Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

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

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 π button, take the value of π 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.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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E:1/1/1/1/1/1/1/

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

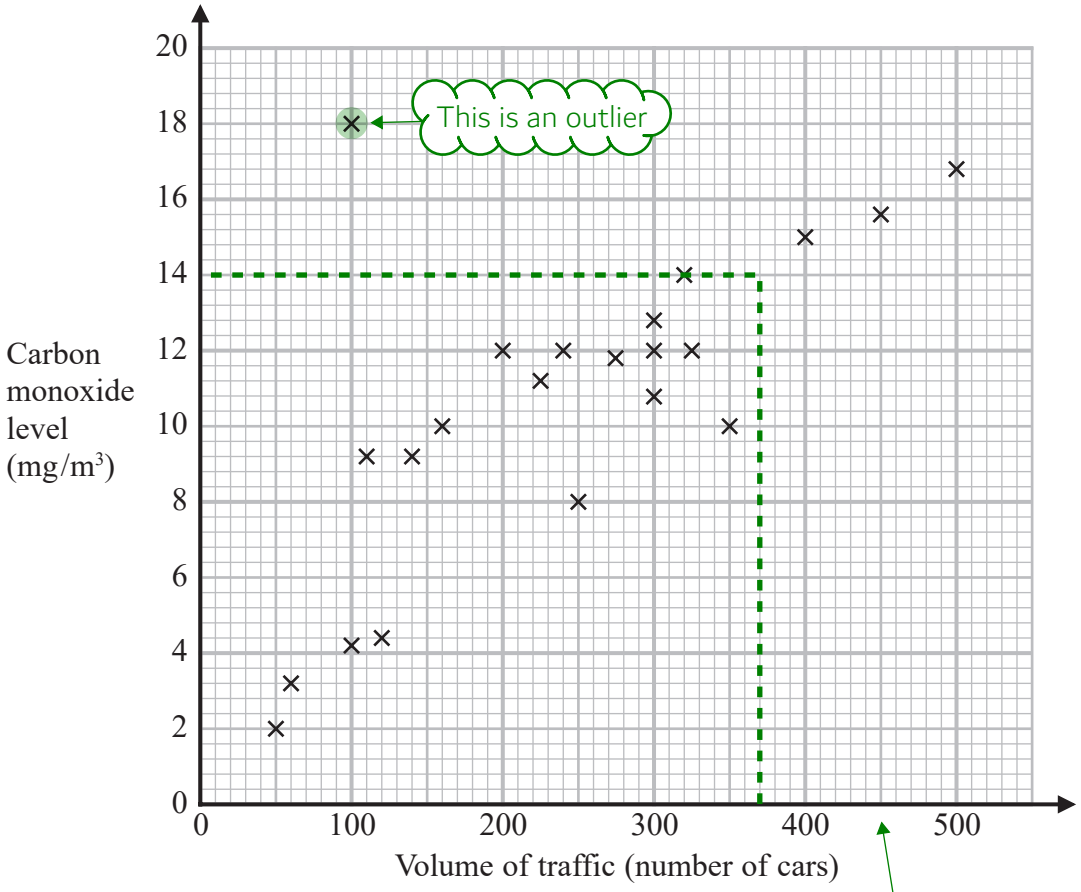
.CG Maths.

Answer ALL questions.

Write your answers in the spaces provided.

You must write down all the stages in your working.

1 The scatter graph shows information about the volume of traffic and the carbon monoxide level at a point on a road each day for 22 days.



The scale goes up 100 over 10 small boxes. 100/10 = 10 so each small box is worth 10

One point is an outlier.

(a) Write down the coordinates of this point.

(100 , 18)

(1)

For another day, 370 cars pass the point on the road.

(b) Estimate the carbon monoxide level for this day.

Reading up to a point on the graph which is about in the middle of the surrounding data then reading across. There is no need to draw a line of best fit and this can actually make it more difficult to make an estimate

14 mg/m³

(2)

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Alfie says,

"Because there is an outlier, there is no correlation."

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

No, this point can be ignored

(1)

(Total for Question 1 is 4 marks)

2 Natalie makes potato cakes in a restaurant.

She mixes potato, cheese and onion so that

weight of potato : weight of cheese : weight of onion = 9 : 2 : 1

Natalie needs to make 6000 g of potato cakes.

Cheese costs £2.25 for 175 g.

Work out the cost of the cheese needed to make 6000 g of potato cakes.

$\frac{6000}{9+2+1} \times 2 \times 2.25$

9 + 2 + 1 works out how many parts there are in total. This number of parts represents the total 6000g. So dividing the 6000 by this many parts works out what 1 part of the ratio is worth. Multiplying this by 2 works out what the 2 parts representing the cheese is worth. Dividing this by 175 works out how many lots of 175g the cheese is. Multiplying this by £2.25 works out the cost of this many lots of the cheese

The answer of 12.857... is rounded to the nearest penny

£ 12.86

(Total for Question 2 is 4 marks)

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3 (a) Write 4.5×10^5 as an ordinary number.

Type into calculator

450000

(1)

(b) Write 0.007 in standard form.

Type into calculator

7×10^{-3}

(1)

(c) Work out $4.2 \times 10^3 + 5.3 \times 10^2$
Give your answer in standard form.

Typing into calculator gives 4730

Standard form is a x 10^n, where $1 \leq a < 10$ and n is an integer. Keep dividing 4730 by 10 until it is a number between 1 and 10 then multiply it by a power of 10 which multiplies by 10 that many times. x10^y multiplies by 10 y times

4.73×10^3

(2)

(Total for Question 3 is 4 marks)

4 A water tank is empty.
Anil needs to fill the tank with 2400 litres of water.

Company **A** supplies water at a rate of 8 litres in 1 minute 40 seconds.
Company **B** supplies water at a rate of 2.2 gallons per minute.

1 gallon = 4.54 litres

Company **A** would take more time to fill the tank than Company **B** would take to fill the tank.

How much more time?
Give your answer in minutes correct to the nearest minute.

$\frac{2400}{8} \times 1{:}40 - \frac{2400}{2.2 \times 4.54}$

Subtracting the time for Company B from the time for Company A works out how many more minutes it takes

This works out the time in minutes for Company A. 2400/8 works out how many lots of the 8 litres are needed. Then multiplying this by the time taken per lot of 8 litres works out the total time taken

This works out the time in minutes for Company B. 2.2 x 4.54 converts the gallons into litres. Dividing the 2400 by this works out how many lots of that many litres it is and therefore how many minutes it takes

1°40°
Time can be entered into the calculator using the ⁰'" button

260 minutes

(Total for Question 4 is 4 marks)

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5 The first four terms of a Fibonacci sequence are

$$a \qquad 2a \qquad 3a \qquad 5a$$

The sum of the first five terms of this sequence is 228

Work out the value of a.

$a+2a+3a+5a+8a$ ← Adding together the first five terms. The fifth term is 8a as 3a + 5a = 8a. In a Fibonacci sequence, the two previous terms are added to get the next term

$19a=228$ ← Simplifying the expression of the sum of the first five terms and setting it equal to 228

Dividing both sides by 19 finds a →

12

(Total for Question 5 is 3 marks)

6 In a bag there are only red counters, blue counters, green counters and pink counters.
A counter is going to be taken at random from the bag.

The table shows the probabilities of taking a red counter or a blue counter.

Colour	red	blue	green	pink
Probability	0.05	0.15	0.5	0.3

The probability of taking a green counter is 0.2 more than the probability of taking a pink counter.

(a) Complete the table.

$p + p + 0.2 = 1 - 0.05 - 0.15$

$2p = 0.8 - 0.2$

$p = \frac{0.6}{2}$

$0.3 + 0.2$

p is the probability for pink. p + 0.2 must be the probability for green. Subtracting the probabilities for red and blue from 1 leaves the total probability for green and pink added together

The probability for pink is 0.3. Adding 0.2 works out the probability for green

(2)

There are 18 blue counters in the bag.

(b) Work out the total number of counters in the bag.

$x \times 0.15 = 18$

x is the total number of counters. Multiplying this by the probability of blue expresses the number of blue counters, which is 18

$x = \frac{18}{0.15}$

Rearranged to find x by dividing both sides by 0.15

120

(2)

(Total for Question 6 is 4 marks)

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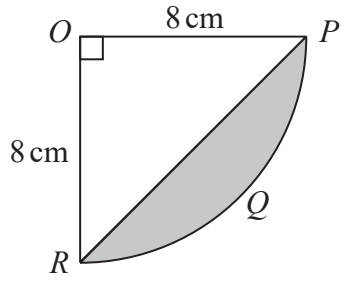
7 The diagram shows a sector $OPQR$ of a circle, centre O and radius 8 cm.



OPR is a triangle.

Work out the area of the shaded segment PQR.
Give your answer correct to 3 significant figures.

$\frac{\pi \times 8^2}{4} - \frac{1}{2} \times 8 \times 8$

Subtracting the area of the triangle from the sector leaves the shaded segment

Area of the sector OPQR. Area of circle = π x radius^2. The radius is 8cm. Dividing the area of the whole circle by 4 as it is a quarter of the circle

Area of the triangle OPR. Area of triangle = 1/2 x base x height. The base and height are both 8cm

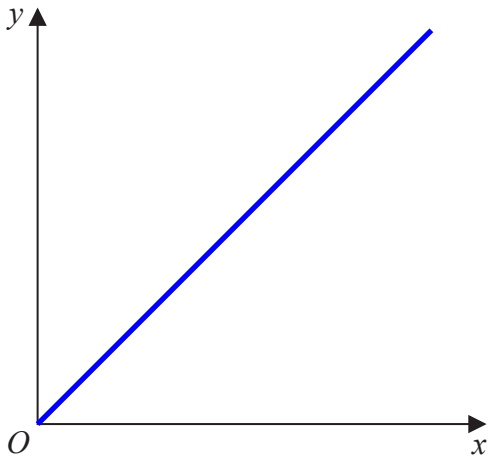
The answer of 18.265... is rounded to 3 significant figures

18.3 cm^2

(Total for Question 7 is 4 marks)

8 (a) Using the axes below, sketch a graph to represent the statement

y is directly proportional to x

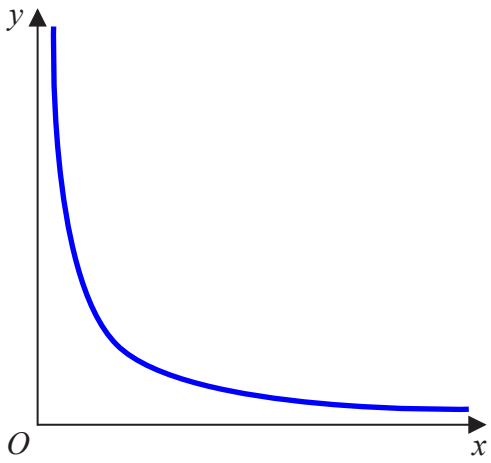


A straight line with a positive gradient going through the origin

(1)

(b) Using the axes below, sketch a graph to represent the statement

y is inversely proportional to x



Using table mode, set f(x) = 1/x. Table range, Start: 0, End: 5, Step: 1

(1)

(Total for Question 8 is 2 marks)

The graph of y = 1/x is a graph in which y is inversely proportional to x

9 On Monday, 12 people took 5 hours to clean a number of cars.
On Tuesday, 15 people cleaned the same number of cars.

Assuming that all the people worked at the same rate,

(a) work out how many hours the 15 people took to clean the cars.

$\frac{12 \times 5}{15}$ ← Multiplying the 12 by the 5 works out how many hours worth of work need to be done. Dividing this by the 15 works out how long it will take for each of the 15 people

4 hours

(2)

The assumption is wrong.

(b) How might this affect the time taken for the 15 people to clean the cars?

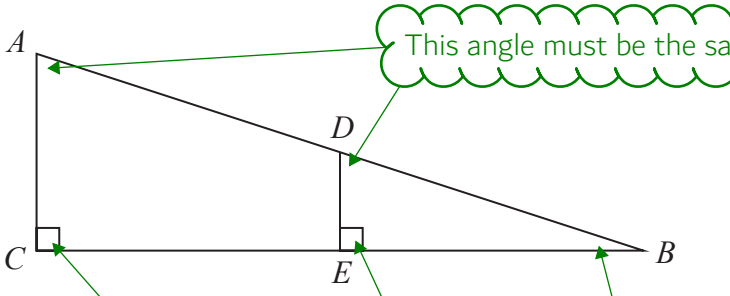
It could be different

It would be impossible to work out an exact time if each person works at a different rate

(1)

(Total for Question 9 is 3 marks)

10 The diagram shows two right-angled triangles *ACB* and *DEB*.



This angle must be the same in both triangles

Both triangles have a right angle

This angle is shared by both triangles

$AD = 9$ cm
$DE = 2$ cm
$DB = 6$ cm

Calculate the length of *CB*.
Give your answer correct to 2 decimal places.

$\frac{9+6}{6} \times 2$ ← Triangles ACB and DEB are similar as the angles in both triangles are the same. 9 + 6 works out the length of AB. Dividing this by DB, which is the smaller version of AB, works out the scale factor. Multiplying this by DE works out AC

$a^2+b^2=c^2$ ← Side CB is the missing side in a right angled triangle so Pythagoras' Theorem can be used to work it out

$a=\sqrt{c^2-b^2}$ ← CB is one of the shorter sides so rearranged to make a the subject

$CB=\sqrt{15^2-5^2}$ ← Substituted CB for a, AB for c as it is the longest side and AC for b

14.14 ..... cm

(Total for Question 10 is 4 marks)

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11 Freya writes down the value of x, correct to 1 decimal place.

She writes $x = 6.4$

Complete the error interval for x.

$6.4 \pm \frac{0.1}{2}$ ← Subtracting half of the resolution works out the lower bound. Adding half of the resolution works out the upper bound. The resolution is 0.1 as it is correct to 1 decimal place

Lower bound → 6.35 ..... $\leqslant x <$ ..... 6.45 ← Upper bound

(Total for Question 11 is 2 marks)

12 $(ax^6)^{\frac{1}{n}} = 7x^3$

Work out the value of a and the value of n.

$\frac{6}{n} = 3$ ← Both parts of ax^6 can be raised to the power separately. $(x^6)^{1/n} = x^{6/n} = x^3$. The power on both sides must be equal. n must be 2 as 6/2 = 3

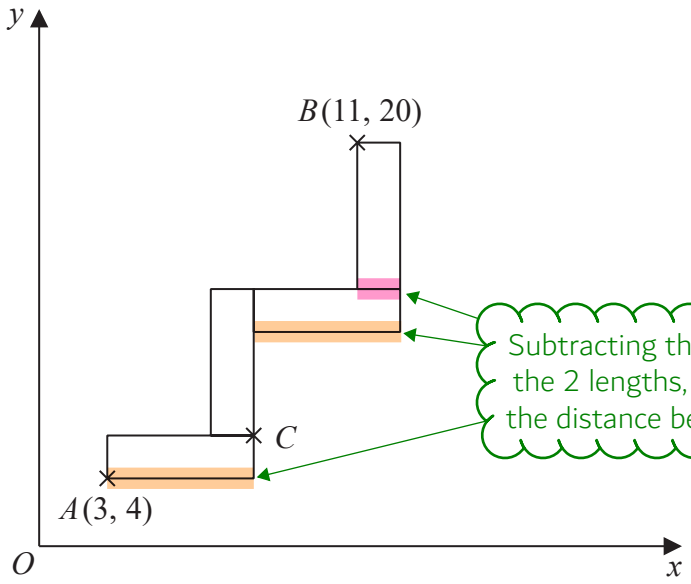
$\sqrt{a} = 7$ ← $a^{1/2} = 7$. The power of 1/2 is the same as square rooting. Squaring both sides finds a

$a =$ 49

$n =$ 2

(Total for Question 12 is 2 marks)

13 A pattern is made from four identical rectangles.
The sides of the rectangles are parallel to the axes.



Subtracting the width, highlighted in pink, from the 2 lengths, highlighted in orange, works out the distance between A and B in the x direction

Point A has coordinates (3, 4)
Point B has coordinates (11, 20)
Point C is marked on the diagram.

Work out the coordinates of C.
You must show all your working.

Let L be the length of a rectangle and W be the width of a rectangle

$2L-W=8$ ← Subtracting a width from 2 lengths works out the distance between A and B in the x direction. This distance is 11 - 3 = 8

$2L+W=16$ ← Adding a width to 2 lengths works out the distance between A and B in the y direction. This distance is 20 - 4 = 16

$2W=8$ ← Solving the equations simultaneously. Subtracting the first equation from the second equation cancels out the lengths and leaves an equation just in terms of the width

$W=4$ ← Dividing both sides by 2 works out the width

$2L-4=8$ ← Substituting 4 for the width in the first equation

$L=\frac{8+4}{2}=6$ ← Rearranging to find the length, which is 6

$3+6$
$4+4$
← Working out the x-coordinate of C by adding 1 length to the x-coordinate of A. Working out the y-coordinate of C by adding 1 width to the y-coordinate of A

(9 , 8)

(Total for Question 13 is 5 marks)

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14 Olivia and Jessica have in total half as many sweets as Fran and Gary have in total.

Fran and Gary share their sweets in the ratio 2 : 3
Olivia and Jessica share their sweets in the ratio 9 : 1

Fran got w sweets.
Gary got x sweets.
Olivia got y sweets.
Jessica got z sweets.

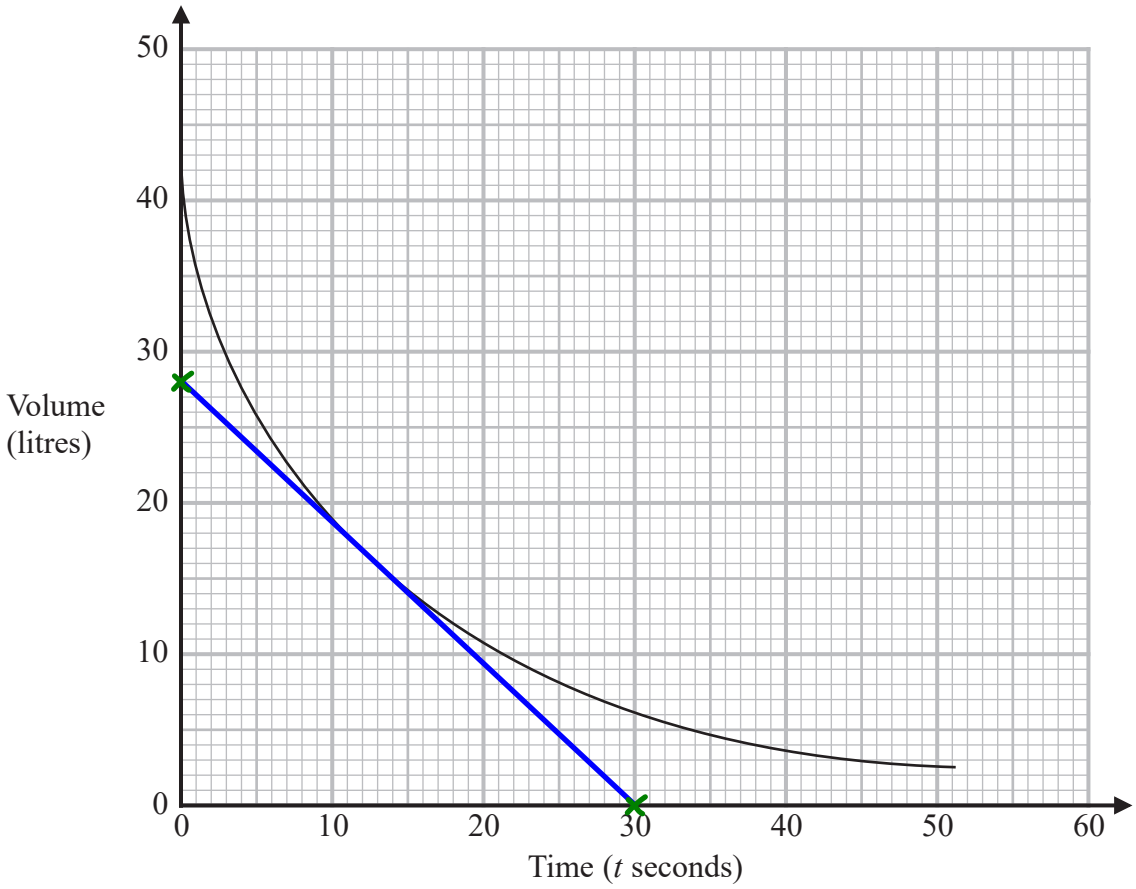
Find, in its simplest form, $w : x : y : z$

The ratio for Fran and Gary has 5 parts in total. The ratio for Olivia and Jessica has 10 parts in total. As Fran and Gary have twice as many sweets in total, there needs to be twice as many parts in total in their ratio. 10 x 2 = 20 so there needs to be 20 parts in their ratio. 5 needs to be multiplied by 4 to get 20 so both sides of the 2 : 3 ratio are multiplied by 4 to get 8 : 12. This can be combined with the other ratio as 1 part is now worth the same in both ratios

8:12:9:1

(Total for Question 14 is 4 marks)

15 The graph gives the volume of water, in litres, in a container at time t seconds after the water started to flow out of the container.



Using the graph, work out an estimate for the rate at which the water is flowing out of the container when $t = 12$
You must show your working.

Drawing a tangent to the curve at the point where t = 12. The gradient of the tangent is an estimate of the gradient of the curve at that point, which is the rate at which the water is flowing

$\frac{-28}{30}$ ← Gradient = (change in y)/(change in x). The change in y is -28 as it decreases from 28 to 0 in the y direction. The change in x is 30 as it increases from 0 to 30 in the x direction

The negative sign is ignored as water flowing out is negative flow → 0.9 litres per second

(Total for Question 15 is 3 marks)

16 The curve **C** has equation $y = x^2 + 3x - 3$

The line **L** has equation $y - 5x + 4 = 0$

Show, algebraically, that **C** and **L** have exactly one point in common.

$x^2+3x-3-5x+4=0$ ← Substituting y for $x^2 + 3x - 3$ in the second equation to eliminate the y terms and leave an equation in terms of x which can be solved

$x^2-2x+1=0$ ← Simplifying by collecting like terms

$x=\frac{-(-2)\pm\sqrt{(-2)^2-4\times1\times1}}{2\times1}$ ← Solving using the quadratic formula. This is easier than factorising on a calculator paper

$x=1$ ← Both solutions of x are 1

There is only 1 x value therefore only one point in common

There can't be 2 y values for the given x value with a linear equation

(Total for Question 16 is 4 marks)

17 x is directly proportional to the square of y.
y is directly proportional to the cube of z.

$z = 2$ when $x = 32$

Find a formula for x in terms of z.

$x = ky^2$ ← Converting both proportions into equations by multiplying the right sides by different letters which represent constants

$y = cz^3$ ←

$x = k(cz^3)^2$ ← Substituting y for cz^3 in the first equation to eliminate y

$= kc^2z^6$ ← Raising both parts in the bracket to the power of 2. $(a^x)^y = a^{xy}$

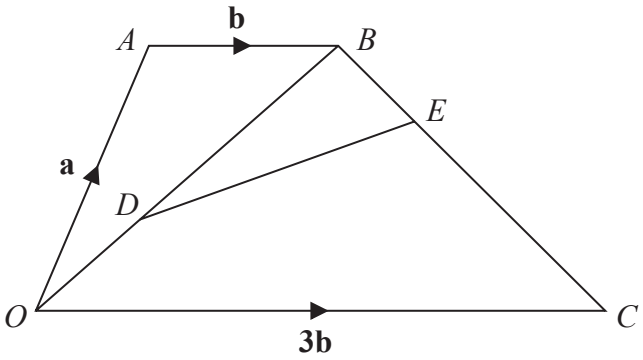
$kc^2 = \frac{x}{z^6}$ ← Both k and c are constants therefore multiplying them together is still constant. Rearranging to find this constant

$= \frac{32}{2^6}$ ← Substituting in the x and z values given

Substituting the value of kc^2 back into the equation → $x = \frac{1}{2}z^6$

(Total for Question 17 is 4 marks)

18 $OABC$ is a trapezium.



$\overrightarrow{OA} = \mathbf{a}$
$\overrightarrow{AB} = \mathbf{b}$
$\overrightarrow{OC} = \mathbf{3b}$

D is the point on OB such that $OD : DB = 2 : 3$
E is the point on BC such that $BE : EC = 1 : 4$

Work out the vector $\overrightarrow{DE}$ in terms of **a** and **b**.
Give your answer in its simplest form.

$\frac{3}{5}(a+b)+\frac{1}{5}(-b-a+3b)$ ← $\overrightarrow{DE} = \overrightarrow{DB} + \overrightarrow{BE}$. $\overrightarrow{DB} = 3/5\ \overrightarrow{OB}$ as there are 5 parts in total in the ratio from O to B and 3 of these are for DB. $\overrightarrow{OB} = \overrightarrow{OA} + \overrightarrow{AB} = a + b$. $\overrightarrow{BE} = 1/5\ \overrightarrow{BC}$ as there are 5 parts in total in the ratio from B to C and 1 of these are for BE. $\overrightarrow{BC} = \overrightarrow{BA} + \overrightarrow{AO} + \overrightarrow{OC} = -b - a + 3b$

$\frac{3}{5}a+\frac{3}{5}b-\frac{1}{5}a+\frac{2}{5}b$ ← Simplifying -b - a + 3b to -a + 2b and expanding the brackets

Simplifying by collecting like terms → $\frac{2}{5}a+b$

(Total for Question 18 is 4 marks)

19 At the start of year n, the number of animals in a population is P_n

At the start of the following year, the number of animals in the population is P_{n+1} where

$$P_{n+1} = kP_n$$

At the start of 2017 the number of animals in the population was 4000
At the start of 2019 the number of animals in the population was 3610

Find the value of the constant k.

$3610 = 4000k^2$ ← If n is 2017, n + 1 is 2018. So to work out the population of the next year, k must be multiplied by the population of the current year. Multiplying the population in 2017 by k once expresses the population in 2018. Multiplying by k again expresses the population in 2019. The 3610 must be equal to this

$\sqrt{\frac{3610}{4000}} = k$ ← Rearranging to find k by dividing both sides by 4000 then square rooting

0.95

(Total for Question 19 is 3 marks)

20 Pat throws a fair coin n times.

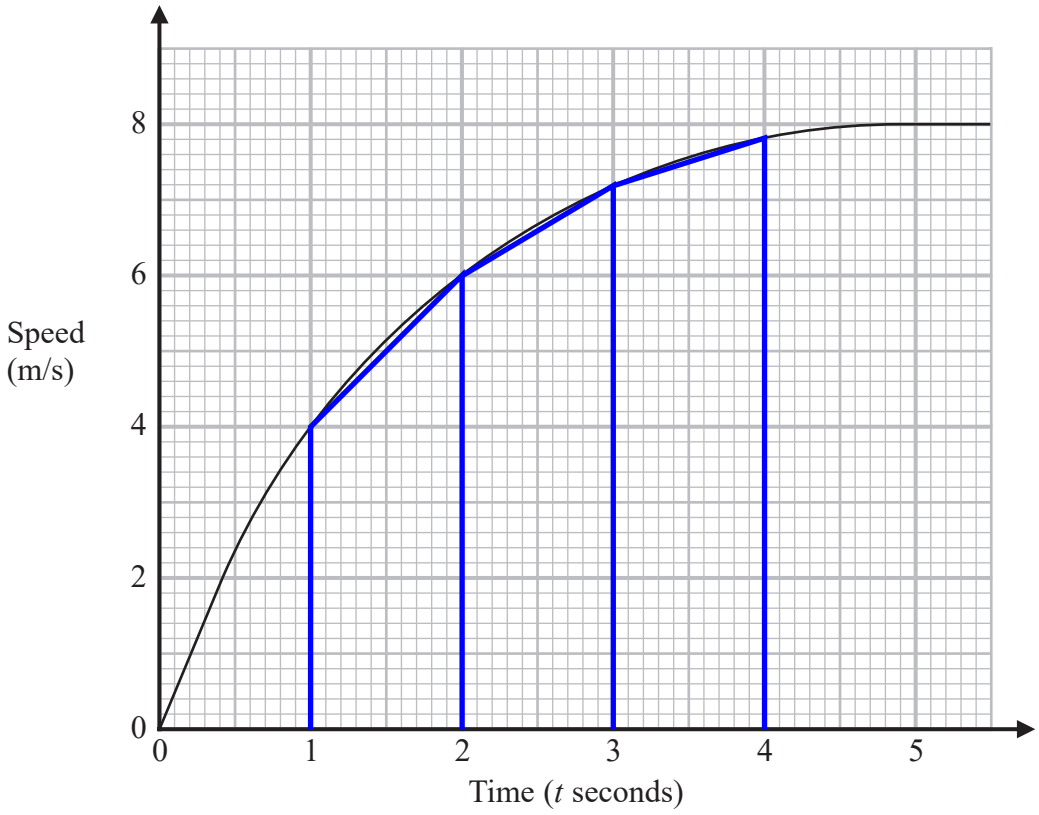
Find an expression, in terms of n, for the probability that Pat gets at least 1 head and at least 1 tail.

The opposite of getting at least 1 head and at least 1 tail is getting all heads or all tails. The probability of getting all heads is $(1/2)^n$ as the probability for the coin to land on head is 1/2 and it is raised to the power of n as 1/2 needs to be multiplied by itself n times. For example when n is 3 the coin needs to land on heads 3 times and this will be 1/2 x 1/2 x 1/2 which is $(1/2)^3$. The probability of getting all tails is also $(1/2)^n$. Adding these together expresses the probability of getting either all heads or all tails. Subtracting this from 1 expresses the probability of not getting all heads or all tails

$1-\left(\left(\frac{1}{2}\right)^n+\left(\frac{1}{2}\right)^n\right)$

(Total for Question 20 is 2 marks)

21 Here is a speed-time graph showing the speed, in metres per second, of an object t seconds after it started to move from rest.



(a) Using 3 trapeziums of equal width, work out an estimate for the area under the graph between $t = 1$ and $t = 4$

$\frac{1}{2}(4+6)\times1+\frac{1}{2}(6+7.2)\times1+\frac{1}{2}(7.2+7.8)\times1$

Area of trapezium = 1/2 (a + b) x h, where a and b are the parallel sides and h is the distance between them. Adding the area of each trapezium works out the total area of the trapeziums

19.1

(3)

(b) What does this area represent?

Distance

1/2 (a + b) basically works out average speed. This is multiplied by h, which is time. Speed x time = distance

(1)

(Total for Question 21 is 4 marks)

22 Show that $\frac{6x^3}{(9x^2 - 144)} \div \frac{2x^4}{3(x - 4)}$ can be written in the form $\frac{1}{x(x + r)}$ where r is an integer.

$(3x+12)(3x-12)$ ← Factorising $9x^2 - 144$ using difference of two squares. $A^2 - B^2 = (A + B)(A - B)$

$3(x+4)\times 3(x-4)$ ← Bringing 3 out as a factor for both brackets

$\frac{6x^3}{9(x+4)(x-4)} \times \frac{3(x-4)}{2x^4}$ ← Multiplication can be done in any order. 3 x 3 = 9. The brackets are left multiplied together. To divide by a fraction, keep the first part, change the sign and flip the second fraction

$\frac{18x^3(x-4)}{18(x+4)(x-4)x^4}$ ← Multiplying the numerators and denominators without expanding any brackets and keeping in factorised form

$\frac{1}{x(x+4)}$ ← Dividing both the numerator and denominator by any common factors to both. 18, (x - 4) and x^3 are common factors so both are divided by these

(Total for Question 22 is 3 marks)

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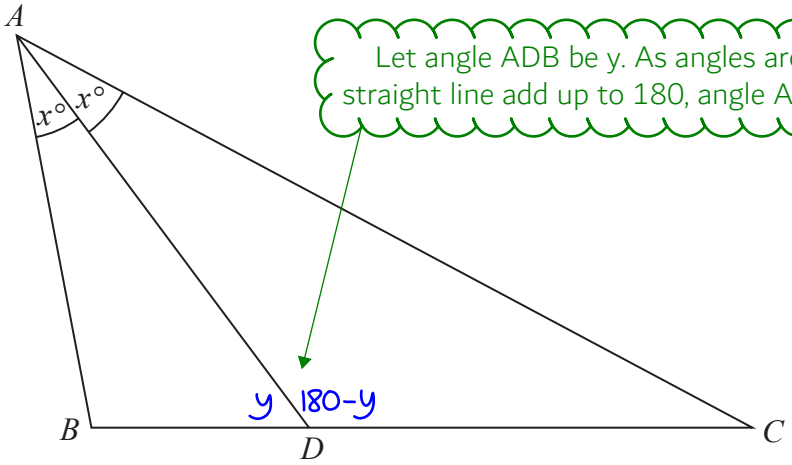
23 ABC is a triangle.



Let angle ADB be y. As angles around a point on a straight line add up to 180, angle ADC must be 180 - y

D is the point on BC such that angle BAD = angle DAC = $x°$

Prove that $\frac{AB}{BD} = \frac{AC}{DC}$

$\frac{BD}{\sin x} = \frac{AB}{\sin y}$ ← Using the sine rule in triangle ABD

$\frac{\sin y}{\sin x} = \frac{AB}{BD}$ ← Rearranging to find AB/BD

$\frac{DC}{\sin x} = \frac{AC}{\sin(180-y)}$ ← Using the sine rule in triangle ADC

$\frac{\sin(180-y)}{\sin x} = \frac{AC}{DC}$ ← Rearranging to find AC/DC

$\frac{\sin y}{\sin x} = \frac{AC}{DC}$ ← sin(180 - y) = siny as the sin graph is symmetrical from 0 to 180

$\frac{AB}{BD} = \frac{AC}{DC}$ ← As both AB/BD and AC/DC equal to siny/sinx

(Total for Question 23 is 4 marks)

TOTAL FOR PAPER IS 80 MARKS