

**Thursday 16 May 2024 – Morning****GCSE (9–1) Mathematics****J560/04 Paper 4 (Higher Tier)****Time allowed: 1 hour 30 minutes****You must have:**

- the Formulae Sheet for Higher Tier (inside this document)

**You can use:**

- a scientific or graphical calculator
- geometrical instruments
- tracing paper

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number

|  |  |  |  |  |
|--|--|--|--|--|
|  |  |  |  |  |
|--|--|--|--|--|

Candidate number

|  |  |  |  |
|--|--|--|--|
|  |  |  |  |
|--|--|--|--|

First name(s)

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Last name

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**INSTRUCTIONS**

- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. You can use extra paper if you need to, but you must clearly show your candidate number, the centre number and the question numbers.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.
- Use the  $\pi$  button on your calculator or take  $\pi$  to be 3.142 unless the question says something different.

**INFORMATION**

- The total mark for this paper is **100**.
- The marks for each question are shown in brackets [ ].
- This document has **20** pages.

**ADVICE**

- Read each question carefully before you start your answer.

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

Any writing in blue should be written in the exam.

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

If you find any mistakes or have any requests or suggestions, please send an email to [curtis@cgmaths.co.uk](mailto:curtis@cgmaths.co.uk)

1 Work out.

$$\sqrt[3]{\frac{19.5^4 - 18^2}{1.45}}$$

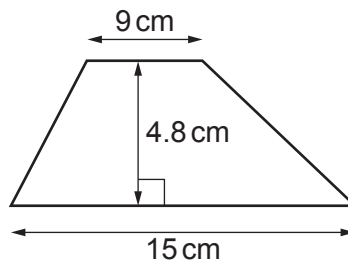
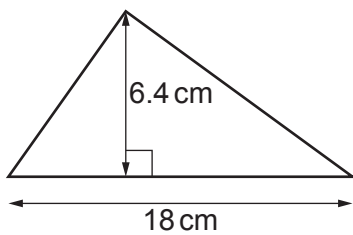
Write your answer correct to 4 significant figures.

Typing it into the calculator exactly as it is above.  
Rounding the answer of 46.337... to 4 significant figures

46.34

[3]

2 The diagram shows a triangle and a trapezium.



**Not to scale**

Show that they have the same area.

[3]

$$\frac{1}{2} \times 18 \times 6.4 = 57.6$$

Area of triangle =  $\frac{1}{2} \times \text{base} \times \text{height}$ . The base is 18 cm and the height is 6.4 cm. So the area of the triangle is 57.6 cm<sup>2</sup>

$$\frac{1}{2} \times (9 + 15) \times 4.8 = 57.6$$

Area of trapezium =  $\frac{1}{2} \times (a + b) \times \text{height}$ , where a and b are the parallel sides. a is 9 cm, b is 15 cm and the height is 4.8 cm. So the area of the trapezium is 57.6 cm<sup>2</sup>

3 Four numbers are written, in ascending order, as algebraic expressions.

$$a \quad a + b \quad a + 2b \quad 3a - b$$

The mean of these four numbers is 27.

The range of these four numbers is 24.

Find the value of  $a$  and the value of  $b$ .

You must show your working.

$$a + a + b + a + 2b + 3a - b \leftarrow \text{Adding all four expressions expresses the total of the four numbers}$$

$$\frac{6a + 2b}{4} = 27 \leftarrow \text{Simplifying the expression of the total by collecting like terms. Then dividing by 4 (as mean = total } \div \text{ number and there are 4 numbers) expresses the mean. This must be equal to 27 as this is the value of the mean}$$

$$6a + 2b = 108 \leftarrow \text{Multiplying both sides by 4 eliminates the denominator. This forms the 1st equation. It cannot be solved on its own as there is more than one unknown}$$

$$3a - b - a \leftarrow \text{This expresses the range of the numbers. Range = largest - smallest. The largest expression is } 3a - b \text{ and the smallest expression is } a \text{ (as they are written in ascending order)}$$

$$2a - b = 24 \leftarrow \text{Simplifying the expression of the range by collecting like terms. This must be equal to 24 as this is the value of the range. This forms the 2nd equation}$$

$$4a - 2b = 48 \leftarrow \text{Multiplying the 2nd equation by 2 so that the magnitude of the } b \text{ is the same as in the 1st equation (one is now } 2b \text{ and the other is } -2b \text{). This forms the 3rd equation}$$

$$10a = 156 \leftarrow \text{Adding the 1st and 3rd equations cancels out the } b \text{ terms and leaves an equation just in terms of } a. 6a + 4a = 10a. 2b - 2b = 0. 108 + 48 = 156$$

$$\text{Dividing both sides by 10 eliminates the 10 on the left and gets } a = 15.6$$

$$2(15.6) - b = 24 \leftarrow \text{Substituting 15.6 for } a \text{ in the 2nd equation}$$

$$31.2 - 24 = b \leftarrow 2(15.6) = 31.2. \text{ Adding } b \text{ to both sides and subtracting 24 from both sides to get } b \text{ positive and on its own}$$

$$a = \dots\dots\dots 15.6$$

$$b = \dots\dots\dots 7.2 \quad [5]$$

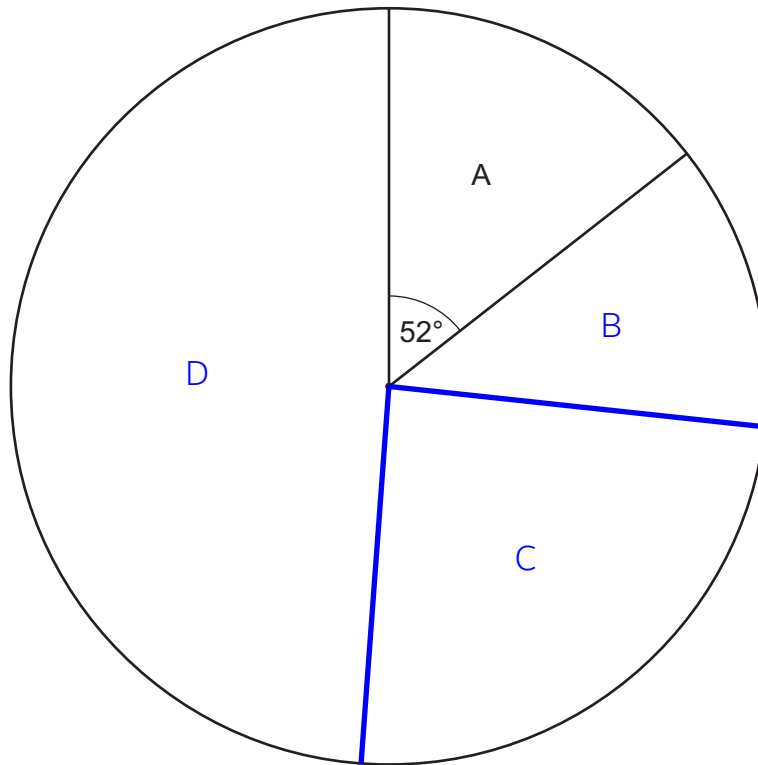
$\uparrow$   
 $31.2 - 24 = 7.2$

- 4 A school is deciding on a charity to support. Each student at the school votes for one of four charities, A, B, C or D. The results are to be shown in a pie chart.

This pie chart shows the sector for charity A.

Twice as many students voted for charity C than charity B.

Twice as many students voted for charity D than charity C.



- (a) (i) Show that the sector for charity B will have an angle of  $44^\circ$ .

[2]

$$360 - 52$$

There are  $360^\circ$  in total in a pie chart. Subtracting the  $52^\circ$  from  $360^\circ$  works out that there are  $308^\circ$  remaining in the pie chart

$$B + 2B + 4B$$

Let B represent the angle for charity B. The angle for charity C would be  $2B$  (as twice as many students voted for charity C than charity B) and the angle for charity D would be  $4B$  (as twice as many students voted for charity D than charity C). Adding these together expresses the total of the remaining angles in the pie chart

$$7B = 308$$

Simplifying the expression and setting equal to the value of the remaining angles

$$B = 44$$

Dividing both sides by 7 eliminates the 7 on the left and gets B on its own

- (ii) Complete the pie chart.

[3]

$$44 \times 2 = 88$$

Twice as many students voted for charity C than charity B so the angle for charity C is  $88^\circ$

Drawing on the angles for B and C using a protractor. The remaining angle is for D. Labelling each sector

- (b) 39 students voted for charity A.

Calculate the total number of students at the school.

$$39 \div 52$$

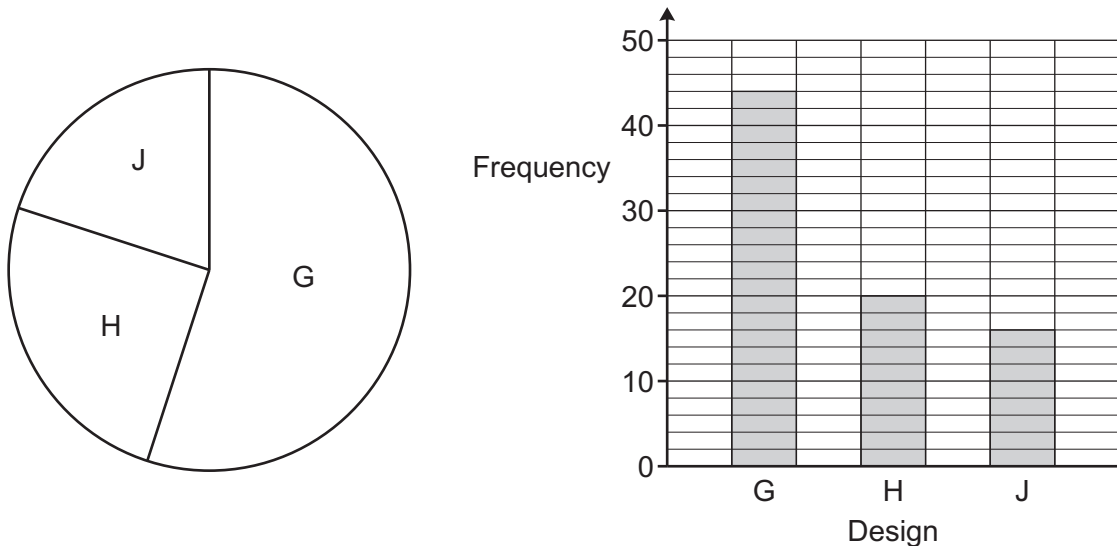
Dividing the 39 students by the  $52^\circ$  representing A works out that  $1^\circ$  represents 0.75 students

$$0.75 \times 360$$

There are  $360^\circ$  in total in a pie chart so multiplying the 0.75 students represented by  $1^\circ$  by 360 works out that there are 270 students in total

(b) ..... 270 [2]

- (c) The school asks 80 of the students to choose a new logo from three designs G, H and J. The same results are shown in a pie chart and in a bar chart.



- (i) Give one **advantage** of using the pie chart rather than the bar chart.

It shows proportions

The bigger the angle of each sector, the higher the proportion of the students chose it

[1]

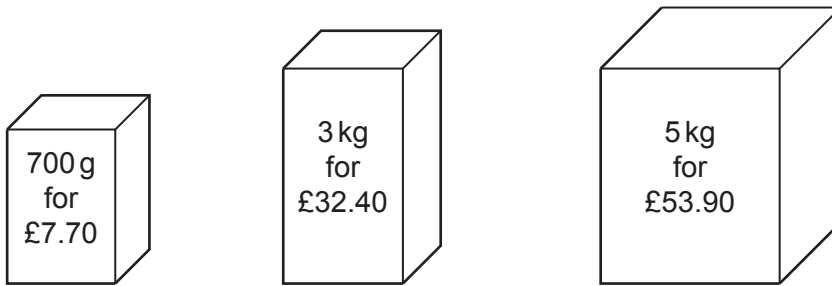
- (ii) Give one **disadvantage** of using the pie chart rather than the bar chart.

Does not show frequencies

The angle only shows the proportions, it does not detail how many students chose each

[1]

- 5 The same dog food is sold in three different sized packs.  
The diagram shows the price of each pack.



Which pack is the best value for money?  
Show how you decide.

|                        |   |                                                                                                   |
|------------------------|---|---------------------------------------------------------------------------------------------------|
| $700 \div 1000$        | ← | There are 1000 g in 1 kg. So dividing the 700 g by 1000 converts it into 0.7 kg                   |
| $7.70 \div 0.7 = 11$   | ← | Dividing the £7.70 by the 0.7 kg works out that the price per kilogram is £11 for the 700 g pack  |
| $32.40 \div 3 = 10.80$ | ← | Dividing the £32.40 by the 3 kg works out that the price per kilogram is £10.80 for the 3 kg pack |
| $53.90 \div 5 = 10.78$ | ← | Dividing the £53.90 by the 5 kg works out that the price per kilogram is £10.78 for the 5 kg pack |

The ..... 5 kg ..... pack because ..... it has the lowest price per kilogram .....  
 ..... £10.78 per kilogram is less than the other prices per kilogram .....  
 ..... [3]

- 6 A regular polygon has  $n$  sides.  
The interior angle of the polygon is 15 times its exterior angle.

Find the value of  $n$ .

$15x + x$

Let  $x$  be the exterior angle. The interior angle must be  $15x$ . Adding these together expresses the total of the exterior and interior angles

$16x = 180$

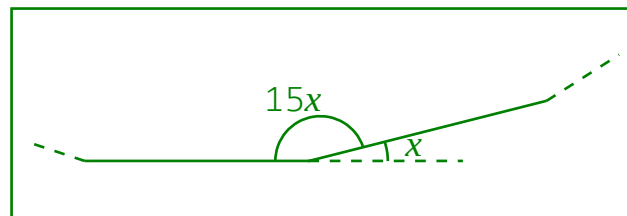
Simplifying by collecting the like terms. The exterior and interior angles lie around a point on a straight line so must add up to  $180^\circ$

$x = 11.25$

Dividing both sides by 16 eliminates the 16 on the left and gets  $x$  on its own. So the exterior angle is  $11.25^\circ$

$360 \div 11.25$

All of the exterior angles of any polygon add up to  $360^\circ$ . As it is a regular polygon, all of the exterior angles are the same. So dividing  $360^\circ$  by the exterior angle works out that there are 32 exterior angles



There must be 32 sides if there are 32 exterior angles

$$n = \dots\dots\dots 32 \quad [4]$$

- 7 Write the following in order of size, smallest first.

0.2     $2^{-2}$      $2 \times 10^{-2}$   
0.20   0.25    0.02  
Show how you decide.

Typing them into the calculator to convert them into decimals and writing them to 2 decimal places to make them easier to compare

$$\dots\dots\dots 2 \times 10^{-2} \dots\dots\dots 0.2 \dots\dots\dots 2^{-2} \dots\dots\dots [3]$$

*smallest*



- 8 The price of a television is increased by 35%.  
In a sale, the new price of the television is decreased by  $r\%$ .

The overall percentage increase in the price of the television is 16.1%.

Find the value of  $r$ .

You must show your working.

$$\frac{100 + 35}{100}$$

Adding the 35% to 100% expresses the percentage it increases to. Putting this over 100 converts it into a fraction. Formatting this as a decimal gives 1.35

$$\frac{100 + 16.1}{100}$$

Adding the 16.1% to 100% expresses the percentage it increases to. Putting this over 100 converts it into a fraction. Formatting this as a decimal gives 1.161

$$x \times 1.35 \times \frac{100 - r}{100} = x \times 1.161$$

Let  $x$  be the original price of the television. Multiplying it by 1.35 increases it by 35%. Subtracting  $r\%$  from 100% expresses the percentage it decreases to in the sale. Putting this over 100 converts it into a fraction. Multiplying by this fraction reduces it by  $r\%$ . Setting the expression of the original price increased by 35% then decreased by  $r\%$  equal to the original price increased by 16.1%. Multiplying  $x$  by 1.161 increases it by 16.1%.

$$\frac{100 - r}{100} = 0.86$$

Dividing both sides by  $x$  cancels them out. Then dividing both sides by 1.35 to eliminate the 1.35 on the left

$$100 - r = 86$$

Multiplying both sides by 100 to eliminate the 100 as the denominator

$$100 - 86 = r$$

Adding  $r$  to both sides to make it positive. Then subtracting 86 from both sides to get  $r$  on its own

$$r = \dots\dots\dots 14 \quad [5]$$

$$100 - 86 = 14$$

9 Sasha and Taylor each have a stamp collection.

They organise their stamp collections according to where the stamps come from:  
United Kingdom (UK), European Union (EU), Other.

The table shows the number of stamps in each collection and the ratio UK : EU : Other.

|                     | Number of stamps | Ratio<br>UK : EU : Other |
|---------------------|------------------|--------------------------|
| Sasha's collection  | 1638             | 9 : 3 : 2                |
| Taylor's collection | 660              | 8 : 1 : 2                |

When they put the two stamp collections together, Sasha and Taylor claim that at least  $\frac{2}{3}$  of all the stamps come from the UK.

Are they correct?

Show how you decide.

|                                  |   |                                                                                                                                                              |
|----------------------------------|---|--------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $1638 + 660$                     | ← | Adding the number of stamps Sasha and Taylor have works out that there are 2298 stamps in total                                                              |
| $\frac{2}{3} \times 2298 = 1532$ | ← | This works out that $\frac{2}{3}$ of all the stamps is 1532 stamps                                                                                           |
| $9 + 3 + 2$                      | ← | Adding all of the parts in the ratio for Sasha's collection works out that there are 14 parts in total which represent the 1638 stamps                       |
| $1638 \div 14$                   | ← | Dividing the 1638 stamps by the 14 parts of the ratio works out that 1 part of the ratio is worth 117 stamps                                                 |
| $117 \times 9 = 1053$            | ← | Multiplying the value of 1 part of the ratio by the 9 parts representing UK works out that Sasha has 1053 stamps from the UK                                 |
| $8 + 1 + 2$                      | ← | Adding all of the parts in the ratio for Taylor's collection works out that there are 11 parts in total which represent the 660 stamps                       |
| $660 \div 11$                    | ← | Dividing the 660 stamps by the 11 parts of the ratio works out that 1 part of the ratio is worth 60 stamps                                                   |
| $60 \times 8$                    | ← | Multiplying the value of 1 part of the ratio by the 8 parts representing UK works out that Taylor has 480 stamps from the UK                                 |
| $1053 + 480 = 1533$              | ← | Adding the 1053 stamps which Sasha has from the UK and the 480 stamps which Taylor has from the UK works out that there are 1533 stamps in total from the UK |

They are ..... **correct** ..... because .....

$\frac{2}{3}$  of all the stamps is 1532. The 1533 stamps from the UK is more than this

[5]

10 Here is a question and an incorrect solution.

Question:

You are given

$y \propto x$  and  $y = 9$  when  $x = 2$ .

Find a formula linking  $x$  and  $y$ .

Solution:

$y \propto x$  so  $y = x + c$

Substituting  $y = 9$  and  $x = 2$  gives

$$9 = 2 + c$$

$$c = 7$$

$$\text{So, } y = x + 7$$

Describe the error made and write out a correct solution.

The error is  $y = x + c$

This is wrong as adding a constant to  $x$  will not make it directly proportional to  $y$

A correct solution is

$$y = kx$$

Let  $k$  be a constant which needs to be found. Multiplying the right side by  $k$  converts the proportion into an equation

$$k = \frac{9}{2}$$

Dividing both sides by  $x$  gets  $k$  on its own. Substituting 9 for  $y$  and 2 for  $x$

$$y = \frac{9}{2}x$$

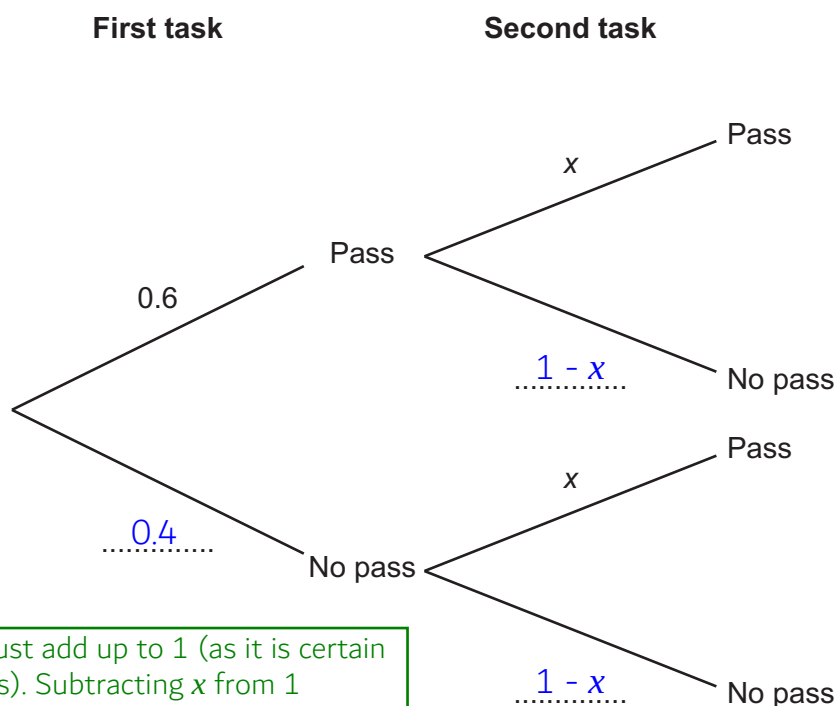
Substituting the value of  $k$  back into the equation

[3]

- 11 A student attempts two tasks.  
The result of each task is either "Pass" or "No pass".

The probability of the student passing the first task is 0.6.  
The probability of the student passing the second task is  $x$ .

- (a) Complete the tree diagram.



Each set of branches must add up to 1 (as it is certain to either pass or no pass). Subtracting  $x$  from 1 expresses the probability of no pass for the second task

[2]

- (b) Write down the mathematical assumption that has been made about the two tasks.

They are independent ← That the first task has no effect on the second task

[1]

- (c) The probability of the student passing just one of these two tasks is 0.528.

Work out the value of  $x$ .

$$0.6(1 - x)$$

Expressing the probability of pass AND no pass. AND means to multiply the probabilities

$$0.6 - 0.6x + 0.4x$$

Expanding the bracket. Adding the expression of the probability of no pass AND pass (as to pass just one of the two tasks it is pass AND no pass OR no pass AND pass. OR means to add the probabilities). AND means to multiply the probabilities

$$0.6 - 0.2x = 0.528$$

Simplifying the expression for the probability of pass AND no pass OR no pass AND pass by collecting like terms. Setting it equal to the value of the probability for this

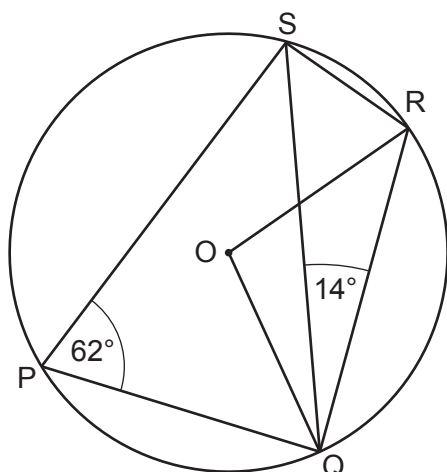
$$0.072 = 0.2x$$

Adding  $0.2x$  to both sides to make the  $x$  term positive.  
Subtracting 0.528 from both sides to get the  $x$  term on its own

Dividing both sides by 0.2 gets  $x$  on its own

(c)  $x = 0.36$  [4]

- 12 (a) P, Q, R and S are points on the circumference of a circle, centre O.  
Angle SQR =  $14^\circ$  and angle SPQ =  $62^\circ$ .



Not to scale

Find the size of angle ROQ.

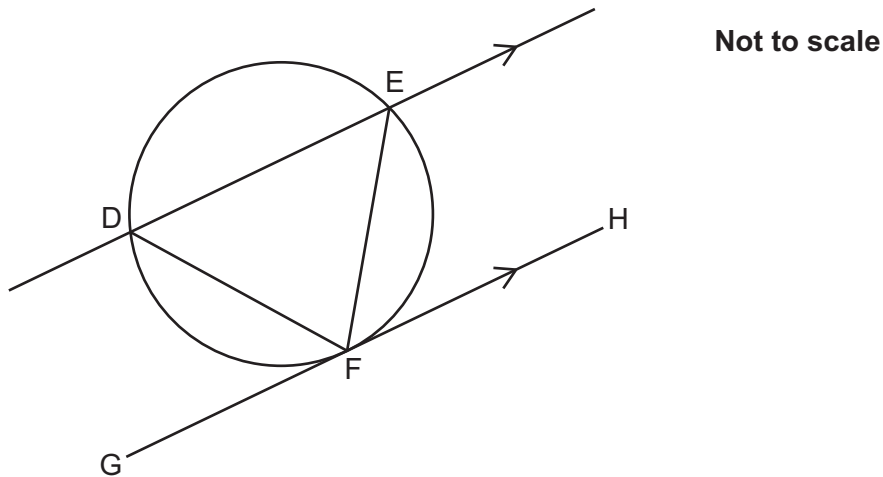
Angle SRQ =  $180^\circ - 62^\circ = 118^\circ$  ← As opposite angles in a cyclic quadrilateral add up to  $180^\circ$

Angle QSR =  $180^\circ - 14^\circ - 118^\circ = 48^\circ$  ← As angles in a triangle add up to  $180^\circ$

Angle ROQ =  $48^\circ \times 2$  ← As the angle at the centre is double the angle at the circumference

(a) Angle ROQ = .....96..... $^\circ$  [3]

(b) D, E and F are points on the circumference of a circle.



Line GH is a tangent to the circle at F.  
Line DE is parallel to line GH.

Complete these statements to prove that triangle DEF is isosceles.  
Give reasons for your statements.  
You may not need all of the lines.

Angle  $\angle DEF$  = Angle  $\angle EFH$  because alternate angles are equal

Angle  $\angle FDE$  = Angle  $\angle EFH$  because of the alternate segment theorem

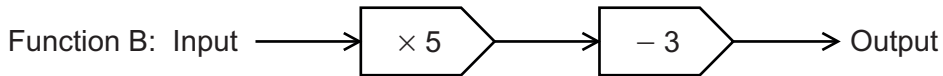
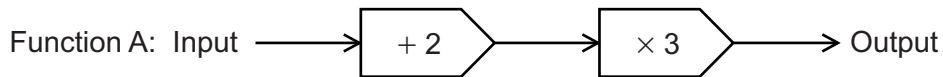
Angle  $\angle DEF$  = Angle  $\angle FDE$  because both are equal to  $\angle EFH$

Angle ..... = Angle ..... because .....

Angle ..... = Angle ..... because .....

Triangle DEF is isosceles because at least two angles are equal [3]

13 Function A and function B are shown below.



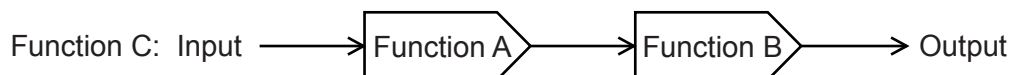
(a) The **output** of function B is  $x$ .

Write an algebraic expression, in terms of  $x$ , for the inverse of function B.

Doing the opposite operations in the opposite order

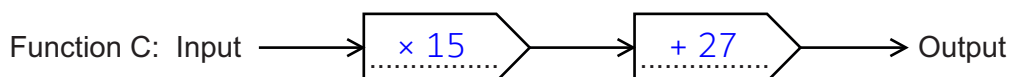
(a) .....  $(x + 3) \div 5$  ..... [2]

(b) Function C is shown below as a composite function.



Complete the diagram below using two arithmetic operations to show function C as a single function.

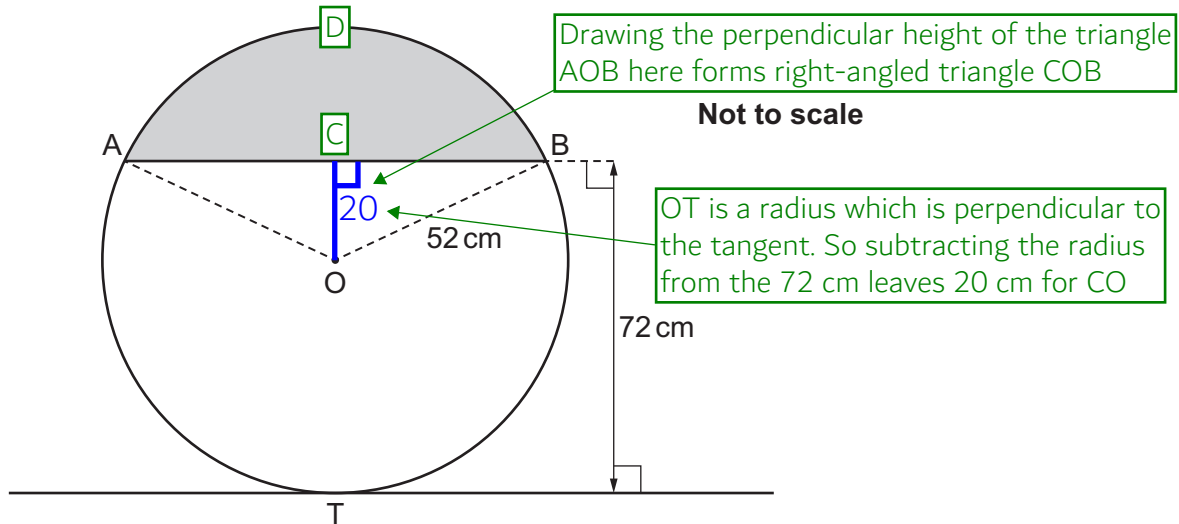
$(A + 2) \times 3 \longleftarrow$  Let A be the input of function A. 2 is added then it is all multiplied by 3  
 $(3A + 6) \times 5 \longleftarrow$  Expanding the brackets. Then it is all multiplied by 5  
 $15A + 30 - 3 \longleftarrow$  Expanding the brackets. Then 3 is subtracted  
 $15A + 27 \longleftarrow$  This is the output of function C in terms of the input A



The order of operations (BIDMAS) means that the multiplication happens first

[4]

- 14 The diagram shows a circle, centre O and radius 52 cm.



AB is a chord of the circle.

The line through T is a tangent to the circle.

The chord is parallel to the tangent.

The perpendicular distance between the chord and the tangent is 72 cm.

Calculate the area of the shaded segment.

You must show your working.

$$\begin{array}{c} \text{O} \quad \text{A} \quad \text{O} \\ \text{S} \quad \text{H} \quad \text{C} \quad \text{H} \quad \text{T} \quad \text{A} \end{array}$$

Using right-angled trigonometry on triangle COB to work out angle COB. Ticking H as the 52 cm is the hypotenuse and ticking A as the 20 cm is the adjacent. There are two ticks on the CAH formula triangle so this one can be used

$$\cos x = \frac{20}{52}$$

Covering C in the CAH formula triangle finds that  $\cos$  of the angle = adjacent/hypotenuse

$$x = \cos^{-1}\left(\frac{20}{52}\right)$$

Doing the inverse cos of both sides gets the angle on its own

$$x = 67.3...$$

$$67.3... \times 2$$

Multiplying the exact value of angle COB by 2 gives angle AOB (as angles COA and COB are the same). Storing the exact value of angle AOB on the calculator

$$\frac{134.7...}{360} \times \pi \times 52^2 = 3179.9...$$

This is the area of the sector ADBO. Putting the exact value of angle AOB over 360 (as there are 360° around the centre of a circle) expresses the sector as a fraction of the whole circle. Doing this fraction of the area of the whole circle. Area of circle =  $\pi \times \text{radius}^2$

$$\frac{1}{2} \times 52 \times 52 \times \sin(134.7...)$$

This is the area of triangle AOB. Area of triangle =  $\frac{1}{2} ab \sin C$ , where a and b are two sides of the triangle and C is the angle between them. So the area of triangle AOB is 960 cm<sup>2</sup>

$$3179.9... - 960$$

Subtracting the area of triangle AOB from the exact value of the area of sector ADBO leaves the area of the shaded segment

$$2219.9 \text{ cm}^2 \text{ [6]}$$



15 (a) Solve by factorisation.

$$3x^2 + 10x - 8 = 0 \leftarrow \text{It is in the quadratic form } ax^2 + bx + c = 0. a = 3, b = 10, c = -8$$

$$3x^2 + 12x - 2x - 8 \leftarrow \text{Multiplying a by c gives -24. Two numbers which multiply to this and add to b are 12 and -2. Splitting the middle x term into these numbers of x}$$

$$3x(x + 4) - 2(x + 4) \leftarrow \text{Factorising the left two terms and the right two terms separately}$$

$$(3x - 2)(x + 4) = 0 \leftarrow \text{Bringing together the 3x and -2 and writing the x + 4 bracket once. Now including the = 0}$$

$$3x - 2 = 0$$

$$x + 4 = 0$$

One of the two brackets must equal to 0 so that they multiply to 0

Adding 2 to both sides of  $3x - 2 = 0$  gives  $3x = 2$ .  
Then dividing both sides by 3 gives  $x = 2/3$

Subtracting 4 from both sides of  $x + 4 = 0$  gives  $x = -4$

(a)  $x = \frac{2}{3}$  or  $x = -4$  [3]

(b) Write  $x^2 + 8x + 11$  in the form  $(x + a)^2 - b$ .

$$(x + 4)^2 + 11 - 4^2 \leftarrow \text{Completing the square. Halving the coefficient of x to get 4. Putting this in a bracket with x and squaring. Subtracting the 4 squared from the end}$$

$$11 - 4^2 = -5$$

(b)  $(x + 4)^2 - 5$  [3]

(c) (i) Write down the coordinates of the turning point of the graph  $y = (x - 3)^2 + 8$ .

The turning point is when the square bracket is equal to 0.  $x = 3$  for this to happen. Then  $y = 8$

(c)(i)  $(3, 8)$  [2]

(ii) Describe the **single** transformation which maps the graph of  $y = x^2$  onto the graph of  $y = (x - 3)^2 + 8$ .

Subtracting 3 from x moves it 3 to the right and adding 8 to all of it moves it up 8

(ii) Translation  $\begin{pmatrix} 3 \\ 8 \end{pmatrix}$  [2]

- 16 A lift can travel at a maximum speed of 9.83 m/s, correct to 3 significant figures. The lift travels a distance of 174 m, correct to the nearest metre, between the ground floor and the top floor of a building.

- (a) Use the above information to work out the shortest possible time for the lift to travel between the ground floor and the top floor. You must show your working.

$$\begin{array}{r} 174 - \frac{1}{2} \\ \hline 9.83 + \frac{0.01}{2} \end{array}$$

Writing the formula triangle for speed, distance, time  
 Covering t in the formula triangle finds that time = distance/speed. Using the lower bound for the distance and the upper bound for the speed. Subtracting half of the resolution of the measurement for the distance (which is 1 as it is to the nearest 1 metre) gives the lower bound of the distance. Adding half of the resolution of the measurement for the speed (which is 0.01 as the 3rd significant figure is in the hundredths place) gives the upper bound of the speed

(a) ..... 17.6 ..... s [4]

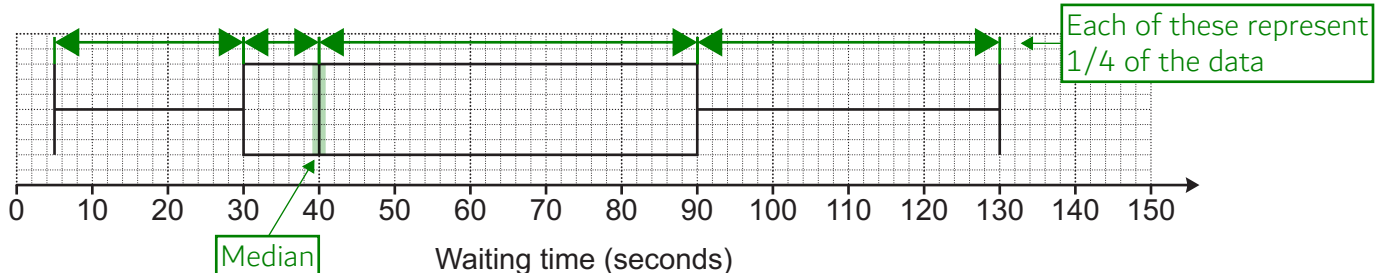
- (b) Explain why your answer to part (a) may not be possible to achieve.

It will not always be at the maximum speed

It needs to speed up and slow down

[1]

- 17 The box plot shows the distribution of the waiting time of cars at a road junction.



- (a) Write down the median waiting time.

(a) ..... 40 ..... s [1]

- (b) What percentage of the waiting times were less than 30 seconds?

30 seconds is the lower quartile. So 1/4 of the data is less than 30 seconds. 1/4 is 25%

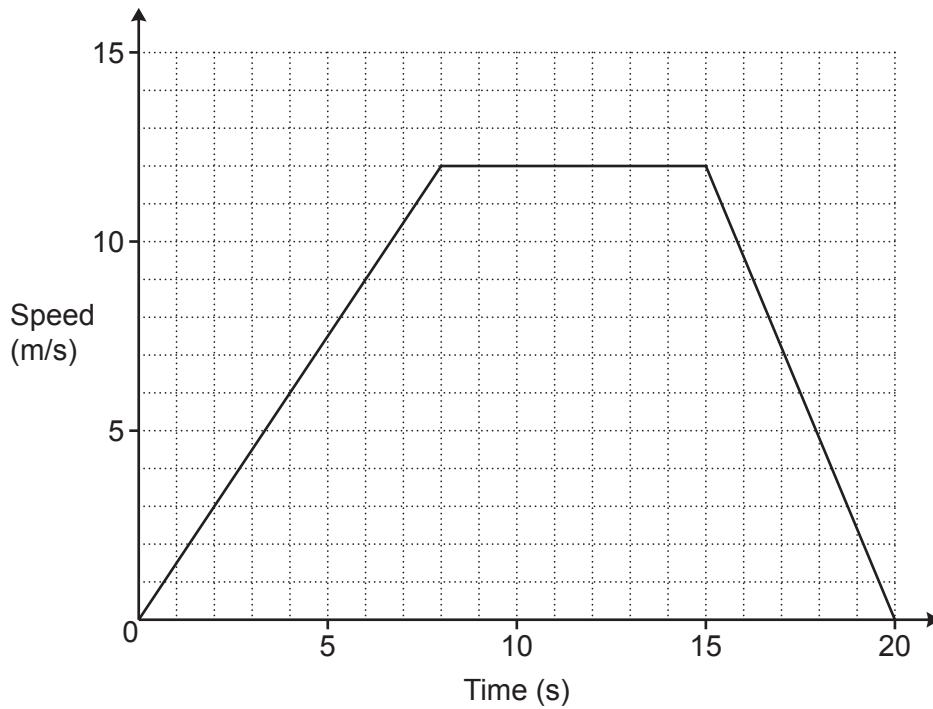
(b) ..... 25 ..... % [1]

- (c) Given that a randomly chosen car waited for more than 30 seconds, write down the probability that the car waited for more than 90 seconds.

3/4 of the data is more than 30 seconds. 1 out of these 3 quarters is more than 90 seconds

(c) .....  $\frac{1}{3}$  ..... [1]

- 18 (a) The graph shows the speed of an object during the first 20 seconds of its motion.



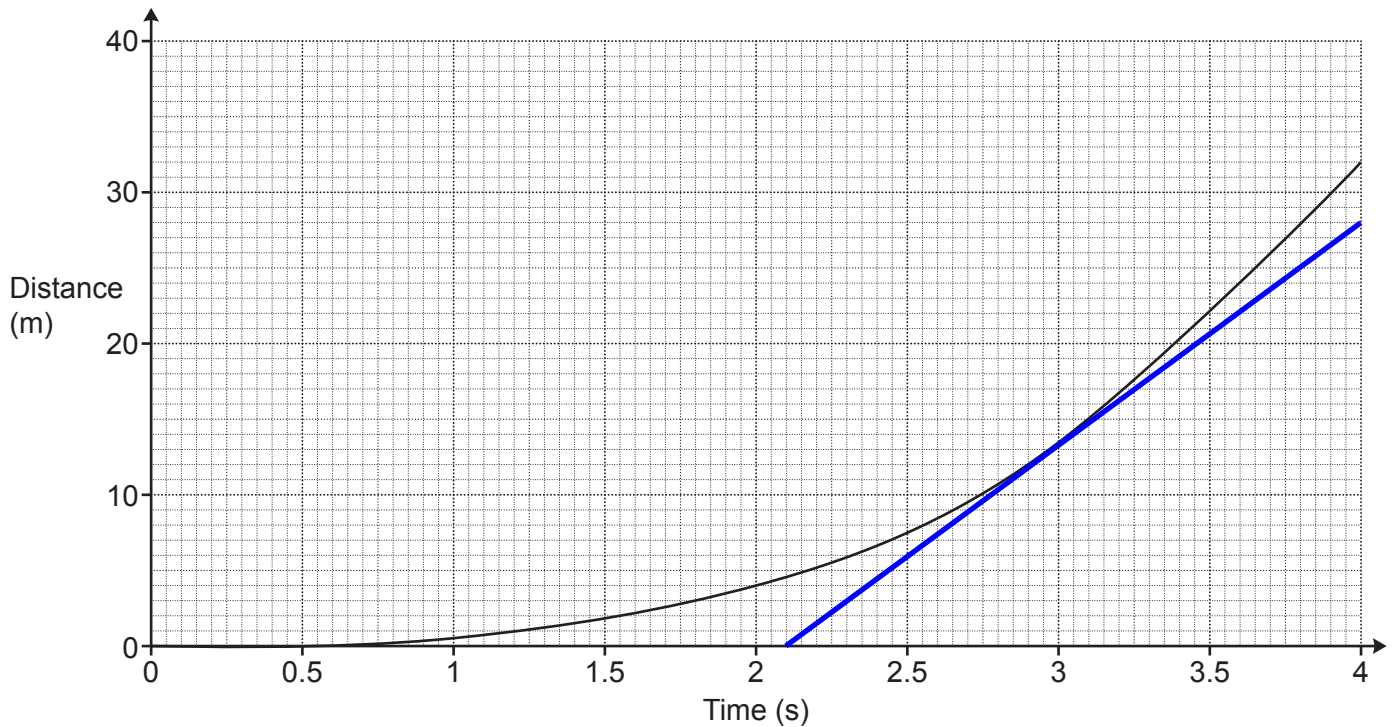
Calculate the distance travelled by the object during the 20 seconds.

$$\frac{1}{2} (7 + 20) \times 12$$

The distance is the area under the line on a speed-time graph. The shape is a trapezium. Area of trapezium =  $\frac{1}{2} (a + b) \times h$ , where a and b are the parallel sides and h is the distance between them

(a) ..... 162 ..... m [3]

(b) The graph shows the distance travelled by an object during the first 4 seconds of its motion.



(i) Work out the average speed of this object between 2 and 4 seconds.

$$\frac{32 - 0}{4 - 2}$$

m/s means to divide the metres travelled by the time taken in seconds. The change in distance from 2 seconds to 4 seconds is  $32 - 0$  and the change in time is  $4 - 2$

(b)(i) ..... 14 ..... m/s [2]

(ii) Use the graph to estimate the speed of this object at 3 seconds.

You must show working to support your estimate.

$$\frac{28 - 0}{4 - 2.1}$$

Speed is the gradient on a distance-time graph. Drawing a tangent at 3 seconds then working out its gradient estimates the speed. Gradient = up/across. It went up from 0 to 28 so  $28 - 0$  is how far it went up. It went across from 2.1 to 4 so  $4 - 2.1$  is how far it went across

(ii) ..... 14.7 ..... m/s [3]

(iii) What happens to the speed of this object during these 4 seconds of motion. Explain how you know.

The speed increases .....

I know this because the gradient increases .....

It is getting steeper

[1]

Turn over for question 19

- 19 Show that  $\frac{\sqrt{3}+2}{\sqrt{48}-6}$  can be written in the form  $\frac{a+b\sqrt{3}}{6}$ .

You must show each step in your working.

[5]

$$\frac{\sqrt{3}+2}{\sqrt{48}-6} \times \frac{\sqrt{48}+6}{\sqrt{48}+6} \quad \leftarrow \text{Flipping the sign on } \sqrt{48}-6 \text{ gives } \sqrt{48}+6. \text{ Multiplying both the numerator and denominator by this will rationalise the denominator}$$

$$\frac{\sqrt{144}+6\sqrt{3}+2\sqrt{48}+12}{48+6\sqrt{48}-6\sqrt{48}-36} \quad \leftarrow \text{Expanding the numerators and expanding the denominators}$$

$$\frac{12+6\sqrt{3}+8\sqrt{3}+12}{12} \quad \leftarrow \text{Simplifying the surds on the numerator. Collecting like terms on the denominator}$$

$$\frac{24+14\sqrt{3}}{12} \quad \leftarrow \text{Collecting like terms on the numerator}$$

$$\frac{12+7\sqrt{3}}{6} \quad \leftarrow \text{Simplifying the fraction by dividing all terms on both the numerator and denominator by 2}$$

END OF QUESTION PAPER

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