Elite Mathematics
Pearson Edexcel International GCSE

IGCSE LINEAR · 4MA1

4MA1/2H June 2024 Worked Solutions

June 2024 paper rebuilt with the worked solution after each question.

25	2020–2026	Single-paper solutions
paper questions	52 past papers	checked by Dr Eslam



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PAST PAPER

4MA1/2H June 2024

June 2024

25	100	2 h
questions	marks	exam time

Each question is followed by its worked solution and final answer.

4MA1/2H JUNE 2024

Question 1

3 marks | Statistics Toolkit

1 Here are eight numbers written in order of size

$$h \quad 6 \quad 7 \quad 8 \quad j \quad 16 \quad k \quad k$$

where h, j and k are integers.

The median of the eight numbers is 10

The mode of the eight numbers is 18

The range of the eight numbers is 13

Work out the value of h, the value of j and the value of k

$h =$ .....

$j =$ .....

$k =$ .....

(Total for Question 1 is 3 marks)

WORKED SOLUTION

Question 1 · 4MA1/2H June 2024

1 **The median is**

The median is 10:

$$\frac{8+j}{2} = 10$$

$$j = 12$$

2 **Calculate statistic**

The mode is 18, so

$$k = 18$$

3 **The range is**

The range is 13:

$$18 - h = 13$$

$$h = 5$$

✓ **FINAL ANSWER**

$h = 5,\ j = 12,\ k = 18.$

4MA1/2H JUNE 2024

Question 2

4 marks | Inequalities (Solving & Graphing)

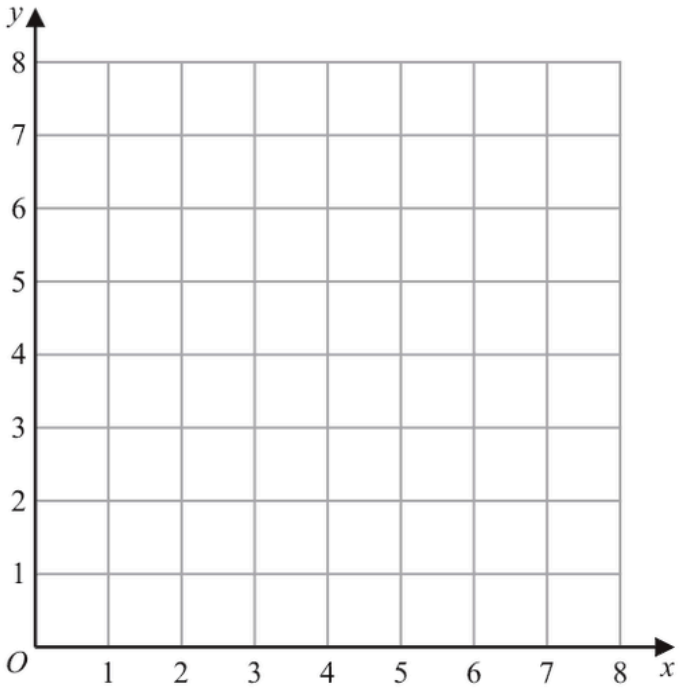
2 (a) On the grid, draw the straight line with equation

(i) $y = 2$

(ii) $x = 6$

(iii) $y = x + 1$

Label each line with its equation.



(3)

(b) Show, by shading on the grid, the region that satisfies all three of the inequalities

$y \geqslant 2$ $x \leqslant 6$ $y \leqslant x + 1$

Label the region **R**

(1)

(Total for Question 2 is 4 marks)

WORKED SOLUTION

Question 2 · 4MA1/2H June 2024

1 **Draw the boundary lines**

Draw the boundary lines:

$$y = 2, \quad x = 6, \quad y = x + 1$$

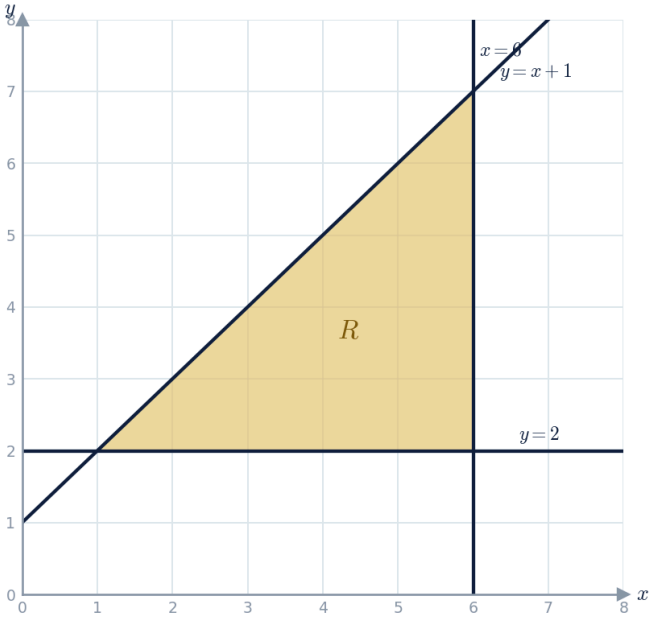
2 **The required region is**

The required region is

$$y \geq 2$$

$$x \leq 6$$

$$y \leq x + 1$$



FINAL ANSWER

Shade $y \geq 2$, $x \leq 6$, $y \leq x + 1$.

4MA1/2H JUNE 2024

Question 3

3 marks | Standard & Compound Units

3 A plane takes 9 hours 36 minutes to fly from New Delhi to Perth.

The plane flies at an average speed of 820 km/h.

Work out the total distance the plane flies.

..... km

(Total for Question 3 is 3 marks)

WORKED SOLUTION

Question 3 · 4MA1/2H June 2024

1 Evaluate fraction

$$9\text{ h }36\text{ min} = 9 + \frac{36}{60} = 9.6\text{ hours}$$

$$\text{distance} = 820 \times 9.6 = 7872$$

FINAL ANSWER

7872 km.

4MA1/2H JUNE 2024

Question 4

3 marks | Fractions

4 Show that $2\frac{4}{7} \times 3\frac{1}{9} = 8$

(Total for Question 4 is 3 marks)

WORKED SOLUTION

Question 4 · 4MA1/2H June 2024

1 Simplify fraction

$$2\frac{4}{7} = \frac{18}{7}$$

$$3\frac{1}{9} = \frac{28}{9}$$

2 Simplify fraction

Now multiply:

$$\frac{18}{7} \times \frac{28}{9}$$

3 Cancel first

Cancel first:

$$\frac{18}{9} \times \frac{28}{7} = 2 \times 4 = 8$$

FINAL ANSWER

8

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Question 5

3 marks | Right-Angled Triangles - Pythagoras & Trigonometry

5 The diagram shows triangle ABC

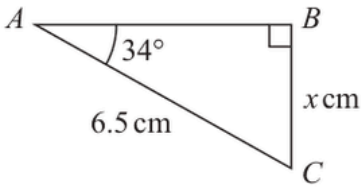


Diagram **NOT** accurately drawn

Work out the value of x
Give your answer correct to one decimal place.

$x =$ .....

(Total for Question 5 is 3 marks)

WORKED SOLUTION

Question 5 · 4MA1/2H June 2024

1 Use trigonometry

The hypotenuse is 6.5 cm, and x is opposite the $34°$ angle.

$$\sin 34° = \frac{x}{6.5}$$

$$x = 6.5 \sin 34° = 3.634\ldots$$

FINAL ANSWER

3.6 cm.

4MA1/2H JUNE 2024

Question 6

3 marks | Standard & Compound Units

6 Change a speed of w metres per second to a speed in kilometres per hour.
Give your answer in terms of w in its simplest form.

..... kilometres per hour

(Total for Question 6 is 3 marks)

WORKED SOLUTION

Question 6 · 4MA1/2H June 2024

1 Convert m/s to km/h multiply

To convert m/s to km/h, multiply by 3.6.

$$w\ \text{m/s} = 3.6w\ \text{km/h}$$

$$3.6w = \frac{18w}{5}$$

FINAL ANSWER

$\frac{18w}{5}$ km/h.

4MA1/2H JUNE 2024

Question 7

4 marks | Perimeter & Area

7 The diagram shows a 6-sided shape $ABCDEF$

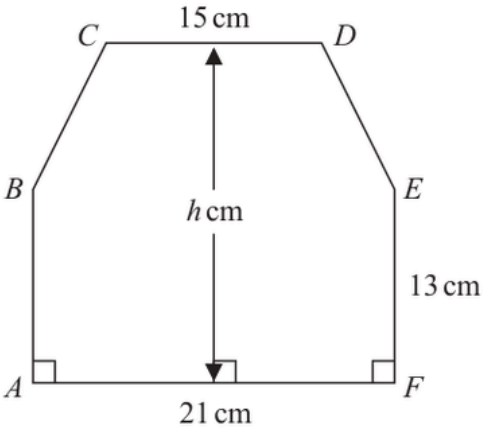


Diagram **NOT** accurately drawn

$AF = 21$ cm $\quad CD = 15$ cm $\quad AB = FE = 13$ cm

The perpendicular height of the shape is h cm
CD is parallel to AF

The area of the shape is $390\,\text{cm}^2$

Work out the value of h

$h =$ .....

(Total for Question 7 is 4 marks)

WORKED SOLUTION

Question 7 · 4MA1/2H June 2024

1 The bottom rectangle has area

The bottom rectangle has area

$$21 \times 13 = 273$$

2 **The top trapezium has height**

The top trapezium has height $h - 13$, with parallel sides 21 and 15.

$$273 + \frac{1}{2}(21 + 15)(h - 13) = 390$$

$$273 + 18(h - 13) = 390$$

$$18h + 39 = 390$$

$$h = 19.5$$

✓ **FINAL ANSWER**

$19.5\ \text{cm}$.

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Question 8

5 marks | Percentages

8 Ishir plants 600 bulbs in a garden.
He plants tulip bulbs, crocus bulbs and daffodil bulbs so that

number of tulip bulbs : number of crocus bulbs : number of daffodil bulbs = 9 : 4 : 2

45% of the tulip bulbs are for yellow flowers.

$\frac{5}{8}$ of the crocus bulbs are for yellow flowers.

All of the daffodil bulbs are for yellow flowers.

Work out the number of bulbs that are for yellow flowers.

(Total for Question 8 is 5 marks)

WORKED SOLUTION

Question 8 · 4MA1/2H June 2024

1 The ratio parts are

The ratio parts are

$$9 + 4 + 2 = 15$$

$$\text{tulips} = 600 \times \frac{9}{15} = 360, \quad \text{crocuses} = 600 \times \frac{4}{15} = 160, \quad \text{daffodils} = 600 \times \frac{2}{15} = 80$$

2 Yellow tulips

Yellow tulips:

$$45\% \times 360 = 0.45 \times 360 = 162$$

3 Yellow crocuses

Yellow crocuses:

$$\frac{5}{8} \times 160 = 100$$

4 All the daffodil bulbs are

All the daffodil bulbs are yellow, so

$$162 + 100 + 80 = 342$$

FINAL ANSWER

342 bulbs

4MA1/2H JUNE 2024

Question 9

3 marks | Compound Interest & Depreciation

9 Giovanni invests 4500 koruna in a savings account for 4 years.
He gets 2.4% per year compound interest.

Work out how much money Giovanni will have in the savings account at the end of 4 years.
Give your answer correct to the nearest koruna.

..... koruna

(Total for Question 9 is 3 marks)

WORKED SOLUTION

Question 9 · 4MA1/2H June 2024

1 The multiplier for compound interest

The multiplier for 2.4% compound interest is

$$1.024$$

2 Use compound interest

After 4 years,

$$4500(1.024)^4 = 4947.8023\ldots$$

3 Use compound interest

Correct to the nearest koruna,

$$4947.8023\ldots \approx 4948$$

FINAL ANSWER

4948 koruna

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Question 10

3 marks | Simultaneous Equations

10 Solve the simultaneous equations

$$6x + 4y = 1$$
$$3x + 5y = 8$$

Show clear algebraic working.

$x =$ .....

$y =$ .....

(Total for Question 10 is 3 marks)

WORKED SOLUTION

Question 10 · 4MA1/2H June 2024

1 Solve simultaneous equations

$$6x + 4y = 1$$

$$3x + 5y = 8$$

2 Double the second equation

Double the second equation:

$$6x + 10y = 16$$

3 Subtract the first equation

Subtract the first equation:

$$6y = 15$$

$$y = \frac{5}{2}$$

4 **Solve simultaneous equations**

Substitute into $3x + 5y = 8$:

$$3x + 5\left(\frac{5}{2}\right) = 8$$

$$3x + \frac{25}{2} = 8$$

$$3x = -\frac{9}{2}$$

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

✓ **FINAL ANSWER**

$x = -\frac{3}{2}$, $y = \frac{5}{2}$.

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Question 11

3 marks | Factorising

11 (i) Factorise $x^2 + 9x - 22$

.....

(2)

(ii) Hence, solve $x^2 + 9x - 22 = 0$

.....

(1)

(Total for Question 11 is 3 marks)

WORKED SOLUTION

Question 11 · 4MA1/2H June 2024

1 **Factorise expression**

$$x^2 + 9x - 22 = (x + 11)(x - 2)$$

2 **Factorise expression**

So

$$(x + 11)(x - 2) = 0$$

FINAL ANSWER

$x = -11$ or $x = 2$

4MA1/2H JUNE 2024

Question 12

3 marks | Statistics Toolkit

12 Ali uses a fitness tracker to count the number of steps he walks each day for 7 days.

For the first 4 days, his mean number of steps is 11 800
For the next 3 days, his mean number of steps is 13 207

Work out his mean number of steps for the 7 days.

(Total for Question 12 is 3 marks)

WORKED SOLUTION

Question 12 · 4MA1/2H June 2024

1 Total for the first 4

Total for the first 4 days:

$$4 \times 11800 = 47200$$

2 Total for the next 3

Total for the next 3 days:

$$3 \times 13207 = 39621$$

3 Total for all 7 days

Total for all 7 days:

$$47200 + 39621 = 86821$$

4 Mean for the 7 days

Mean for the 7 days:

$$\frac{86821}{7} = 12403$$

FINAL ANSWER

12403.

Question 13

7 marks | Cumulative Frequency Diagrams

13 The table gives information about the distances, in km, that 70 teachers travel to school.

Distance (d km)	Frequency
$0 < d \leqslant 10$	7
$10 < d \leqslant 20$	17
$20 < d \leqslant 30$	18
$30 < d \leqslant 40$	14
$40 < d \leqslant 50$	10
$50 < d \leqslant 60$	4

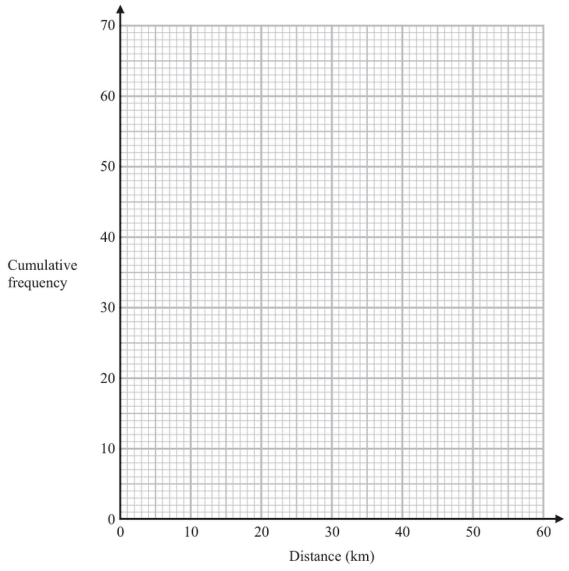
(a) Complete the cumulative frequency table.

Distance (d km)	Cumulative frequency
$0 < d \leqslant 10$	
$0 < d \leqslant 20$	
$0 < d \leqslant 30$	
$0 < d \leqslant 40$	
$0 < d \leqslant 50$	
$0 < d \leqslant 60$	

(1)

(b) On the grid opposite, draw a cumulative frequency graph for your table.

(2)



(c) Use your graph to find an estimate for the interquartile range of the distances.

..... km

(2)

(d) Use your graph to find an estimate for the number of teachers who travel more than 46 km.

.....

(2)

(Total for Question 13 is 7 marks)

1

(a) Running totals

$$7,\ 24,\ 42,\ 56,\ 66,\ 70$$

2

(b) Plot at the upper class boundaries

Plot $(10, 7), (20, 24), (30, 42), (40, 56), (50, 66), (60, 70)$, start at $(0, 0)$, and join with a smooth curve.

3

(c) Read the quartiles

Lower quartile at $\frac{70}{4} = 17.5$: about 16 km. Upper quartile at $\frac{3}{4} \times 70 = 52.5$: about 37.5 km.

$$\text{IQR} \approx 37.5 - 16 = 21.5 \text{ km}$$

(Answers from about 19 to 23 km are accepted, depending on the curve.)

4

(d) More than 46 km

At 46 km the curve reads about 62, so

$$70 - 62 = 8 \text{ teachers}$$

✓ **FINAL ANSWER**

(a) $7, 24, 42, 56, 66, 70$ (c) about 21 km (d) about 8

4MA1/2H JUNE 2024

Question 14

7 marks | Algebraic Proof

14 (a) Show that $3y(2y + 5)(y + 7)$ can be written in the form $ay^3 + by^2 + cy$ where a, b and c are integers.

(3)

(b) Solve $\frac{2x + 3}{5} + \frac{6x - 5}{4} = \frac{163}{100}$

Show clear algebraic working.

$x =$ .....

(4)

(Total for Question 14 is 7 marks)

WORKED SOLUTION

Question 14 · 4MA1/2H June 2024

1 **(a)**

(a)

$$3y(2y+5)(y+7)$$

2 **Expand brackets**

First expand the two brackets:

$$(2y+5)(y+7) = 2y^2 + 14y + 5y + 35 = 2y^2 + 19y + 35$$

3 **Multiply by**

Now multiply by $3y$:

$$3y(2y^2 + 19y + 35) = 6y^3 + 57y^2 + 105y$$

4 **Calculate value**

So $a = 6$, $b = 57$, and $c = 105$.

5 **(b)**

(b)

$$\frac{2x+3}{5} + \frac{6x-5}{4} = \frac{163}{100}$$

6 **Multiply by 100**

Multiply by 100:

$$20(2x+3)+25(6x-5)=163$$

$$40x+60+150x-125=163$$

$$190x-65=163$$

$$190x=228$$

$$x=\frac{228}{190}=\frac{6}{5}$$

FINAL ANSWER

$6y^3+57y^2+105y$, and $x=\frac{6}{5}$.

4MA1/2H JUNE 2024

Question 15

7 marks | Rearranging Formulae

15 (a) Make g the subject of $e = \sqrt{\dfrac{7g + 5}{11 + 2g}}$

.....

(4)

(b) Solve the inequality $3y^2 + 4y - 32 > 0$
Show your working clearly.

.....

(3)

(Total for Question 15 is 7 marks)

WORKED SOLUTION

Question 15 · 4MA1/2H June 2024

1 **(a)**

(a)

$$e = \sqrt{\frac{7g + 5}{11 + 2g}}$$

$$e^2 = \frac{7g + 5}{11 + 2g}$$

$$e^2(11 + 2g) = 7g + 5$$

$$g(2e^2 - 7) = 5 - 11e^2$$

$$g = \frac{5 - 11e^2}{2e^2 - 7}$$

2 **(b)**

(b)

$$3y^2 + 4y - 32 = (3y - 8)(y + 4)$$

3 Solve quadratic equation

The critical values are $y = -4$ and $y = \frac{8}{3}$. Since the quadratic is positive outside the roots,

$$y < -4 \quad \text{or} \quad y > \frac{8}{3}$$

FINAL ANSWER

(a) $g = \frac{5-11e^2}{2e^2-7}$, (b) $y < -4$ or $y > \frac{8}{3}$

Question 16

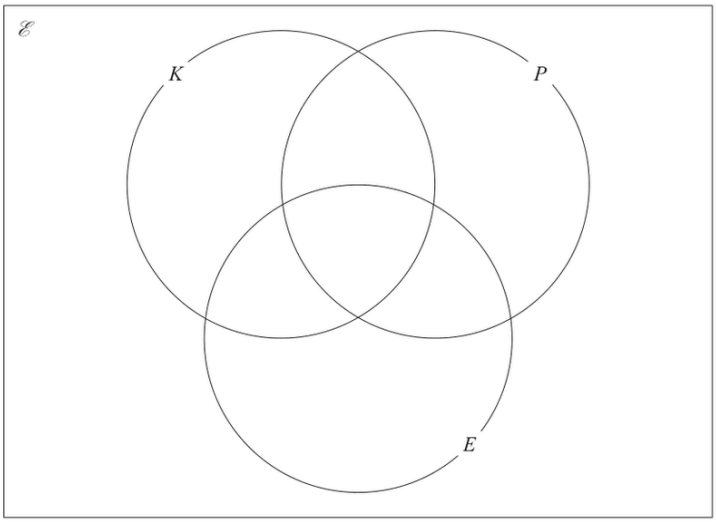
7 marks | Set Notation & Venn Diagrams

16 60 art students were asked if they would like to attend workshops for knitting (K), for photography (P) or for embroidery (E)

Of these students

9 chose knitting, photography and embroidery
17 chose knitting and photography
16 chose photography and embroidery
20 chose knitting and embroidery
28 chose photography
39 chose embroidery
2 chose none of the workshops

(a) Using this information, complete the Venn diagram to show the numbers of students in each subset.



(3)

One of the students is chosen at random.

Given that this student chose photography,

(b) find the probability that this student also chose knitting.

.....

(2)

(c) Find $n(P \cap K')$

.....

(1)

(d) Find $n([P \cup E] \cap K)$

.....

(1)

(Total for Question 16 is 7 marks)

1 **(a) Start from the centre**

All three: 9.

$$K \cap P \text{ only} = 17 - 9 = 8, \quad P \cap E \text{ only} = 16 - 9 = 7, \quad K \cap E \text{ only} = 20 - 9 = 11$$

2 **(a) Single regions**

$$P \text{ only} = 28 - 8 - 7 - 9 = 4, \qquad E \text{ only} = 39 - 11 - 7 - 9 = 12$$

58 students are inside the circles ($60 - 2$):

$$K \text{ only} = 58 - (8 + 7 + 11 + 9 + 4 + 12) = 7$$

Outside: 2.

3 **(b) Knitting, given photography**

28 chose photography; $8 + 9 = 17$ of them also chose knitting.

$$\frac{17}{28}$$

4 **(c) Photography but not knitting**

P only and $P \cap E$ only: $4 + 7 = 11$.

5 **(d) Knitting and (photography or embroidery)**

$8 + 9 + 11 = 28$

FINAL ANSWER

(a) K only 7, P only 4, E only 12, $K \cap P$ only 8, $P \cap E$ only 7, $K \cap E$ only 11, centre 9, outside 2

(b) $\frac{17}{28}$ (c) 11 (d) 28

4MA1/2H JUNE 2024

Question 17

3 marks | Direct & Inverse Proportion

17 Q is directly proportional to the square root of d

$Q = 4.5$ when $d = 324$

Find a formula for Q in terms of d

(Total for Question 17 is 3 marks)

WORKED SOLUTION

Question 17 · 4MA1/2H June 2024

1 Find inverse function

Q is directly proportional to $\sqrt{d}$, so

$$Q = k\sqrt{d}$$

2 Use when

Use $Q = 4.5$ when $d = 324$:

$$4.5 = k\sqrt{324}$$

$$4.5 = 18k$$

$$k = 0.25$$

3 Find inverse function

Therefore

$$Q = \frac{1}{4}\sqrt{d}$$

FINAL ANSWER

$Q = \frac{1}{4}\sqrt{d}$.

4MA1/2H JUNE 2024

Question 18

2 marks | Linear Graphs

18 The straight line **P** has equation $5y + 2x = 7$

Find the gradient of a straight line that is perpendicular to **P**

(Total for Question 18 is 2 marks)

WORKED SOLUTION

Question 18 · 4MA1/2H June 2024

1 The line is

The line is

$$5y + 2x = 7$$

$$5y = -2x + 7$$

$$y = -\frac{2}{5}x + \frac{7}{5}$$

2 Find the gradient

So the gradient of line P is $-\frac{2}{5}$.

3 A line perpendicular to P

A line perpendicular to P has gradient

$$\frac{5}{2}$$

FINAL ANSWER

$\frac{5}{2}$.

4MA1/2H JUNE 2024

Question 19

3 marks | Rounding, Estimation & Bounds

19 $G = \dfrac{c}{2f - 3h}$

$c = 8$ correct to the nearest whole number
$f = 6.62$ correct to 2 decimal places
$h = 1.2$ correct to 1 decimal place

Work out the lower bound for the value of G
Give your answer correct to 3 decimal places.
Show your working clearly.

(Total for Question 19 is 3 marks)

WORKED SOLUTION

Question 19 · 4MA1/2H June 2024

1 Estimate the value

$$G = \frac{c}{2f - 3h}$$

2 Find lower bound

For the lower bound, use the lower bound of c and make the denominator as large as possible.

$$c \geq 7.5$$

$$f < 6.625, \quad h \geq 1.15$$

$$(2f - 3h)_{\text{upper}} = 2(6.625) - 3(1.15) = 9.8$$

$$G_{\text{lower}} = \frac{7.5}{9.8} = 0.765306\ldots$$

✓ **FINAL ANSWER**

0.765

4MA1/2H JUNE 2024

Question 20

3 marks | Algebraic Fractions

20 Given that $k = x - y$ and $x = \dfrac{1}{4y}$

express $\dfrac{5k}{x+2}$ in the form $\dfrac{a - by^2}{c + dy}$ where a, b, c and d are integers.

(Total for Question 20 is 3 marks)

WORKED SOLUTION

Question 20 · 4MA1/2H June 2024

1 **Simplify fraction**

$$k = x - y, \quad x = \frac{1}{4y}$$

2 **Simplify fraction**

So

$$k = \frac{1}{4y} - y = \frac{1 - 4y^2}{4y}$$

3 **Simplify fraction**

Also

$$x + 2 = \frac{1}{4y} + 2 = \frac{1 + 8y}{4y}$$

4 **Simplify fraction**

Therefore

$$\frac{5k}{x+2} = \frac{5\left(\frac{1-4y^2}{4y}\right)}{\frac{1+8y}{4y}}$$

5 **Cancel**

Cancel $4y$:

$$\frac{5(1-4y^2)}{1+8y}$$

$$= \frac{5-20y^2}{1+8y}$$

✓ **FINAL ANSWER**

$$\frac{5-20y^2}{1+8y}$$

4MA1/2H JUNE 2024

Question 21

5 marks | Circles, Arcs & Sectors

21 The diagram shows a square $ABCD$ and a circle.

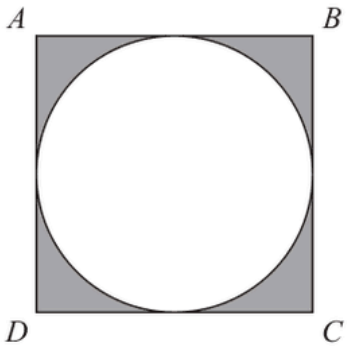


Diagram **NOT** accurately drawn

The sides of the square are tangents to the circle.

The total area of the shaded regions is $80\,\text{cm}^2$

Work out the length of AC
Give your answer correct to 3 significant figures.

..... cm

(Total for Question 21 is 5 marks)

WORKED SOLUTION

Question 21 · 4MA1/2H June 2024

1 **Let the side length**

Let the side length of the square be s.

2 **Square**

The circle is inscribed in the square, so its radius is

$$\frac{s}{2}$$

3 **The shaded area is the**

The shaded area is the area of the square minus the area of the circle:

$$s^2 - \pi\left(\frac{s}{2}\right)^2 = 80$$

$$s^2 - \frac{\pi s^2}{4} = 80$$

$$s^2\left(1 - \frac{\pi}{4}\right) = 80$$

$$s = \sqrt{\frac{80}{1 - \frac{\pi}{4}}} = 19.3076\ldots$$

---

4 **The diagonal of the square**

The diagonal of the square is

$$AC = s\sqrt{2}$$

$$AC = 19.3076\ldots\sqrt{2} = 27.3051\ldots$$

✓ **FINAL ANSWER**

$\boxed{27.3\text{ cm}}$

4MA1/2H JUNE 2024

Question 22

5 marks | Linear Graphs

22 The straight line **L** has equation $x + y = 5$

The curve **C** has equation $2x^2 + 3y^2 = 210$

Find the coordinates of the points where **L** and **C** intersect.
Show clear algebraic working.

(..... , ...) (..... , ...)

(Total for Question 22 is 5 marks)

WORKED SOLUTION

Question 22 · 4MA1/2H June 2024

1 The line is

The line is

$$x + y = 5$$

2 Calculate value

So

$$y = 5 - x$$

3 Substitute into the curve

Substitute into the curve:

$$2x^2 + 3y^2 = 210$$

$$2x^2 + 3(5 - x)^2 = 210$$

$$2x^2 + 3(x^2 - 10x + 25) = 210$$

$$5x^2 - 30x + 75 = 210$$

$$5x^2 - 30x - 135 = 0$$

4 **Divide by 5**

Divide by 5:

$$x^2 - 6x - 27 = 0$$

5 **Factorise**

Factorise:

$$(x - 9)(x + 3) = 0$$

6 **Calculate value**

So

$$x = 9 \quad \text{or} \quad x = -3$$

7 **Calculate value**

Using $y = 5 - x$:

$$x = 9 \Rightarrow y = -4$$

$$x = -3 \Rightarrow y = 8$$

✓ **FINAL ANSWER**

$(9, -4)$ and $(-3, 8)$

4MA1/2H JUNE 2024

Question 23

3 marks | Algebraic Roots & Indices

23 Simplify $\dfrac{30 \times 25^{2x+7}}{\sqrt{180} \times \left(\sqrt{5}\right)^{4x+9}}$

Give your answer in the form 5^w where w is an expression in terms of x
Show each stage of your working clearly.

(Total for Question 23 is 3 marks)

WORKED SOLUTION

Question 23 · 4MA1/2H June 2024

1 Simplify surd

$$\frac{30 \times 25^{2x+7}}{\sqrt{180} \times (\sqrt{5})^{4x+9}}$$

2 Simplify the number part

Simplify the number part:

$$\sqrt{180} = 6\sqrt{5}$$

$$\frac{30}{6\sqrt{5}} = \frac{5}{\sqrt{5}} = \sqrt{5} = 5^{1/2}$$

3 Simplify surd

Now write the powers with base 5:

$$25^{2x+7} = (5^2)^{2x+7} = 5^{4x+14}$$

$$(\sqrt{5})^{4x+9} = 5^{(4x+9)/2} = 5^{2x+9/2}$$

4 Use index laws

So the full expression is

$$5^{1/2+4x+14-(2x+9/2)}$$

$$= 5^{2x+10}$$

FINAL ANSWER

5^{2x+10}.

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Question 24

6 marks | Vectors

24

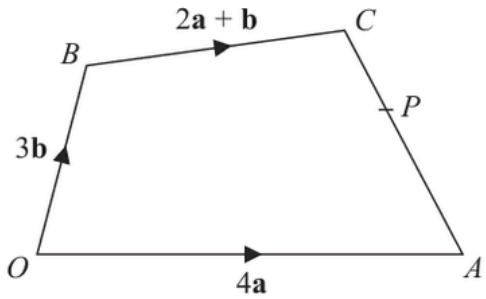


Diagram **NOT** accurately drawn

The diagram shows a quadrilateral $OACB$ in which

$\overrightarrow{OA} = 4\mathbf{a}$ $\overrightarrow{OB} = 3\mathbf{b}$ $\overrightarrow{BC} = 2\mathbf{a} + \mathbf{b}$

(a) Find $\overrightarrow{AC}$ in terms of **a** and **b**
Give your answer in its simplest form.

$\overrightarrow{AC} =$ .....

(2)

The point P lies on AC such that $AP : PC = 3 : 2$

The point Q is such that OPQ and BCQ are straight lines.

(b) Using a vector method, find $\overrightarrow{OQ}$ in terms of **a** and **b**
Give your answer in its simplest form.
Show your working clearly.

$\overrightarrow{OQ} =$ .....

(4)

(Total for Question 24 is 6 marks)

WORKED SOLUTION

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1 **Read the graph**

$$\vec{OA} = 4\mathbf{a}, \quad \vec{OB} = 3\mathbf{b}, \quad \vec{BC} = 2\mathbf{a} + \mathbf{b}$$

2 **Read the graph**

So

$$\vec{OC} = \vec{OB} + \vec{BC}$$

$$\vec{OC} = 2\mathbf{a} + 4\mathbf{b}$$

---

3 **Read the graph**

For part (a),

$$\vec{AC} = \vec{OC} - \vec{OA}$$

$$\vec{AC} = (2\mathbf{a} + 4\mathbf{b}) - 4\mathbf{a}$$

$$\vec{AC} = 4\mathbf{b} - 2\mathbf{a}$$

---

4 **Read the graph**

For part (b), $AP : PC = 3 : 2$, so

$$\vec{OP} = \vec{OA} + \frac{3}{5}\vec{AC}$$

$$\vec{OP} = 4\mathbf{a} + \frac{3}{5}(4\mathbf{b} - 2\mathbf{a})$$

$$\vec{OP} = \frac{14}{5}\mathbf{a} + \frac{12}{5}\mathbf{b}$$

---

5 **Read the graph**

Since O, P, Q are collinear,

$$\vec{OQ} = t\vec{OP}$$

$$\vec{OQ} = t\left(\frac{14}{5}\mathbf{a} + \frac{12}{5}\mathbf{b}\right)$$

---

6 **Read the graph**

Since B, C, Q are collinear,

$$\vec{OQ} = \vec{OB} + s\vec{BC}$$

$$\vec{OQ} = 3\mathbf{b} + s(2\mathbf{a} + \mathbf{b})$$

$$\vec{OQ} = 2s\mathbf{a} + (3 + s)\mathbf{b}$$

---

7 **Equate coefficients**

Equate coefficients:

$$\frac{14}{5}t = 2s$$

$$\frac{12}{5}t = 3 + s$$

---

8 **Solve equation**

From the first equation,

$$s = \frac{7}{5}t$$

---

9 **Substitute into the second**

Substitute into the second:

$$\frac{12}{5}t = 3 + \frac{7}{5}t$$

$$t = 3$$

---

10 **Read the graph**

Therefore

$$\vec{OQ} = 3\vec{OP}$$

$$\vec{OQ} = \frac{42}{5}\mathbf{a} + \frac{36}{5}\mathbf{b}$$

✓ **FINAL ANSWER**

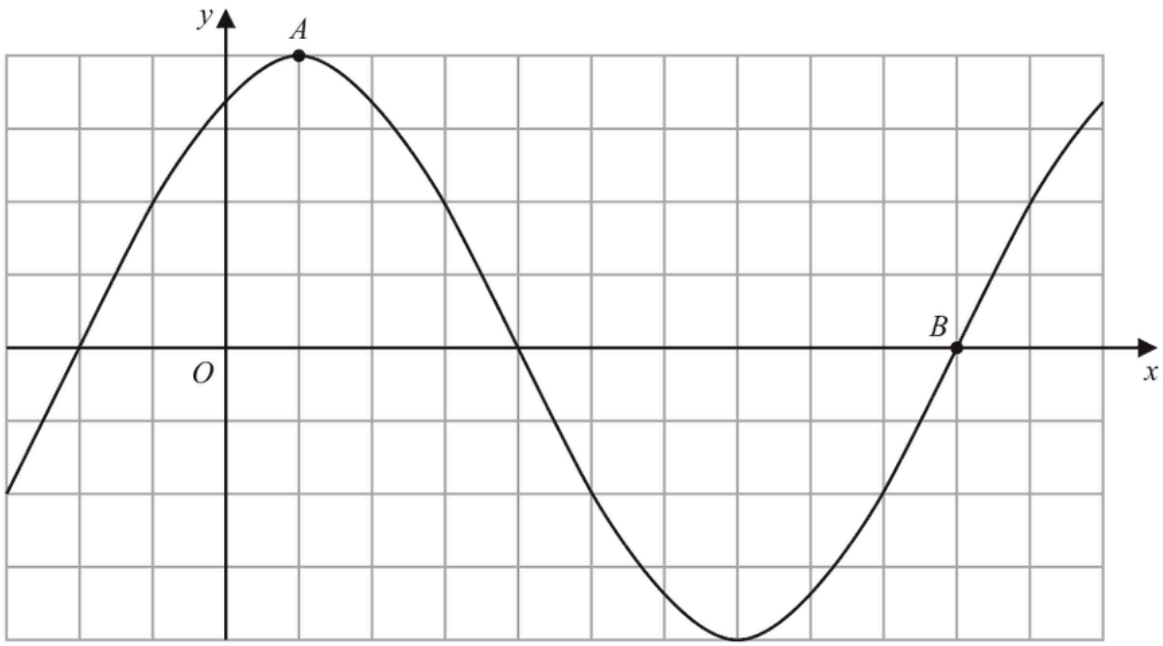
$\vec{AC} = 4\mathbf{b} - 2\mathbf{a}$, $\vec{OQ} = \frac{42}{5}\mathbf{a} + \frac{36}{5}\mathbf{b}$

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Question 25

2 marks | Graphs of Functions

25 The diagram shows a sketch of the graph of $y = 2\sin(x + 60)°$



(i) Find the coordinates of the point A

(..... , ...)

(1)

(ii) Find the coordinates of the point B

(..... , ...)

(1)

(Total for Question 25 is 2 marks)

WORKED SOLUTION

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1 Use trigonometry

$$y = 2\sin(x + 60)°$$

2 Point is the maximum point

Point A is the maximum point.

3 **The maximum value is**

The maximum value is

$$y = 2$$

4 **This happens when**

This happens when

$$x + 60 = 90$$

$$x = 30$$

5 **Read the graph**

So

$$A = (30, 2)$$

6 **Point is the positive intercept**

Point B is the positive x-intercept after the minimum.

$$2\sin(x + 60)° = 0$$

$$\sin(x + 60)° = 0$$

7 **Read the graph**

For this point,

$$x + 60 = 360$$

$$x = 300$$

8 **Read the graph**

So

$$B = (300, 0)$$

✓ **FINAL ANSWER**

$A = (30, 2),\ B = (300, 0)$