Please check the examination details below before entering your candidate information

| Candidate surname | Other names |
|---|---|

**Pearson Edexcel**
**Level 1/Level 2 GCSE (9–1)**

Centre Number | Candidate Number

# Monday 11 November 2019

Afternoon (Time: 1 hour 30 minutes) | Paper Reference **1MA1/3H**

# Mathematics

## Paper 3 (Calculator)
## Higher Tier

**You must have:** Ruler graduated in centimetres and millimetres, protractor, pair of compasses, pen, HB pencil, eraser, calculator. Tracing paper may be used.

Total Marks

## Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*
- You must **show all your working**.
- Diagrams are **NOT** accurately drawn, unless otherwise indicated.
- **Calculators may be used.**
- If your calculator does not have a $\pi$ button, take the value of $\pi$ to be 3.142 unless the question instructs otherwise.

## Information

- The total mark for this paper is 80
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*

## Advice

- Read each question carefully before you start to answer it.
- Keep an eye on the time.
- Try to answer every question.
- Check your answers if you have time at the end.

*Turn over* ▶

P58876RA



6/1/1/1/1/



Pearson

**Please note that these worked solutions have neither been provided nor approved by Pearson Education and may not necessarily constitute the only possible solutions. Please refer to the original mark schemes for full guidance.**

Any writing in blue indicates what must be written in order to answer the questions and get the marks. The worked solutions have been designed to show the smallest amount of work which needs to be done to answer the question.

Anything written in green in a cloud doesn't have to be written in the exam.

Anything written in orange in a rectangle doesn't have to be written in the exam and is there to show what should be put into a calculator or measured using a ruler or protractor.

If you find any mistakes or have any requests or suggestions, please send an email to curtis@cgmaths.co.uk

**.CG Maths.**

**Answer ALL questions.**

**Write your answers in the spaces provided.**

**You must write down all the stages in your working.**

**1** (a) Expand and simplify $(x + 5)(x - 9)$

$x^2-9x+5x-45$

$x^2-4x-45$

**(2)**

(b) Factorise fully $9x^2 + 6x$

3 is the highest common factor of 9 and 6. x is the highest common factor of $x^2$ and x. Bringing both of these out as factors and leaving the remainder in a bracket

$3x(3x+2)$

**(2)**

**(Total for Question 1 is 4 marks)**

**2** (a) Use your calculator to work out $\dfrac{29^2 - 4.6}{\sqrt{35 - 1.9^3}}$

Write down all the figures on your calculator display.

157.668255

**(2)**

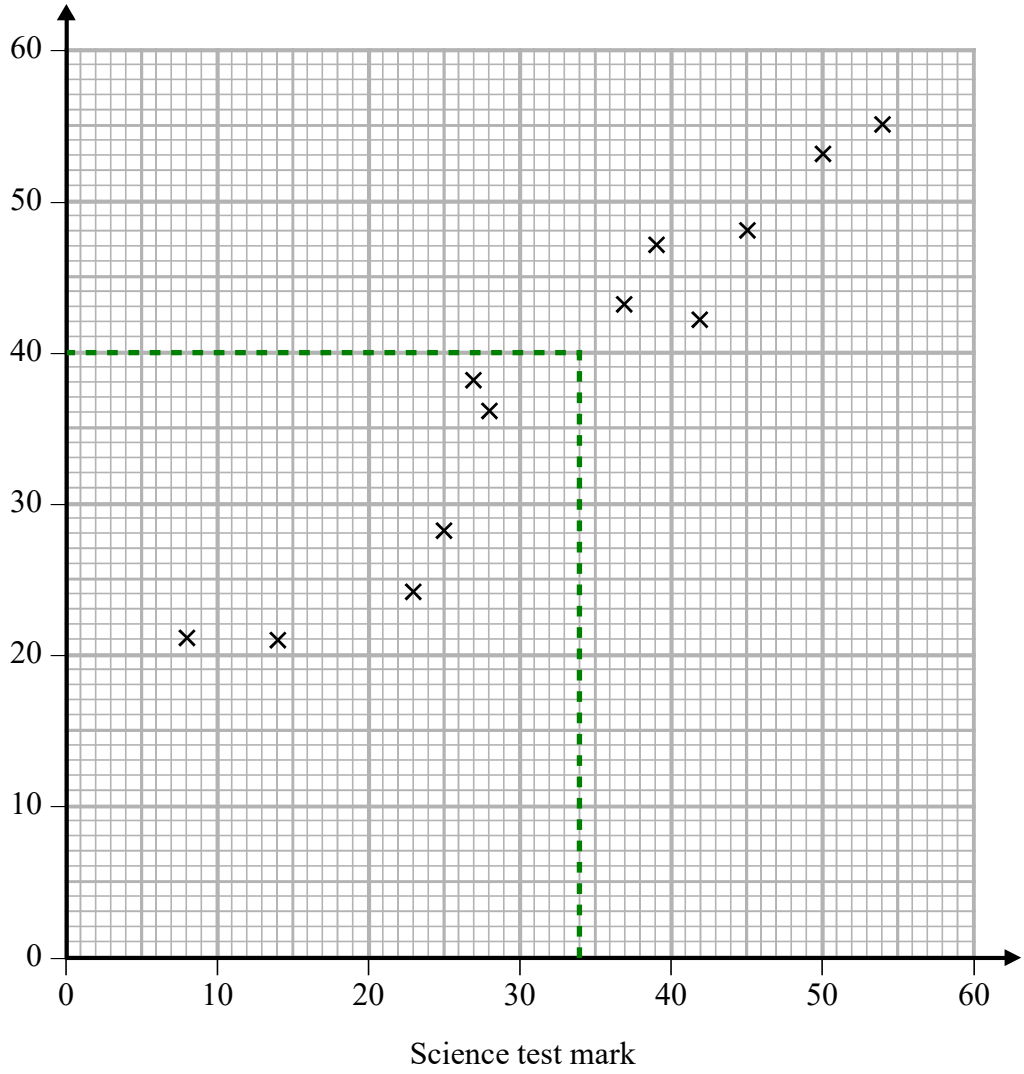
(b) Write your answer to part (a) correct to 4 significant figures.

157.7

**(1)**

**(Total for Question 2 is 3 marks)**

**3** The scatter graph shows information about the marks a group of students got in a Science test and in a Maths test.




Jamie got a mark of 34 in the Science test.

Using the scatter graph, find an estimate for Jamie's mark in the Maths test.

Reading up from 34 to somewhere in the middle of the data points close by then reading across works out the estimate. There is no need to draw a line of best fit as this may make it harder to get an easy value to read

40

**(Total for Question 3 is 2 marks)**

**4** The table gives information about the times taken, in seconds, by 18 students to run a race.

| Time ($t$ seconds) | Frequency |
|---|---|
| $5 < t \leqslant 10$ | 1 |
| $10 < t \leqslant 15$ | 2 |
| $15 < t \leqslant 20$ | 7 |
| $20 < t \leqslant 25$ | 8 |

Work out an estimate for the mean time.
Give your answer correct to 3 significant figures.

$$\frac{\frac{5+10}{2}\times 1+\frac{10+15}{2}\times 2+\frac{15+20}{2}\times 7+\frac{20+25}{2}\times 8}{18}$$

Working out the mean of the upper and lower bound of each interval works out the midpoints. To do this, the upper and lower bound are added for each interval then divided by 2 as there are 2 numbers. The midpoint is the best estimate for the values of each of the times. Multiplying the midpoints by the frequencies works out an estimate for the total time of each interval. Adding all of these together works out an overall estimated total time for all 18 students. Mean = total/number, so the estimated total time is divided by the 18 students

The value of 18.61 is rounded to 3 significant figures

18.6 seconds

**(Total for Question 4 is 3 marks)**

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

**5** Write 37 $cm^3$ in $mm^3$

$37 \times 10^3$ ← There are 10mm in 1cm so multiplying by 10 converts centimetres into millimetres. However the unit is cubed so the 37 needs to be multiplied by $10^3$

..... 37000 ..... $mm^3$

**(Total for Question 5 is 1 mark)**

**6** Nimer was driving to a hotel.
He looked at his Sat Nav at 13 30

| | |
|---|---|
| Time | 13 30 |
| Distance to destination | 65 miles |

Nimer arrived at the hotel at 14 48

Work out the average speed of the car from 13 30 to 14 48
You must show all your working.

$\frac{65}{14°48° - 13°30°}$ ← From the unit of mph, the number of miles needs to be divided by the time in hours. Subtracting the 13 30 from 14 48 works out how much time the journey took

Time can be put into the calculator by using the time button

..... 50 ..... mph

**(Total for Question 6 is 4 marks)**

**7** (a) Write 32460000 in standard form.

The number needs to be divided by 10 7 times to make it between 1 and 10. So it needs to be multiplied by $10^7$ to keep it equal

$3.246 \times 10^7$

**(1)**

(b) Write $4.96 \times 10^{-3}$ as an ordinary number.

$\times 10^{-3}$ means to divide by 10 3 times. This moves the decimal point 3 times to the left

0.00496

**(1)**

Asma was asked to compare the following two numbers.

$$A = 6.212 \times 10^8 \quad \text{and} \quad B = 4.73 \times 10^9$$

She says,

"6.212 is bigger than 4.73 so $A$ is bigger than $B$."

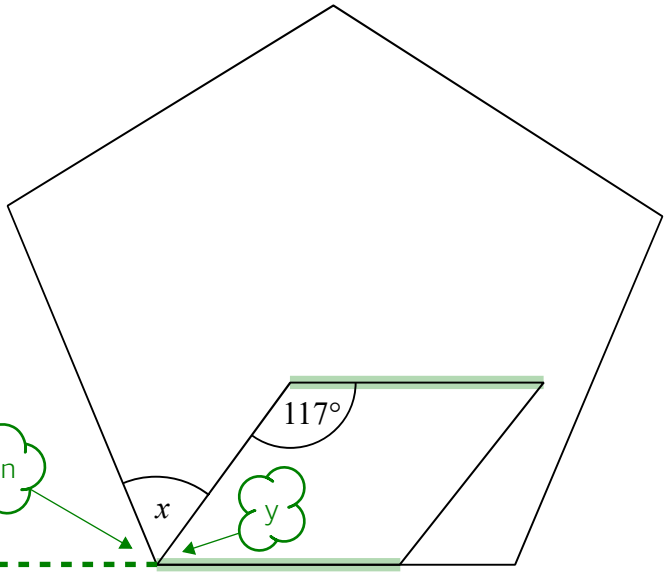
(c) Is Asma correct?
You must give a reason for your answer.

No as $6.212 \times 10^8 - 4.73 \times 10^9$ is negative

**(1)**

**(Total for Question 7 is 3 marks)**

**8** The diagram shows a regular pentagon and a parallelogram.




Exterior angle of the pentagon

Work out the size of the angle marked $x$.
You must show all your working.

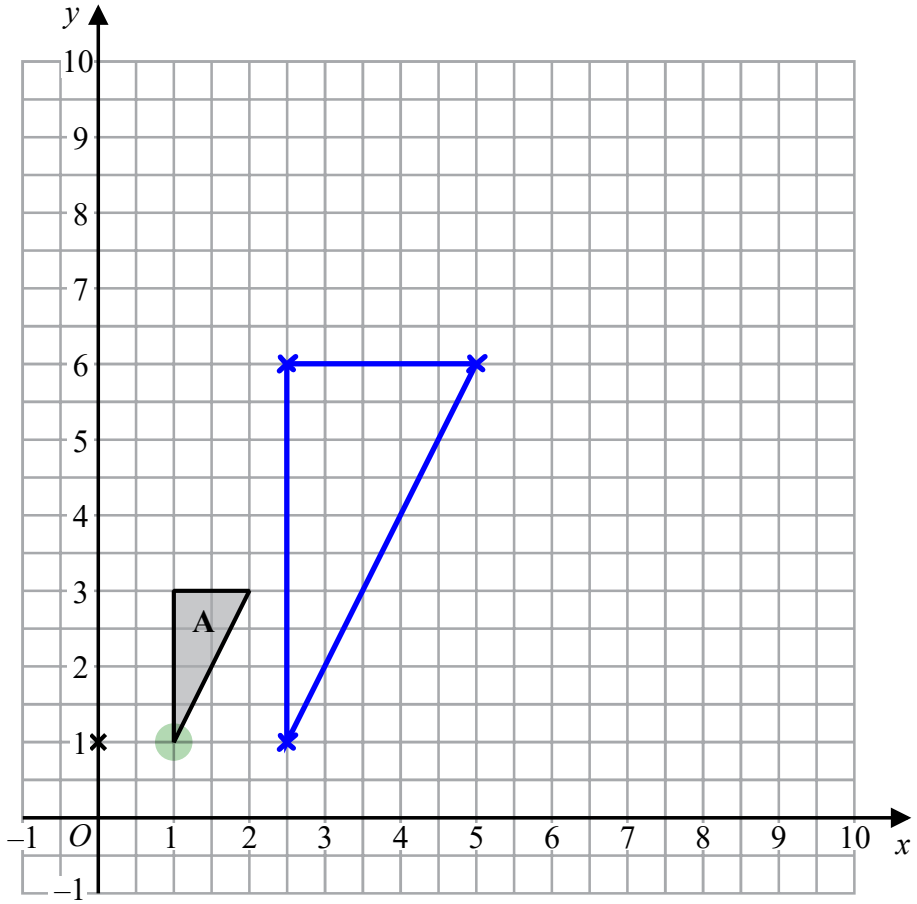
$(180-\frac{360}{5})-(180-117)$

The exterior angles of any polygon add up to 360°. So 360/5 works out the exterior angle of the regular pentagon as it has 5 exterior angles and they are all equal. There are 180° around a point on a straight line and the exterior angle and interior angle lie on a straight line so subtracting the exterior angle from 180 leaves the interior angle (x and y combined). 180 - 117 works out the angle y as the lines highlighted in green are parallel and co-interior angles add up to 180°. Subtracting angle y from the interior angle leaves angle x

45 °

**(Total for Question 8 is 4 marks)**

**9**




Enlarge triangle **A** by scale factor 2.5 with centre (0, 1)

**(Total for Question 9 is 2 marks)**

$\begin{pmatrix}1\\0\end{pmatrix} \times 2.5 = \begin{pmatrix}2.5\\0\end{pmatrix}$

$\begin{pmatrix}1\\2\end{pmatrix} \times 2.5 = \begin{pmatrix}2.5\\5\end{pmatrix}$

$\begin{pmatrix}2\\2\end{pmatrix} \times 2.5 = \begin{pmatrix}5\\5\end{pmatrix}$

Multiplying the vector from the centre of enlargement to each corner by 2.5 works out the new vector from the cente of enlargement. For the closest corner, highlighted in green, it is 2 in the x direction and 0 in the y direction from the centre of enlargement. So doing 2.5 in the x direction and 0 in the y direction works out where the corner is transformed to. A similar method is done for the other corners then they are joined up with straight lines to form the triangle

**10** (a) Solve $\frac{9+x}{7} = 11 - x$

$9+x = 77-7x$ ← Multiplying both sides by 7 eliminates the denominator on the left

$8x = 68$ ← Adding 7x to both sides and subtracting 9 from both sides to get all the x terms on their own on the left

Dividing both sides by 8

$x =$ 8.5

**(3)**

(b) Simplify $\frac{4(y+3)^3}{(y+3)^2}$

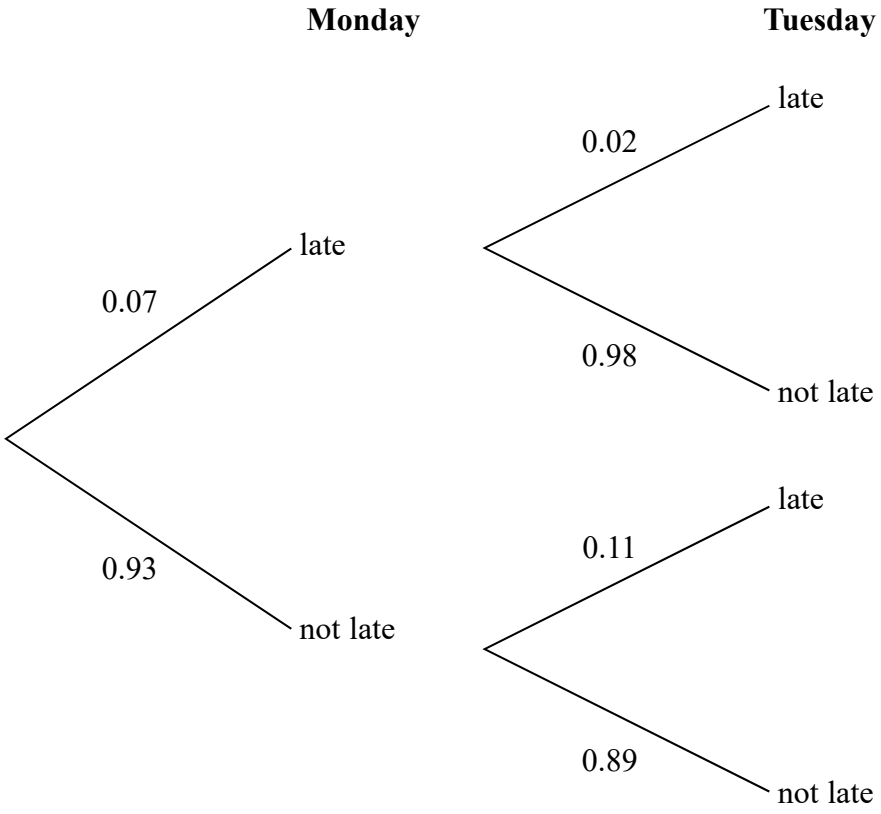
$a^x/a^y = a^{x-y}$. 3 - 2 = 1 so the power of (y + 3) becomes 1

4(y+3)

**(1)**

**(Total for Question 10 is 4 marks)**

**11** The probability tree diagram shows the probabilities that Bismah will be late for work on two days next week.




Calculate the probability that Bismah will be late on exactly one of the two days.

0.07×0.98+0.93×0.11 ← Late AND not late OR not late AND late. AND means to multiply the probabilities and OR means to add the probabilities

0.1709

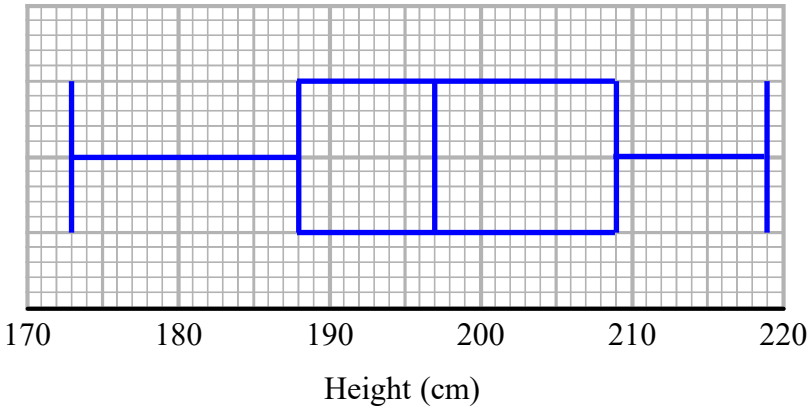
**(Total for Question 11 is 3 marks)**

**12** The stem and leaf diagram shows information about the heights, in cm, of 23 sunflowers.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 17 | 3 | 4 | 9 | | | | |
| 18 | 6 | 8 | 8 | | | | |
| 19 | 0 | 0 | 1 | 4 | 6 | 7 | 8 |
| 20 | 1 | 4 | 7 | 7 | 9 | 9 | |
| 21 | 4 | 8 | 8 | 9 | | | |

Key: 17|3 represents 173 cm

On the grid, draw a box plot for this information.




**(Total for Question 12 is 3 marks)**

173 is the lowest value and 219 is the greatest value. Drawing vertical lines for these

(23 + 1)/4 = 6 ← Using the formula (n + 1)/4, where n is the number of sunflowers, works out that the 6th value, highlighted in green, is the lower quartile. Drawing a vertical line for this

(23 + 1)/2 = 12 ← Using the formula (n + 1)/2, where n is the number of sunflowers, works out that the 12th value, highlighted in orange, is the median. Drawing a vertical line for this

6 x 3 = 18 ← Multiplying the 6, which is from the 6th value calculated for the lower quartile, by 3 works out that the 18th value, highlighted in pink, is the upper quartile. Drawing a vertical line for this

Drawing a horizontal line from the lowest to the lower quartile and from the upper quartile to the greatest and drawing a box around the quartiles

**13** Liquid A and liquid B are mixed together in the ratio 2 : 13 by volume to make liquid C.

Liquid A has density 1.21 g/cm$^3$
Liquid B has density 1.02 g/cm$^3$

A cylindrical container is filled completely with liquid C.
The cylinder has radius 3 cm and height 25 cm.

Work out the mass of the liquid in the container.
Give your answer correct to 3 significant figures.
You must show all your working.

$\frac{\pi \times 3^2 \times 25}{15}$

Volume of cylinder is the same formula as the volume of a prism. Volume = cross sectional area x length. The cross section is a circle. Area of circle = π x radius$^2$. The radius is 3cm. The length is 25cm. Dividing the volume of the cylinder by 15 to work out the value of 1 part in the ratio as this is the total volume of the liquid A and B and there are 15 parts in total in the ratio

$d \quad m \quad V$

Writing the formula triangle for density, mass and volume

$1.21 \times 15\pi \times 2 + 1.02 \times 15\pi \times 13$

From the formula triangle, mass = density x volume. Multiplying the value of 1 part of the ratio by 2 works out the volume of liquid A, which is multiplied by the density of liquid A to get its mass. Multiplying the value of 1 part of the ratio by 13 works out the volume of liquid B, which is multiplied by the density of liquid B to get its mass. Adding the mass of liquid A and the mass of liquid B gives the mass of the liquid in the container

The answer of 738.9025921 is rounded to 3 significant figures

739 ..... g

**(Total for Question 13 is 4 marks)**

**14** A group of people went to a restaurant.
Each person chose one starter and one main course.

| starter | main course |
|---|---|
| soup | lasagne |
| prawns | curry |

the number of people who chose soup : the number of people who chose prawns = 2 : 3

Of those who chose soup,
the number of people who chose lasagne : the number of people who chose curry = 5 : 3

Of those who chose prawns,
the number of people who chose lasagne : the number of people who chose curry = 1 : 5

What fraction of the people chose curry?
You must show how you get your answer.

$\frac{3}{8} \times \frac{2}{5} + \frac{5}{6} \times \frac{3}{5}$

5 + 3 = 8 so there are 8 parts in total in the 5 : 3 ratio. Out of these 8 parts, there were 3 parts for choosing curry. So 3/8 of those who chose soup also chose curry. 2/5 of the people chose soup. 3/8 x 2/5 works out 3/8 of the 2/5 so works out the fraction who chose soup and curry. A similar method is done for prawns and curry and the two fractions are added together

$\frac{13}{20}$

**(Total for Question 14 is 4 marks)**

**15** Prove algebraically that the sum of the squares of any two consecutive even numbers is always a multiple of 4

$(2n)^2+(2n+2)^2$ ← Let n be an integer. Multiplying it by 2 makes it even so 2n represents an even number. Adding 2 to 2n expresses the next even number. Squaring both of the expressions and adding them expresses the sum of the squares

$4n^2+4n^2+8n+4$ ← Expanding the brackets. The second bracket is expanded by squaring the first term, doubling the product of the two terms, and squaring the last term

$4(2n^2+2n+1)$ ← $4n^2 + 4n^2 = 8n^2$ then bringing out 4 as a factor to show that it is a multiple of 4

**(Total for Question 15 is 3 marks)**

**16** $y$ is inversely proportional to the square of $x$.

$y = 8$ when $x = 2.5$

Find the negative value of $x$ when $y = \frac{8}{9}$

$y=\frac{k}{x^2}$ ← $y \propto 1/x^2$. Multiplying the right side by k, which represents any constant value, converts the proportion into an equation

$K=8\times2.5^2$ ← Rearranged to make k the subject by multiplying both sides by $x^2$ then substituting in the given values of x and y to find that k = 50

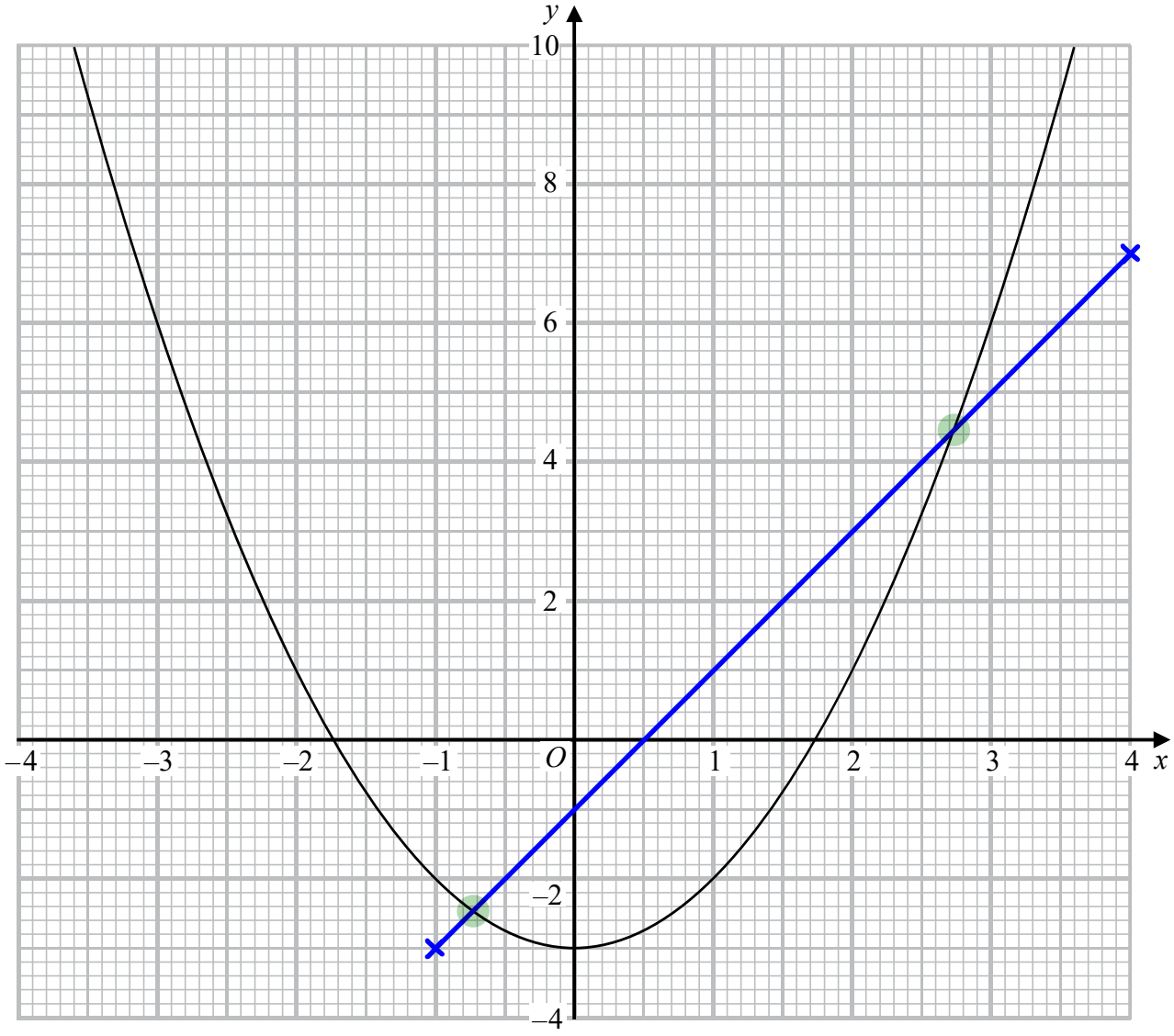
$\frac{8}{9}x^2=50$ ← The equation is now $y = 50/x^2$. Multiplying both sides by $x^2$ and substituting 8/9 for y

$x=\sqrt{\frac{50}{(\frac{8}{9})}}$ ← Dividing both sides by 8/9 then square rooting both sides to find x

The calculator gives the positive square root which is 7.5. The question asks for the negative value → -7.5

**(Total for Question 16 is 3 marks)**

**17** Here is the graph of $y = x^2 - 3$




Use the graph to find estimates for the solutions to the equation $x^2 - 2x - 2 = 0$
You must show how you get your solutions.

$x^2-3=2x-1$ ↔ 2x must be added to both sides and 1 must be subtracted from both sides to get the $x^2$ - 3 on the left side of the equation. As it is equal to 2x - 1, the graph of y = 2x - 1 is drawn and the solutions are where the two graphs cross

Using table mode, enter f(x) = 2x - 1. Start: -4. End: 4. Step: 1

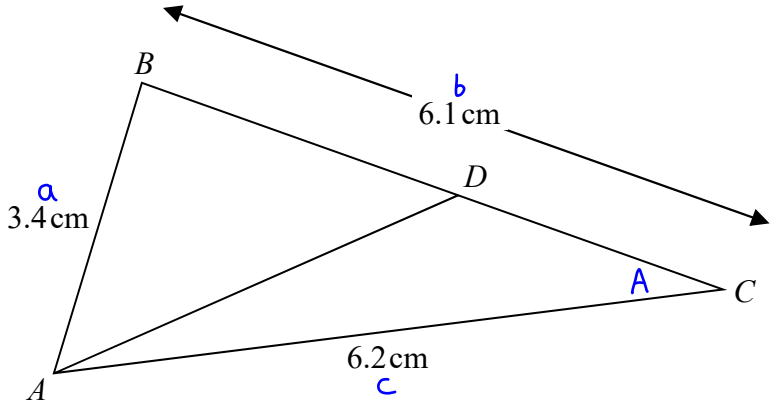
This does a table of values for the graph of y = 2x - 1. As it is a straight line (as it is in the form y = mx + c), two points can be plotted then joined up with a straight line

$x=-0.7$
$x=2.7$

**(Total for Question 17 is 4 marks)**

Only the x coordinates of the intersections are needed

**18** The diagram shows triangle $ABC$.




$AB = 3.4\,\text{cm}$ $AC = 6.2\,\text{cm}$ $BC = 6.1\,\text{cm}$

$D$ is the point on $BC$ such that

$$\text{size of angle } DAC = \frac{2}{5} \times \text{ size of angle } BCA$$

Calculate the length $DC$.
Give your answer correct to 3 significant figures.
You must show all your working.

$a^2 = b^2 + c^2 - 2bc\cos A$ ← Angle BCA needs to be found. Triangle ABC does not have a given right angle so right angled trigonometry cannot be used. It does not have opposite pairs of sides and angles so the sine rule cannot be used. Therefore the cosine rule should be used

$A = \cos^{-1}\left(\frac{a^2 - b^2 - c^2}{-2bc}\right)$ ← Labelling the triangle with angle A and sides a, b and c. a is opposite A. Rearranging the cosine rule to make A the subject

$= \cos^{-1}\left(\frac{3.4^2 - 6.1^2 - 6.2^2}{-2 \times 6.1 \times 6.2}\right)$ ← Substituting in the values

$= 32.0...$ ← Storing the exact value of 32.08046913 as A on the calculator

$\frac{2}{5} \times 32.0... = 12.8...$ ← Doing 2/5 of the exact value of angle BCA to find DAC

Storing the exact value of 12.83218765 as B on the calculator

$180 - 32.0... - 12.8... = 135.0...$ ← Working out angle ADC. There are 180° in a triangle

Storing the exact value of 135.0873432 as C on the calculator

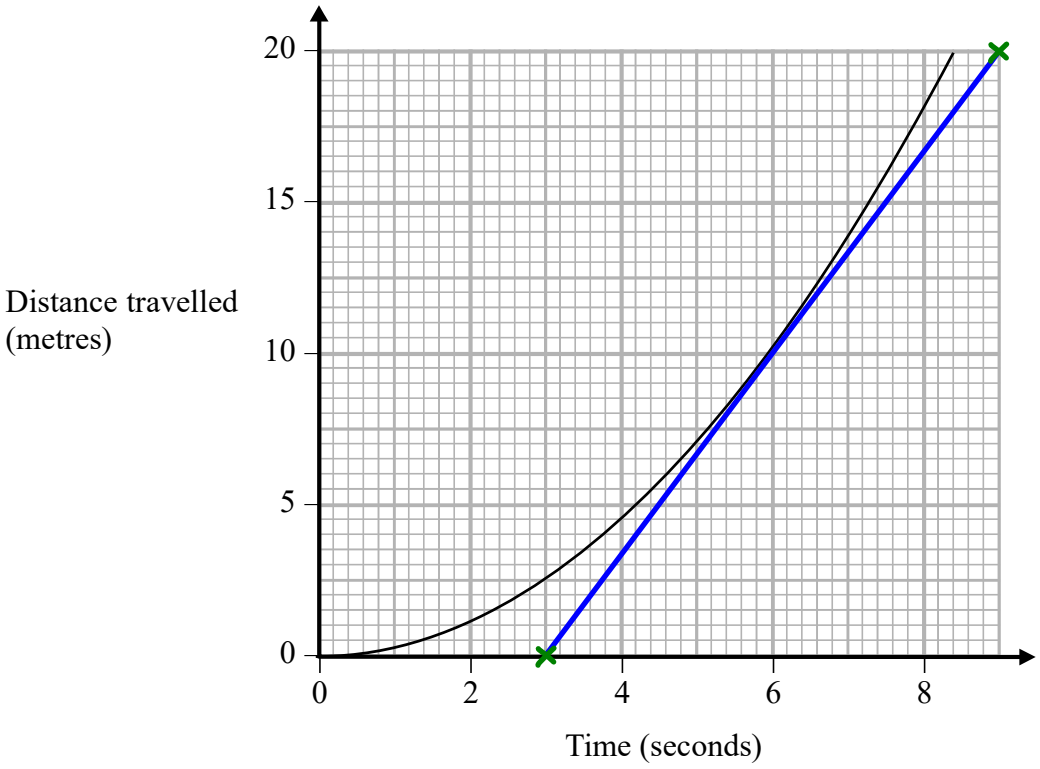
$\frac{a}{\sin A} = \frac{b}{\sin B}$ ← There are opposite pairs of sides and angles in triangle ADC so the sine rule can be used to work out side DC

$DC = \frac{6.2 \times \sin 12.8...}{\sin 135.0...}$ ← Rearranged to make a the subject and replacing it with DC. Substituting 6.2 for b, the exact value of angle DAC for A and the exact value of angle ADC for B

1.95 ..... cm

**(Total for Question 18 is 5 marks)**

**19** The graph shows information about part of a cyclist's journey.




Work out an estimate of the speed, in m/s, of the cyclist at time 6 seconds.

$\frac{20-0}{9-3}$ ← Drawing a tangent to the curve at the point where the time is 6 seconds then working out its gradient works out an estimate of the speed. Gradient = (change in y)/(change in x). The line is drawn so that it starts and ends at convenient points. 20 - 0 works out the change in y from the start to the end of the line. 9 - 3 works out the change in x from the start to the end of the line

$\frac{10}{3}$ ..... m/s

**(Total for Question 19 is 3 marks)**

**20** Here are the first five terms of a sequence.

Working out the differences then the second difference (the difference of the differences)

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 2 | | 2 | | | | |
| | 1 | | 3 | | 5 | | | |
| −1 | | 0 | | 3 | | 8 | | 15 |

Find an expression, in terms of $n$, for the $n$th term of this sequence.

The second difference is constant so it must be a quadratic sequence in the form $an^2 + bn + c$

1 4 ← Halving the second difference works out a, so a is 1. Listing out the sequence of $1n^2$

-2 -4 ← Listing what needs to be added to the sequence of $1n^2$ to get the original sequence

The sequence -2, -4, decreases by 2 between each term so must involve -2n. The 0th term, the one before the first term, is 0 so 0 needs to be added to this. Combining the sequence of $n^2$ and -2n gives the original sequence

$n^2-2n$

**(Total for Question 20 is 2 marks)**

**21** When a biased coin is thrown 4 times, the probability of getting 4 heads is $\frac{16}{81}$

Work out the probability of getting 4 tails when the coin is thrown 4 times.

$\sqrt[4]{\frac{16}{81}}$ ← Heads AND heads AND heads AND heads. AND means to multiply the probabilities. Let H be the probability of heads. H x H x H x H = $H^4$ = 16/81. So H is the fourth root of 16/81

$1-\frac{2}{3}$ ← The probability of heads is 2/3. Subtracting this from 1 works out the probability of tails

$\left(\frac{1}{3}\right)^4$ ← Tails AND tails AND tails AND tails. AND means to multiply the probabilities. Let T be the probability of tails. The probability of 4 tails = T x T x T x T = $T^4$

$\frac{1}{81}$

**(Total for Question 21 is 2 marks)**

**22** Show that $\dfrac{7x-14}{x^2+4x-12} \div \dfrac{x-6}{x^3-36x}$ simplifies to $ax$ where $a$ is an integer.

$x(x^2-36)$ ← Factorising the $x^3 - 36x$

$\dfrac{7(x-2)}{(x+6)(x-2)} \times \dfrac{x(x+6)(x-6)}{x-6}$ ← Fully factorising all the numerators and denominators and dividing by the fraction by multiplying by the reciprocal (keep, change, flip)

$7x$ ← Cancelling out the factors in common to the numerators and denominators leaves 7x. x - 2, x + 6 and x - 6 are all common factors

**(Total for Question 22 is 4 marks)**

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

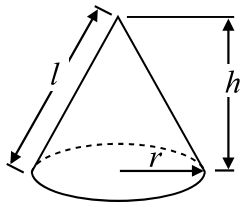
DO NOT WRITE IN THIS AREA

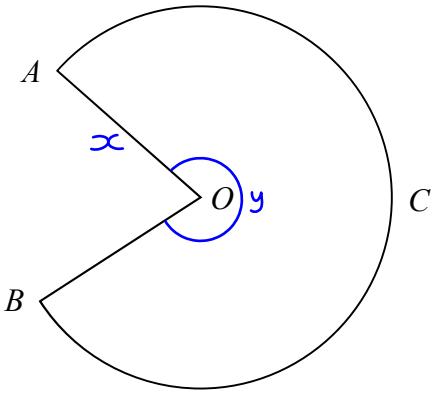
**23** The diagram shows a sector $OACB$ of a circle with centre $O$.
The point $C$ is the midpoint of the arc $AB$.

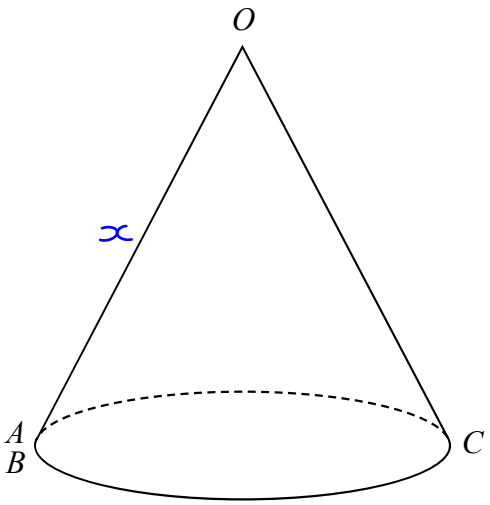
The diagram also shows a hollow cone with vertex $O$.
The cone is formed by joining $OA$ and $OB$.

Volume of cone $= \frac{1}{3}\pi r^2 h$

Curved surface area of cone $= \pi r l$




The cone has volume 56.8 cm$^3$ and height 3.6 cm.

Calculate the size of angle $AOB$ of sector $OACB$.
Give your answer correct to 3 significant figures.
You must show all your working.

$\sqrt{\frac{56.8}{\frac{1}{3}\pi \times 3.6}}$ ← This works out the radius of the cone. Started with the formula for the volume of cone then rearranged to make r the subject by dividing both sides by 1/3, π and h then square rooting both sides. Substituted in the values of the volume, which is 56.8, and h, which is 3.6

$a^2+b^2=c^2$ ← Pythagoras' Theorem can be used to work out x, the slant length of the cone, as the radius, the height and the slant height can form a right angled triangle

$\sqrt{3.6^2+3.8...^2}$ ← The slant length is the longest side so square rooting both sides to make c the subject. Substituting the height, h, for a and the exact value of the radius for b

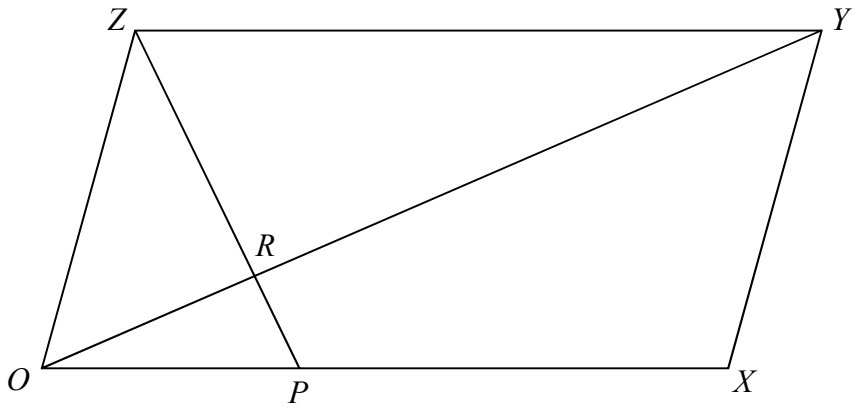
$\pi \times 5.2...^2 \times \frac{y}{360} = \pi \times 3.8... \times 5.2...$ ← Expressing the area of the sector and setting this equal to the curved surface area of the cone. They must be the same as the cone is formed from the sector. Area of circle = π x radius$^2$. Then doing y/360 of this as this is the fraction of the whole circle that the sector is. The radius of the sector is the slant length of the cone, x

$\frac{\pi \times 3.8... \times 5.2... \times 360}{\pi \times 5.2...^2}$ ← Rearranged to find y, the angle AOB

264 °

**(Total for Question 23 is 5 marks)**

**24** $OXYZ$ is a parallelogram.




$\overrightarrow{OX} = \mathbf{a}$

$\overrightarrow{OY} = \mathbf{b}$

$P$ is the point on $OX$ such that $OP : PX = 1 : 2$
$R$ is the point on $OY$ such that $OR : RY = 1 : 3$

Work out, in its simplest form, the ratio $ZP : ZR$
You must show all your working.

$\overrightarrow{ZO} = \overrightarrow{YX} = -b + a$ ← $\overrightarrow{ZO}$ is needed to express $\overrightarrow{ZP}$ and $\overrightarrow{ZR}$. It is equal to $\overrightarrow{YX}$ as opposite sides of a parallelogram are equal and parallel. $\overrightarrow{YX} = \overrightarrow{YO} + \overrightarrow{OX}$

$\overrightarrow{ZP} = -b + a + \frac{1}{3}a$ ← $\overrightarrow{ZP} = \overrightarrow{ZO} + \overrightarrow{OP}$. $\overrightarrow{OP}$ is 1/3 of $\overrightarrow{OX}$ according to the ratio of OP : PX so is 1/3 a

$= \frac{4}{3}a - b$

$\overrightarrow{ZR} = -b + a + \frac{1}{4}b$ ← $\overrightarrow{ZR} = \overrightarrow{ZO} + \overrightarrow{OR}$. $\overrightarrow{OR}$ is 1/4 of $\overrightarrow{OY}$ according to the ratio of OR : RY so is 1/4 b

$= a - \frac{3}{4}b$

$\overrightarrow{ZP}$ is 4/3 times $\overrightarrow{ZR}$ → $\frac{4}{3} : 1$

.....

**(Total for Question 24 is 5 marks)**

**TOTAL FOR PAPER IS 80 MARKS**