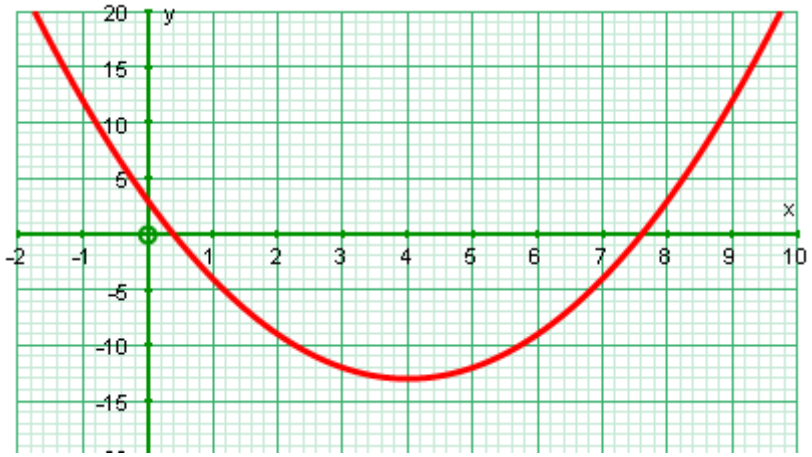
(c) $\mathrm{h}(0)$

(d) $\mathrm{h}\left(-\dfrac{1}{2}\right)$

(e) the value of x such that $\mathrm{h}(x)$ has no value.

Finding Turning Points using differentiation

1. A curve has equation $y = x^2 - 8x + 3$



(a) Find $\frac{dy}{dx}$.

(b) Solve $\frac{dy}{dx} = 0$.

(c) What is the x coordinate of the point where the curve turns?

2. A curve has equation $y = 3x^2 - 12x + 5$.

(a) Find $\frac{dy}{dx}$.

(b) Solve $\frac{dy}{dx} = 0$.

(c) What is the x coordinate of the point where the curve turns?

3. A curve has equation $y = 2x^3 - 9x^2 + 12x + 7$.

(a) Show that $\frac{dy}{dx} = 6(x - a)(x - b)$ where a and b need to be found.

(b) Solve $\frac{dy}{dx} = 0$.

(c) What are the x coordinates of the points where the curve turns?

4. A curve has equation $y = x^3 - 3x^2 - 9x + 7$. What are the x and y coordinates of the points where the curve turns?

Vectors

1. If A, B and C are the points (2, 5), (4, -2) and (-1, 1) respectively then find the following:
   (a) $\overrightarrow{AB}$
   (b) $\overrightarrow{BC}$
   (c) $\overrightarrow{BA}$
   (d) $\overrightarrow{AC}$
   (e) an equation connecting $\overrightarrow{AB}$, $\overrightarrow{BC}$ and $\overrightarrow{AC}$.
   (f) the co-ordinates of the point E where $\overrightarrow{AE} = \begin{pmatrix} 6 \\ 5 \end{pmatrix}$.
   (g) the co-ordinates of the point D such that $ABDE$ is a parallelogram.

2. If $\mathbf{a} = \begin{pmatrix} 2 \\ 3 \end{pmatrix}$, $\mathbf{b} = \begin{pmatrix} 5 \\ 1 \end{pmatrix}$ and $\mathbf{c} = \begin{pmatrix} -3 \\ 4 \end{pmatrix}$ then find the following:
   (a) $3\mathbf{a}$
   (b) $5\mathbf{b}$
   (c) $\frac{1}{2}(\mathbf{a} + \mathbf{b})$
   (d) $\mathbf{b} - \mathbf{c}$
   (e) $5\mathbf{b} + 3\mathbf{a}$
   (f) $2\mathbf{a} - 3\mathbf{b} + 4\mathbf{c}$

3. $ABCD$ is a parallelogram where A, B, C and D have coordinates (3, 4), (9, 6), (7, 9) and (1, 7) respectively and E is the midpoint of AB. Find the following:
   (a) $\overrightarrow{OE}$
   (b) $\overrightarrow{AB}$
   (c) $\overrightarrow{DE}$
   (d) $\overrightarrow{EC}$
   (e) the co-ordinates of X, the midpoint of AC
   (f) the co-ordinates of Y, the midpoint of BD

4. $ABCD$ is a parallelogram such that $\overrightarrow{AB} = \mathbf{p}$ and $\overrightarrow{BC} = \mathbf{q}$. Find the following in terms of $\mathbf{p}$ and $\mathbf{q}$:
   (a) $\overrightarrow{CD}$
   (b) $\overrightarrow{AD}$
   (c) $\overrightarrow{AC}$
   (d) $\overrightarrow{AM}$ where M is the midpoint of AB
   (e) $\overrightarrow{AN}$ where N is the midpoint of AC
   (f) $\overrightarrow{AP}$ where P is the point along AC which is twice as far from A as from C (P is between A and C).