

Indices

1. Simplify the following:

(a) $a^2 \times a^3$	(b) $b^3 \times b^{14}$
(c) $c^6 \times c^5$	(d) $x^6 \times x^7$
(e) $y^9 \div y^2$	(f) $z^{11} \div z^4$
(g) $(q^3)^4$	(h) $(w^2)^6$
(i) $(r^2)^3 \div r^4$	(j) $(s^5)^3 \times s^6$
(k) $\frac{t^2 \times t^5}{t^3}$	(l) $\frac{(w^3)^4 \times w^6}{w^2}$

2. Find a in the following:

(a) $2^3 \times 2^a = 2^7$	(b) $x^5 \times x^a = x^6$	(c) $y^2 \times y^a = y^2$
(d) $r^a \div r^{11} = r^9$	(e) $s^a \div s^9 = s^7$	(f) $2^9 \div 2^a = 2^2$
(g) $(3^5)^a = 3^{20}$	(h) $(u^a)^a = u^9$	(i) $(x^a)^{a+1} = x^{42}$

3. Simplify the following:

(a) $(b^2)^3 \times (b^4)^5$	(b) $\frac{(t^3)^5 \times (t^2)^4}{t^3}$
(c) $\frac{(g^2)^3 \times (g^3)^2}{(g^5)^2}$	(d) $\frac{(h^3)^4 \times (h^2)^7}{(h^5)^2 \times (h^3)^4}$
(e) $\frac{(k^5)^7 \times (k^3)^4}{(k^8)^3 \times (k^2)^2}$	(f) $\frac{(m^2)^9 \times (m^7)^3}{(m^4)^3 \times (m^2)^{11}}$

4. Simplify the following:

(a) $(2x^2) \times (3x^4)$	(b) $(5x^3) \times (7x^2)$
(c) $(6x^6) \times (2x^3)$	(d) $(3x^5) \times (9x^3)$
(e) $(8x^2) \times (6x^5)$	(f) $(7x^7) \times (8x^5)$
(g) $(9x^7) \times (4x^3)$	(h) $(9x^2) \times (7x)$

5. Simplify the following:

(a) $(8x^5) \div (2x^3)$	(b) $(6x^4) \div (3x)$
(c) $(24x^6) \div (6x^4)$	(d) $(12x^7) \div (4x^3)$
(e) $(9x^5) \div (3x^2)$	(f) $(63x^8) \div (9x^7)$
(g) $(72x^{10}) \div (8x)$	(h) $(56x^7) \div (7x^5)$

Solving Equations

1. Solve the following equations:

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

(b) $2(5x+2) = 6(3x-2)$

(c) $5(7x-3) = 4(9x-4)$

(d) $3(4x+5) + 7 = 2(3x+23)$

(e) $7(4x+9) + 3 = 5(x+4)$

(f) $4(2x-3) = 2(2x+1) + 10$

2. Solve the following equations.

(a) $\frac{15}{x} = 5$

(b) $\frac{6}{x} = 2$

(c) $\frac{42}{x+3} = 6$

(d) $\frac{35}{2x+1} = 5$

(e) $\frac{24}{5x+3} = 3$

(f) $\frac{12}{5x+1} = 2$

3. Solve the following equations:

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

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

(c) $7(2x+1) - 1 = 5(3x+2)$

(d) $8(3x+4) + 1 = 3(12x-1)$

(e) $5(2x+1) - 5 = 2(6x+5)$

(f) $5(2x-1) - 6(x+1) = 1$

(g) $2(4x-3) - 7(2x-7) = 1$

(h) $4(2x+1) - 9(x-1) = 3$

4. Solve the following equations (note that all the answers are integers).

(a) $\frac{12}{x} = 4$

(b) $\frac{15}{x} = 3$

(c) $\frac{45}{x+1} = 5$

(d) $\frac{30}{2x+1} = 6$

(e) $\frac{20}{3x-1} = 4$

(f) $\frac{10}{2x+3} = 2$

(g) $1 + \frac{5}{x+1} = 2$

(h) $5 - \frac{6}{2x-7} = 3$

(i) $\frac{9}{2x-1} = \frac{15}{x+3}$

(j) $\frac{6}{2x-5} = \frac{10}{x+1}$

(k) $\frac{8}{x-7} = \frac{24}{x+1}$

(l) $\frac{30}{2x+1} = \frac{8}{x-3}$

5. Find x in the following (to 3sf if necessary).

(a) $\frac{x}{2} = 6$

(b) $\frac{3}{x} = 2$

(c) $\frac{4}{x-1} = 5$

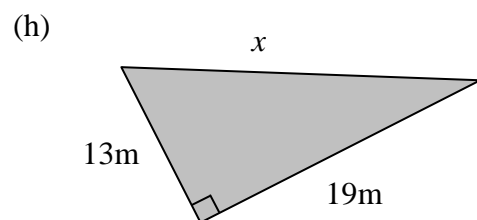
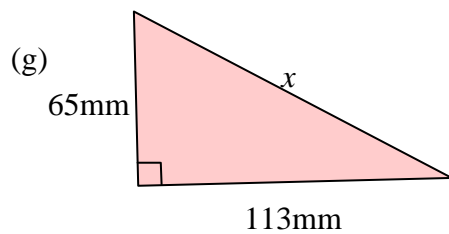
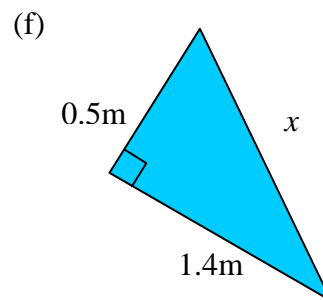
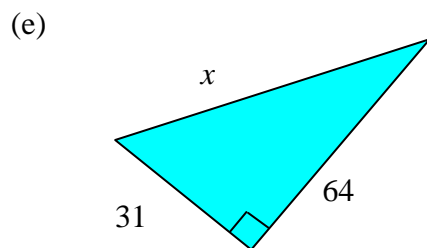
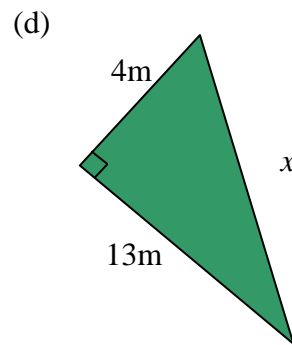
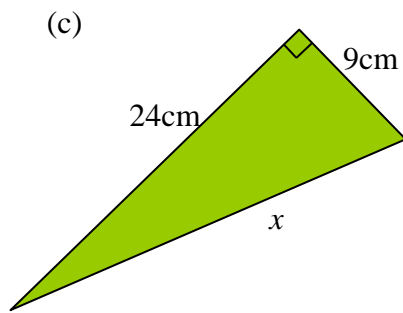
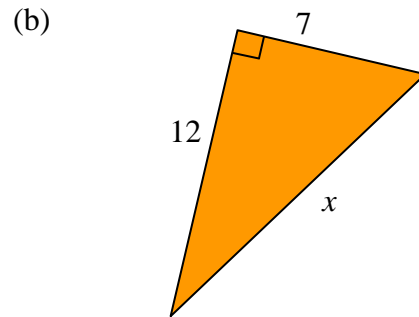
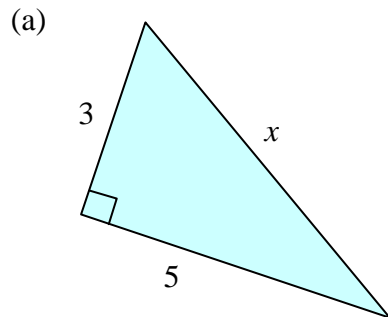
(c) $\frac{x-1}{x+1} = 2$

(d) $\frac{2x-3}{3x+4} = 4$

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

Pythagoras' Theorem

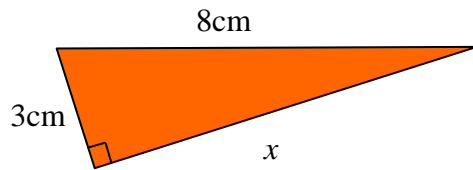
1. Find x in the following (to 3sf):



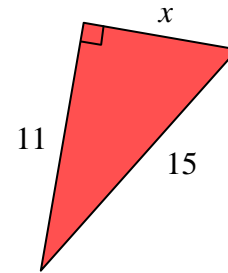
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2. Find x in the following (to 3sf):

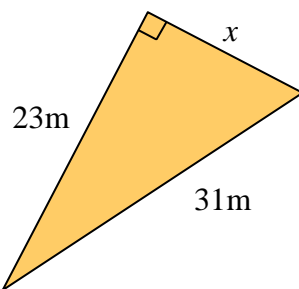
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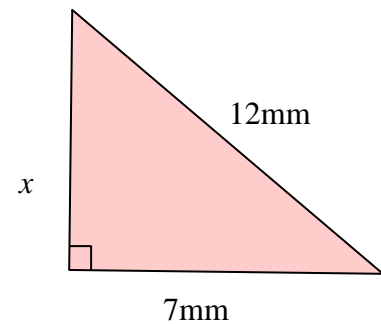
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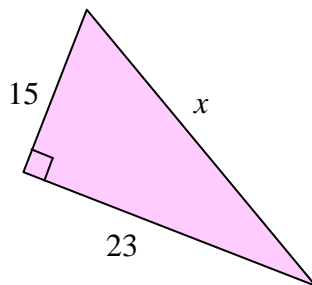
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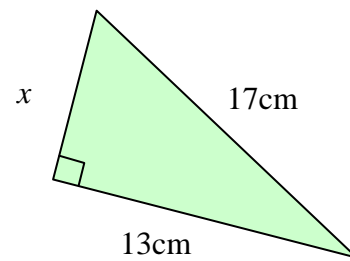
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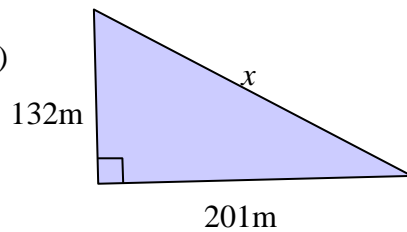
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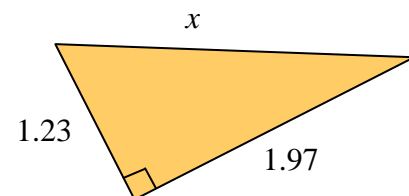
(f)



(g)



(h)

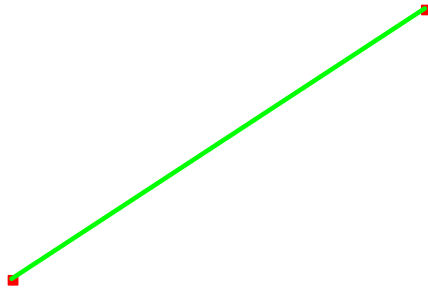
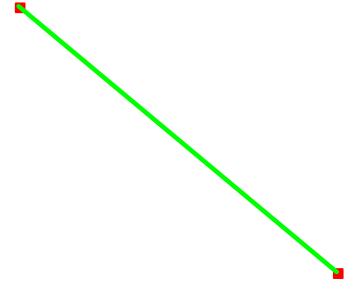
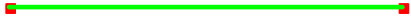


3. A rectangular field has length 75m and width 60m. How far is it from one corner to the one diagonally opposite it (to 3sf)?

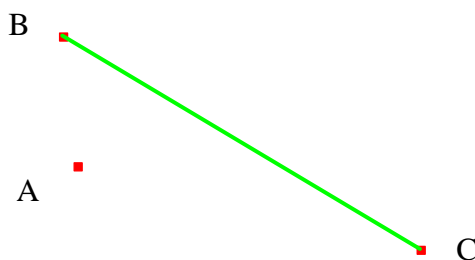
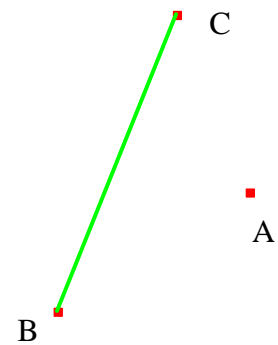
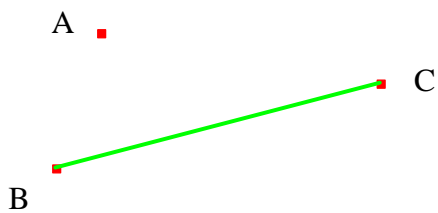
Constructions using a Straight Edge and a Compass

Construct the following using a compass and ruler, showing your working clearly.

1. The perpendicular bisectors of the following solid lines.

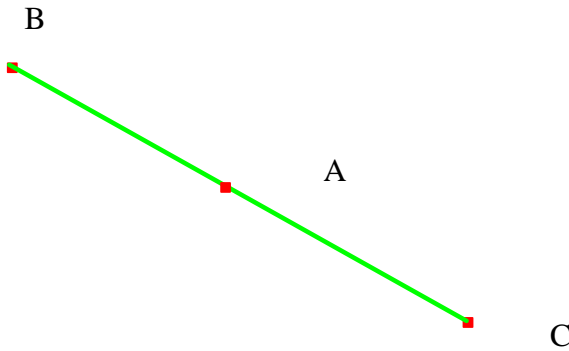
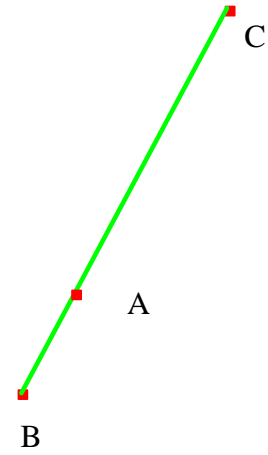
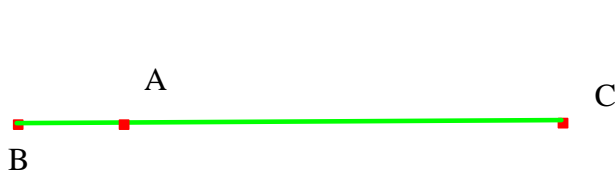


2. Check with a ruler whether you have cut the lines in half.
3. The lines which are perpendicular to the line BC and which pass through the point A .

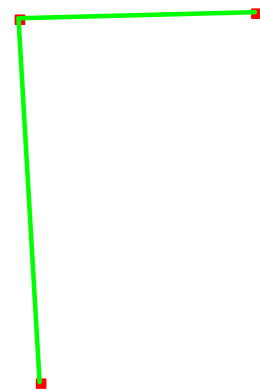
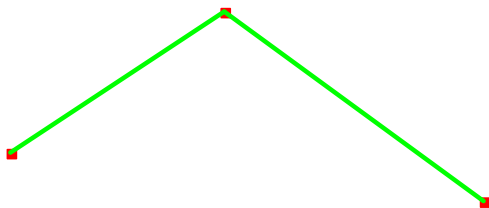
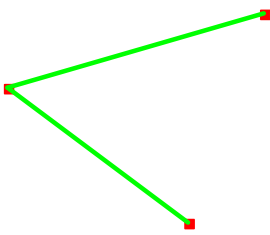


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4. Construct the lines which are perpendicular to the line BC and which pass through the point A .



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



Lowest Common Multiples, Highest Common Factors

- Write the following as the product of prime numbers (e.g. $72 = 2^3 \times 3^2$)
 - 30
 - 24
 - 18
 - 28
 - 105
 - 64
 - 108
 - 42
 - 150
 - 200
 - 378
 - 144
 - 385
 - 126
 - 420
 - 45
 - 60
 - 75
- Use question 1 to find the highest common factor of the following pairs of numbers (write each answer first as the product of prime numbers and then calculate this):
 - 45 and 105
 - 28 and 64
 - 385 and 75
 - 420 and 126
 - 108 and 150
- Use question 1 to find the lowest common multiple of the following pairs of numbers (write each answer first as the product of prime numbers and then calculate this):
 - 24 and 60
 - 200 and 420
 - 30 and 144
 - 42 and 28
 - 378 and 18
- Two cars complete laps of a circuit. One takes 315 seconds per lap, the other takes 525 seconds per lap. They start their circuits of the laps at the same time.

 - Express 315 and 525 as the product of prime numbers.
 - Find the lowest common multiple of 315 and 525.
 - Use this to find how many laps the faster car will do before the cars first get to the starting point at the same time.
- Find the highest common factor and lowest common multiple of 210 and 550.
 - Multiply the two numbers that you found in (a) together.
 - Multiply 210 and 550 together.
 - What do you notice about the answers to (b) and (c)?

Simplifying Square Roots

1. Simplify the following as far as possible:
- | | | |
|-----------------|-----------------|-----------------|
| (a) $\sqrt{18}$ | (b) $\sqrt{8}$ | (c) $\sqrt{12}$ |
| (d) $\sqrt{50}$ | (e) $\sqrt{45}$ | (f) $\sqrt{44}$ |
| (g) $\sqrt{75}$ | (h) $\sqrt{63}$ | (i) $\sqrt{72}$ |
2. Simplify the following as far as possible:
- | | | |
|------------------|------------------|------------------|
| (a) $\sqrt{320}$ | (b) $\sqrt{180}$ | (c) $\sqrt{300}$ |
| (d) $\sqrt{245}$ | (e) $\sqrt{200}$ | (f) $\sqrt{343}$ |
| (g) $\sqrt{135}$ | (h) $\sqrt{150}$ | (i) $\sqrt{216}$ |
3. Find the following in the form \sqrt{n} :
- | | | |
|-----------------|-----------------|-----------------|
| (a) $7\sqrt{2}$ | (b) $3\sqrt{3}$ | (c) $2\sqrt{7}$ |
| (d) $3\sqrt{7}$ | (e) $2\sqrt{2}$ | (f) $5\sqrt{5}$ |
4. Simplify the following as far as possible, leaving your answer in the form $a\sqrt{b}$:
- | | | |
|------------------------------|------------------------------|------------------------------|
| (a) $2\sqrt{3} + 5\sqrt{3}$ | (b) $7\sqrt{2} - 3\sqrt{2}$ | (c) $\sqrt{3} + \sqrt{12}$ |
| (d) $\sqrt{27} + 2\sqrt{3}$ | (e) $5\sqrt{5} + \sqrt{45}$ | (f) $7\sqrt{2} + \sqrt{50}$ |
| (g) $\sqrt{18} + \sqrt{200}$ | (h) $\sqrt{60} + \sqrt{135}$ | (i) $\sqrt{180} - \sqrt{20}$ |
5. Simplify the following as far as possible:
- | | | |
|------------------------------------|------------------------------------|--|
| (a) $2\sqrt{3} \times 5\sqrt{3}$ | (b) $5\sqrt{2} \times 2\sqrt{2}$ | (c) $\sqrt{3} \times \sqrt{27}$ |
| (d) $\sqrt{50} \times 2\sqrt{2}$ | (e) $2\sqrt{7} \times 3\sqrt{28}$ | (f) $3\sqrt{3} \times 5\sqrt{75}$ |
| (g) $\frac{4\sqrt{2}}{\sqrt{8}}$ | (h) $\frac{12\sqrt{3}}{\sqrt{48}}$ | (i) $\frac{10\sqrt{6}}{\sqrt{150}}$ |
| (j) $\frac{\sqrt{12}}{\sqrt{300}}$ | (k) $\frac{3\sqrt{28}}{\sqrt{7}}$ | (l) $\frac{\sqrt{8} + \sqrt{12}}{\sqrt{2} + \sqrt{3}}$ |

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) $\frac{1}{512}$

Simultaneous Equations

1. Solve the following simultaneous equations:

(a) $3x + 4y = 17$	(b) $5p + 2q = 28$	(c) $7v + 6w = 46$
$5x + 4y = 23$	$5p + 3q = 37$	$5v + 6w = 38$

(d) $5a + 3b = 13$	(e) $4c + 5d = 17$	(f) $9x + 2y = 31$
$7a + 6b = 20$	$8c + 3d = 27$	$3x + y = 11$

(g) $11p + 2q = 63$	(h) $5g + 3h = 27$	(i) $9m + 7n = 43$
$6p + 4q = 46$	$4g + 5h = 32$	$5m + 2n = 22$

(j) $8b + 3c = 46$	(k) $6x + 5y = 13$	(l) $8r + 5s = 41$
$5b + 2c = 29$	$7x + 2y = 19$	$9r + 11s = 30$

2. Solve the following simultaneous equations:

(a) $2x + y = 11$	(b) $3u + 2v = 10$	(c) $11p + 3q = 71$
$3x - y = 14$	$7u - v = 29$	$5p - q = 37$

(d) $9a + 2b = 41$	(e) $7p - 3q = 15$	(f) $13b - 7c = 47$
$5a - 4b = 33$	$5p + 2q = 19$	$7b - 9c = 41$

3. Solve the following simultaneous equations:

(a) $3x - 2y = 19$	(b) $3a - 7b = 1$	(c) $6r - 5s = 38$
$5x + 3y = 19$	$7a + 2b = 39$	$5r - 2s = 23$

4. Solve the following simultaneous equations (to 3sf):

(a) $2x + 7y = 10$	(b) $6a + 5b = 11$	(c) $9g + 7h = 45$
$3x + 2y = 7$	$5a - 2b = 5$	$5g - 2h = 31$

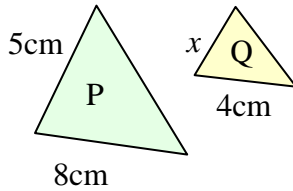
Sequences

1. Find the next two terms in the following sequence
 - (a) 5, 7, 9, 11...
 - (b) 1, 11, 21, 31...
 - (c) 15, 22, 29, 36...
 - (d) 2, 11, 20, 29...
 - (e) 14, 21, 28, 35...
 - (f) $1, 1\frac{1}{2}, 2, 2\frac{1}{2}, \dots$
 - (g) 15, 12, 9, 6...
 - (h) 101, 99, 97, 95...
 - (i) 17, 11, 5, $-1, \dots$
 - (j) $-3, -7, -11, -15, \dots$
 - (k) $-9, -2, 5, 12, \dots$
 - (l) $-3, -1\frac{1}{2}, 0, 1\frac{1}{2}, \dots$
 - (m) $\frac{1}{2}, \frac{3}{4}, 1, 1\frac{1}{4}, \dots$
 - (n) $1, \frac{7}{8}, \frac{3}{4}, \frac{5}{8}, \dots$
 - (o) $\frac{1}{2}, 1\frac{1}{4}, 2, 2\frac{3}{4}, \dots$
2. Find the n th term, t_n , of the sequences in question 1.
3.
 - (a) Find the n th term, t_n of 5, 11, 17, 23,
 - (b) Find the 40th term of 5, 11, 17, 23,
 - (c) Which term of 5, 11, 17, 23, ... is equal to 479?
4.
 - (a) Find the n th term, t_n of 3, 10, 17, 24, ...
 - (b) Find the 71st term of 3, 10, 17, 24,
 - (c) Which term of 3, 10, 17, 24, ... is equal to 710?
5.
 - (a) Find the n th term, t_n of 19, 14, 9, 4,
 - (b) Find the 23rd term of 19, 14, 9, 4,
 - (c) Which term of 19, 14, 9, 4, ... is equal to -346 ?
6.
 - (a) Find the n th term, t_n of $-3, -5, -7, -9, \dots$
 - (b) Find the 15th term of $-3, -5, -7, -9, \dots$.
 - (c) Which term of $-3, -5, -7, -9, \dots$ is equal to -287 ?
7.
 - (a) Find the n th term, t_n of 4, 7, 10, 13, ...
 - (b) Find the 150th term of 4, 7, 10, 13,
 - (c) Which is the first term of this sequence to be greater than 1000?
8.
 - (a) Find the n th term, t_n of 1082, 1075, 1068, 1061, ...
 - (b) Find the 100th term of 1082, 1075, 1068, 1061,
 - (c) Which is the first negative term of this sequence?

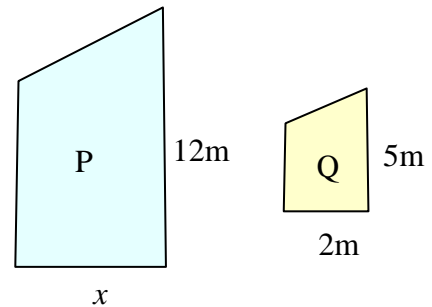
Similar Shapes

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 .

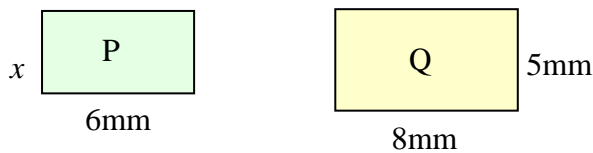
(a)



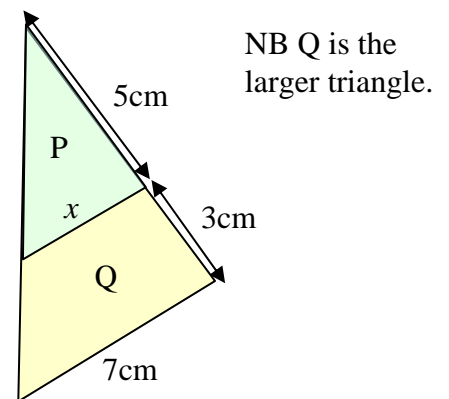
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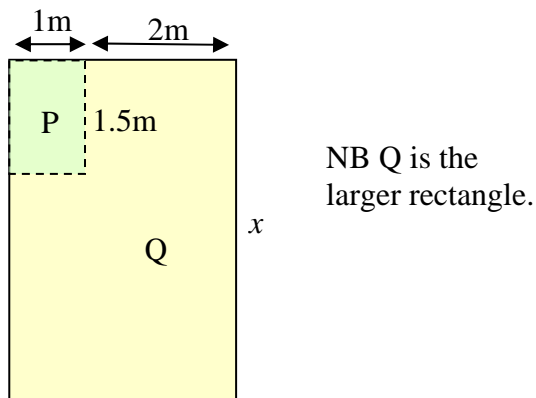
(c)



(d)



(e)

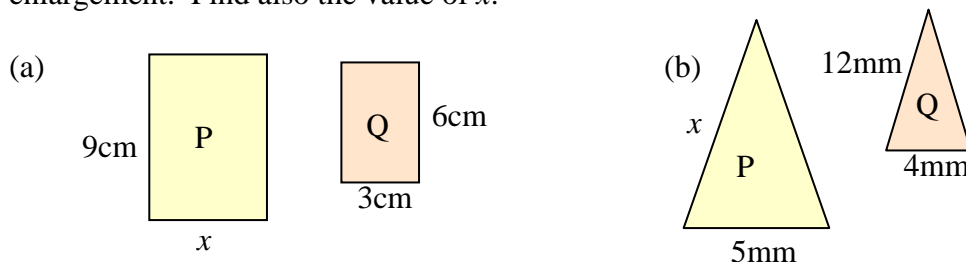


2. A photocopier is set to reduce the lengths of copies to $\frac{2}{3}$ of the original size. If the original measured 12cm by 15cm what will be the dimensions of the copy?
3. A photography shop produces enlargements of photos. A 15cm x 10cm photo was enlarged so that its longest side was 24cm. What 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?

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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.
- What is the scale factor of enlargement?
 - 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.
- What is the scale factor of enlargement?
 - If the shortest side of P is 8cm find the shortest side of Q.
7. A map measures 24cm by 30cm and it is reduced to $\frac{2}{3}$ of its original size. What are the dimensions of the reduced map?

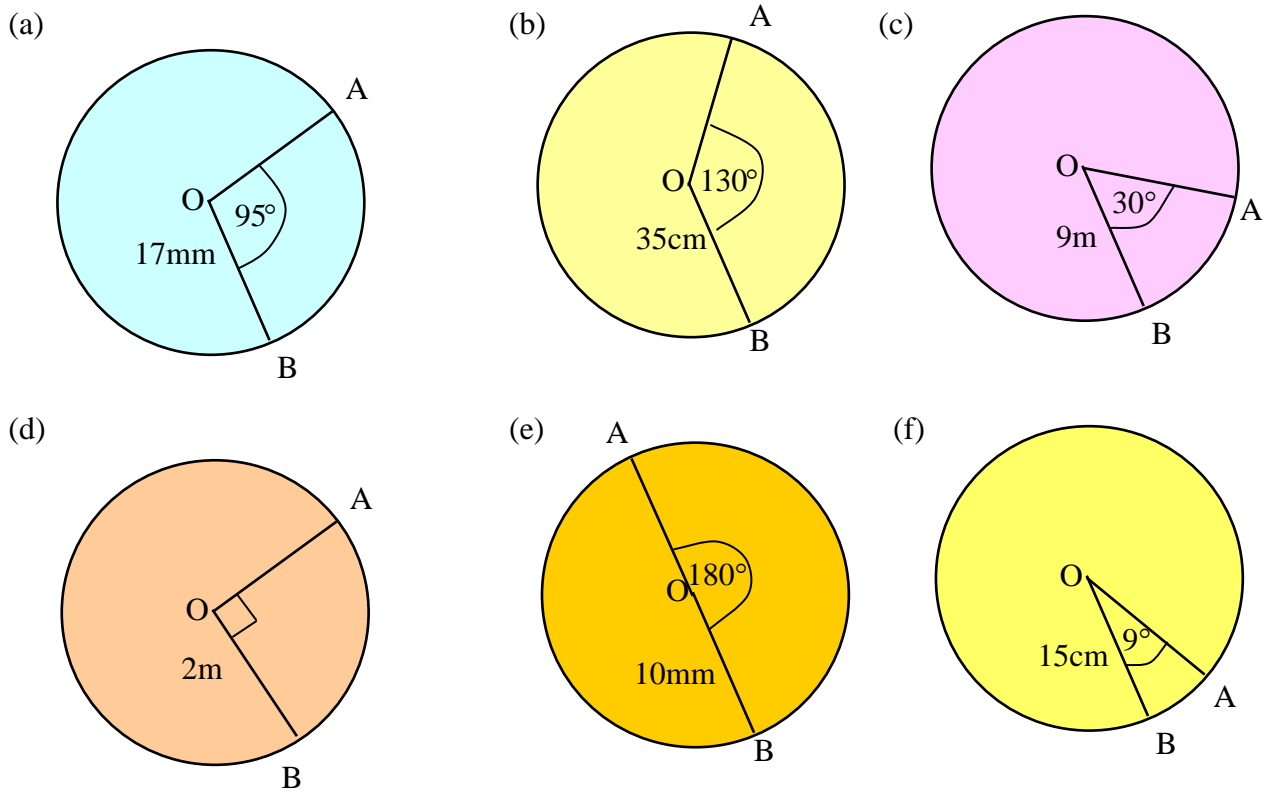
8. In each of the following, shape P is enlarged to a shape Q. Find the scale factor, k , for each enlargement. Find also the value of x .



9. A document is reduced to $\frac{3}{5}$ of its original size. 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 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 $\frac{1}{4}$ of the area of the original. If the original had dimensions 112mm by 142mm what will the dimensions of the copy be?

Sectors of Circles

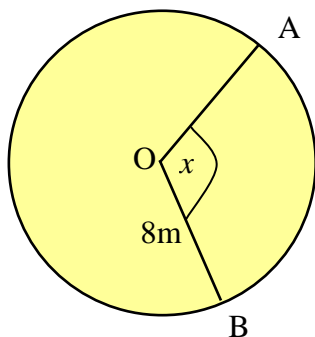
1. Find the area of the sectors OAB in the diagrams below (to 3sf):



2. Find the length of the curved edge AB in the above diagrams (to 3sf).

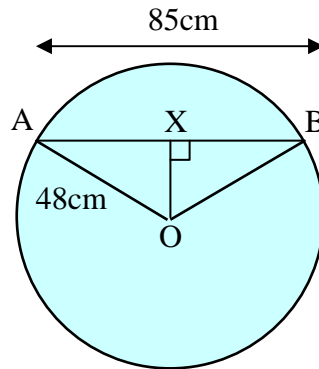
3. The area of the minor sector AOB shown below is 60m^2 .

- Find an expression for the area of the minor sector AOB in terms of x .
- By putting this expression equal to 60m^2 , find the angle x (to 1dp).
- Find an expression for the length of the minor sector AOB in terms of x .
- Find the *exact* length of the minor arc AB (by using “Ans” on calculator for the value of x).



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4. In the diagram below $AB = 85\text{cm}$, X is the midpoint of AB , and O is the centre of the circle
- (a) Show that $\angle AOX = 62.3^\circ$ (to 1dp) (by using trigonometry).
 - (b) Find the angle AOB (to 1dp).
 - (c) Find the length OX (to 3sf).
 - (d) Find the area of triangle AOB (to 3sf).
 - (e) Find the area of the sector AOB (to 3sf).
 - (f) Find the area of the shaded segment (to 3sf).



Histograms

1. (a) Copy and complete the following table which shows the time taken by a group of candidates to finish an exam:

Time in minutes	$45 \leq x < 50$	$50 \leq x < 55$	$55 \leq x < 60$	$60 \leq x < 70$	$70 \leq x < 90$
Number of candidates	21	32	37	29	18
Frequency Density	$\frac{21}{5} = 4.2$				

- (b) Draw a histogram to illustrate this data, using a scale of 1cm per 5 minutes on the horizontal axis (TIME - which goes from 45 to 90) and 1cm per unit on the vertical axis (FREQUENCY DENSITY - which goes from 0 to 8). Label your axes clearly.

2. The height in cm of plants is shown below:

Height (cm)	Frequency	Class Width	Frequency Density
5-	6	5	$\frac{6}{5} = 1.2$
10-	9		
15-	11		
20-	6	10	$\frac{6}{10} = 0.6$
30-	4		
40-60	2		

- (a) Copy and complete the above table.
 (b) Draw a histogram to illustrate this data, using a scale of 1cm per 5 units on the horizontal axis (which goes from 5cm to 60cm) and 5cm per unit on the vertical axis (which goes from 0 to 2.5).

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3. The table below shows the ages of the people stopped by a company investigating the voting intentions of the adults in a certain town:

Age	18-21	22-25	26-35	36-49	50-74
Age (inequality)	$18 \leq a < 22$				$50 \leq a < 75$
Frequency	14	24	39	28	20
Frequency Density	3.5				

- (a) Explain why the 18-21 category is represented by the inequality $18 \leq a < 22$.
- (b) Copy and complete the table shown above.
- (c) Draw a histogram to illustrate this data, using a scale of 1cm per 5 units on the horizontal axis (which goes from 15 to 75) and 2cm per unit on the vertical axis (which goes from 0 to 6).