

Please check the examination details below before entering your candidate information

Candidate surname		Other names	
Pearson Edexcel International GCSE		Centre Number	Candidate Number
Tuesday 15 January 2019			
Morning (Time: 2 hours 30 minutes)		Paper Reference 4MB1/02R	
Mathematics B Paper 2R			
You must have: Ruler graduated in centimetres and millimetres, protractor, 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.*

Information

- The total mark for this paper is 100.
- 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.
- Check your answers if you have time at the end.
- Without sufficient working, correct answers may be awarded no marks.

Turn over ►

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Answer ALL ELEVEN questions.

Write your answers in the spaces provided.

You must write down all the stages in your working.

1

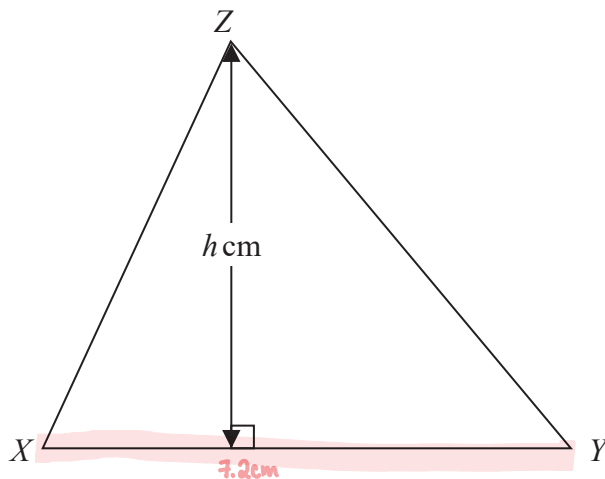


Diagram NOT
accurately drawn

Figure 1

In Figure 1, $\triangle XYZ$ has base XY and height h cm.

The length of XY is 7.2 cm, to 2 significant figures.

(a) Write down the lower bound for the length of XY .

(1)

The area of $\triangle XYZ$ is 29 cm^2 , to 2 significant figures.

(b) Write down the upper bound for the area of $\triangle XYZ$.

(1)

(c) Calculate, to 3 decimal places, the upper bound of h .

(2)

(a) 7.2 cm is rounded to 0.1 of a cm.

You can divide 0.1 by 2 and add/subtract to 7.2 cm to find the upper/lower bound.

$$\frac{0.1}{2} = 0.05$$

$$7.15 \text{ cm} < 7.2 \text{ cm} < 7.25 \text{ cm}$$

The lower bound is the smaller of the two bounds.

Answer: 7.15 cm



Question 1 continued

(b) 29 cm^2 is rounded to 1 cm .

$$\frac{1}{2} = 0.5\text{ cm}$$

$$28.5\text{ cm}^2 \leq 29\text{ cm}^2 < 29.5\text{ cm}^2$$

The upper bound is the bigger of the two bounds.

Answer: 29.5 cm^2

(c) You can find h by working backwards from the upper and lower bounds for area and the base, xy .

$$\text{Area} = \text{base} \times \text{height}$$

$$\text{Area} = xy \times h$$

$$h = \frac{\text{Area}}{xy}$$

Rules for bounds when dividing:

$$\text{upper bound} = \frac{\text{upper bound}}{\text{lower bound}}$$

$$\text{lower bound} = \frac{\text{lower bound}}{\text{upper bound}}$$

Since you need the upper bound for h , you need to divide the upper bound for Area by the lower bound for xy .

$$\text{upper bound of } h = \frac{29.5}{7.15}$$

$$= 4.1258\dots$$

$$\approx 4.13 \text{ (3 d.p.)}$$

Answer = 4.13 cm

(Total for Question 1 is 4 marks)



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

x	-1	0	1	2	3	4	5
y	5	1	-1	-1	1	5	11

(2)

- (b) On the grid opposite, plot the points from your completed table and join them to form a smooth curve.

(2)

- (c) Use your graph to find an estimate for the minimum value of y .

(1)

- (d) Use your graph to find estimates, to one decimal place, for the solutions of the equation $x^2 - 3x + 1 = 0$

(1)

- (e) By drawing a suitable straight line on your grid, find estimates, to one decimal place, for the solutions of the equation $x^2 - 4x + 2 = 0$

(3)

(a) You need to substitute the x values into the equation given to find the y values.

$$x = -1$$

$$x = 2$$

$$(-1)^2 - 3(-1) + 1 = 5$$

$$(2)^2 - 3(2) + 1 = -1$$

$$x = 0$$

$$x = 5$$

$$(0)^2 - 3(0) + 1 = 1$$

$$(5)^2 - 3(5) + 1 = 11$$

(b) Plot point and draw a smooth curve.

(c) The minimum value for y is the lowest y -coordinate reached by the curve.

$$\text{Answer} = -1.20$$

(d) You can find the x -values for when $y=0$ as solutions.

$$x = 0.5 \quad x = 2.7$$

(e) $x^2 - 3x + 1$

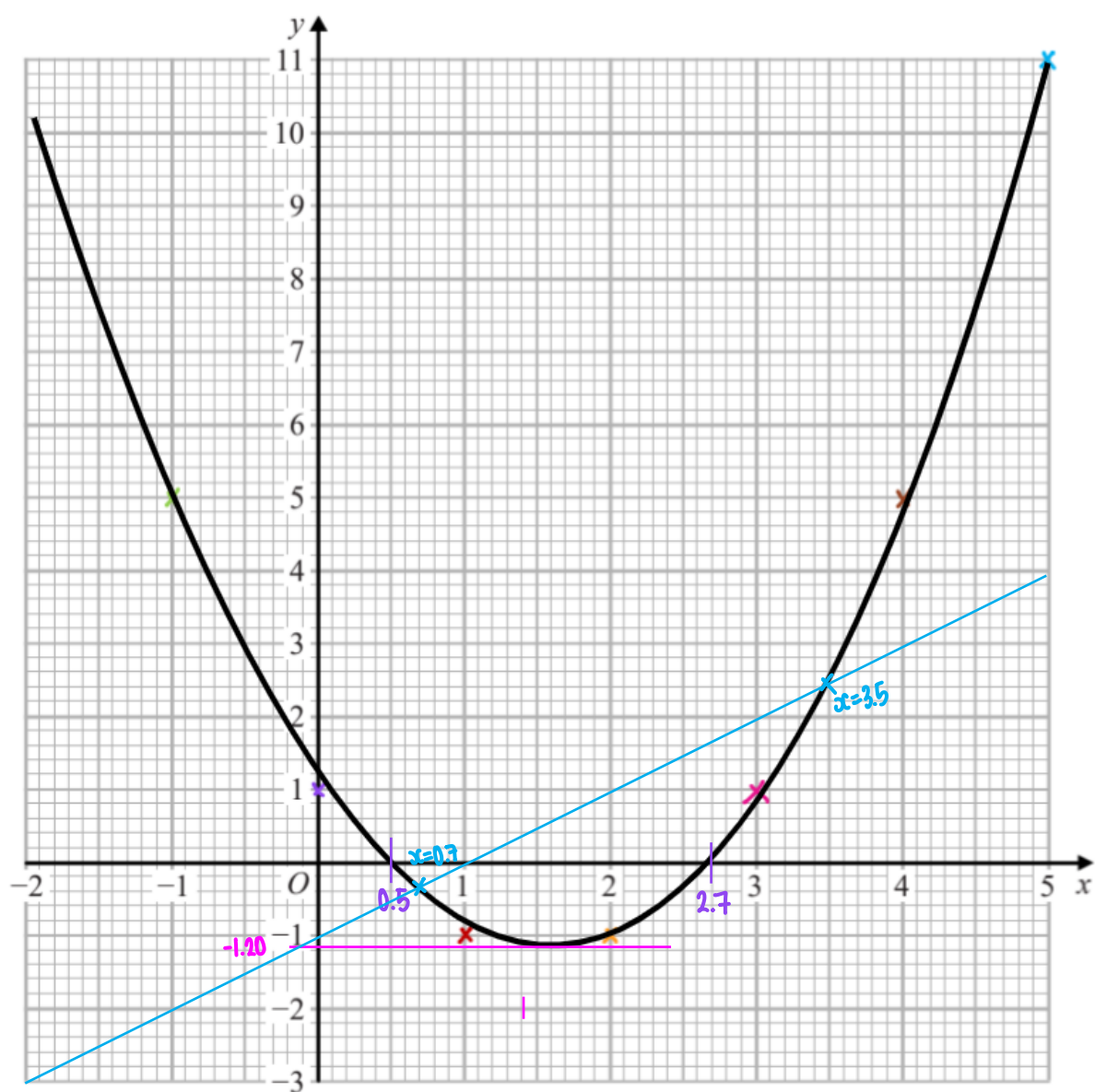
$$= x^2 - 4x + 2$$

$x - 1 \rightarrow$ Draw graph of $y = x - 1$ and find intersections.

$$x = 0.7 \quad x = 3.5$$



Question 2 continued



Turn over for a spare grid if you need to redraw your graph.



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Question 2 continued

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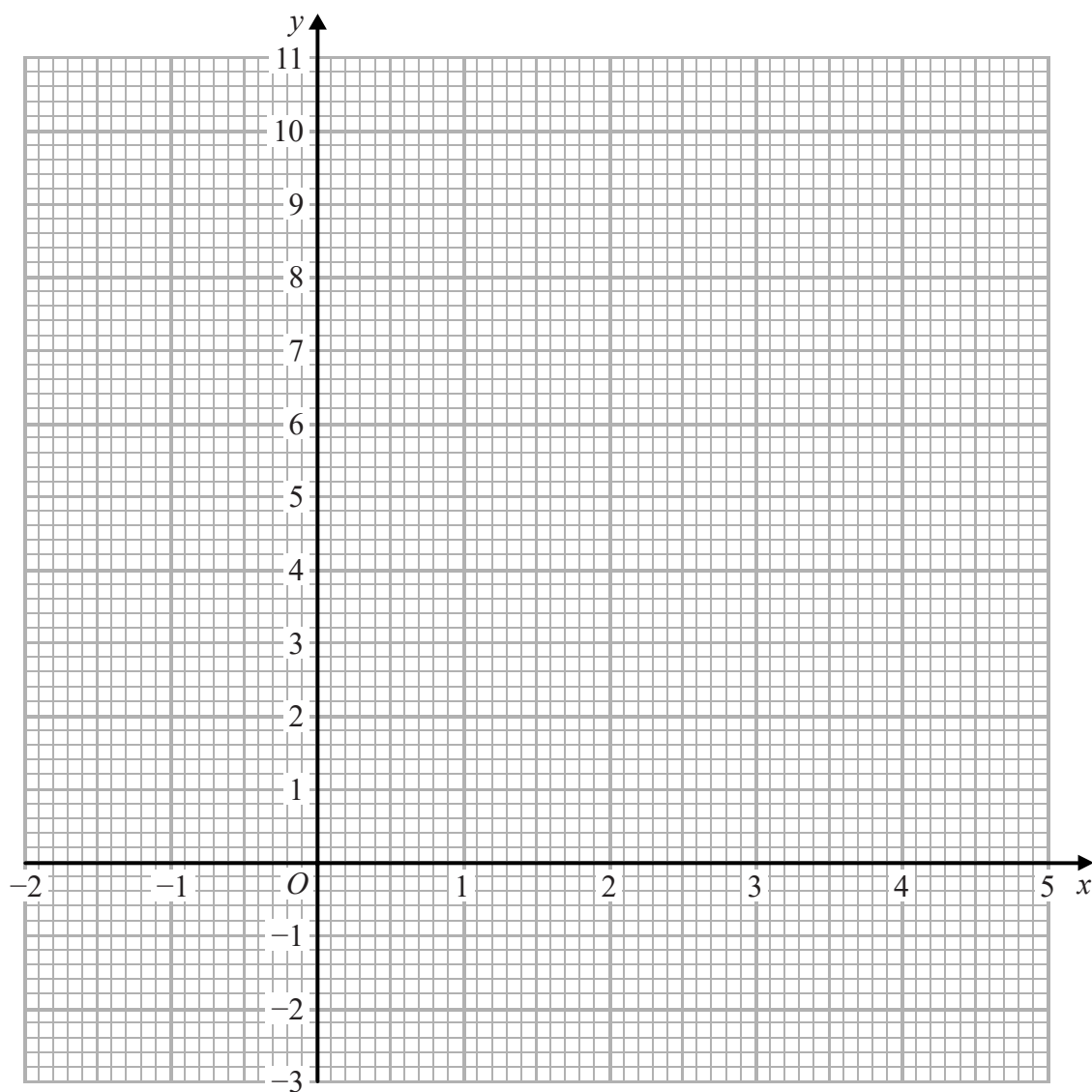
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Question 2 continued

Only use this grid if you need to redraw your graph.



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(Total for Question 2 is 9 marks)



- 3 Hugh and Pau are planning to sell ice creams at a charity event.

They buy enough ingredients to make exactly 270 ice creams.

Hugh and Pau make vanilla flavour, strawberry flavour and chocolate flavour ice creams. The numbers of vanilla flavour, strawberry flavour and chocolate flavour ice creams they make are in the ratios 2 : 3 : 4

- (a) Calculate the number of chocolate flavour ice creams they make.

(3)

Hugh and Pau buy all the ingredients for the 270 ice creams at a total cost of £64.80

They calculate the selling price of each ice cream so that if they sell all 270 ice creams, they would make a profit of £1.20 on each ice cream.

- (b) Calculate the percentage profit that Hugh and Pau would make if they sell all 270 ice creams at their calculated selling price.

(3)

At the charity event, Hugh and Pau sell $\frac{8}{9}$ of the 270 ice creams at their calculated selling price.

They then sell the remainder of the ice creams at half this selling price.

- (c) Calculate the total profit, in pounds, that they make by selling all 270 ice creams.

(3)

(a) To find the number of each flavoured ice cream, you need to find the scale factor.

Finding scale factor: Divide the number of ice creams by the sum of the ratios and then scale the ratios up.

$$\frac{270}{2+3+4} = 30$$

vanilla : strawberry : chocolate

$$\begin{array}{ccc} 2 & : & 3 & : & 4 \\ \times 30 & \swarrow & & \searrow & \times 30 \\ 60 & : & 90 & : & 120 \end{array}$$

Answer: 120 chocolate ice creams

(b) You know that total Hugh and Pau spent was £64.80 but you need to find the total profit as well to find percentage profit.

Total profit: $270 \times 1.20 = £324$

$$\text{Percentage profit} = \frac{\text{Profit}}{\text{Cost}} \times 100$$



Question 3 continued

Percentage profit: $\frac{324}{64.80} \times 100 = 500\%$

Answer: 500%

(c) Here you have to find the total profit made from full priced ice creams separate to half-priced ones.

Find profit from full priced ice creams:

$$270 \times \frac{8}{9} = 240$$

$$240 \times 1.20 = £288$$

Profit from half-priced ice creams:

You first need to find the original selling price of each ice cream.

Since there are 270 ice creams and they would profit £1.20 from each

$$\text{Original estimated profit} = 270 \times 1.20 = 324$$

Plus, they spent £64.80 on making the ice creams.

$$\text{Total revenue} = 64.80 + 324 = 388.80$$

$$\text{Revenue from each ice cream} = 388.8 \div 270 = £1.44$$

$$\text{Revenue from each ice cream at half price} = 1.44 \div 2 = £0.72$$

$$\text{Cost of making each ice cream} = 64.80 \div 270 = £0.24$$

$$\text{Profit from each ice cream at half price} = 0.72 - 0.24 = £0.48$$

Now you can calculate profit from half-priced ice creams.

$$270 - 240 = 30$$

$$30 \times 0.48 = £14.40$$

$$\text{Total profit: } 288 + 14.40 = £302.40$$



Question 3 continued

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Question 3 continued

Handwriting practice area with horizontal dotted lines.

(Total for Question 3 is 9 marks)



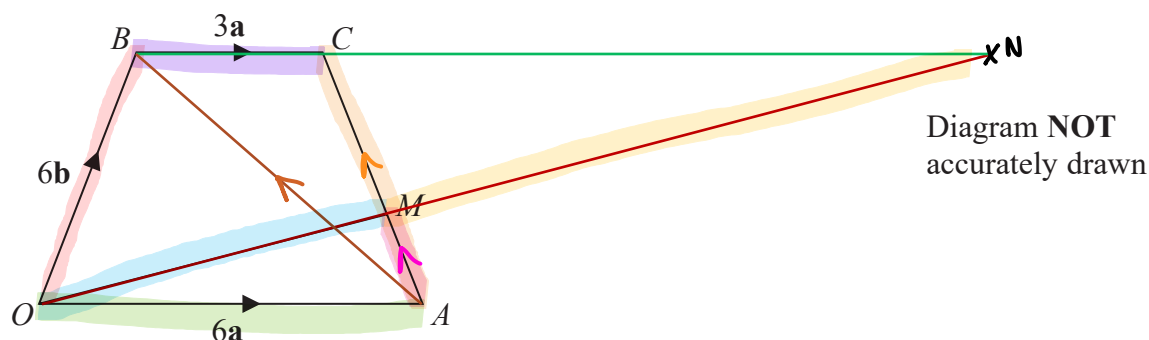


Figure 2

In Figure 2, $OACB$ is a trapezium in which $\vec{OA} = 6\mathbf{a}$, $\vec{OB} = 6\mathbf{b}$ and $\vec{BC} = 3\mathbf{a}$

M is the point on AC such that $AM : AC = 1 : 3$

(a) Find, in terms of $\mathbf{a}$ and $\mathbf{b}$, simplifying your answer where possible,

- (i) $\vec{AB}$ (ii) $\vec{AC}$ (iii) $\vec{AM}$

(3)

The point N is such that $\vec{ON} = \mu\vec{OM}$ where $\mu > 1$ and such that BCN is a straight line.

(b) Find and simplify an expression, in terms of $\mathbf{a}$ and $\mathbf{b}$, for $\vec{ON}$.

(4)

Given that the area of $\triangle OAM$ is 12 cm^2

(c) find the area, in cm^2 , of $\triangle NMC$.

(3)

(a) (i) $\vec{AB} = \vec{AO} + \vec{OB}$

$$\vec{AB} = -6\mathbf{a} + 6\mathbf{b}$$

(ii) $\vec{AC} = \vec{AO} + \vec{OB} + \vec{BC}$

$$\vec{AC} = -6\mathbf{a} + 6\mathbf{b} + 3\mathbf{a}$$

$$\vec{AC} = 6\mathbf{b} - 3\mathbf{a}$$

(iii) $\vec{AM} : \vec{AC}$

$$1 : 3$$

Since you found the value of $\vec{AC}$ in part (a)(ii), you can use the ratio given in the question to find $\vec{AM}$

$$2\mathbf{b} - \mathbf{a} : 6\mathbf{b} - 3\mathbf{a} \quad \therefore \vec{AM} = 2\mathbf{b} - \mathbf{a}$$

(b) $\vec{OM}$ must be a factor of $\vec{ON}$. This is one way of finding $\vec{ON}$.

$$\vec{ON} = \vec{OM} + \vec{MN}$$



Question 4 continued

$$\vec{OM} = 6a + 2b - a$$

$$\vec{OM} = 5a + 2b$$

$$\vec{ON} = \mu(5a + 2b)$$

Another way of finding $\vec{ON}$ is $\vec{OB} + \vec{BN}$. Since BCN is a straight line $\vec{BN}$ must be a multiple of a.

$$\vec{ON} = \vec{OB} + \vec{BN}$$

$$\vec{ON} = 6b + \lambda a$$

$$\vec{ON} = \vec{ON}$$

$$\mu(5a + 2b) = 6b + \lambda a$$

At this point, you can form simultaneous equations by only considering μ $5a + \mu 2b = \lambda a + 6b$

and λ as unknowns. $6b = \mu 2b$ $\mu 5a = \lambda a \rightarrow$ Substitute $\mu = 3$ to find λ

$$\mu = 3 \quad (3) 5a = \lambda a$$

$$15 = \lambda$$

$$\therefore \vec{ON} = 6b + 15a \text{ or } 3(2b + 5a)$$

(c) Since all the angles in $\triangle OAM$ and $\triangle ONC$ are equal so they must be similar triangles. Therefore, if we can find the scale factor for length, we can find the scale factor for area.



The line $\vec{OM}$ corresponds to the line $\vec{MN}$.

$$\vec{OM} = 5a + 2b$$

$$\vec{MN} = \vec{ON} - \vec{OM}$$

$$\vec{MN} = 15a + 6b - (5a + 2b)$$

$$\vec{MN} = 10a + 4b$$



Question 4 continued

$$\overrightarrow{OA} : \overrightarrow{MA}$$

$$5a + 2b : 10a + 4b$$

↖
x4

The scale factor for the lengths of $\triangle OAM$ to $\triangle NAM$ is 4 so the area scale factor must be $4^2 = 16$.

$$\triangle OAM : \triangle NAM$$

$$12\text{cm}^2 : 192\text{cm}^2$$

↖
x16

Answer: 192 cm²

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Question 4 continued

Handwriting practice area with 20 horizontal dotted lines.

(Total for Question 4 is 10 marks)



5 On the grid opposite, triangle B is the image of triangle A under a single transformation.

(a) Describe fully the single transformation.

(3)

Triangle B is transformed to triangle C under the transformation with matrix $\mathbf{M}$ where

$$\mathbf{M} = \begin{pmatrix} -1 & 0 \\ -3 & -1 \end{pmatrix}$$

(b) On the grid, draw and label triangle C .

(3)

Triangle C is transformed to triangle D under the transformation with matrix $\mathbf{N}$ where

$$\mathbf{N} = \begin{pmatrix} 3 & -1 \\ -1 & 0 \end{pmatrix}$$

(c) On the grid, draw and label triangle D .

(3)

Triangle D is the image of triangle B under a **single** transformation.

(d) Describe fully this transformation.

(2)

(a) Triangle A is transformed to triangle B by only one transformation.

Triangle A is transformed to triangle B under

an enlargement

of scale factor $\frac{1}{2}$

centre of enlargement $(-6, 0)$

(b) You have to take each vertices on triangle B and multiply them with matrix $\mathbf{M}$.

Rule for multiplying a 1×2 by a 2×2 matrix:

$$\begin{pmatrix} a & b \\ c & d \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} ax + by \\ cx + dy \end{pmatrix}$$

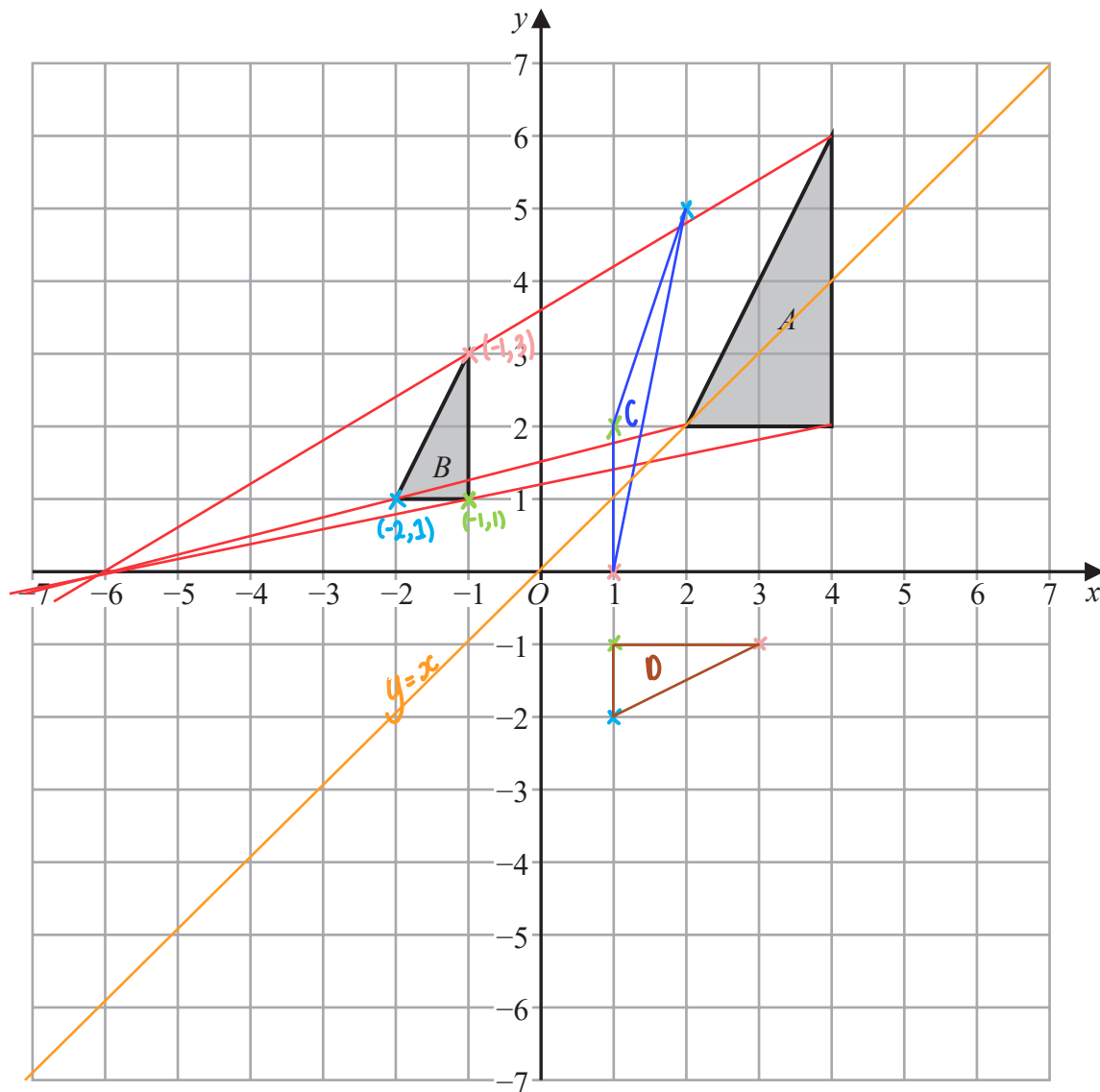
$$\begin{pmatrix} -1 & 0 \\ -3 & -1 \end{pmatrix} \begin{pmatrix} -1 \\ 3 \end{pmatrix} = \begin{pmatrix} -1(-1) + 0(3) \\ -3(-1) + -1(3) \end{pmatrix} = \begin{pmatrix} 1 \\ 0 \end{pmatrix}$$

$$\begin{pmatrix} -1 & 0 \\ -3 & -1 \end{pmatrix} \begin{pmatrix} -1 \\ 1 \end{pmatrix} = \begin{pmatrix} -1(-1) + 0(1) \\ -3(-1) + -1(1) \end{pmatrix} = \begin{pmatrix} 1 \\ 2 \end{pmatrix}$$

$$\begin{pmatrix} -1 & 0 \\ -3 & -1 \end{pmatrix} \begin{pmatrix} -2 \\ 1 \end{pmatrix} = \begin{pmatrix} -1(-2) + 0(1) \\ -3(-2) + -1(1) \end{pmatrix} = \begin{pmatrix} 2 \\ 5 \end{pmatrix}$$



Question 5 continued



(c) You have to use the same method in part b to find triangle D.

$$\begin{pmatrix} 3 & -1 \\ -1 & 0 \end{pmatrix} \begin{pmatrix} 1 \\ 0 \end{pmatrix} = \begin{pmatrix} 3(1) + -1(0) \\ -1(1) + 0(0) \end{pmatrix} = \begin{pmatrix} 3 \\ -1 \end{pmatrix}$$

$$\begin{pmatrix} 3 & -1 \\ -1 & 0 \end{pmatrix} \begin{pmatrix} 1 \\ 2 \end{pmatrix} = \begin{pmatrix} 3(1) + -1(2) \\ -1(1) + 0(2) \end{pmatrix} = \begin{pmatrix} 1 \\ -1 \end{pmatrix}$$

$$\begin{pmatrix} 3 & -1 \\ -1 & 0 \end{pmatrix} \begin{pmatrix} 2 \\ 5 \end{pmatrix} = \begin{pmatrix} 3(2) + -1(5) \\ -1(2) + 0(5) \end{pmatrix} = \begin{pmatrix} 1 \\ -2 \end{pmatrix}$$

Turn over for a spare grid if you need to redraw your triangles.



Question 5 continued

(a) The triangle B is transformed to triangle D by a

reflection

in the line $y=x$.

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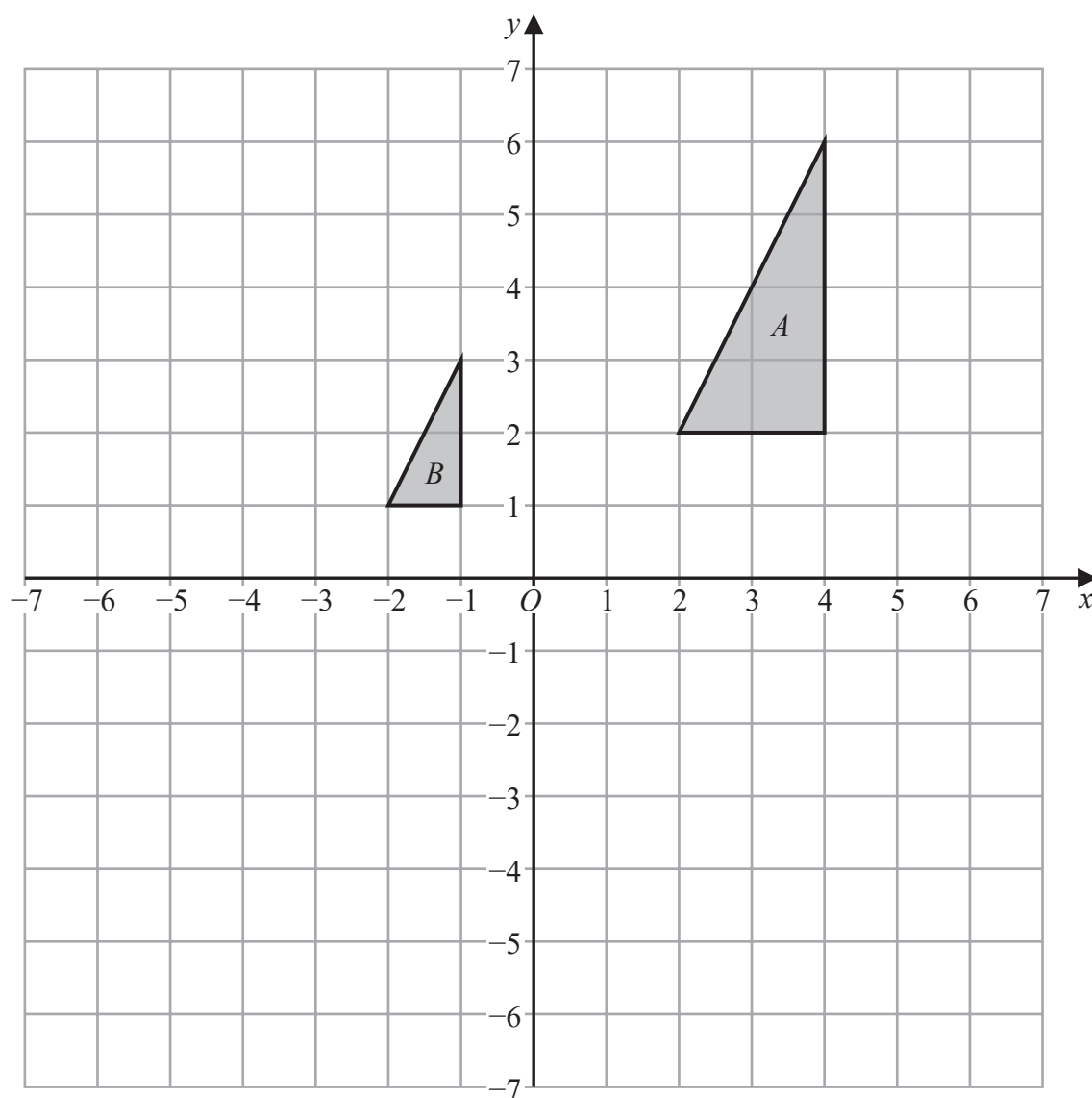
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Question 5 continued

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(Total for Question 5 is 11 marks)



- 6 All 35 students in class 11T were asked which of rugby (R), cricket (C) and football (F) they like.

Of these 35 students

14 like rugby $14 - 4 - 3 - (x - 4) = 11 - x$

20 like cricket $20 - 4 - 2 - (x - 4) = 18 - x$

12 like football $12 - 2 - 3 - 4 = 3$

6 like both cricket and football $6 - 4 = 2$

7 like both rugby and football $7 - 4 = 3$

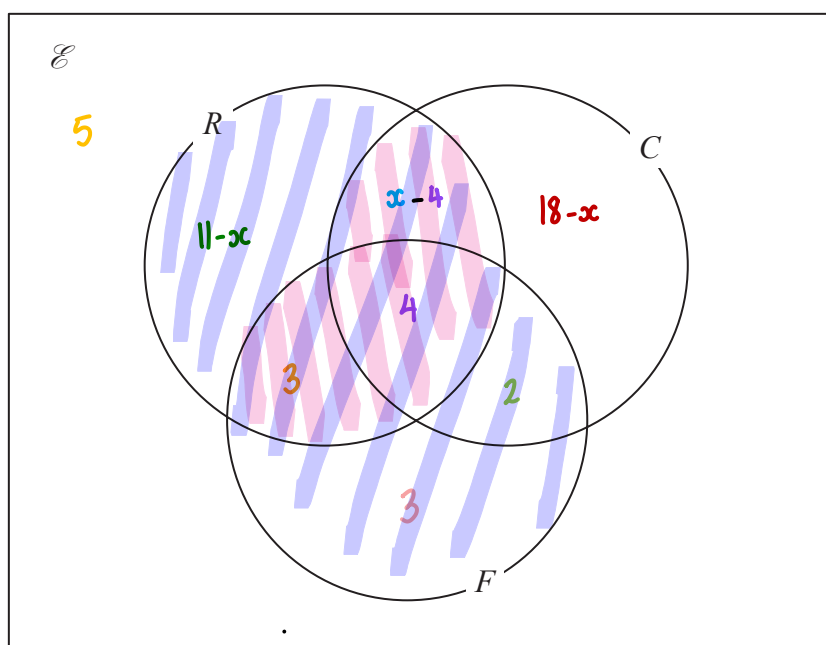
4 like all three sports

5 do not like any of rugby, cricket or football.

Let x be the number of students in class 11T who like both rugby and cricket. $x - 4$

- (a) Show all this information on the Venn diagram, giving the number of elements in each appropriate subset, in terms of x where necessary.

(3)



- (b) Find the value of x .

(2)

- (c) Find

(i) $n(R \cup F)$

(ii) $n(R \cap [C \cup F])$

(2)

(b) Since you know that there are 35 students in total you can work backwards to find x .

$$5 + (11 - x) + (x - 4) + 3 + 4 + 3 + 2 + (18 - x) = 35$$

$$42 - x = 35$$

$$-x = -7$$

$$x = 7$$



Question 6 continued

(c) (i) $n(R \cup F)$ refers to the number of students who play either rugby or football.

$$(11-7) + 3 + 3 + 4 + (7-4) + 2 = \underline{\underline{19}}$$

(ii) $n(R \cap [C \cup F])$ refers to the number of students who play cricket or football dependent on that they play rugby.

$$4 + 3 + (7-4) = \underline{\underline{10}}$$

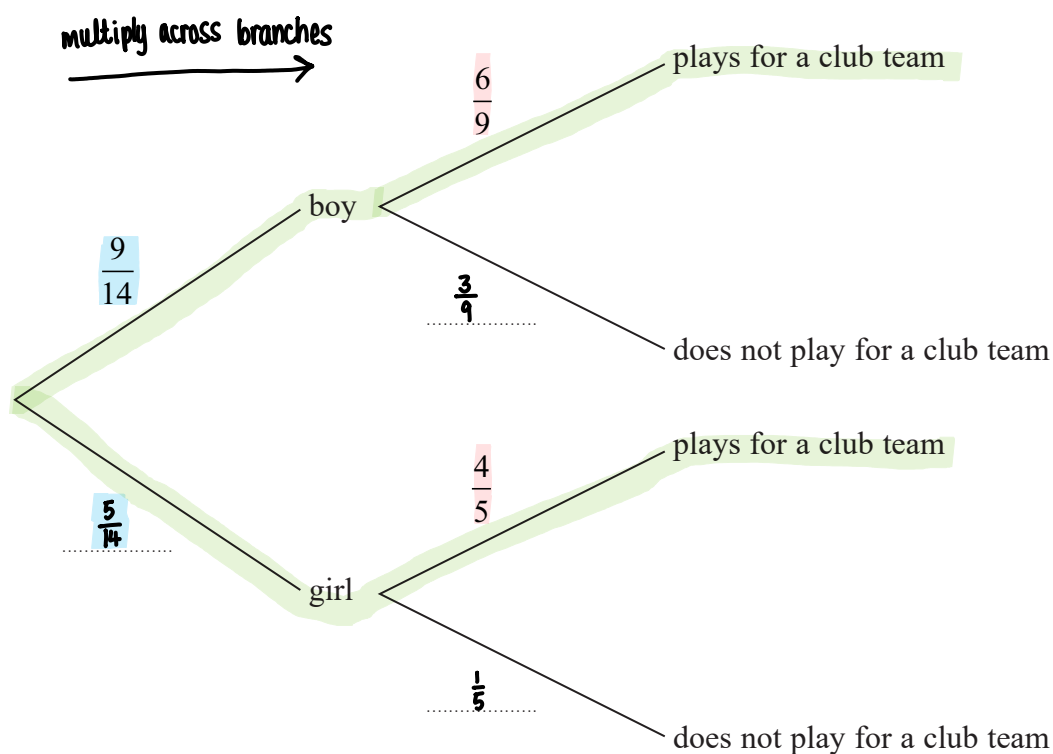
Question 6 continues on the next page.



Question 6 continued

Some of the 14 students in class 11T, who like rugby, play for a rugby club team.

The incomplete probability tree diagram gives information about these 14 students.



(d) Complete the probability tree diagram.

(2)

A student who likes rugby in class 11T is to be chosen at random.

(e) Find the probability that this student plays rugby for a club team.

(2)

(d) The fractions on each branch have to add to 1.

(e) $\frac{9}{14} \times \frac{6}{9} = \frac{3}{7}$

$\frac{5}{14} \times \frac{4}{5} = \frac{2}{7}$

$\frac{3}{7} + \frac{2}{7} = \frac{5}{7}$



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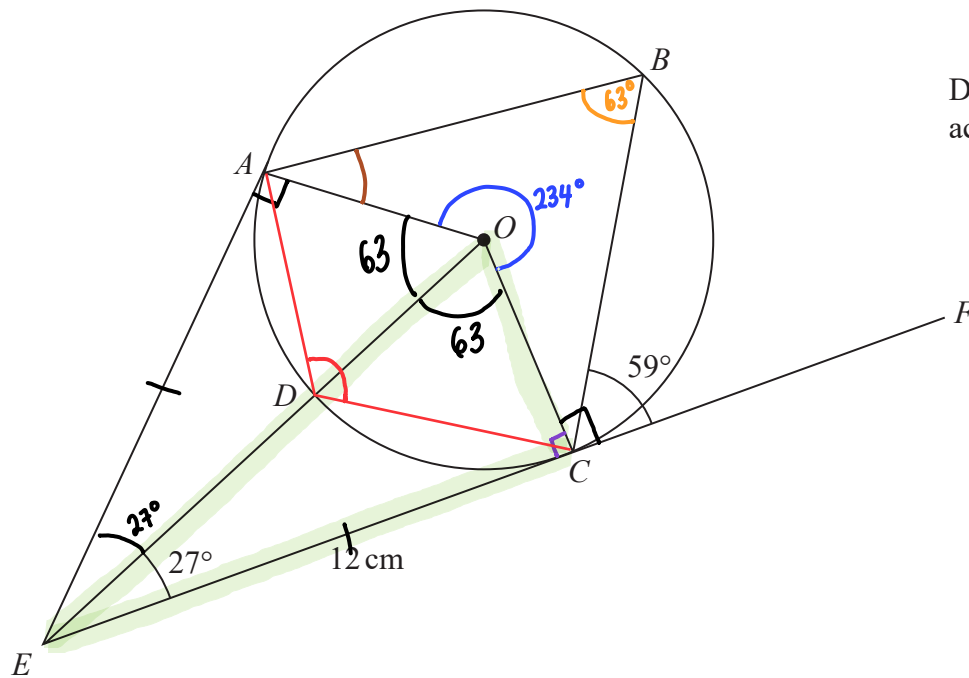


Diagram NOT
accurately drawn

Figure 3

In Figure 3, $ABCD$ is a circle, centre O .

EA is the tangent to the circle at A .

ECF is the tangent to the circle at C .

EDO is a straight line.

$$\angle OEC = 27^\circ \quad \angle BCF = 59^\circ \quad EC = 12 \text{ cm}$$

- Explain why $\angle OCE = 90^\circ$ (1)
- Calculate the area, in cm^2 to 3 significant figures, of $\triangle OEC$. (4)
- Giving reasons, calculate the size, in degrees, of $\angle ABC$. (4)
- Calculate the size, in degrees, of $\angle ADC$. (2)
- Calculate the size, in degrees, of $\angle BAO$. (3)

(a) The angle between a radius and a tangent is 90° .

(b) You can find the area of a triangle using

$$\frac{1}{2}ab\sin C$$

In this case: $a = 12 \text{ cm}$ $b = ?$ $c = 27^\circ$



Question 7 continued

You can use $\text{S}^{\circ}\text{H}^{\circ}\text{C}^{\circ}\text{A}$ to find b . Since you have the angle and adjacent length, you can find hypotenuse length using $\cos\theta = \text{adjacent} \div \text{hypotenuse}$.

$$\cos(27) = \frac{12}{H}$$

$$H = \frac{12}{\cos(27)}$$

$$= 13.4679... \rightarrow \text{Do not round yet!}$$

$$\frac{1}{2} \times a \times b \times \sin C$$

$$\frac{1}{2} \times (12) \times (13.4679...) \times \sin(27) = 36.6858...$$

$$\approx \underline{\underline{36.7 \text{ cm}^2}}$$

(c) Since $\triangle OEC$ and $\triangle OAE$ are congruent, they must have equal angles. So, $\angle AOE$ and $\angle COE$ will be equal.

Angles in a triangle add to 180° .

$$\angle COE + 27 + 90 = 180$$

$$\angle COE = 63^\circ$$

$$\angle AOC = \angle AOE + \angle COE$$

$$\angle AOC = 63 + 63$$

$$= 126^\circ$$

The angle at the circumference is half the angle at the centre.

$$\angle AOC \times \frac{1}{2} = \angle ABC$$

$$126 \times \frac{1}{2} = \angle ABC$$

$$\underline{\underline{63^\circ = \angle ABC}}$$



Question 7 continued

(a) Angles round a point add to 360° .

$$\text{reflex } \angle AOC = 360 - 126$$

$$= 234^\circ$$

Angles at the circumference are half the angles at the centre.

$$\angle ADC = \frac{1}{2} \times 234$$

$$= 117^\circ$$

(e) $\angle BCD = \angle OCF - \angle BCF$

$$= 90 - 59$$

$$= 31^\circ$$

$$\angle OAB = 360 - 234 - 63 - 31$$

$$= 32^\circ$$



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Question 7 continued

Handwriting practice area with 28 horizontal dotted lines.

(Total for Question 7 is 14 marks)



Question 8 continued

You can now substitute your y -values into the equation $x = 3 + 2y$ to find x -values.

when $y = -2$

$$x = 3 + 2(-2)$$

$$x = 3 - 4$$

$$= -1$$

when $y = -\frac{2}{3}$

$$x = 3 + 2(-\frac{2}{3})$$

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

$$= \frac{5}{3}$$

$$x = -1$$

$$y = -2$$

$$x = \frac{5}{3}$$

$$y = -\frac{2}{3}$$

(Total for Question 8 is 6 marks)





(5)

Question 9 continued

$$5 \times h = 10$$

$$h = 2$$

∴ The frequency density goes up in 2s.

Now you need to find the number of people who spent over 45 min in the supermarket. This area is shaded green.

$$\text{Area of green shaded region} = (5 \times 2.4) + (10 \times 6.8)$$

$$= 12 + 68$$

$$= 80$$

Now you can find the probability that both people chosen spent over 45 minutes in the supermarket.

$$\frac{\text{number of people over 45m}}{\text{total number of people}} \times \frac{80-1}{440-1} = 0.0327189...$$

total number of people

6 ≈ 0.0327
→ Subtract 1 since you have already chosen 1 person

(Total for Question 9 is 5 marks)



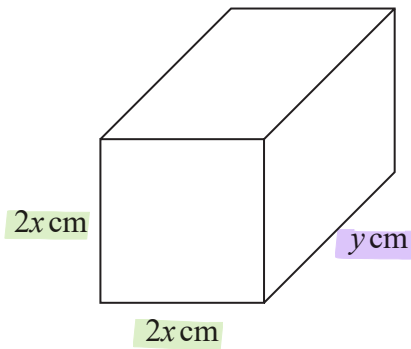


Diagram NOT
accurately drawn

Figure 5

Figure 5 shows a cuboid with width $2x$ cm, height $2x$ cm and length y cm.

Given that the total surface area of the cuboid is 240 cm^2

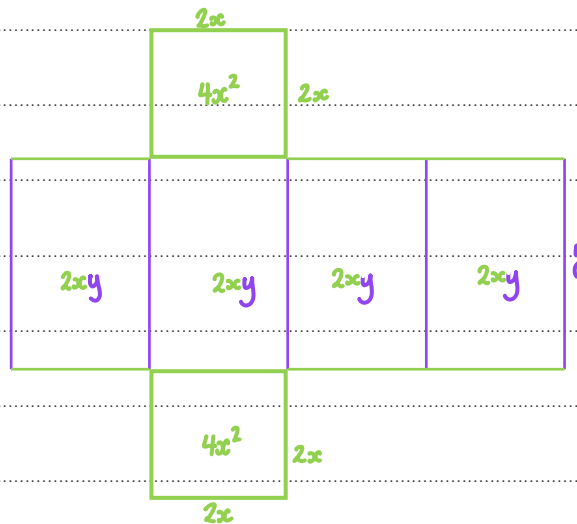
(a) show that

$$x^2 + xy - 30 = 0 \quad (2)$$

(b) Using calculus, calculate the exact value of x for which the volume of the cuboid is a maximum.

(5)

(a) The surface area is the sum of the areas of all sides of the cuboid.



$$\begin{aligned} \text{Surface area} &= 4x^2 + 4x^2 + 2xy + 2xy + 2xy + 2xy \\ &= 8x^2 + 8xy \end{aligned}$$



Question 10 continued

$$\begin{aligned}
 8x^2 + 8xy &= 240 \\
 -240 & \quad -240 \\
 8x^2 + 8xy - 240 &= 0 \\
 \div 8 & \quad \div 8 \\
 x^2 + xy - 30 &= 0
 \end{aligned}$$

(b) To differentiate you first need to remove y . You can do this by finding the volume.

$$\text{volume} = \text{length} \times \text{width} \times \text{height}$$

$$\begin{aligned}
 \text{volume} &= 2x \cdot 2x \cdot y \\
 &= 4x^2y
 \end{aligned}$$

Rearrange expression for SA to make y the subject.

$$\begin{aligned}
 x^2 + xy - 30 &= 0 \\
 +30 & \quad +30 \\
 x^2 + xy &= 30 \\
 -x^2 & \quad -x^2 \\
 xy &= 30 - x^2 \\
 \div x & \quad \div x \\
 y &= \frac{30 - x^2}{x}
 \end{aligned}$$

Substitute y into expression for volume.

$$\begin{aligned}
 4x^2 \left(\frac{30 - x^2}{x} \right) &= \frac{120x^2 - 4x^4}{x} \\
 &= 120x - 4x^3
 \end{aligned}$$

Differentiate expression for volume.

$$\begin{aligned}
 y &= 120x^1 - 4x^3 \\
 \frac{dy}{dx} &= (1)120x^{1-1} - (3)4x^{3-1} \\
 &= 120 - 12x^2
 \end{aligned}$$

You can solve for x .

$$\begin{aligned}
 120 - 12x^2 &= 0 \\
 +12x^2 & \quad +12x^2 \\
 120 &= 12x^2 \\
 \div 12 & \quad \div 12 \\
 10 &= x^2 \\
 \sqrt{} & \quad \sqrt{} \\
 \sqrt{10} &= x
 \end{aligned}$$

(Total for Question 10 is 7 marks)



11 The three functions, f , g and h , are defined as

$$f : x \mapsto x^2 + 3x - 4$$

$$g : x \mapsto 2x + 3$$

$$h : x \mapsto \frac{x}{3x - 25}$$

(a) Write down the value of x that must be excluded from any domain of h . (1)

(b) Find $f(6)$. (1)

(c) Solve the equation $h(x) = 7$. (3)

(d) Find $hg(4)$. (2)

(e) Express the inverse function h^{-1} in the form $h^{-1} : x \mapsto \dots$. (3)

(f) Solve the equation $fg(x) = 0$. (4)

(a) The value of x that must be excluded is the value that makes the denominator equal to 0 since a denominator of 0 will give an answer undefined.

$$\begin{array}{l} 3x - 25 = 0 \\ +25 \quad \swarrow \quad \searrow +25 \\ 3x = 25 \\ \div 3 \quad \swarrow \quad \searrow \div 3 \\ x = \frac{25}{3} \end{array}$$

(b) To find $f(6)$, you need to substitute $x=6$ into the equation $f(x)$.

$$\begin{aligned} f(6) &= (6)^2 + 3(6) - 4 \\ &= 50 \end{aligned}$$

(c) If $h(x) = 7$, you need to work backwards to find x .

$$\begin{array}{l} \frac{x}{3x - 25} = 7 \\ \times (3x - 25) \quad \swarrow \quad \searrow \times (3x - 25) \\ x = 7(3x - 25) \\ \text{Expand} \\ x = 21x - 175 \\ -21x \quad \swarrow \quad \searrow -21x \\ -20x = -175 \\ \div -20 \quad \swarrow \quad \searrow \div -20 \\ x = 8.75 \end{array}$$



Question 11 continued

(f) You should first find $fg(x)$ and then solve.

$$fg(x) = (2x+3)^2 + 3(2x+3) - 4$$

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

$$= 4x^2 + 18x + 14$$

$$4x^2 + 18x + 14 = 0$$

$$2x^2 + 9x + 7 = 0$$

$$(2x + 7)(x + 2) = 0$$

$$(2x+7)(x+2)=0$$

$$2x+7=0$$

$$x+2=0$$

$$2x = -7$$

$$x = -2$$

$$x = -\frac{7}{2}$$

(Total for Question 11 is 14 marks)

TOTAL FOR PAPER IS 100 MARKS

