MathsWatch Worksheets

HIGHER

Questions and Answers

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Factors, Multiples and Primes

1) Write the factors of

   a) 6   b) 16   c) 18   d) 30
   1, 2, 3, 6   1, 2, 4, 8, 16   1, 2, 3, 6, 9, 18   1, 2, 3, 5, 6, 10, 15, 30

2) In a pupil's book the factors of 12 are listed as

   1   2   3   4   ~~8~~   12
                   6

   The above list contains a mistake.

   Cross it out from the list and replace it with the correct number.

3) The factors of 30 and 40 are listed
   30: 1, 2, 3, 5, 6, 10, 15, 30
   40: 1, 2, 4, 5, 8, 10, 20, 40

   Write the common factors of 30 and 40 (the numbers that are factors of 30 and 40).
   1, 2, 5, 10

4) Write the first four multiples of

   a) 3   b) 5   c) 10   d) 15
   3, 6, 9, 12   5, 10, 15, 20   10, 20, 30, 40   15, 30, 45, 60

5) In a pupil's book the first 7 multiples of 8 are listed as

   8   16   ~~22~~   32   40   48   ~~54~~
            24   56
   The above list contains 2 mistakes.
   Cross them out and replace them with the correct numbers.

6) The first five multiples of 4 and 10 are listed
    4:   4, 8, 12, 16, 20
   10: 10, 20, 30, 40, 50

   From the two lists above, write the common multiple of 4 and 10.
   20

7) List the first five prime numbers
   2, 3, 5, 7, 11

8) Using just this list of numbers:

   11   18   1   4   21   24   9   3   12   2   19

   find the following:

   a) The prime numbers   2, 3, 11, 19

   b) The factors of 18   1, 2, 3, 9, 18

   c) The multiples of 3   3, 9, 12, 18, 21, 24

Evaluate Powers, Squares, Cubes & Roots

1. Evaluate
   a) 7^2 **49** b) 2^4 **16** c) 5^2 **25** d) 3^3 **27** e) 1^6 **1**
   7 × 7 = 49 2 × 2 × 2 × 2 = 16 5 × 5 = 25 3 × 3 × 3 = 27 1 × 1 × 1 × 1 × 1 × 1 = 1

2. Work out the square of
   a) 1 **1** b) 2 **4** c) 4 **16** d) 6 **36** e) 11 **121**
   1^2 = 1 2^2 = 4 4^2 = 16 6^2 = 36 11^2 = 121

3. Work out
   a) 3^2 **9** b) 9^2 **81** c) 10^2 **100** d) 12^2 **144** e) 100^2 **10 000**
   3 × 3 = 9 9 × 9 = 81 10 × 10 = 100 12 × 12 = 144 100 × 100 = 10 000

4. Work out the cube of
   a) 1 **1** b) 3 **27** c) 5 **125** d) 6 **216** e) 100 **1 000 000**
   1^3 = 1 3^3 = 27 5^3 = 125 6^3 = 216 100^3 = 1 000 000

5. Work out
   a) 2^3 **8** b) 4^3 **64** c) 10^3 **1000**
   2 × 2 × 2 = 8 4 × 4 × 4 = 64 10 × 10 × 10 = 1000

6. Work out the square root of
   a) 1 **1** b) 9 **3** c) 81 **9**
   1 × 1 = 1 3 × 3 = 9 9 × 9 = 81

7. Work out
   a) $\sqrt{25}$ **5** b) $\sqrt{49}$ **7** c) $\sqrt{121}$ **11**
   5^2 = 25 7^2 = 49 11^2 = 121

8. Work out the cube root of
   a) 27 **3** b) 1 **1** c) 125 **5**
   3^3 = 27 1^3 = 1 5^3 = 125

9. From the following numbers
   4   27   8   64   16   19   100   360   45   3
   Find
   a) The square numbers
   4   64   16   100 2² = 4, 8² = 64, 4² = 16, 10² = 100
   b) The cube numbers
   27   8   64 3³ = 27, 2³ = 8, 4³ = 64
   c) The square root of 64
   8 8² = 64
   d) The cube root of 27
   3 3² = 27

10. Match together cards with the same answer
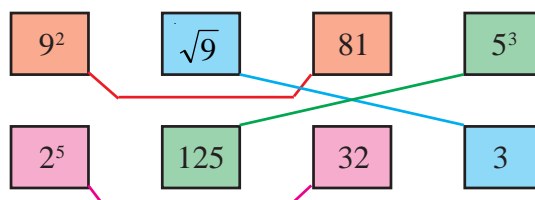
Equivalent Fractions, Simplifying and Ordering Fractions

1) Write down three equivalent fractions for each of these

   a) $\dfrac{3}{4}$ $\dfrac{6}{8}$ $\dfrac{9}{12}$ $\dfrac{12}{16}$ etc...

   b) $\dfrac{2}{5}$ $\dfrac{4}{10}$ $\dfrac{6}{15}$ $\dfrac{8}{20}$ etc...

   c) $\dfrac{7}{8}$ $\dfrac{14}{16}$ $\dfrac{21}{24}$ $\dfrac{28}{32}$ etc...

2) Match together equivalent fractions

   $\dfrac{10}{15}$ $\dfrac{3}{5}$ $\dfrac{18}{21}$ $\dfrac{21}{35}$ $\dfrac{2}{3}$ $\dfrac{6}{7}$ $\dfrac{30}{50}$

   A   B   C   B   A   C   B

3) Find the missing values in these equivalent fractions

   a) $\dfrac{1}{4} = \dfrac{2}{8} = \dfrac{4}{16} = \dfrac{10}{40}$

   c) $\dfrac{4}{5} = \dfrac{12}{15} = \dfrac{20}{25} = \dfrac{28}{35} = \dfrac{48}{60}$

   b) $\dfrac{6}{9} = \dfrac{2}{3} = \dfrac{60}{90} = \dfrac{48}{72} = \dfrac{66}{99}$

   d) $\dfrac{4}{10} = \dfrac{24}{60} = \dfrac{2}{5} = \dfrac{48}{120} = \dfrac{80}{200}$

4) Write these fractions in their simplest form

   a) $\dfrac{24}{48}$ $\dfrac{1}{2}$ b) $\dfrac{8}{20}$ $\dfrac{2}{5}$ c) $\dfrac{45}{63}$ $\dfrac{5}{7}$ d) $\dfrac{39}{45}$ $\dfrac{13}{15}$ e) $\dfrac{72}{104}$ $\dfrac{9}{13}$

5) Write these fractions in order of size (smallest first)

   a) $\dfrac{3}{8}$ $\dfrac{9}{16}$ $\dfrac{1}{4}$ $\dfrac{5}{16}$ $\dfrac{1}{4}$ $\dfrac{5}{16}$ $\dfrac{3}{8}$ $\dfrac{9}{16}$
   $\dfrac{6}{16}$ $\dfrac{9}{16}$ $\dfrac{4}{16}$ $\dfrac{5}{16}$

   c) $\dfrac{5}{8}$ $\dfrac{4}{6}$ $\dfrac{3}{24}$ $\dfrac{7}{12}$ $\dfrac{3}{24}$ $\dfrac{7}{12}$ $\dfrac{5}{8}$ $\dfrac{4}{6}$
   $\dfrac{15}{24}$ $\dfrac{16}{24}$ $\dfrac{3}{24}$ $\dfrac{14}{24}$

   b) $\dfrac{2}{3}$ $\dfrac{7}{12}$ $\dfrac{3}{4}$ $\dfrac{5}{6}$ $\dfrac{7}{12}$ $\dfrac{2}{3}$ $\dfrac{3}{4}$ $\dfrac{5}{6}$
   $\dfrac{8}{12}$ $\dfrac{7}{12}$ $\dfrac{9}{12}$ $\dfrac{10}{12}$

   d) $\dfrac{6}{10}$ $\dfrac{4}{5}$ $\dfrac{5}{12}$ $\dfrac{16}{30}$ $\dfrac{5}{12}$ $\dfrac{16}{30}$ $\dfrac{6}{10}$ $\dfrac{4}{5}$
   $\dfrac{36}{60}$ $\dfrac{48}{60}$ $\dfrac{25}{60}$ $\dfrac{32}{60}$

6) Ben spent his pocket money this way:

   $\dfrac{7}{20}$ on magazines; $\dfrac{7}{20}$

   $\dfrac{4}{10}$ on chocolates; $\dfrac{8}{20}$

   $\dfrac{1}{4}$ on games. $\dfrac{5}{20}$

   Order the items Ben bought by value (largest first).   chocolates, magazines, games
   Show all working

Value for Money

1) Which of the following offer better value for money?
   Working must be shown

   a) 200ml of toothpaste for 50p or 400ml of toothpaste for 90p

   × 2
   400ml of toothpaste for £1.00

   b) 600g of bananas for 70p or 200g of bananas for 22p

   × 3
   600g of bananas for 66p

   c) 2 litres of paint for £1.60 or 5 litres of paint for £3.50

   ÷ 2   **÷ 5**
   1 litre of paint for 80p or 1 litre of paint for 70p

   d) 60 teabags for £1.62 or 40 teabags for £0.96

   × 2   **× 3**
   120 teabags for £3.24 or 120 teabags for £2.88

2) Which of these is the best buy?
   Working must be shown
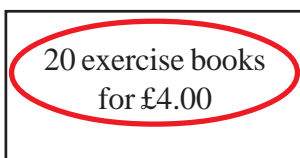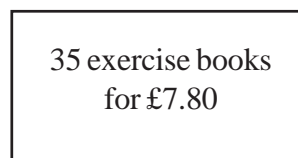
20 exercise books for £4.00	35 exercise books for £7.80
400 ÷ 20 = 20	**780 ÷ 35 = 22.3**
20p per book	**22p per book**

3) Hamza needs to buy 2 litres of paint.

   At the shop he gets two choices:

   500ml for £2.55 or 1 litre for £4.79.

   × 2
   1 litre of paint for £5.10

   a) Work out which of these would be the best buy for Hamza.

   1 litre of paint for £4.79

   b) How much does he save if he buys the 'best buy' rather than the 'worst buy'.

   £0.31 or 31p

   You must show all your working.

   £5.10
   − £4.79
   £0.31

4) Honey pots are sold in two sizes.

   A small pot costs 45p and weighs 450g.   **45 ÷ 450 = 0.1p per g**
   A large pot costs 80p and weighs 850g.   **80 ÷ 850 = 0.09p per g**

   Which pot of honey is better value for money?   **Large pot at 80p for 850g**
   You must show all your working.

Find a Percentage with a Calculator

1) Work out

   a) 21% of 340   **71.4**   d) 3.5% of 78.6   **2.751**

   b) 9% of 2700   **243**   e) 80.5% of 3200   **2576**

   c) 17.5% of 420   **73.5**   f) 117.5% of 35   **41.125**

2) Work out the total cost (including VAT) of the following items.

Trainers £45.50 plus 17.5% VAT	Tennis racquet £28.99 plus 17.5% VAT	Football boots £57 plus 17.5% VAT
£53.46	**£34.06**	**£66.98**

3) 850 people attended a festival.

   16% of the people were children.

   Work out the number of children at the festival.   **136 children**

Find a Percentage Without a Calculator

1) Work out   (i) 10% and (ii) 5% and (iii) 15% of:

   a) 200 **(i) 20**   b) 30 **(i) 3**   c) 450 **(i) 45**   d) 54 **(i) 5.4**

             (ii) 10   **(ii) 1.5**   **(ii) 22.5**   **(ii) 2.7**

             (iii) 30   **(iii) 4.5**   **(iii) 67.5**   **(iii) 8.1**

2) Work out

   a) 30% of 280   **84**   d) 17.5% of 300   **52.5**

   b) 80% of 3500   **2800**   e) 55% of 700   **385**

   c) 15% of 540   **81**   f) 17.5% of 180   **31.5**

3) Work out the total cost (including VAT) of the following items.

100 %	200		60		1200
+ 10 %	+ 20		+ 6		+ 120
+ 5 %	+ 10	Video recorder £200 + 17.5% VAT	+ 3	Tape player £60 + 17.5% VAT	+ 60	Laptop £1200 + 17.5% VAT
+ 2.5%	+ 5		+ 1.5		+ 30
	235	**£235**	70.5	**£70.50**	1410	**£1410**

4) There are 1300 students at MathsWatch College.

   45% of these students are boys.

   Work out the number of boys.   **585 boys**

   10 % = 130

   40% = 130 × 4 = 520

   5% = 130 ÷ 2 = 65

   520 + 65 = 585

Change to a Percentage With a Calculator

1) In a class of 37 pupils, 22 are boys.

   a) What percentage of the class are boys? **59.5%** $\frac{22}{37} \times 100 = 59.5\%$

   b) What percentage of the class are girls? **40.5%** $\frac{15}{37} \times 100 = 40.5\%$

2) Sarah sat a mock examination and gained the following marks:

Subject	Mark		
English	$\frac{82}{94}$	**87.2%**	$\frac{82}{94} \times 100 = 87.2\%$
Maths	$\frac{79}{123}$	**64.2%**	$\frac{79}{123} \times 100 = 64.2\%$
Science	$\frac{38}{46}$	**82.6%**	$\frac{38}{46} \times 100 = 82.6\%$

   a) Write each of Sarah's marks as a percentage.

   b) Which is Sarah's best subject in terms of percentage score? **English**

3) A brand new car costs £16 500.
   A discount of £2 227.50 is negotiated with the dealer.
   What is the percentage discount? **13.5%**

   $\frac{2227.5}{16500} \times 100 = 13.5\%$

Change to a Percentage Without a Calculator

1) Write the following as percentages:

   a) 13 out of 50 **26%** $\frac{13}{50} \underset{\times 2}{=} \frac{26}{100}$

   b) 6 out of 20 **30%** $\frac{6}{20} \underset{\times 5}{=} \frac{30}{100}$

   c) 17 out of 25 **68%** $\frac{17}{25} \underset{\times 4}{=} \frac{68}{100}$

   d) 34 out of 40 **85%** $\frac{34}{40} \underset{\div 2}{=} \frac{17}{20} \underset{\times 5}{=} \frac{85}{100}$

   e) 12 out of 80 **15%** $\frac{12}{80} \underset{\div 4}{=} \frac{3}{20} \underset{\times 5}{=} \frac{15}{100}$

   f) 27 out of 60 **45%** $\frac{27}{60} \underset{\div 3}{=} \frac{9}{20} \underset{\times 5}{=} \frac{45}{100}$

2) In a football tournament, Team A won 16 of the 20 games they played,
   whilst team B won 19 of their 25 games.
   What percentage of their games did they each win?
   Team A: 80%   Team B: 76%

   Team A: $\frac{16}{20} \underset{\times 5}{=} \frac{80}{100}$ **80%**

   Team B: $\frac{19}{25} \underset{\times 4}{=} \frac{76}{100}$ **76%**

3) 60 participants were invited to a conference.
   36 of the participants were females.

   a) Work out the percentage of female participants. **60%**

   $\frac{36}{60} \underset{\div 3}{=} \frac{12}{20} \underset{\times 5}{=} \frac{60}{100}$

   b) What is the percentage of male participants? **40%**

   $100\% - 60\% = 40\%$

4) A company has 800 employees.
   440 of these 800 employees are males.
   176 of these 800 employees are under 25 years old.

   a) What percentages of males are employed in this company? **55%**

   $\frac{440}{800} \underset{\div 8}{=} \frac{55}{100}$

   b) What percentage of employees are under 25? **22%**

   $\frac{176}{800} \underset{\div 8}{=} \frac{22}{100}$

Find a Fraction of an Amount

1. Work out these amounts.

    a) $\frac{3}{4}$ of £20   £15   b) $\frac{2}{3}$ of 60 kg   40 kg   c) $\frac{3}{8} \times 24$ 9

    d) $150 \times \frac{2}{3}$ 100   e) $\frac{2}{9}$ of 180 cm   40 cm   f) $49 \times \frac{4}{7}$ 28

    g) $60 \times \frac{1}{4}$ 15   h) $\frac{5}{8}$ of £48   £30   i) $4000 \times \frac{7}{8}$ 3 500

2. There are 600 apples on a tree and there are maggots in $\frac{3}{5}$ of them.

    How many apples have maggots in them?   360 apples

3. Liz and Lee are travelling in a car from Glasgow to Poole (770 km).

    At midday they had already travelled $\frac{5}{7}$ of the total distance.

    What distance, in km, had they travelled by midday?   550 km

4. A digital camera that cost £49 was sold on eBay for $\frac{3}{7}$ of the original price.

    What was the selling price?   £21

5. Yesterday Thomas travelled a total of 175 miles.

    He travelled $\frac{2}{5}$ of this distance in the morning.

    $\frac{2}{5}$ of 175 miles is 70 miles
    175 - 70 = 105

    How many miles did he travel during the rest of the day?   105 miles

6. Debra received her £15 pocket money on Saturday.

    She spent $\frac{1}{3}$ of her pocket money on magazines.

    She spent $\frac{2}{5}$ of her pocket money on a necklace.

    $\frac{1}{3}$ of £15 is £5
    $\frac{2}{5}$ of £15 is £6
    15 - 5 - 6 = 4

    How much of the £15 did she have left?   £4

1. Work out the following giving your answer as a fraction in its simplest form

   a) $\frac{3}{5} + \frac{1}{5}$ **$\frac{4}{5}$**   b) $\frac{3}{7} + \frac{2}{7}$ **$\frac{5}{7}$**   c) $\frac{5}{8} - \frac{3}{8}$ **$\frac{1}{4}$**   d) $\frac{7}{13} - \frac{4}{13}$ **$\frac{3}{13}$**

2. Work out the following giving your answer as a fraction in its simplest form

   a) $\frac{3}{5} + \frac{2}{10}$ **$\frac{4}{5}$**   b) $\frac{1}{3} + \frac{2}{9}$ **$\frac{5}{9}$**   c) $\frac{13}{20} - \frac{3}{5}$ **$\frac{1}{20}$**   d) $\frac{9}{12} - \frac{1}{3}$ **$\frac{5}{12}$**

3. Change the following to mixed numbers

   a) $\frac{8}{5}$ **$1\frac{3}{5}$**   b) $\frac{14}{3}$ **$4\frac{2}{3}$**   c) $\frac{35}{6}$ **$5\frac{5}{6}$**   d) $\frac{17}{5}$ **$3\frac{2}{5}$**

4. Change the following to top heavy (or improper) fractions

   a) $1\frac{2}{5}$ **$\frac{7}{5}$**   b) $3\frac{1}{4}$ **$\frac{13}{4}$**   c) $6\frac{1}{5}$ **$\frac{31}{5}$**   d) $2\frac{5}{9}$ **$\frac{23}{9}$**

5. Work out the following giving your answer as a fraction in its simplest form

   a) $1\frac{2}{5} + 6\frac{1}{5}$ **$7\frac{3}{5}$**   b) $2\frac{3}{4} + 1\frac{1}{5}$ **$3\frac{19}{20}$**   c) $4\frac{1}{6} - 3\frac{1}{3}$ **$\frac{5}{6}$**   d) $7\frac{4}{9} - 2\frac{5}{9}$ **$4\frac{8}{9}$**

6. Work out the following giving your answer as a fraction in its simplest form

   a) $\frac{3}{4} - \frac{1}{5}$ **$\frac{11}{20}$**   b) $\frac{5}{11} + \frac{3}{11}$ **$\frac{8}{11}$**   c) $5\frac{1}{2} - \frac{2}{3}$ **$4\frac{5}{6}$**   d) $\frac{7}{12} + \frac{3}{4}$ **$1\frac{1}{3}$**

   e) $2\frac{4}{5} + 9\frac{2}{5}$ **$12\frac{1}{5}$** f) $\frac{2}{7} + \frac{1}{2}$ **$\frac{11}{14}$**   g) $9\frac{1}{4} - 5\frac{2}{5}$ **$3\frac{17}{20}$** h) $\frac{12}{15} - \frac{7}{15}$ **$\frac{1}{3}$**

7. Ted received his pocket money on Friday.

   He spent $\frac{3}{5}$ of his pocket money on games.

   He spent $\frac{1}{10}$ of his pocket money on magazines.

   What fraction of his pocket money did he have left? **$\frac{3}{10}$**

   $\frac{3}{5} + \frac{1}{10} = \frac{7}{10}$

   $1 - \frac{7}{10} = \frac{3}{10}$

8. Maisie buys a bag of flour.

   She uses $\frac{1}{4}$ to bake a cake and $\frac{2}{5}$ to make a loaf.

   a) What fraction of the bag of flour was used? **$\frac{13}{20}$**
   b) What fraction of the bag of flour is left? **$\frac{7}{20}$**

9. Work out the total length of this shape. **$5\frac{11}{12}$** inches
   Give your answer as a mixed number.

   Diagram **NOT** accurately drawn

   $\longleftarrow 3\frac{1}{4}$ inches $\longrightarrow\longleftarrow 2\frac{2}{3}$ inches$\longrightarrow$
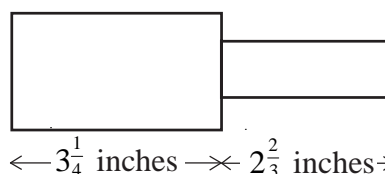
Multiplication and Division of Fractions

Work out the following giving your answer as a fraction in its simplest form.

1) $\dfrac{4}{5} \times \dfrac{1}{3}$ $\dfrac{4}{15}$

2) $\dfrac{3}{4} \times \dfrac{2}{3}$ $\dfrac{1}{2}$

3) $\dfrac{3}{10} \times \dfrac{4}{9}$ $\dfrac{2}{15}$

4) $\dfrac{3}{7} \times \dfrac{5}{6}$ $\dfrac{5}{14}$

5) $\dfrac{6}{25} \times \dfrac{15}{18}$ $\dfrac{1}{5}$

6) $\dfrac{4}{15} \times \dfrac{3}{16}$ $\dfrac{1}{20}$

7) $2\frac{2}{5} \times 3\frac{3}{4}$ 9

8) $1\frac{2}{3} \times 3\frac{3}{10}$ $5\frac{1}{2}$

9) $4\frac{2}{3} \times \dfrac{5}{7}$ $3\frac{1}{3}$

10) $\dfrac{3}{5} \times 12\frac{1}{2}$ $7\frac{1}{2}$

11) $\dfrac{1}{3} \div \dfrac{5}{6}$ $\dfrac{2}{5}$

12) $\dfrac{2}{7} \div \dfrac{10}{21}$ $\dfrac{3}{5}$

13) $\dfrac{4}{5} \div 8$ $\dfrac{1}{10}$

14) $\dfrac{4}{11} \div \dfrac{4}{11}$ 1

15) $\dfrac{4}{5} \div \dfrac{8}{9}$ $\dfrac{9}{10}$

16) $\dfrac{5}{8} \div \dfrac{10}{19}$ $1\frac{3}{16}$

17) $1\frac{2}{3} \div 2\frac{1}{2}$ $\dfrac{2}{3}$

18) $3\frac{1}{5} \div 2\frac{2}{3}$ $1\frac{1}{5}$

19) $25 \div 2\frac{1}{7}$ $11\frac{2}{3}$

20) $\dfrac{2}{3} \div 2\frac{2}{9}$ $\dfrac{3}{10}$

Change a Fraction to a Decimal

Write the following fractions as decimals

1) $\dfrac{3}{10}$ 0.3 $\begin{array}{r} 0.3 \\ 10\overline{)3\ 0} \end{array}$

2) $\dfrac{7}{10}$ 0.7

3) $\dfrac{9}{100}$ 0.09

4) $\dfrac{1}{2}$ 0.5

5) $\dfrac{3}{4}$ 0.75

6) $\dfrac{2}{5}$ 0.4

7) $\dfrac{7}{20}$ 0.35

8) $\dfrac{1}{3}$ 0.$\dot{3}$

9) $\dfrac{1}{8}$ 0.125

10) $\dfrac{5}{8}$ 0.625

BODMAS

Work out

1) $6 \times 5 + 2$ **= 32**   30 + 2 = 32

2) $2 + 6 \times 5$ **= 32**   2 + 30 = 32

3) $35 - 4 \times 3$ **= 23**   35 - 12 = 23

4) $48 \div (14 - 2)$ **= 4**   48 ÷ 12 = 4

5) $27 \div (3 + 6)$ **= 3**   27 ÷ 9 = 3

6) $27 \div 3 + 6$ **= 15**   9 + 6 = 15

7) $(9 + 2) \times 2 + 5$ **= 27**   11 × 2 + 5 , 22 + 5 = 27

8) $4 \times (1 + 4) - 6$ **= 14**   4 × 5 - 6 , 20 - 6 = 14

9) $6 \times 4 - 3 \times 5$ **= 9**   24 - 15 = 9

10) $\dfrac{9 + 3}{4 + 2}$ **= 2** $\dfrac{12}{6}$ = 2

11) $\dfrac{23 + 9}{7 - 3}$ **= 8** $\dfrac{32}{4}$ = 8

12) $\dfrac{7 - 2^2}{4^2 - 15}$ **= 3** $\dfrac{7 - 4}{16 - 15}$, $\dfrac{3}{1}$ = 3

13) $\dfrac{5^2 + 3}{2 \times 7}$ **= 2** $\dfrac{25 + 3}{14}$, $\dfrac{28}{14}$ = 2

14) $\dfrac{5 \times 6 - 4}{13}$ **= 2** $\dfrac{30 - 4}{13}$, $\dfrac{26}{13}$ = 2

15) $\dfrac{8 \times 2 - 4}{3 + 1^2}$ **= 3** $\dfrac{16 - 4}{3 + 1}$, $\dfrac{12}{4}$ = 3

16) $\dfrac{12 - 3 \times 2}{14 \div 7}$ **= 3** $\dfrac{12 - 6}{2}$, $\dfrac{6}{2}$ = 3

17) $\dfrac{20 - 3^2}{10 - (5 + 4)}$ **= 11** $\dfrac{20 - 9}{10 - 9}$, $\dfrac{11}{1}$ = 11

18) $\dfrac{3 + 9 \times 8}{1 + 6 \times 4}$ **= 3** $\dfrac{3 + 72}{1 + 24}$, $\dfrac{75}{25}$ = 3

Long Multiplication of Decimals

1. Work out

   a) 7×4.3 **30.1**   b) 5×3.16 **15.8**   c) 2.3×1.2 **2.76**

   d) 7.2×42.5 **306**   e) 12.5×0.59 **7.375**   f) 0.652×0.37 **0.24124**

   g) 5.62×9 **50.58**   h) 26.7×4.9 **130.83**   i) 1.56×0.059 **0.09204**

2. David buys 5 books for £8.75 each.
   How much does he pay?   **£43.75**

3. A DVD costs £12.25.
   Work out the cost of 9 of these DVDs.   **£110.25**

4. John takes 27 boxes out of his van.
   The weight of each box is 41.7 kg.
   Work out the total weight of the 27 boxes.   **1 125.9 kg**

5. Nina bought 43 teddy bears at £9.35 each.
   Work out the total amount she paid.   **£402.05**

6. Elliott goes shopping.
   He buys
   0.5 kg of pears at £0.84 per kg.   **£0.42**
   2.5 kg of grapes at £1.89 per kg.   **£4.73**
   6 kg of potatoes at £0.25 per kg.   **+ £1.50**

   How much does he pay?   **£6.65**

7. Brian hires a car for 3 days.
   Tariffs are:
      £44.80 for the first day and   **£44.80**
      £37.50 for each extra day.   **£37.50**
                          + £37.50
   How much does he pay?   **£119.80**

Ratio

1. Write the following ratios in their simplest form
   a) 6 : 9   b) 10 : 5   c) 7 : 21   d) 4 : 24
      2 : 3   2 : 1   1 : 3   1 : 6

   e) 12 : 40   f) 18 : 27   g) 4 : 2 : 8   h) 18 : 63 : 9
         3 : 10   2 : 3   2 : 1 : 4   2 : 7 : 1

2. Complete the missing value in these equivalent ratios
   a) 3 : 5 = 12 : $\boxed{20}$ b) 4 : 9 = $\boxed{12}$: 27   c) $\boxed{8}$: 7 = 16 : 14   d) 2 : 3 = 3 : $\boxed{4.5}$

3. Match together cards with equivalent ratios:

   | 3 : 4 | | 10 : 5 | | 50 : 100 | | 2 : 1 |

   | 5 : 2 | | 15 : 20 | | 15 : 6 | | 1 : 2 |

4. The ratio of girls to boys in a class is 4 : 5.
   a) What fraction of the class are girls? $\frac{4}{9}$
   b) What fraction of the class are boys? $\frac{5}{9}$

5. A model of a plane is made using a scale of 1 : 5.
   a) If the real length of the plane is 20m, what is the length of the model in metres? **4m**
   b) If the wings of the model are 100cm long, what is the real length of the wings in metres? **5m**

6. Share out £250 in the following ratios:
   a) 1 : 4   b) 2 : 3   c) 7 : 3   d) 9 : 12 : 4
   £50 and £200   **£100 and £150**   **£175 and £75**   **£90 and £120 and £40**

7. Share out £80 between Tom and Jerry in the ratio 3 : 2. **Tom gets £48, Jerry gets £32**
   3 + 2 = 5   **80 ÷ 5 = 16**   **3 × 16 = 48**   **2 × 16 = 32**

8. A box of chocolates has 3 milk chocolates for every 2 white chocolates.
   There are 60 chocolates in the box.
   Work out how many white chocolates are in the box. **24 white chocolates**
   3 + 2 = 5   **60 ÷ 5 = 12**   **2 × 12 = 24**

9. In a bracelet, the ratio of silver beads to gold beads is 5 : 2.
   The bracelet has 25 silver beads.
   How many gold beads are in the bracelet? **10 gold beads**

             S   G
    ×5 (5   2) ×5
         25   ?

10. To make mortar you mix 1 shovel of cement with 5 shovels of sand.
    How much sand do you need to make 30 shovels of mortar? **25 shovels of sand**
    1 + 5 = 6
    30 ÷ 6 = 5
    5 × 5 = 25

Recipe Type Ratio Questions

1) Here are the ingredients for making a vegetable soup for 6 people:

> **2 carrots**
> **1 onion**
> **800ml stock**
> **50g lentils**
> **4g thyme**

Work out the amount of each ingredient for

a) 12 people

b) 9 people

c) 30 people.

a) For 12 people:
4 carrots
2 onions
1600ml stock
100g lentils
8g thyme

b) For 9 people:
3 carrots
1½ onions
1200ml stock
75g lentils
6g thyme

c) For 30 people:
10 carrots
5 onions
4000ml stock
250g lentils
20g thyme

2) Here are the ingredients for making apple crumble for 4 people:

> **80g plain flour**
> **60g ground almonds**
> **90g sugar**
> **60g butter**
> **4 apples**

Work out the amount of each ingredient for

a) 2 people

b) 6 people

c) 18 people.

a) For 2 people:
40g plain flour
30g ground almonds
45g sugar
30g butter
2 apples

b) For 6 people:
120g plain flour
90g ground almonds
135g sugar
90g butter
6 apples

c) For 18 people:
360g plain flour
270g ground almonds
405g sugar
270g butter
18 apples

3) Here are the ingredients for making 1500 ml of parsnip soup:

> **450g parsnips**
> **300g leeks**
> **150g bramley apples**
> **3 onions**
> **1½ pints of chicken stock**

a) For 500ml:
150g parsnips
100g leeks
50g bramley apples
1 onion
½ pint of chicken stock

Work out the amount of each ingredient for

a) 500 ml of soup

b) 1000 ml of soup

c) 2500 ml of soup.

b) For 1000ml:
300g parsnips
200g leeks
100g bramley apples
2 onions
1 pint of chicken stock

c) For 2500ml:
750g parsnips
500g leeks
250g bramley apples
5 onions
2½ pints of chicken stock

Hard Calculator Questions

1) Find the value of the following:
   (write down all the figures on your calculator display)

   a) $(0.3 + 2.8)^2$ b) $2.7^2 + 3.9^2$ c) $4.5^2 - \sqrt{53}$ d) $6 \times \sqrt{(37 \div 4)}$

   9.61   22.5   12.96989011   18.24828759

2) Find the value of the following:
   (write your answers correct to 1 decimal place)

   a) $5.6^3 + 11.2$ b) $87.4 \div (\sqrt{39} + 3)$ c) $\dfrac{\sqrt{3412}}{4.3^2}$ d) $\dfrac{15^2 - 12^2}{\sqrt{9.6 - 3.87}}$

   186.8   9.5   3.2   33.8
   186.816   9.453760835   3.159130745   33.83823544

3) Work out

   $\sqrt{16.75} + 1.53^2$

   a) Write down all the figures on your calculator display.   6.433576386

   b) Write your answer to part (a) correct to 1 decimal place.   6.4

4) Work out

   $(2.4 \times 1.9)^2 \times 2.03$ 42.211008
   Write down all the figures on your calculator display.

5) Use your calculator to work out the value of

   $\dfrac{7.34 \times 4.71}{5.63 + 11.89}$

   a) Write down all the figures on your calculator display.   1.973253425

   b) Write your answer to part (a) to an appropriate degree of accuracy.   1.97 or 2.0

Real-Life Money Questions

1) Lance goes on holiday to France.
   The exchange rate is £1 = 1.40 Euros.

   He changes £350 into Euros.

   a) How many Euros should he get? €490   350 × 1.40 = 490

   In France, Lance buys a digital camera for 126 Euros.

   b) Work out the cost of the camera in pounds. £90   126 ÷ 1.40 = 90

2) Whilst on holiday in Spain, Gemma bought a pair of sunglasses for 77 Euros.
   In England, an identical pair of sunglasses costs £59.99.
   The exchange rate is £1 = 1.40 Euros.

   In which country were the glasses the cheapest, and by how much?
   Show all your working.   Spain, by £4.99

   77 ÷ 1.40 = 55   59.99 - 55.00 = 4.99

3) Luke buys a pair of trainers in Switzerland.
   He can pay either 86 Swiss Francs or 56 Euros.
   The exchange rates are:
   £1 = 2.10 Swiss Francs
   £1 = 1.40 Euros

   Which currency should he choose to get the best price, and how much would he save?
   Give your answer in pounds (£).   Euros, saving £0.95

   86 ÷ 2.10 = 40.95   56 ÷ 1.40 = 40

4) The total cost of 5 kg of potatoes and 2 kg of carrots is £4.88.
   3 kg of potatoes cost £1.98.

   Work out the cost of 1 kg of carrots.   £0.79

   1.98 ÷ 3 = 0.66   5 × 0.66 = 3.30   4.88 - 3.30 = 1.58   1.58 ÷ 2 = 0.79

5) The cost of 4 kg of bananas is £5.80.
   The total cost of 3 kg of bananas and 1.5 kg of pears is £5.61.

   Work out the cost of 1 kg of pears. £0.84

   5.80 ÷ 4 = 1.45
   3 × 1.45 = 4.35
   5.61 - 4.35 = 1.26
   1.26 ÷ 1.5 = 0.84

Nth Term

1. Write down the first 5 terms and the 10th term of the following sequences:

   eg.   *2n + 1*   *3, 5, 7, 9, 11.....21*

   a) 2n + 2   4, 6, 8, 10, 12, . . 22   d) 7n   7, 14, 21, 28, 35, . . 70

   b) 3n + 1   4, 7, 10, 13, 16, . . 31   e) 3n – 1   2, 5, 8, 11, 14, . . 29

   c) n + 3   4, 5, 6, 7, 8, . . 13   f) 7n – 3   4, 11, 18, 25, 32, . . 67

2. Find the *n*th term of the following sequences:

   0 a) 5, 10, 15, 20...   5n   +26 d) 22, 18, 14, 10...   -4n + 26
      5   5   5   -4 -4 -4

   +2 b) 5, 8, 11, 14...   3n + 2   -9 e) –3, 3, 9, 15...   6n - 9
      3   3   3   6   6   6

   -6 c) 1, 8, 15, 22...   7n - 6   +9 f) 4, –1, –6, –11...   -5n + 9
      7   7   7   -5 -5 -5

3. Here are some patterns made from sticks.

   Pattern 1   Pattern 2   Pattern 3

   a) Draw pattern 4 in the space, below..

          Pat 1 Pat 2 Pat 3 Pat 4 Pat 5 Pat 6
   +1   6   11   16   21   26   31
             5   5   5   5   5

   b) How many sticks are used in

       (i)   pattern 10   51 sticks   nth term is 5n + 1

       (ii)   pattern 20   101 sticks

       (iii) pattern 50   251 sticks

   c) Find an expression, in terms of *n*, for the number of sticks in pattern number *n*.   5n + 1

   d) Which pattern number can be made using 301 sticks?   Pattern 60

Substitution

1) Work out the value of $5x$ when
   a) $x = 2$ **10**
   5×2

   b) $x = 6$ **30**
   5×6

   c) $x = 10$ **50**
   5×10

2) Work out the value of $3x$ when
   a) $x = -2$ **-6**
   $3 \times (-2)$

   b) $x = 10$ **30**
   3×10

   c) $x = -12$ **-36**
   $3 \times (-12)$

3) Work out the value of x^2 when
   a) $x = 3$ **9**
   3×3

   b) $x = -4$ **16**
   $(-4) \times (-4)$

   c) $x = -10$ **100**
   $(-10) \times (-10)$

4) Work out the value of $2x^2$ when
   a) $x = 5$ **50**
   2×5^2

   b) $x = -4$ **32**
   $2 \times (-4)^2$

   c) $x = 10$ **200**
   2×10^2

5) Work out the value of $3x + 5$ when
   a) $x = 2$ **11**
   $3 \times 2 + 5$

   b) $x = 6$ **23**
   $3 \times 6 + 5$

   c) $x = -1$ **2**
   $3 \times (-1) + 5$

6) Work out the value of $4 + 2x$ when
   a) $x = 7$ **18**
   $4 + 2 \times 7$

   b) $x = -1$ **2**
   $4 + 2 \times (-1)$

   c) $x = -3$ **-2**
   $4 + 2 \times (-3)$

7) Work out the value of $3x + 2y$ when
   a) $x = 1$ and $y = 2$ **7**
   $3 \times 1 + 2 \times 2$

   b) $x = 4$ and $y = 3$ **18**
   $3 \times 4 + 2 \times 3$

   c) $x = 5$ and $y = -4$ **7**
   $3 \times 5 + 2 \times (-4)$

8) Work out the value of $6x - 3y$ when
   a) $x = 2$ and $y = 1$ **9**
   $6 \times 2 - 3 \times 1$

   b) $x = 1$ and $y = -2$ **12**
   $6 \times 1 - 3 \times (-2)$

   c) $x = -3$ and $y = 4$ **-30**
   $6 \times (-3) - 3 \times 4$

9) Work out the value of $3x^2 + 4y$ when
   a) $x = 1$ and $y = 5$ **23**
   $3 \times 1^2 + 4 \times 5$

   b) $x = -2$ and $y = 2$ **20**
   $3 \times (-2)^2 + 4 \times 2$

   c) $x = 3$ and $y = -2$ **19**
   $3 \times 3^2 + 4 \times (-2)$

10) Using the formula $P = H \times R$, where P is the total pay, H is the number of hours worked, and R is the hourly rate of pay.

    Work out the total pay (P) of the following people:

    a) Betty worked 10 hours at £7 per hour   **£70** $P = 10 \times 7$

    b) John worked 15 hours and is paid £9 per hour   **£135** $P = 15 \times 9$

    c) Mike worked for 90 minutes at £16 an hour.   **£24** $P = 1.5 \times 16$

11) The equation of a straight line is given as $y = 3x + 2$

    a) Work out the value of y when
    (i) $x = 0$ **y = 2** $y = 3 \times 0 + 2$
    (ii) $x = 1$ **y = 5** $y = 3 \times 1 + 2$
    (iii) $x = 2$ **y = 8** $y = 3 \times 2 + 2$

    b) What is the value of x when $y = 17$?   **x = 5** $17 = 3x + 2$

                                           $17 - 2 = 3 \times x$

                                           $\dfrac{15}{3} = x$

Alternate Angles

1) Line PQ is parallel to line RS

   If angle PQR is equal to 36°

   a) What is the size of angle QRS?   **36°**

   b) Give a reason for you answer.   **Alternate angles**

P ——————→——————— Q

36°

R ◄———————→——————— S
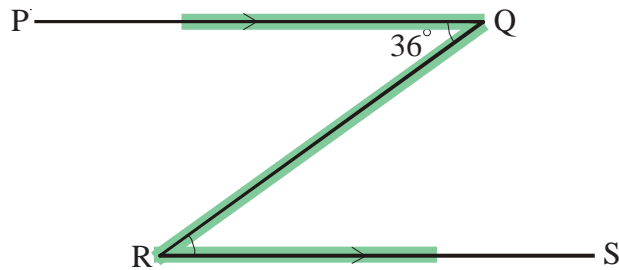
2) Line DCE is parallel to line AB

   a) Find the size of angle ABC   **33°**

   b) Find the size of angle DCA   **68°**

   c) Calculate the size of angle ACB   **79°**

   DCE is straight line
   180° – 68° – 33° = 79°

C

D ——————— 33° ——→——— E

68°

A ————→———— B
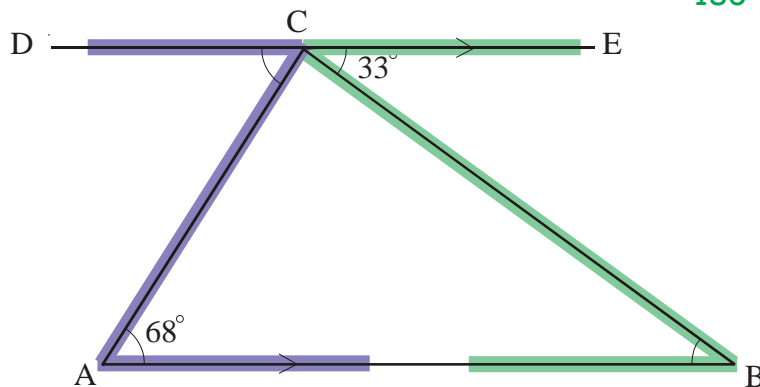
3) a) Find the size of angle DBF   **54°**

   b) Find the size of angle HGC   **136°**
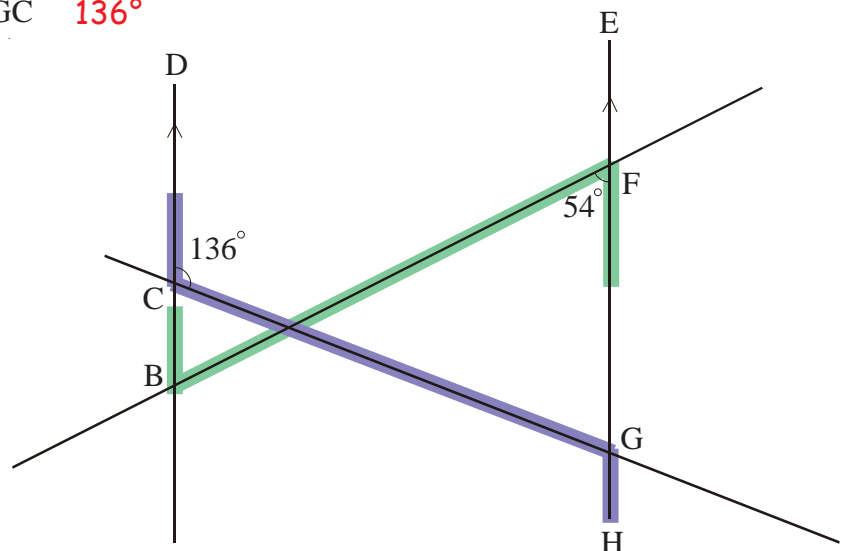
E

D

F

54°

136°

C

B

G

H

1) Work out the size of the angles marked with letters.

30°   **a = 80°**

70°   a

b = 40°   b

100°

40°

10°

c = 140°

c

30°

d = 38°

d

67°

75°

e = 118°

28°   34°

e

f = 47°

87°

f   46°

2) Work out the size of the angles marked with letters.

a   **a = 70°**

55°   **55°**

b = 40°   70°

b

70°

c = 66°   c

57°

57°

d   **d = 60°**

60°   e   **e = 60°**

35°

90°   f   **f = 55°**

27°   **90°**

g = 63°   g

45°

h = 45°

45°   h

90°   **180 - 90 = 90**

90 ÷ 2 = 45

i   **i = 45°**

180 - 120 = 60

60 ÷ 2 = 30

120°

j   j

j = 30°

3) Work out the size of the angles marked with letters.

a   **a = 40°**

80°   **60°**   120°

b   **b = 75°**

140°   **40°**   65°   115°

300°

60°

c = 50°   c   70°

d = 60°

d

150°   **30°**

f = 40°   f

e = 110°   e   70°   70°

g = 120°

60°

g   **60°**   **60°**
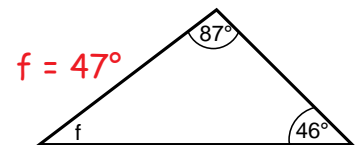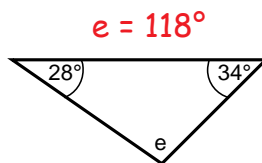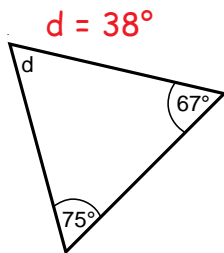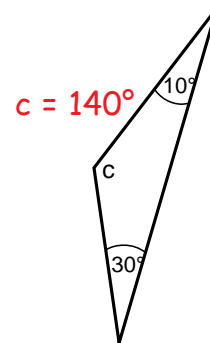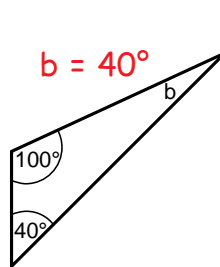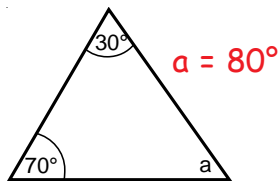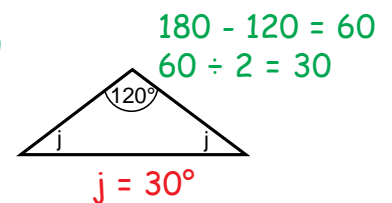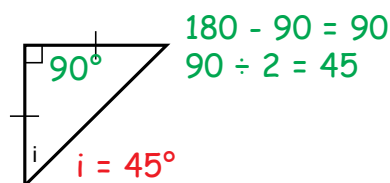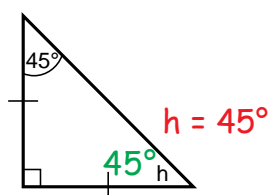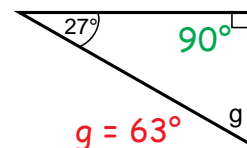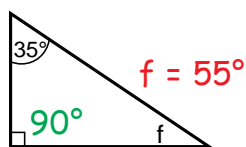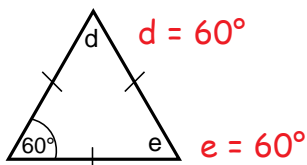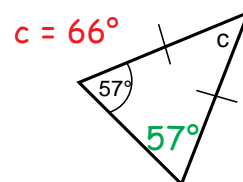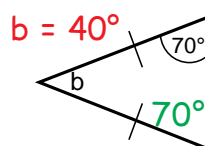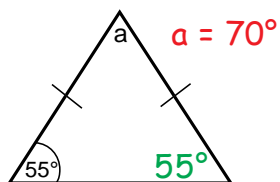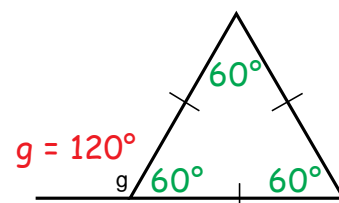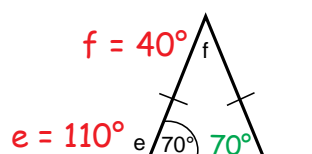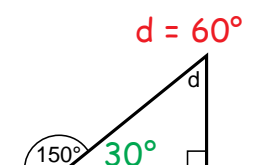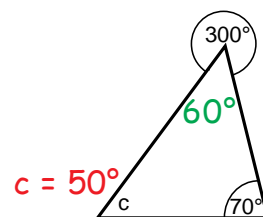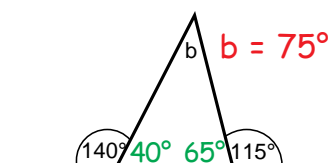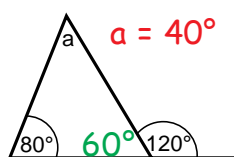
Angle Sum of Triangles - 2 of 2

1) *ABC* is a triangle.

Diagram **NOT** accurately drawn

a) Find the size of angle *A*.   180 - 60 - 60
   Angle A is 60°

b) Triangle *ABC* is equilateral.

   Explain why.
   Triangle ABC is equilateral because all three angles are 60°.
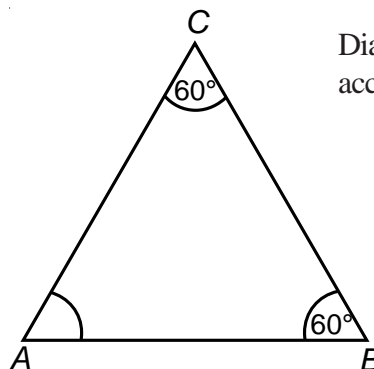
2) *BCD* is a triangle.

   ABC is a straight line.

   Angle *CBD* = 70°.

   BD = *CD*.

   Diagram **NOT** accurately drawn

a) (i) Work out the value of *x*.
       x = 110°   180 - 70

   (ii) Give a reason for your answer.
        Angles on a straight line add up to 180°.

b) (i) Work out the value of *y*.
       y = 40°   180 - 70 - 70

   (ii) Give reasons for your answer.
        Base angles of an isosceles triangle are equal.
        180° in a triangle.
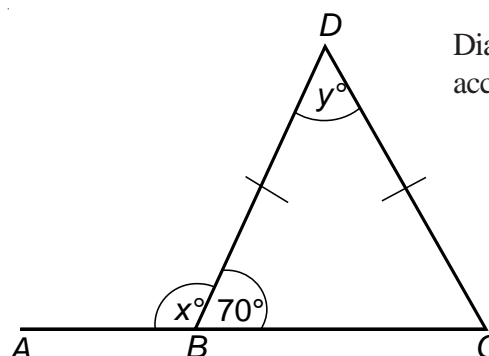
3) The diagram shows a 5-sided shape.

   All the sides of the shape are equal in length.

   Diagram **NOT** accurately drawn

a) (i) Find the value of *x*.
       x = 60°

   (ii) Give a reason for your answer.
        The triangle in the diagram is equilateral.

b) (i) Work out the value of *y*.
       y = 150°

   (ii) Explain your answer.

        Angle y is made up of the angle in the square and the angle in the equilateral triangle. This is 90° + 60° = 150°.
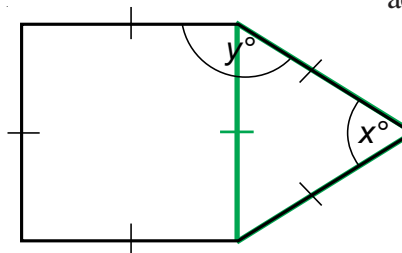
Angles of Regular Polygons

1)

120° 60°
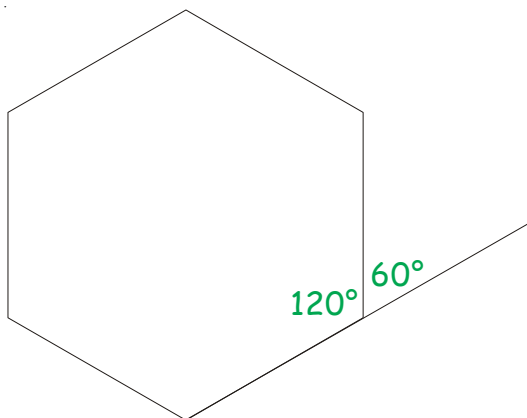
a) Work out the size of an **exterior** angle of a regular hexagon. 60° 360 ÷ 6

b) Work out the size of an **interior** angle of a regular hexagon. 120° 180 – 60

2)
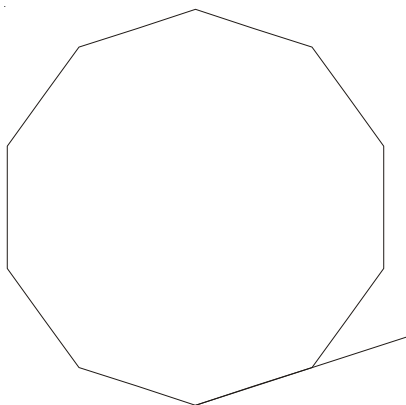
a) Name the regular polygon, above. Decagon

b) Work out the size of an **exterior** angle and of an **interior** angle for this polygon.
Exterior angle = 36° Interior angle = 144°
360 ÷ 10 180 – 36

3) The size of each **exterior** angle of a regular polygon is 90°.
Work out the number of sides of the regular polygon. 4 sides 360 ÷ ? = 90

4) The size of each **exterior** angle of a regular polygon is 40°.
Work out the number of sides of the regular polygon. 9 sides 360 ÷ ? = 40

5) The size of each **interior** angle of a regular polygon is 120°.
Work out the number of sides of the regular polygon. 6 sides
Interior angle = 120, exterior angle = 60, 360 ÷ ? = 60

6) The size of each **interior** angle of a regular polygon is 150°.
Work out the number of sides of the regular polygon. 12 sides
Interior angle = 150, exterior angle = 30, 360 ÷ ? = 30

Area of Circles

1) Find the areas of the following shapes.

   Take π to be 3.14

a)

3cm

3.14 × 3² = 28.26 cm²

b)

5m

3.14 × 5² = 78.5 m²

c)

8cm

3.14 × 4² = 50.24 cm²

2) Work out the areas of the following shapes.

a)

12 mm

3.14 × 6² = 113.04
113.04 ÷ 2 = 56.52 mm²

b)

3.14 × 10² = 314
314 ÷ 4 = 78.5 cm²

10cm
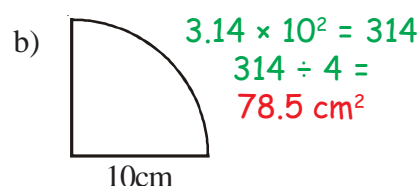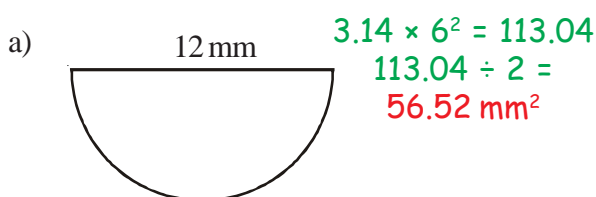
3) The diagram shows a circular garden comprising a rectangular pond enclosed by grass.
The circular garden has a diameter of 10 m.
The rectangular pond measures 8 m by 6 m.

Work out the area of the garden covered in grass.

Take π to be 3.14 and give your answer to the nearest m².

31 m² to the nearest m²
Circular garden area: 3.14 × 5² = 78.5
Rectangular pond area: 8 × 6 = 48
78.5 - 48 = 30.5

6 m

8 m
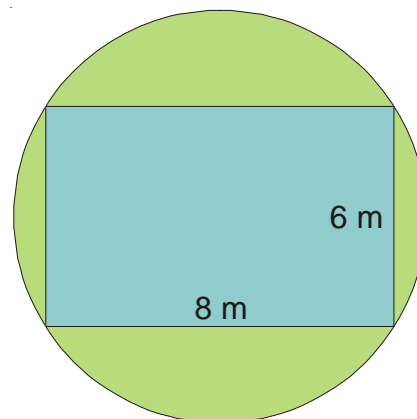
4) The **radius** of the top of a circular table is 60 cm.
The table also has a circular base with **diameter** 30 cm.

a) Work out the area of the top of the table.

3.14 × 60²
11 304 cm²

b) Work out the area of the base of the table.

3.14 × 15²
706.5 cm²

5) The diagram shows a shape, made from a semi-circle and a rectangle.
The diameter of the semi-circle is 13 cm.
The length of the rectangle is 17 cm.

Calculate the area of the shape.
Give your answer correct to
3 significant figures. 287 cm²

221 + 66.3325 = 287.3325

13cm

Rectangle area:
17 × 13 = 221 cm²

Semi-circle area:
3.14 × 6.5² = 132.665
132.665 ÷ 2 = 66.3325 cm²

17cm
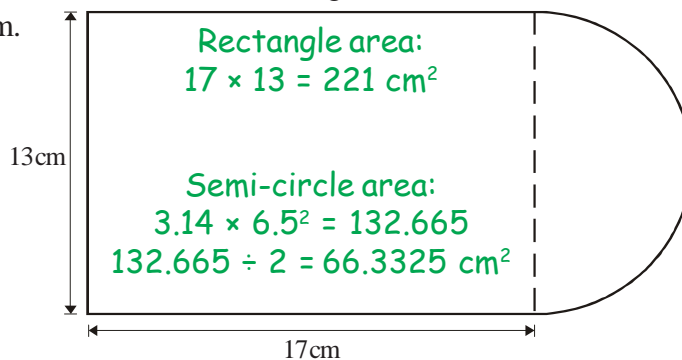
Circumference of Circles

Diagrams **NOT** accurately drawn

1) Find the circumference of the following shapes.

Take π to be 3.14.

a) C = 18.84 cm

3 cm

C = 2 × 3.14 × 3

b) C = 31.4 m

5 m
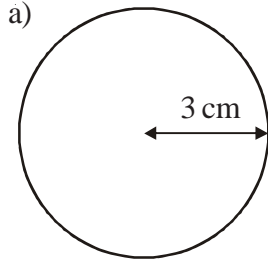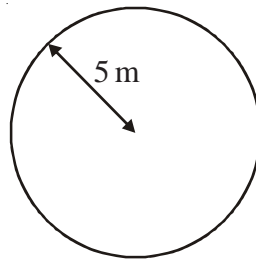
C = 2 × 3.14 × 5

c) C = 25.12 cm

8 cm
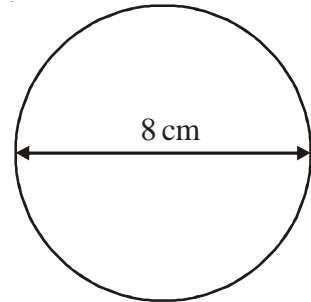
C = 2 × 3.14 × 4

2) Work out the perimeter of the following shapes, taking π to be 3.14.

a) 12 mm

Perimeter is green length plus 12 mm.
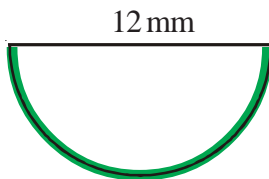
P = 30.84 mm
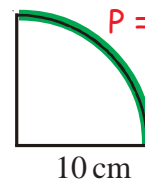
b) P = 35.7 cm

Perimeter is green length plus 10 cm + 10 cm

10 cm

3) The **radius** of the top of a circular table is 60 cm.
The table also has a circular base with **diameter** 30 cm.

C = 2 × 3.14 × 60

a) Work out the circumference of the top of the table.
   Let π be 3.14   C = 376.8 cm

b) Work out the circumference of the base of the table.
   Let π be 3.14   C = 94.2 cm

C = 2 × 3.14 × 15

4) The diameter of a wheel on Kyle's bicycle is 0.75 m.

C = 2 × 3.14 × 0.375

a) Calculate the circumference of the wheel.   C = 2.36 m
   Give your answer correct to 2 decimal places.

Kyle cycles 2000 metres.

Turns = 2000 ÷ 2.36

b) Using your answer in (a), calculate the number
   of complete turns the wheel makes.   847 complete turns
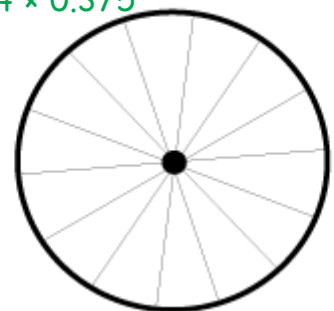
5) The diagram shows a shape, made from a semi-circle and a rectangle.
The diameter of the semi-circle is 12 cm.
The length of the rectangle is 15 cm.

Calculate the perimeter of the shape.
Give your answer correct to
3 significant figures.   P = 60.8 cm

12 cm
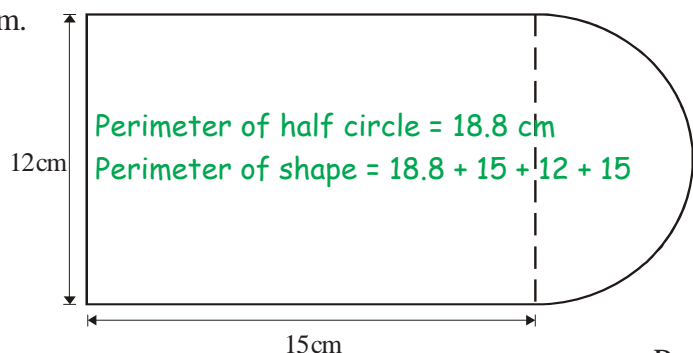
Perimeter of half circle = 18.8 cm
Perimeter of shape = 18.8 + 15 + 12 + 15

15 cm

Area of Compound Shapes

1) Find the area of each shape.

a) Area = 82 cm²

13 cm
52 cm²
10 cm
4 cm
8 cm
6 cm | 30 cm²
5 cm

b)
15 cm
Area = 525 cm²
150 cm² | 10 cm
2 cm | 8 cm
375 cm²
15 cm
25 cm

c) Area = 72 m²
4 m
18 m²
6 m | 54 m²
9 m
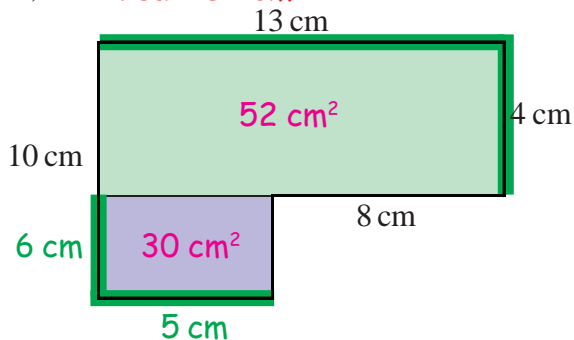
d) Area = 24 mm²
4 mm
5 mm
6 mm | 6 mm²
6 mm
3 mm
18 mm² | 2 mm
9 mm
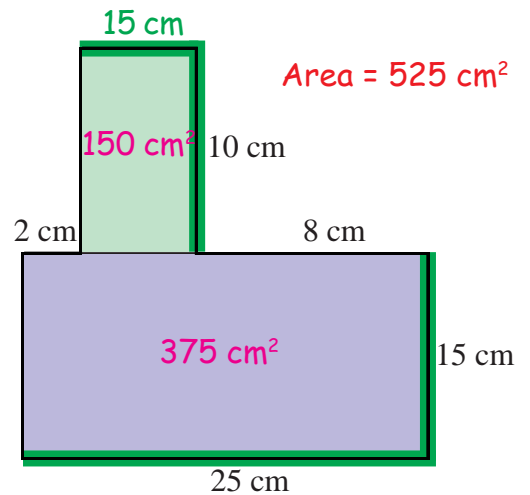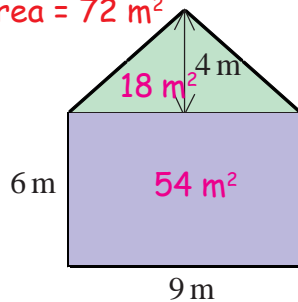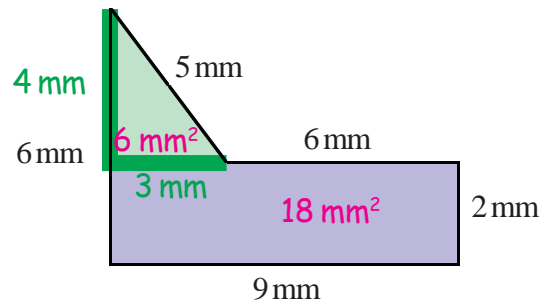
2) Find the shaded area of each shape.

a) Area = 54 cm²   (60 - 6)
3 cm
2 cm
6 cm
10 cm

b) Area = 56 cm²   (84 - 28)
12 cm
7 cm
4 cm
7 cm
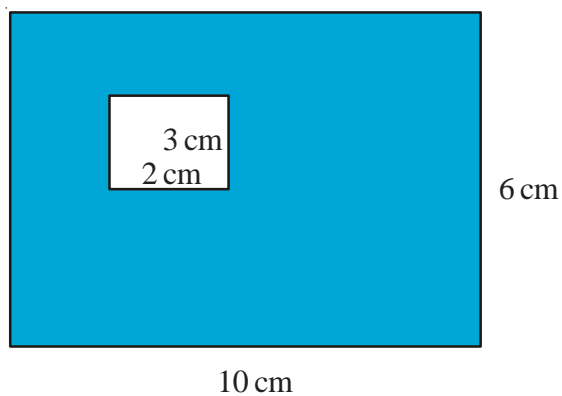
c) Area = 48 mm²   (60 - 4 - 8)
2 mm
6 mm | 2 mm
4 mm
2 mm
10 mm
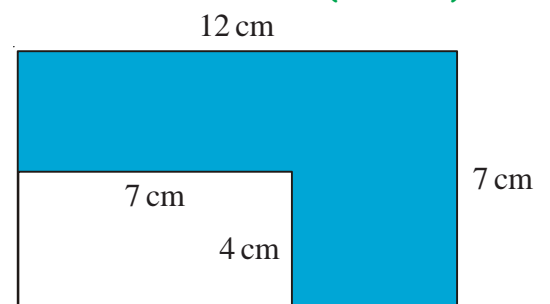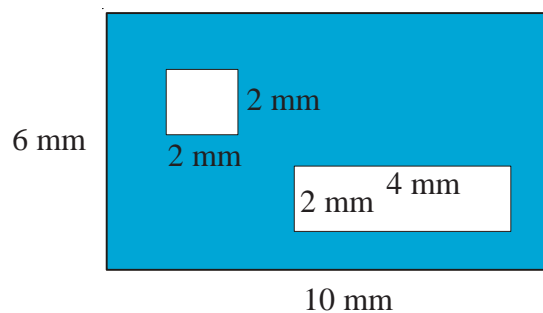
d) Area = 66 m²   (132 - 66)
12 m
11 m
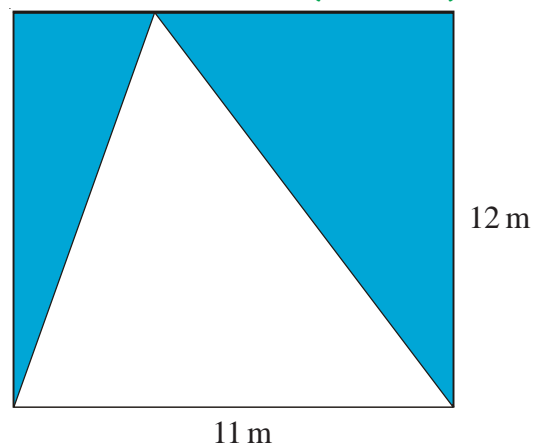
Rotations

1) a) Rotate triangle T 90°
      anti-clockwise about the
      point (0, 0).
      Label your new triangle U

   b) Rotate triangle T 180°
      about the point (2, 0).
      Label your new triangle V
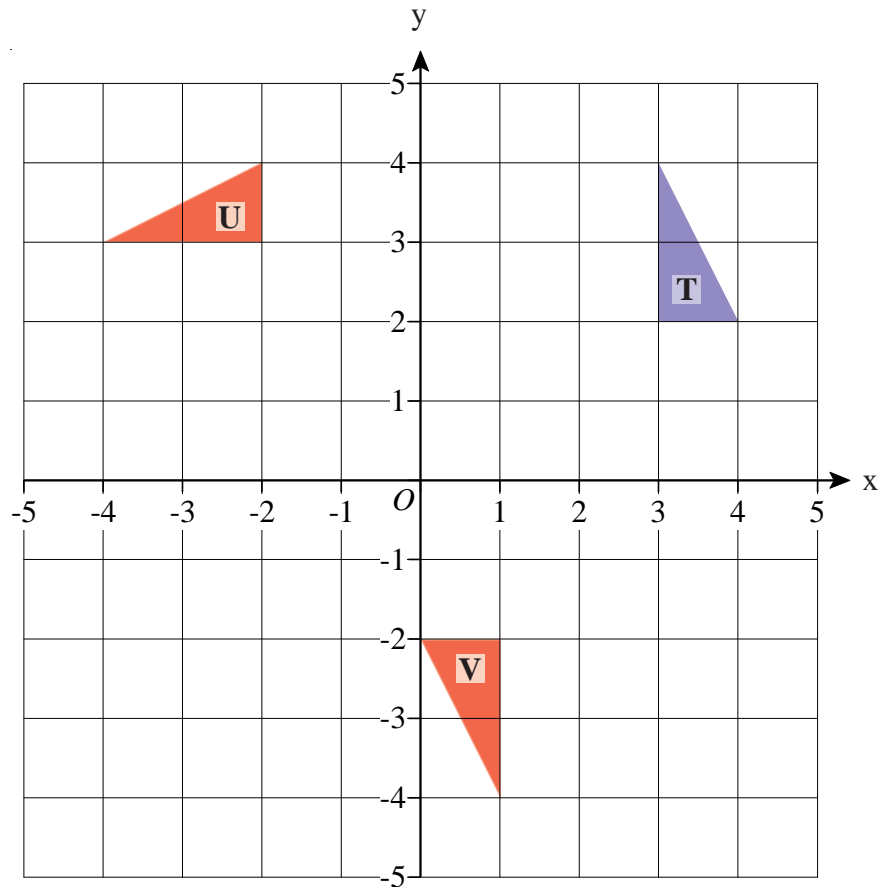
2) Describe fully the single
   transformation which maps
   triangle T to triangle U.

   Rotation,
   90° clockwise,
   centre of rotation (-1, -1)

Reflections

y = -x
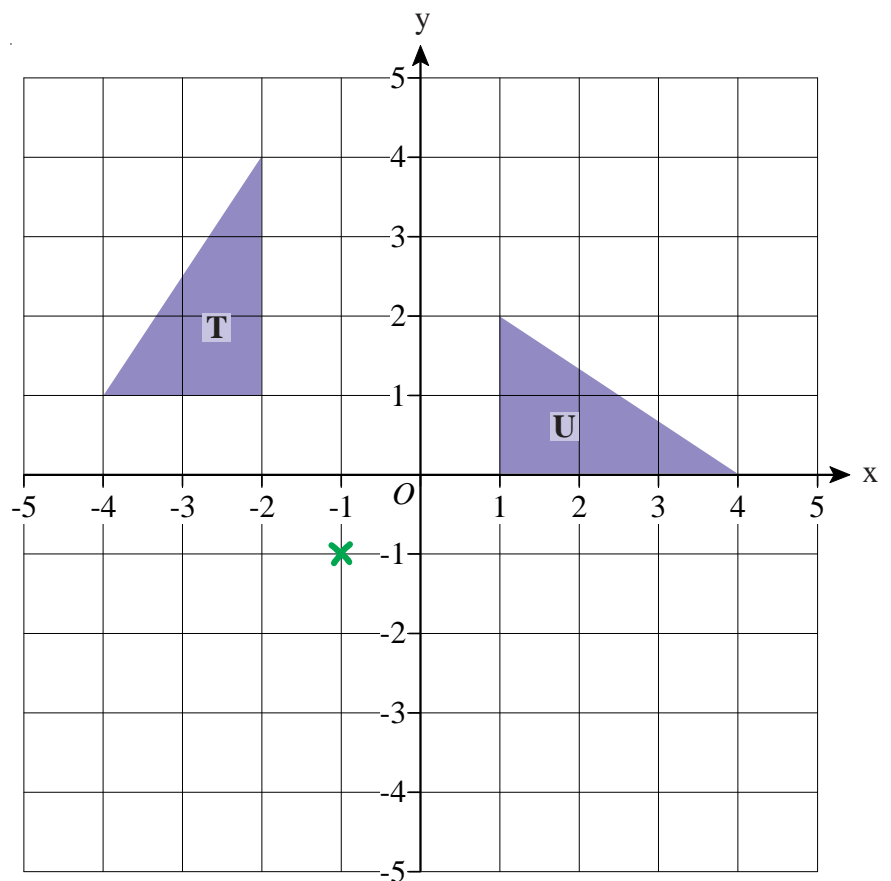
1) a) Reflect triangle T in the x axis.
Label your new triangle U.

b) Reflect triangle T in the line with
equation y = -x.
Label your new triangle V.

T

U

V
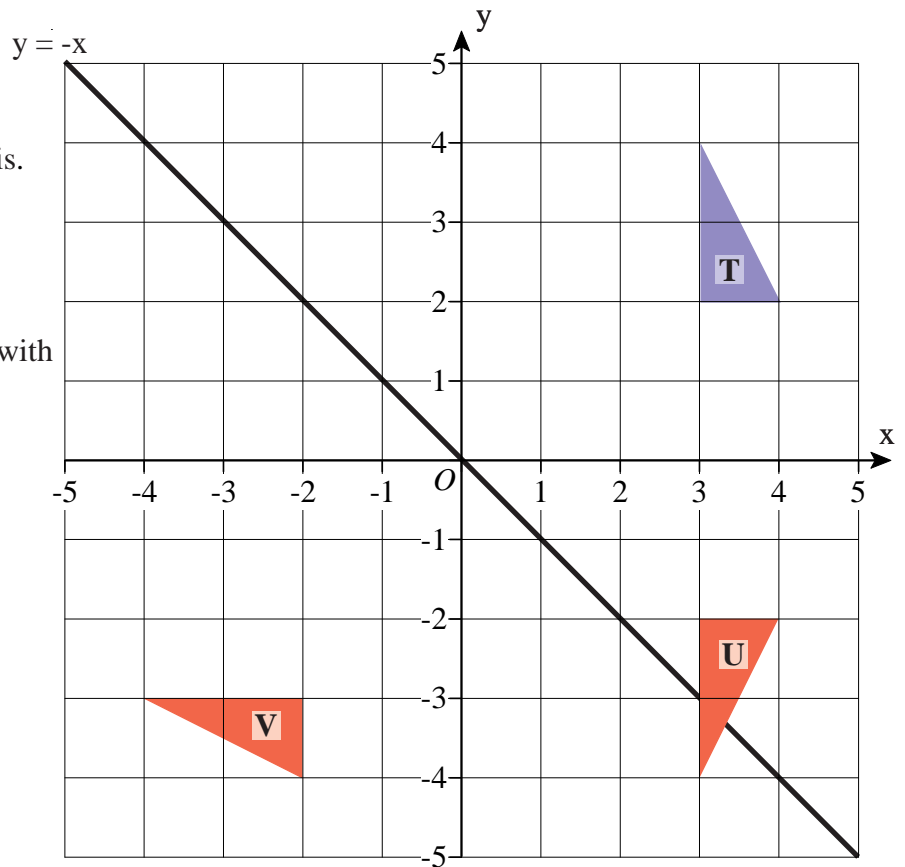
2) a) Describe fully the single
transformation which maps
triangle T to triangle U.

Reflection in the x axis.

b) Describe fully the single
transformation which maps
triangle T to triangle V.

Reflection in the y = x line.

y = x

T

U

V
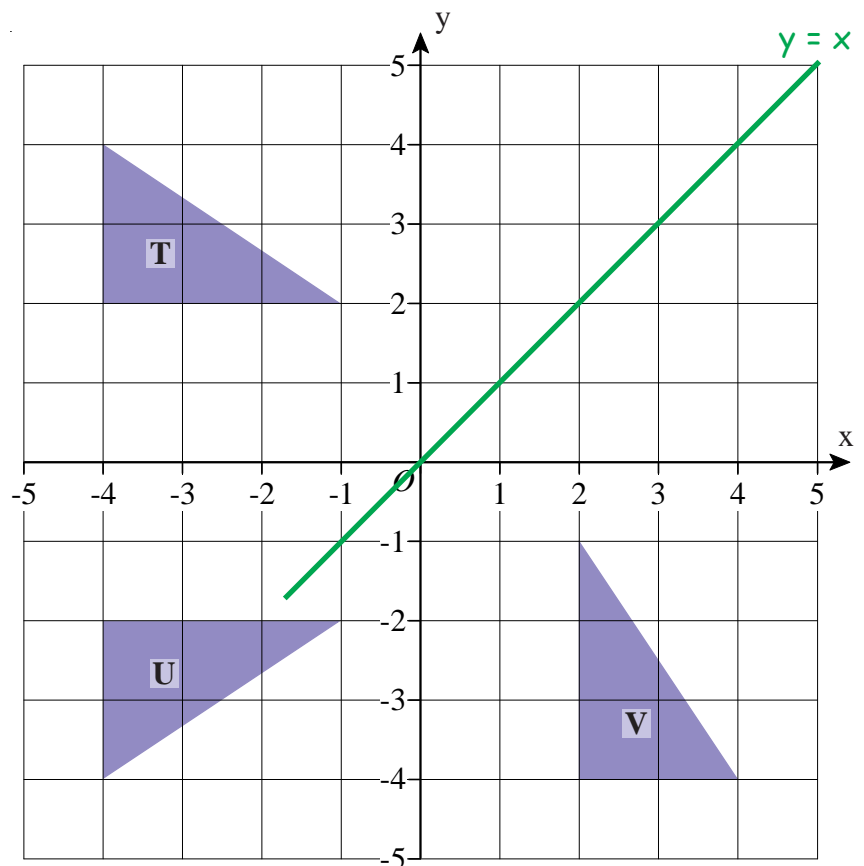
Enlargements

1) a) Enlarge triangle T by scale factor 2 using point (-5, 2) as the centre of enlargement.

Label your new triangle U.

b) Enlarge triangle V by scale factor a half using the point (-2, -3) as the centre of enlargement.

Label your new triangle W.
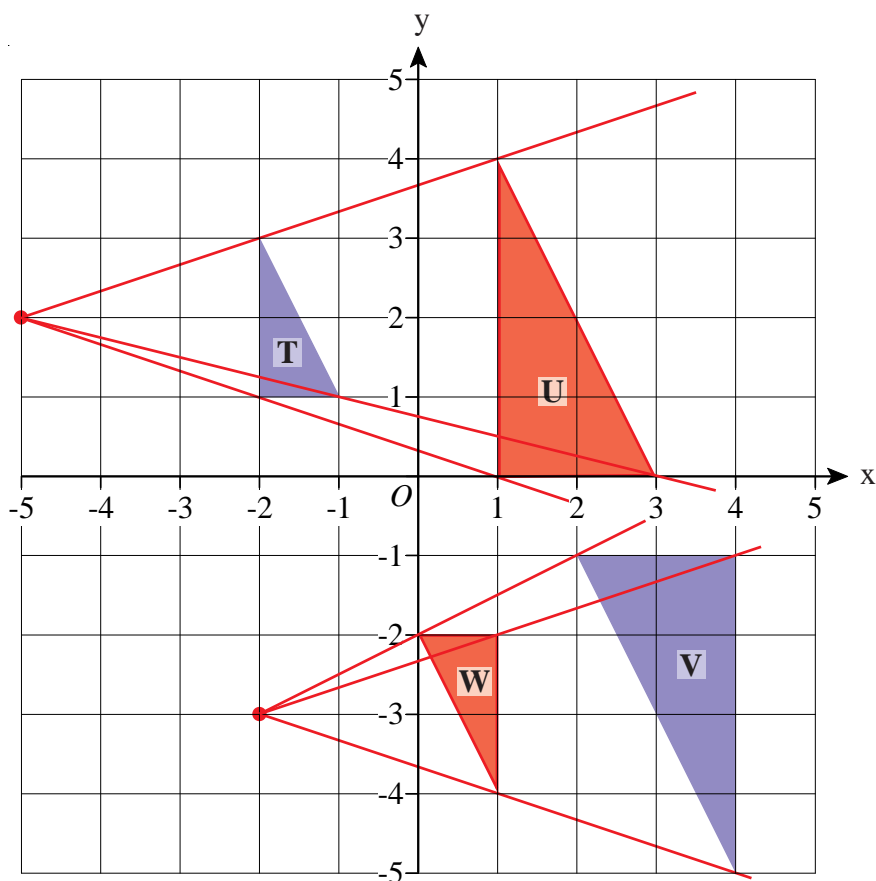
2) Describe fully the single transformation which maps triangle S to triangle T

Enlargement, scale factor 3, centre of enlargement (0, 3).
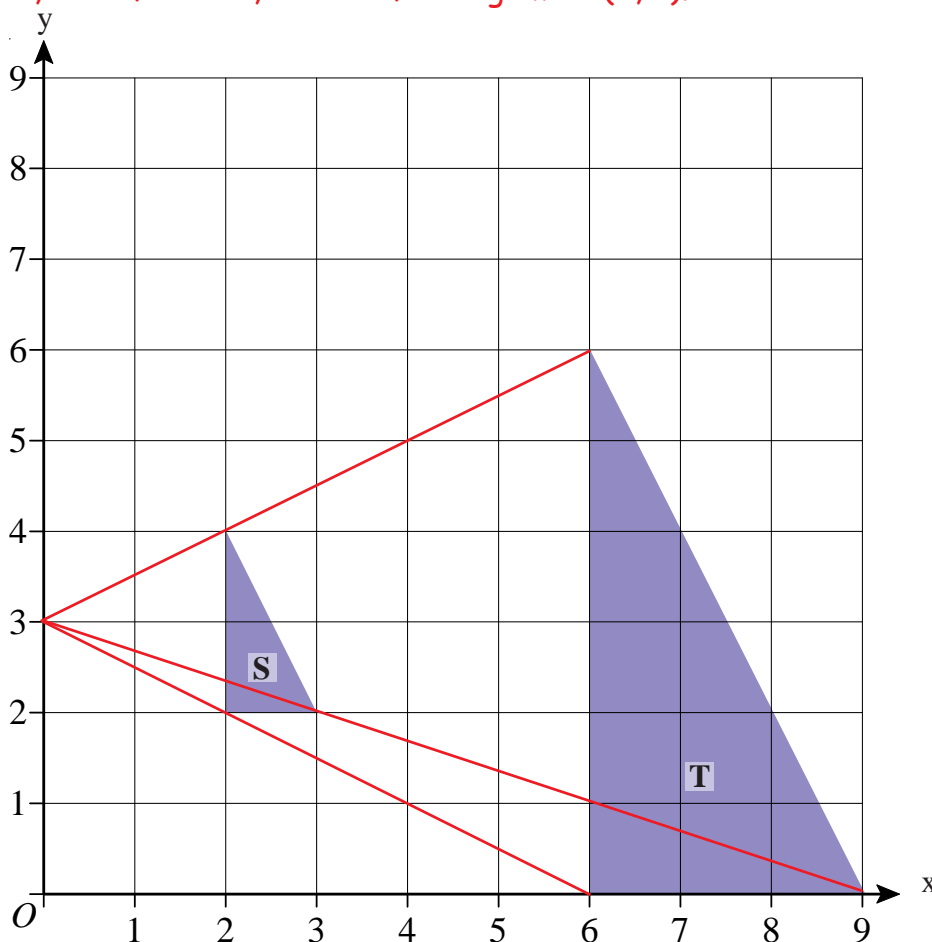
Translations

1)　a) Translate triangle T by vector $\begin{bmatrix} -4 \\ 2 \end{bmatrix}$ and label it U

　　b) Translate triangle T by vector $\begin{bmatrix} 3 \\ -2 \end{bmatrix}$ and label it V
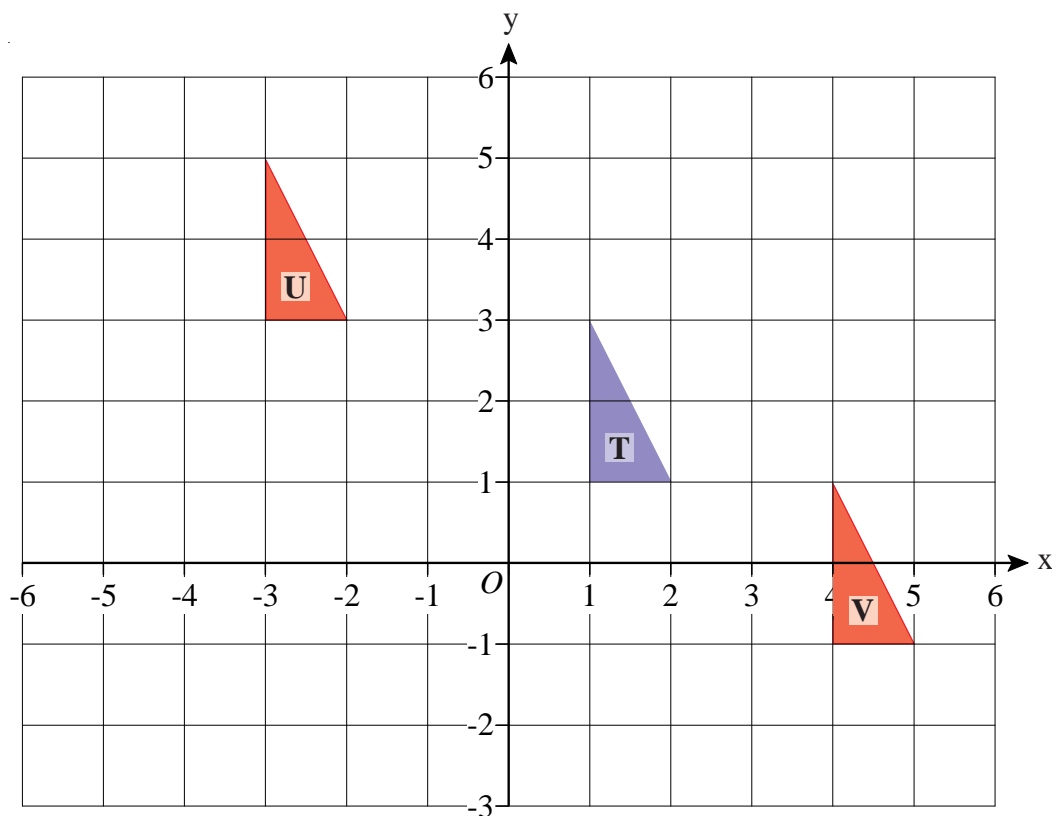
Translation with vector $\begin{bmatrix} -6 \\ -3 \end{bmatrix}$

2)　a) Describe fully the single transformation which maps triangle A to triangle B.

　　b) Describe fully the single transformation which maps triangle A to triangle C.
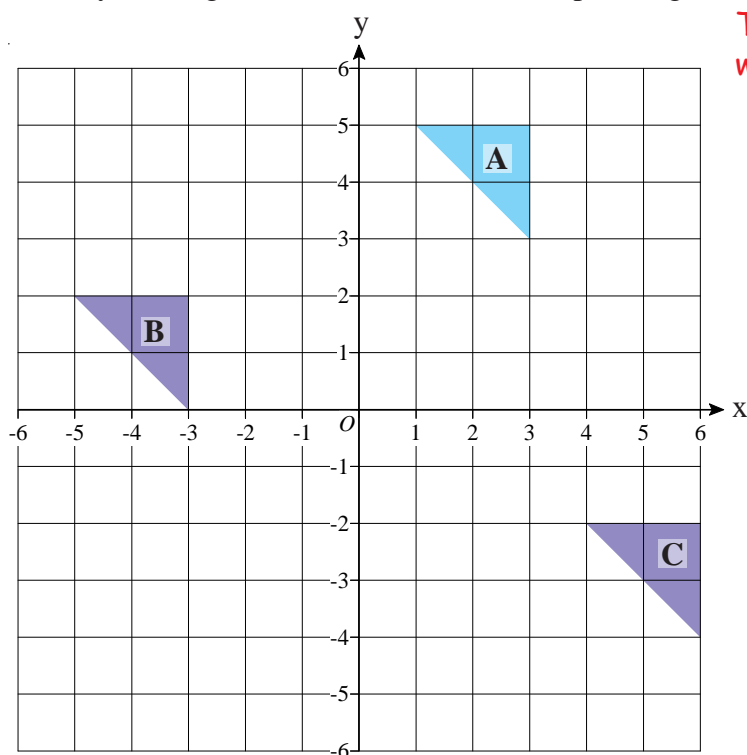
Translation with vector $\begin{bmatrix} 3 \\ -7 \end{bmatrix}$

Find the Mid-Point of a Line

1) Find the midpoint of A and B where A has coordinates (-2, 5) and
   B has coordinates (4, -1). Midpoint at (1, 2)
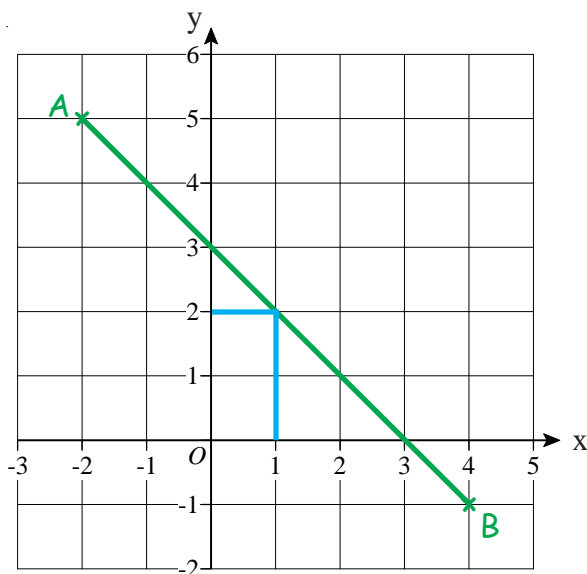
2) Find the midpoint of A and B where A has coordinates (2, 0) and
   B has coordinates (8, 6). Midpoint at (5, 3)

   x (2 + 8) ÷ 2 = 5
   y (0 + 6) ÷ 2 = 3

3) Find the midpoint of A and B where A has coordinates (-4, -2) and
   B has coordinates (2, 4). Midpoint at (-1, 1)

   x (-4 + 2) ÷ 2 = -1
   y (-2 + 4) ÷ 2 = 1

4) Find the midpoint of A and B where A has coordinates (-3, -2) and
   B has coordinates (7, 5). Midpoint at (2, 1.5)

   x (-3 + 7) ÷ 2 = 2
   y (-2 + 5) ÷ 2 = 1.5

5) Find the midpoint of A and B where A has coordinates (2, -5) and
   B has coordinates (7, 4). Midpoint at (4.5, -0.5)

   x (2 + 7) ÷ 2 = 4.5
   y (-5 + 4) ÷ 2 = -0.5

6) Find the midpoint of A and B where A has coordinates (-7, -4) and
   B has coordinates (-2, -1). Midpoint at (-4.5, -2.5)

   x (-7 + -2) ÷ 2 = -4.5
   y (-4 + -1) ÷ 2 = -2.5

7) The midpoint of A and B is at (1, 3).
   The coordinates of A are (-2, 4).
   Work out the coordinates of B. (4, 2)

   x (-2 + ?) ÷ 2 = 1
   y (4 + ?) ÷ 2 = 3

8) The midpoint of A and B is at (3.5, 2.5).
   The coordinates of A are (2, 5).
   Work out the coordinates of B. (5, 0)

   x (2 + ?) ÷ 2 = 3.5
   y (5 + ?) ÷ 2 = 2.5

Measuring and Drawing Angles

1) Measure the following angles:

45° a

113° b

54° c

117° d

225° e

331° f
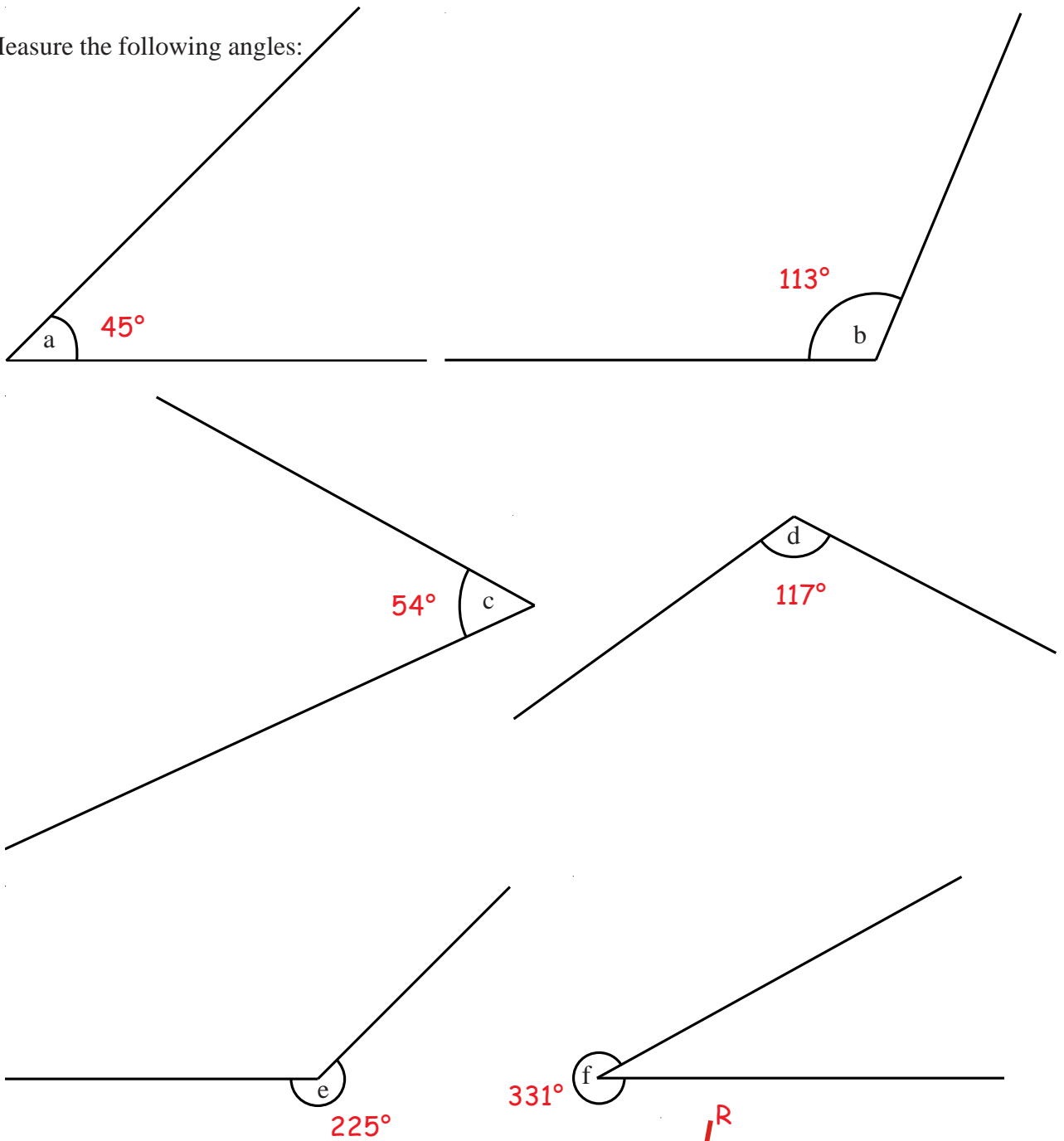
2) Draw the following angles:

a) angle ABC = 60°

C

60°

B   A

b) angle PQR = 127°

R

127°

Q

P

c) angle XYZ = 275°

X

Z
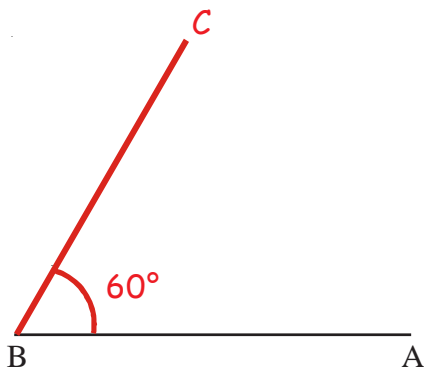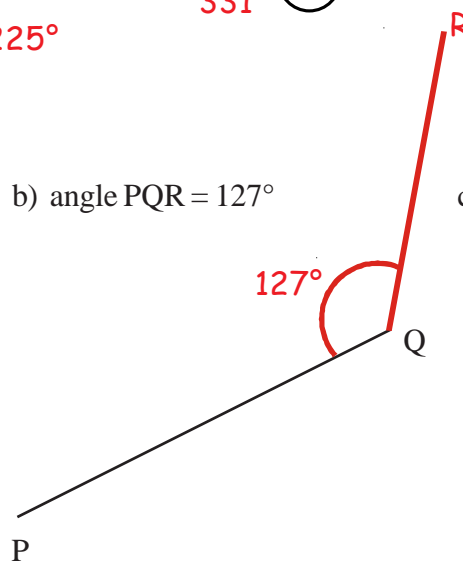
Y   **275°**
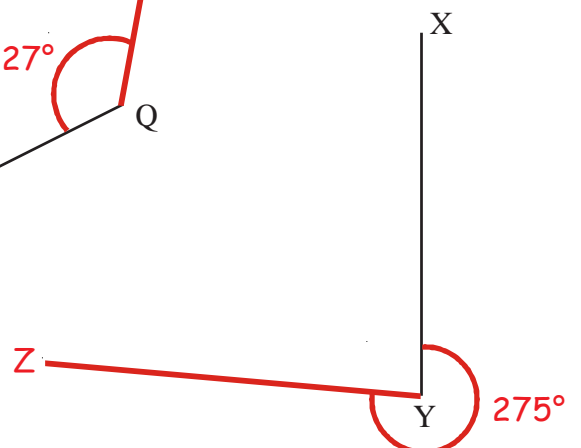
Drawing Triangles

1) The diagram shows the sketch of triangle ABC.

C

7.4 cm

38°

A   B

8.5 cm
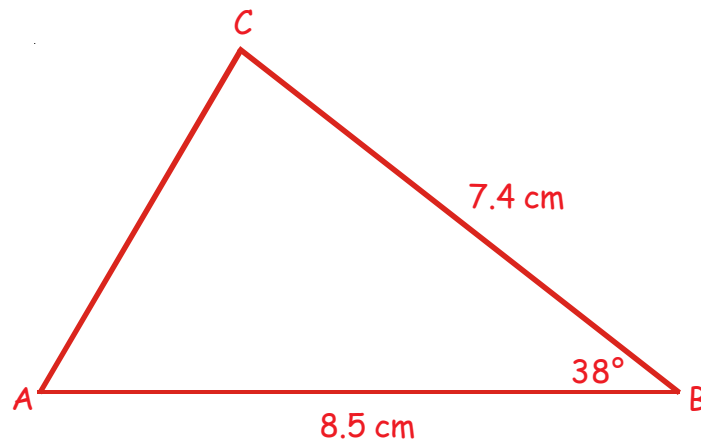
a) Make an accurate drawing of triangle ABC.

b) Measure the size of angle A on your diagram.   *Angle A = 59°*

2) Use ruler and compasses to **construct** an equilateral triangle with sides of length 6 centimetres.
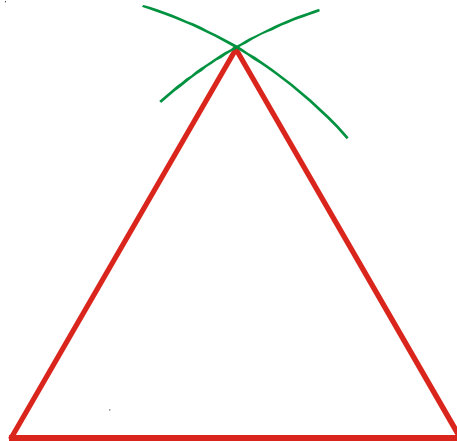
3) The diagram shows the sketch of triangle PQR.

Angle P = 43°

Q

10.5 cm

7.3 cm

43°

P   R

9 cm
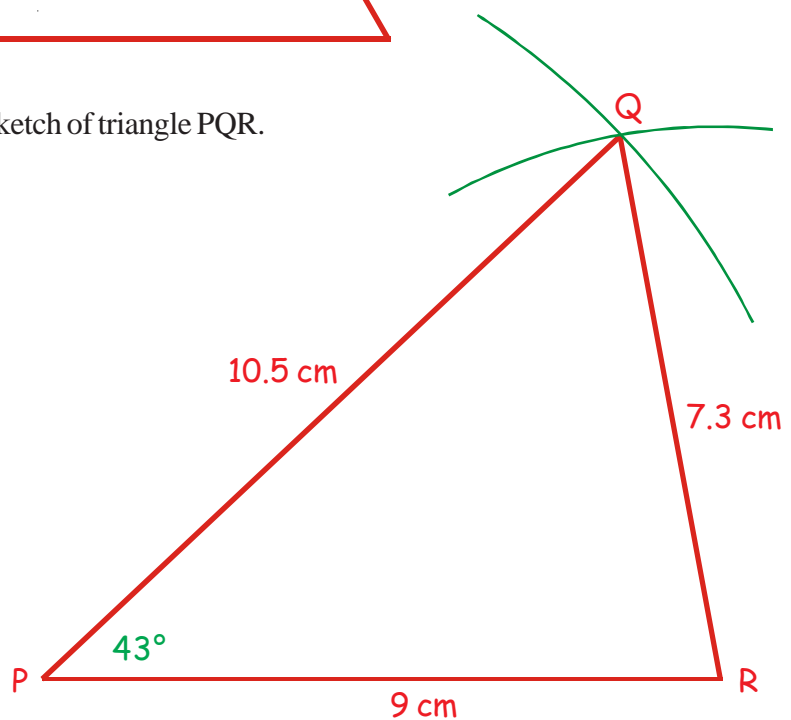
Plans and Elevations

The diagram shows a prism drawn on an isometric grid.
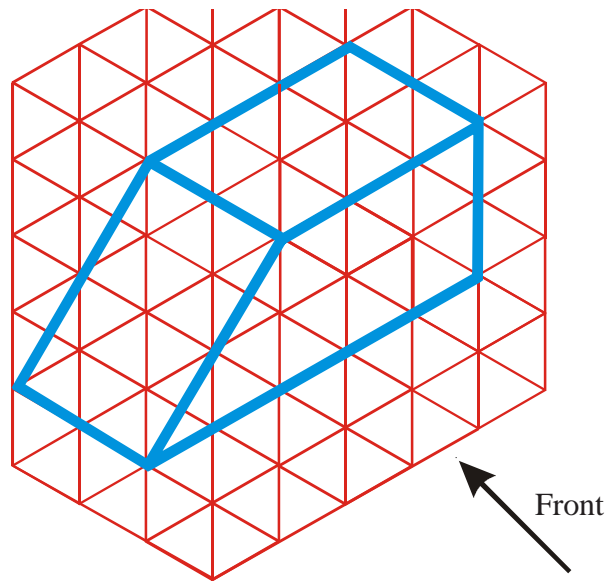
Front

a) On the grid below, draw the front elevation of the prism from the direction marked by the arrow.
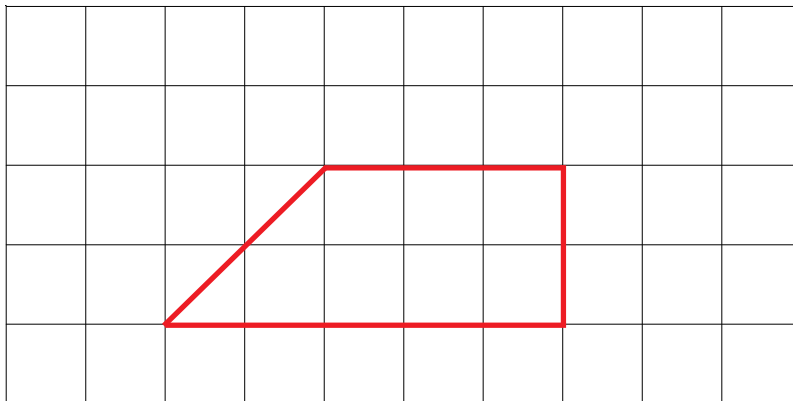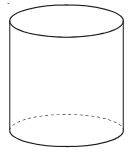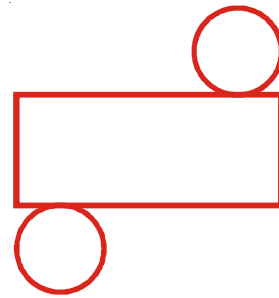

b) On the grid below draw a plan of the prism.
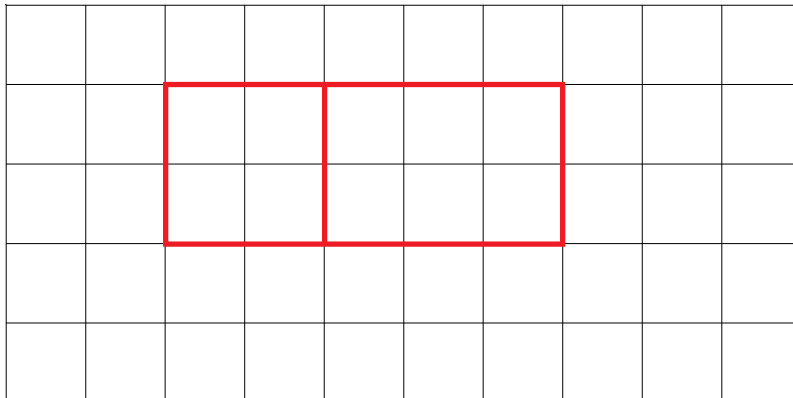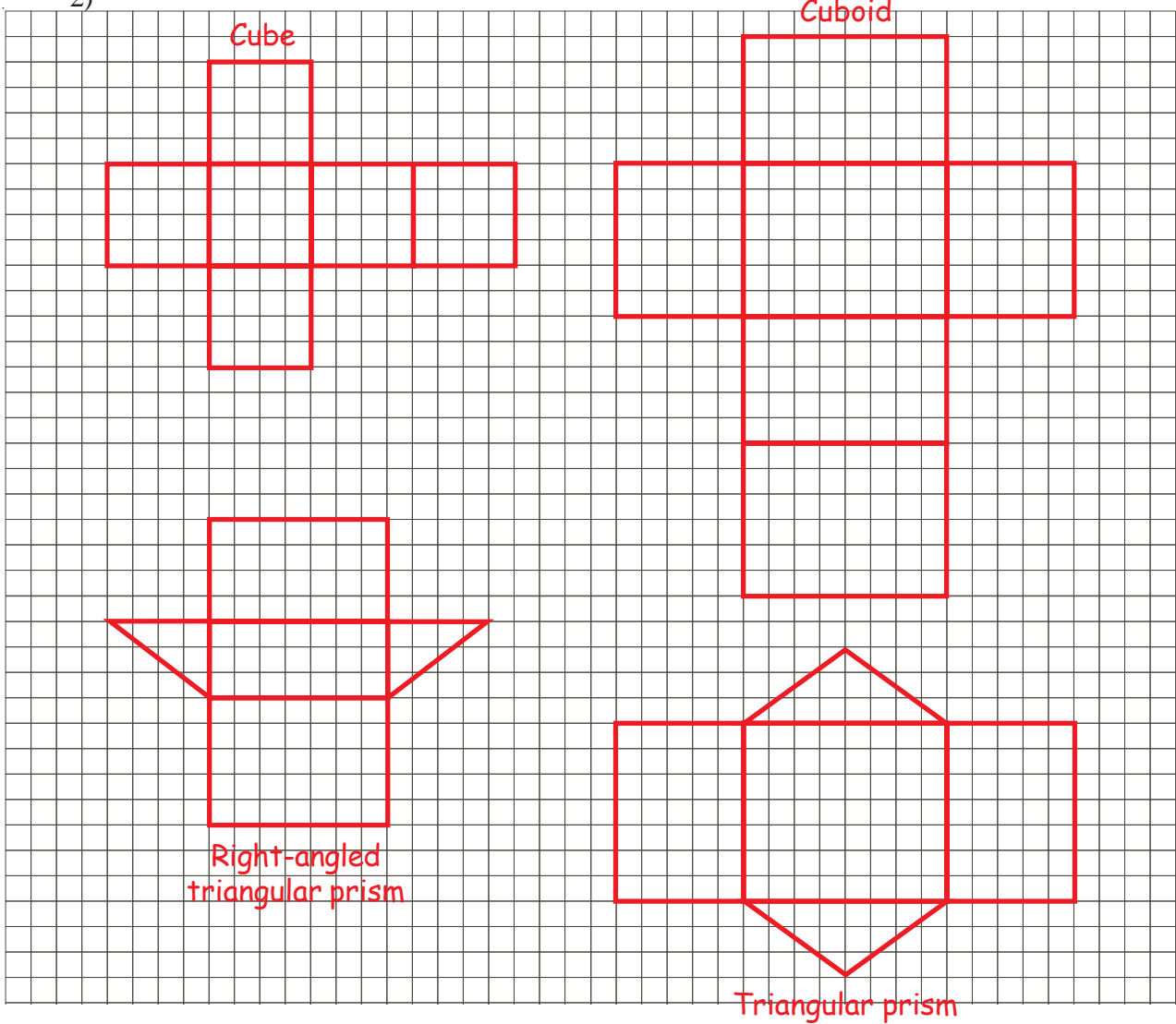
Nets

1) Sketch nets of these solids.

a)

b)

2)

Cube

Cuboid

Right-angled
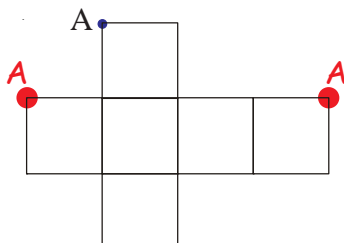triangular prism

Triangular prism
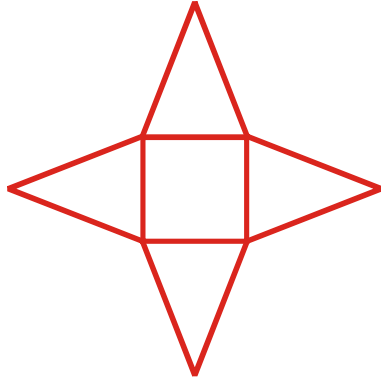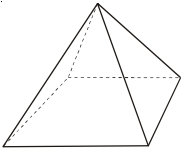
3) The two nets, below, are folded to make cubes.
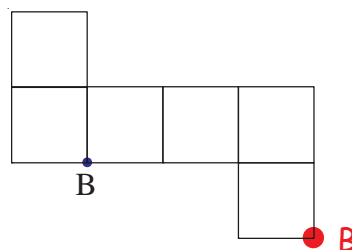   Two other vertices will meet at the the dot, A. Mark them with As.
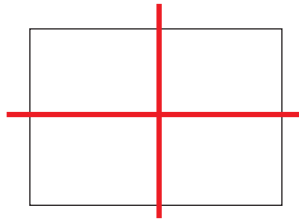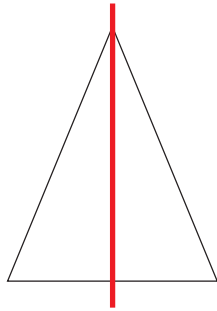   One other vertex will meet at the dot B. Mark it with B.
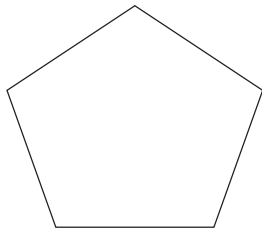
a)   A

A   A

b)

B

B

Symmetries

1) Draw all the lines of symmetry on the triangle and the rectangle.
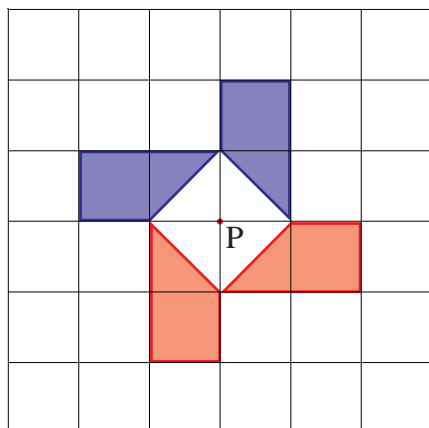
2) What is the order of rotational symmetry of the two shapes below.

Rotational symmetry order 5   Rotational symmetry order 2
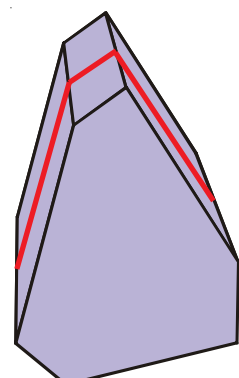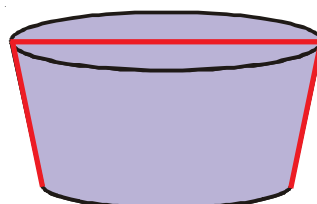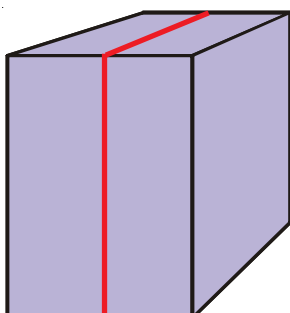
3) The diagram below, shows part of a shape.

P

The shape has rotational symmetry of order 4 about point P.

Complete the shape.

4) On each of the shapes below, draw one plane of symmetry.

There are other
answers for these
two questions.

1) Claire wants to find how much time pupils spend on their homework.
She hands out a questionnaire with the question

How much time do you spend on your homework?

A lot ☐   *Not much* ☐

a) Write down two things that are wrong with this question

No mention of time. Does it mean 'per night', 'per week', etc.

'A lot' and 'Not much' are not specific enough. They mean different things to different people.

b) Design a suitable question she could use.
You should include response boxes.

How much time do you spend on homework per night?

Less than 15 mins ☐   Between 15 and 30 mins ☐   More than 30 mins ☐

2) Tony wants to know which type of programme pupils in his class like watching on TV.
Design a suitable data collection sheet he could use to gather the information.

Type of programme	Tally	Frequency
Soap opera		
Reality TV		
Films		
Situation comedy		
Documentary		

3) Emma asked 20 people what was their favourite pet.
Here are their answers.

cat	cat	hamster	cat
mouse	hamster	cat	dog
dog	dog	snake	hamster
cat	cat	hamster	dog
cat	hamster	snake	cat

Design and complete a suitable data collection sheet that Emma could have used to collect and show this information.

Favourite pet	Tally	Frequency
Cat	ЖЖ III	8
Hamster	ЖЖ	5
Mouse	I	1
Dog	IIII	4
Snake	II	2

Two-Way Tables

1. Billy has been carrying out a survey.
   He asked 100 people the type of water they like to drink (still, sparkling or both).
   Here are part of his results:

	Still	Sparkling	Both	Total
Male	26	21	6	53
Female	17	20	10	47
Total	43	41	16	100

a) Complete the two-way table.

b) How many males were in the survey?   53

c) How many females drink only still water?   17

d) How many people drink only sparkling water?   41

2. 90 students each study one of three languages.
   The two-way table shows some information about these students.

	French	German	Spanish	Total
Female	6	11	23	40
Male	14	7	29	50
Total	20	18	52	90

50 of the 90 students are male.

29 of the 50 male students study Spanish.

a) Complete the two-way table.

b) How many females study French?   6

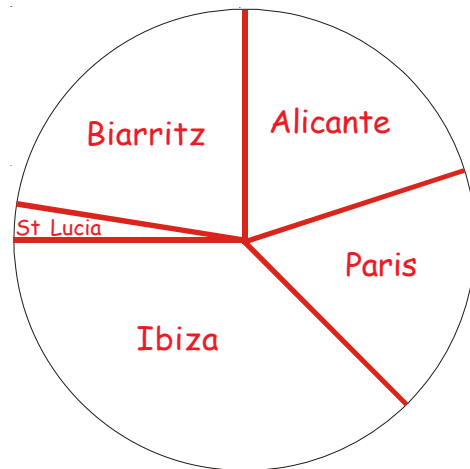c) How many people study Spanish?   52

Pie Charts

1) Patrick asked some of his colleagues which was their favourite holiday destination.
   The table shows the results.

City	Frequency	Angle
Alicante	8 × 9	72°
Paris	7 × 9	63°
Ibiza	15 × 9	135°
St Lucia	1 × 9	9°
Biarritz	9 × 9	81°
	40	360°

360 ÷ ?
360 ÷ 40 = 9

Draw a pie chart to illustrate the information.
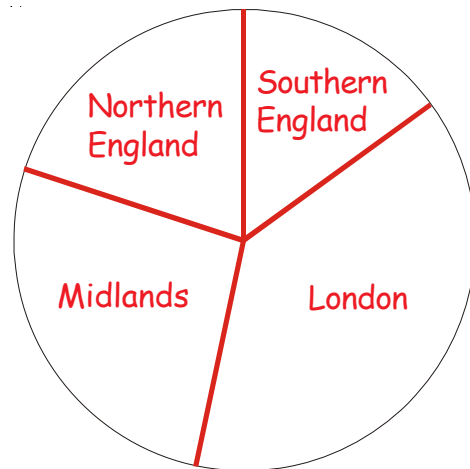

2) Brian asked 60 people which region their favourite rugby team came from.
   The table shows the results.

Region	Frequency	Angle
Southern England	9 × 6	54°
London	23 × 6	138°
Midlands	16 × 6	96°
Northern England	12 × 6	72°
Total	60	360°

360 ÷ ?
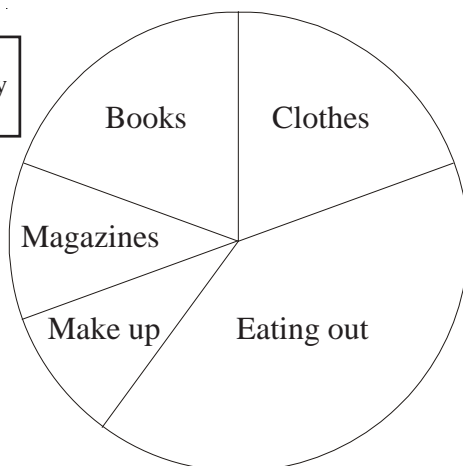360 ÷ 60 = 6

Draw a pie chart to illustrate the information.

3) Sophie represents her monthly expenses using a pie chart.

Diagram accurately drawn

Numbers from her table have been rubbed out by mistake.
Use the pie chart to complete the table.

		Angle
Clothes	£35	70°
Eating out	£73	146°
Make up	£17	34°
Magazines	£20	40°
Books	£35	70°
Total	£180	360°

Scatter Graphs

1) The scatter graph shows some information about the marks of six students.

It shows each student's marks in Maths and Science.

The table below shows the marks for four more students.

| Maths	22	8	17	26
Science	30	12	24	24

a) On the scatter graph, plot the information from the table.

b) Draw a line of best fit.

c) Describe the correlation between the marks in Maths and the marks in Science.
   There is a positive correlation

Another student has a mark of 18 in Science.

d) Use the line of best fit to estimate the mark in Maths of this student.
   My answer is 14. Yours will depend on your line of best fit.
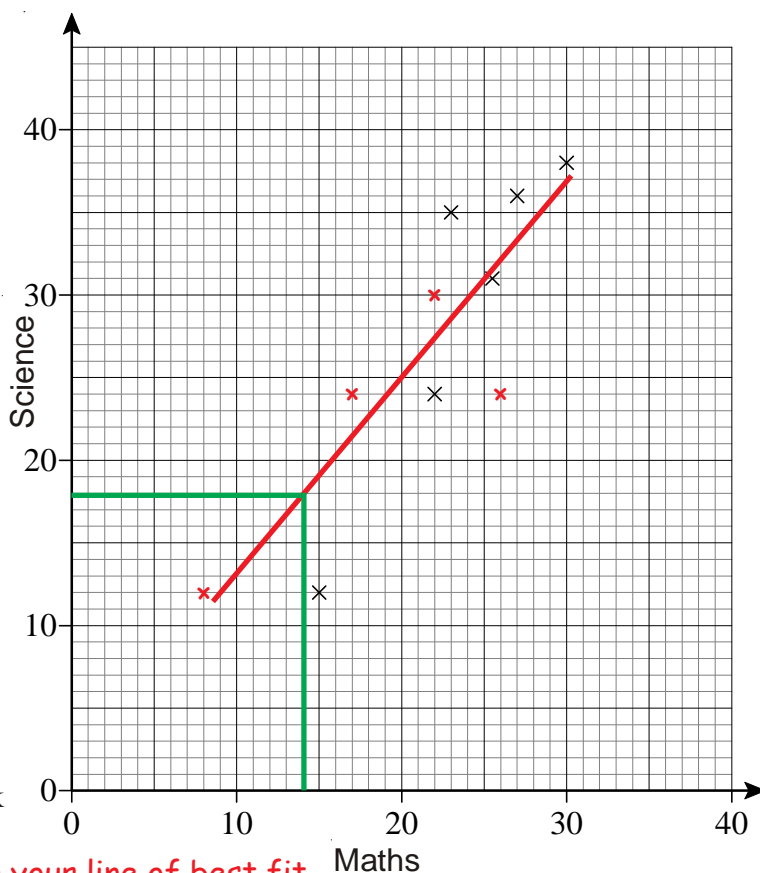
2) The table below shows the average daily number of hours sleep of 10 children.

Age (years)	4	2	5	1	9	6	8	7	10	1.5
Number of hours sleep	14	13	12.5	15	10	12.5	10.8	12	11	14

The first five results have been plotted on the scatter diagram.

a) Plot the next five points.

b) Draw a line of best fit.

c) Decribe the relationship between the age of the children and their number of hours sleep per day.
   A negative correlation.

d) Use your scatter graph to estimate the number of hours sleep for a 3 year old child.
   My answer is 13.6
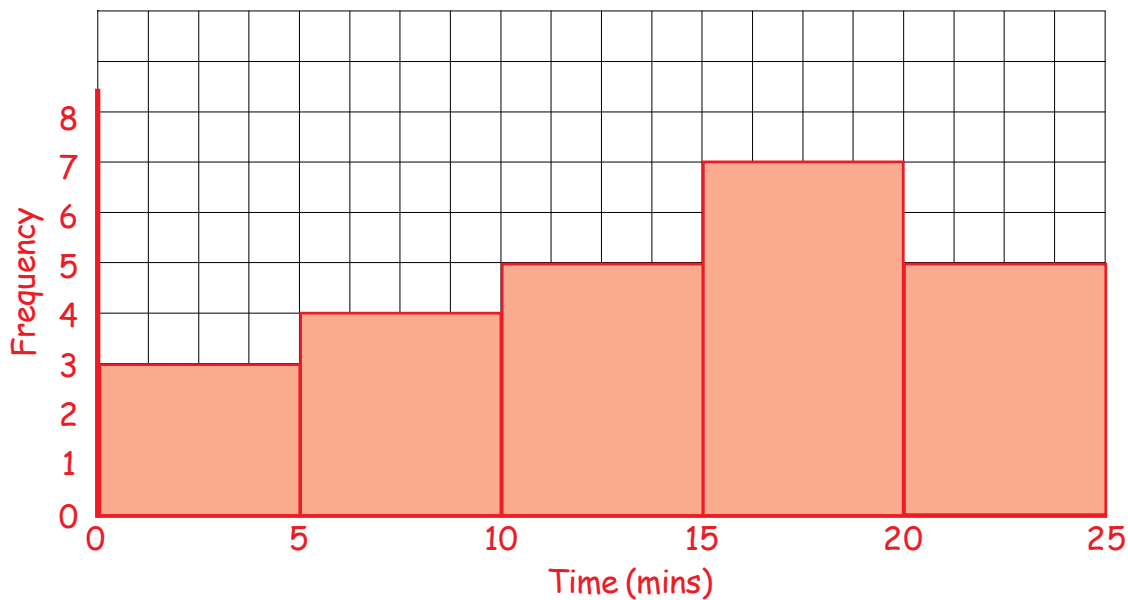   Yours will depend on your line of best fit.
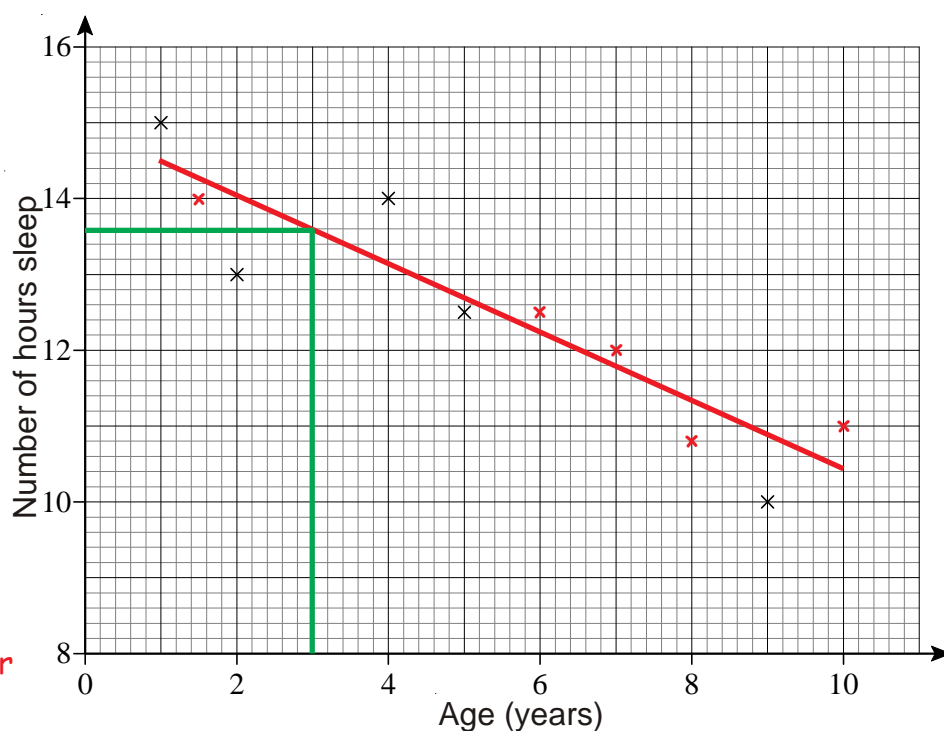
Frequency Diagrams

A class of pupils is asked to solve a puzzle.
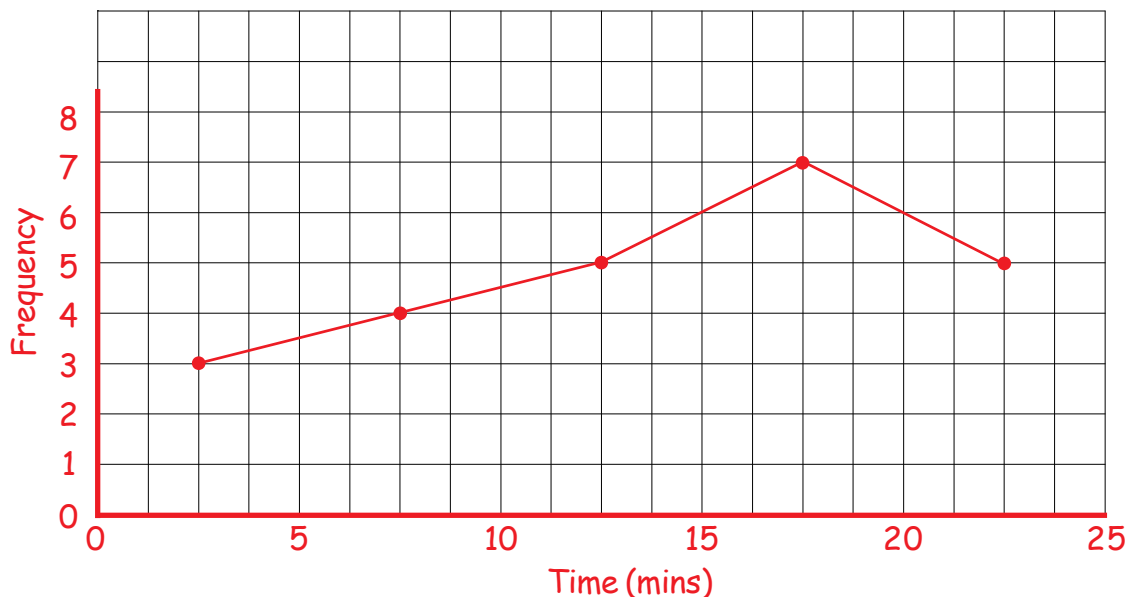The frequency table below shows the times taken by the pupils to solve the puzzle.

Time (t) in min	Frequency
$0 < t \leqslant 5$	3
$5 < t \leqslant 10$	4
$10 < t \leqslant 15$	5
$15 < t \leqslant 20$	7
$20 < t \leqslant 25$	5

a) Draw a frequency diagram to show this information.

It is OK to use a different scale.

b) Draw a frequency polygon to show this information.

Stem and Leaf Diagrams

1) 16 students sat a Maths test.
   Here are their marks:

64	72	39	45	49	67	73	50
73	44	55	77	51	62	64	79

   39, 44, 45, 49, 50, 51, 55, 62, 64, 64, 67, 72, 73, 73, 77, 79

   Draw a stem and leaf diagram to show this information.

   ```
   3 | 9
   4 | 4 5 9
   5 | 0 1 5        Key: 3|9 means 39 marks
   6 | 2 4 4 7
   7 | 2 3 3 7 9
   ```

2) Pat is carrying out a survey on how tall pupils in her class are.
   Here are their heights in cm:

173	162	170	169	163	173	156
159	161	168	177	182	170	169

   156, 159, 161, 162, 163, 168, 169, 169, 170, 170, 173, 173, 177, 182

   Draw a stem and leaf diagram to show this information.

   ```
   15 | 6 9
   16 | 1 2 3 8 9 9     Key: 15|6 means 156 cm
   17 | 0 0 3 3 7
   18 | 2
   ```

3) The stem and leaf diagram below, shows information about the times, in minutes,
   it takes a group of people to eat their breakfast.

   ```
   0 | 5 7 9
   1 | 0 0 5 8 8        Key: 1|0 represents 10 minutes.
   2 | 0 2 3 5 7
   3 | 2 5
   ```

   a) How many people are in the group?   15 people

   b) How many people spend 15 minutes or more eating their breakfast?   10 people

   c) Find the median time that it took to eat breakfast.   18 minutes

List of Outcomes

1) Three coins are flipped.
   a) How many possible outcomes are there?
   b) List all the possible outcomes.

   a) 8 possible outcomes (2 × 2 × 2)
   b) HHH, HHT, HTH, HTT,
      TTT, TTH, THT, THH.

2) Two coins are flipped and a dice is rolled.
   a) How many possible outcomes are there?
   b) List all the possible outcomes.

   24 possible outcomes (2 × 2 × 6)

   HH1, HH2, HH3, HH4, HH5, HH6,
   HT1, HT2, HT3, HT4, HT5, HT6,
   TH1, TH2, TH3, TH4, TH5, TH6,
   TT1, TT2, TT3, TT4, TT5, TT6.

Mutually Exclusive Events

1) If the probability of passing a driving test is 0.54, what is the probability of failing it?

   1 - 0.54 =
   0.46

2) The probability that a football team will win their next game is $\frac{2}{11}$.
   The probability they will lose is $\frac{3}{11}$.
   What is the probability the game will be a draw?

   $\frac{6}{11}$

   $\frac{2}{11} + \frac{3}{11} = \frac{5}{11}$

   $1 - \frac{5}{11} = \frac{6}{11}$

3) On the school dinner menu there is only ever one of four options.
   Some of the options are more likely to be on the menu than others.
   The table shows the options available on any day, together with three of the probabilities.

Food	Curry	Sausages	Fish	Casserole
Probability	0.36	0.41		0.09

   a) Work out the probability of the dinner option being Fish.

   1 - 0.36 - 0.41 - 0.09 =
   0.14

   b) Which option is most likely? **Sausages**

   c) Work out the probability that it is a Curry or Sausages on any particular day.

   0.36 + 0.41 =
   0.77

   d) Work out the probability that it is **not** Casserole. 1 - 0.09 = 0.91

4) Julie buys a book every week.
   Her favourite types are Novel, Drama, Biography and Romance.
   The table shows the probability that Julie chooses a particular type of book.

Type of book	Novel	Drama	Biography	Romance
Probability	0.24	0.16	x	x

   a) Work out the probability that she will choose a Novel or a Drama. 0.24 + 0.16 = 0.4

   b) Work out the probability that she will choose a Biography or a Romance. 1 - 0.4 = 0.6

   The probability that she will choose a Biography is the same as the probability she will choose a Romance.

   c) Work out the probability that she will choose a Biography. 0.6 ÷ 2 = 0.3

Overview of Percentages

With a calculator

1) Find the following to the nearest penny:

    a) 23% of £670 £154.10

    b) 12% of £580 £69.60

    c) 48% of £64 £30.72

    d) 13% of £7.50 £0.98

    e) 87% of £44 £38.28

    f) 15.7% of £7000 £1099

    g) 23.8% of £980 £233.24

    h) 34% of £16.34 £5.56

    i) 48.6% of £971.26 £472.03

    j) 78.24% of £12.82 £10.03

    k) 42.15% of £7876.42 £3319.91

    l) 0.57% of £60000 £342

Without a calculator

2) Find the following:

    a) 10% of £700 £70

    b) 10% of £400 £40

    c) 10% of £350 £35

    d) 10% of £530 £53

    e) 10% of £68 £6.80

    f) 10% of £46 £4.60

    g) 10% of £6.50 £0.65

    h) 10% of £12.20 £1.22

    i) 20% of £600 £120

    j) 30% of £900 £270

    k) 60% of £800 £480

    l) 20% of £650 £130

    m) 40% of £320 £128

    n) 15% of £300 £45

    o) 15% of £360 £54

    p) 65% of £12000 £7800

    q) 45% of £64 £28.80

    r) 85% of £96 £81.60

    s) 17.5% of £800 £140

    t) 17.5% of £40 £7

    u) 17.5% of £8.80 £1.54

With a calculator

3) Change the following to percentages:

    a) 6 out of 28 21.4%

    b) 18 out of 37 48.6%

    c) 42 out of 83 50.6%

    d) 24 out of 96 25%

    e) 73 out of 403 18.1%

    f) 234 out of 659 35.5%

    g) 871 out of 903 96.5%

    h) 4.7 out of 23 20.4%

    i) 6.9 out of 79 8.7%

    j) 14.8 out of 23.6 62.7%

    k) 65.8 out of 203.7 32.3%

    l) 12 out of 2314 0.5%

Without a calculator

4) Change the following to percentages:

    a) 46 out of 100 46%

    b) 18 out of 50 36%

    c) 7 out of 25 28%

    d) 23 out of 25 92%

    e) 9 out of 20 45%

    f) 16 out of 20 80%

    g) 7 out of 10 70%

    h) 9.5 out of 10 95%

    i) 10 out of 40 25%

    j) 16 out of 40 40%

    k) 30 out of 40 75%

    l) 12 out of 40 30%

    m) 28 out of 80 35%

    n) 32 out of 80 40%

    o) 60 out of 80 75%

    p) 3 out of 5 60%

    q) 4 out of 5 80%

    r) 15 out of 75 20%

    s) 24 out of 75 32%

    t) 30 out of 75 40%

No calculator

5) A shop gives a discount of 20% on a magazine that usually sells for £2.80. Work out the discount in pence. 56p

With a calculator

6) A television costs £595 plus VAT at 17.5%.

    Work out the cost of the television including VAT. £699.13

With a calculator

7) Peter has 128 trees in his garden.

    16 of the trees are pear trees.

    What percentage of the trees in his garden are pear trees? 12.5%

With a calculator

8) A battery operated car travels for 10m when it is first turned on.

    Each time it is turned on it travels 90% of the previous distance as the battery starts to run out.

    How many times does the car travel at least 8 metres? 3

With a calculator

9) Jane scored 27 out of 42 in a Maths test and 39 out of 61 in a Science test.

    What were her percentages in both subjects to 1 decimal place? Maths 64.3% Sci 63.9%

No calculator

10) In class 7A there are 7 girls and 18 boys. What percentage of the class are girls? 28%

No calculator

11) A shop decides to reduce all the prices by 15%.

    The original price of a pair of trainers was £70. How much are they after the reduction? £59.50

No calculator

12) VAT at 17.5% is added to the price of a car. Before the VAT is added it cost £18000.

    How much does it cost with the VAT? £21150

Increase/Decrease by a Percentage

1) Increase:
   a) 500 by 10%
      10% = 50
      500 + 50
      550

   b) 320 by 10%
      10% = 32
      320 + 32
      352

   c) 80 by 15%
      10% = 8, 5% = 4
      80 + 8 + 4
      92

   d) 75 by 20%
      10% = 7.5, 20% = 15
      75 + 15
      90

2) Decrease:
   a) 400 by 10%
      10% = 40
      400 - 40
      360

   b) 380 by 10%
      10% = 38
      380 - 38
      342

   c) 140 by 15%
      10% = 14, 5% = 7
      140 - 14 - 7
      119

   d) 35 by 20%
      10% = 3.5, 20% = 7
      35 - 7
      28

3) The price of laptop is increased by 15%.
   The old price of the laptop was £300.
   Work out the new price. **£345**
   10% = 30, 5% = 15
   300 + 30 + 15 = 345

4) The price of a £6800 car is reduced by 10%.
   What is the new price? **£6 120**
   10% = 680
   6800 - 680 = 6120

5) Increase:
   a) 65 by 12% **72.8** $\dfrac{112}{100} \times 65$

   b) 120 by 23% **147.6** $\dfrac{123}{100} \times 120$

   c) 600 by 17.5% **705** $\dfrac{117.5}{100} \times 600$

   d) 370 by 17.5% **434.75** $\dfrac{117.5}{100} \times 370$

6) Decrease:
   a) 42 by 15% **35.7** $\dfrac{85}{100} \times 42$

   b) 79 by 12% **69.52** $\dfrac{88}{100} \times 79$

   c) 52 by 8.5% **47.58** $\dfrac{91.5}{100} \times 52$

   d) 8900 by 18% **7 298** $\dfrac{82}{100} \times 8900$

7) The price of a mobile phone is £78.40 plus VAT.
   VAT is charged at a rate of 17.5%.
   What is the total price of the mobile phone? **£92.12**
   $\dfrac{117.5}{100} \times 78.40$

8) In a sale, normal prices are reduced by 7%.
   The normal price of a camera is £89.
   Work out the sale price of the camera. **£82.77**
   $\dfrac{93}{100} \times 89$

9) A car dealer offers a discount of 20% off the normal price of a car, for cash.
   Peter intends to buy a car which usually costs £6800.
   He intends to pay by cash.
   Work out how much he will pay. **£5 440**
   $\dfrac{80}{100} \times 6800$

10) A month ago, John weighed 97.5 kg.
    He now weighs 4.5% more.
    Work out how much John now weighs. **101.9 kg**
    Give your answer to 1 decimal place.
    $\dfrac{104.5}{100} \times 97.5$

Ratio

1. Write the following ratios in their simplest form

   a) 6 : 9
   2 : 3

   b) 10 : 5
   2 : 1

   c) 7 : 21
   1 : 3

   d) 4 : 24
   1 : 6

   e) 12 : 40
   3 : 10

   f) 18 : 27
   2 : 3

   g) 4 : 2 : 8
   2 : 1 : 4

   h) 18 : 63 : 9
   2 : 7 : 1

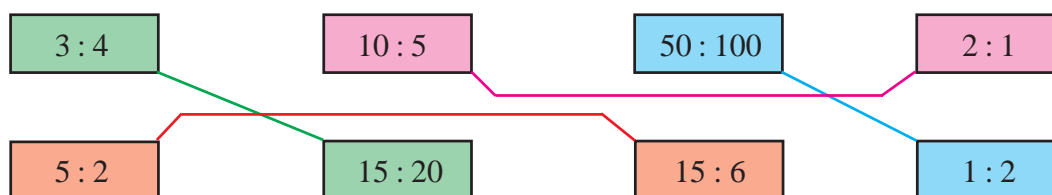2. Complete the missing value in these equivalent ratios

   a) 3 : 5 = 12 : **20**

   b) 4 : 9 = **12** : 27

   c) **8** : 7 = 16 : 14

   d) 2 : 3 = 3 : **4.5**

3. Match together cards with equivalent ratios:

   | 3 : 4 | | 10 : 5 | | 50 : 100 | | 2 : 1 |

   | 5 : 2 | | 15 : 20 | | 15 : 6 | | 1 : 2 |

4. The ratio of girls to boys in a class is 4 : 5.

   a) What fraction of the class are girls? $\frac{4}{9}$

   b) What fraction of the class are boys? $\frac{5}{9}$

5. A model of a plane is made using a scale of 1 : 5.

   a) If the real length of the plane is 20m, what is the length of the model in metres? **4m**

   b) If the wings of the model are 100cm long, what is the real length of the wings in metres? **5m**

6. Share out £250 in the following ratios:

   a) 1 : 4
   £50 and £200

   b) 2 : 3
   £100 and £150

   c) 7 : 3
   £175 and £75

   d) 9 : 12 : 4
   £90 and £120 and £40

7. Share out £80 between Tom and Jerry in the ratio 3 : 2. **Tom gets £48, Jerry gets £32**
   3 + 2 = 5   80 ÷ 5 = 16   3 × 16 = 48   2 × 16 = 32

8. A box of chocolates has 3 milk chocolates for every 2 white chocolates.
   There are 60 chocolates in the box.
   Work out how many white chocolates are in the box. **24 white chocolates**
   3 + 2 = 5   60 ÷ 5 = 12   2 × 12 = 24

9. In a bracelet, the ratio of silver beads to gold beads is 5 : 2.
   The bracelet has 25 silver beads.
   How many gold beads are in the bracelet? **10 gold beads**

   S G
   ×5 (5   2) ×5
   **   25 ?**

10. To make mortar you mix 1 shovel of cement with 5 shovels of sand.
    How much sand do you need to make 30 shovels of mortar? **25 shovels of sand**
    1 + 5 = 6
    30 ÷ 6 = 5
    5 × 5 = 25

Product of Prime Factors

1) List the first seven prime numbers.

   2, 3, 5, 7, 11, 13, 17

2) Express the following number as the product of their prime factors:

   a) 30   b) 60   c) 360   d) 220

   $2 \times 3 \times 5$ $2 \times 2 \times 3 \times 5$ $2 \times 2 \times 2 \times 3 \times 3 \times 5$ $2 \times 2 \times 5 \times 11$

3) Express the following number as the product of **powers** of their prime factors:

   a) 24   b) 64   c) 192   d) 175
   $2^3 \times 3$ 2^6 $2^6 \times 3$ $5^2 \times 7$

   $2 \times 2 \times 2 \times 3$

4) The number 96 can be written as $2^m \times n$, where m and n are prime numbers.
   Find the value of m and the value of n.   m = 5

   $96 = 2 \times 2 \times 2 \times 2 \times 2 \times 3$ n = 3
   $96 = 2^5 \times 3$

5) The number 75 can be written as $5^x \times y$, where x and y are prime numbers.
   Find the value of x and the value of y.   x = 2

   $75 = 3 \times 5 \times 5$ y = 3
   $75 = 3 \times 5^2$

HCF and LCM

1) Find the Highest Common Factor (HCF) of each of these pairs of numbers.

   a) 16 and 24   8   b) 21 and 28   7   c) 60 and 150   30   d) 96 and 108   12
   $16 = 2 \times 2 \times 2 \times 2$ $21 = 3 \times 7$ $60 = 2 \times 2 \times 3 \times 5$ $96 = 2 \times 2 \times 2 \times 2 \times 2 \times 3$
   $24 = 2 \times 2 \times 2 \times 3$ $28 = 2 \times 2 \times 7$ $150 = 2 \times 3 \times 5 \times 5$ $108 = 2 \times 2 \times 3 \times 3 \times 3$

2) Find the Least (or Lowest) Common Multiple (LCM) of each of these pairs of numbers.

   a) 16 and 24   48   b) 21 and 28   84   c) 60 and 150   300   d) 96 and 108   864

3) a) Write 42 and 63 as products of their prime factors. $42 = 2 \times 3 \times 7$
                                                               $63 = 3 \times 3 \times 7$

   b) Work out the HCF of 42 and 63.   21

   c) Work out the LCM of 42 and 63.   126

4) a) Write 240 and 1500 as products of their prime factors. $240 = 2 \times 2 \times 2 \times 2 \times 3 \times 5$
                                                                  $1500 = 2 \times 2 \times 3 \times 5 \times 5 \times 5$

   b) Work out the HCF of 240 and 1500.   60

   c) Work out the LCM of 240 and 1500.   6 000

1) Change the following to normal (or ordinary) numbers.

a) 4.3×10^4
   43 000

b) 6.79×10^6
   6 790 000

c) 7.03×10^3
   7 030

d) 9.2034×10^2
   920.34

e) 1.01×10^4
   10 100

f) 4×10^5
   400 000

2) Change the following to normal (or ordinary) numbers.

a) 4.3×10^{-4}
   0.00043

b) 6.79×10^{-6}
   0.00000679

c) 7.03×10^{-3}
   0.00703

d) 9.2034×10^{-2}
   0.092034

e) 1.01×10^{-4}
   0.000101

f) 4×10^{-5}
   0.00004

3) Change the following to standard form.

a) 360
   3.6×10^2

b) 8 900
   8.9×10^3

c) 520 000
   5.2×10^5

d) 62 835
   6.2835×10^4

e) 1 003
   1.003×10^3

f) 6 450 000
   6.45×10^6

4) Change the following to standard form.

a) 0.71
   7.1×10^{-1}

b) 0.0008
   8×10^{-4}

c) 0.00076
   7.6×10^{-4}

d) 0.0928
   9.28×10^{-2}

e) 0.00009
   9×10^{-5}

f) 0.00000173
   1.73×10^{-6}

5) Work out the following, giving your answer in standard form.

a) $3\,000 \times 5\,000$ 15 000 000
   1.5×10^7

b) 240×0.0002 0.048
   4.8×10^{-2}

c) $9 \times 1.1 \times 10^7$
   9.9×10^7

d) $5 \times 4 \times 10^3$ 20×10^3
   2×10^4

e) $\dfrac{8 \times 10^4}{4 \times 10^2}$
   2×10^2

f) $9 \times 10^2 \times 2 \times 10^{-5}$ 18×10^{-3}
   1.8×10^{-2}

g) $7 \times 10^2 \times 3 \times 10^{-4}$
   2.1×10^{-1} 21×10^{-2}

h) $2 \times 3.6 \times 10^{-5}$
   7.2×10^{-5}

i) $6 \times 4.1 \times 10^3$ 24.6×10^3
   2.46×10^4

Recurring Decimals into Fractions

1) Write each recurring decimal as an exact fraction,
   in its lowest terms.

a) $0.\dot{5}$ $\quad\quad \dfrac{5}{9}$

b) $0.\dot{7}$ $\quad\quad \dfrac{7}{9}$

c) $0.\dot{4}$ $\quad\quad \dfrac{4}{9}$

d) $0.\dot{2}\dot{4}$ $\quad \dfrac{24}{99} \quad \dfrac{8}{33}$

e) $0.\dot{7}\dot{5}$ $\quad \dfrac{75}{99} \quad \dfrac{25}{33}$

f) $0.\dot{8}\dot{2}$ $\quad\quad \dfrac{82}{99}$

g) $0.\dot{6}1\dot{7}$ $\quad\quad \dfrac{617}{999}$

h) $0.\dot{2}1\dot{6}$ $\quad \dfrac{216}{999} \quad \dfrac{8}{37}$

i) $0.\dot{7}1\dot{4}$ $\quad \dfrac{714}{999} \quad \dfrac{238}{333}$

j) $0.\dot{3}2\dot{4}$ $\quad \dfrac{324}{999} \quad \dfrac{12}{37}$

k) $0.\dot{7}235\dot{7}$ $\quad \dfrac{72357}{99999} \quad \dfrac{89}{123}$

l) $0.\dot{6}521\dot{4}$ $\quad \dfrac{65214}{99999} \quad \dfrac{7246}{11111}$

Four Rules of Negatives

Work out the following without a calculator

a) 6 – 9 =   -3

b) 4 × -3 =   -12

c) -10 ÷ -5 =   2

d) -7 – -6 =   -1

e) 25 ÷ -5 =   -5

f) -2 + -6 =   -8

g) 7 – -3 =   10

h) 6 × -9 =   -54

i) 5 + -11 =   -6

j) -8 × 4 =   -32

k) 12 + -3 =   9

l) 5 + 9 – 3 =   11

m) -3 × -2 × 4 =   24

n) -6 – -5 – 8 =   -9

o) -5 × -6 × -2=   -60

p) 8 ÷ -4 × -5 =   10

q) 2 + -8 + -7 =   -13

r) 13 + -13 =   0

s) 16 ÷ -2 × 4 =   -32

t) 11 – 3 + -9 – -5 =   4

u) -7 × -2 × -3 =   -42

v) -1 + -3 + 2 =   -2

Division by Two-Digit Decimals

1) Work out the following without a calculator

a) 350 ÷ 0.2   1750   3500 ÷ 2

b) 2 ÷ 0.25   8   200 ÷ 25

c) 0.45 ÷ 0.9   0.5   4.5 ÷ 9

d) 2.42 ÷ 0.4   6.05   24.2 ÷ 4

e) 30.66 ÷ 2.1   14.6   306.6 ÷ 21

f) 5.886 ÷ 0.9   6.54   58.86 ÷ 9

g) 38.08 ÷ 1.7   22.4   380.8 ÷ 17

h) 98.8 ÷ 0.08   1235   9880 ÷ 8

2) Sam is filling a jug that can hold 1.575 litres, using a small glass.
   The small glass holds 0.035 litres.
   How many of the small glasses will he need?   45

   1575 ÷ 35 = 45

   $$\begin{array}{r} 4\ 5 \\ \overline{35\,|\,1\ 5\ 7\,^{17}5} \end{array}$$

Estimating Answers

1. Work out an estimate for the value of

   a) $\dfrac{547}{4.8 \times 9.7}$ $\color{red}{10}$ $\dfrac{500}{5 \times 10}$ $\dfrac{500}{50}$

   b) $\dfrac{69 \times 398}{207}$ $\color{red}{140}$ $\dfrac{70 \times 400}{200}$ $\dfrac{28\ 000}{200}$

   c) $\dfrac{7.5 \times 2.79}{2.71 + 3.19}$ $\color{red}{4}$ $\dfrac{8 \times 3}{3 + 3}$ $\dfrac{24}{6}$

   d) $\dfrac{409 \times 5.814}{0.19}$ $\color{red}{12\ 000}$ $\dfrac{400 \times 6}{0.2}$ $\dfrac{2\ 400}{0.2}$

2. a) Work out an estimate for

   $\dfrac{19.6 \times 31.7}{7.9 \times 5.2}$ $\color{red}{15}$ $\dfrac{20 \times 30}{8 \times 5}$ $\dfrac{600}{40}$

   b) Use your answer to part (a) to find an estimate for

   $\dfrac{196 \times 317}{79 \times 52}$ $\color{red}{15}$

3. a) Work out an estimate for

   $\dfrac{6.13 \times 9.68}{3.79 \times 2.56}$ $\color{red}{5}$ $\dfrac{6 \times 10}{4 \times 3}$ $\dfrac{60}{12}$

   b) Use your answer to part (a) to find an estimate for

   $\dfrac{613 \times 968}{379 \times 256}$ $\color{red}{5}$

Algebraic Simplification

1) Simplify

   a) $x + x$ **2x**

   b) $x \times x$ **x²**

   c) $3x + 2x$ **5x**

   d) $3x \times 2x$ **6x²**

   e) $2x^2y^3 + 4x^2y^3$ **6x²y³**

   f) $2x^2y \times 3xy^3$ **6x³y⁴**

2) Simplify

   a) $x + y + x + y$ **2x + 2y**

   b) $3x + 2y + x + 5y$ **4x + 7y**

   c) $6y + 2x - 2y - 3x$ **4y - x**

   d) $5p - 3q + p + 2q$ **6p - q**

3) Expand and simplify

   a) $2(x + y) + 3(x + y)$
      5x + 5y

   b) $3(2x + y) + 2(5x + 3y)$
      16x + 9y

   c) $5(x + y) + 3(2x - y)$
      11x + 2y

   d) $3(2c + d) - 2(c + d)$
      4c + d

   e) $4(2p + q) - 3(2p - q)$
      2p + 7q

   f) $3(4x - 2y) + 2(x + 2y)$
      14x - 2y

   g) $6(x - 3y) - 2(2x - 5y)$
      2x - 8y

4) Expand and simplify

   a) $5(3p + 2) - 2(4p - 3)$
      7p + 16

   b) $4(2x + 3) - (x - 2)$
      7x + 14

5) a) Simplify $pq + 2pq$ **3pq**

   b) Simplify $5x + 3y - x - 4y$ **4x - y**

6) a) Simplify $6a + 5b - 3b + a$ **7a + 2b**

   b) Simplify $x^4 + x^4$ **2x⁴**

7) a) Simplify $x + y + x + y + x$ **3x + 2y**

   b) Simplify $t^2 + t^2 + t^2$ **3t²**

8) a) Simplify $a^3 \times a^3$ **a⁶**

   b) Simplify $3x^2y \times 4xy^3$ **12x³y⁴**

9) a) Simplify $3d + e - d + 4e$ **2d + 5e**

   b) Simplify $3x^2 - x^2$ **2x²**

   c) Simplify $5t + 8d - 2t - 3d$ **3t + 5d**

   d) Simplify $4t \times 2q$ **8tq**

10) The table shows some expressions.

2(p + p)	2p × p	3p + 2p	2 + 2p	2p + 2p
✓				✓

Two of the expressions **always** have the same value as 4p.

Tick the boxes underneath the **two** expressions.

11) Expand and simplify

   (i) $4(x + 5) + 3(x - 6)$ **7x + 2**

   (ii) $3(2x - 1) - 2(x - 4)$ **4x + 5**

   (iii) $5(2y + 2) - (y + 3)$ **9y + 7**

Expanding and Simplifying Brackets

1) Expand these brackets

   a) $2(x + 3)$ $2x + 6$

   b) $3(2x + 4)$ $6x + 12$

   c) $5(3p - 2q)$ $15p - 10q$

   d) $4(x^2 + 2y^2)$ $4x^2 + 8y^2$

   e) $r(r - r^2)$ $r^2 - r^3$

2) Expand and simplify

   a) $(x + 1)(x + 2)$ $x^2 + 3x + 2$ $x^2 + 1x + 2x + 2$

   b) $(x + 3)(2x + 4)$ $2x^2 + 10x + 12$ $2x^2 + 6x + 4x + 12$

   c) $(2x + 1)(3x + 2)$ $6x^2 + 7x + 2$ $6x^2 + 3x + 4x + 2$

3) Expand and simplify

   a) $(x + 3)(x - 2)$ $x^2 + x - 6$ $x^2 + 3x - 2x - 6$

   b) $(x - 1)(x + 4)$ $x^2 + 3x - 4$ $x^2 - 1x + 4x - 4$

   c) $(x - 3)(x - 2)$ $x^2 - 5x + 6$ $x^2 - 3x - 2x + 6$

4) Expand and simplify

   a) $(2p + 3)(p - 2)$ $2p^2 - p - 6$ $2p^2 + 3p - 4p - 6$

   b) $(3t - 2)(2t + 3)$ $6t^2 + 5t - 6$ $6t^2 - 4t + 9t - 6$

   c) $(2x - 5)(3x - 2)$ $6x^2 - 19x + 10$ $6x^2 - 15x - 4x + 10$

5) Expand and simplify

   a) $(x + 3y)(x + 4y)$ $x^2 + 7xy + 12y^2$ $x^2 + 3xy + 4xy + 12y^2$

   b) $(2p + q)(3p + 2q)$ $6p^2 + 7pq + 2q^2$ $6p^2 + 3pq + 4pq + 2q^2$

6) Expand and simplify

   a) $(2x + 1)^2$ $4x^2 + 4x + 1$ $(2x + 1)(2x + 1) = 4x^2 + 2x + 2x + 1$

   b) $(3x - 2)^2$ $9x^2 - 12x + 4$ $(3x - 2)(3x - 2) = 9x^2 - 6x - 6x + 4$

   c) $(2p + q)^2$ $4p^2 + 4pq + q^2$ $(2p + q)(2p + q) = 4p^2 + 2pq + 2pq + q^2$

Factorisation

1) Factorise

    a) $2x + 4$ 2(x + 2)

    b) $2y + 10$ 2(y + 5)

    c) $3x + 12$ 3(x + 4)

    d) $3x - 6$ 3(x - 2)

    e) $5x - 15$ 5(x - 3)

2) Factorise

    a) $p^2 + 7p$ p(p + 7)

    b) $x^2 + 4x$ x(x + 4)

    c) $y^2 - 2y$ y(y - 2)

    d) $p^2 - 5p$ p(p - 5)

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

3) Factorise

    a) $2x^2 + 6x$ 2x(x + 3)

    b) $2y^2 - 8y$ 2y(y - 4)

    c) $5p^2 + 10p$ 5p(p + 2)

    d) $7c^2 - 21c$ 7c(c - 3)

    e) $6x^2 + 9x$ 3x(2x + 3)

4) Factorise

    a) $2x^2 - 4xy$ 2x(x - 2y)

    b) $2t^2 + 10tu$ 2t(t + 5u)

    c) $6x^2 - 8xy$ 2x(3x - 4y)

    d) $3x^2y^2 + 9xy$ 3xy(xy + 3)

Solving Equations

Solve the following equations

1) $2p - 1 = 13$ p = 7
$$2p = 13 + 1$$
$$2p = 14$$
$$p = 7$$

2) $4y + 1 = 21$ y = 5
$$4y = 21 - 1$$
$$4y = 20$$
$$y = 5$$

3) $6x - 7 = 32$ x = 6.5
$$6x = 32 + 7$$
$$6x = 39$$
$$x = 6.5$$

4) $x + x + x + x = 20$ x = 5
$$4x = 20$$
$$x = 5$$

5) $x + 3x = 40$ x = 10
$$4x = 40$$
$$x = 10$$

6) $5(t - 1) = 20$ t = 5
$$5t - 5 = 20$$
$$5t = 20 + 5$$
$$5t = 25$$
$$t = 5$$

7) $4(5y - 2) = 52$ y = 3
$$20y - 8 = 52$$
$$20y = 52 + 8$$
$$20y = 60$$
$$y = 3$$

8) $4(y + 3) = 24$ y = 3
$$4y + 12 = 24$$
$$4y = 24 - 12$$
$$4y = 12$$
$$y = 3$$

9) $20x - 15 = 18x - 7$ x = 4
$$20x - 18x = -7 + 15$$
$$2x = 8$$
$$x = 4$$

10) $4y + 3 = 2y + 10$ y = 3.5
$$4y - 2y = 10 - 3$$
$$2y = 7$$
$$y = 3.5$$

11) $2x + 17 = 5x - 4$ x = 7
$$4 + 17 = 5x - 2x$$
$$21 = 3x$$
$$7 = x$$

12) $2x + 7 = 16 - 4x$ x = 1.5
$$2x + 4x = 16 - 7$$
$$6x = 9$$
$$x = 1.5$$

13) $5(x + 3) = 2(x + 6)$ x = -1
$$5x + 15 = 2x + 12$$
$$5x - 2x = 12 - 15$$
$$3x = -3$$
$$x = -1$$

14) $4(2y + 1) = 2(12 - y)$ y = 2
$$8y + 4 = 24 - 2y$$
$$8y + 2y = 24 - 4$$
$$10y = 20$$
$$y = 2$$

15) $7 - 3x = 2(x + 1)$ x = 1
$$7 - 3x = 2x + 2$$
$$7 - 2 = 2x + 3x$$
$$5 = 5x$$
$$1 = x$$

16) $\dfrac{x - 3}{2} = 5$ x = 13
$$x - 3 = 5 \times 2$$
$$x - 3 = 10$$
$$x = 13$$

17) $\dfrac{2x + 4}{3} = 7$ x = 8.5
$$2x + 4 = 21$$
$$2x = 17$$
$$x = 8.5$$

18) $\dfrac{40 - x}{3} = 4 + x$ x = 7
$$40 - x = (4 + x) \times 3$$
$$40 - x = 12 + 3x$$
$$40 - 12 = 3x + x$$
$$28 = 4x$$
$$7 = x$$

Forming Equations

1) The width of a rectangle is x centimetres.
   The length of the rectangle is $(x + 5)$ centimetres.

   $x + 5$

   x x

   P = x + 5 + x + x + 5 + x
   P = 4x + 10

   $x + 5$
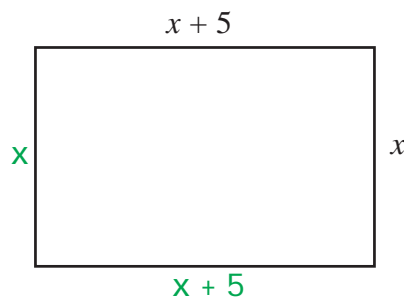
   a) Find an expression, in terms of x, for the perimeter of the rectangle.
      Give your answer in its simplest form.   4x + 10

   The perimeter of the rectangle is 38 centimetres.

   4x + 10 = 38
   4x   = 28
   x   =   7

   b) Work out the length of the rectangle.   Length is 12 cm

2)

   $x + 80$

   $x + 30$

   $x + 10$ *Diagram NOT accurately drawn*

   $2x$
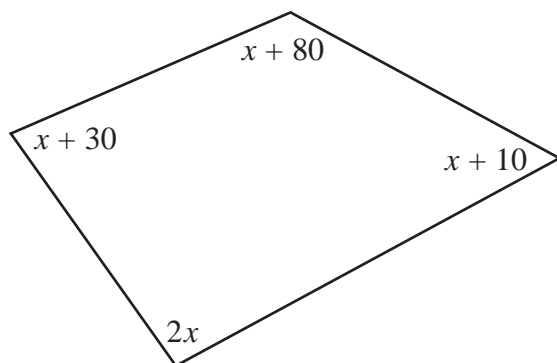
   The sizes of the angles, in degrees, of the quadrilateral are

   $x + 10$ Angles of a quadrilateral add up to 360°
   $2x$ x + 80 + x + 10 + 2x + x + 30 = 360
   $x + 80$ 5x + 120 = 360
   $x + 30$

   a) Use this information to write down an equation in terms of x.   5x + 120 = 360

   b) Use your answer to part (a) to work out the size of the smallest angle of
      the quadrilateral.   Smallest angle is 58°

   5x + 120 = 360
   5x   = 240
   x   =   48

3) Sarah buys 6 cups and 6 mugs
   A cup costs £x
   A mug costs £$(x + 3)$

   a) Write down an expression, in terms of x, for the total cost, in pounds,
      of 6 cups and 6 mugs.   12x + 18

   b) If the total cost of 6 cups and 6 mugs is £48, write an equation in
      terms of x.   12x + 18 = 48

   c) Solve your equation to find the cost of a cup and the cost of a mug.
      A cup costs £2.50 and a mug costs £5.50

1) Make c the subject of the formula.

$a = b + cd$ $c = \dfrac{a - b}{d}$

2) Make t the subject of the formula.

$u = v + 2t$ $t = \dfrac{u - v}{2}$

3) Make n the subject of the formula.

$M = 3n + 5$ $n = \dfrac{M - 5}{3}$

4) Make z the subject of the formula.

$x = 3y + z$ $z = x - 3y$

5) $r = 5s + 3t$

    a) Make t the subject of the formula. $t = \dfrac{r - 5s}{3}$

    b) Make s the subject of the formula. $s = \dfrac{r - 3t}{5}$

6) Rearrange $y = 3x + 1$ to make x the subject. $x = \dfrac{y - 1}{3}$

7) Rearrange $y = \dfrac{1}{2}x + 2$ to make x the subject. $x = 2(y - 2)$ or $x = 2y - 4$

8) Rearrange $y = \dfrac{1}{3}x + 1$ to make x the subject. $x = 3(y - 1)$ or $x = 3y - 3$

1) Represent this inequality on the number line

$$-3 < x \leqslant 2$$
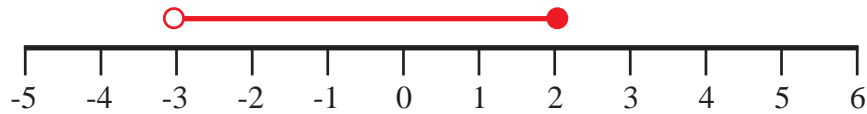
2) Represent this inequality on the number line

$$-1 < x < 5$$
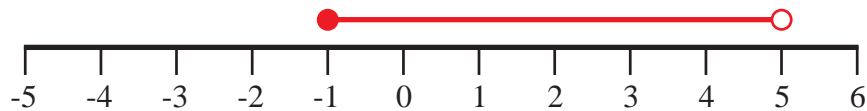
3) Write down the inequality shown $-4 < x \leqslant 4$
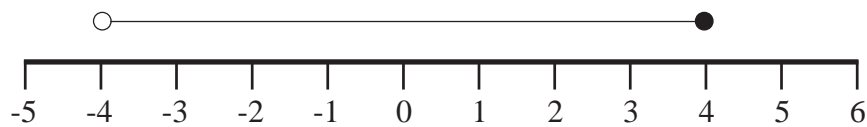
4) Write down the inequality shown $-5 \leqslant x < 3$
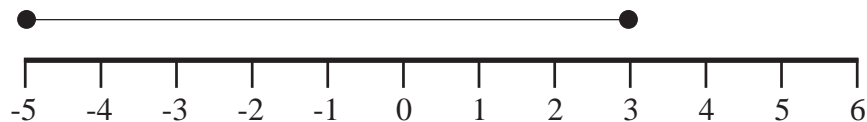
5) If y is an integer, write down all the possible values of

$$-2 < y \leqslant 5$$
-1, 0, 1, 2, 3, 4, 5

6) If x is an integer, write down all the possible values of

$$-9 < x < -5$$
-8, -7, -6

Solving Inequalities

1) Solve

a) $3x - 1 > 5$
x > 2

b) $7y + 2 \leq 30$
y ⩽ 4

c) $\dfrac{x}{2} - 3 \geq 2$
x ⩾ 10

d) $5 + 2x > 7$
x > 1

e) $8 < 5p - 2$
2 < p

f) $\dfrac{y}{3} + 5 \geq 3$
y ⩾ -6

g) $\dfrac{2x}{3} - 5 \geq -3$
x ⩾ 3

h) $6x - 5 > 2x + 3$
x > 2

i) $3p - 9 < 6 - 2p$
p < 3

j) $5 - 3y < 2y - 10$
3 < y

a) 3x > 5 + 1
   3x > 6
    x > 6/3

b) 7y ⩽ 30 - 2
   7y ⩽ 28
    y ⩽ 28/7

c) x/2 ⩾ 2 + 3
    x/2 ⩾ 5
    x ⩾ 5 × 2

d) 2x > 7 - 5
   2x > 2
    x > 2/2

e) 8 + 2 < 5p
   10 < 5p
   10/5 < p

f) y/3 ⩾ 3 - 5
    y/3 ⩾ -2
    y ⩾ -2 × 3

g) 2x/3 ⩾ -3 + 5
   2x/3 ⩾ 2
    x ⩾ (2 × 3)/2

h) 6x - 2x > 3 + 5
   4x   > 8
    x   > 8/4

i) 3p + 2p < 6 + 9
   5p   < 15
   p   < 15/5

j) 5 + 10 < 2y + 3y
   15   < 5y
   15/5   < y

2) a) Solve the inequality

   $2z + 2 \geq 7$
   z ⩾ 2.5

   2z ⩾ 7 - 2
   2z ⩾ 5
   z ⩾ 5/2

   b) Write down the smallest **integer** value of z which satisfies the inequality

   $2z + 2 \geq 7$
   z = 3

3) $5x + 2y < 10$

   x and *y* are both integers.

   Write down two possible pairs of values that satisfy this inequality.
   $x = \underline{....1....}, y = \underline{....1....}$ 5 × 1 + 2 × 1 = 7
   and
   $x = \underline{....1....}, y = \underline{....2....}$ 5 × 1 + 2 × 2 = 9

   other pairs of values are possible.

Trial and Improvement

1) The equation

$$x^3 - x = 29$$

has a solution between 3 and 4
Use a trial and improvement method to find this solution.
Give your answer correct to 1 decimal place.
You must show **all** your working.

x³ - x = 29		
x = 3	3³ - 3 = 24	too low
x = 4	4³ - 4 = 60	too high
x = 3.1	3.1³- 3.1 = 26.691	too low
x = 3.2	3.2³- 3.2 = 29.568	too high
x = 3.15	3.15³ - 3.15 = 28.105875	too low

Therefore, x = 3.2 to 1 decimal place.

```
  3.1        3.15        3.2
  |_____|_____|
  Low         Low        High
```

2) The equation

$$x^3 - 4x = 25$$

has a solution between 3 and 4
Use a trial and improvement method to find this solution.
Give your answer correct to 1 decimal place.
You must show **all** your working.

x³ - 4x = 25		
x = 3	3³ - 4 × 3 = 15	too low
x = 4	4³ - 4 × 4 = 48	too high
x = 3.4	3.4³ - 4 × 3.4 = 25.704	too high
x = 3.3	3.3³ - 4 × 3.3 = 22.737	too low
x = 3.35	3.35³- 4 × 3.35 = 24.195375	too low

Therefore, x = 3.4 to 1 decimal place.

```
  3.3        3.35        3.4
  |_____|_____|
  Low         Low        High
```

3) The equation

$$x^3 - 2x = 68$$

has a solution between 4 and 5
Use a trial and improvement method to find this solution.
Give your answer correct to 1 decimal place.
You must show **all** your working.

x³ - 2x = 68		
x = 4	4³ - 2 × 4 = 56	too low
x = 5	5³ - 2 × 5 = 115	too high
x = 4.2	4.2³ - 2 × 4.2 = 65.688	too low
x = 4.3	4.3³ - 2 × 4.3 = 70.907	too high
x = 4.25	4.25³- 2 × 4.25 = 68.265625	too high

Therefore, x = 4.2 to 1 decimal place.

```
  4.2        4.25        4.3
  |_____|_____|
  Low         High       High
```

4) The equation

$$x^3 + 4x = 101$$

has one solution which is a positive number.

Use a trial and improvement method to find this solution.
Give your answer correct to 1 decimal place.
You must show **all** your working.

x³ + 4x = 101		
x = 3	3³ + 4 × 3 = 39	too low
x = 4	4³ + 4 × 4 = 80	too low
x = 5	5³ + 4 × 5 = 145	too high
x = 4.2	4.2³ + 4 × 4.2 = 90.888	too low
x = 4.3	4.3³ + 4 × 4.3 = 96.707	too low
x = 4.4	4.4³ + 4 × 4.4 = 102.784	too high
x = 4.35	4.35³+ 4 × 4.35 = 99.712875	too low

Therefore, x = 4.4 to 1 decimal place.

```
  4.3        4.35        4.4
  |_____|_____|
  Low         Low        High
```

1) Write as a power of 8
   a) $8^4 \times 8^3$ 8^7 b) $8^{12} \div 8^7$ 8^5

2) Write as a power of 3
   a) $3^2 \times 3^9$ 3^{11} b) $3^{10} \div 3^3$ 3^7

3) Simplify
   a) $k^5 \times k^2$ k^7

   b) $x^4 \div x^2$ x^2

   c) $\dfrac{k^{11}}{k^6}$ k^5

   d) $(k^8)^2$ k^{16}

4) Simplify
   eg. $(2xy^3)^4 = 2xy^3 \times 2xy^3 \times 2xy^3 \times 2xy^3 = 16x^4y^{12}$

   a) $(2xy^5)^3$ $8x^3y^{15}$

   b) $(2x^2y^2)^3$ $8x^6y^6$

   c) $(4xy^4)^2$ $16x^2y^8$

   d) $(3xy^2)^4$ $81x^4y^8$

5) $2^x \times 2^y = 2^{10}$
     and
  $2^x \div 2^y = 2^2$

   Work out the value of x and the value of y.
   x = 6   and   y = 4

6) $5^x \times 5^y = 5^{12}$
     and
  $5^x \div 5^y = 5^6$

   Work out the value of x and the value of y.
   x = 9   and   y = 3

7) $a = 2^x$, $b = 2^y$
   Express in terms of a and b
   a) 2^{x+y} ab

   b) 2^{2x} a^2

   c) 2^{3y} b^3

   d) 2^{x+2y} ab^2

Nth Term

1. Write down the first 5 terms and the 10th term of the following sequences:

eg.   *2n + 1*   *3, 5, 7, 9, 11.....21*

a) 2n + 2   4, 6, 8, 10, 12, . . 22   d) 7n   7, 14, 21, 28, 35, . . 70

b) 3n + 1   4, 7, 10, 13, 16, . . 31   e) 3n – 1   2, 5, 8, 11, 14, . . 29

c) n + 3   4, 5, 6, 7, 8, . . 13   f) 7n – 3   4, 11, 18, 25, 32, . . 67

2. Find the nth term of the following sequences:

0 a) 5, 10, 15, 20...   5n   +26 d) 22, 18, 14, 10...   -4n + 26
      5   5   5   -4   -4   -4

+2 b) 5, 8, 11, 14...   3n + 2   -9 e) –3, 3, 9, 15...   6n - 9
      3   3   3   6   6   6

-6 c) 1, 8, 15, 22...   7n - 6   +9 f) 4, –1, –6, –11...   -5n + 9
      7   7   7   -5   -5   -5

3. Here are some patterns made from sticks.

Pattern 1   Pattern 2   Pattern 3

a) Draw pattern 4 in the space, below..

Pat 1   Pat 2   Pat 3   Pat 4   Pat 5   Pat 6
+1   6   11   16   21   26   31
     5   5   5   5   5

b) How many sticks are used in

    nth term is 5n + 1

(i)   pattern 10   51 sticks

(ii)   pattern 20   101 sticks

(iii)   pattern 50   251 sticks

c) Find an expression, in terms of *n*, for the number of sticks in pattern number *n*.   5n + 1

d) Which pattern number can be made using 301 sticks?   Pattern 60

Drawing Straight Line Graphs

1) a) Complete the table of values for y = 2x – 3

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

b) Using the axes on the right draw the graph of y = 2x – 3

c) Use your graph to work out the value of y when x = 2.5   y = 2

d) Use your graph to work out the value of x when y = 4.5   x = 3.75

_____
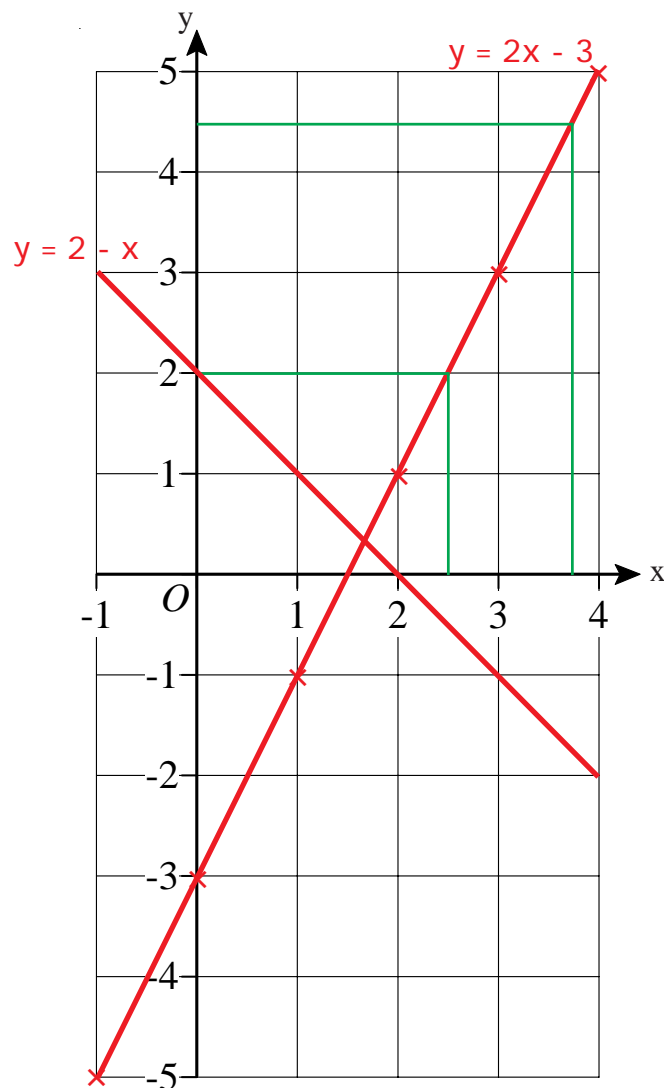
2) a) Complete the table of values for y = 2 – x

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

b) Using the axes on the right, again, draw the graph of y = 2 – x

y = 2x - 3

y = 2 - x

3) a) Complete the table of values for y = ½x – 1

b) Draw the graph of y = ½x – 1

x	-1	0	1	2	3	4
y	-1½	-1	-½	0	½	1

y = ½x - 1
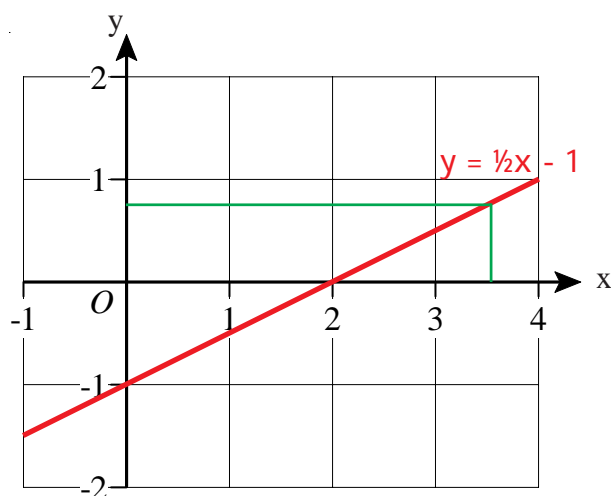
c) Use your graph to find the value of y when x = 3.5   x = 0.75

1)   Find the equations of lines A, B and C on the axes below
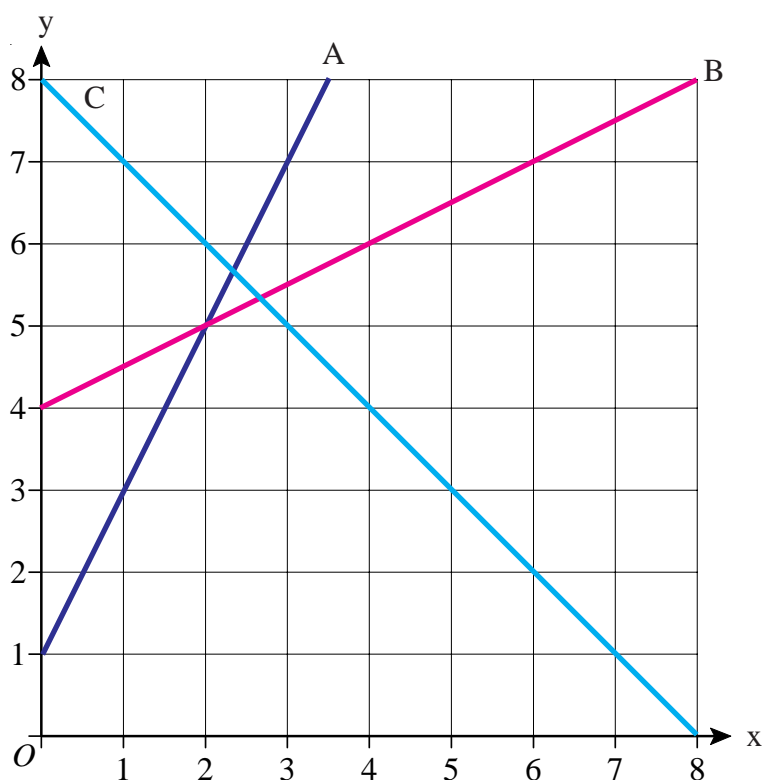
Line A: y = 2x + 1

Line B: y = ½x + 4

Line C: y = -x + 8

or Line C: y = 8 - x

2)   Find the equations of lines A, B and C on the axes below
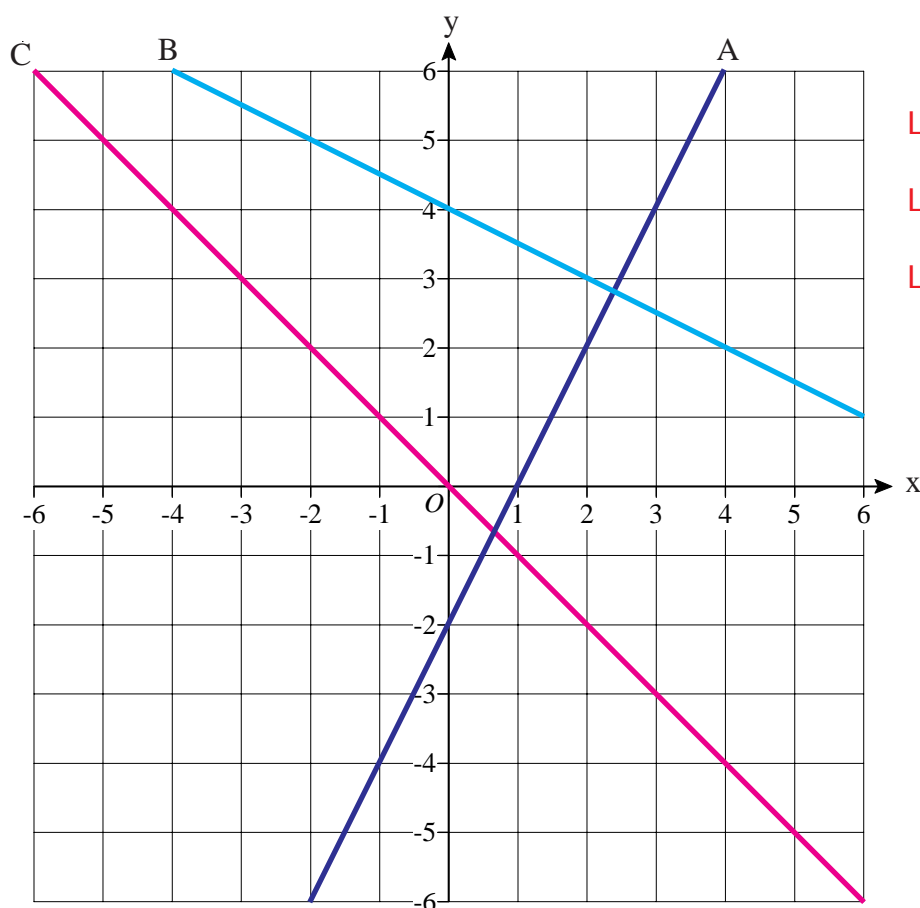
Line A: y = 2x - 2

Line B: y = -½x + 4

Line C: y = -x

1) On the axes below, the graphs of $y = x + 2$ and $y = 6 - x$ have been drawn.

Use the graphs to solve the simultaneous equations $y = x + 2$ and $y = 6 - x$

x = 2 and y = 4
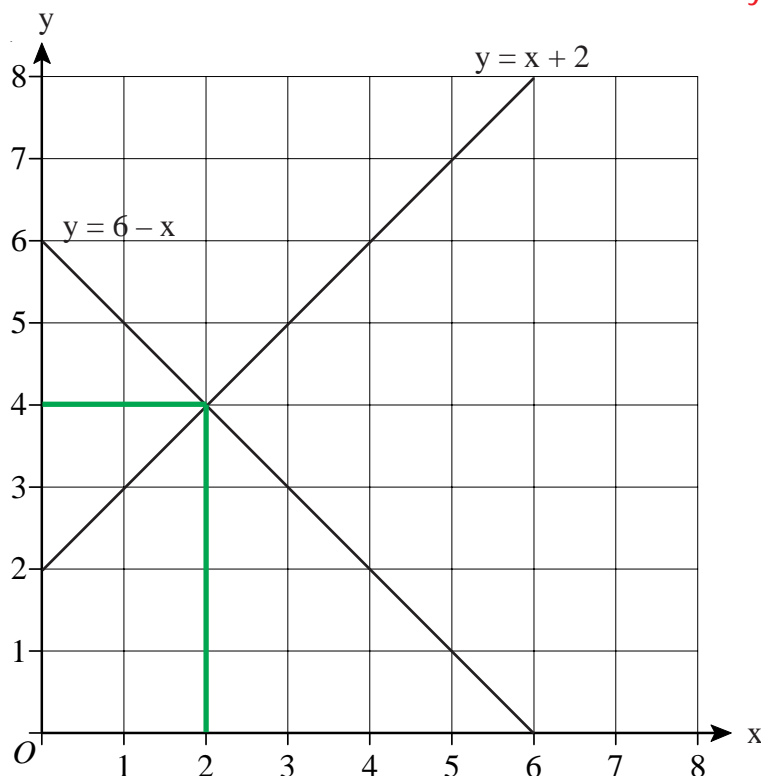
2) On the axes below draw the graphs of $y = 2x + 1$ and $y = 7 - x$

Use your graphs to solve the simultaneous equations $y = 2x + 1$ and $y = 7 - x$

x = 2 and y = 5
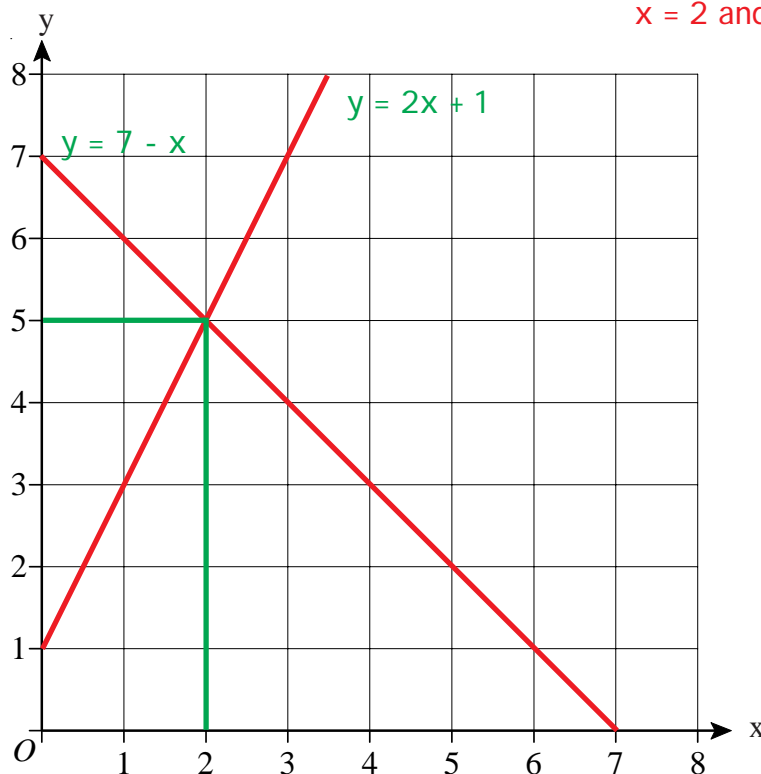
Drawing Quadratic Graphs

1) a) Complete the table of values for $y = 2x^2 - 3x$

x	-2	-1	0	1	2	3
y	14	5	0	-1	2	9

b) On the grid, draw the graph of $y = 2x^2 - 3x$ for values of x from -2 to 3
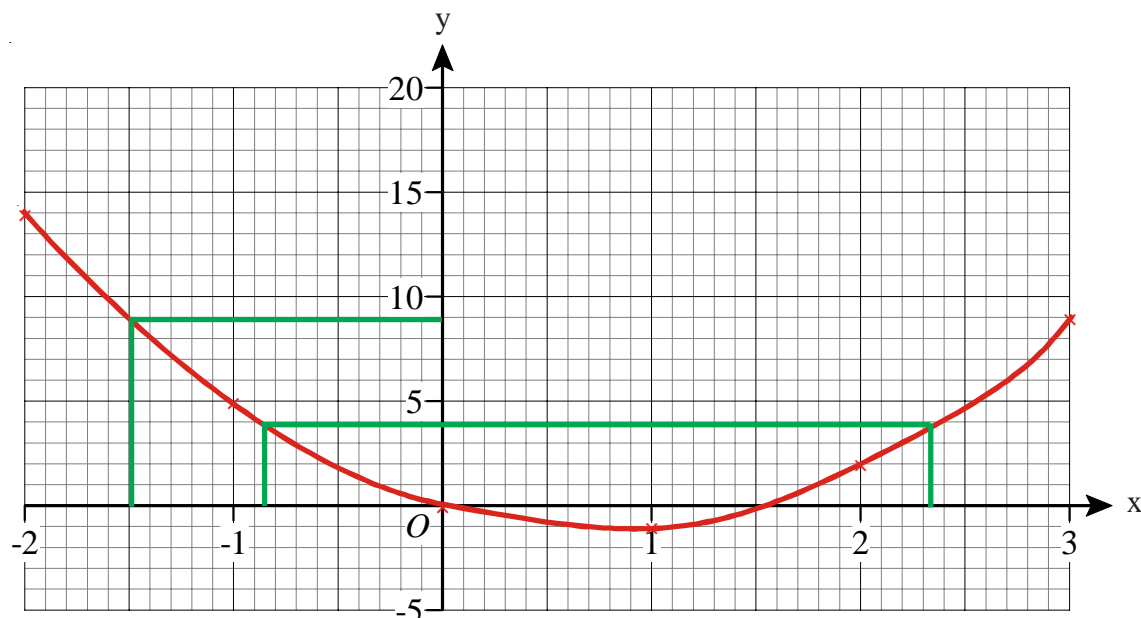
c) Use the graph to find the value of y when x = -1.5   y = 9

d) Use the graph to find the values of x when y = 4   x = -0.85 or x = 2.33

---

2) a) Complete the table of values for $y = x^2 - 2x$

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

b) On the grid, draw the graph of $y = x^2 - 2x$ for values of x from -2 to 3

y = 2.5
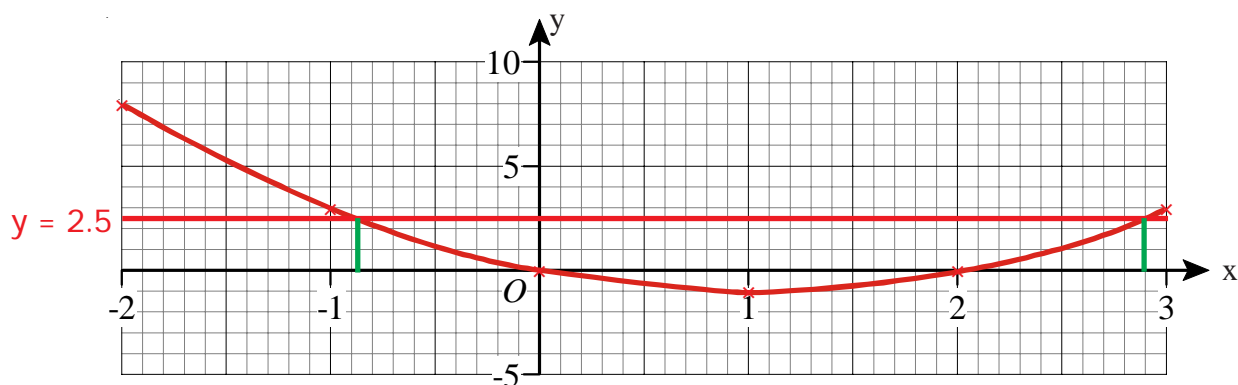
c) (i) On the same axes draw the straight line y = 2.5

(ii) Write down the values of x for which $x^2 - 2x = 2.5$ x = -0.89 or x = 2.9

Real Life Graphs

1) Sarah travelled 20 km from home to her friend's house.
   She stayed at her friend's house for some time before returning home.
   Here is the travel graph for part of Sarah's journey.
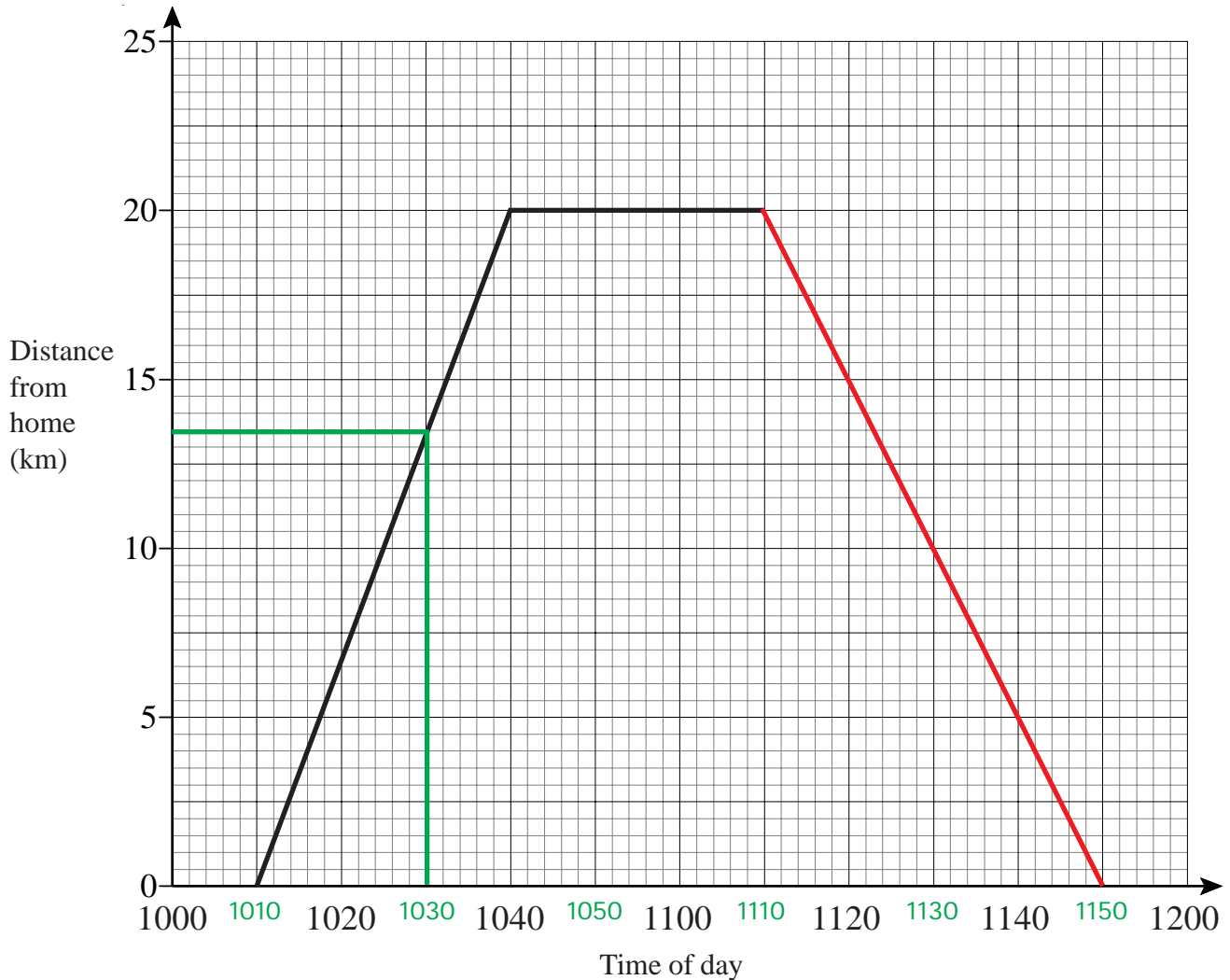
a) At what time did Sarah leave home?   10 10

b) How far was Sarah from home at 10 30?   13.5 km

Sarah left her friend's house at 11 10 to return home.

c) Work out the time in minutes Sarah spent at her friend's house.   30 minutes

Sarah returned home at a steady speed.
She arrived home at 11 50

d) Complete the travel graph.

e) Work out Sarah's average speed on her journey from her home to her friend's house.
   Give your answer in kilometres per hour.   40km/h

f) Work out Sarah's average speed on her journey home from her friend's house.
   Give your answer in kilometres per hour.   30km/h

Pythagoras' Theorem

1) Find the length of side AC.   **13.9cm**
   Give your answer to 1 decimal place.

   A

   Longest side

   $12^2 = 144$
   $7^2 = \underline{49}$
   193

   $\sqrt{193} = 13.9$

   12cm

   B   7cm   C

---
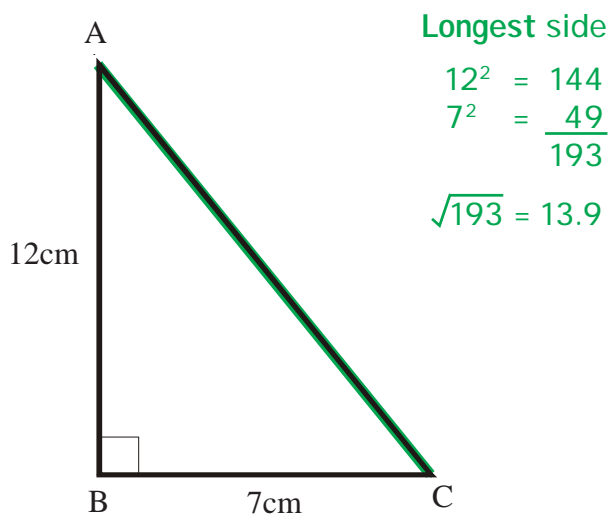
2) Find the length of side QR   **5.9cm**
   Give your answer to 1 decimal place.

   4.8cm
   Q _____ P

   7.6cm

   R

   Shorter side

   $7.6^2 = 57.76$
   $4.8^2 = \underline{23.04}$
   34.72

   $\sqrt{34.72} = 5.9$

---
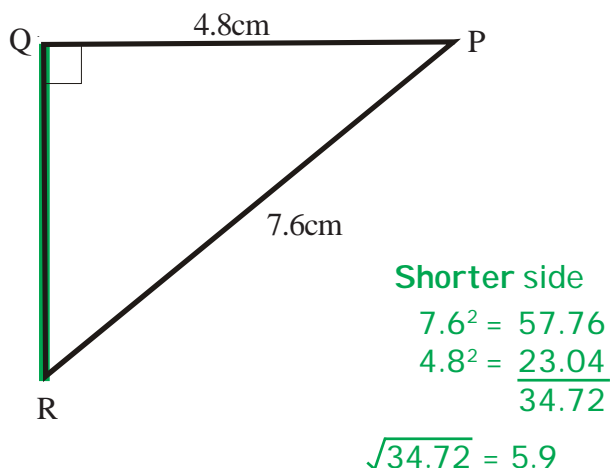
3) Find the length of side SU   **18.2cm**
   Give your answer to 1 decimal place.

   23cm
   T _____ S

   14cm

   U

   Shorter side

   $23^2 = 529$
   $14^2 = \underline{196}$
   333

   $\sqrt{333} = 18.2$

---
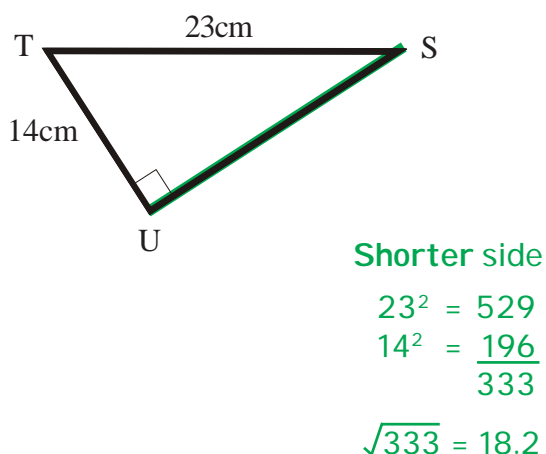
4) Below is a picture of a doorway.   **2.2m**
   Find the size of the diagonal of the doorway.
   Give your answer to 1 decimal place.

   Longest side

   $2.1^2 = 4.41$
   $0.8^2 = \underline{0.64}$
   5.05

   $\sqrt{5.05} = 2.2$

   2.1m

   0.8m

---
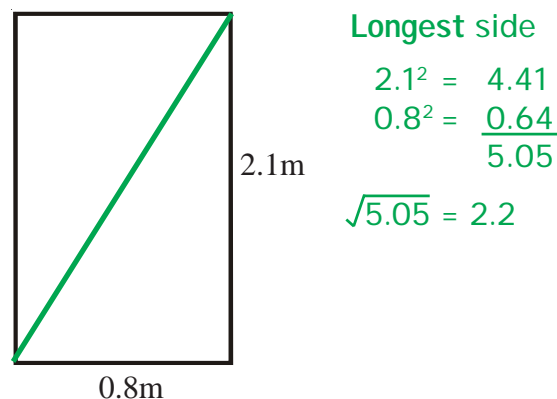
5) In the sketch of the rectangular field, below,
   James wants to walk from B to D.

   A   B

   60m

   D   50m   C

   B to C to D
   60m + 50m = 110m

   B to D
   Longest side

   $60^2 = 3600$
   $50^2 = \underline{2500}$
   6100

   $\sqrt{6100} = 78$
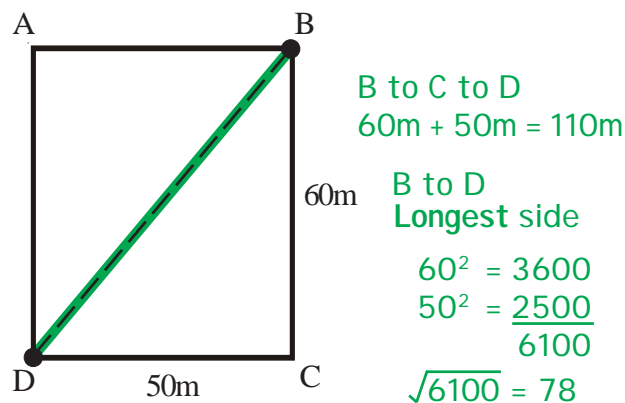
   Which of the following routes is shorter and
   by how much? **B to D by 32m**
   From B to C to D or straight across the field
   from B to D.   **110m - 78m = 32m**
   Give your answer to the nearest metre.

---

6) Fiona keeps her pencils in a cylindrical
   beaker as shown below.
   The beaker has a diameter of 8cm and
   a height of 17cm.
   Will a pencil of length 19cm fit in the beaker
   without poking out of the top? **No. The**
   All workings must be shown.   **diagonal is**
   only 18.8cm.

   Longest side

   $17^2 = 289$
   $8^2 = \underline{64}$
   353

   $\sqrt{353} = 18.79$

   17cm

   8cm

Pythagoras - Line on a Graph
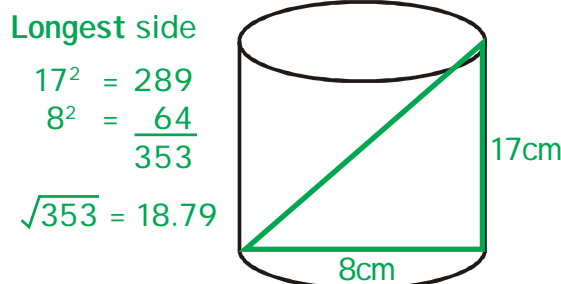
1) Points P and Q have coordinates (1, 4) and (5, 2).
   Calculate the shortest distance between P and Q.
   Give your answer correct to 1 decimal place.   4.5

$4^2 = 16$
$2^2 = \underline{4}$
     20

$\sqrt{20} = 4.5$
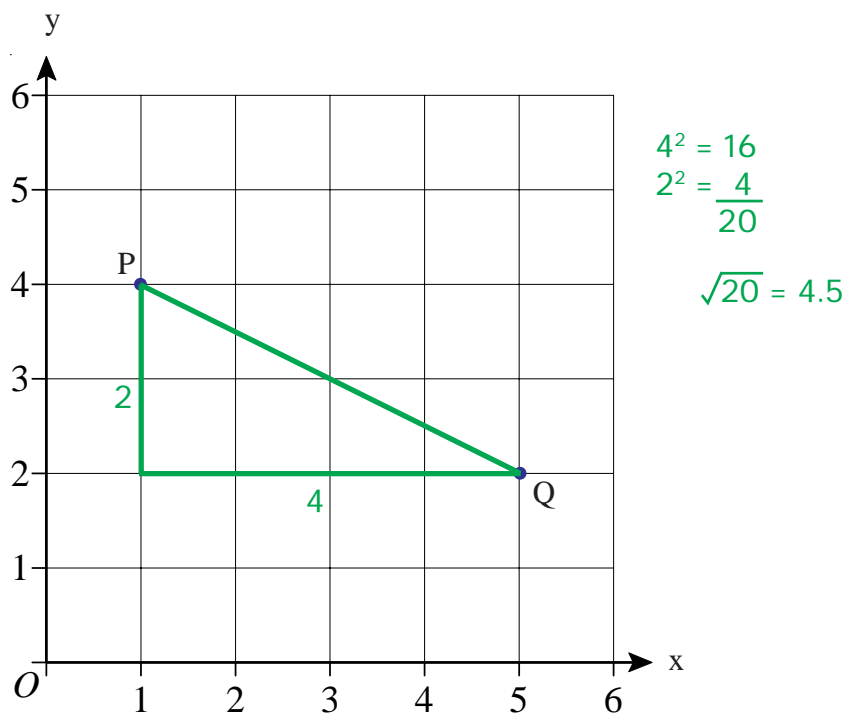
2) Points A and B have coordinates (-4, 3) and (3, -2).
   Calculate the shortest distance between A and B.
   Give your answer correct to 1 decimal place.   8.6

$7^2 = 49$
$5^2 = \underline{25}$
     74

$\sqrt{74} = 8.6$
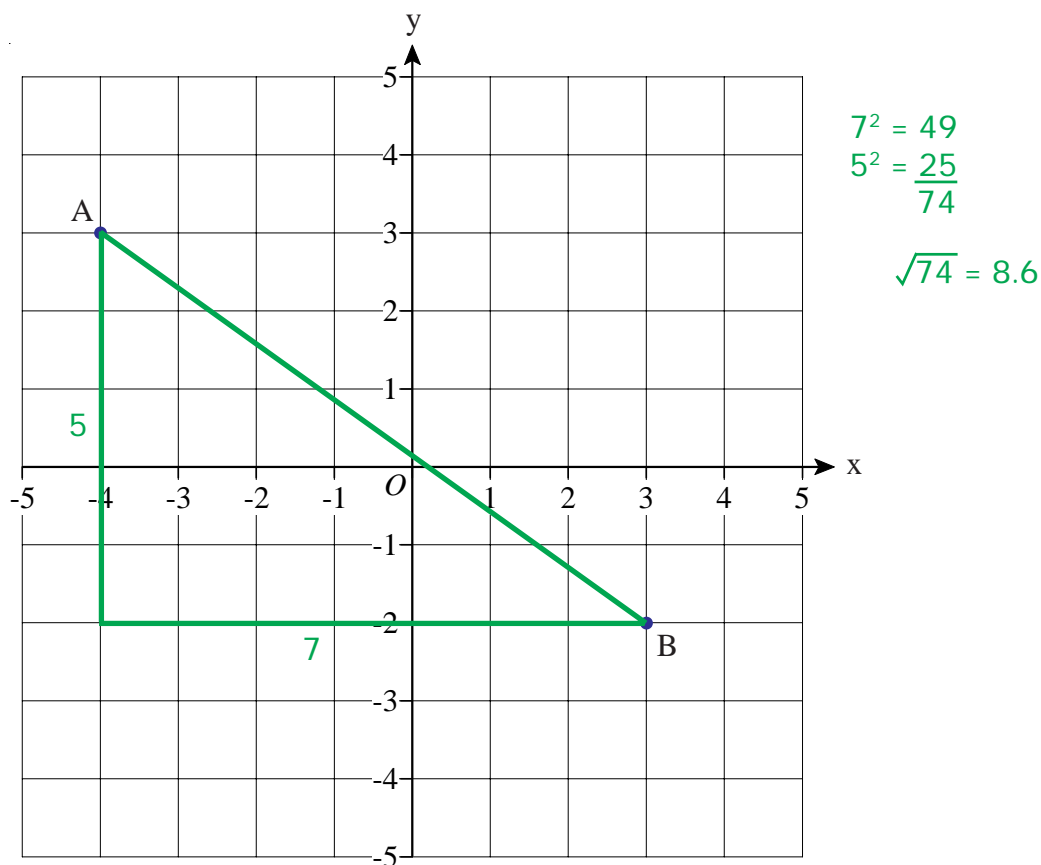
1)   A cuboid lies on the coordinate axes.
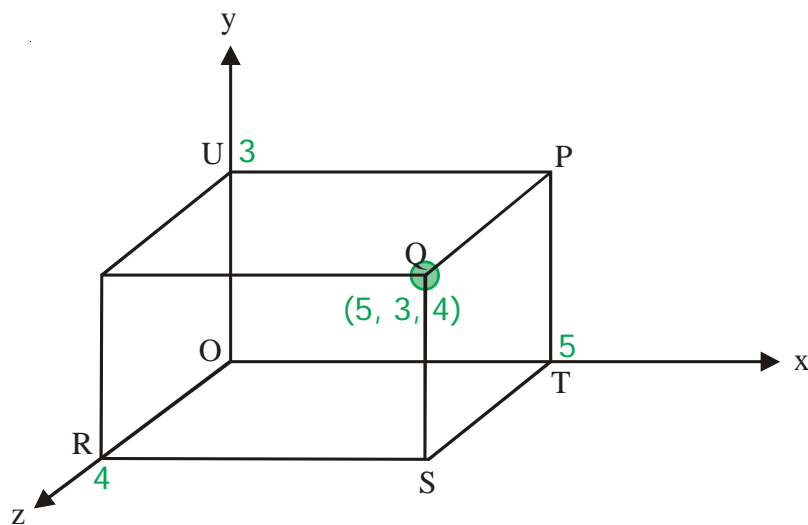
The point Q has coordinates (5, 3, 4)

a)   Write down the coordinates of the point P   (5, 3, 0)

b)   Write down the coordinates of the point T   (5, 0, 0)

c)   Write down the coordinates of the point S   (5, 0, 4)

d)   Write down the coordinates of the point R   (0, 0, 4)

e)   Write down the coordinates of the point U   (0, 3, 0)

2)   A cuboid lies on the coordinate axes.
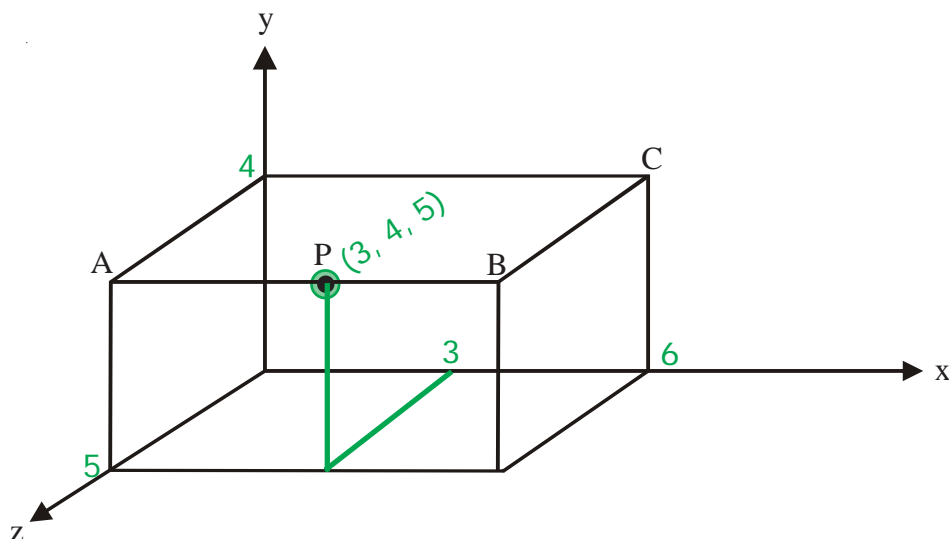
Point P lies half way between A and B and has coordinates (3, 4, 5)

a)   Write down the coordinates of B.   (6, 4, 5)

b)   Write down the coordinates of C.   (6, 4, 0)

Surface Area of Cuboids

1) Find the surface area of this cube and cuboid.

Cube
Surface area = 96 cm²

16 cm²

4 cm   16 cm²   16 cm²

4 cm

4 cm

plus the sides
you can't see

Cuboid
Surface area = 280 cm²

6 cm

60 cm²

5 cm   50 cm²   30 cm²

10 cm
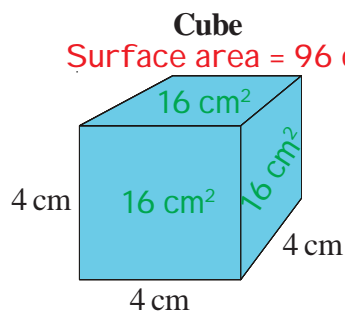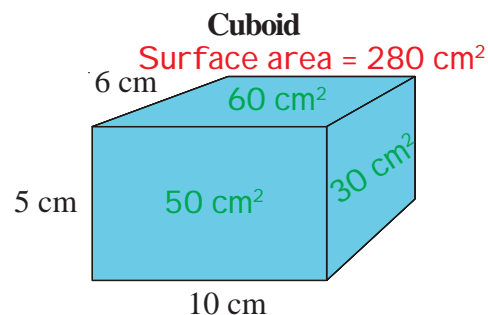
2) Find the surface area of this cuboid.
Surface area = 14.22 m²

3.91 m²

1.36 m²

1.84 m²   0.8 m

1.7 m

2.3 m
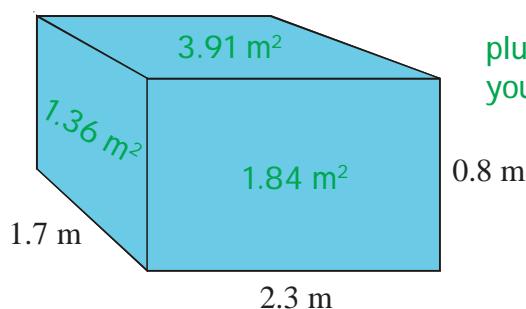
plus the sides
you can't see

3) A water tank measures 2 m by 3 m by 4 m.
It has no top.
The outside of the tank, including the base,
has to be painted.

Calculate the surface area which will be painted.
Surface area = 40 m²

2 m

4 m

3 m
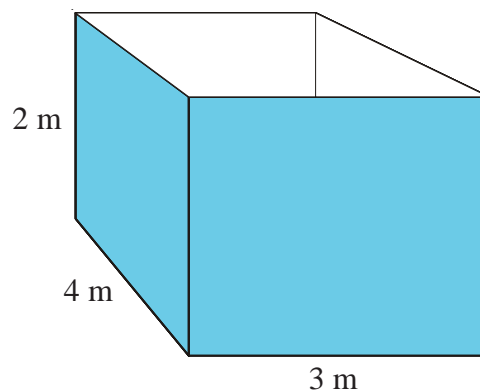
4) A water tank measures 2 m by 5 m by 6 m.
It has no top.
The outside of the tank, including the base,
has to be painted.
A litre of paint will cover an area of 4.3 m².
Paint is sold in 5 litre tins and each tin costs £13.50.

How much will it cost to paint the tank? £54
You must show all your working.

2 m

6 m

5 m
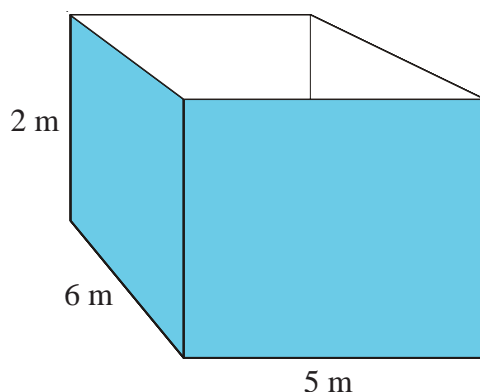
Surface area to be painted:
5 × 2 = 10 m²
5 × 2 = 10 m²
6 × 2 = 12 m²   **74 m² in total**
6 × 2 = 12 m²
6 × 5 = 30 m²

Litres of paint needed:
74 ÷ 4.3 = 17.2 litres

3 tins is only 15 litres
so **4 tins must be bought.**

4 × £13.50 = £54

Volume of a Prism

1) The diagram shows a cuboid.

   Work out the volume of the cuboid.

   V = 22500 cm³

50 cm

30 cm

15 cm

A = L × H
A = 15 × 50
A = 750 cm²

V = A × L
V = 750 × 30
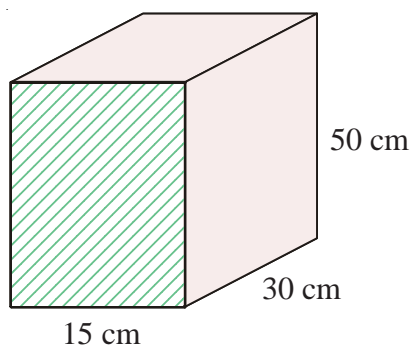
2) Calculate the volume of this triangular prism.

   V = 54 cm³

4 cm

5 cm

3 cm

9 cm

A = $\frac{b \times h}{2}$

A = $\frac{3 \times 4}{2}$

A = 6 cm²

V = A × L
V = 6 × 9
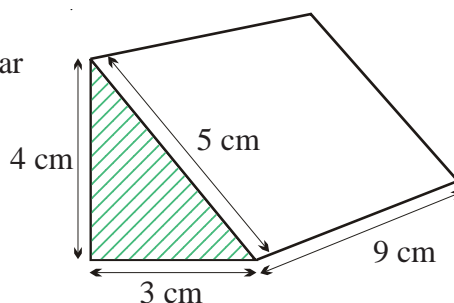
3) An ice hockey puck is in the shape of a cylinder with a radius of 3.8 cm and a thickness of 2.5 cm.

   Take π to be 3.14

   Work out the volume of the puck.

   V = 113.354 cm³

2.5 cm

3.8 cm
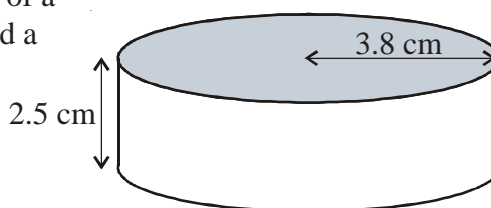
A = πr²
A = 3.14 × 3.8²
A = 45.3416 cm²

V = A × L
V = 45.3416 × 2.5

4) A cuboid has: a volume of 80cm³
                   a length of 5 cm
                   a width of 2 cm

   80 ÷ 5 ÷ 2

   Work out the height of the cuboid.
   H = 8 cm

5) Work out the maximum number of boxes which can fit in the carton.

   160 boxes will fit.
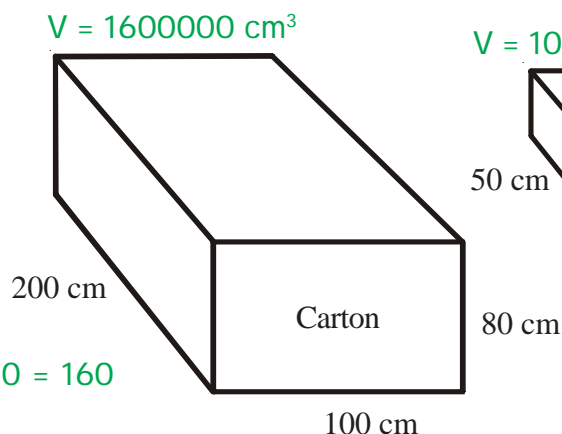
   1600000 ÷ 10000 = 160

V = 1600000 cm³

V = 10000 cm³

200 cm

Carton

100 cm

80 cm

50 cm

Box

10 cm

20 cm

Similar Shapes

1) The diagram shows two quadrilaterals that are mathematically **similar**.

× 3.5

8 cm

Q

A

P

21 cm

B

S 4 cm R

D 14 cm C

14 ÷ 4 = 3.5
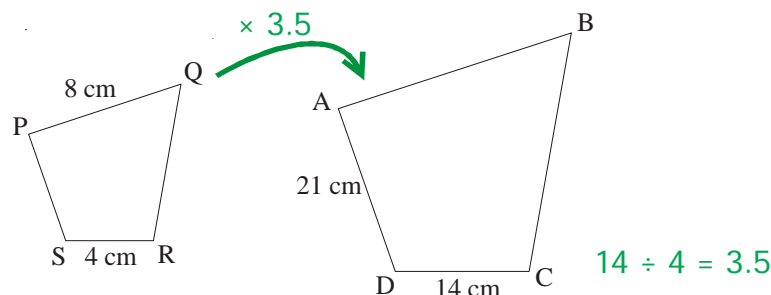
a) Calculate the length of AB   28 cm   AB = PQ × 3.5

b) Calculate the length of PS   6 cm   PS = AD ÷ 3.5

2) SV is parallel to TU.
RST and RVU are straight lines.
RS = 9 cm, ST = 3 cm, TU = 7 cm, RV = 6 cm

12 ÷ 9 = 1.3333333

Calculate the length of VU.   2 cm

× 1.33333333

RU = 1.333333 × 6
RU = 8

VU = RU - RV
VU = 8 - 6

R

9 cm

6 cm

9

6

12

S

V

V

3 cm

T   U

7cm

U
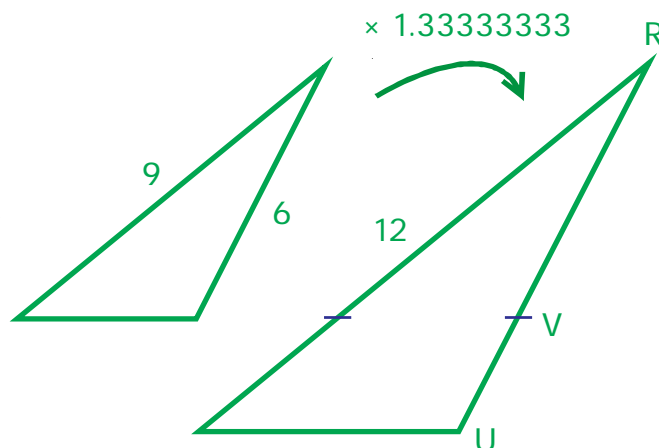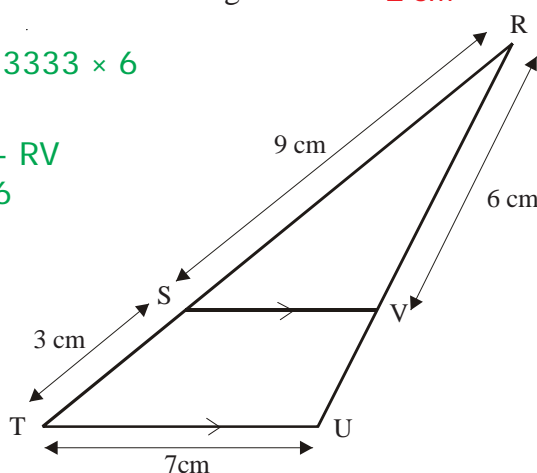
3) BE is parallel to CD.
ABC and AED are straight lines.
AB = 4 cm, BC = 6 cm, BE = 5 cm, AE = 4.4 cm   Scale factor = 2.5   (10 ÷ 4)

a) Calculate the length of CD.   12.5 cm

A

4 cm

4.4 cm

b) Calculate the length of ED.   6.6 cm

B   E

5 cm

6 cm

C   D
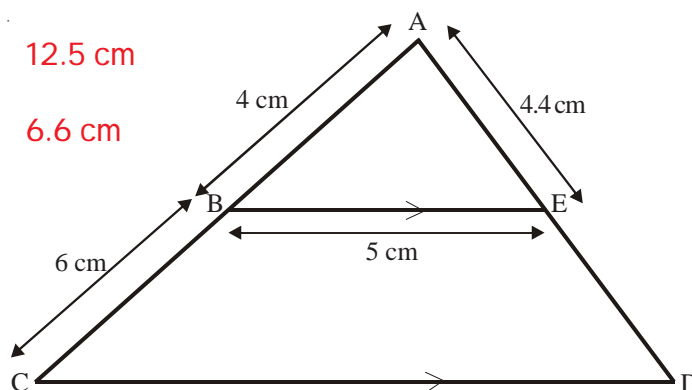
Dimensions

1) The table shows some expressions.
   The letters a, b, c and d represent lengths.
   π and 3 are numbers that have no dimensions.

   Underneath each one write
   L if it is a length
   A if it is an area
   V if it is a volume
   N if it is none of the above.

$\dfrac{\pi\,abc}{3d}$	$\pi\,a^3$	$3a^2$	$\pi a^2 + b$	$\pi(a + b)$	$3(c^2 + d^2)$	$3ad^2$
A	V	A	N	L	A	V

2) The table shows some expressions.
   The letters a, b, c and d represent lengths.
   π and 2 are numbers that have no dimensions.

   Underneath each one write
   L if it is a length
   A if it is an area
   V if it is a volume
   N if it is none of the above.

$2a^2$	$\dfrac{\pi ab^3}{2d}$	$\pi\,bc$	$ac + bd$	$\pi d(a + b)$	$2(c + d)^3$	$2\pi bc^2$
A	V	A	A	A	V	V

Bounds

1. A silver necklace has a mass of 123 grams, correct to the nearest gram.

   a) Write down the least possible mass of the necklace. **122.5 g**

   b) Write down the greatest possible mass of the necklace. **123.5 g**

2. Each of these measurements was made correct to one decimal place.
   Write the maximum and minimum possible measurement in each case.

   a) 4.6 cm   b) 0.8 kg   c) 12.5 litres   d) 25.0 km/h
   max: 4.65 cm   max: 0.85 kg   max: 12.55 L   max: 25.05 km/h
   min: 4.55 cm   min: 0.75 kg   min: 12.45 L   min: 24.95 km/h

   e) 10.3 s   f) 36.1 m   g) 136.7 m/s   h) 0.1 g
   max: 10.35 s   max: 36.15 m   max: 136.75 m/s   max: 0.15 g
   min: 10.25 s   min: 36.05 m   min: 136.65 m/s   min: 0.05 g

3. Each side of a regular octagon has a length of 20.6 cm, correct to the nearest millimetre.

   a) Write down the least possible length of each side. **20.55 cm**

   b) Write down the greatest possible length of each side. **20.65 cm**

   c) Write down the greatest possible perimeter of the octagon. **165.2 cm**

4. A girl has a pencil that is of length 12 cm, measured to the nearest centimetre.
   Her pencil case has a diagonal of length 12.3 cm, measured to the nearest millimetre.

   Explain why it might not be possible for her to fit the pen in the pencil case.
   12 cm to the nearest cm has a maximum possible length of 12.5 cm.
   12.3 cm to the nearest mm has a minimum possible length of 12.25 cm.
   A 12.5 cm pencil won't fit into a pencil case with a diagonal length of 12.25 cm.

5. A square has sides of length 7 cm, correct to the nearest centimetre.

   a) Calculate the lower bound for the perimeter of the square. **26 cm**   6.5 + 6.5 + 6.5 + 6.5

   b) Calculate the upper bound for the area of the square. **56.25 cm²**   7.5 × 7.5

   min is 6.5 cm
   min is 6.5 cm   min is 6.5 cm
   min is 6.5 cm

   max is 7.5 cm
   max is 7.5 cm   max is 7.5 cm
   max is 7.5 cm
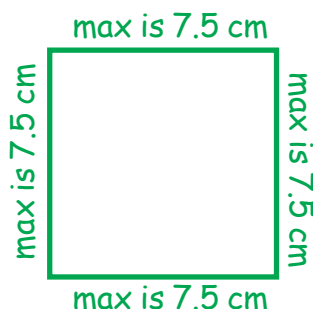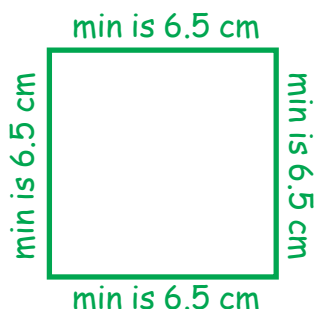
Compound Measures

1) Jane runs 200 metres in 21.4 seconds.

   Work out Jane's average speed in metres per second.
   Give your answer correct to 1 decimal place.

   S = 9.3 m/s

   $S = \dfrac{D}{T}$

   $S = \dfrac{200}{21.4}$

2) A car travels at a steady speed and takes five hours to travel 310 miles.

   Work out the average speed of the car in miles per hour.

   S = 62 mph

   $S = \dfrac{D}{T}$

   $S = \dfrac{310}{5}$

3) A plane flies 1440 miles at a speed of 240 mph.

   How long does it take?

   T = 6 hours

   $T = \dfrac{D}{S}$

   $T = \dfrac{1440}{240}$

4) A marathon runner runs at 7.6 mph for three and a half hours.

   How many miles has he run?

   D = 26.6 miles

   $D = S \times T$

   $D = 7.6 \times 3.5$

5) A car takes 15 minutes to travel 24 miles.

   Find its speed in **mph**.

   S = 96 mph

   $S = \dfrac{D}{T}$ 15 mins is 0.25 of an hour

   $S = \dfrac{24}{0.25}$

6) A cyclist takes 10 minutes to travel 2.4 miles.

   Calculate the average speed in mph.

   S = 14.4 mph

   $S = \dfrac{D}{T}$ 10 mins is 0.1̇6 of an hour

   $S = \dfrac{2.4}{0.1\dot{6}}$

7) An ice hockey puck has a volume of 113 cm³.

   It is made out of rubber with a density of 1.5 grams per cm³.

   Work out the mass of the ice hockey puck.

   M = 169.5 g

   $M = D \times V$

   $M = 1.5 \times 113$

8) An apple has a mass of 160 g and a volume of 100 cm³.

   Find its density in g/cm³.

   D = 1.6 g/cm³

   $D = \dfrac{M}{V}$

   $D = \dfrac{160}{100}$

9) A steel ball has a volume of 1500 cm³.

   The density of the ball is 95 g/cm³.

   Find the mass of the ball in kg.

   M = 142.5 kg

   $M = D \times V$

   M = 95 × 1500
   M = 142 500

10) The mass of a bar of chocolate is 1800 g.

    The density of the chocolate is 9 g/cm³.

    What is the volume of the bar of chocolate?

    V = 200 cm³

    $V = \dfrac{M}{D}$

    $D = \dfrac{1800}{9}$

Bisecting a Line

1) Using ruler and compasses, bisect line AB.

B

A
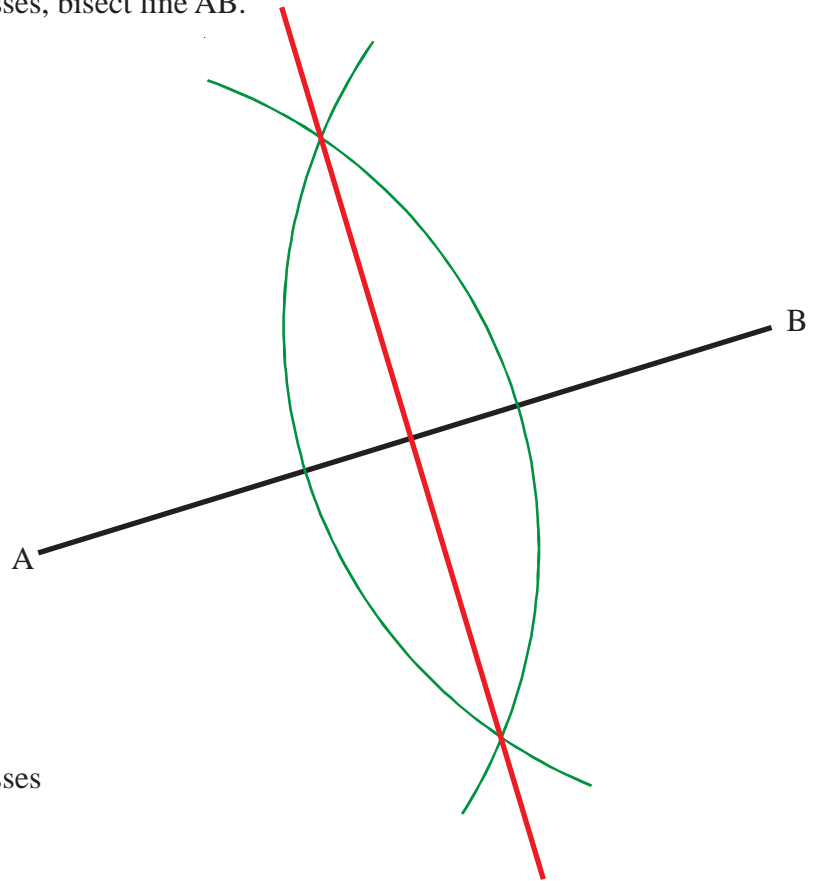
2) Using ruler and compasses
   a) Bisect line AB
   b) Bisect line BC
   c) Bisect line AC
   d) Place your compass point where your three lines cross*

   Now open them out until your pencil is touching vertex A.
   Draw a circle using this radius.

C

B

A
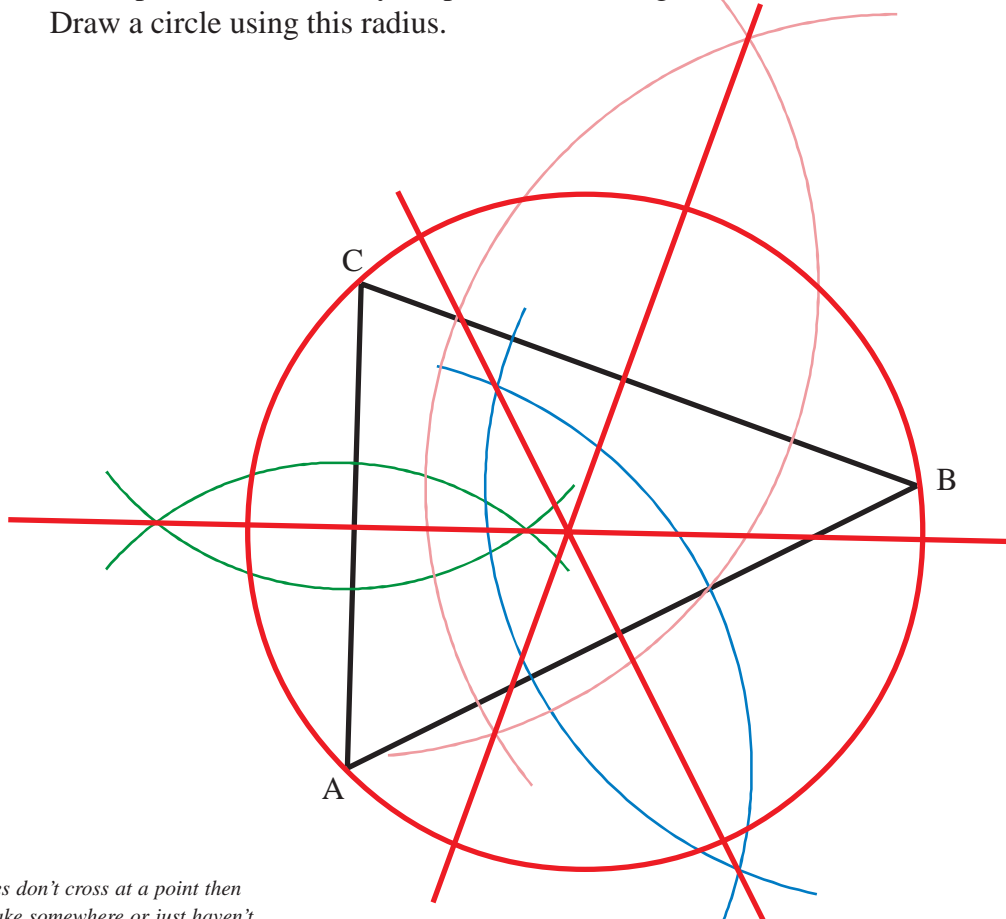
*If your three lines don't cross at a point then
you have a mistake somewhere or just haven't
been accurate enough.

Drawing a Perpendicular to a Line

1) Use ruler and compasses to **construct** the perpendicular to the line segment AB that passes through the point P.

   You must show all construction lines.
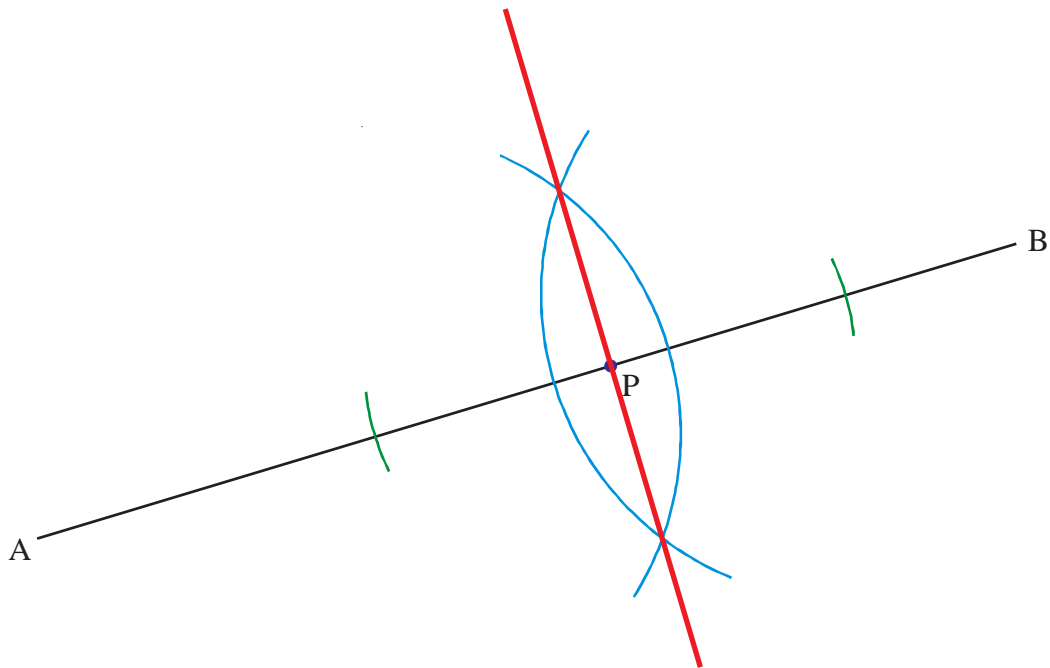
2) Use ruler and compasses to **construct** the perpendicular to the line segment CD that passes through the point P.

   You must show all construction lines.
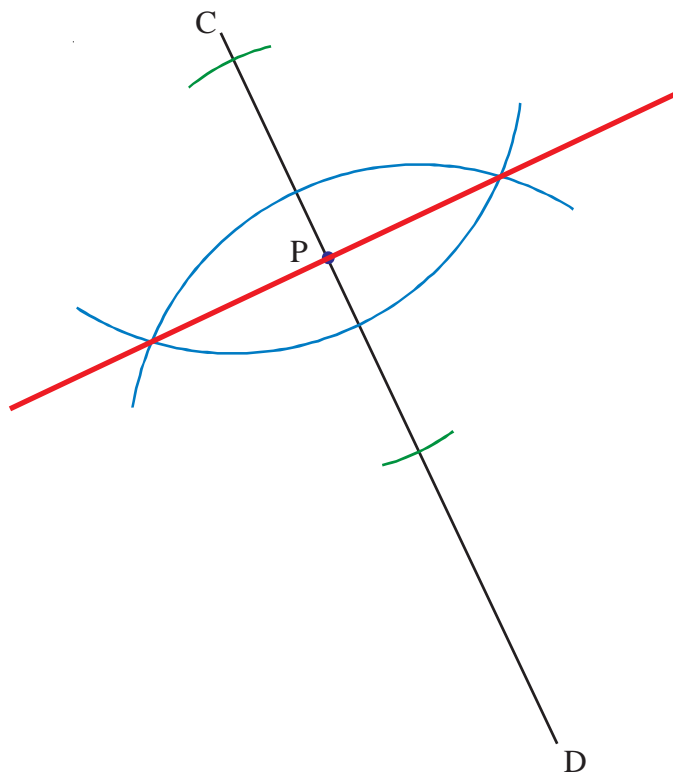
Bisecting an Angle

1) Using ruler and compasses, bisect angle ABC.

A

B

C
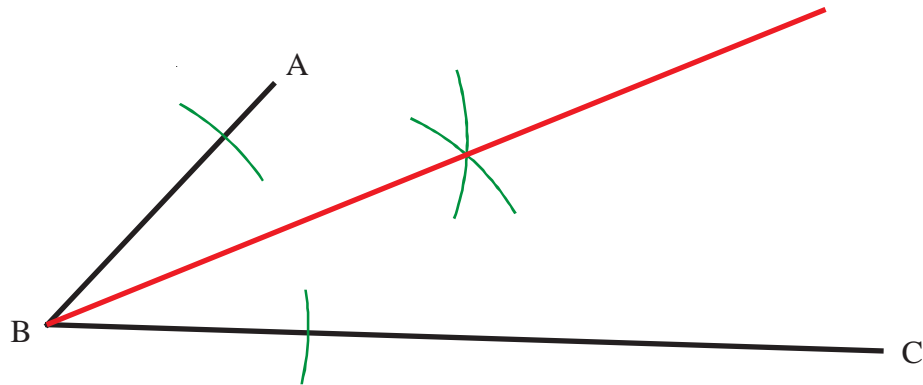
2) The diagram below shows the plan of a park.
The border of the park is shown by the quadrilateral RSUV

S   T   U

V

R
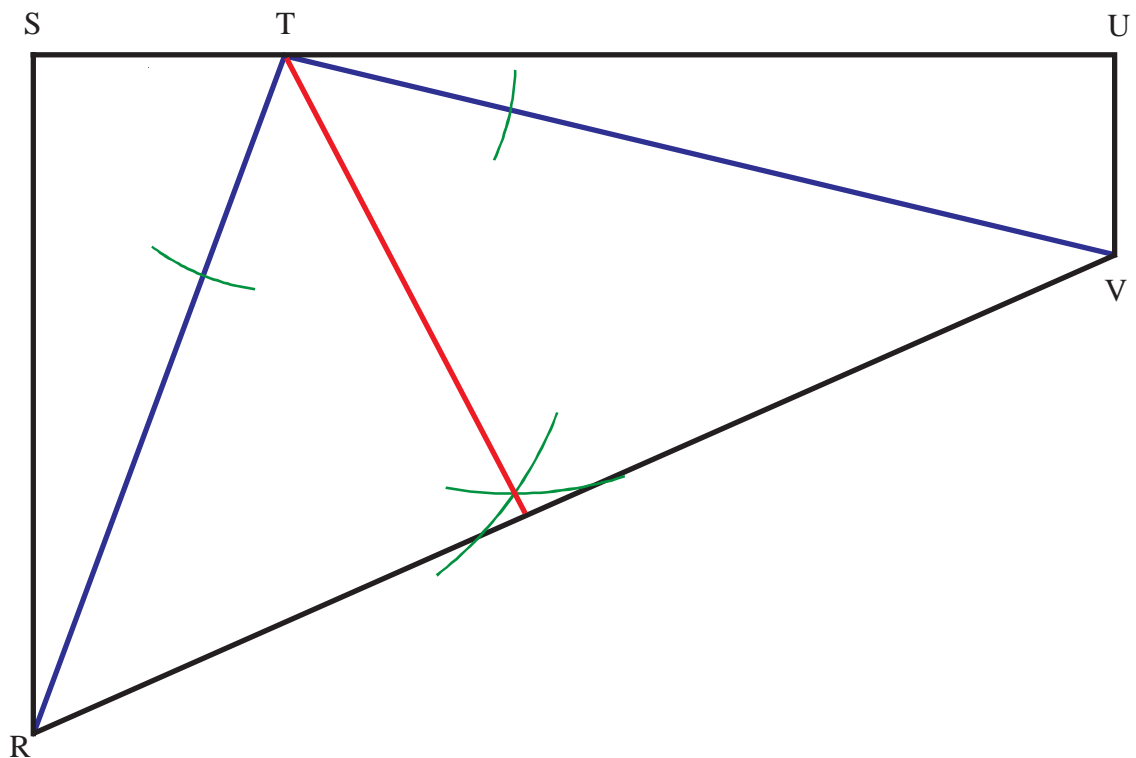
There are two paths in the park. One is labelled TR and the other TV.
A man walks in the park so that he is always the same distance from both paths.
Using ruler and compasses show exactly where the man can walk.

Loci - page 1 of 2

1)

A ⌐─────────────────────────────┐ B

D └─────────────────────────────┘ C
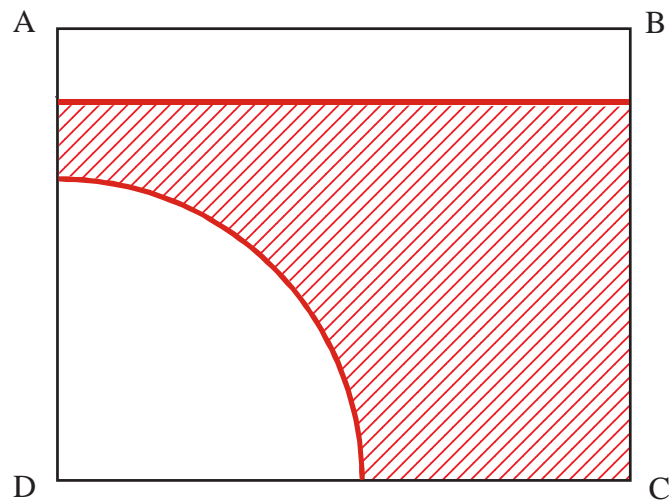
ABCD is a rectangle.

Shade the set of points inside the rectangle which are **both**
     more than 4 centimetres from the point D
and   more than 1 centimetre from the line AB.

2)   Two radio transmitters, A and B, are situated as below.

B •

A •
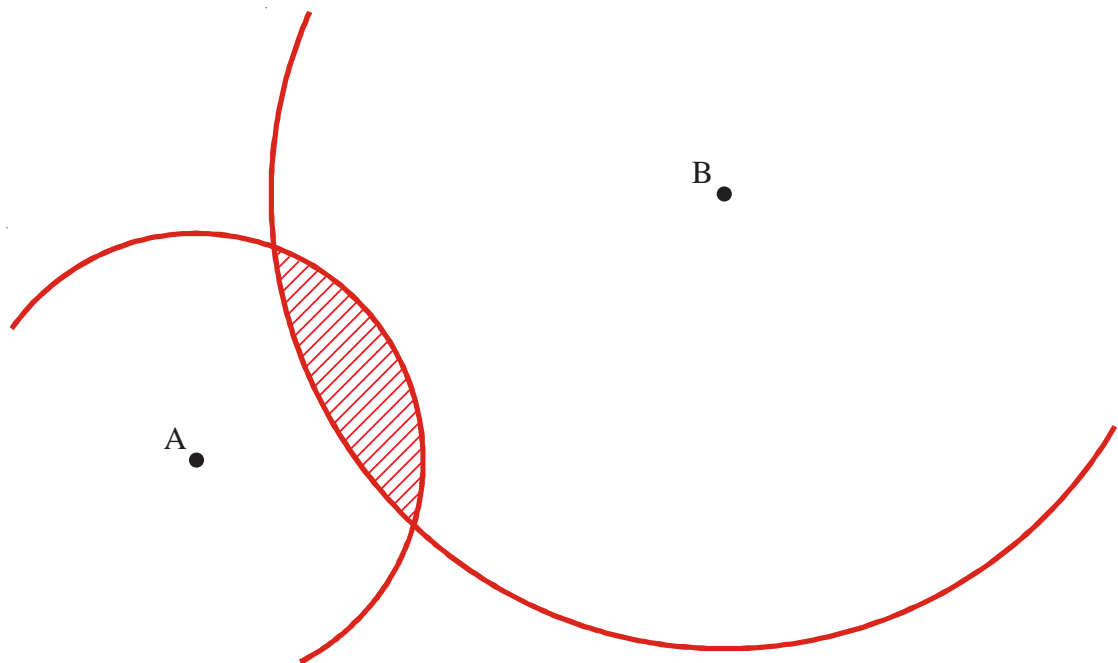
Transmitter A broadcasts signals which can be heard up to 3 km from A.

Transmitter B broadcasts signals which can be heard up to 6 km from B.

Shade in the area in which radio signals can be heard from both transmitters.
Use a scale of 1 cm = 1 km.

Loci - page 2 of 2

1)

A
×

×B

×
C

Point C is equidistant from points A and B.

Sarah rolls a ball from point C.

At any point on its path the ball is the same distance from point A and point B.

a) On the diagram above draw accurately the path that the ball will take.

b) On the diagram shade the region that contains all the points that are no more than 3cm from point B.

2) The map shows part of a lake.
In a competition for radio-controlled ducks, participants have to steer their ducksso that:

    its path between AB and CD is a straight line

    this path is always the same distance from A as from B

a) On the map, draw the path the ducks should take.

Scale: 1 cm represents 10 m

E
×

B
×

C
×

A
×

D
×

There is a practice region for competitors.
This is the part of the lake which is less than 30 m from point E.

b) Shade the practice region on the map.

Bearings

1) School B is due east of school A.
   C is another school.
   The bearing of C from A is 065°.
   The bearing of C from B is 313°.

   Complete the scale drawing below.
   Mark with a cross the position of C.

N

C

65°

47°

A

B

313°
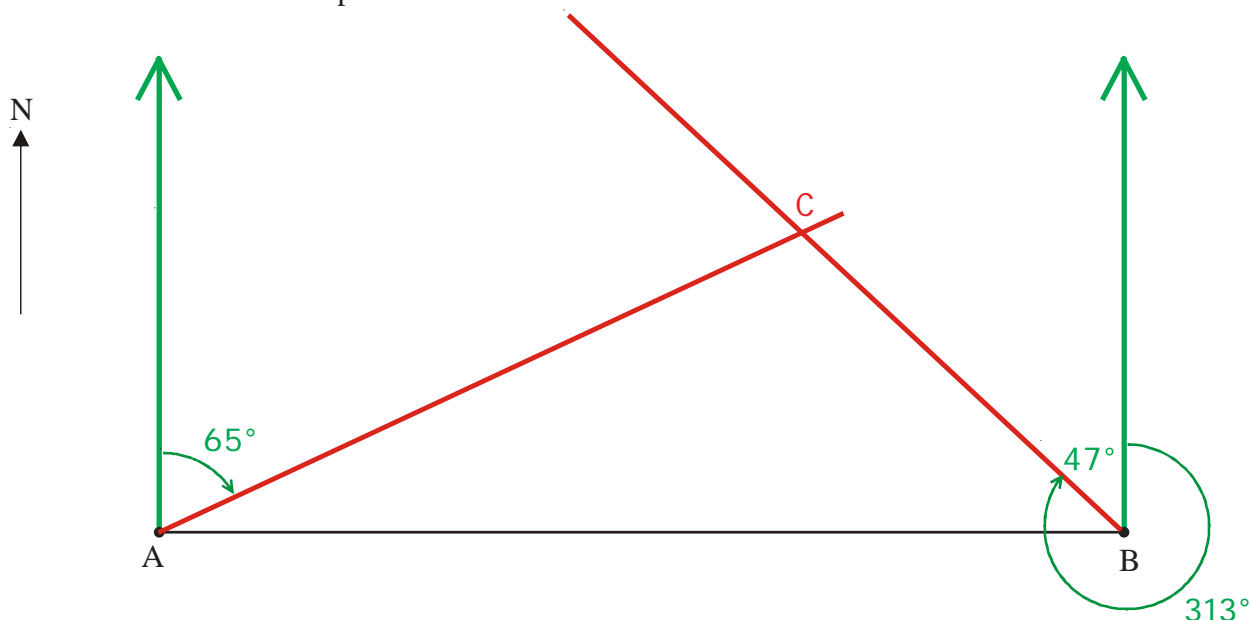
2) In the diagram, point A marks the position of Middlewitch.
   The position of Middlemarch is to be marked on the diagram as point B
   On the diagram, mark with a cross the position of B given that:
   B is on a bearing of 320° from A and
   B is 5 cm from A

B

N

40°

A

320°
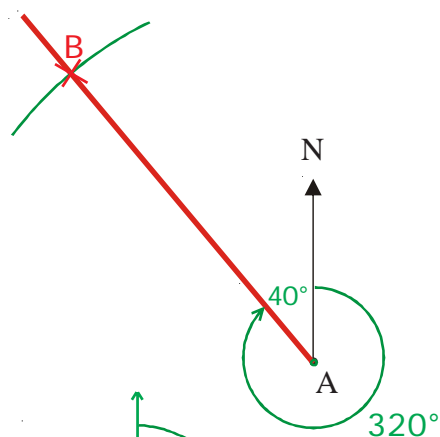
3) **Work out** the bearing of
   a) B from P   222°
   b) P from A   244°

N

A

64°

180° + 64°

64°

138°

P 158°

*Diagram NOT
accurately drawn.*

64° + 158°

B
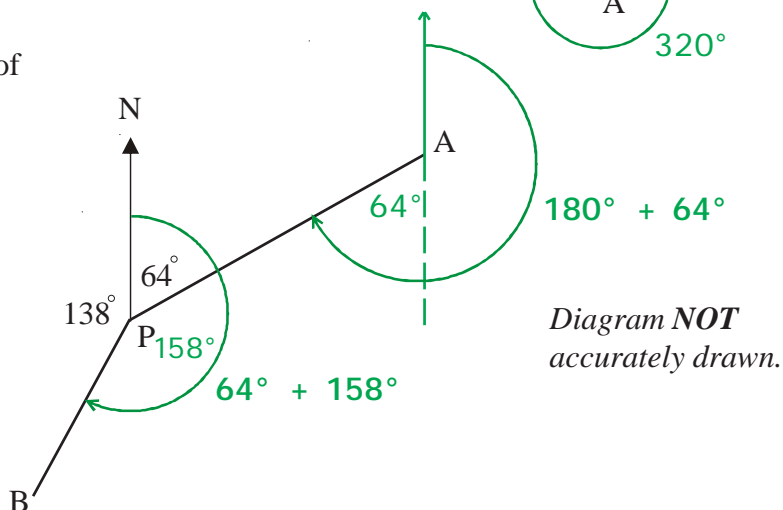
Experimental Probabilities

1) Ahmad does a statistical experiment.

   He throws a dice 600 times.

   He scores one, 200 times.

   Is the dice fair? Explain your answer Two possible answers:
   No, you would expect to score 1 about 100 times.
   Yes, although you would expect 1 about 100 times, you could still get it 200 times.

2) Chris has a biased coin.

   The probability that the biased coin will land on a tail is 0.3

   Chris is going to flip the coin 150 times.

   Work out an estimate for the number of times the coin will land on a tail. 45 times
   0.3 × 150 = 45

3) On a biased dice, the probability of getting a six is $\frac{2}{3}$.

   The dice is rolled 300 times.

   Work out an estimate for the number of times the dice will land on a six. 200 times
   $\frac{2}{3}$ × 300 = 200

4) On a biased dice, the probability of getting a three is 0.5

   The dice is rolled 350 times.

   Work out an estimate for the number of times the dice will land on a three. 175 times
   0.5 × 350 = 175

5) Jenny throws a biased dice 100 times.

   The table shows her results.

Score	Frequency
1	15
2	17
3	10
4	24
5	18
6	16

   a) She throws the dice once more.

      Find an estimate for the probability that she will get a four. $\frac{24}{100}$ or 0.24

   b) If the dice is rolled 250 times, how many times would you expect to get a five? 45 times

      $\frac{18}{100}$ × 250 = 45

Averages From a Table

1) The number of pens in each pupil's pencil case in a classroom has been counted.
The results are displayed in a table.

Number of pens	Number of pupils		
0	4 0 × 4	0
1	6 1 × 6	6
2	7 2 × 7	14
3	5 3 × 5	15
4	3 4 × 3	12
5	1 5 × 1	5
	26	52	Total

a) Work out the total number of pens in the classroom.   **52 pens**

b) Write down the modal number of pens in a pencil case.   **2 pens**

c) Work out the mean number of pens in a pencil case.   **2 pens**   52 ÷ 26

d) Work out the range of the number of pens in a pencil case.   **5 pens**   5 - 0

2) Thomas is analysing the local football team.
He records the number of goals scored in each
football match in the past twelve months.

Thomas said that the mode is 7
Thomas is wrong.   **Thomas gave the highest**
a) Explain why.   **frequency instead of giving
the number of "goals scored"
associated with it.**

b) Calculate the mean number of goals scored.

   1.92 goals   48 ÷ 25

Goals scored	Frequency		
0	7 0 × 7	0
1	5 1 × 5	5
2	3 2 × 3	6
3	6 3 × 6	18
4	2 4 × 2	8
5	1 5 × 1	5
6	1 6 × 1	6
Total	25	48

3) Tina recorded how long, in minutes, she watched
TV for each day during a month.

a) Find the class interval in which the median lies.

   30 < t ⩽ 45

b) Work out an estimate for the mean amount of
time Tina watched TV each day of this month.
Give your answer to the nearest minute.

   37 minutes   1140 ÷ 31

Time (t in minutes)	Frequency	MP	MP × F
$10 < t \leqslant 20$	5	15	75
$20 < t \leqslant 30$	9	25	225
$30 < t \leqslant 45$	8	37.5	300
$45 < t \leqslant 60$	6	52.5	315
$60 < t \leqslant 90$	3	75	225
Total	31		1140

1) A survey into how people communicate with each other is carried out.
A questionnaire is designed and two of the questions used are shown below.
The questions are **not** suitable.
For each question, write down a reason why.

a) Do you prefer to communicate with your friend by phone (voice call) or by text message?

Yes ☐   No ☐

Reason .....This is not a question you can answer 'yes' or 'no' to..............
....

b) How many text messages do you send?

1 ☐   2 ☐   3 ☐   4 ☐

Reason .....Response boxes need to include '0' and 'more than 4'...............
.....Question needs a time frame eg per day, per week...................

2) A restaurant owner has made some changes.
He wants to find out what customers think of these changes.

He uses this question on a questionnaire.

"What do you think of the changes in the restaurant?"

☐   ☐   ☐
Excellent   Very good   Good

a) Write down what is wrong with this question.

There is no negative or neutral response box.

This is another question on the questionnaire.

"How often do you come to the restaurant?"

☐   ☐
Very often   Not often

b) i) Write down one thing that is wrong with this question.

Question needs a time frame eg per week, per month.
Response boxes need to be more specific eg once a week, twice a week.

ii) Design a better question to use.
You should include some response boxes.

How many times do you visit this restaurant per month?

☐   ☐   ☐   ☐
None   Once   Twice   More
                         than
                         twice

Standard Form Calculation

1) Work out the following, giving your answer in standard form.

a) $(6 \times 10^2) \times (8 \times 10^4)$ 4.8×10^7

c) $\dfrac{3 \times 10^3}{6 \times 10^{-5}}$ 5×10^7

b) $(2 \times 10^5) + (3 \times 10^4)$ 2.3×10^5

d) $(9.2 \times 10^5) \div (2 \times 10^2)$ 4.6×10^3

2) A spaceship travelled for 5×10^3 hours at a speed of 9×10^4 km/h.

a) Work out the distance travelled by the spaceship.
Give your answer in standard form. 4.5×10^8 km

$D = S \times T$
$D = 5 \times 10^3 \times 9 \times 10^4$

Another spaceship travelled a distance of 2×10^7 km, last month.
This month it has travelled 5×10^6 km.

$2 \times 10^7 = 20\,000\,000$
$5 \times 10^6 = 5\,000\,000 +$

b) Work out the total distance travelled by the spaceship over these past two months.
Give your answer as a normal (or ordinary) number. $25\,000\,000$ km

3) Work out the following, giving your answer in standard form,
correct to 2 significant figures.

a) $2.6 \times 10^3 \times 4.3 \times 10^4$ 1.1×10^8

c) $\dfrac{9.435 \times 10^5}{3.28 \times 10^3}$ 2.9×10^2

b) $(7.5 \times 10^5) \times (1.9 \times 10^{-2})$ 1.4×10^4

d) $\dfrac{5.98 \times 10^8}{6.14 \times 10^{-2}}$ 9.7×10^9

4) Work out the following, giving your answer in standard form
correct to 3 significant figures.

a) $\dfrac{5.76 \times 10^7 + 3.89 \times 10^9}{7.18 \times 10^{-2}}$ 5.50×10^{10}

c) $\dfrac{3 \times 10^8 \times 2 \times 10^7}{3 \times 10^8 + 2 \times 10^7}$ 1.88×10^7

b) $\dfrac{7.2 \times 10^{-2} - 5.4 \times 10^{-1}}{9.25 \times 10^{-7}}$ -5.06×10^5

d) $\dfrac{3 \times 3.2 \times 10^{12} \times 1.5 \times 10^{12}}{3.2 \times 10^{12} - 1.5 \times 10^{12}}$ 8.47×10^{12}

5) A microsecond is 0.000 001 seconds.

a) Write the number 0.000 001 in standard form. 1×10^{-6}

A computer does a calculation in 3 microseconds.

b) How many of these calculations can the computer do in 1 second? $1 \div (3 \times 10^{-6})$
Give your answer in standard form, correct to 3 significant figures. 3.33×10^5

6) 340 000 tomato seeds weigh 1 gram.
Each tomato seed weighs the same.

a) Write the number 340 000 in standard form. 3.4×10^5

b) Calculate the weight, in grams, of one tomato seed.
Give your answer in standard form, correct to 2 significant figures. 2.9×10^{-6}

$1 \div (3.4 \times 10^5)$

Percentage Increase and Decrease

1) A car dealer is comparing his sales over the past two years.

   In 2006, he sold 175 cars.

   In 2007, he sold 196 cars.

   Work out the percentage increase in the number of cars sold.   12%

   196 - 175 = 21 $\dfrac{21}{175}$ × 100 = 12

2) In September 2005, the number of pupils attending MathsWatch College was 1352.

   In September 2006, the number of pupils attending MathsWatch College was 1014.

   Work out the percentage decrease in the number of pupils attending MathsWatch College.   25%

   1352 - 1014 = 338 $\dfrac{338}{1352}$ × 100 = 25

3) The usual price of a shirt is £32.50

   In a sale, the shirt is reduced to £29.25

   What is the percentage reduction?   10%

   32.50 - 29.25 = 3.25 $\dfrac{3.25}{32.50}$ × 100 = 10

4) Olivia opened an account with £750 at the MathsWatch Bank.

   After one year, the bank paid her interest.

   She then had £795 in her account.

   Work out, as a percentage, MathsWatch Bank's interest rate.   6%

   795 - 750 = 45 $\dfrac{45}{750}$ × 100 = 6

5) Ken buys a house for £270 000 and sells it two years later for £300 000.

   What is his percentage profit?

   Give your answer to 2 significant figures.   11%

   300 000 - 270 000 = 30 000 $\dfrac{30\ 000}{270\ 000}$ × 100 = 11

6) Shelley bought some items at a car boot sale and then sold them on ebay.

   Work out the percentage profit or loss she made on each of these items.

   a) Trainers bought for £15, sold for £20   33% profit

   b) DVD recorder bought for £42, sold for £60.90   45% profit

   c) Gold necklace bought for £90, sold for £78.30   13% loss

   d) A DVD collection bought for £120, sold for £81.60   32% loss

Compound Interest/Depreciation

1) Henry places £6000 in an account which pays 4.6% compound interest each year.

 Calculate the amount in his account after 2 years. £6564.70

 $6000 \times 1.046^2 = 6564.70$

2) Sarah puts £8600 in a bank. The bank pays compound interest of 3.8% per year.

 Calculate the amount Sarah has in her account after 4 years. £9983.62

 $8600 \times 1.038^4 = 9983.62$

3) Mary deposits £10000 in an account which pays 5.6% compound interest per year.

 How much will Mary have in her account after 5 years? £13131.66

 $10000 \times 1.056^5 = 13131.66$

4) Susan places £7900 in an account which pays 2.4% compound interest per year.

 How much interest does she earn in 3 years? £582.56

 $7900 \times 1.024^3 = 8482.56$ £8482.56 - £7900 = £582.56

5) Harry puts money into an account which pays 6% compound interest per year.

 If he puts £23000 in the account for 5 years how much interest will he earn altogether? £7779.19

 $23000 \times 1.06^5 = 30779.19$ £30779.19 - £23000 = £7779.19

6) Laura buys a new car for £14600.

 The annual rate of depreciation is 23%.

 How much is the car worth after 3 years? £6665.38

 $14600 \times 0.77^3 = 6665.38$

7) The rate of depreciation of a particular brand of computer is 65% per year. If the cost of the computer when new is £650 how much is it worth after 2 years? £79.63

 $650 \times 0.35^2 = 79.63$

8) Sharon pays £3500 for a secondhand car.

 The annual rate of depreciation of the car is 24%

 How much will it be worth four years after she has bought it? £1167.68

 $3500 \times 0.76^4 = 1167.68$

9) Dave places £17000 in an account which pays 4% compound interest per year.

 How many years will it take before he has £19122.68 in the bank? 3 years

 $17000 \times 1.04^3 = 19122.68$

10) A new motorbike costs £8900.

 The annual rate of depreciation is 18% per year.

 After how many years will it be worth £2705.66? 6 years

 $8900 \times 0.82^6 = 2705.66$

Reverse Percentages

1) In a sale, normal prices are reduced by 20%.

   The sale price of a shirt is £26

   Calculate the normal price of the shirt.   £32.50
   (26 ÷ 80) × 100 = 32.5

2) A car dealer offers a discount of 15% off the normal price of a car for cash.

   Emma pays £6120 cash for a car.

   Calculate the normal price of the car.   £7200
   (6120 ÷ 85) × 100 = 7200

3) In a sale, normal prices are reduced by 13%.

   The sale price of a DVD recorder is £108.75

   Calculate the normal price of the DVD recorder.   £125
   (108.75 ÷ 87) × 100 = 125

4) A salesman gets a basic wage of £160 per week plus a commision of 30%
   of the sales he makes that week.

   In one week his total wage was £640

   Work out the value of the sales he made that week.   £1600
   640 - 160 = 480
   (480 ÷ 30) × 100 = 1600

5) Jason opened an account at MathsWatch Bank.

   MathsWatch Bank's interest rate was 4%.

   After one year, the bank paid him interest.

   The total amount in his account was then £1976

   Work out the amount with which Jason opened his account   £1900
   (1976 ÷ 104) × 100 = 1900

6) Jonathan's weekly pay this year is £960.

   This is 20% more than his weekly pay last year.

   Tess says "This means Jonathan's weekly pay last year was £768".
   Tess is wrong.

   a) Explain why   Tess has calculated 20% of £960, and subtracted it.

   b) Work out Jonathan's weekly pay last year.   £800
      (960 ÷ 120) × 100 = 800

7) The price of all rail season tickets to London increased by 4%.

   a) The price of a rail season ticket from Oxford to London increased by £122.40
      Work out the price before this increase.   £3060   (122.40 ÷ 4) × 100 = 3060

   b) After the increase, the price of a rail season ticket from Newport to London was £2932.80
      Work out the price before this increase.   £2820
      (2932.80 ÷ 104) × 100 = 2820

Four Rules of Fractions

Work out

1) $\frac{2}{3}+\frac{1}{5}$ $\quad$ $\frac{13}{15}$

2) $1\frac{2}{3}+2\frac{3}{4}$ $\quad$ $4\frac{5}{12}$

3) $\frac{2}{5}+\frac{3}{8}$ $\quad$ $\frac{31}{40}$

4) $\frac{3}{4}+\frac{1}{6}$ $\quad$ $\frac{11}{12}$

5) $3\frac{2}{5}-1\frac{3}{4}$ $\quad$ $1\frac{13}{20}$

6) $\frac{4}{5}\times\frac{2}{9}$ $\quad$ $\frac{8}{45}$

7) $14\frac{3}{4}-11\frac{1}{2}$ $\quad$ $3\frac{1}{4}$

8) $\frac{9}{10}-\frac{3}{7}$ $\quad$ $\frac{33}{70}$

9) $\frac{4}{9}\div\frac{12}{18}$ $\quad$ $\frac{2}{3}$

10) $\frac{7}{10}\times\frac{5}{8}$ $\quad$ $\frac{7}{16}$

11) $\frac{2}{3}\times\frac{3}{4}$ $\quad$ $\frac{1}{2}$

12) $\frac{11}{12}-\frac{5}{6}$ $\quad$ $\frac{1}{12}$

13) $2\frac{1}{4}\div\frac{3}{5}$ $\quad$ $3\frac{3}{4}$

14) $2\frac{2}{3}\times1\frac{1}{4}$ $\quad$ $3\frac{1}{3}$

15) $\frac{1}{3}+\frac{3}{5}$ $\quad$ $\frac{14}{15}$

16) $1-(\frac{1}{2}+\frac{1}{6})$ $\quad$ $\frac{1}{3}$

17) $1-(\frac{1}{5}+\frac{3}{8})$ $\quad$ $\frac{17}{40}$

18) $2\frac{1}{3}\times3\frac{1}{2}$ $\quad$ $8\frac{1}{6}$

19) $\frac{4}{7}+\frac{1}{3}$ $\quad$ $\frac{19}{21}$

20) $3\frac{1}{3}+2\frac{3}{4}$ $\quad$ $6\frac{1}{12}$

21) $\frac{2}{5}\times\frac{3}{7}$ $\quad$ $\frac{6}{35}$

22) $5\frac{2}{3}-2\frac{3}{4}$ $\quad$ $2\frac{11}{12}$

23) $2\frac{1}{2}+1\frac{2}{3}$ $\quad$ $4\frac{1}{6}$

24) $1\frac{2}{5}+2\frac{3}{7}$ $\quad$ $3\frac{29}{35}$

25) $3\frac{3}{4}+11\frac{1}{2}$ $\quad$ $15\frac{1}{4}$

26) $12\frac{1}{2}\div\frac{5}{8}$ $\quad$ 20

27) $1-(\frac{3}{10}+\frac{3}{5})$ $\quad$ $\frac{1}{10}$

28) $6\frac{1}{4}\div\frac{5}{12}$ $\quad$ 15

29) $2\frac{1}{3}\times\frac{2}{5}$ $\quad$ $\frac{14}{15}$

30) $1-(\frac{2}{3}+\frac{1}{5})$ $\quad$ $\frac{2}{15}$

Solving Quadratic Equations by Factorising

1) Factorise and solve the following equations:

    a) $x^2 + 5x + 6 = 0$ $(x + 2)(x + 3) = 0$ x = -2 or -3

    b) $x^2 + 9x + 20 = 0$ $(x + 4)(x + 5) = 0$ x = -4 or -5

    c) $x^2 + x - 6 = 0$ $(x + 3)(x - 2) = 0$ x = -3 or 2

    d) $x^2 + 5x - 24 = 0$ $(x + 8)(x - 3) = 0$ x = -8 or 3

    e) $x^2 - 6x + 8 = 0$ $(x - 2)(x - 4) = 0$ x = 2 or 4

    f) $x^2 - 3x - 28 = 0$ $(x - 7)(x + 4) = 0$ x = 7 or -4

    g) $2x^2 + 7x + 3 = 0$ $(x + 3)(2x + 1) = 0$ x = -3 or $-\dfrac{1}{2}$

    h) $6x^2 + 11x + 3 = 0$ $(2x + 3)(3x + 1) = 0$ x = $-\dfrac{3}{2}$ or $-\dfrac{1}{3}$

    i) $3x^2 + 13x - 10 = 0$ $(x + 5)(3x - 2) = 0$ x = -5 or $\dfrac{2}{3}$

    j) $3x^2 - 34x + 63 = 0$ $(3x - 7)(x - 9) = 0$ x = $\dfrac{7}{3}$ or 9

2) Lucy said that -1 is the only solution of x that satisfies the equation
$x^2 + 2x + 1 = 0$

    Was Lucy correct?   Yes
    Show working to justify your answer
    x² + 2x + 1 = 0
  (x + 1)(x + 1) = 0
      so x = -1

3) Ben said that -5 is the only solution of x that satisfies the equation
$x^2 + 10x + 25 = 0$

    Was Ben correct?   Yes
    Show working to justify your answer
    x² + 10x + 25 = 0
  (x + 5)(x + 5) = 0
      so x = -5

Difference of Two Squares

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

1) Factorise

    a) $x^2 - 16$ (x - 4)(x + 4)

    c) $y^2 - 9$ (y - 3)(y + 3)

    e) $x^2 - \dfrac{1}{4}$ (x - $\frac{1}{2}$)(x + $\frac{1}{2}$)

    b) $a^2 - b^2$ (a - b)(a + b)

    d) $x^2 - 1$ (x - 1)(x + 1)

    f) $x^2 - \dfrac{1}{9}$ (x - $\frac{1}{3}$)(x + $\frac{1}{3}$)

2) Factorise

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

    c) $9x^2 - 16y^2$
      (3x - 4y)(3x + 4y)

    e) $4x^2 - 25y^2$
      (2x - 5y)(2x + 5y)

    b) $9a^2 - b^2$
      (3a - b)(3a + b)

    d) $\dfrac{1}{4}x^2 - y^2$
      ($\frac{1}{2}$x - y)($\frac{1}{2}$x + y)

    f) $x^2 - \dfrac{1}{9}y^2$
      (x - $\frac{1}{3}$y)(x + $\frac{1}{3}$y)

3) Simplify

    a) $\dfrac{y^2 - 4}{y + 2} \times \dfrac{5}{y + 5}$ $\dfrac{5(y - 2)}{y + 5}$ $\dfrac{(y - 2)\cancel{(y + 2)}}{\cancel{y + 2}} \times \dfrac{5}{y + 5}$

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

    c) $\dfrac{12x^2 + 8x}{9x^2 - 4}$ $\dfrac{4x}{3x - 2}$ $\dfrac{4x\cancel{(3x + 2)}}{(3x - 2)\cancel{(3x + 2)}}$

    d) $\dfrac{25a^2 - 16b^2}{10ab - 8b^2}$ $\dfrac{5a + 4b}{2b}$ $\dfrac{\cancel{(5a - 4b)}(5a + 4b)}{2b\cancel{(5a - 4b)}}$

4) Solve

    a) $4x^2 - 16 = 0$ (2x - 4)(2x + 4) = 0
      x = 2   ,   x = -2

    c) $49x^2 = 121$ (7x - 11)(7x + 11) = 0
      x = $1\frac{4}{7}$,   x = $-1\frac{4}{7}$

    b) $25x^2 = 1$ (5x - 1)(5x + 1) = 0
      x = $\dfrac{1}{5}$,   x = $-\dfrac{1}{5}$

    d) $9x^2 - 9 = 7$ (3x - 4)(3x + 4) = 0
      x = $1\frac{1}{3}$,   x = $-1\frac{1}{3}$

Simultaneous Linear Equations

1) Solve

$$4x + 3y = 6$$
$$5x - 3y = 21$$

x = 3 and y = -2

2) Solve

$$4x + 3y = 19$$
$$3x - 5y = 7$$

x = 4 and y = 1

3) Solve

$$3x + 5y = 13$$
$$2x + 3y = 8$$

x = 1 and y = 2

4) Solve

$$x + 4y = 5$$
$$4x - 2y = 11$$

x = 3 and y = 0.5

5) Solve

$$2a + b = 3$$
$$4a - 5b = 20$$

a = 2.5 and b = -2

6) Solve

$$5x + 3y = 4$$
$$3x + 4y = 9$$

x = -1 and y = 3

7) Solve

$$6x - 2y = 13$$
$$2x + 3y = -3$$

x = 1.5 and y = -2

8) Solve

$$3a - 2b = 14$$
$$4a + 3b = 13$$

a = 4 and b = -1

9) Solve

$$5x + 4y = 5$$
$$2x + 7y = 29$$

x = -3 and y = 5

10) Solve

$$6x - 4y = 39$$
$$2x + y = 6$$

x = 4.5 and y = -3

Understand $y = mx + c$

gradient — cuts the y-axis

1) a) Find the equation of line A. $y = 3x - 2$

   b) Draw the line B, with equation $y = x - 1$.

   c) Draw the line C, with equation $y = 1 - 2x$.

$y = 1 - 2x$ $y = x - 1$ A
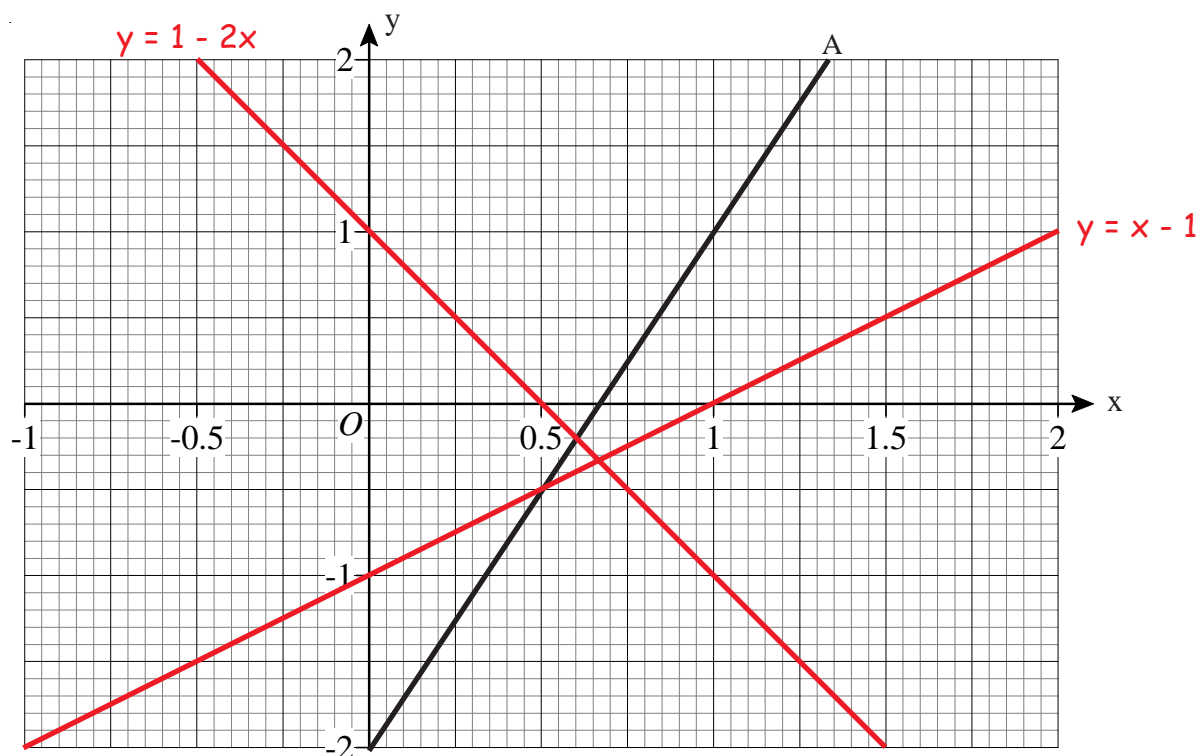
2) A straight line passes through points (0, 4) and (3, 13).
   What is its equation? $y = 3x + 4$

3) A straight line passes through points (0, 7) and (2, -1).
   What is its equation? $y = -4x + 7$

4) A straight line is parallel to $y = 3x - 2$ and goes
   through (1, 8).
   What is its equation? $y = 3x + 5$

5) A straight line is parallel to $y = 2x + 5$ and goes
   through (5, 6).
   What is its equation? $y = 2x - 4$

6) A is the point (-1, 2).
   B is the point (1, 6).
   C is the point (0, -1).
   Find the equation of the line which passes through C
   and is parallel to AB. $y = 2x - 1$

B (1, 6)

A (-1, 2)

C (0, -1)
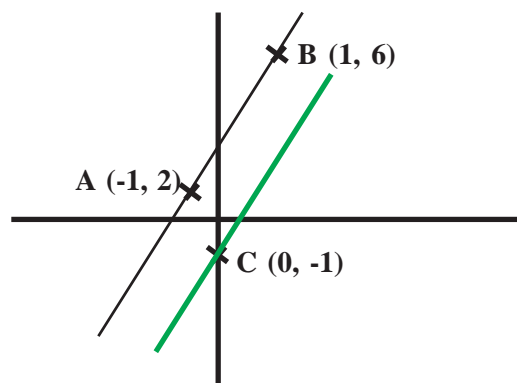
Regions

1) On the grid below, draw straight lines and use shading to show the region **R** that satisfies the inequalities $x > 1$ $y > x$ $x + y < 7$
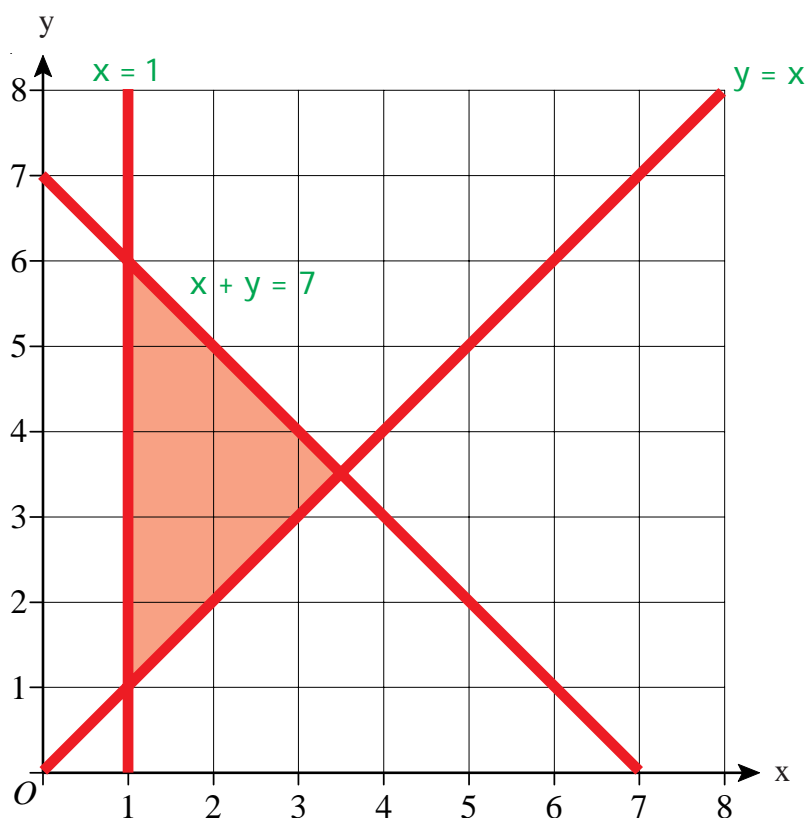
2) On the grid below, draw straight lines and use shading to show the region **R** that satisfies the inequalities $y > x + 1$ $y < 5$ $x > 1$
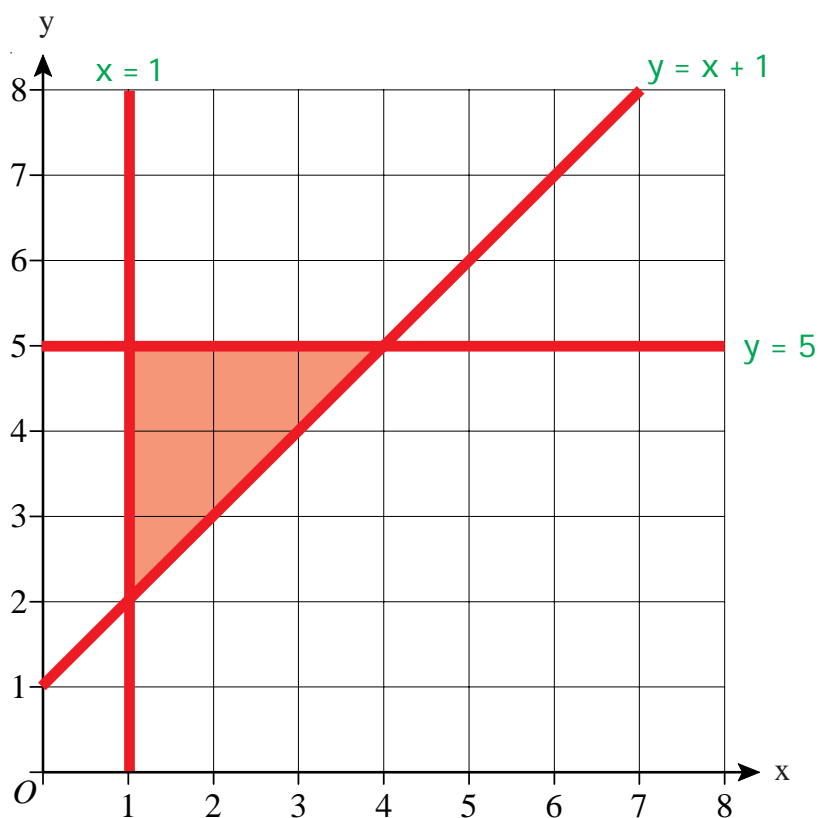
1) a) Complete this table of values for
$$y = x^3 + x - 4$$

x	–2	–1	0	1	2
y	–14	-6	-4	–2	6

b) On the grid, draw the graph of
$$y = x^3 + x - 4$$

c) Use the graph to find the value
of x when y = 2

x = 1.75
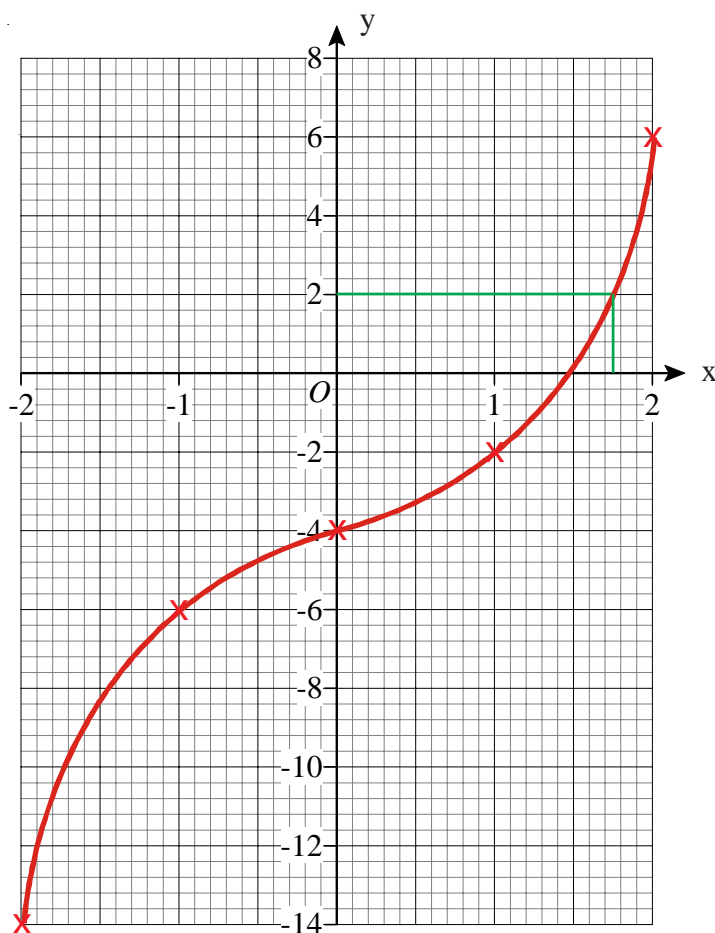
2) a) Complete this table of values for
$$y = x^3 + 2x$$

x	–2	–1	0	1	2
y	–12	-3	0	3	12

b) On the grid, draw the graph of
$$y = x^3 + 2x$$

c) Use the graph to find the value
of x when y = -6

x = -1.5
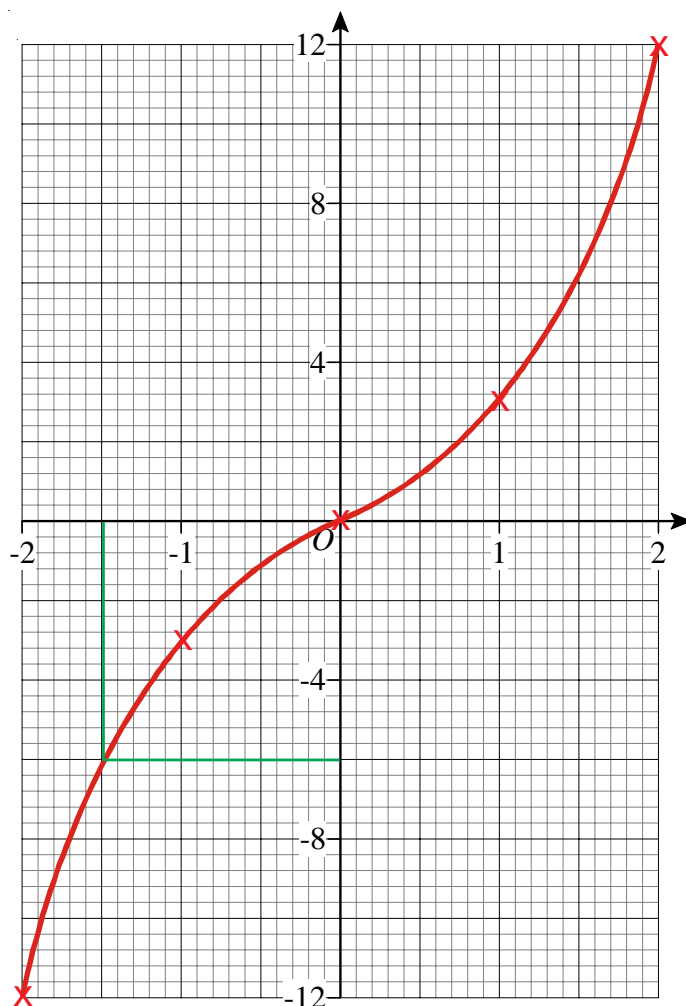
3) Sketch the graph of $y = 1 + \dfrac{1}{x}$
in your book.
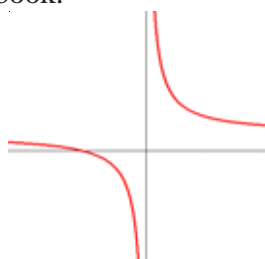
Recognise the Shapes of Functions

Match each of the functions below, with the correct sketch of its graph.

$$y = 3x^3 \qquad y = \frac{-2}{x} \qquad y = 3x - 1 \qquad y = 2^x$$

$$y = 2x^2 + 1 \qquad y = \frac{2}{x} \qquad y = 5x - x^3 \qquad y = -2x^3$$

$y = 2^x$

$y = 2x^2 + 1$

$y = 5x - x^3$

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

$y = 3x^3$

$y = -2x^3$

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

$y = 3x - 1$

Trigonometry
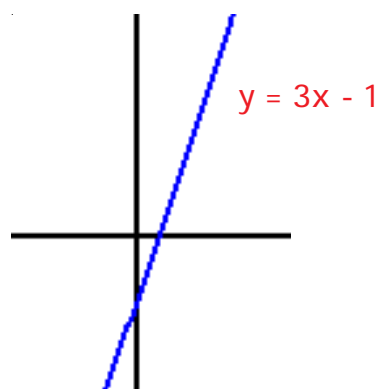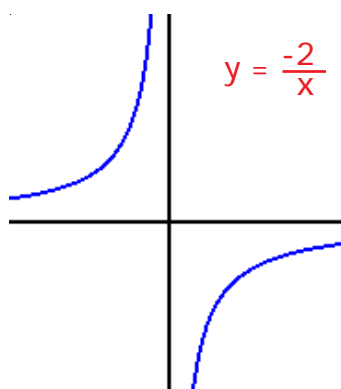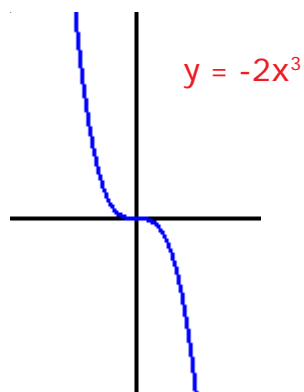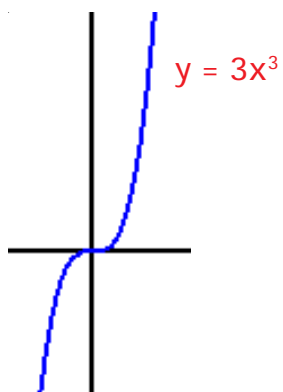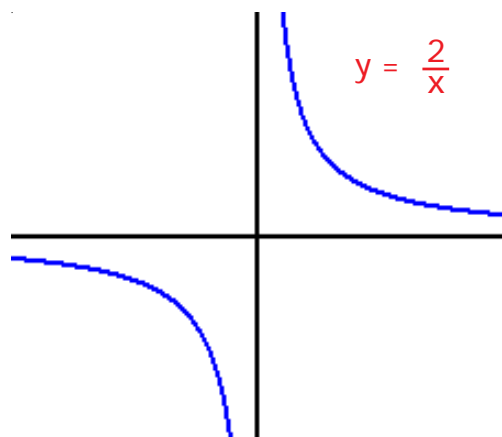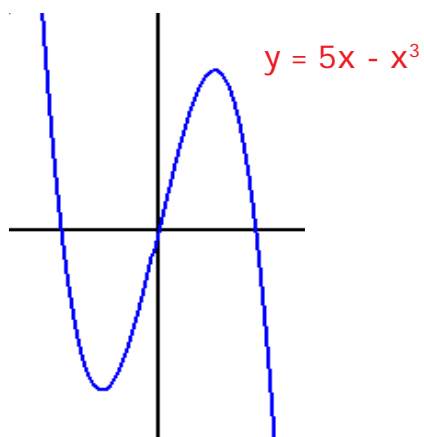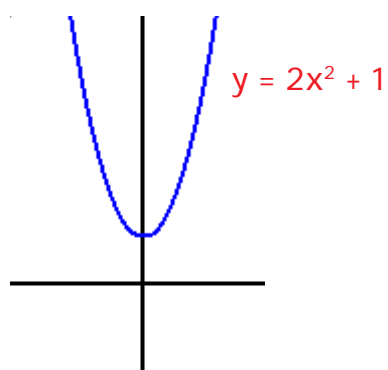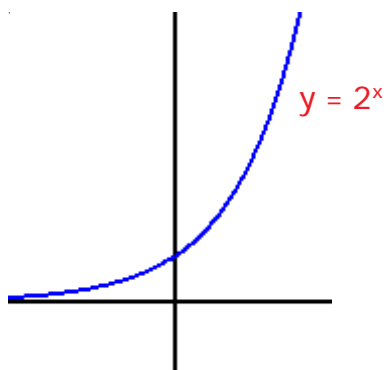
1) PQR is a right-angled triangle.
PR = 11 cm.
QR = 4.5 cm
Angle PRQ = 90°

Work out the value of x. **22.2°**
Give your answer correct to 1 decimal place.
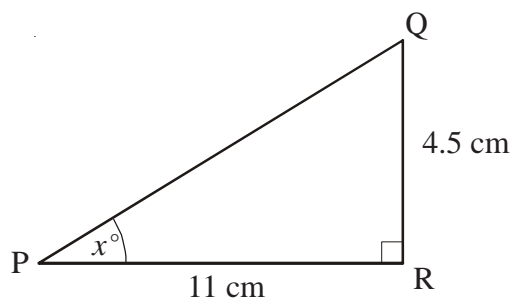
2) AC = 14 cm.
Angle ABC = 90°
Angle ACB = 34°

Calculate the length of BC. **11.6 cm**
Give your answer correct to
3 significant figures.
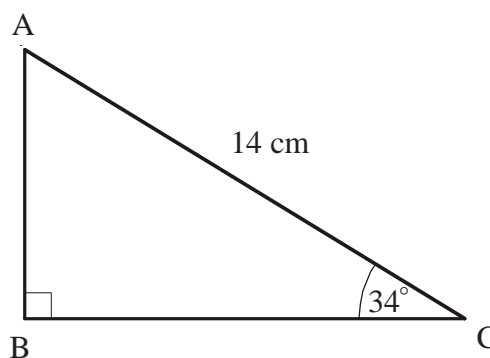
3) PQR is a right-angled triangle.
PQ = 18 cm.
QR = 8.4 cm
Angle PRQ = 90°

Work out the value of x. **27.8°**
Give your answer correct to 1 decimal place.
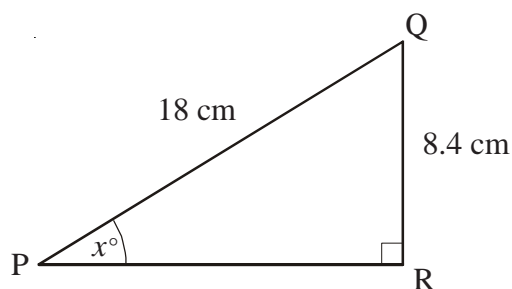
4) AB = 23 cm.
Angle ABC = 90°
Angle ACB = 21°

Calculate the length of AC. **64.2 cm**
Give your answer correct to
3 significant figures.
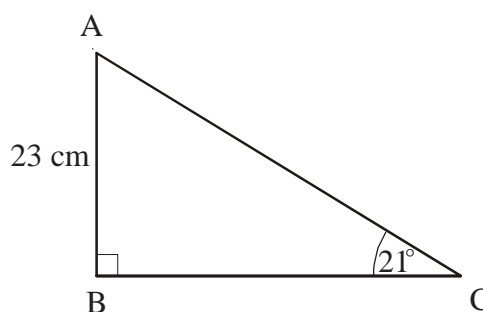
5) A lighthouse, L, is 3.4 km due West of a port, P.
A ship, S, is 1.8 km due North of the lighthouse, L.

Calculate the size of the angle marked x. **27.9°**
Give your answer correct to 3 significant figures.

Bearings by Trigonometry

1)

Crowdace

N
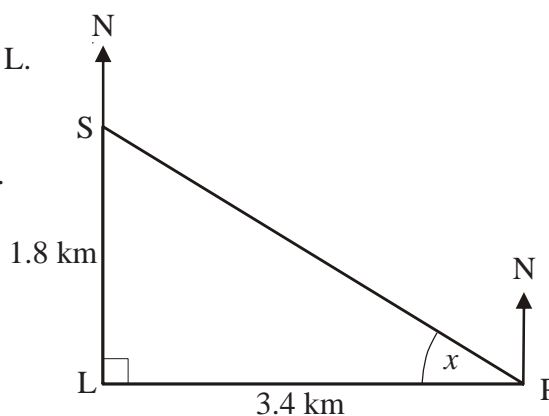
Diagram **NOT**
accurately drawn.
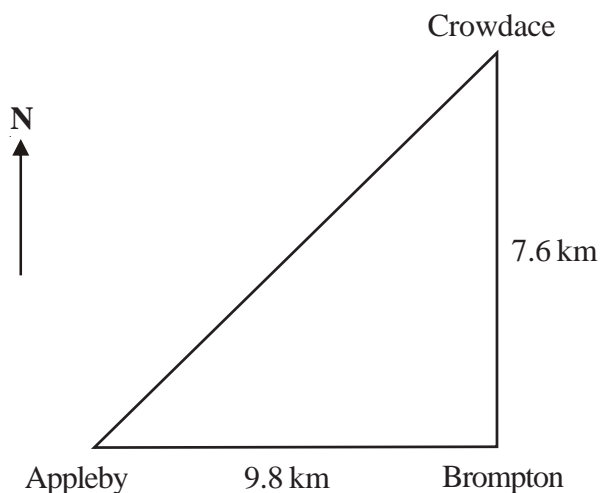
7.6 km

Appleby   9.8 km   Brompton

Appleby, Brompton and Crowdace are three towns.

Appleby is 9.8 km due west of Brompton.
Brompton is 7.6 km due south of Crowdace.

a) Calculate the bearing of Crowdace from Appleby.
   Give your answer correct to 1 decimal place.   052.2°

b) Calculate the bearing of Appleby from Crowdace.
   Give your answer correct to 1 decimal place.   232.2°

2)   Froncham

Diagram **NOT**
accurately drawn.

N
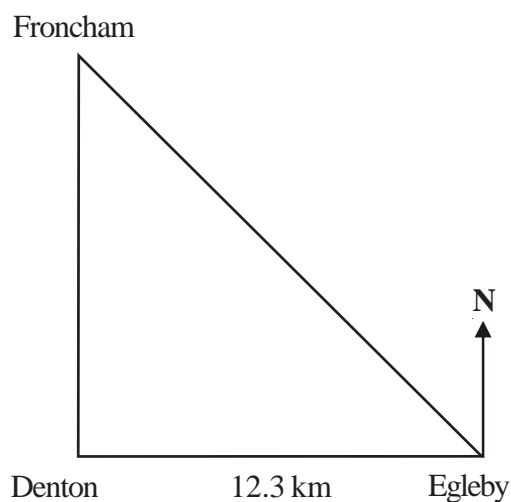
Denton   12.3 km   Egleby

Denton, Egleby and Froncham are three towns.

Egleby is 12.3 km due East of Denton.
Froncham is due north of Denton and on a bearing of 320° from Egleby.

Calculate the distance between Froncham and Egleby.
Give your answer correct to 1 decimal place.   19.1 km

Similar Shapes

1) BE is parallel to CD.
   AB = 12 cm, BC = 3 cm, CD = 7 cm, AE = 8 cm.

   a) Calculate the length of ED. **2 cm**

   AD = 8 × 1.25 = 10 cm
   ED = 10 - 8 = 2 cm

   b) Calculate the length of BE. **5.6 cm**

   BE = 7 ÷ 1.25
   BE = 5.6

   15 ÷ 12 = 1.25

   × 1.25

   ÷ 1.25

   12 cm

   8 cm

   15 cm

   7 cm

   Diagram **NOT**
   accurately drawn.

   3 cm

   8 cm

   7 cm

2)

   Diagram **NOT**
   accurately drawn.

   A

   B
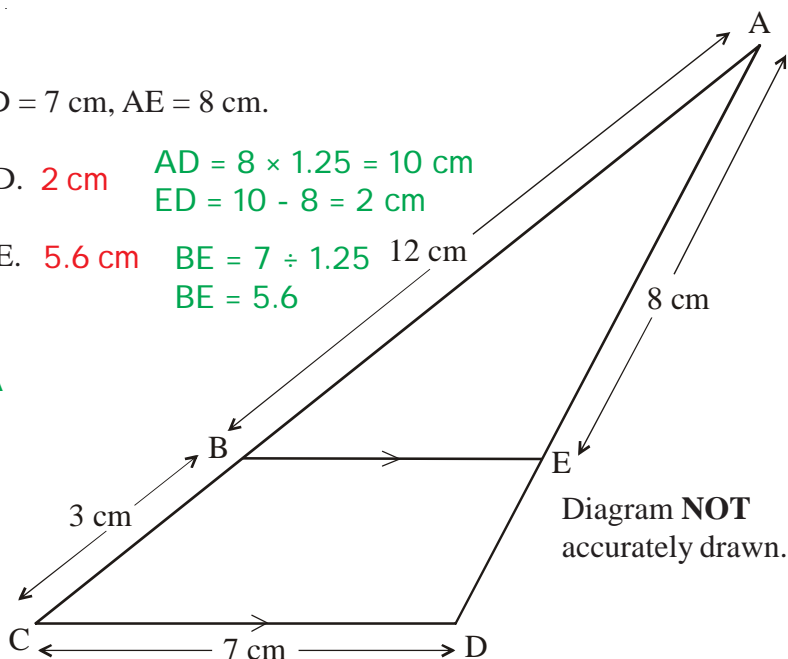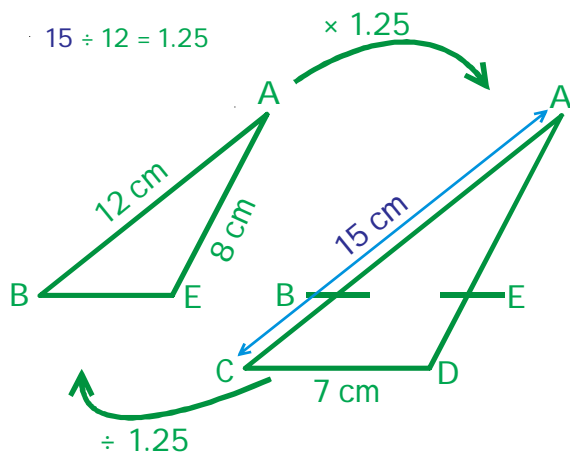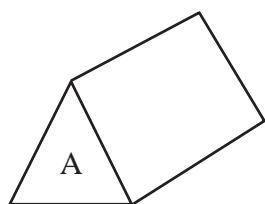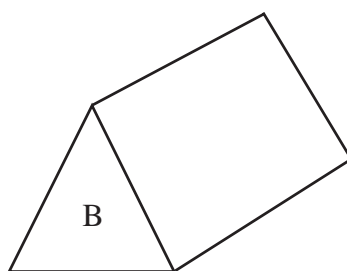
   V = 36000 cm³   V = 383328 cm³

   Volume scale factor
   383328 ÷ 36000 = 10.648

   Linear scale factor
   $\sqrt[3]{10.648}$ = 2.2

   Two prisms, A and B, are mathematically similar.
   The volume of prism A is 36000 cm³.
   The volume of prism B is 383328 cm³.
   The total surface area of prism B is 40656 cm².

   Area scale factor
   2.2² = 4.84

   40656 ÷ 4.84 = 8400 cm²

   Calculate the total surface area of prism A.   **8400 cm²**

3) P and Q are two geometrically similar solid shapes.

   The total surface area of shape P is 540 cm².
   The total surface area of shape Q is 960 cm².

   The volume of shape P is 2700 cm³.

   Calculate the volume of shape Q.   **6400 cm³**

   Area scale factor
   960 ÷ 540 = 1.$\dot{7}$

   Linear scale factor
   $\sqrt{1.\dot{7}}$ = 1.$\dot{3}$

   Volume scale factor
   1.$\dot{3}$³ = 2.$\dot{3}$7$\dot{0}$

   2700 × 2.$\dot{3}$7$\dot{0}$ = 6400 cm³

Circle Theorems

1) In the diagram, A, B and C are points
   on the circumference of a circle, centre O.
   PA and PB are tangents to the circle.
   Angle ACB = 72°.
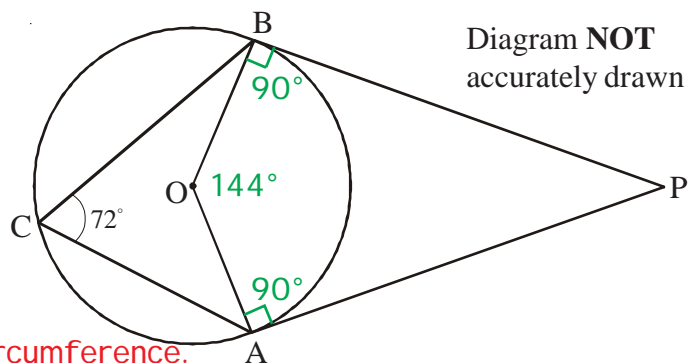
   a) (i) Work out the size of angle AOB. **144°**

      (ii) Give a reason for your answer.
      Angle at centre is twice angle on circumference.

   b) Work out the size of angle APB. **36°**

B
90°
O **144°**
C)72°
90°
A
P

Diagram **NOT**
accurately drawn

2) P, Q, R and S are points on the circle.
   PQ is a diameter of the circle.
   Angle RPQ = 32°.
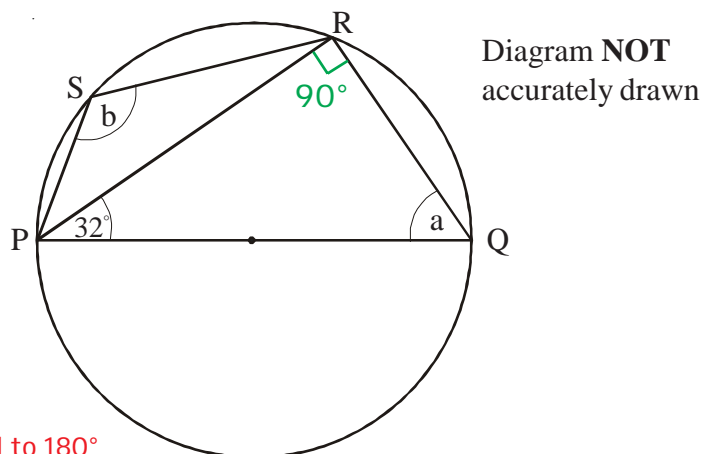
   a) (i) Work out the size of angle PQR. **58°**

      (ii) Give reasons for your answer.
      Angle in semi-circle is 90°
      Angles in triangle add to 180°

   b) (i) Work out the size of angle PSR. **122°**

      (ii) Give a reason for your answer.
      Opposite angles of a cyclic quadrilateral add to 180°

R
S b **90°**
P 32° a Q

Diagram **NOT**
accurately drawn

3) The diagram shows a circle, centre O.
   AC is a diameter.
   Angle BAC = 31°.
   D is a point on AC such that angle BDA
   is a right angle.
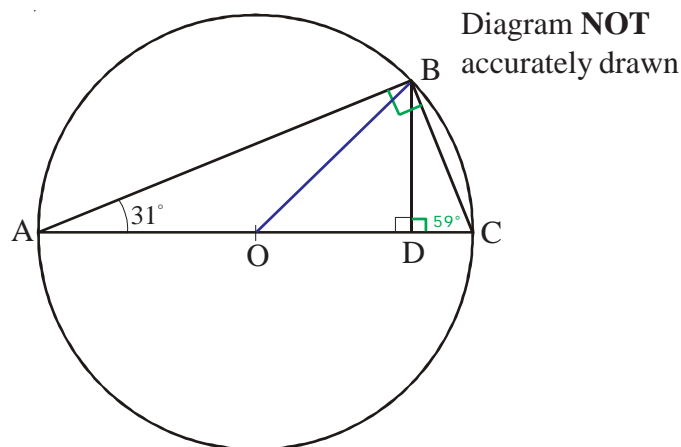
   a) Work out the size of angle BCA. **59°**
      Give reasons for your answer.
      Angle in semi-circle is 90°
      Angles in triangle add to 180°

   b) Calculate the size of angle DBC. **31°**

   c) Calculate the size of angle BOA. **118°**

Diagram **NOT**
accurately drawn
B
A 31° 59°
O D C

4) A, B, C and D are four points on the circumference of a circle.
   ABE and DCE are straight lines.
   Angle BAC = 21°. Angle EBC = 58°.
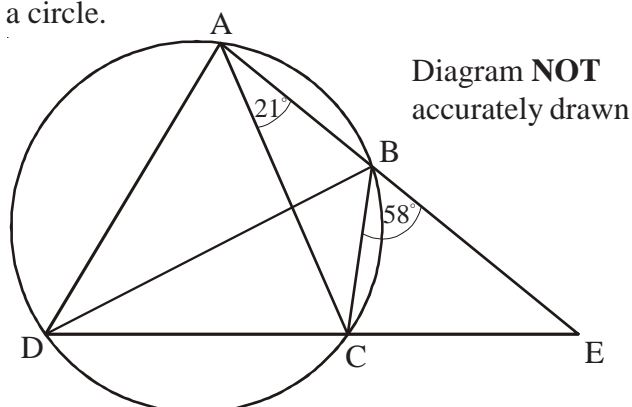
   a) Find the size of angle ADC. **58°**

   b) Find the size of angle ADB. **37°**

   Angle CAD = 69°.

   c) Is BD a diameter of the circle? **Yes**
      You must explain your answer.
      Angle DAB = 69° + 21° = 90°
      BD subtends 90° on the circumference. Therefore BD is a diameter.

A
21°
B
58°
D C E

Diagram **NOT**
accurately drawn

Cumulative Frequency

The heights of 80 plants were measured and can be seen in the table, below.

Height (cm)	Frequency
0 < h ≤ 10	2
10 < h ≤ 20	5
20 < h < 30	19
30 < h ≤ 40	38
40 < h < 50	13
50 < h < 60	3

a) Complete the cumulative frequency table for the plants.

Height (cm)	Cumulative Frequency
0 < h ≤ 10	2
0 < h < 20	7
0 < h < 30	26
0 < h ≤ 40	64
0 < h ≤ 50	77
0 < h ≤ 60	80
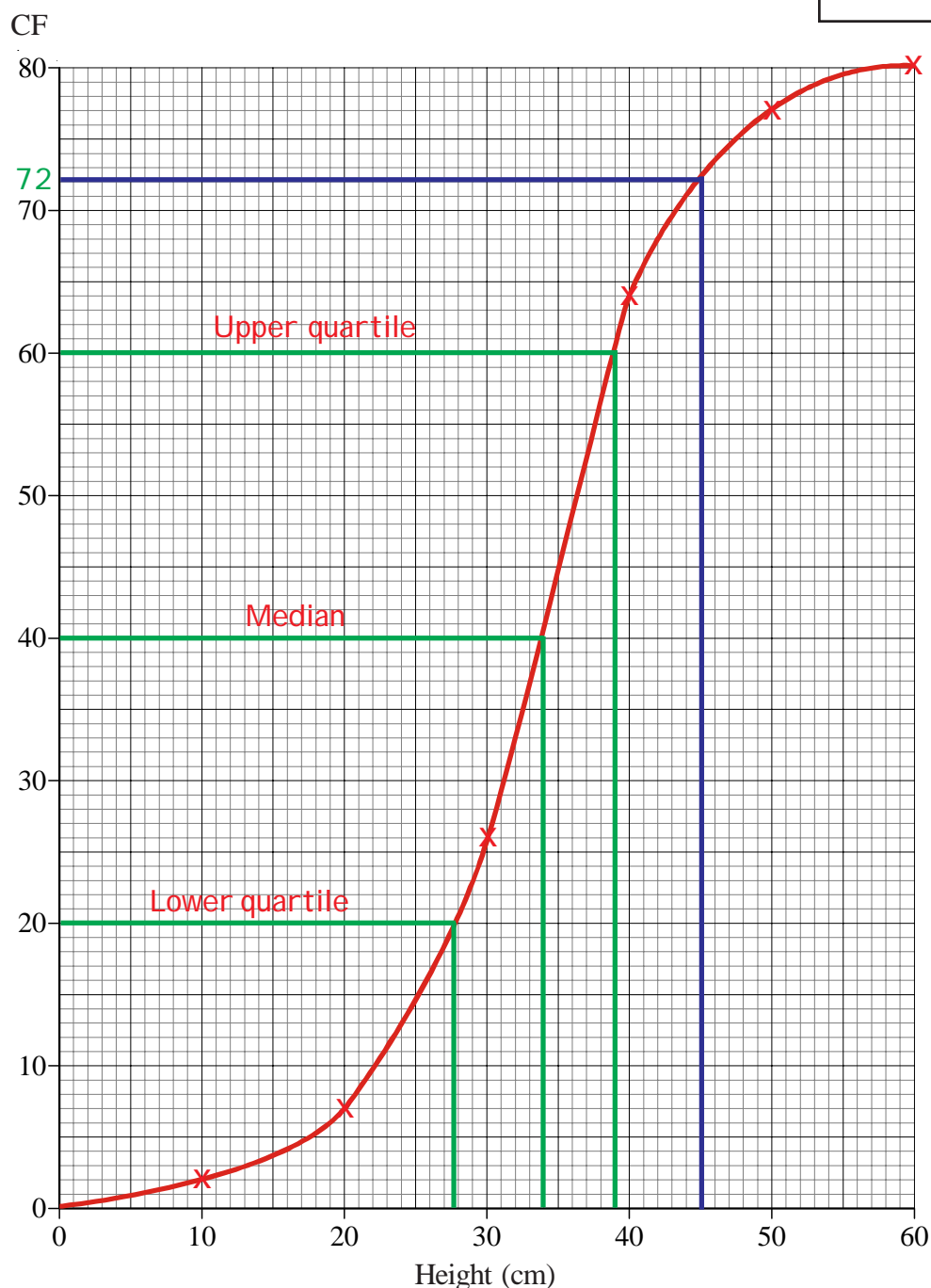
b) Draw a cumulative frequency graph for your table.

c) Use your graph to find an estimate for

   (i) the median height of a plant.

   34 cm

   (ii) the interquartile range of the heights of the plants.

   39 - 27.7 = 11.3 cm

d) Use your graph to estimate how many plants had a height that was greater than 45cm.

   80 - 72 = 8 plants

CF

Upper quartile

Median

Lower quartile

Height (cm)

Box Plots

1) The ages of 20 teachers are listed below.

27   31.5   46.5

22, 22, 24, 25, 27, 27, 28, 29, 29, 29, 34, 35, 41, 43, 44, 49, 55, 57, 58, 58

a) On the grid below, draw a boxplot to show the information about the teachers.
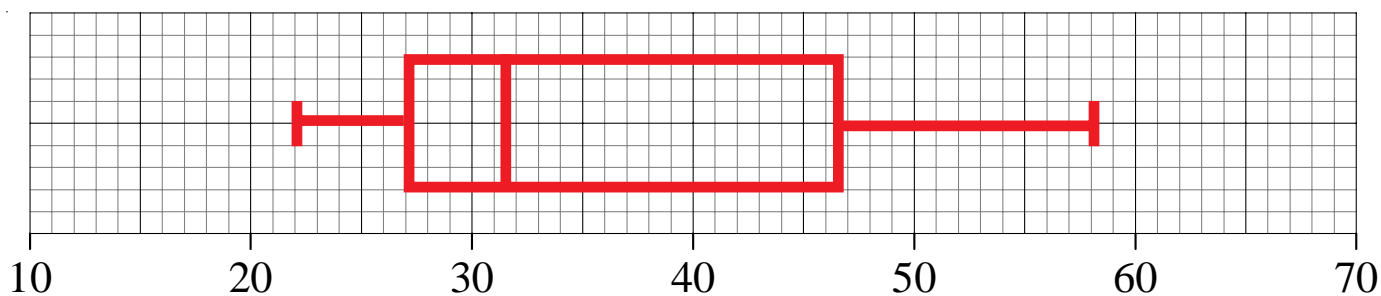
b) What is the interquartile range of the ages of the teachers?   19.5 years

2) A warehouse has 60 employees working in it.

The age of the youngest employee is 16 years.
The age of the oldest employee is 55 years.

The median age is 37 years.
The lower quartile age is 29 years.
The upper quartile age is 43 years.

On the grid below, draw a boxplot to show information about the ages of the employees.
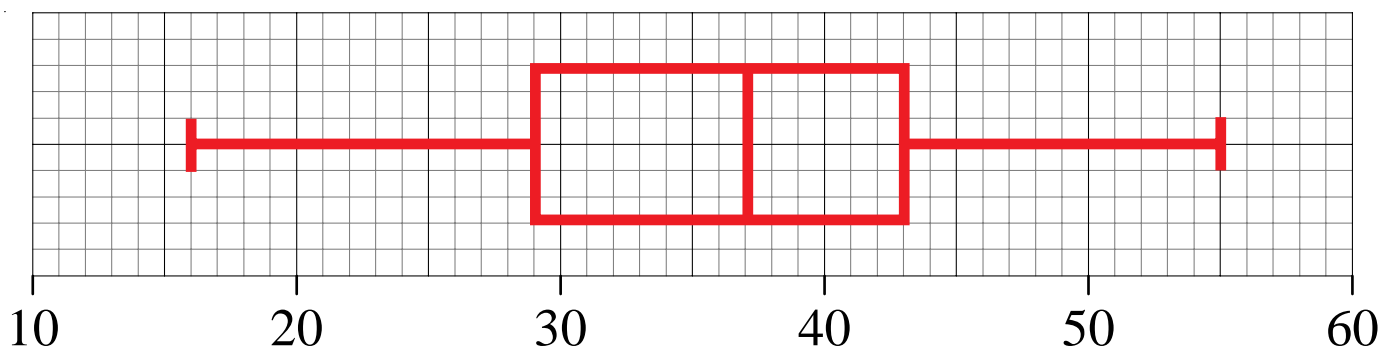
Moving Averages

1) The table shows the number of board games sold in a supermarket each month from January to June.

Jan	Feb	Mar	Apr	May	Jun
146	163	237	134	169	259

Work out the 3-month moving averages for this information.

$$\underline{\quad 182 \quad}, \quad \underline{\quad 178 \quad}, \quad \underline{\quad 180 \quad}, \quad \underline{\quad 187.\dot{3} \quad}$$

(146+163+237) ÷ 3   (163+237+134) ÷ 3   (237+134+169) ÷ 3   (134+169+259) ÷ 3

2) The table shows the number of computers sold in a shop in the first five months of 2007.

Jan	Feb	Mar	Apr	May	June
74	83	112	78	91	x

a) Work out the first two 3-month moving averages for this information.

$$\underline{\quad 89.\dot{6} \quad}, \quad \underline{\quad 91 \quad}$$

(74 + 83 + 112) ÷ 3   (83 + 112 + 78) ÷ 3

b) Work out the first 4-month moving average for this information.

$$\underline{\quad 86.75 \quad}$$

(74 + 83 + 112 + 78) ÷ 4

The third 4-month moving average of the number of computers sold in 2007 is 96. The number of computers sold in the shop in June was x.

c) Work out the value of x.   x = 103

$$4 \times 96 = 384$$
$$112 + 78 + 91 = 281$$
$$384 - 281 = 103$$

Tree Diagrams

1) Lucy throws a biased dice twice.
   Complete the probability tree diagram to show the outcomes.
   Label clearly the branches of the tree diagram.

1st Throw   **2nd Throw**

$\frac{2}{6}$ → six

$\frac{2}{6}$ — *Six*

$\frac{4}{6}$ → not six

$\frac{4}{6}$ — *Not Six*

$\frac{2}{6}$ → six

$\frac{4}{6}$ → not six
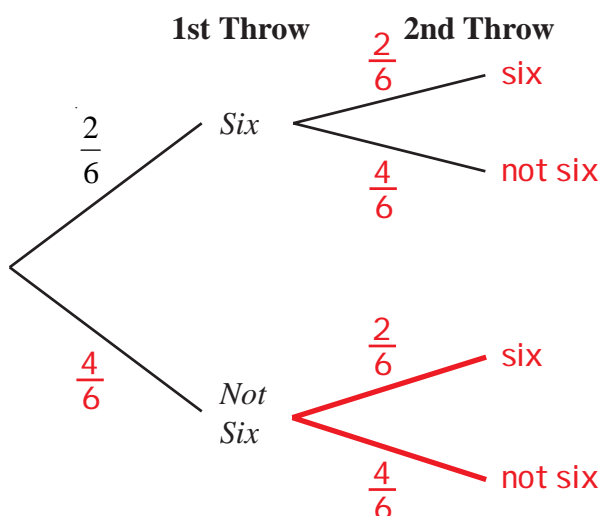
2) A bag contains 10 coloured balls.
   7 of the balls are blue and 3 of the balls are green.
   Nathan is going to take a ball, replace it, and then take a second ball.

   a) Complete the tree diagram.

1st Ball   **2nd Ball**

$\frac{7}{10}$ → Blue   B B $\frac{7}{10} \times \frac{7}{10}$

$\frac{7}{10}$ — Blue

$\frac{3}{10}$ → Green   B G $\frac{7}{10} \times \frac{3}{10}$

$\frac{3}{10}$ — Green

$\frac{7}{10}$ → Blue   G B $\frac{3}{10} \times \frac{7}{10}$

$\frac{3}{10}$ → Green   G G $\frac{3}{10} \times \frac{3}{10}$
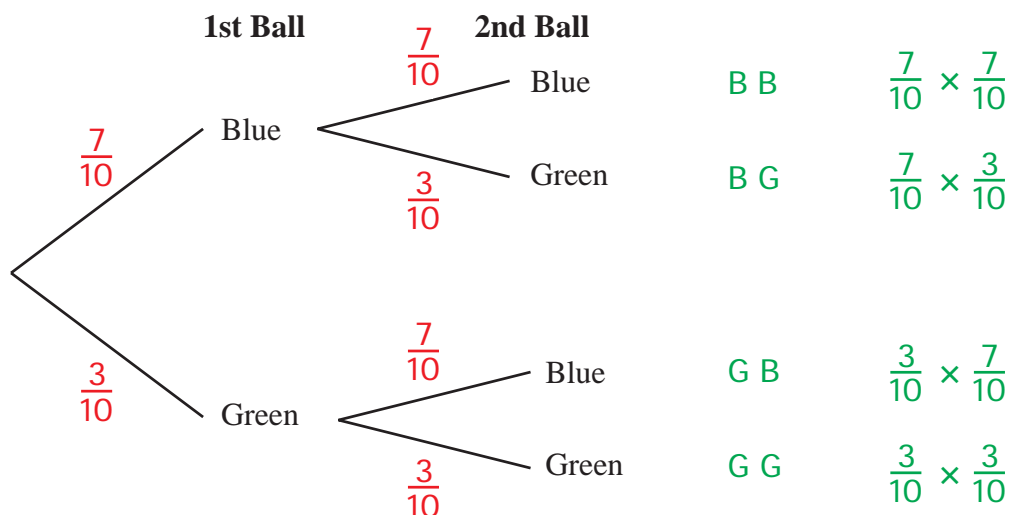
b) Work out the probability that Nathan will take two blue balls. $\frac{49}{100}$ $\frac{7}{10} \times \frac{7}{10}$

c) Work out the probability that Nathan will take one of each coloured balls. $\frac{42}{100}$ $\frac{21}{100} + \frac{21}{100}$

d) Work out the probability that Nathan will take two balls of the same colour. $\frac{58}{100}$ $\frac{49}{100} + \frac{9}{100}$

Recurring Decimals

1) a) Convert the recurring decimal $0.\dot{3}\dot{6}$ to a fraction in its simplest form. $\dfrac{4}{11}$

$x = 0.3636...$
$100x = 36.3636...$
$99x = 36$
$x = \dfrac{36}{99} = \dfrac{4}{11}$

b) Prove that the recurring decimal $0.\dot{7}\dot{2} = \dfrac{8}{11}$

$0.\dot{7}\dot{2} = 2 \times 0.\dot{3}\dot{6}$
$0.\dot{7}\dot{2} = 2 \times \dfrac{4}{11}$
$0.\dot{7}\dot{2} = \dfrac{8}{11}$

2) a) Change $\dfrac{4}{9}$ to a decimal. $0.\dot{4}$

$\begin{array}{r} 0.44 \\ 9\overline{)4\,{}^4 0\,0} \end{array}$

b) Prove that the recurring decimal $0.\dot{5}\dot{7} = \dfrac{19}{33}$

$x = 0.5757...$
$100x = 57.5757...$
$99x = 57$
$x = \dfrac{57}{99} = \dfrac{19}{33}$

3) a) Change $\dfrac{3}{11}$ to a decimal. $0.\dot{2}\dot{7}$

b) Prove that the recurring decimal $0.\dot{4}\dot{5} = \dfrac{15}{33}$

$x = 0.4545...$
$100x = 45.4545...$
$99x = 45$
$x = \dfrac{45}{99} = \dfrac{15}{33}$

4) a) Change $\dfrac{1}{6}$ to a decimal. $0.1\dot{6}$

$\begin{array}{r} 0.166 \\ 6\overline{)1\,0\,{}^4 0\,{}^4 0} \end{array}$

b) Prove that the recurring decimal $0.\dot{1}3\dot{5} = \dfrac{5}{37}$

$x = 0.135135...$
$1000x = 135.135135...$
$999x = 135$
$x = \dfrac{135}{999} = \dfrac{5}{37}$

5) a) Convert the recurring decimal $0.\dot{2}6\dot{1}$ to a fraction in its simplest form. $\dfrac{29}{111}$

$0.\dot{2}6\dot{1} = \dfrac{261}{999}$

b) Prove that the recurring decimal $0.2\dot{7} = \dfrac{5}{18}$

$x = 0.2777...$
$100x = 27.777...$
$99x = 27.5$
$x = \dfrac{27.5}{99} = \dfrac{55}{198} = \dfrac{5}{18}$

6) a) Convert the recurring decimal $5.\dot{2}$ to a fraction in its simplest form.

$x = 5.222...$
$10x = 52.222...$
$9x = 47$
$x = \dfrac{47}{9} = 5\dfrac{2}{9}$

b) Prove that the recurring decimal $0.1\dot{3}\dot{6} = \dfrac{3}{22}$

$x = 0.13636...$
$100x = 13.63636...$
$99x = 13.5$
$x = \dfrac{13.5}{99} = \dfrac{27}{198} = \dfrac{3}{22}$

Fractional and Negative Indices

$$a^x \times a^y = a^{x+y} \qquad \frac{a^x}{a^y} = a^{x-y} \qquad (a^x)^y = a^{xy}$$

$$a^0 = 1 \qquad a^{-x} = \frac{1}{a^x} \qquad a^{\frac{x}{y}} = (\sqrt[y]{a})^x \qquad a^{-\frac{x}{y}} = \frac{1}{(\sqrt[y]{a})^x}$$

1) Simplify
   a) $(p^5)^5$ p^{25}
   b) $k^3 \times k^2$ k^5

   c) $x^5 \div x^2$ x^3
   d) $(p^2)^{-3}$ p^{-6}

   e) $(m^{-5})^{-2}$ m^{10}
   f) $(3xy^2)^3$ $27x^3y^6$

2) Without using a calculator, find the exact value of the following.
   a) $4^0 \times 4^2$ 16
      $1 \times 16 = 16$
   b) $5^4 \times 5^{-2}$ 25
      $5^2 = 25$

   c) $7^5 \div 7^3$ 49
      $7^2 = 49$
   d) $\frac{6^7}{6^6}$ 6
      $6^1 = 6$

   e) $(8^5)^0$ 1
      $8^0 = 1$
   f) $(2^3)^2$ 64
      $2^6 = 64$

3) Work out each of these, leaving your answers as exact fractions when needed.

   a) 4^0 1
   b) 7^0 1
   c) 25^0 1
   d) 139^0 1

   e) 4^{-2} $\frac{1}{16}$
   f) 8^{-1} $\frac{1}{8}$
   g) 5^{-3} $\frac{1}{125}$
   h) 10^{-5} $\frac{1}{100000}$

   i) $49^{\frac{1}{2}}$ 7
   j) $32^{\frac{2}{5}}$ 4
   k) $27^{\frac{1}{3}}$ 3
   l) $16^{\frac{3}{2}}$ 64

   m) $49^{-\frac{1}{2}}$ $\frac{1}{7}$
   n) $32^{-\frac{2}{5}}$ $\frac{1}{4}$
   o) $27^{-\frac{1}{3}}$ $\frac{1}{3}$
   p) $16^{-\frac{3}{2}}$ $\frac{1}{64}$

4) $5\sqrt{5}$ can be written in the form 5^n.
   Find the value of n.   1.5 $5^1 \times 5^{\frac{1}{2}}$

5) $2 \times \sqrt{8} = 2^m$
   Find the value of m.   2.5 $2^1 \times (2^3)^{\frac{1}{2}}$

6) Find the value of x when
   $\sqrt{125} = 5^x$ 1.5 $(5^3)^{\frac{1}{2}}$

7) Find the value of y when
   $\sqrt{128} = 2^y$ 3.5 $(2^7)^{\frac{1}{2}}$

8) $a = 2^x$, $b = 2^y$
   a) Express in terms of a and b
      i) 2^{x+y} ab   ii) 2^{2x} a^2 iii) 2^{x+2y} ab^2

      $ab = 16$ and $2ab^2 = 16$
   b) Find the value of x and the value of y.   x = 5, y = -1
      $16 = 2^x \times 2^y$ $16 = 2(2^x \times 2^y \times 2^y)$
      $= 2^{x+y}$ $8 = 2^x \times 2^y \times 2^y$
      $x + y = 4$ $x + 2y = 3$

Surds

$\sqrt{25}$ is not a surd because it is equal to exactly 5.

$\sqrt{3}$ is a surd because you can only ever approximate the answer.

We don't like surds as denominators.
When we **rationalise** the denominator it means that we transfer the surd expression to the numerator.

---

1) Simplify the following:

a) $\sqrt{7} \times \sqrt{7}$ 7

b) $\sqrt{3} \times \sqrt{3}$ 3

c) $\sqrt{20}$ $2\sqrt{5}$

d) $\sqrt{24}$ $2\sqrt{6}$

e) $\sqrt{72}$ $6\sqrt{2}$

f) $\sqrt{200}$ $10\sqrt{2}$

g) $\sqrt{\dfrac{2}{25}}$ $\dfrac{\sqrt{2}}{5}$

2) Simplify the following:

a) $\sqrt{2} \times \sqrt{18}$ 6

b) $\sqrt{8} \times \sqrt{32}$ 16

c) $\sqrt{99} \times \sqrt{22}$ $33\sqrt{2}$

d) $\sqrt{45} \times \sqrt{20}$ 30

e) $\sqrt{18} \times \sqrt{128}$ 48

f) $\sqrt{28} \times \sqrt{175}$ 70

3) Expand and simplify where possible:

a) $\sqrt{3}\left(3 - \sqrt{3}\right)$ $3\sqrt{3}$ - 3

b) $\sqrt{2}\left(6 + 2\sqrt{2}\right)$ $6\sqrt{2}$ + 4

c) $\sqrt{7}\left(2 + 3\sqrt{7}\right)$ $2\sqrt{7}$ + 21

d) $\sqrt{2}\left(\sqrt{32} - \sqrt{8}\right)$ 4

4) Expand and simplify where possble:

a) $\left(1+\sqrt{2}\right)\left(1-\sqrt{2}\right)$ -1

b) $\left(3+\sqrt{5}\right)\left(2-\sqrt{5}\right)$ 1 - $\sqrt{5}$

c) $\left(\sqrt{3}+2\right)\left(\sqrt{3}+4\right)$ 11 + $6\sqrt{3}$

d) $\left(\sqrt{5}-3\right)\left(\sqrt{5}+1\right)$ 2 - $2\sqrt{5}$

e) $\left(2+\sqrt{7}\right)\left(2-\sqrt{7}\right)$ -3

f) $\left(\sqrt{6}-3\right)^2$ 15 - $6\sqrt{6}$

5) Rationalise the denominator, simplifying where possible:

a) $\dfrac{3}{\sqrt{2}}$ $\dfrac{3\sqrt{2}}{2}$

b) $\dfrac{2}{\sqrt{2}}$ $\sqrt{2}$

c) $\dfrac{3\sqrt{2}}{\sqrt{7}}$ $\dfrac{3\sqrt{14}}{7}$

d) $\dfrac{\sqrt{5}}{\sqrt{10}}$ $\dfrac{\sqrt{2}}{2}$

e) $\dfrac{1}{4\sqrt{8}}$ $\dfrac{\sqrt{2}}{16}$

f) $\dfrac{\sqrt{15}}{\sqrt{3}}$ $\sqrt{5}$

g) $\dfrac{1}{\sqrt{27}}$ $\dfrac{\sqrt{3}}{9}$

6) $3 \times \sqrt{27} = 3^n$ 2½

Find the value of n

7) Express $8\sqrt{8}$ in $16\sqrt{2}$
the form m $\sqrt{2}$ where m is an integer.

8) Rationalise the denominator

of $\dfrac{1}{8\sqrt{8}}$ giving the answer in

the form $\dfrac{\sqrt{2}}{p}$ $\dfrac{\sqrt{2}}{32}$

9) Work out the following, giving your answer in its simplest form:

a) $\dfrac{(5+\sqrt{3})(5-\sqrt{3})}{\sqrt{22}}$ $\sqrt{22}$

b) $\dfrac{(4-\sqrt{5})(4+\sqrt{5})}{\sqrt{11}}$ $\sqrt{11}$

c) $\dfrac{(3-\sqrt{2})(3+\sqrt{2})}{\sqrt{14}}$ $\dfrac{\sqrt{14}}{2}$

d) $\dfrac{(\sqrt{3}+1)^2}{\sqrt{3}}$ $\dfrac{4\sqrt{3} + 6}{3}$

e) $\dfrac{(\sqrt{5}+3)^2}{\sqrt{20}}$ $\dfrac{7\sqrt{5} + 15}{5}$

f) $\dfrac{(5-\sqrt{5})(2+2\sqrt{5})}{\sqrt{20}}$ 4

Direct and Inverse Proportion

1) x is directly proportional to y.
   When $x = 21$, then $y = 3$.

   $x = k\,y$
   $21 = k \times 3$

   a) Express x in terms of y.　$x = 7y$　　$k = 7$

   b) Find the value of x when y is equal to:
   (i) 1　7　　(ii) 2　14　　(iii) 10　70

2) a is inversely proportional to b.
   When $a = 12$, then $b = 4$.

   $a = \dfrac{k}{b}$
   $12 = \dfrac{k}{4}$

   a) Find a formula for a in terms of b.　$a = \dfrac{48}{b}$　　$k = 48$

   b) Find the value of a when b is equal to:
   (i) 1　48　　(ii) 8　6　　(iii) 10　4.8

   c) Find the value of b when a is equal to:　$b = \dfrac{48}{a}$
   (i) 4　12　　(ii) 24　2　　(iii) 3.2　15

3) The variables u and v are in inverse proportion to one another.
   When $u = 3$, then $v = 8$.

   $u = \dfrac{k}{v}$
   $3 = \dfrac{k}{8}$

   Find the value of u when $v = 12$.　$u = 2$

   $k = 24$
   $u = \dfrac{24}{v}$

4) p is directly proportional to the square of q.
   $p = 75$ when $q = 5$

   $p = k\,q^2$
   $75 = k \times 5^2$
   $75 = k \times 25$

   a) Express p in terms q.　$p = 3q^2$　　$k = 3$

   b) Work out the value of p when $q = 7$.　$p = 147$

   $p = 3 \times 7^2$
   $p = 3 \times 49$

   c) Work out the positive value of q when $p = 27$.　$q = 3$

5) y is directly proportional to x^2.
   When $x = 3$, then $y = 36$.

   a) Express y in terms of x.　$y = 4x^2$

   z is inversely proportional to x.
   When $x = 4$, $z = 2$.

   b) Show that $z = c\,y^n$, where c and n are numbers and $c > 0$.
      You must find the values of c and n.　$z = 16y^{-0.5}$

   $c = 16$
   $n = -0.5$

Upper and Lower Bounds

1) A = 11.3 correct to 1 decimal place
   B = 300 correct to 1 significant figure
   C = 9 correct to the nearest integer

   11.3 ⟨ 11.35 / 11.25 ⟩   300 ⟨ 350 / 250 ⟩   9 ⟨ 9.5 / 8.5 ⟩

   a) Calculate the upper bound for A + B.   361.35
      11.35 + 350 = 361.35
   b) Calculate the lower bound for B ÷ C.   26.3 (1 dp)
      250 ÷ 9.5 = 26.3 (1 dp)
   c) Calculate the least possible value of AC.   95.625
      11.25 × 8.5 = 95.625
   d) Calculate the greatest possible value of $\dfrac{A+B}{B+C}$ 1.4 (1 dp) $\dfrac{11.35 + 350}{250 + 8.5} = 1.4$ (1 dp)

---

2) An estimate of the acceleration due to gravity can be found using the formula:

$$g = \frac{2L}{T^2 \sin x}$$

Using
T = 1.2 correct to 1 decimal place
L = 4.50 correct to 2 decimal places
x = 40 correct to the nearest integer

1.2 ⟨ 1.25 / 1.15 ⟩   4.50 ⟨ 4.505 / 4.495 ⟩   40 ⟨ 40.5 / 39.5 ⟩

   a) Calculate the lower bound for the value of g.
      Give your answer correct to 3 decimal places.   8.859 $\dfrac{2 \times 4.495}{1.25^2 \times \sin 40.5} = 8.859$

   b) Calculate the upper bound for the value of g.
      Give your answer correct to 3 decimal places.   10.711 $\dfrac{2 \times 4.505}{1.15^2 \times \sin 39.5} = 10.711$

---

3) The diagram shows a triangle ABC.

   AB = 73mm correct to 2 significant figures.
   BC = 80mm correct to 1 significant figure.
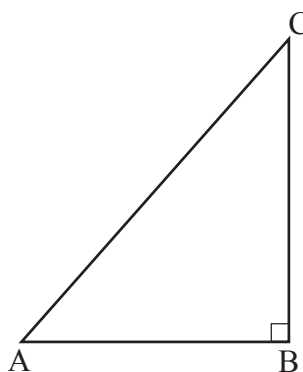
   Diagram **NOT** accurately drawn

   (a) Write the upper and lower bounds of both AB and BC.

   AB_{upper} = ...73.5..... BC_{upper} = ...85.....
   AB_{lower} = ...72.5..... BC_{lower} = ...75.....

   (b) Calculate the upper bound for the area of the triangle ABC.
   .....3123.75.....mm² $\dfrac{73.5 \times 85}{2} = 3123.75$

   Angle CAB = x°

   (c) Calculate the lower bound for the value of tan x°.   1.02 (2 dp)

   $\tan x = \dfrac{O}{A} = \dfrac{BC}{AB} = \dfrac{75}{73.5} = 1.02$ (2 dp)

Solve Quadratics Using the Formula

$$ax^2 + bx + c = 0 \qquad\qquad x_{1,2} = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

1) Solve the equation $a = 1 \quad b = 4 \quad c = 1$
   $x^2 + 4x + 1 = 0$

   Give your answers correct to 3 decimal places.
   x = -0.268   or   x = -3.732

2) Solve the equation $a = 1 \quad b = 8 \quad c = 6$
   $x^2 + 8x + 6 = 0$

   Give your answers correct to 3 significant figures.
   x = -0.838   or   x = -7.16

3) Solve the equation $a = 1 \quad b = -3 \quad c = -1$
   $x^2 - 3x - 2 = 0$

   Give your answers correct to 3 significant figures.
   x = -0.562   or   x = 3.56

4) Solve the equation $a = 1 \quad b = -7 \quad c = 2$
   $x^2 - 7x + 2 = 0$

   Give your answers correct to 3 significant figures.
   x = 0.298   or   x = 6.70

5) Solve the equation $a = 2 \quad b = 6 \quad c = -1$
   $2x^2 + 6x - 1 = 0$

   Give your answers correct to 3 significant figures.
   x = -3.16   or   x = 0.158

6) Solve the equation $a = 3 \quad b = -2 \quad c = -20$
   $3x^2 - 2x - 20 = 0$

   Give your answers correct to 3 significant figures.
   x = -2.27   or   x = 2.94

7) Solve the equation $a = 1 \quad b = -14 \quad c = -161.25$
   $x^2 - 14x - 161.25 = 0$
   x = -7.5   or   x = 21.5

8) Solve the equation $a = 17 \quad b = -92 \quad c = -206$
   $17x^2 - 92x - 206 = 0$

   Give your answers correct to 3 significant figures.
   x = -1.70   or   x = 7.11

9) $x^2 + 10x = 300$ $a = 1 \quad b = 10 \quad c = -300$
   x² + 10x - 300 = 0

   Find the positive value of x.
   Give your answer correct to 3 significant figures.
   x = 13.0

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

   a) Show that $x^2 - x - 7 = 0$
   x² - 3x + 2x - 6 = 1
   x² - x - 6 = 1
   x² - x - 7 = 0

   b) Solve the equation $x^2 - x - 7 = 0$
   Give your answers correct to 3 significant figures.
   x = -2.19   or   x = 3.19

Completing the Square

1) Show that if $y = x^2 + 8x - 3$
   then $y \geq -19$ for all values of x.

   y = (x + 4)² - 16 - 3
   y = (x + 4)² - 19
   (x + 4)² ⩾ 0
   y ⩾ -19

2) Show that if $y = x^2 - 10x + 30$
   then $y \geq 5$ for all values of x.

   y = (x - 5)² - 25 + 30
   y = (x - 5)² + 5
   (x - 5)² ⩾ 0
   y ⩾ 5

3) The expression $x^2 + 4x + 10$ can be written in the form
   $(x + p)^2 + q$ for all values of x.
   Find the values of p and q.

   (x + 2)² - 4 + 10
   (x + 2)² + 6

   p = 2 and q = 6

4) Given that $x^2 - 6x + 17 = (x - p)^2 + q$ for all values of x,
   find the value of p and the value of q.

   (x - 3)² - 9 + 17
   (x - 3)² + 8

   p = 3 and q = 8

5) For all values of x,

   $$x^2 + 6x = (x + p)^2 + q$$

   (x + 3)² - 9

   a) Find the values of p and q. p = 3 and q = -9

   b) Find the minimum value of $x^2 + 6x$. -9

6) For all values of x,

   $$x^2 - 8x - 5 = (x - p)^2 + q$$

   a) Find the value of p and the value of q.

   (x - 4)² - 16 - 5
   (x - 4)² - 21

   p = 4 and q = -21

   b) On the axes, sketch the graph of $y = x^2 - 8x - 5$.
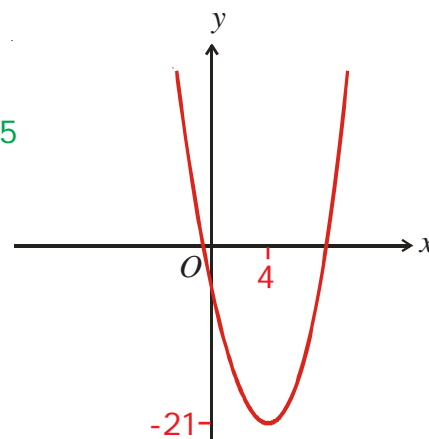
   c) Find the coordinate of the minimum point on the graph of $y = x^2 - 8x - 5$.

   (4, -21)

7) The expression $10x - x^2$ can be written in the form $p - (x - q)^2$ for all values of x.

   10x - x² can be rearranged as

   a) Find the values of p and q.

   -x² + 10x

   p = 25 and q = 5

   -(x² - 10x)

   b) The expression $10x - x^2$ has a maximum value.

   -[(x - 5)² - 25]

   (i) Find the maximum value of $10x - x^2$.

   -(x - 5)² + 25   rearranged as

   25

   25 - (x - 5)²

   (ii) State the value of x for which this maximum value occurs.

   x = 5

Algebraic Fractions

1) Simplify fully

a) $\dfrac{9x^2}{21x^3}$ $\dfrac{3}{7x}$

b) $\dfrac{10xy^3}{5y^2}$ $2xy$

c) $\dfrac{18a^3b^2}{2ab^2}$ $9a^2$

d) $\dfrac{4x^2+12x}{10x}$ $\dfrac{2(x+3)}{5}$

e) $\dfrac{2a^2b-14a^2b^3}{6a^3b^3}$ $\dfrac{1-7b^2}{3ab^2}$

f) $\dfrac{5x^2y+5xy^2}{10x^2y^2}$ $\dfrac{x+y}{2xy}$

2) Simplify fully

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

b) $\dfrac{x^2-6x+8}{2x^2-8x}$ $\dfrac{x-2}{2x}$

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

d) $\dfrac{x^2+7x+10}{x^2+5x}$ $\dfrac{x+2}{x}$

3) a) Factorise $4x^2-12x+9$ $(2x-3)^2$

b) Simplify $\dfrac{6x^2-7x-3}{4x^2-12x+9}$ $\dfrac{3x+1}{2x-3}$

4) Write as single fractions in their simplest form

a) $\dfrac{3}{x}+\dfrac{3}{2x}$ $\dfrac{9}{2x}$

b) $\dfrac{5}{3x}-\dfrac{3}{4x}$ $\dfrac{11}{12x}$

c) $\dfrac{x+2}{5}+\dfrac{x-1}{2}$ $\dfrac{7x-1}{10}$

d) $\dfrac{3}{x+2}-\dfrac{5}{2x+1}$ $\dfrac{x-7}{(x+2)(2x+1)}$

5) a) Factorise $2x^2+7x+6$ $(x+2)(2x+3)$

b) Write as a single fraction in its simplest form $\dfrac{3}{x+2}+\dfrac{4x}{2x^2+7x+6}$ $\dfrac{10x+9}{(x+2)(2x+3)}$

6) Solve

a) $\dfrac{1}{x}+\dfrac{1}{3x}=2$ $x=\dfrac{2}{3}$

b) $\dfrac{1}{x-2}+\dfrac{3}{x+6}=\dfrac{1}{2}$ $x=-2$ or 6

c) $\dfrac{1}{x-5}+\dfrac{6}{x}=2$ $x=2.5$ or 6

d) $\dfrac{7}{x+2}+\dfrac{1}{x-1}=4$ $x=-0.5$ or 1.5

e) $\dfrac{3}{x+2}+\dfrac{1}{x-2}=\dfrac{7}{x^2-4}$ $x=2.75$

f) $\dfrac{x}{2x-1}+\dfrac{2}{x+2}=1$ $x=0$ or 3

1) Make c the subject of the formula.

$v = 2a + 3b + c$ $c = v - 2a - 3b$

2) Make t the subject of the formula.

$A = \pi t + 5t$ $t = \dfrac{A}{\pi + 5}$ $A = t(\pi + 5)$

3) Make s the subject of the formula. $R - 2t = 3s + \pi s$

$R = 3s + \pi s + 2t$ $s = \dfrac{R - 2t}{3 + \pi}$ $R - 2t = s(3 + \pi)$

4) $k = \dfrac{l}{m-l}$ $k(m - l) = l$

    a) Make l the subject of the formula. $l = \dfrac{km}{1 + k}$ $km - kl = l$

                                         $km = l + kl$

    b) Make m the subject of the formula. $m = \dfrac{l + kl}{k}$ $km = l(1 + k)$

5) $A = \dfrac{k(x+5)}{3}$ $3A = k(x + 5)$

    Make x the subject of the formula. $x = \dfrac{3A - 5k}{k}$ $3A = kx + 5k$

                                           $3A - 5k = kx$

6) $R = \dfrac{u+v^2}{u+v}$ $R(u + v) = u + v^2$

                                   $Ru + Rv = u + v^2$

    Make u the subject of the formula. $u = \dfrac{v^2 - Rv}{R - 1}$ $Ru - u = v^2 - Rv$

                                   $u(R - 1) = v^2 - Rv$

7) $\dfrac{3x+2}{5} = \dfrac{y}{10+y}$ $(3x + 2)(10 + y) = 5y$

                          $30x + 3xy + 20 + 2y = 5y$

                           $30x + 20 = 5y - 3xy - 2y$

    Make y the subject of the formula. $y = \dfrac{30x + 20}{3 - 3x}$ $30x + 20 = 3y - 3xy$

                           $30x + 20 = y(3 - 3x)$

8) $\sqrt{\dfrac{a-3}{5}} = 4b$

                                           $\dfrac{a - 3}{5} = 16b^2$

    Rearrange this formula to give a in terms of b. $a = 80b^2 + 3$ $a - 3 = 80b^2$

9) $S = 2\pi d\sqrt{h^2 + d^2}$ $\dfrac{S}{2\pi d} = \sqrt{h^2 + d^2}$

    Rearrange this formula to make h the subject. $h = \sqrt{\dfrac{S^2}{4\pi^2 d^2} - d^2}$ $\dfrac{S^2}{4\pi^2 d^2} = h^2 + d^2$

                                           $\dfrac{S^2}{4\pi^2 d^2} - d^2 = h^2$

Simultaneous Equations With a Quadratic

1) Solve these simultaneous equations.

$y = x$

$y = x^2 - 6$

x = 3 and y = 3

x = -2 and y = -2

$x = x^2 - 6$

$x^2 - x - 6 = 0$

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

x = 3 or x = -2

2) Solve these simultaneous equations.

$y = x^2 - 4$

$y = 3x$

x = 4 and y = 12

x = -1 and y = -3

$3x = x^2 - 4$

$x^2 - 3x - 4 = 0$

$(x - 4)(x + 1) = 0$

x = 4 or x = -1

3) Solve these simultaneous equations.

$y = x^2 - x - 13$

$y = x + 2$

x = 5 and y = 7

x = -3 and y = -1

$x + 2 = x^2 - x - 13$

$x^2 - 2x - 15 = 0$

$(x - 5)(x + 3) = 0$

x = 5 or x = -3

4) Solve these simultaneous equations.

$y = x^2 - 35$

$x - y = 5$

x = 6 and y = 1

x = -5 and y = -10

y = x – 5

$x - 5 = x^2 - 35$

$x^2 - x - 30 = 0$

$(x - 6)(x + 5) = 0$

x = 6 or x = -5

5) Solve these simultaneous equations.

$x^2 + y^2 = 26$

$y + 6 = x$

x = 5 and y = -1

x = 1 and y = -5

y = x – 6

$x^2 + (x - 6)^2 = 26$

$x^2 + x^2 - 12x + 10 = 0$

$2x^2 - 12x + 10 = 0$

$x^2 - 6x + 5 = 0$

$(x - 5)(x - 1) = 0$

x = 5 or x = 1

6) Sarah said that the line y = 7 cuts the curve $x^2 + y^2 = 25$ at two points.

$x^2 + 49 = 25$

$x^2 = -24$

a) By eliminating y show that Sarah is **not** correct.

There is no solution to $x^2 = -24$ hence y = 7 does not cut the curve.

b) By eliminating y, find the solutions to the simultaneous equations

$x^2 + y^2 = 25$

$y = 3x - 9$

x = 1.4 and y = -4.8

x = 4 and y = 3

$x^2 + (3x - 9)^2 = 25$

$x^2 + 9x^2 - 54x + 81 = 25$

$10x^2 - 54x + 56 = 0$

$5x^2 - 27x + 28 = 0$

$(5x - 7)(x - 4) = 0$

x = 1.4 or x = 4

Gradients of Lines

1)

Diagram **NOT**
accurately drawn

y = ½x + 2   × B (10, 7)

× A (0, 2)
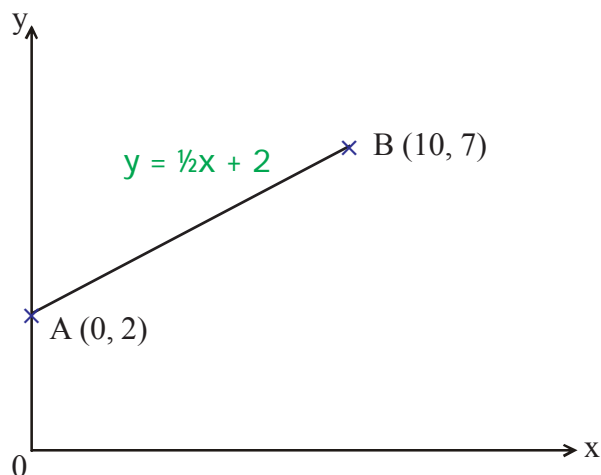
A is the point (0, 2)
B is the point (10, 7)

In qu a) and b)
c and m can be any numbers
you choose.

The equation of the straight line through A and B is $y = \frac{1}{2}x + 2$

a) Write down the equation of another straight line that is parallel to $y = \frac{1}{2}x + 2$ y = ½x + c

b) Write down the equation of another straight line that passes through the point (0, 2). y = mx + 2

c) Find the equation of the line perpendicular to AB passing through B.

y = -2x + 27

y = mx + c
m = -2, x = 10, y = 7
7 = -20 + c
c = 27

2)   A straight line has equation $y = 2x - 5$
The point P lies on the straight line.
The y coordinate of P is -6

a) Find the x coordinate of P.   x = -0.5

A straight line **L** is parallel to $y = 2x - 5$ and passes through the point (3, 2).

b) Find the equation of line **L**.   y = 2x - 4

c) Find the equation of the line that is perpendicular to line **L** and passes through point (3, 2).
y = -½x + 3½

3)   In the diagram   A is the point (0, -2)
B is the point (-4, 2)
C is the point (0, 2)

a) Find the equation of the line that passes through
C and is parallel to AB.   y = -x + 2

b) Find the equation of the line that passes through
C and is perpendicular to AB.   y = x + 2

Transformations of Functions
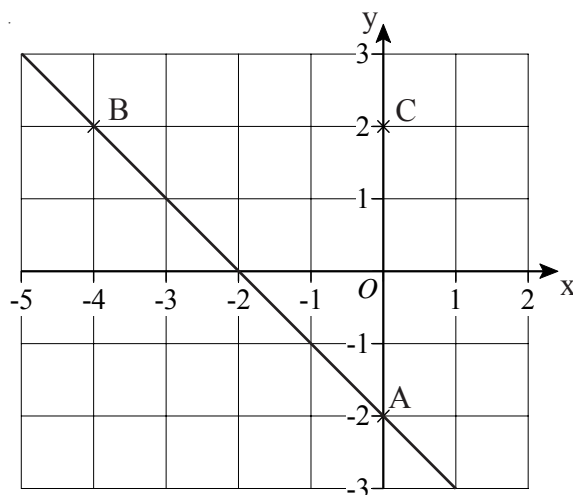
1) This is a sketch of the curve with equation $y = f(x)$.
   It passes through the origin O.

   The only vertex of the curve is at A (1, -1)

   a) Write down the coordinates of the vertex of the curve
      with equation

       (i) $y = f(x - 3)$ **(4, -1)**

       (ii) $y = f(x) - 5$ **(1, -6)**

       (iii) $y = -f(x)$ **(1, 1)**

       (iv) $y = f(2x)$ **(½, -1)**

   A (1, -1)

   b) The curve $y = x^2$ has been translated to give
      the curve $y = f(x)$.

      Find $f(x)$ in terms of x. **$y = x^2 - 2x$**
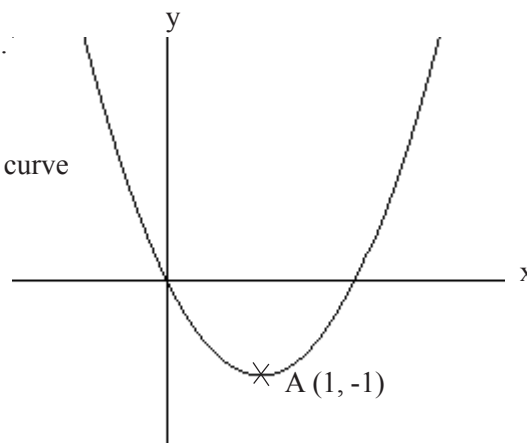
   $y = (x - 1)^2 - 1$
   $y = x^2 - 2x + 1 - 1$
   $y = x^2 - 2x$

2) The graph of $y = f(x)$ is shown on the grids.

   a) On this grid, sketch the graph of $y = f(x - 1)$
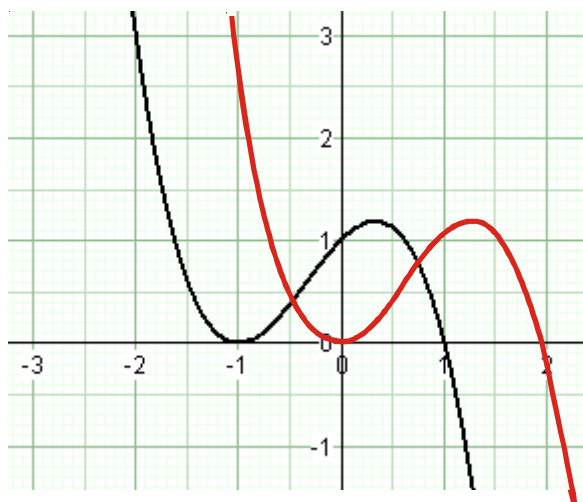
   b) On this grid, sketch the graph of $y = 2f(x)$
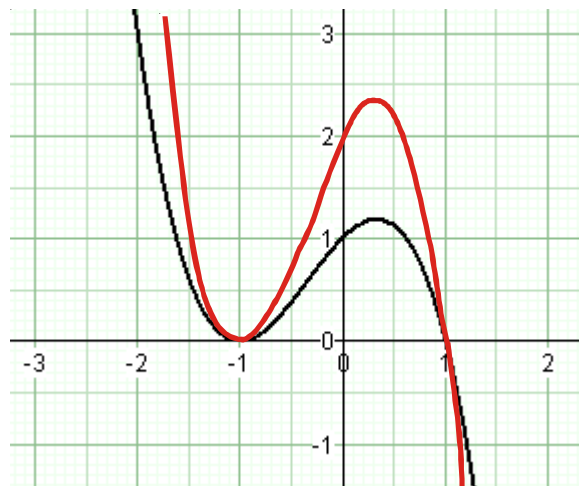
3) Sketch the graph of $y = (x - 2)^2 + 3$
   State the coordinates of the vertex.

   vertex is at (2, 3)
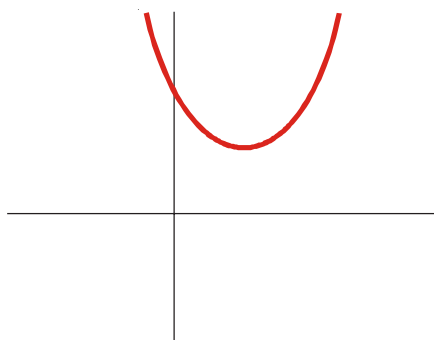
4) Sketch the graph of $y = x^2 + 4x - 1$
   State the coordinates of the vertex and
   the points at which the curve crosses the
   x - axis.

   vertex is at (-2, -5)
   crosses x axis at ($\sqrt{5}$ - 2, 0)
   and (-$\sqrt{5}$ - 2, 0)

Graphs of Trigonometric Functions - 1 of 2
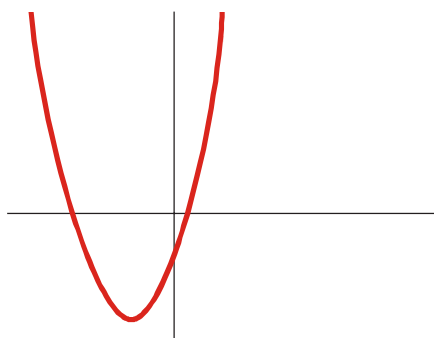
1) On the axes below below, draw a sketch-graph to show $y = \sin x$
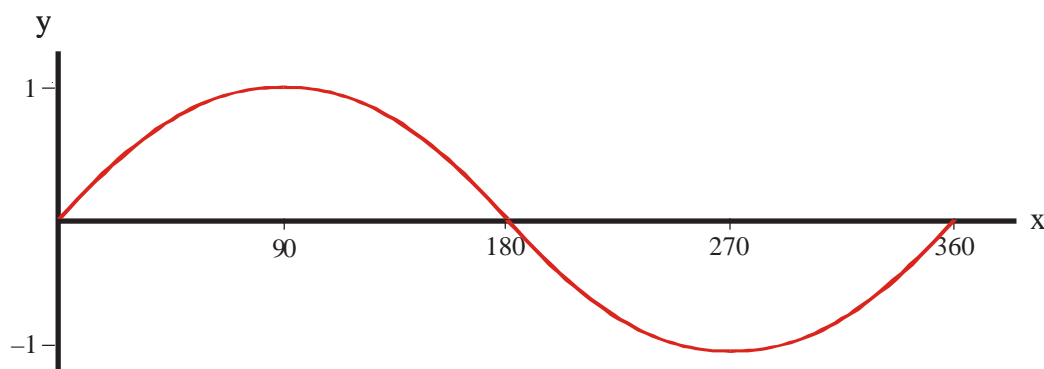
Given that $\sin 30° = 0.5$, write down the value of:

(i) $\sin 150°$ 0.5

(ii) $\sin 330°$ -0.5

2) On the axes below, draw a sketch-graph to show $y = \cos x$
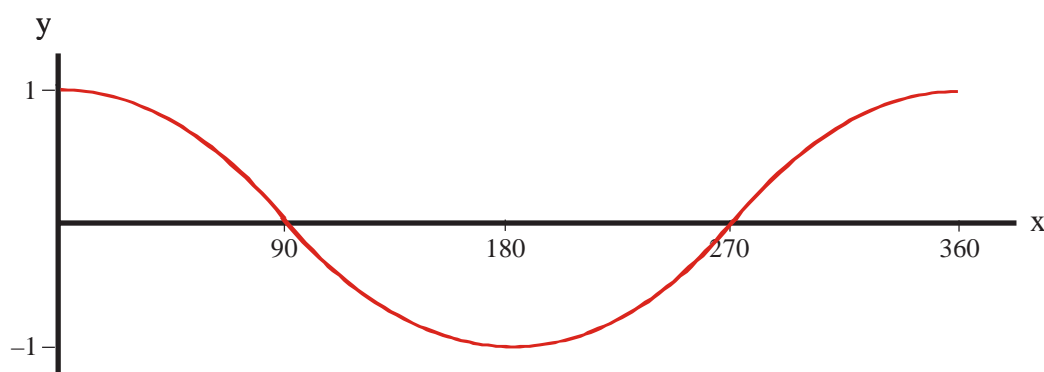
Given that $\cos 60° = 0.5$, write down the value of:

(i) $\cos 120°$ -0.5

(ii) $\cos 240°$ -0.5

1) On the axes below, draw a sketch-graph to show $y = \tan x$
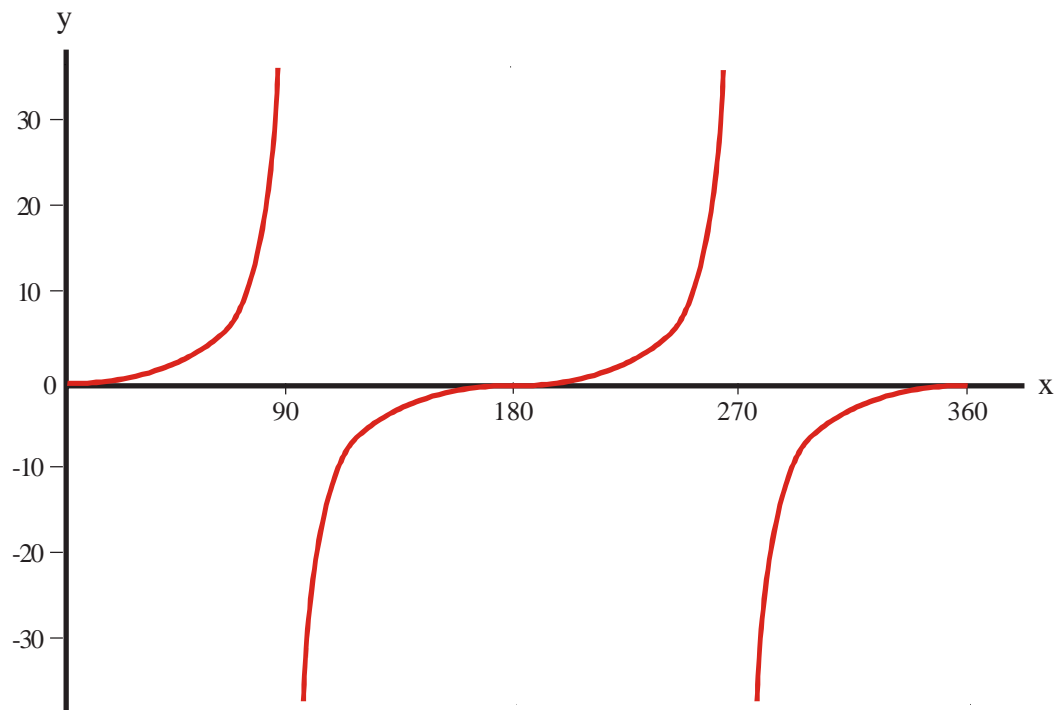
2) Here is the graph of the curve $y = \cos x$ for $0 < x < 360°$.
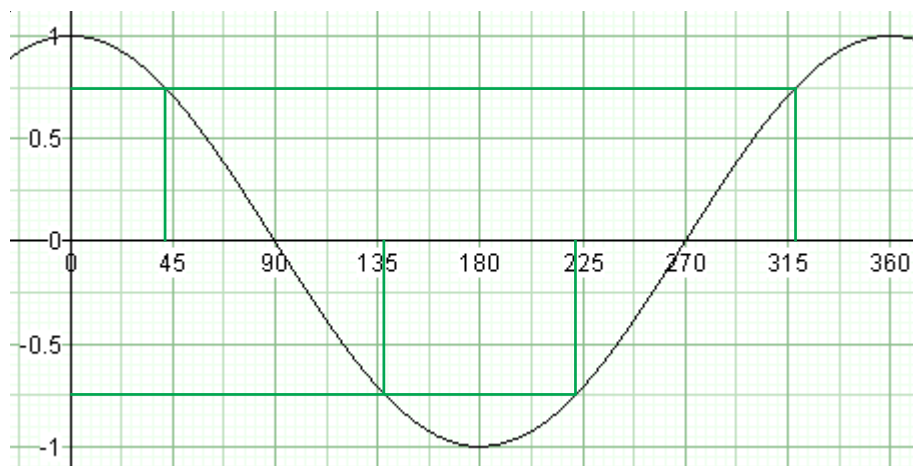
a) Use the graph to solve $\cos x = 0.75$ for $0 < x < 360°$ x = 41° and 319°

b) Use the graph to solve $\cos x = -0.75$ for $0 < x < 360°$ x = 138° and 221°

1) The diagram below shows the graph of $y = 2\sin x$, for values of x between 0 and 360°.
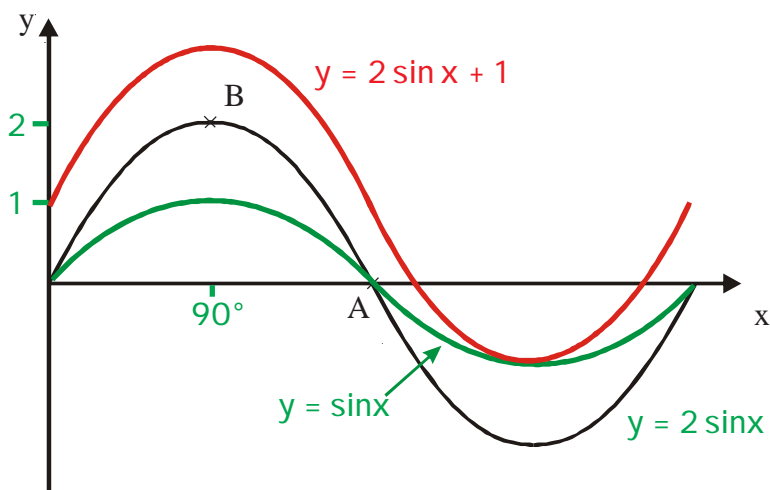
The curve cuts the x axis at the point A.
The graph has a maximum at the point B.

a) (i)   Write down the coordinates of A.   (180°, 0)

    (ii)   Write down the coordinates of B.   (90°, 2)

b) On the same diagram, sketch the graph of $y = 2\sin x + 1$ for values of x between 0 and 360°.

2) The diagram below shows the graph of $y = \cos \mathbf{a}x + \mathbf{b}$, for values of x between 0 and 300°.

Work out the values of **a** and **b**.   a = 2   b = 3
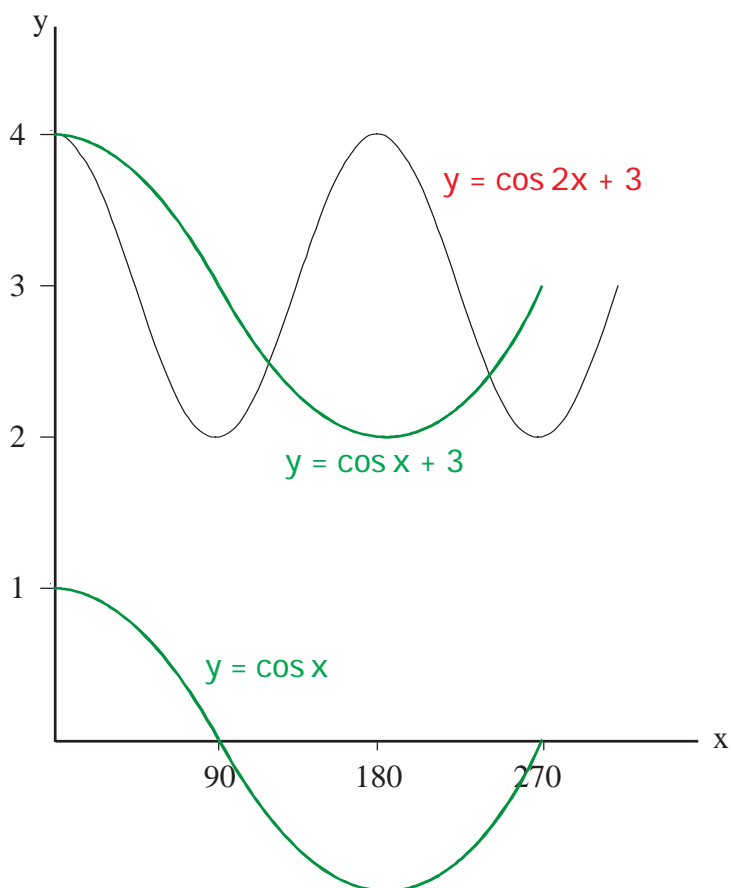
Graphs of Exponential Functions

1)
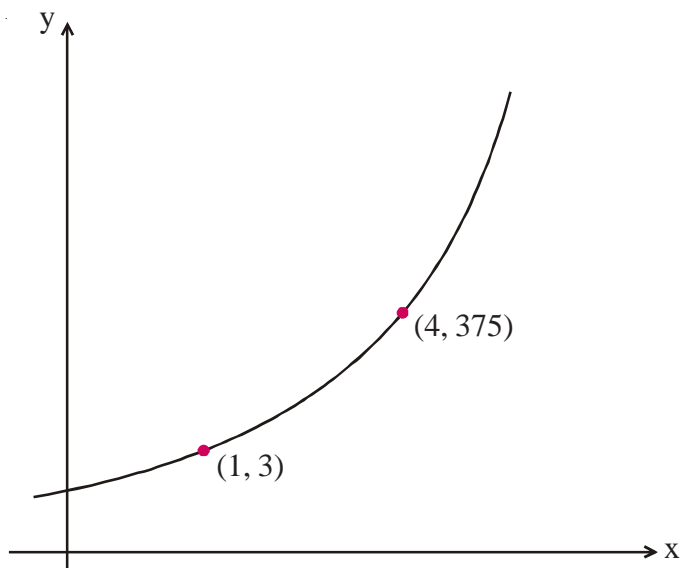
$y = pq^x$
$3 = pq^1$
$3 = pq$
$p = \dfrac{3}{q}$

Using (4, 375)

$y = pq^x$
$375 = pq^4$

Replacing p with $\dfrac{3}{q}$

$375 = pq^4$

$375 = \dfrac{3}{q} \times q^4$

$375 = 3q^3$

$q^3 = 125$

$q = 5$

$p = \dfrac{3}{q}$

$p = \dfrac{3}{5}$

The sketch-graph shows a curve with equation $y = pq^x$.

The curve passes through the points (1, 3) and (4, 375).

Calculate the value of p and the value of q. p = 0.6 and q = 5

2) The graph shows the number of bacteria living in a petri dish.
The number N of bacteria at time t is given by the relation:

$N = a \times b^t$

The curve passes through the point (0, 400).
a) Use this information to show that $a = 400$.

$N = a \times b^t$
$400 = a \times b^0$
$400 = a \times 1$
$a = 400$

The curve also passes through (2, 900).
b) Use this information to find the value of b.

$N = 400 \times b^t$
$900 = 400 \times b^2$
$b^2 = \dfrac{900}{400}$
$b = \dfrac{30}{20}$
$b = 1.5$
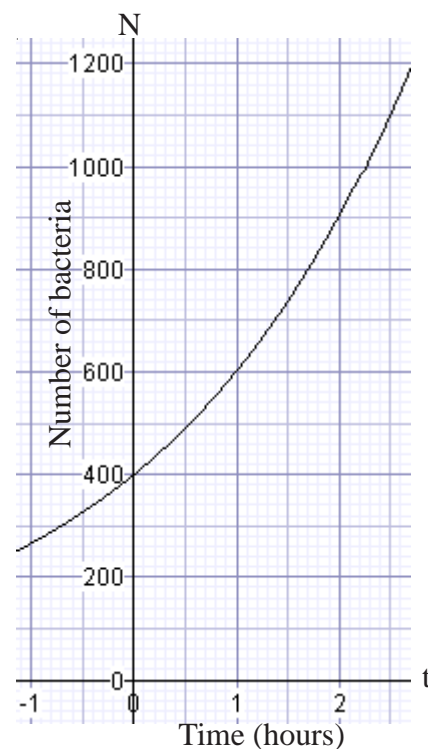
c) Work out the number of bacteria in the dish at time $t = 3$. N = 1350

$N = 400 \times 1.5^t$
$N = 400 \times \left(\dfrac{3}{2}\right)^3$
$N = 400 \times \left(\dfrac{27}{8}\right)$
$N = 50 \times 27$
$N = 1350$

Enlargement by Negative Scale Factor

1) Enlarge triangle T by scale factor -2 using coordinates (2, 2) as the centre of enlargement.
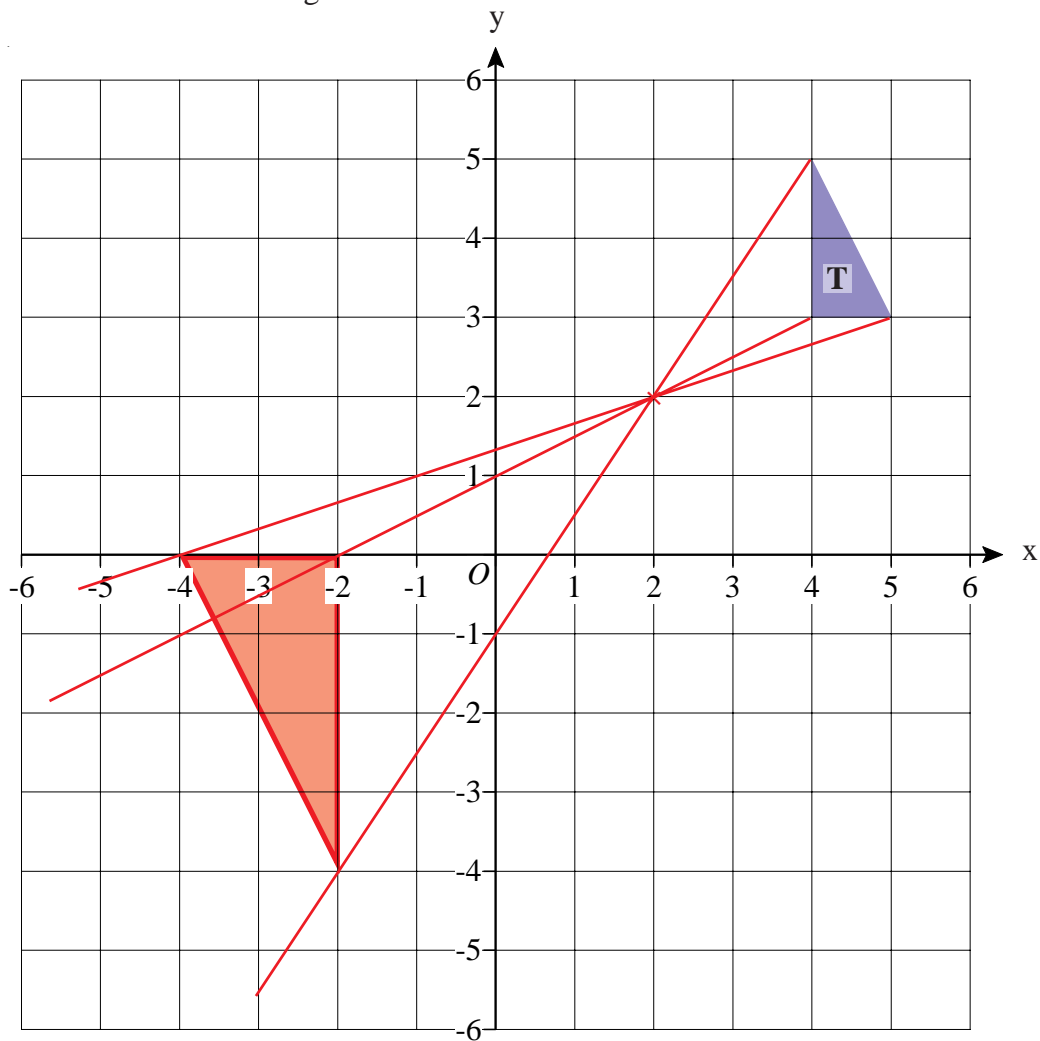
2) Describe fully the single transformation which maps triangle T to triangle U.
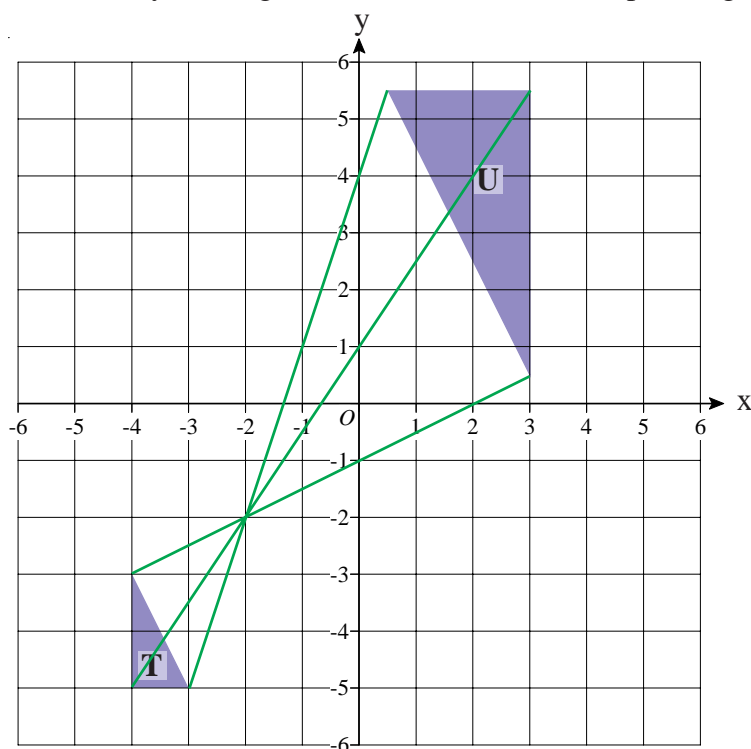
Enlargement with scale factor -2.5
Centre of enlargement at (-2, -2)

1) Show that any straight line which passes through the point (1, 1) must
   intersect the curve with equation $x^2 + y^2 = 9$ at two points.
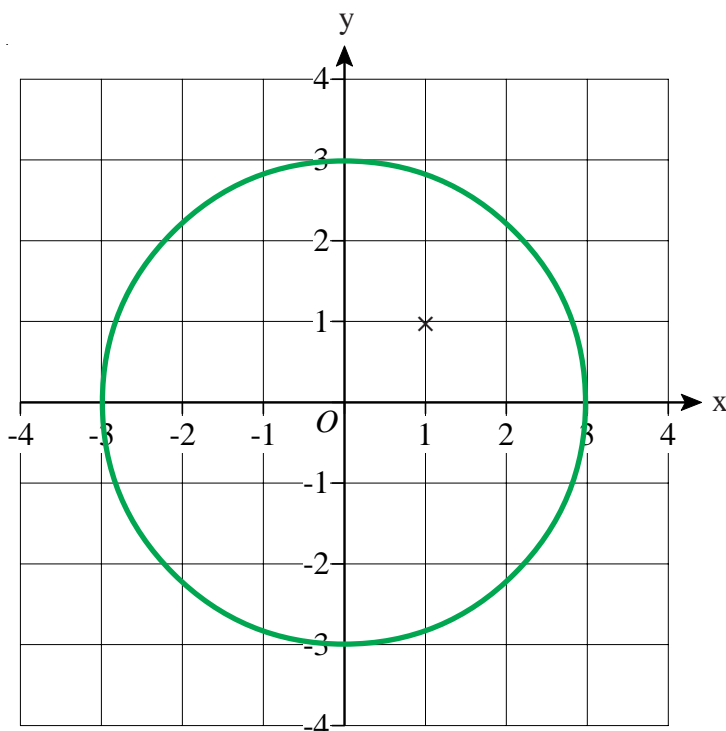
$x^2 + y^2 = 9$ is a circle with centre (0, 0).
Point (1, 1) lies inside the circle.
Therefore any point which passes through (1, 1) must intersect the curve at two points.

2)
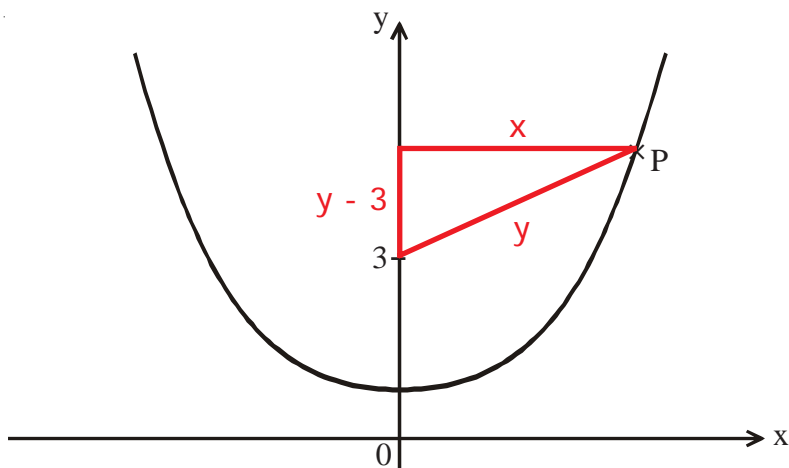
The diagram shows a sketch of a curve.
The point P(x, y) lies on the curve.
The locus of P has the following property:

   The distance of the point P from the point (0, 3) is the
   same as the distance of the point P from the x-axis.

Show that $y = \dfrac{x^2 + 9}{6}$

$y^2 = x^2 + (y - 3)^2$

$y^2 = x^2 + y^2 - 6y + 9$

$6y = x^2 + 9$

$y = \dfrac{x^2 + 9}{6}$

Sine and Cosine rules

1) Work out the size of the angle marked x.   **36.2°**
Give your answer correct to one decimal place.

$\dfrac{Sin\ A}{a} = \dfrac{Sin\ B}{b}$

$\dfrac{Sin\ A}{13} = \dfrac{Sin\ 30}{11}$
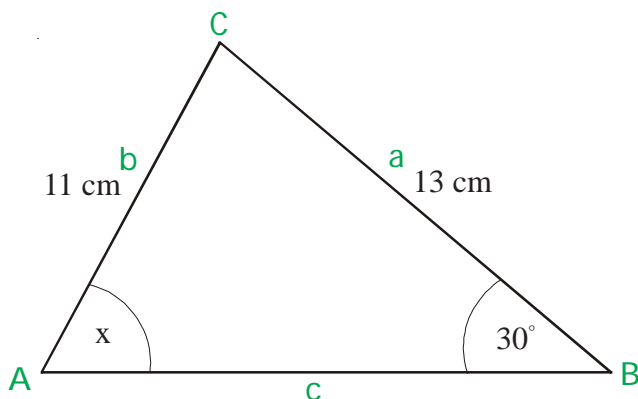
$Sin\ A = \dfrac{13 \times Sin\ 30}{11}$

2) ABC is a triangle.
AC = 8 cm
BC = 9 cm
Angle ACB = 43°

Calculate the length of AB.   **6.30 cm**
Give your answer correct to 3 significant figures.

$c^2 = a^2 + b^2 - 2ab\ Cos\ C$
$c^2 = 9^2 + 8^2 - 2 \times 9 \times 8 \times Cos\ 43$
$c^2 = 39.6851$
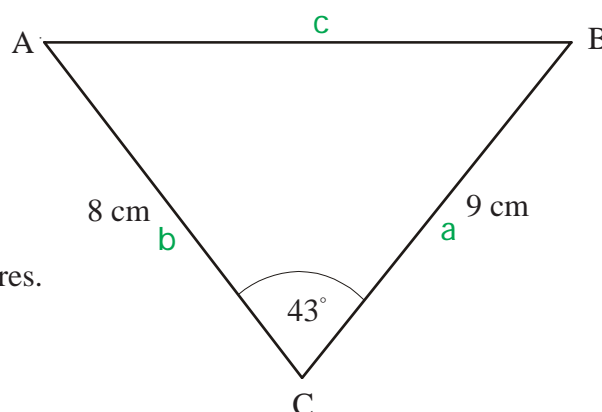
3) The lengths of the sides of a triangle are 4.1 cm, 5.4 cm and 7.8 cm.

Calculate the size of the largest angle of the triangle. **109.6°**
Give your answer correct to 1 decimal place.
A is the largest angle because it is opposite
the largest side.

$Cos\ A = \dfrac{b^2 + c^2 - a^2}{2bc}$

$Cos\ A = \dfrac{5.4^2 + 4.1^2 - 7.8^2}{2 \times 5.4 \times 4.1}$
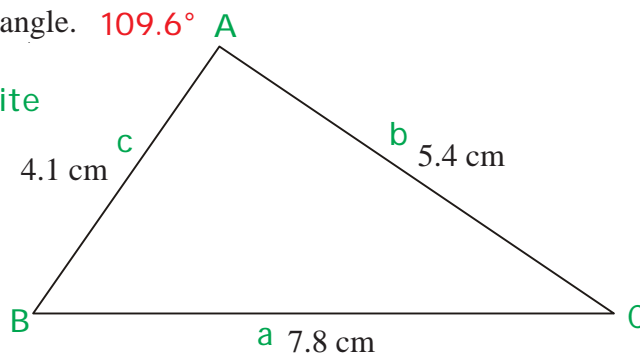
4) Find the missing lengths, x cm and y cm,
in this triangle. **x = 13.9 cm   y = 11.3 cm**

Give your answers to 3 significant figures.

$\dfrac{b}{Sin\ 71} = \dfrac{12.6}{Sin\ 59}$

$x = \dfrac{12.6 \times Sin\ 71}{Sin\ 59}$

$\dfrac{c}{Sin\ 50} = \dfrac{12.6}{Sin\ 59}$

$y = \dfrac{12.6 \times Sin\ 50}{Sin\ 59}$
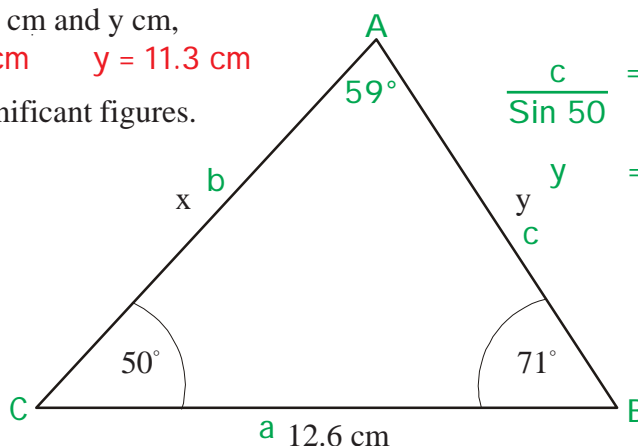
Pythagoras in 3 Dimensions

1) The diagram shows a box in the
   shape of a cuboid.
   AB = 6cm, BC = 4cm, CG = 3cm

   A string runs diagonally across the
   box from A to G.

   Calculate the length of the string AG.
   Give your answer correct   7.81 cm
   to 3 significant figures.

   AG = $\sqrt{6^2 + 4^2 + 3^2}$

H   G
E   F   3cm
D   C
        4cm
A   6cm   B
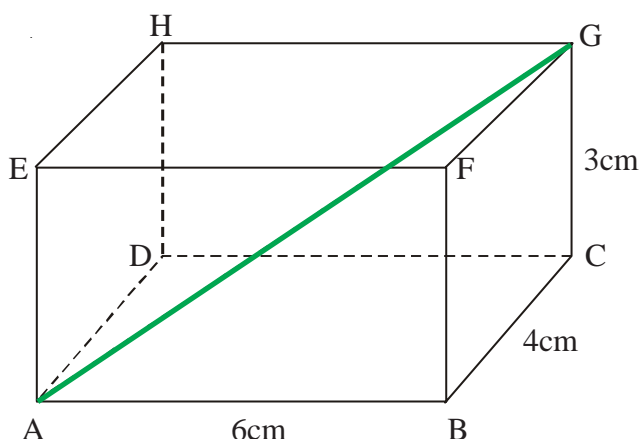
2) The diagram shows a box in the shape
   of a cuboid.
   AB = 8cm, BC = 11cm

   A string runs diagonally across the
   box from D to F and is 18cm long.

   Calculate the length AE.   11.8 cm
   Give your answer correct
   to 3 significant figures.

   AE = $\sqrt{18^2 - 11^2 - 8^2}$

H   G
E   18cm   F
D   C
        11cm
A   8cm   B
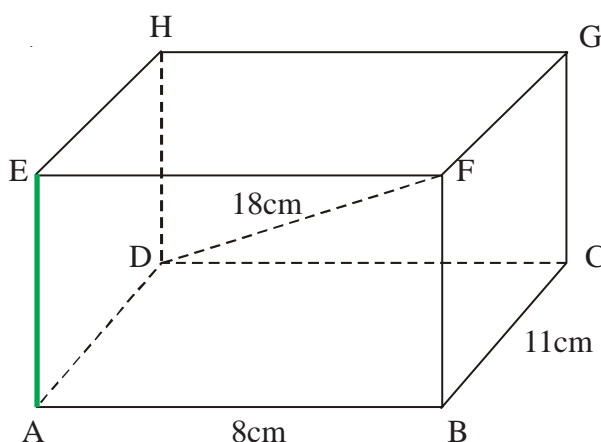
3) The diagram shows a wedge in the shape
   of a prism.
   Angle BFC is a right angle.

   String runs diagonally across the wedge
   from A to C.
   AC = $\sqrt{20^2 + 17^2 + 8^2}$
   Calculate the length AC   27.4 cm
   Give your answer correct to
   3 significant figures.

D   C
        8cm
E   F
        17cm
A   20cm   B
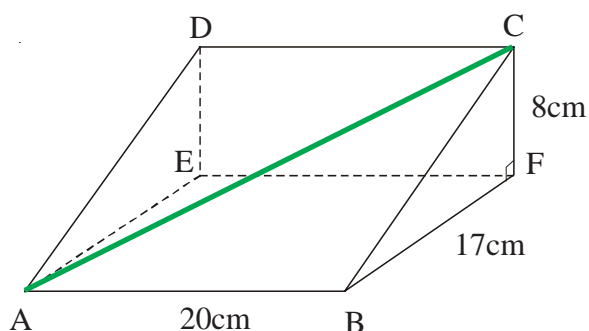
4) Two points, P and Q, lie on coordinate axes.

   Find the distance PQ to 1 decimal place.   5.5
   D² = x² + y² + z²
   Q (7, 5, 2)   P (2, 3, 1)
   D² = (7 - 2)² + (5 - 3)² + (2 - 1)²
   D² = 5² + 2² + 1²
   D = $\sqrt{30}$

y
Q (7, 5, 2)
P (2, 3, 1)
x
z

1) The diagram shows a wedge.
   The base of the wedge is a horizontal rectangle measuring 80 cm by 60 cm.
   The sloping face ABRS makes an angle of 21° to the horizontal.
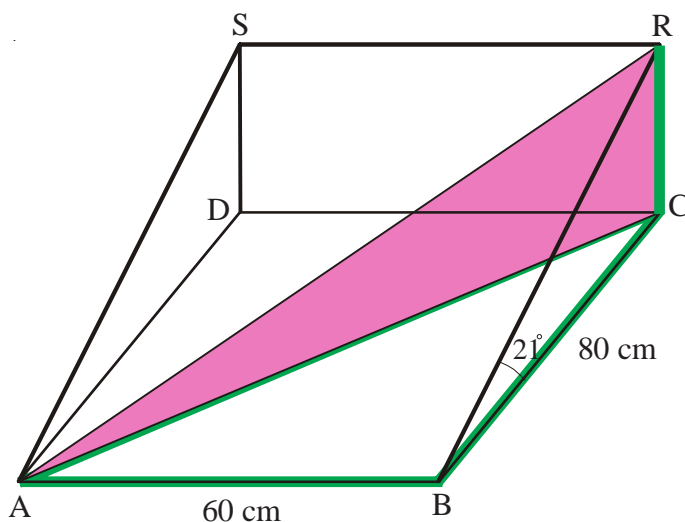
Step 1:
Find AC using Pythagoras in triangle ABC.
Answer: AC = 100 cm

Step 2:
Find CR using Tan 21 in triangle BCR.
Answer: CR = 30.71 cm

Step 3:
Find angle RAC using Tan in triangle RAC.
Answer: Angle RAC = 17.1°

Calculate the angle that AR makes with the horizontal plane ABCD. 17.1°
Give your answer correct to 1 decimal place.

2) The diagram shows a box in the shape of a cuboid.
   A string runs diagonally across the box from C to E.
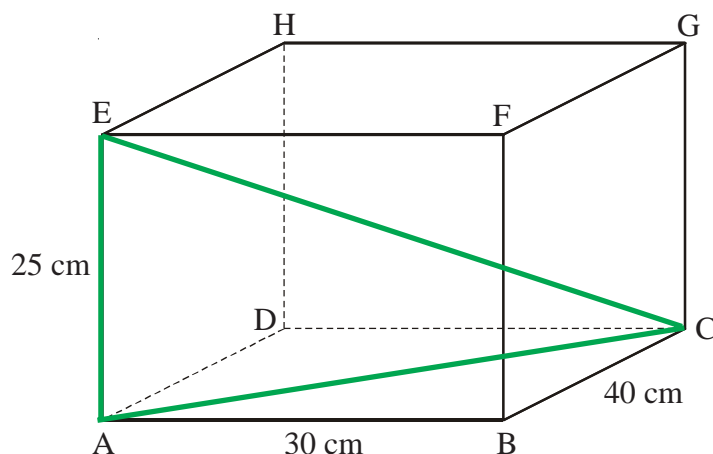
a) Work out the length of the string CE. 55.9 cm $CE = \sqrt{30^2 + 40^2 + 25^2}$
   Give your answer correct to 1 decimal place.

b) Work out the angle between the string CE and the horizontal plane ABCD.
   Give your answer correct to 1 decimal place. 26.6°

   In triangle CAE we have CE = 55.9 cm and
   AE = 25 cm.
   It has a right angle at A.
   Use Sin to find the required angle.

Area of Triangles Using ½abSinC

1)

A _____ B

Diagram **NOT**
accurately drawn.

8 cm   10 cm

42°

C

A = ½abSinC

ABC is a triangle.
AC = 8 cm.
BC = 10 cm
Angle ACB = 42°
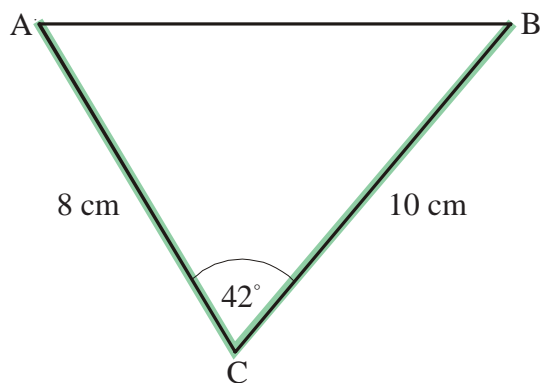
Calculate the area of triangle ABC.   26.8 cm²
Give your answer correct to 3 significant figures.

2)

C

Diagram **NOT**
accurately drawn.

18 cm

A = ½abSinC

ABC is a triangle.
AB = 20 cm.
BC = 18 cm
Angle ABC = 144°

144°

B

A

20 cm
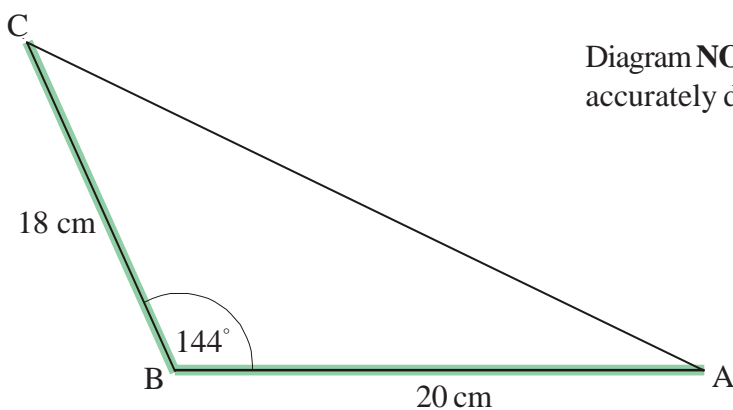
Calculate the area of triangle ABC.   106 cm²
Give your answer correct to 3 significant figures.

3)

C

Diagram **NOT**
accurately drawn.

87°

23 cm   31 cm

A = ½abSinC

ABC is a triangle.
AC = 23 cm.
BC = 31 cm
Angle BAC = 54°
Angle ABC = 39°

54°   39°

A   B
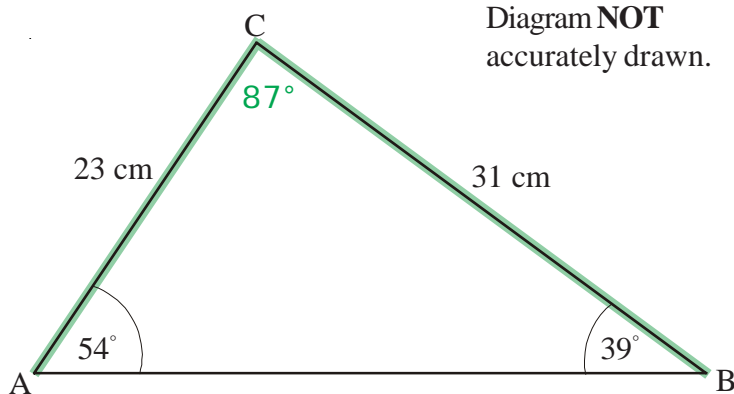
Calculate the area of triangle ABC.   356 cm²
Give your answer correct to 3 significant figures.

Cones and Spheres

1) A cone has a base radius of 4 cm and a vertical height of 8 cm.

$V = \frac{1}{3}\pi r^2 h$

CSA $= \pi r l$

a) Calculate the volume of the cone.   134 cm³
   Give your answer correct to 3 significant figures.

b) Use Pythagoras' Theorem to find the slant height
   of the cone.   8.9 cm
   Give your answer correct to 1 decimal place.

8 cm

c) Find the curved surface area of the cone.   112 cm²
   Give your answer correct to 3 significant figures.

4 cm
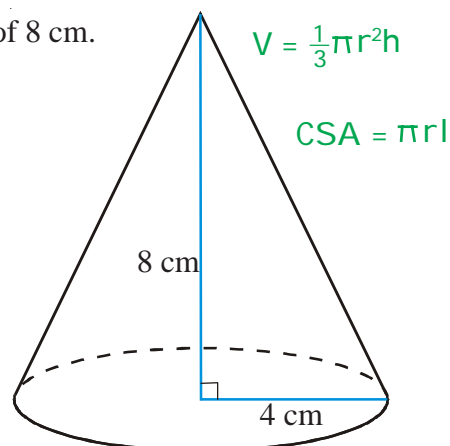
$V = \frac{4}{3}\pi r^3$

2) A sphere has a radius of 12cm.   CSA $= 4\pi r^2$

12 cm

a) Calculate the volume of the sphere.   7240 cm³
   Give your answer correct to 3 significant figures.

b) Find the curved surface area of the sphere.   1810 cm²
   Give your answer correct to 3 significant figures.
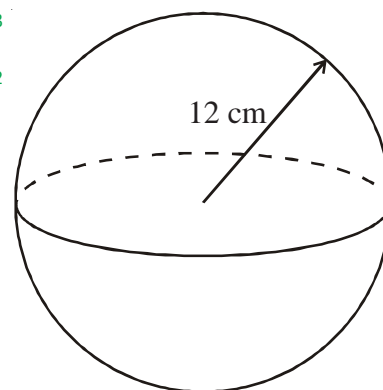
3) A cone has a base radius of 8 cm and a slant height of 10 cm.

Calculate the volume of the cone.   128π cm³
Leave your answer in terms of π

Find height using Pythagoras

10² = 100

8² = 64   -

36

√36 = 6

10 cm

10 cm

h

8 cm

$V = \frac{1}{3}\pi r^2 h$

$= \frac{1}{3} \times \pi \times 8^2 \times 6$

$= 128\pi$
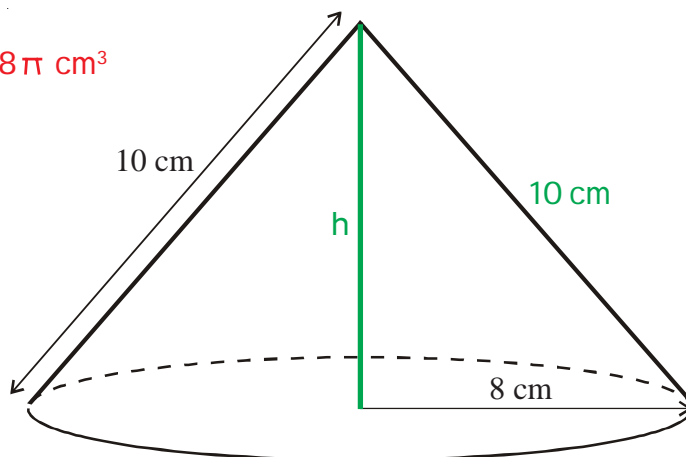
Segments and Frustums

1) Find the area of the segment shaded in the diagram below. **13.7 cm²**
   Give your answer to 3 significant figures.
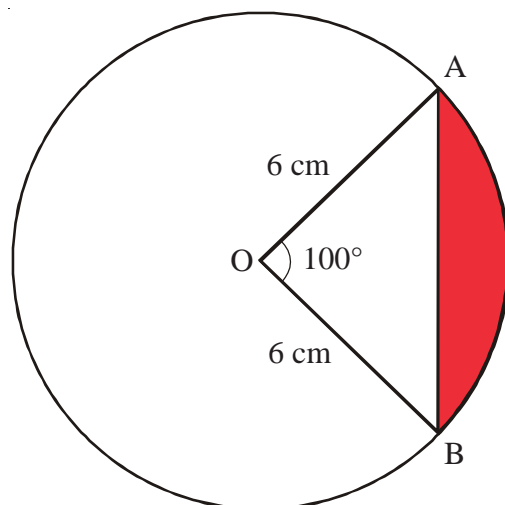
Area of sector AOB
$$\frac{100}{360} \times 3.142 \times 6^2 = 31.42$$

Area of triangle AOB
$$\frac{1}{2} \times 6 \times 6 \times \sin 100 = 17.73$$

Area of shaded segment
$$31.42 - 17.73 = 13.7 \text{ to 3 sig figs.}$$

6 cm
O 100°
6 cm
A
B

2) The diagram shows a cone of height 40 cm and base radius 10 cm.
   A smaller cone of height 8 cm is removed to form a frustum.
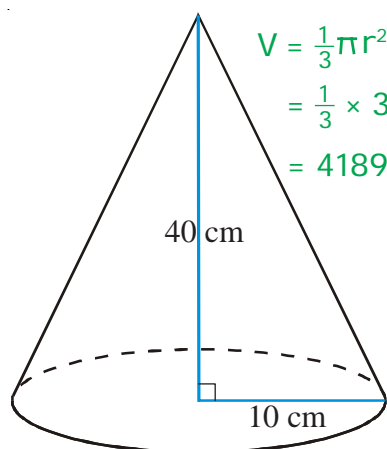
$V = \frac{1}{3}\pi r^2 h$
$= \frac{1}{3} \times 3.142 \times 10^2 \times 40$
$= 4189.3$

40 cm
10 cm
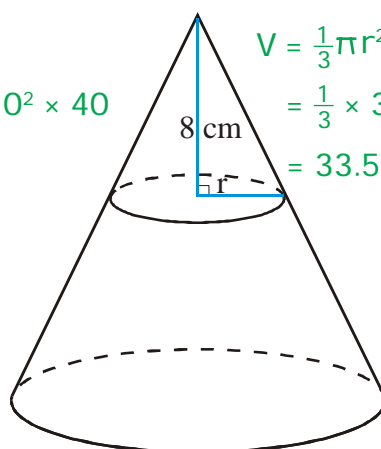
$V = \frac{1}{3}\pi r^2 h$
$= \frac{1}{3} \times 3.142 \times 2^2 \times 8$
$= 33.51$

8 cm
r
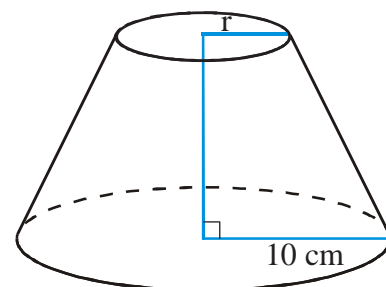
$V = 4189.33 - 33.51$
$= 4155.82$

r
10 cm

similar triangles

÷ 5

8

40

10

a) Work out the radius r of the base of the smaller cone. **2 cm**

Calculate, to the nearest cm³

b) The volume of the larger cone. **4189cm³**

c) The volume of the smaller cone. **34cm³**

d) The volume of the frustum. **4156cm³**
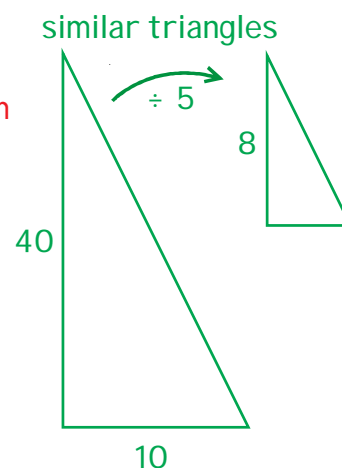
1) ABCD is a quadrilateral.
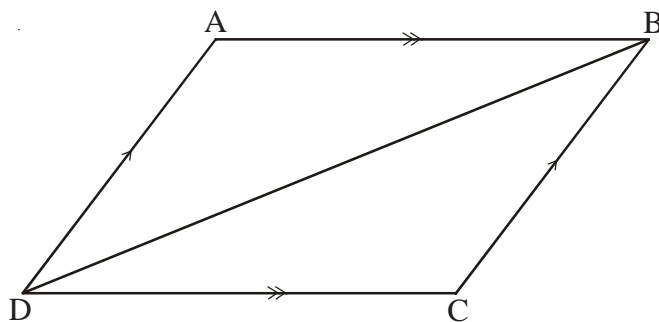
AB is parallel to DC.
DA is parallel to CB.

Prove that triangle ABD is congruent to triangle CDB.

AB = CD (opp. sides of parallelogram are equal)
AD = CB (opp. sides of parallelogram are equal)
DB is a shared side.
Therefore ABD is congruent to CDB (SSS)

2)
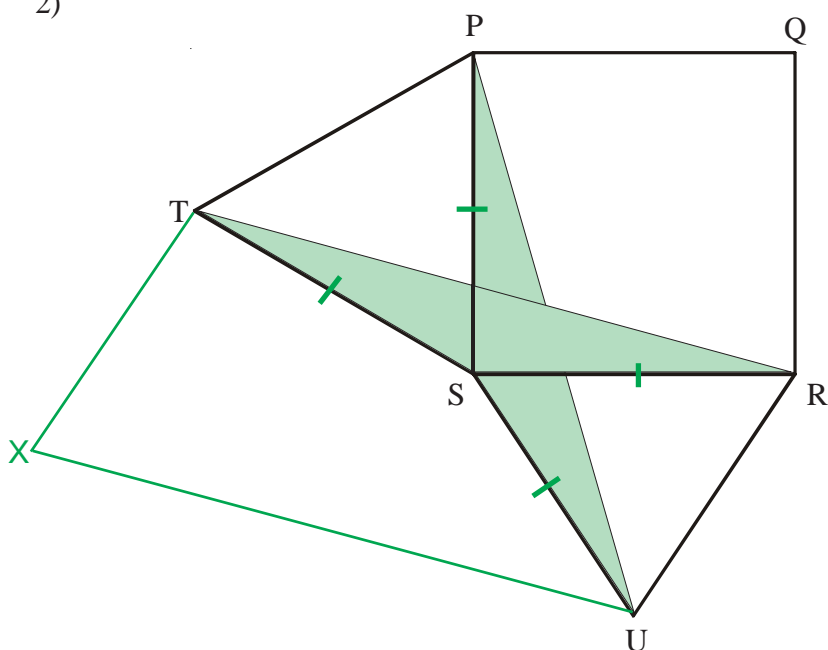
PQRS is a square.

PTS and SUR are equilateral triangles.

a) Prove that triangle USP is congruent to triangle TSR.

US = TS
SP = SR
Angle USP = 60° + 90° = 150°
Angle TSR = 60° + 90° = 150°
USP is congruent to TSR (SAS)

X is the point such that RUXT is a parallelogram.

b) Prove that UP = UX
UP = RT (corresponding sides of congruent triangles)
RT = UX (opp. sides of parallelogram are equal)
Therefore UP = UX

Vectors - page 1 of 2

1) The diagram shows a trapezium *PQRS*.
   $\overrightarrow{PQ}$ = **a** and $\overrightarrow{QR}$ = **b**.
   PS is three times the length of *QR*.

Diagram **NOT**
accurately drawn

$\overrightarrow{QS} = \overrightarrow{QP} + \overrightarrow{PS}$
= -**a** + 3**b**
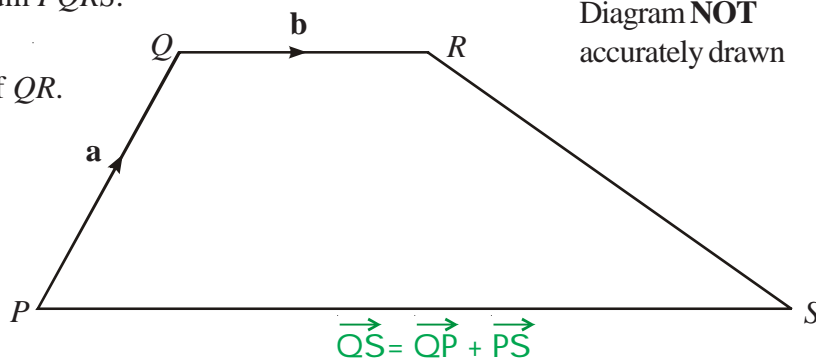
Find, in terms of **a** and **b**, expressions for

a) $\overrightarrow{QP}$ = **-a**   b) $\overrightarrow{PR}$ = **a + b**   c) $\overrightarrow{PS}$ = **3b**   d) $\overrightarrow{QS}$ = **3b - a**

2) In triangle *ABC*, *P* and *Q* are the midpoints of *AB* and *AC*.

   $\overrightarrow{AP}$ = **p** and $\overrightarrow{AQ}$ = **q**.

Diagram **NOT**
accurately drawn

a) Find, in terms of **p** and **q**, expressions for

(i) $\overrightarrow{PQ}$ (ii) $\overrightarrow{AB}$ (iii) $\overrightarrow{AC}$ (iv) $\overrightarrow{BC}$
   q - p   **2p**   **2q**   **2q - 2p**
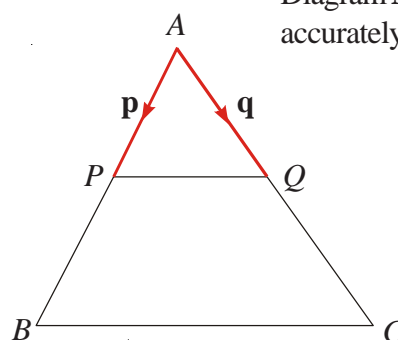
b) Use your results from (a) to prove that *PQ* is parallel to *BC*.

$\overrightarrow{PQ}$ = **q - p**
$\overrightarrow{BC}$ = **2q - 2p**
    = **2(q - p)**
Therefore $\overrightarrow{PQ}$ is parallel to $\overrightarrow{BC}$

3)

B
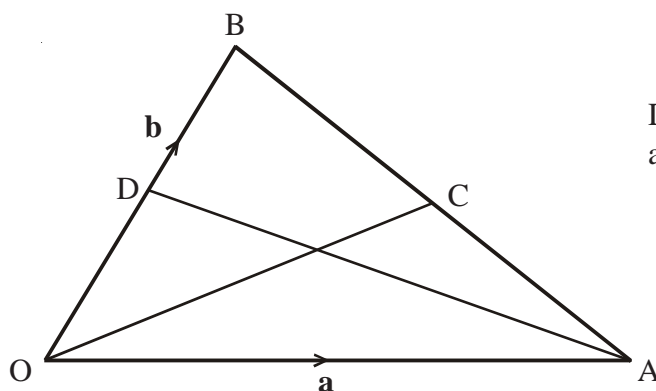
Diagram **NOT**
accurately drawn

OAB is a triangle.
D is the midpoint of OB.
C is the midpoint of AB.
$\overrightarrow{OA}$ = **a** and $\overrightarrow{OB}$ = **b**

$\overrightarrow{OC}$ = $\overrightarrow{OA}$ + $\overrightarrow{AC}$
$\overrightarrow{AC}$ = ½$\overrightarrow{AB}$
$\overrightarrow{AB}$ = **-a + b**
$\overrightarrow{OC}$ = **a** + ½(**-a + b**)
$\overrightarrow{OC}$ = ½(**a + b**)

(i) Find $\overrightarrow{OC}$ in terms of **a** and **b**.
   $\overrightarrow{OC}$ = ½(**a + b**)

(ii) Show that DC is parallel to OA.

$\overrightarrow{DC}$ = $\overrightarrow{DO}$ + $\overrightarrow{OC}$
   = **-½b** + ½(**a + b**)
   = **½a**
$\overrightarrow{OA}$= **a**   Therefore $\overrightarrow{DC}$ is parallel to $\overrightarrow{OA}$

1)

Diagram **NOT** accurately drawn
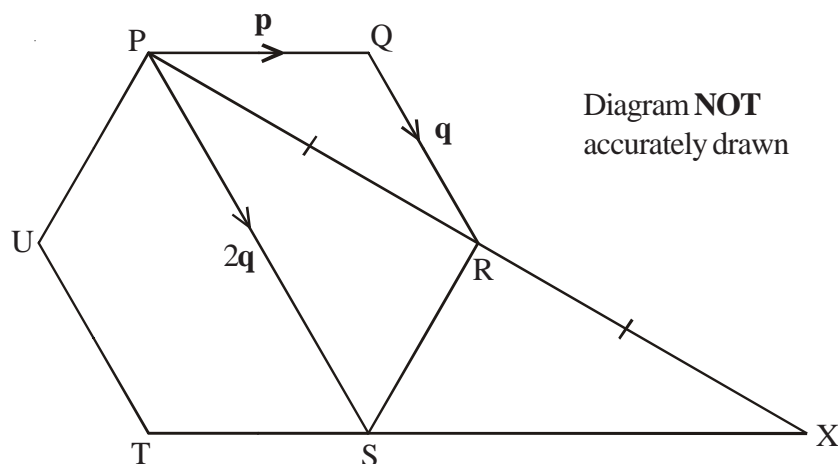
PQRSTU is a regular hexagon.

$\overrightarrow{PQ} = \mathbf{p}$ $\overrightarrow{QR} = \mathbf{q}$ $\overrightarrow{PS} = 2\mathbf{q}$

a) Find the vector PR in terms of **p** and **q**.

$\overrightarrow{PR} = \overrightarrow{RX}$

b) Prove that PQ is parallel to SX

PR = **p** + **q**

$\overrightarrow{SX} = \overrightarrow{SP} + \overrightarrow{PX}$
= $\overrightarrow{SP}$ + 2$\overrightarrow{PR}$
= -2**q** + 2(**p** + **q**)
= -2**q** + 2**p** + 2**q**
= 2**p**

$\overrightarrow{PQ}$ = **p**   Therefore $\overrightarrow{PQ}$ is parallel to $\overrightarrow{SX}$

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2)
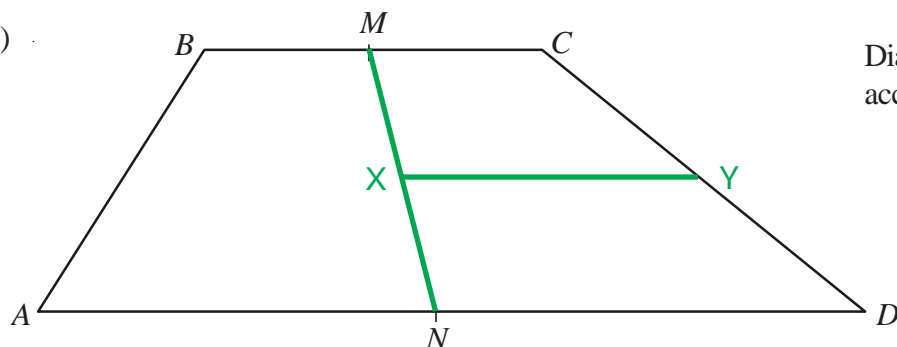
Diagram **NOT** accurately drawn

ABCD is a trapezium with *BC* parallel to *AD*.

$\overrightarrow{AB} = 3\,\mathbf{b}$ $\overrightarrow{BC} = 3\,\mathbf{a}$ $\overrightarrow{AD} = 9\,\mathbf{a}$

M is the midpoint of *BC* and N is the midpoint of *AD*.
a) Find the vector *MN* in terms of **a** and **b**.

$\overrightarrow{MN}$ = 3**a** - 3**b**

X is the midpoint of *MN* and *Y* is the midpoint of *CD*.
b) Prove that *XY* is parallel to *AD*.

Working for part b)

$\overrightarrow{XY} = \overrightarrow{XN} + \overrightarrow{ND} + \overrightarrow{DY}$
    = ½$\overrightarrow{MN}$ + $\overrightarrow{ND}$ + $\overrightarrow{DY}$
    = ½(3**a** - 3**b**) + 4½**a** + $\overrightarrow{DY}$
    = 6**a** - 1½**b** + $\overrightarrow{DY}$

$\overrightarrow{DY} = ½\overrightarrow{DC}$
    = ½($\overrightarrow{DA} + \overrightarrow{AB} + \overrightarrow{BC}$)
    = -4½**a** + 1½**b** + 1½**a**
    = 1½**b** - 3**a**

$\overrightarrow{XY}$ = 6**a** - 1½**b** + 1½**b** - 3**a**
    = 3**a**

Therefore $\overrightarrow{XY}$ is parallel to $\overrightarrow{AD}$

Histograms

1. The table gives information about the heights, in centimetres, of some 18 year old students.

Use the table to draw a histogram.

Height (h cm)	Frequency
$135 < h \leqslant 145$	12
$145 < h \leqslant 165$	46
$165 < h \leqslant 180$	45
$180 < h \leqslant 190$	25
$190 < h \leqslant 195$	4

Frequency density

Height (h cm)
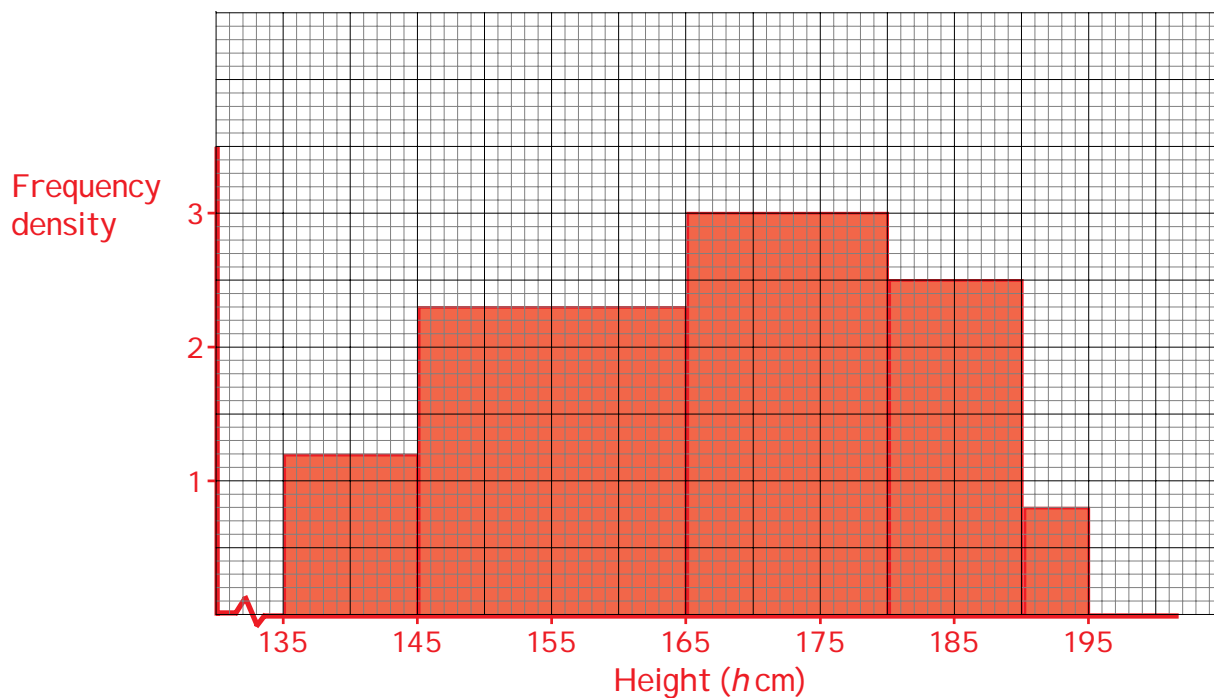
2. The histogram shows the amount of time, in hours, that students spend on their homework per week.

$$\text{Frequency density} = \frac{\text{Frequency}}{\text{Class width}}$$

From the numbers in the table:

$$\text{Frequency density} = \frac{27}{1} = 27$$
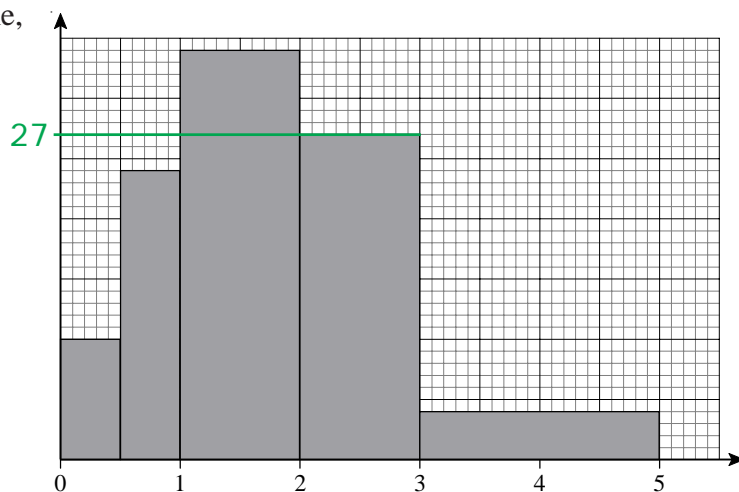
Use the histogram to complete the table.

Time (t hours)	Frequency
$0 < t \leqslant \frac{1}{2}$	5
$\frac{1}{2} < t \leqslant 1$	12
$1 < t \leqslant 2$	34
$2 < t \leqslant 3$	27
$3 < t \leqslant 5$	8

And & Or Questions

1) Jordan designs a game for a school fair.

He has two 8-sided spinners.

The spinners are equally likely to land on each of their sides.

One spinner has 3 blue sides, 2 yellow sides and 3 white sides.

The other spinner has 2 blue sides, 2 green sides and 4 white sides.

Calculate the probability that the two spinners will land on the same colour. $\frac{18}{64}$ or $\frac{9}{32}$

Blue and Blue: $\frac{3}{8} \times \frac{2}{8} = \frac{6}{64}$

Blue and Blue OR White and White

$\frac{6}{64} + \frac{12}{64} = \frac{18}{64}$

White and White: $\frac{3}{8} \times \frac{4}{8} = \frac{12}{64}$

2) The probability that it will snow in Paris on Christmas day is 0.06.

a) Work out the probability that it will snow in Paris on **both** Christmas day 2008 **and** Christmas day 2009. 0.0036   0.06 × 0.06

b) Work out the probability that it will snow in Paris on **either** Christmas Day 2008 **or** Christmas Day 2009, but **not** on both. 0.1128   0.06 × 0.94 + 0.94 × 0.06
snow   not snow   not snow   snow

3) A bag contains 2 black beads, 5 yellow beads and 3 red beads.

Natalie takes a bead at random from the bag, records its colour and replaces it.

She does this two more times.

Work out the probability that, of the three beads Natalie takes, exactly two are the same colour. $\frac{750}{1000}$ (or any equivalent fraction)

P(two same colour) = 1 - P(BBB) - P(YYY) - P(RRR) -P(BYR) - P(YBR) - P(RBY)

$\frac{8}{1000}$ $\frac{125}{1000}$ $\frac{27}{1000}$ $\frac{30}{1000}$ $\frac{30}{1000}$ $\frac{30}{1000}$

$= 1 - \frac{250}{1000}$

Stratified Sampling

$$\frac{Sample\ size}{Population\ size} \times Stratum\ size$$

1) The table below shows the number of employees in each section of a company.

Department	Managerial	Sales	Technical	Production
Number of employees	18	45	288	549

= 900 employees

A survey on job satisfaction is to be carried out.

a) Explain why a simple random sample of employees is unsuitable.
   The numbers in each department are very different - it might not be fair.

b) A stratified random sample of 100 is used. Complete the table below to show how many employees from each department will be included.

Department	Managerial	Sales	Technical	Production
Number of employees in sample	2	5	32	61

$\frac{100}{900} \times 18$ $\frac{100}{900} \times 45$ $\frac{100}{900} \times 288$ $\frac{100}{900} \times 549$

2) MathsWatch High-School has 798 pupils.
   The size of each year group is shown below.

Year Group	Boys	Girls
7	77	72
8	74	79
9	72	74
10	93	107
11	85	65

The headteacher wants to find out the opinions of the pupils on changing the timing of the school day. A stratified sample of 80 pupils is taken.

a) Complete the table below to show the numbers of pupils to be sampled.

Year Group	Boys in Sample	Girls in Sample
7	$\frac{80}{798} \times 77$ 8	$\frac{80}{798} \times 72$ 7
8	$\frac{80}{798} \times 74$ 7	$\frac{80}{798} \times 79$ 8
9	$\frac{80}{798} \times 72$ 7	$\frac{80}{798} \times 74$ 7
10	$\frac{80}{798} \times 93$ 9	$\frac{80}{798} \times 107$ 11
11	$\frac{80}{798} \times 85$ 9	$\frac{80}{798} \times 65$ 7

The table below shows the number of pupils in the sample who answered YES to a change in the timing of the school day.

Year Group	Boys in Sample who answered YES	Girls in Sample who answered YES
7	2	3
8	3	5
9	2	1
10	1	4
11	0	1
	8	14

8 + 14 = 22 answered YES

$\frac{22}{80} \times 100 = 27.5$

b) Use the table to estimate the percentage of pupils in the school who would answer YES to the question. 27.5%

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