Elite Mathematics
Pearson Edexcel International GCSE

IGCSE LINEAR · 4MA1

4MA1/1H January 2020 Worked Solutions

January 2020 paper rebuilt with the worked solution after each question.

22	2020–2026	Single-paper solutions
paper questions	52 past papers	checked by Dr Eslam



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PAST PAPER

4MA1/1H January 2020

January 2020

22	100	2 h
questions	marks	exam time

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

4MA1/1H JANUARY 2020

Question 1

4 marks | Linear Graphs

1 The point A has coordinates $(5, -4)$
The point B has coordinates $(13, 1)$

(a) Work out the coordinates of the midpoint of AB.

(..... , ...)

(2)

Line **L** has equation $y = 2 - 3x$

(b) Write down the gradient of line **L**.

.....

(1)

Line **L** has equation $y = 2 - 3x$

(c) Does the point with coordinates $(100, -302)$ lie on line **L**?
You must give a reason for your answer.

.....

(1)

(Total for Question 1 is 4 marks)

WORKED SOLUTION

Question 1 · 4MA1/1H January 2020

1 **Find the midpoint**

(a) The midpoint of $A(5, -4)$ and $B(13, 1)$ is

$$\left(\frac{5+13}{2}, \frac{-4+1}{2}\right)$$

$$= (9, -1.5)$$

2 **(b)**

(b)

$$y = 2 - 3x$$

3 **The gradient is**

The gradient is -3.

4 **Calculate value**

(c) For $x = 100$,

$$y = 2 - 3(100) = -298$$

5 **Calculate value**

The point has $y = -302$, not -298, so it does not lie on the line.

FINAL ANSWER

$(9, -1.5)$, gradient -3, and no.

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Question 2

2 marks | Prime Factors, HCF & LCM

2 Find the lowest common multiple (LCM) of 28 and 105

(Total for Question 2 is 2 marks)

WORKED SOLUTION

Question 2 · 4MA1/1H January 2020

1 Write both numbers as products

Write both numbers as products of prime factors:

$$28 = 2^2 \times 7$$

$$105 = 3 \times 5 \times 7$$

2 Find the LCM

For the lowest common multiple, take the highest power of each prime:

$$\text{LCM} = 2^2 \times 3 \times 5 \times 7 = 420$$

FINAL ANSWER

420

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Question 3

4 marks | Perimeter & Area

3 The diagram shows a shape.

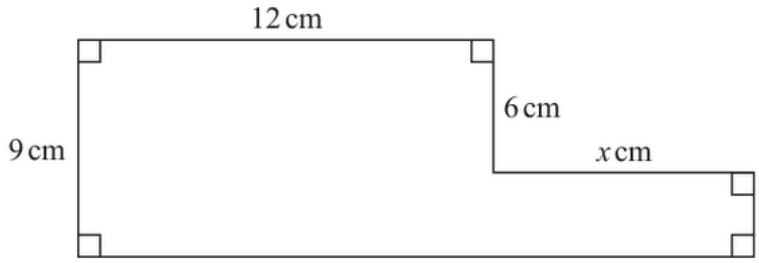


Diagram **NOT** accurately drawn

The shape has area 129 cm^2

Work out the value of x.

$x =$ .....

(Total for Question 3 is 4 marks)

WORKED SOLUTION

Question 3 · 4MA1/1H January 2020

1 Split the shape into two

Split the shape into two rectangles.

2 The left rectangle has area

The left rectangle has area

$$12 \times 9 = 108 \text{ cm}^2$$

3 The right rectangle has height

The right rectangle has height

$$9 - 6 = 3 \text{ cm}$$

4 Calculate area

So its area is

$$3x$$

5 **Total area**

Total area:

$$108 + 3x = 129$$

$$3x = 21$$

$$x = 7$$

✓ **FINAL ANSWER**

$7\ \text{cm}$.

4MA1/1H JANUARY 2020

Question 4

7 marks | Averages from Frequency Tables

4 The table shows information about the weights, in kilograms, of 40 babies.

Weight (w kg)	Frequency
$2 < w \leqslant 3$	12
$3 < w \leqslant 4$	16
$4 < w \leqslant 5$	9
$5 < w \leqslant 6$	2
$6 < w \leqslant 7$	1

(a) Write down the modal class.

.....

(1)

(b) Work out an estimate for the mean weight of the 40 babies.

..... kg

(4)

One of the 40 babies is going to be chosen at random.

(c) Find the probability that this baby has a weight of more than 5 kg.

.....

(2)

(Total for Question 4 is 7 marks)

WORKED SOLUTION

Question 4 · 4MA1/1H January 2020

1 **(a) The greatest frequency is**

(a) The greatest frequency is 16, so the modal class is

$$3 < w \leq 4$$

2 **(b) Use class midpoints**

(b) Use class midpoints:

$$\frac{2.5(12) + 3.5(16) + 4.5(9) + 5.5(2) + 6.5(1)}{40} = 3.6$$

3 (c) Weights greater than kg

(c) Weights greater than 4 kg:

$$9 + 2 + 1 = 12$$

$$P(w > 4) = \frac{12}{40} = \frac{3}{10}$$

FINAL ANSWER

(a) $3 < w \leq 4$, (b) $3.6\ \text{kg}$, (c) $\frac{3}{10}$.

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Question 5

6 marks | Ratio Toolkit

5 120 children go on an activity holiday.
The ratio of the number of girls to the number of boys is 3 : 5

On Sunday, all the children either go sailing or go climbing.

$\frac{16}{25}$ of the boys go climbing.

Twice as many girls go sailing as go climbing.

Work out how many children go sailing on Sunday.

(Total for Question 5 is 6 marks)

WORKED SOLUTION

Question 5 · 4MA1/1H January 2020

1 Split the ratio

Girls : boys $= 3 : 5$, so there are 8 parts.

$$\text{girls} = 120 \times \frac{3}{8} = 45$$

$$\text{boys} = 120 \times \frac{5}{8} = 75$$

2 Split the ratio

Boys climbing:

$$\frac{16}{25} \times 75 = 48$$

3 Split the ratio

Boys sailing:

$$75 - 48 = 27$$

4 Split the ratio

For the girls, twice as many go sailing as climbing, so the girls are split in the ratio

$$\text{sailing} : \text{climbing} = 2 : 1$$

5 **Split the ratio**

Girls sailing:

$$\frac{2}{3} \times 45 = 30$$

6 **Total sailing**

Total sailing:

$$27 + 30 = 57$$

✓ **FINAL ANSWER**

57

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Question 6

3 marks | Standard Form

6 (a) Write 7.8×10^{-4} as an ordinary number.

.....

(1)

(b) Work out $\dfrac{5.6 \times 10^4 + 7 \times 10^3}{2.8 \times 10^{-3}}$

Give your answer in standard form.

.....

(2)

(Total for Question 6 is 3 marks)

WORKED SOLUTION

Question 6 · 4MA1/1H January 2020

1 Convert standard form

$$7.8 \times 10^{-4} = 0.00078$$

2 Convert standard form

For part (b),

$$5.6 \times 10^4 + 7 \times 10^3 = 56000 + 7000 = 63000$$

3 Convert standard form

Then

$$\frac{63000}{2.8 \times 10^{-3}} = \frac{63000}{0.0028}$$

$$= 22500000 = 2.25 \times 10^7$$

FINAL ANSWER

(a) 0.00078, (b) 2.25×10^7

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Question 7

9 marks | Linear Equations

7 (a) Expand and simplify $(m - 8)(m + 5)$

.....

(2)

(b) Factorise fully $5y + 20y^2$

.....

(2)

(c) Simplify $(p^2 + 3)^0$

.....

(1)

(d) Solve $3(2x - 5) = \frac{9 - x}{2}$

Show clear algebraic working.

$x =$ .....

(4)

(Total for Question 7 is 9 marks)

WORKED SOLUTION

Question 7 · 4MA1/1H January 2020

1 **(a)**

(a) $(m-8)(m+5) = m^2 - 3m - 40$.

2 **(b)**

(b) $5y + 20y^2 = 5y(1 + 4y)$.

3 **(c)**

(c) $(p^2+3)^0 = 1$.

4 **(d)**

(d)

$$3(2x-5)=\frac{9-x}{2}$$

$$12x-30=9-x$$

$$13x=39$$

FINAL ANSWER

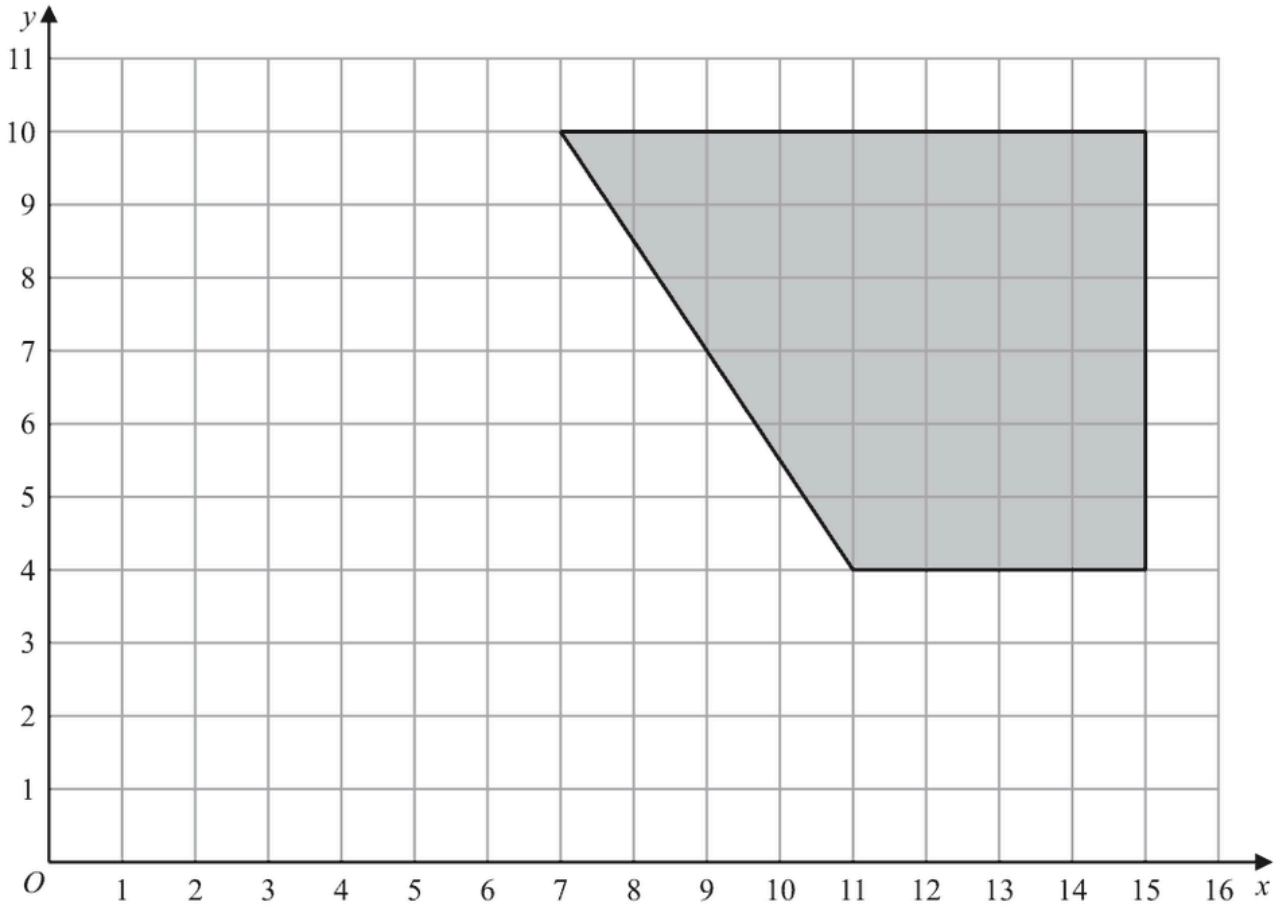
(a) $m^2-3m-40$, (b) $5y(1+4y)$, (c) 1, (d) $x=3$

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Question 8

2 marks | Transformations

8



On the grid, enlarge the shaded shape with scale factor $\frac{1}{2}$ and centre (1, 2)

(Total for Question 8 is 2 marks)

WORKED SOLUTION

Question 8 · 4MA1/1H January 2020

1 **Use**

Use

$$\text{new point} = (1, 2) + \frac{1}{2}(\text{old point} - (1, 2))$$

2 **The vertices**

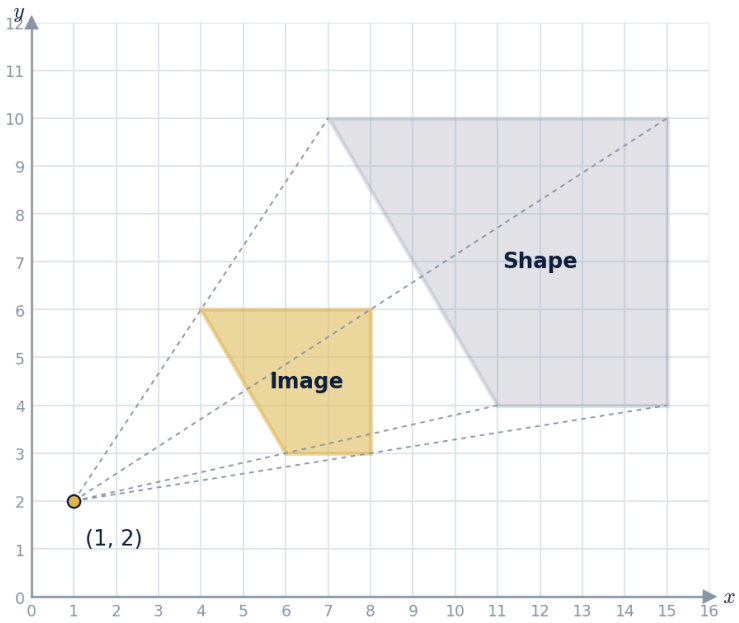
The vertices

$$(7, 10),\ (15, 10),\ (15, 4),\ (11, 4)$$

3 **become**

become

$$(4, 6),\ (8, 6),\ (8, 3),\ (6, 3)$$



FINAL ANSWER

draw the enlarged shape with vertices $(4, 6), (8, 6), (8, 3), (6, 3)$.

Question 9

3 marks

Right-Angled Triangles - Pythagoras & Trigonometry

9 Here is a right-angled triangle.

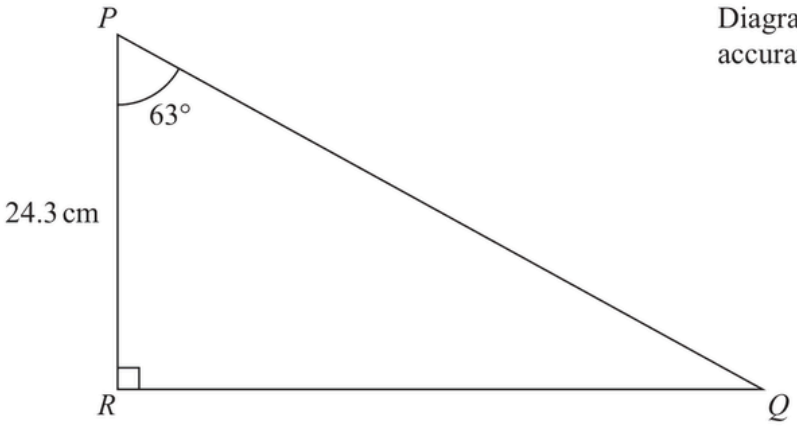


Diagram **NOT** accurately drawn

Calculate the length of PQ.
Give your answer correct to 3 significant figures.

..... cm

(Total for Question 9 is 3 marks)

1 Use trigonometry

$$\cos 63^\circ = \frac{24.3}{PQ}$$

$$PQ = \frac{24.3}{\cos 63^\circ} = 53.525\ldots$$

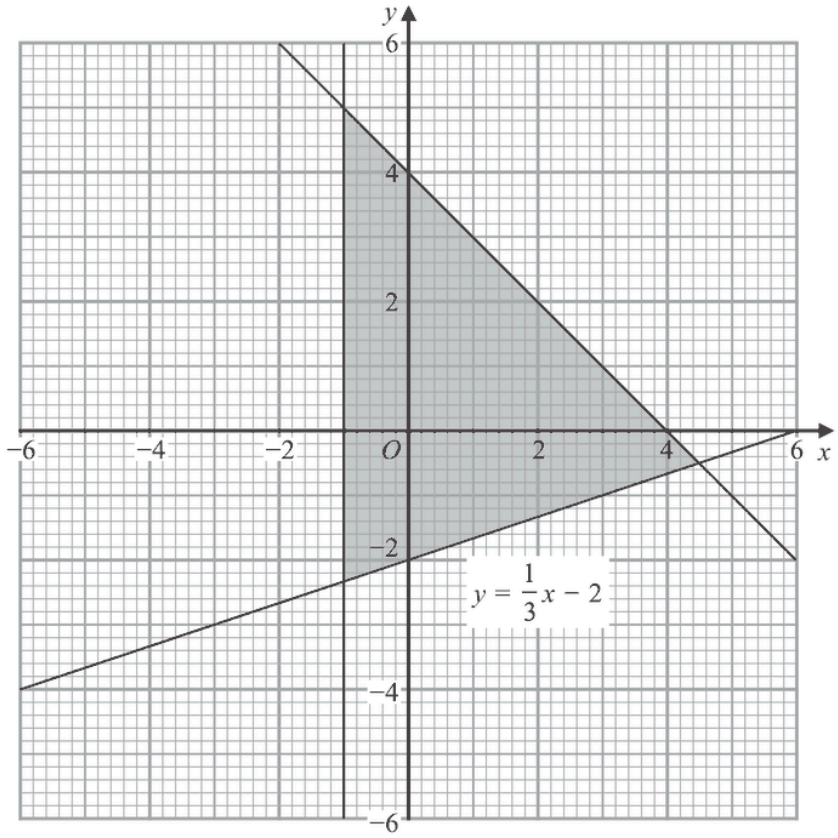
FINAL ANSWER

53.5 cm.

Question 10

3 marks | Inequalities (Solving & Graphing)

10 The shaded region in the diagram is bounded by three lines.
The equation of one of the lines is given.



Write down the three inequalities that define the shaded region.

.....

.....

.....

(Total for Question 10 is 3 marks)

1 **The shaded region is left**

The shaded region is left of the y-axis:

$$x \leq 0$$

2 **It is below the line**

It is below the line through $(0, 4)$ and $(4, 0)$:

$$y \leq -x + 4$$

3 **It is above the line**

It is above the line

$$y = \frac{1}{3}x - 2$$

4 **Evaluate fraction**

So

$$y \geq \frac{1}{3}x - 2$$

✓ **FINAL ANSWER**

$x \leq 0$, $y \leq -x + 4$, $y \geq \frac{1}{3}x - 2$.

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Question 11

3 marks | Compound Interest & Depreciation

11 Max invests \$6000 in a savings account for 3 years.
The account pays compound interest at a rate of 1.5% per year for the first 2 years.

The compound interest rate changes for the third year.
At the end of 3 years, there is a total of \$6311.16 in the account.

Work out the compound interest rate for the third year.
Give your answer correct to 1 decimal place.

..... %

(Total for Question 11 is 3 marks)

WORKED SOLUTION

Question 11 · 4MA1/1H January 2020

1 **Use compound interest**

After the first 2 years,

$$6000(1.015)^2 = 6181.35$$

2 **Let the third year interest**

Let the third-year interest rate be $r\%$.

$$6181.35\left(1+\frac{r}{100}\right)=6311.16$$

$$1+\frac{r}{100}=\frac{6311.16}{6181.35}=1.021000\ldots$$

$$r=2.1000\ldots$$

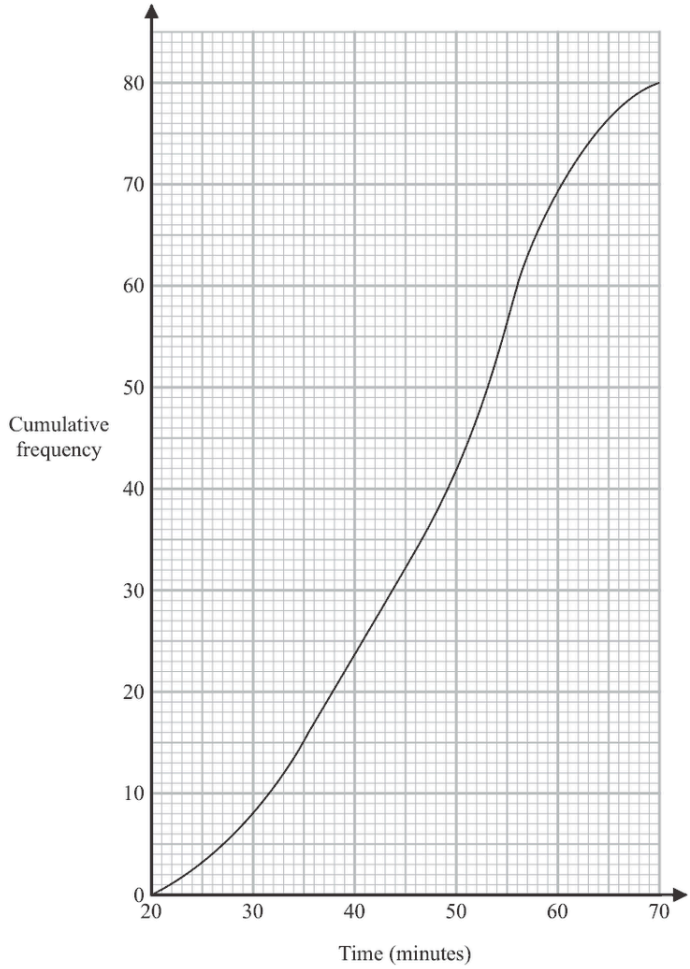
✓ **FINAL ANSWER**

2.1%

Question 12

5 marks | Cumulative Frequency Diagrams

12 A total of 80 men and women took part in a race.
The cumulative frequency graph gives information about the times, in minutes, they took for the race.



(a) Use the graph to find an estimate for the interquartile range.

..... minutes
(2)

60% of the men took 50 minutes or less for the race.
No women took 50 minutes or less for the race.

(b) Work out an estimate for the number of men who took part in the race.

.....
(3)

(Total for Question 12 is 5 marks)

1 **There are people**

There are 80 people.

2 **Use cumulative frequency**

For the interquartile range:

$$Q_1 \text{ is at cumulative frequency } 20$$

$$Q_3 \text{ is at cumulative frequency } 60$$

3 **Use cumulative frequency**

From the graph,

$$Q_1 \approx 38, \qquad Q_3 \approx 56$$

$$\text{IQR} \approx 56 - 38 = 18$$

4 **Use cumulative frequency**

At 50 minutes, the cumulative frequency is about 42.

5 **Use cumulative frequency**

No women took 50 minutes or less, so these 42 people are men.

$$0.6 \times \text{number of men} = 42$$

$$\text{number of men} = \frac{42}{0.6} = 70$$

FINAL ANSWER

IQR about 18 minutes, and about 70 men.

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Question 13

4 marks | Standard & Compound Units

13 The diagram shows a solid cube.
The cube is placed on a table so that the whole of one face of the cube is in contact with the table.

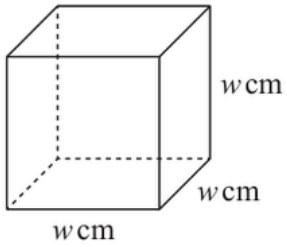


Diagram **NOT** accurately drawn

The cube exerts a force of 56 newtons on the table.
The pressure on the table due to the cube is 0.14 newtons/cm^2

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

Work out the volume of the cube.

..... cm^3

(Total for Question 13 is 4 marks)

WORKED SOLUTION

Question 13 · 4MA1/1H January 2020

1 Calculate area

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

$$0.14 = \frac{56}{\text{area}}$$

$$\text{area} = \frac{56}{0.14} = 400 \text{ cm}^2$$

2 **The cube rests on one**

The cube rests on one square face, so

$$w^2 = 400$$

$$w = 20$$

3 **Volume of the cube is**

Volume of the cube is

$$20^3 = 8000$$

FINAL ANSWER

$8000\ \text{cm}^3$.

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Question 14

5 marks | Sine & Cosine Rules

14 The diagram shows parallelogram $EFGH$.

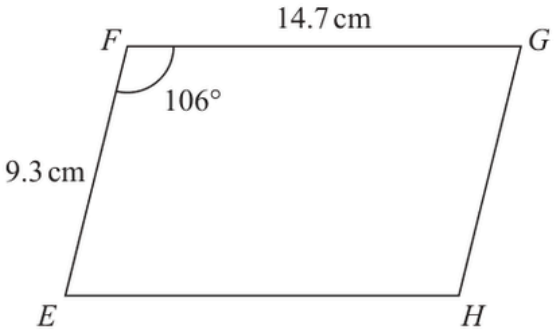


Diagram **NOT** accurately drawn

$EF = 9.3$ cm
$FG = 14.7$ cm
Angle $EFG = 106°$

(a) Work out the area of the parallelogram.
Give your answer correct to 3 significant figures.

..... cm^2
(2)

(b) Work out the length of the diagonal EG of the parallelogram.
Give your answer correct to 3 significant figures.

..... cm
(3)

(Total for Question 14 is 5 marks)

WORKED SOLUTION

Question 14 · 4MA1/1H January 2020

1 **(a)**

(a)

$$\text{area} = 9.3 \times 14.7 \times \sin 106° = 131.414\ldots$$

2 **Answer**

Answer: $131\ cm^2$.

3 **Use trigonometry**

(b) In triangle EFG,

$$EG^2 = 9.3^2 + 14.7^2 - 2(9.3)(14.7)\cos 106°$$

$$EG = 19.440\ldots$$

✓ **FINAL ANSWER**

$19.4\ \text{cm}$.

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Question 15

8 marks | Differentiation & Turning Points

15

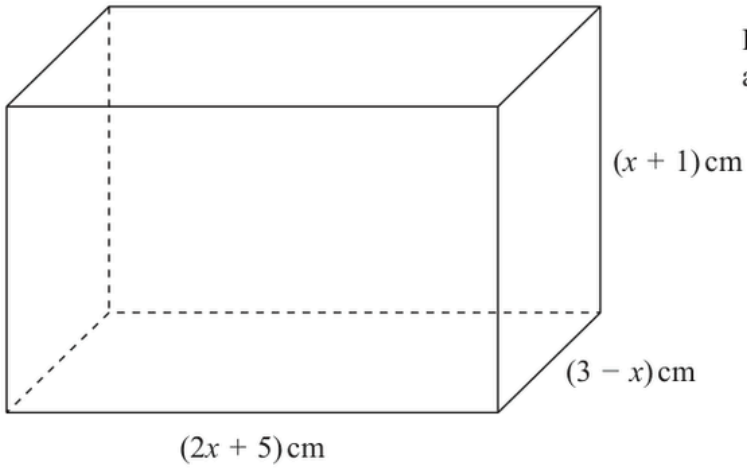


Diagram **NOT** accurately drawn

The diagram shows a cuboid of volume $V\,\text{cm}^3$

(a) Show that $V = 15 + 16x - x^2 - 2x^3$

(3)

There is a value of x for which the volume of the cuboid is a maximum.

(b) Find this value of x.
Show your working clearly.
Give your answer correct to 3 significant figures.

$x =$ .....

(5)

(Total for Question 15 is 8 marks)

WORKED SOLUTION

Question 15 · 4MA1/1H January 2020

1 The volume is

The volume is

$$V = (2x + 5)(x + 1)(3 - x)$$

2 **Expand brackets**

First expand:

$$(2x+5)(x+1) = 2x^2 + 7x + 5$$

$$V = (2x^2 + 7x + 5)(3 - x)$$

$$V = 15 + 16x - x^2 - 2x^3$$

---

3 **Calculate volume**

For the maximum volume,

$$\frac{dV}{dx} = 0$$

$$\frac{dV}{dx} = 16 - 2x - 6x^2$$

$$16 - 2x - 6x^2 = 0$$

$$3x^2 + x - 8 = 0$$

---

4 **Solve quadratic equation**

Using the quadratic formula,

$$x = \frac{-1 \pm \sqrt{97}}{6}$$

---

5 **The valid positive value is**

The valid positive value is

$$x = 1.4748\ldots$$

✓ **FINAL ANSWER**

$x = 1.47$ to 3 significant figures.

4MA1/1H JANUARY 2020

Question 16

3 marks | Rounding, Estimation & Bounds

16 $P = \dfrac{2a - c}{d}$

$a = 58.4$ correct to 3 significant figures.
$c = 20$ correct to 2 significant figures.
$d = 3.6$ correct to 2 significant figures.

Work out the upper bound for the value of P.
Show your working clearly.
Give your answer correct to 2 decimal places.

.....

(Total for Question 16 is 3 marks)

WORKED SOLUTION

Question 16 · 4MA1/1H January 2020

1 **Estimate the value**

$$P = \frac{2a - c}{d}$$

2 **Find upper bound**

For the upper bound of P, make the numerator as large as possible and the denominator as small as possible.

$$a < 58.45, \quad c \geq 19.5, \quad d \geq 3.55$$

$$P_{\text{upper}} = \frac{2(58.45) - 19.5}{3.55} = 27.4366\ldots$$

✓ **FINAL ANSWER**

27.44

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Question 17

6 marks | Algebraic Roots & Indices

17 (a) Show that $\left(6+2\sqrt{12}\right)^2 = 12\left(7+4\sqrt{3}\right)$

Show each stage of your working.

(3)

(b) Simplify fully $\left(\frac{27a^{12}}{t^{15}}\right)^{-\frac{2}{3}}$

.....

(3)

(Total for Question 17 is 6 marks)

WORKED SOLUTION

Question 17 · 4MA1/1H January 2020

1 **Simplify surd**

First,

$$\sqrt{12} = 2\sqrt{3}$$

2 **Simplify surd**

So

$$6 + 2\sqrt{12} = 6 + 4\sqrt{3}$$

3 **Simplify surd**

Now square:

$$(6 + 4\sqrt{3})^2 = 36 + 48\sqrt{3} + 48$$

$$= 84 + 48\sqrt{3}$$

4 **Factor out**

Factor out 12:

$$84 + 48\sqrt{3} = 12(7 + 4\sqrt{3})$$

5 **Simplify surd**

For part (b),

$$\left(\frac{27a^{12}}{t^{15}}\right)^{-\frac{2}{3}} = \left(\frac{t^{15}}{27a^{12}}\right)^{\frac{2}{3}}$$

$$= \frac{t^{10}}{9a^{8}}$$

✓ **FINAL ANSWER**

(a) shown, (b) $\frac{t^{10}}{9a^{8}}$

4MA1/1H JANUARY 2020

Question 18

4 marks | Probability Toolkit

18 There are 16 sweets in a bowl.

4 of the sweets are blackcurrant.
5 of the sweets are lemon.
7 of the sweets are orange.

Anna, Ravi and Sam each take at random one sweet from the bowl.

Work out the probability that the 5 lemon sweets are still in the bowl.

(Total for Question 18 is 4 marks)

WORKED SOLUTION

Question 18 · 4MA1/1H January 2020

1 Count the sweets that are not lemon

There are 16 sweets and 5 are lemon, so 11 are not lemon.

2 Three picks without replacement, none lemon

All 5 lemon sweets stay in the bowl only if Anna, Ravi and Sam each take a non-lemon sweet:

$$\frac{11}{16} \times \frac{10}{15} \times \frac{9}{14} = \frac{990}{3360} = \frac{33}{112}$$

FINAL ANSWER

$$\frac{33}{112}$$

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Question 19

4 marks | 3D Pythagoras & Trigonometry

19 The diagram shows a cuboid $ABCDEFGH$.

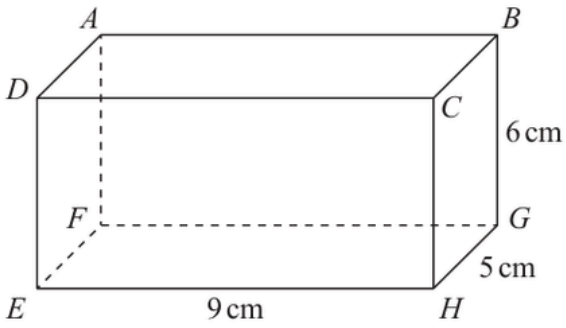


Diagram **NOT** accurately drawn

$EH = 9\,\text{cm}$, $HG = 5\,\text{cm}$ and $GB = 6\,\text{cm}$.

Work out the size of the angle between AH and the plane $EFGH$.
Give your answer correct to 3 significant figures.

.....°

(Total for Question 19 is 4 marks)

WORKED SOLUTION

Question 19 · 4MA1/1H January 2020

1 The projection of onto the

The projection of AH onto the base plane is the diagonal of the base rectangle:

$$\sqrt{9^2 + 5^2} = \sqrt{106}$$

2 Use trigonometry

The vertical height is $6\ \text{cm}$, so

$$\tan\theta = \frac{6}{\sqrt{106}}$$

$$\theta = 30.232\ldots^\circ$$

FINAL ANSWER

30.2°.

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Question 20

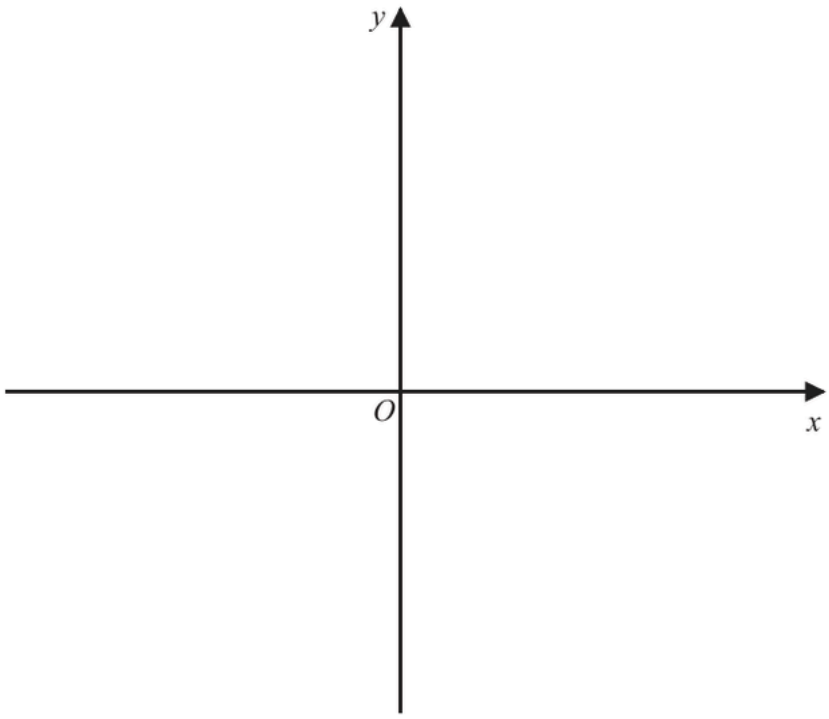
4 marks | Graphs of Functions

20 The curve **C** has equation $y = 4(x - 1)^2 - a$ where $a > 4$

Using the axes below, sketch the curve **C**.
On your sketch show clearly, in terms of a,

(i) the coordinates of any points of intersection of **C** with the coordinate axes,

(ii) the coordinates of the turning point.



(Total for Question 20 is 4 marks)

WORKED SOLUTION

Question 20 · 4MA1/1H January 2020

1 **Calculate value**

$$y = 4(x - 1)^2 - a$$

2 **The turning point is read**

The turning point is read directly from the completed square form:

$$(1, -a)$$

3 **Find intercepts**

For the y-intercept, put $x = 0$:

$$y = 4(0-1)^2 - a$$

$$y = 4 - a$$

4 **Find intercepts**

So the y-intercept is

$$(0, 4-a)$$

5 **Find intercepts**

For the x-intercepts, put $y = 0$:

$$4(x-1)^2 - a = 0$$

$$4(x-1)^2 = a$$

$$(x-1)^2 = \frac{a}{4}$$

$$x - 1 = \pm\frac{\sqrt{a}}{2}$$

$$x = 1 \pm \frac{\sqrt{a}}{2}$$

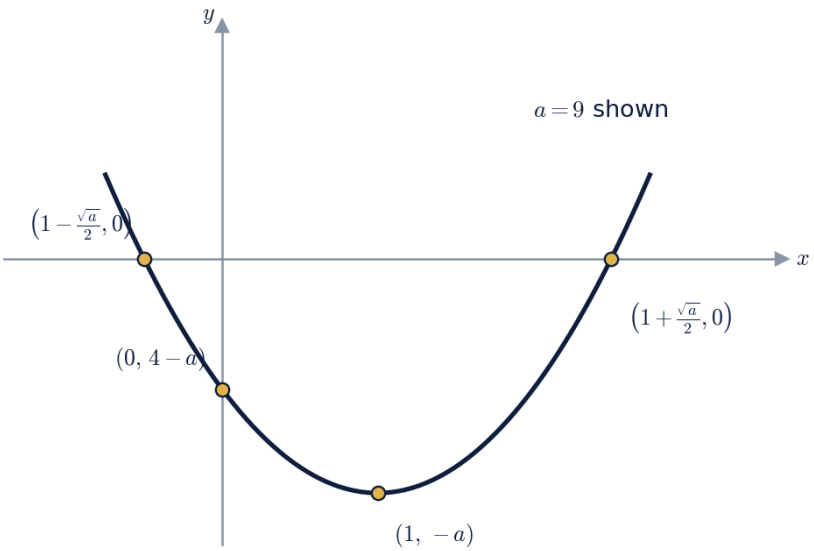
6 **Find intercepts**

So the x-intercepts are

$$\left(1 - \frac{\sqrt{a}}{2}, 0\right) \quad \text{and} \quad \left(1 + \frac{\sqrt{a}}{2}, 0\right)$$

7 **Solve inequality**

Since $a > 4$, the turning point is below the x-axis and the curve crosses the x-axis twice.



FINAL ANSWER

turning point $(1, -a)$, y-intercept $(0, 4-a)$, x-intercepts $\left(1-\frac{\sqrt{a}}{2}, 0\right)$ and $\left(1+\frac{\sqrt{a}}{2}, 0\right)$

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Question 21

5 marks | Functions

21 The functions f and g are such that

$$f(x) = x^2 - 2x \qquad g(x) = x + 3$$

The function h is such that $h(x) = fg(x)$ for $x \geqslant -2$

Express the inverse function $h^{-1}(x)$ in the form $h^{-1}(x) = \ldots$

$h^{-1}(x) =$ .....

(Total for Question 21 is 5 marks)

WORKED SOLUTION

Question 21 · 4MA1/1H January 2020

1 **Calculate value**

$$f(x) = x^2 - 2x$$

$$g(x) = x + 3$$

$$h(x) = fg(x) = f(g(x))$$

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

$$h(x) = x^2 + 4x + 3$$

$$h(x) = (x+2)^2 - 1$$

2 **Let**

Let

$$y = (x+2)^2 - 1$$

3 Find inverse function

Since the domain is $x \geq -2$, take the positive square root:

$$x + 2 = \sqrt{y + 1}$$

$$x = \sqrt{y + 1} - 2$$

FINAL ANSWER

$$h^{-1}(x) = \sqrt{x + 1} - 2$$

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Question 22

6 marks | Linear Graphs

22 Triangle HJK is isosceles with $HJ = HK$ and $JK = \sqrt{80}$

H is the point with coordinates $(-4, 1)$
J is the point with coordinates $(j, 15)$ where $j < 0$
K is the point with coordinates $(6, k)$

M is the midpoint of JK.
The gradient of HM is 2

Find the value of j and the value of k.

$j =$ .....

$k =$ .....

(Total for Question 22 is 6 marks)

WORKED SOLUTION

Question 22 · 4MA1/1H January 2020

1 Find the midpoint

Since M is the midpoint of JK,

$$M = \left(\frac{j+6}{2}, \frac{15+k}{2}\right)$$

2 Find the gradient

The gradient of HM is 2, and $H = (-4, 1)$.

$$\frac{\frac{15+k}{2} - 1}{\frac{j+6}{2} + 4} = 2$$

$$\frac{k+13}{j+14} = 2$$

$$k = 2j + 15$$

3 **Simplify surd**

Also,

$$JK = \sqrt{80}$$

---

4 **Calculate value**

So

$$(6 - j)^2 + (k - 15)^2 = 80$$

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5 **Substitute**

Substitute $k = 2j + 15$:

$$(6 - j)^2 + (2j)^2 = 80$$

$$j^2 - 12j + 36 + 4j^2 = 80$$

$$5j^2 - 12j - 44 = 0$$

$$(5j + 10)(j - 4.4) = 0$$

---

6 **Solve inequality**

Since $j < 0$,

$$j = -2$$

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7 **Calculate value**

Then

$$k = 2(-2) + 15 = 11$$

✓ **FINAL ANSWER**

$j = -2,\ k = 11$