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)

Wednesday 6 November 2024

Morning (Time: 1 hour 30 minutes)

Paper reference **1MA1/1H**

Mathematics

PAPER 1 (Non-Calculator)

Higher Tier

You must have: Ruler graduated in centimetres and millimetres, protractor, pair of compasses, pen, HB or B pencil, eraser, Formulae Sheet (enclosed). Tracing paper may be used.

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- **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 not be used**.

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

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 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

Answer ALL questions.

Write your answers in the spaces provided.

You must write down all the stages in your working.

1 Work out 818.4 ÷ 1.2

0 6 8 2
12 | 8 ^{8}1 ^{9}8 ^{2}4

Multiplying both the 818.4 and the 1.2 by 10 eliminates the decimal on the 1.2. This is an equivalent division

12, 24, 36, 48, 60, 72, 84, 96, 108

Listing out the 12 times table can help with the division

682

(Total for Question 1 is 3 marks)

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2 The table shows the probabilities that a biased dice will land on 3, on 4, on 5 and on 6

Number on dice	1	2	3	4	5	6
Probability			0.10	0.30	0.05	0.25

Karim assumes that the probabilities that the dice will land on 1 and on 2 are the same.

Karim rolls the biased dice 500 times.

(a) Assuming Karim is right, work out an estimate for the number of times the dice will land on 2

0.10
+ 0.30
+ 0.05
+ 0.25
0.70

Adding the probabilities for 3, 4, 5, 6 works out that the probability of the dice not landing on 1 or 2 is 0.7

1.0
- 0.7
0.3

It is certain to either land on 1 or 2 or to not land on 1 or 2. So the probabilities need to add up to 1. Subtracting the probability of not landing on 1 or 2 from 1 works out that the probability of landing on 1 or 2 is 0.3

500 × 0.3

Multiplying the 500 rolls by the probability of landing on 1 or 2 estimates that the dice will land on 1 or 2 150 times. 5 × 3 = 15 so 500 × 0.3 = 150

150 ÷ 2 = 075

It is assumed that the probabilities of 1 and 2 are the same. So the number of times it lands on 2 would be half of the time it lands on 1 or 2

75

(3)

Karim is wrong.
The probability that the dice will land on 2 is greater than the probability that the dice will land on 1

(b) How does this information affect your answer to part (a)?

It will be greater

Increasing the probability of 2 should increase the number of times it lands on 2

(1)

(Total for Question 2 is 4 marks)

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3 (a) Work out $3\frac{1}{2} - 1\frac{1}{6}$

Give your answer as a mixed number.

$\frac{7}{2} - \frac{7}{6}$ ← Converted the mixed numbers into improper fractions by multiplying the whole numbers by the denominators then adding the results to the numerators

$\frac{21}{6} - \frac{7}{6}$ ← Multiplying both the numerator and denominator of 7/2 by 3 so that the denominator is 6 and is the same as the denominator of 7/6

$\frac{14}{6}$ ← Subtracting the numerators. The denominator stays the same

Converting into a mixed number by dividing the numerator by the denominator to get the whole number and leaving the remainder in the fraction → $2\frac{2}{6}$

(2)

(b) Show that $5\frac{1}{4} \div 2\frac{1}{3} = 2\frac{1}{4}$

Working with the left side to show that it gives the right side

$\frac{21}{4} \div \frac{7}{3}$ ← Converted the mixed numbers into improper fractions by multiplying the whole numbers by the denominators then adding the results to the numerators

$\frac{21}{4} \times \frac{3}{7}$ ← To divide by a fraction: keep the first part, change the division to a multiplication, flip the fraction

$\frac{3}{4} \times \frac{3}{1}$ ← Simplifying the fractions by dividing both the numerator of the first fraction and the denominator of the second fraction by 7

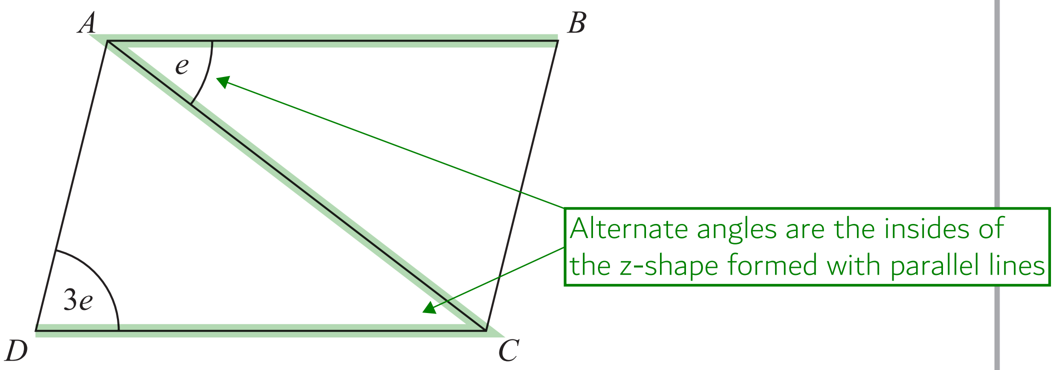
$\frac{9}{4}$ ← To multiply fractions: multiply the numerators and multiply the denominators

$2\frac{1}{4}$ ← Converting into a mixed number by dividing the numerator by the denominator to get the whole number and leaving the remainder in the fraction

(3)

(Total for Question 3 is 5 marks)

4 *ABCD* is a parallelogram.



All angles are measured in degrees.

Find an expression, in terms of *e*, for the size of angle *CAD*.
Give a reason for each stage of your working.

Angle ACD = e, as alternate angles are equal ← Angle ACD = angle CAB

3e + e ← Adding angles ADC and ACD works out that there is 4e in the triangle ACD so far

Angle CAD = 180 - 4e, as angles in a triangle add up to 180°

Subtracting the 4e in the triangle so far from the total of 180° leaves angle CAD

180 - 4e

(Total for Question 4 is 3 marks)

5 A car travelled 4.96 miles at an average speed of 30.4 miles per hour.

(a) Work out an estimate for the time taken by the car.
Give your answer in minutes.

$\overset{d}{s\ \ t}$ ← Writing the formula triangle for distance, speed, time

$\frac{5}{30}$ ← Covering t in the formula triangle finds that time = distance/speed. Rounding the 4.96 miles to 5 miles and the 30.4 miles per hour to 30 miles per hour

$\frac{1}{6} \times 60$ ← Simplifying the fraction by dividing both the numerator and denominator by 5 works out that the estimated time taken is 1/6 of an hour. There are 60 minutes in an hour so multiplying this by 60 converts it into minutes

1/6 × 60 = 60 ÷ 6 = 10 → 10 minutes

(3)

(b) Is your answer to part (a) an underestimate or an overestimate?
Give a reason for your answer.

Overestimate as the distance was rounded up and the speed was rounded down

Dividing a greater number by less will give a greater value. So the estimated time is too great

(1)

(Total for Question 5 is 4 marks)

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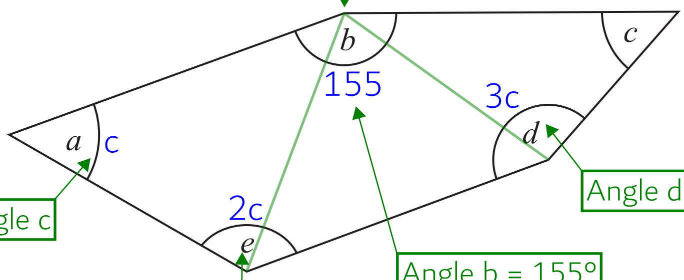
6 Here is a pentagon.

Shown in green: dividing the pentagon into triangles



Angle a = angle c

Angle d is three times the size of angle c

Angle b = 155°

Angle e is two times the size of angle c

Angle a = angle c
Angle b = 155°
Angle d is three times the size of angle c
Angle e is two times the size of angle c

Giving all the angles in terms of c

Work out the size of angle a

$180 \times 3 = 540$

The pentagon can be divided into 3 triangles. Each triangle is 180°. Multiplying 180° by 3 works out that there are 540° in total in the pentagon

$c + 155 + c + 2c + 3c$

Expressing the total of the angles in the pentagon in terms of c by adding all the angles in the pentagon

$7c + 155 = 540$

Simplifying the expression of the total of the angles in the pentagon by collecting like terms. This must be equal to the value of the total 540°

$540 - 155 = 385$

Subtracting 155 from both sides eliminates the +155 on the left and get the c term on its own. 7c = 385

$385 \div 7 = 055$

Dividing both sides of 7c = 385 by 7 eliminates the 7 on the left and gets c on its own. So c = 55

Angle a = angle c. So angle a must also be 55° → 55 °

(Total for Question 6 is 4 marks)

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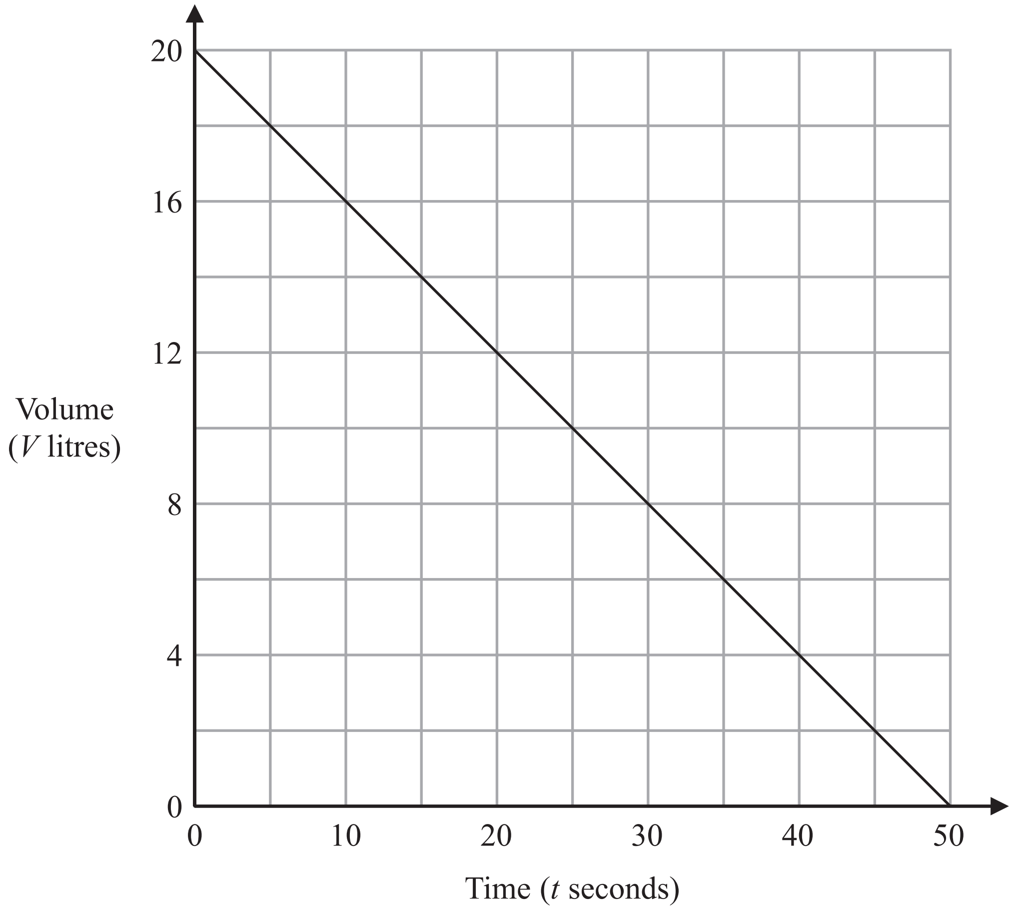
7 The graph shows the volume of water, V litres, in a tank at time t seconds.



What does the gradient of this graph represent?

Change in litres of water per second

Gradient = (change in y)/(change in x), so the change in litres is divided by the seconds taken. Per means to divide

(Total for Question 7 is 1 mark)

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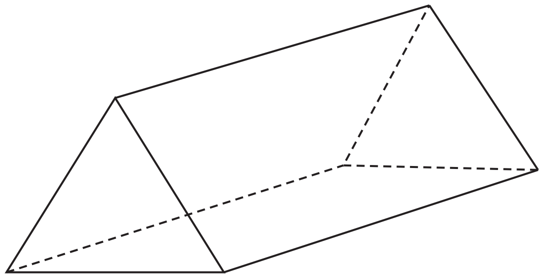
8 The diagram shows a solid triangular prism on a horizontal floor.



$$\text{pressure} = \frac{\text{force}}{\text{area}}$$

The face in contact with the floor is a rectangle of width 2 m.

The pressure on the floor due to the prism is 80 newtons/m^2
The force exerted by the prism on the floor is 720 newtons.

Work out the length of the prism.

$pa = f$ ← Multiplying both sides of the formula by area eliminates area as the denominator

$a = \frac{f}{p}$ ← Dividing both sides by pressure gets area on its own

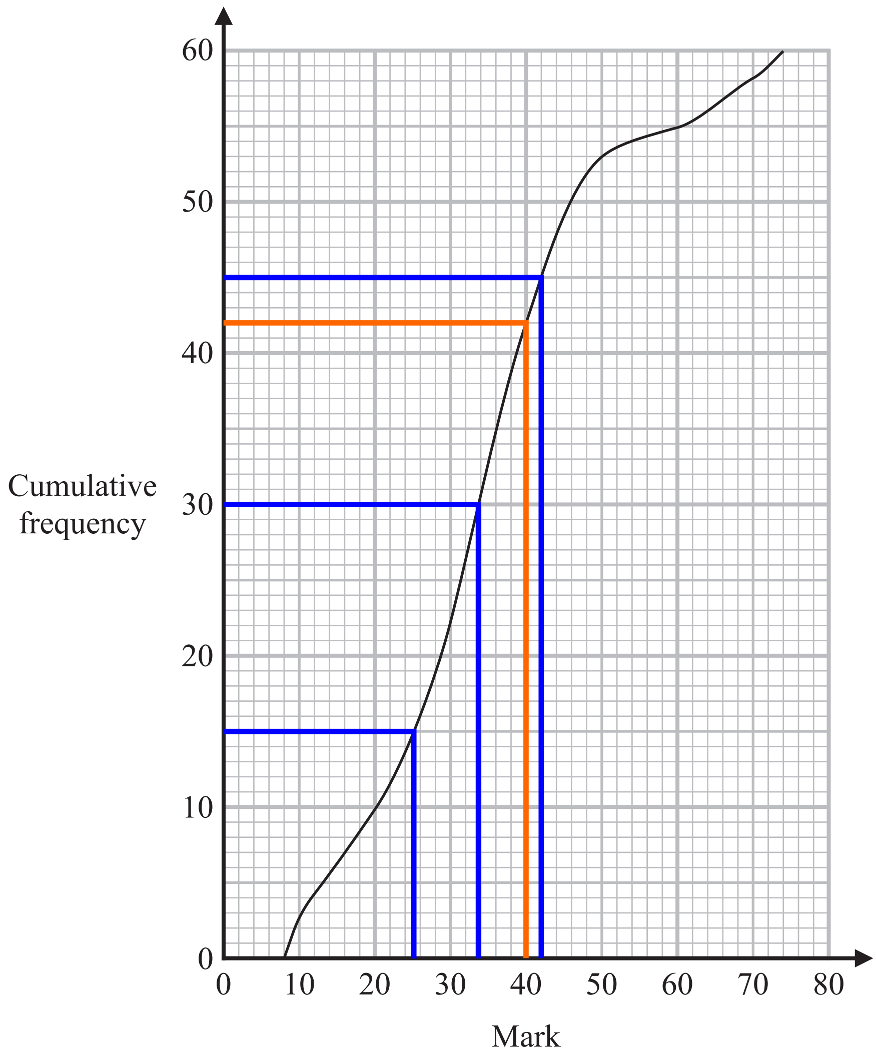
$720 \div 80 = 009$ ← Dividing the force by the pressure works out that the area of the rectangle in contact with the floor is 9 m^2

$9.0 \div 2 = 4.5$ ← Area of rectangle = length × width. Length = area ÷ width

4.5 m

(Total for Question 8 is 3 marks)

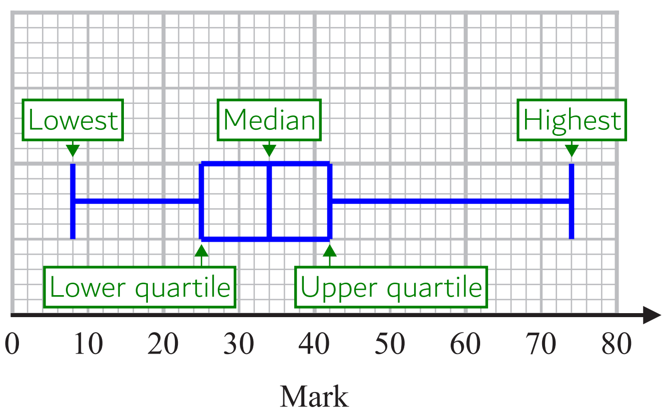
9 The cumulative frequency graph gives information about the marks that 60 students got in a test.



For these 60 students
the highest mark was 74
the lowest mark was 8

The median is roughly halfway through the 60 students. The lower quartile is roughly 1/4 of the way through the 60 students. The upper quartile is roughly 3/4 of the way through the 60 students

(a) On the grid below, draw a box plot for the distribution of the marks.



(3)

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The pass mark for the test was 40

Sian says,

"30% of the 60 students passed the test."

(b) Is Sian correct?
You must show how you get your answer.

$60 - 42 = 18$ ← Drawing a line up from the mark of 40 to the line and across finds that 42 students had a mark less than 40. Subtracting these 42 students from the total 60 students finds that 18 students had a mark of at least 40 so passed

$60 \div 10$ ← This finds that 10% of the 60 students is 6

$6 \times 3 = 18$ ← Multiplying the value of 10% by 3 finds that 30% of the 60 students is 18

Yes ← 30% of the students is 18. Also 18 students had at least 40 marks on the cumulative frequency graph

(3)

(Total for Question 9 is 6 marks)

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10 (a) Work out $25^{\frac{1}{2}} \times 8^{\frac{1}{3}}$

5×2 ← 1/2 as a power means to square root. 1/3 as a power means to cube root

10

(2)

(b) Find the value of $\left(\frac{1}{32}\right)^{\frac{3}{5}}$

$\frac{1}{2}$ ← The 5 as the denominator of the power means to do the fifth root. $\sqrt[5]{1} = 1$ and $\sqrt[5]{32} = 2$

The 3 as the numerator of the power means to cube. $1^3 = 3$ and $2^3 = 8$ → $\frac{1}{8}$

(2)

(Total for Question 10 is 4 marks)

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11 Kate was asked to factorise $x^2 + 5x + 6$ in the form $(x + a)(x + b)$

Kate says,

"The sum of a and b must be 6 and the product of a and b must be 5"

(a) Explain what is wrong with Kate's statement.

The product of a and b must be 6 and the sum of a and b must be 5

This is how to factorise a quadratic in the form $x^2 + bx + c$. Alternatively, consider that $(x + a)(x + b)$ expands to $x^2 + (a + b)x + ab$ then equating coefficients finds that $a + b = 5$ and $ab = 6$

(1)

(b) Factorise fully $2m^2 - 2$

$2(m^2 - 1)$ ← The highest common factor is 2. Bringing this 2 out as a factor, dividing both terms by 2 and leaving the result in a bracket

Factorising further by using difference of two squares. $A^2 - B^2 = (A + B)(A - B)$ → $2(m + 1)(m - 1)$

(2)

(c) Factorise fully $ax + bx - ay - by$

$x(a + b) - y(a + b)$ ← Bringing out x as a factor for the first two terms and bringing out -y as a factor for the last two terms

The a + b bracket is repeated so the x and -y can be brought together into a bracket and multiplied by the a + b bracket once → $(x - y)(a + b)$

(2)

(Total for Question 11 is 5 marks)

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12 **A**, **B** and **C** are three solid spheres.

All spheres are similar

Sphere **A** has a volume of 64 cm^3
Sphere **B** has a volume of 125 cm^3

The radius of sphere **C** is 50% of the radius of sphere **B**.

Work out the ratio of the surface area of sphere **A** to the surface area of sphere **C**.
Give your answer in the form $a : b$ where a and b are integers.

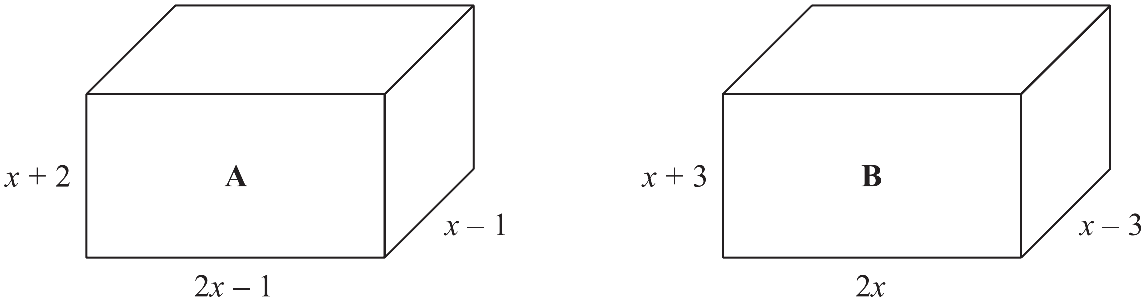
	A	B	C
cm^3 =	64	125	
cm =	4	5	
cm =	8	10	5

Writing the ratio of the volume of A to the volume of B. The unit of volume is cm^3 so cube rooting both the 64 and 125 in this ratio takes it down to the ratio of length, which has unit of cm. So the ratio of length A to the length of B is 4 : 5. Doubling both of these gives 8 : 10, so that the 10 can be halved to give an integer. 50% of 10 is 5, so the ratio of length A to length B to length C is 8 : 10 : 5

The unit of area is cm^2, so squaring both the 8 and 5 gives the ratio of the surface area of A to the surface area of C → 64 : 25

(Total for Question 12 is 4 marks)

13 Here are two cuboids.



All lengths are measured in centimetres.

The volume of cuboid **A** is 142 cm^3 greater than the volume of cuboid **B**.

Work out the value of x.

$(2x - 1)(x - 1)$ ← Volume of cuboid = length × width × height. First multiplying the length and width of A

$2x^2 - 2x - x + 1$ ← Expanding the brackets

$(2x^2 - 3x + 1)(x + 2)$ ← Collecting like terms then multiplying by the height of A

$2x^3 + 4x^2 - 3x^2 - 6x + x + 2$ ← Expanding the brackets

$2x^3 + x^2 - 5x + 2$ ← Collecting like terms to give the expression of the volume of A in its simplest form

$2x(x - 3)$ ← Volume of cuboid = length × width × height. First multiplying the length and width of B

$(2x^2 - 6x)(x + 3)$ ← Expanding the brackets then multiplying by the height of B

$2x^3 + 6x^2 - 6x^2 - 18x$ ← Expanding the brackets

$2x^3 - 18x$ ← Collecting like terms to give the expression of the volume of B in its simplest form

$2x^3 + x^2 - 5x + 2 = 2x^3 - 18x + 142$ ← The volume of cuboid A is 142 cm^3 greater than the volume of cuboid B. So adding 142 to the expression of the volume of B makes it equal to the expression of the volume of A

$x^2 + 13x - 140 = 0$ ← Subtracting $2x^3$ from both sides cancels out the x^3 terms. Adding 18x to both sides and subtracting 142 from both sides puts the equation into the quadratic form

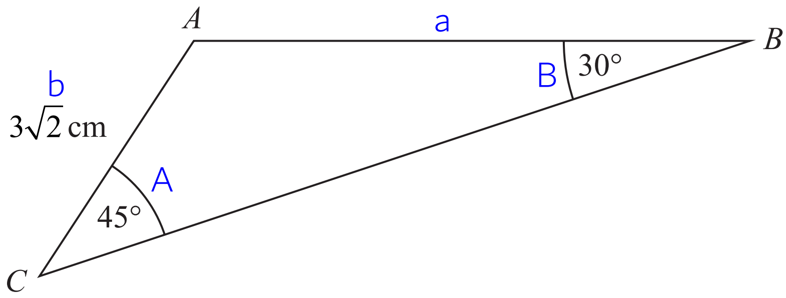
$(x + 20)(x - 7) = 0$ ← Factorising the left side. Two numbers which multiply to the -140 and add to the 13 are 20 and -7 so putting these in brackets with x

Either x + 20 = 0 (so x = -20) or x - 7 = 0 (so x = 7). The solution of x = -20 is ignored as this will give negative lengths and length must be positive

$x =$ .... 7 ....

(Total for Question 13 is 5 marks)

14 *ABC* is a triangle.



Work out the length of *AB*.

$\frac{AB}{\sin 45} = \frac{3\sqrt{2}}{\sin 30}$ ← $\frac{a}{\sin A} = \frac{b}{\sin B}$ ← The sine rule can be used as there are two opposite pairs of angles and sides. Substituting in the values

$AB = \frac{3\sqrt{2}}{\sin 30} \times \sin 45$ ← Multiplying both sides by sin45 gets AB on its own

0 30 45 60 90
0 1 2 3 4 ← Working out the sin values by listing the angles 0, 30, 45, 60, 90 degrees and 0, 1, 2, 3, 4 under these. Square rooting the 1 and putting it over 2 works out that sin30 = 1/2 and square rooting the 2 and putting it over 2 works out that sin45 = $\sqrt{2}/2$

$3\sqrt{2} \div \frac{1}{2}$ ← First dividing the $3\sqrt{2}$ by the value of sin30. To divide by a fraction: keep the first part, change the division to a multiplication, flip the fraction

$6\sqrt{2} \times \frac{\sqrt{2}}{2}$ ← Then multiplying the result by the value of sin45

To multiply by a fraction: divide the number by the denominator then multiply the result by the numerator. $6\sqrt{2} \div 2 = 3\sqrt{2}$ then $3\sqrt{2} \times \sqrt{2} = 3 \times 2 = 6$ → 6 .... cm

(Total for Question 14 is 3 marks)

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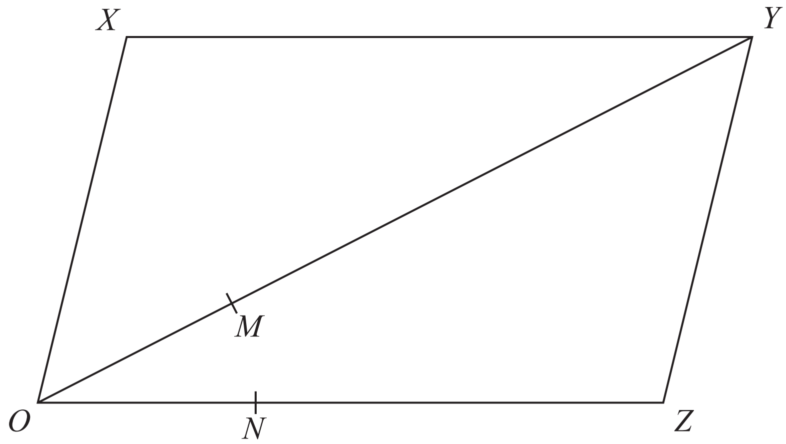
15 *OXYZ* is a parallelogram.



$\overrightarrow{OY} = \mathbf{a}$ and $\overrightarrow{OZ} = \mathbf{b}$

M is the point on *OY* such that $OM : MY = 1 : 3$
N is the point on *OZ* such that $ON : NZ = 1 : 2$

Work out the ratio $XN : MN$
You must show all your working.

$\overrightarrow{XN} = \overrightarrow{XO} + \overrightarrow{ON}$

$\overrightarrow{MN} = \overrightarrow{MO} + \overrightarrow{ON}$

$\overrightarrow{XO} = \overrightarrow{YZ}$ ← As opposite sides of a parallelogram are equal and parallel

$\overrightarrow{YZ} = \overrightarrow{YO} + \overrightarrow{OZ}$

$= -a + b$

$\overrightarrow{OM} = \frac{1}{4}a$ ← 1 + 3 = 4 parts in total in the ratio OM : MY. 1 out of these 4 parts is for $\overrightarrow{OM}$ so $\overrightarrow{OM}$ is 1/4 of $\overrightarrow{OY}$

$\overrightarrow{ON} = \frac{1}{3}b$ ← 1 + 2 = 3 parts in total in the ratio ON : NZ. 1 out of these 3 parts is for $\overrightarrow{ON}$ so $\overrightarrow{ON}$ is 1/3 of $\overrightarrow{OZ}$

$\overrightarrow{XN} = -a + b + \frac{1}{3}b$ ← $\overrightarrow{XN} = \overrightarrow{XO} + \overrightarrow{ON}$. $\overrightarrow{XO} = \overrightarrow{YZ} = -a + b$. $\overrightarrow{ON} = 1/3\ b$

$= -a + \frac{4}{3}b$ ← Collecting like terms

$\overrightarrow{MN} = -\frac{1}{4}a + \frac{1}{3}b$ ← $\overrightarrow{MN} = \overrightarrow{MO} + \overrightarrow{ON}$. $\overrightarrow{MO} = -\overrightarrow{OM} = -1/4\ a$. $\overrightarrow{ON} = 1/3\ b$

$\overrightarrow{XN}$ is 4 times greater than $\overrightarrow{MN}$ →

4 : 1

(Total for Question 15 is 4 marks)

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16 (a) Rationalise the denominator of $\frac{15}{\sqrt{5}}$

Give your answer in its simplest form.

$\frac{15}{\sqrt{5}} \times \frac{\sqrt{5}}{\sqrt{5}}$ ← Multiplying both the numerator and denominator by $\sqrt{5}$ to rationalise the denominator (eliminate the surd)

$\frac{15\sqrt{5}}{5}$ ← $15 \times \sqrt{5} = 15\sqrt{5}$ and $\sqrt{5} \times \sqrt{5} = 5$

The 15 can be divided by the 5 on the denominator →

$3\sqrt{5}$

(2)

(b) Write $\frac{\sqrt{75} - 2}{1 + 2\sqrt{3}}$ in the form $\frac{a - b\sqrt{3}}{c}$ where a, b and c are integers.

$\sqrt{75} = \sqrt{25} \times \sqrt{3} = 5\sqrt{3}$ ← Simplifying $\sqrt{75}$ using $\sqrt{a} \times \sqrt{b} = \sqrt{ab}$

$\frac{5\sqrt{3} - 2}{1 + 2\sqrt{3}} \times \frac{1 - 2\sqrt{3}}{1 - 2\sqrt{3}}$ ← Rationalising the denominator by multiplying both the numerator and denominator by $1 - 2\sqrt{3}$ (which is the same as the denominator with the + changed to a -)

$\frac{5\sqrt{3} - 30 - 2 + 4\sqrt{3}}{1 - 2\sqrt{3} + 2\sqrt{3} - 12}$ ← Expanding the numerators and expanding the denominators like brackets

$\frac{9\sqrt{3} - 32}{-11}$ ← Collecting like terms

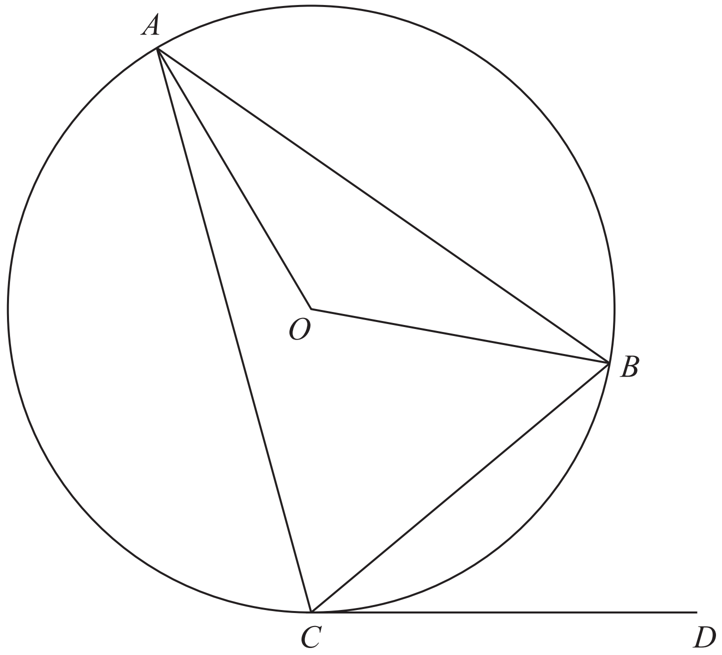
Flipping all the positives to negatives and all the negatives to positives by dividing both the numerator and denominator by -1 →

$\frac{32 - 9\sqrt{3}}{11}$

(4)

(Total for Question 16 is 6 marks)

17 A, B and C are points on a circle, centre O.



CD is a tangent to the circle.

Angle $BCD = 40°$
Angle $OAB = 3 \times$ angle OAC

Work out the size of angle ACD.
Write down any circle theorems that you use.

CAB = 40°, due to the alternate segment theorem ← The angle between tangent CD and chord CB (which is angle BCD) is equal to the interior opposite angle (which is angle CAB)

OAC + 3OAC ← Expressing the total of angle CAB in terms of OAC. Angle CAB can be split into angle OAB and angle OAC. Angle OAB = 3 × angle OAC

4OAC = 40° ← Collecting like terms and setting the expression of angle CAB in terms of OAC equal to the value of angle CAB

OAC = 10° ← Dividing both sides by 4 finds that angle OAC is 10°

OAB = 40° - 10° = 30° ← Subtracting angle OAC from angle CAB finds that angle OAB is 30°

OBA = 30° ← Triangle AOB is isosceles as both OA and OB are radii so are equal in length. So the base angles are equal

AOB = 180° - 30° - 30° = 120° ← There are 180° in total in a triangle. Subtracting angles OAB and OBA from 180° finds that angle AOB is 120°

ACB = 120° ÷ 2 = 60°, as the angle at the circumference is half the angle at the centre

Angle ACB is the angle at the circumference and angle AOB is the angle at the centre

ACD = 60° + 40° ← Adding angles ACB and BCD gives angle ACD

100 °

(Total for Question 17 is 4 marks)

18 $f(x) = \dfrac{5x - 3}{4}$

(a) Find $f^{-1}(x)$

$x = \dfrac{5y - 3}{4}$

$4x = 5y - 3$

$4x + 3 = 5y$

Switching f(x) with x and x with y then rearranging to make y the subject finds the inverse function $f^{-1}(x)$

$f^{-1}(x) = \dfrac{4x + 3}{5}$

(2)

For all values of x

$$g(x) = (x - 1)^2 \text{ and } h(x) = 1 - 2x$$

(b) Work out the value of gh(5)

$1 - 2(5)$

$1 - 10$

Substituting 5 for x in h(x) finds that h(5) = -9

$(-9 - 1)^2$

$(-10)^2$

Substituting -9 for x in g(x) finds g(-9)

$(-10)^2 = -10 \times -10 = --100 = 100$

gh(5) = 100

(2)

(Total for Question 18 is 4 marks)

19 In the semi-finals of a chess tournament,
player **A** will play player **B**
and player **C** will play player **D**.

The two winners will then play each other in the final.

The probability that player **A** will win against player **B** is 0.6
The probability that player **A** will win against player **C** is 0.5
The probability that player **A** will win against player **D** is 0.3
The probability that player **C** will win against player **D** is 0.2

Work out the probability that player **A** will win the chess tournament.

[A win B] AND ([C win D] AND [A win C] OR [D win C] AND [A win D])

A must win against B in order to play the second game. A will then either be playing against C or D. C has to win the first game for A to play C in the second game. D has to win the first game for A to play D in the second game. A must win the second game whether it is against C or D

$$\frac{6}{10} \times \left(\frac{2}{10} \times \frac{5}{10} + \frac{8}{10} \times \frac{3}{10} \right)$$

Filling in the probabilities as fractions. AND means to multiply, OR means to add

$$\frac{6}{10} \times \left(\frac{10}{100} + \frac{24}{100} \right)$$

Following the order of operations so doing the multiplication in the brackets first

$$\frac{6}{10} \times \frac{34}{100}$$

Adding the fractions in the brackets

$$\begin{array}{r} 34 \\ \times\ 6 \\ \hline 204 \end{array}$$

Multiplying the numerators

$\frac{204}{1000}$

(Total for Question 19 is 4 marks)

20 **C** is the circle with equation $x^2 + y^2 = 4$

Find an equation of the tangent to **C** at the point $(p, 1)$ where $p > 0$
Give your answer in the form $y + \sqrt{a}x = b$ where a and b are integers.
You must show all your working.

$p^2 + 1^2 = 4$ ← The tangent touches the circle at point (p, 1) so this point must satisfy the equation of the circle. Substituting p for x and 1 for y in the equation of the circle

$p^2 = 3$ ← $1^2 = 1$ then subtracting 1 from both sides to get p^2 on its own

$p = \sqrt{3}$ ← Square rooting both sides and ignoring the negative solution of p as p > 0

$\frac{1 - 0}{\sqrt{3} - 0}$ ← The centre of the circle is (0, 0). Expressing the gradient of the radius to point (p, 1). Gradient = (change in y)/(change in x). So the gradient of the radius is $1/\sqrt{3}$

$1 = -\sqrt{3}(\sqrt{3}) + c$ ← The tangent is a straight line so its equation can be given in the form y = mx + c, where m is the gradient and c is the y-intercept. The tangent is perpendicular to the radius so its gradient is the negative reciprocal of the gradient of the radius, so is $-\sqrt{3}$. Substituting in the x and y-coordinates of point (p, 1)

$1 = -3 + c$ ← $-\sqrt{3}(\sqrt{3}) = -3$

$4 = c$ ← Adding 3 to both sides finds that c is 4

$y = -\sqrt{3}x + 4$ ← Substituting in the gradient for m and the value of c into the equation y = mx + c

Adding $\sqrt{3}x$ to both sides to put the equation in the correct form

$y + \sqrt{3}x = 4$

(Total for Question 20 is 4 marks)

TOTAL FOR PAPER IS 80 MARKS

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