Elite Mathematics
Pearson Edexcel International GCSE

IGCSE LINEAR · 4MA1

4MA1/2H June 2023 Worked Solutions

June 2023 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 2023

June 2023

25	100	2 h
questions	marks	exam time

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

4MA1/2H JUNE 2023

Question 1

3 marks | Algebraic Proof

1 Show that $4\frac{2}{3} \div 1\frac{1}{5} = 3\frac{8}{9}$

(Total for Question 1 is 3 marks)

WORKED SOLUTION

Question 1 · 4MA1/2H June 2023

1 **Evaluate fraction**

$$4\frac{2}{3} = \frac{14}{3}, \qquad 1\frac{1}{5} = \frac{6}{5}$$

$$4\frac{2}{3} \div 1\frac{1}{5} = \frac{14}{3} \div \frac{6}{5}$$

$$= \frac{14}{3} \times \frac{5}{6} = \frac{70}{18} = \frac{35}{9}$$

$$\frac{35}{9} = 3\frac{8}{9}$$

FINAL ANSWER

$3\frac{8}{9}$.

4MA1/2H JUNE 2023

Question 2

3 marks | Probability Toolkit

2 A biased spinner can land on green or on yellow or on brown or on pink.

The table gives the probabilities that, when the spinner is spun, it will land on green or on yellow or on brown.

Colour	green	yellow	brown	pink
Probability	0.32	0.13	0.28	

Timucin spins the spinner 200 times.

Work out an estimate for the number of times the spinner lands on pink.

(Total for Question 2 is 3 marks)

WORKED SOLUTION

Question 2 · 4MA1/2H June 2023

1 Probability of pink

$$1 - (0.32 + 0.13 + 0.28) = 1 - 0.73 = 0.27$$

2 Estimate for 200 spins

$$200 \times 0.27 = 54$$

FINAL ANSWER

54

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Question 3

4 marks | Angles in Polygons & Parallel Lines

3 $ABCD$ is a trapezium.

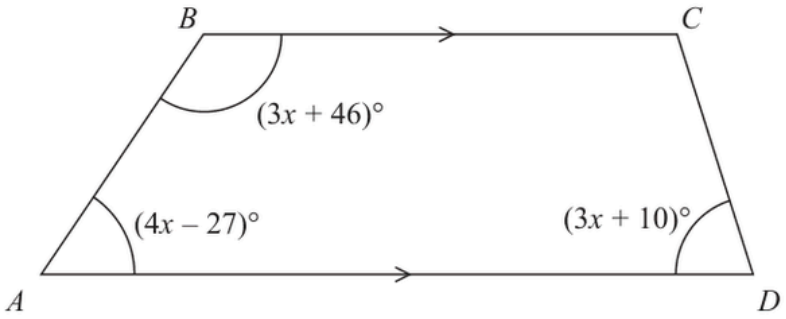


Diagram **NOT** accurately drawn

BC is parallel to AD

Find the size of the largest angle inside the trapezium.

.....°

(Total for Question 3 is 4 marks)

WORKED SOLUTION

Question 3 · 4MA1/2H June 2023

1 **Find the gradient**

Since $BC \parallel AD$, the co-interior angles on side AB add to $180°$:

$$(4x - 27) + (3x + 46) = 180$$

$$7x + 19 = 180$$

$$7x = 161$$

$$x = 23$$

2 **Find the gradient**

Now find the angles:

$$\angle A = 4(23) - 27 = 65°$$

$$\angle B = 3(23) + 46 = 115°$$

$$\angle D = 3(23) + 10 = 79°$$

---

3 **Find the gradient**

Also, co-interior angles on side CD add to $180°$:

$$\angle C = 180° - 79° = 101°$$

---

4 **The largest angle is**

The largest angle is $115°$.

✓ **FINAL ANSWER**

$115°$.

Question 4

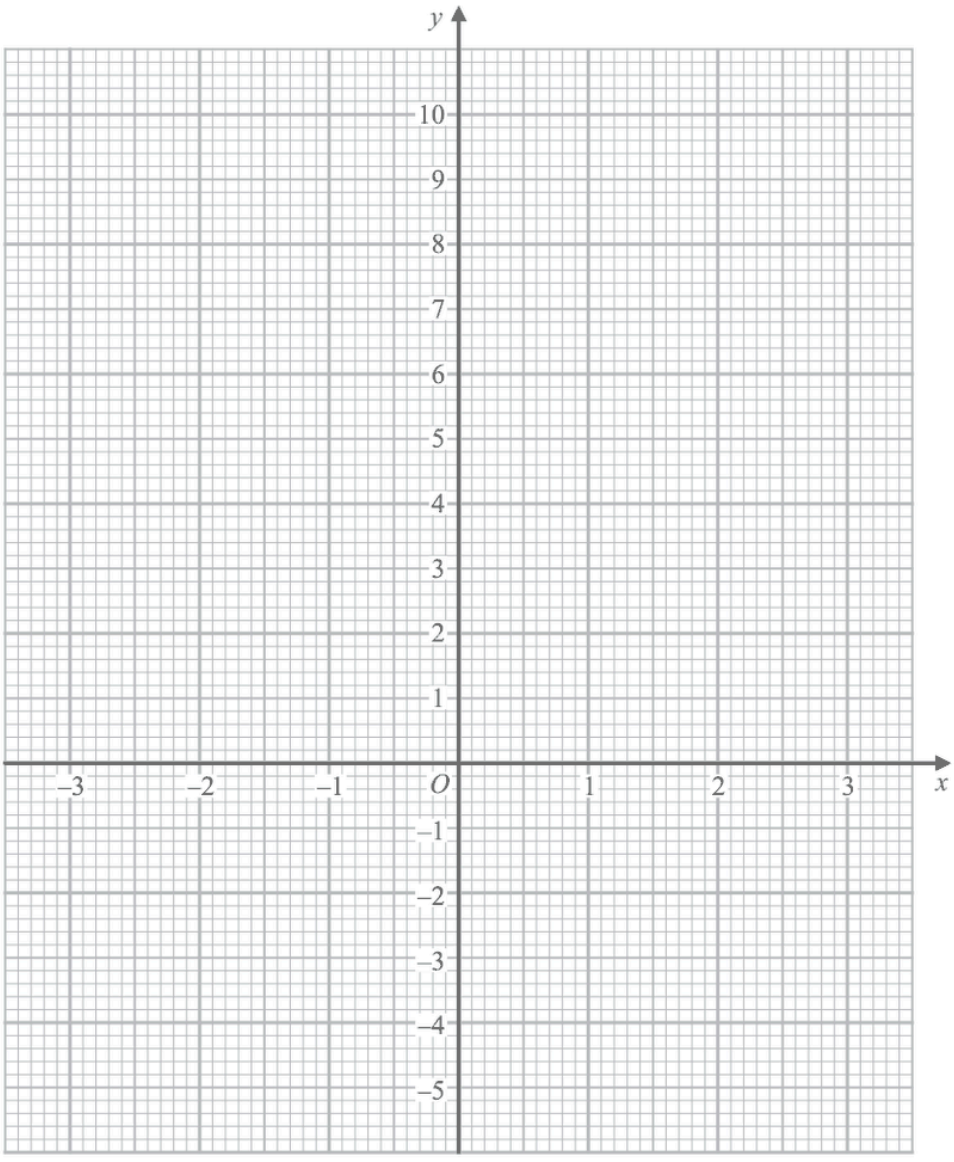
4 marks | Graphs of Functions

4 (a) Complete the table of values for $y = x^2 - x - 4$

x	–3	–2	–1	0	1	2	3
y		2			–4		

(2)

(b) On the grid below, draw the graph of $y = x^2 - x - 4$ for values of x from –3 to 3



(2)

(Total for Question 4 is 4 marks)

1 Solve quadratic equation

$$y = x^2 - x - 4$$

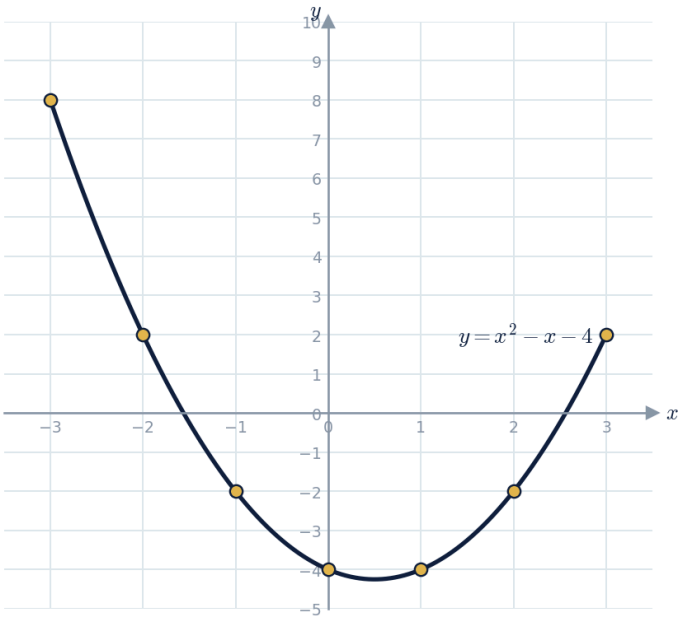
2 The completed table is

The completed table is:

x	-3	-2	-1	0	1	2	3
y	8	2	-2	-4	-4	-2	2

3 Plot the points and join

Plot the points and join them with a smooth U-shaped curve.



FINAL ANSWER

Missing values are $8, -2, -4, -2, 2$.

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Question 5

4 marks | Ratio Toolkit

5 Nancy has some coins with a total value of 85 pence.
She has only 2 pence coins and 5 pence coins.
The ratio

$$\text{number of 2 pence coins} : \text{number of 5 pence coins} = 1 : 3$$

Nancy has more 5 pence coins than 2 pence coins.

How many more?

(Total for Question 5 is 4 marks)

WORKED SOLUTION

Question 5 · 4MA1/2H June 2023

1 Let the number of pence

Let the number of 2 pence coins be x.

2 Split the ratio

Then the number of 5 pence coins is $3x$.

3 Total value

Total value:

$$2x + 5(3x) = 85$$

$$17x = 85$$

$$x = 5$$

4 Split the ratio

So there are 5 two-pence coins and 15 five-pence coins.

$$15 - 5 = 10$$

FINAL ANSWER

10 more 5 pence coins

4MA1/2H JUNE 2023

Question 6

2 marks | Standard Form

6 (a) Write $76\,000\,000$ in standard form.

.....

(1)

(b) Write 5.4×10^{-4} as an ordinary number.

.....

(1)

(Total for Question 6 is 2 marks)

WORKED SOLUTION

Question 6 · 4MA1/2H June 2023

1 Convert standard form

$$76000000 = 7.6 \times 10^{7}$$

$$5.4 \times 10^{-4} = 0.00054$$

FINAL ANSWER

(a) 7.6×10^{7}, (b) 0.00054

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Question 7

3 marks | Circle Theorems

7

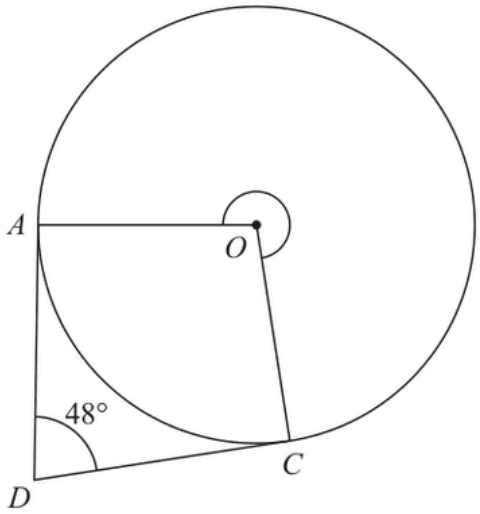


Diagram **NOT** accurately drawn

A and C are points on a circle, centre O
DA is the tangent to the circle at A and DC is the tangent to the circle at C

Angle $ADC = 48°$

Work out the size of reflex angle AOC

.....°

(Total for Question 7 is 3 marks)

WORKED SOLUTION

Question 7 · 4MA1/2H June 2023

1 Use circle theorem

A radius is perpendicular to a tangent, so

$$\angle OAD = 90°$$

2 Use trigonometry

and

$$\angle OCD = 90°$$

3 Use trigonometry

In quadrilateral $AOCD$,

$$\angle AOC = 360° - 90° - 90° - 48° = 132°$$

4 **The question asks for the**

The question asks for the reflex angle:

$$360° - 132° = 228°$$

✓ **FINAL ANSWER**

$228°$.

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Question 8

3 marks | Compound Interest & Depreciation

8 Charlotte buys a painting for \$680
The value of the painting increases by 4% each year.

Work out the value of the painting at the end of 3 years.
Give your answer correct to the nearest \$

\$.....

(Total for Question 8 is 3 marks)

WORKED SOLUTION

Question 8 · 4MA1/2H June 2023

1 A increase each year gives

A 4% increase each year gives a multiplier of

$$1.04$$

2 Use compound interest

After 3 years, the value is

$$680(1.04)^3$$

$$= 680(1.124864)$$

$$= 764.90752$$

3 Correct to the nearest dollar

Correct to the nearest dollar:

$$765$$

✓ FINAL ANSWER

$\$765$

4MA1/2H JUNE 2023

Question 9

3 marks | Standard & Compound Units

9 Change a speed of 27 kilometres per hour to a speed in metres per second.

..... m/s

(Total for Question 9 is 3 marks)

WORKED SOLUTION

Question 9 · 4MA1/2H June 2023

1 Convert km/h to m/s divide

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

$$27 \div 3.6 = 7.5$$

FINAL ANSWER

7.5 m/s.

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Question 10

4 marks | Statistics Toolkit

10 Team **A** and Team **B** take part in a quiz league.

After 11 rounds, Team **A** has a mean score per round of 17
After 9 rounds, Team **B** has a mean score per round of 18

Both teams take part in a further round.
After this round, both teams have a mean score per round of 18.5

In the further round, Team **A** scored more points than Team **B**.

How many more?

(Total for Question 10 is 4 marks)

WORKED SOLUTION

Question 10 · 4MA1/2H June 2023

1 **Team A**

Team A:

$$11 \times 17 = 187$$

2 **Estimate the value**

After the next round:

$$12 \times 18.5 = 222$$

$$\text{next score} = 222 - 187 = 35$$

3 **Team B**

Team B:

$$9 \times 18 = 162$$

4 **Estimate the value**

After the next round:

$$10 \times 18.5 = 185$$

$$\text{next score} = 185 - 162 = 23$$

5 **Difference**

Difference:

$$35 - 23 = 12$$

✓ **FINAL ANSWER**

12.

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Question 11

3 marks | Angles in Polygons & Parallel Lines

11 Here is a 9-sided regular polygon $ABCDEFGHJ$, with centre O

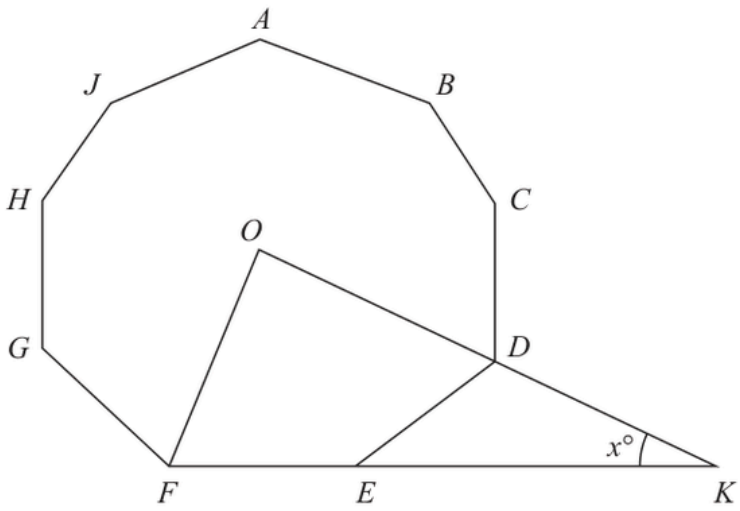


Diagram **NOT** accurately drawn

ODK and FEK are straight lines.

Work out the value of x

$x =$ .....

(Total for Question 11 is 3 marks)

WORKED SOLUTION

Question 11 · 4MA1/2H June 2023

1 **Find the gradient**

For a regular 9-sided polygon, the angle at the centre between adjacent vertices is

$$\frac{360}{9} = 40°$$

2 **Find the gradient**

The side FE is perpendicular to the radius drawn to the midpoint of side FE.

3 **From to this midpoint radius**

From OD to this midpoint radius is

$$40° + 20° = 60°$$

4 **Find the gradient**

So the angle between OD and the side FE is

$$90° - 60° = 30°$$

5 **Find the gradient**

Since ODK and FEK are straight lines, this is the angle x.

✓ **FINAL ANSWER**

$x = 30°$.

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Question 12

4 marks | Right-Angled Triangles - Pythagoras & Trigonometry

12 The diagram shows right-angled triangle ABD

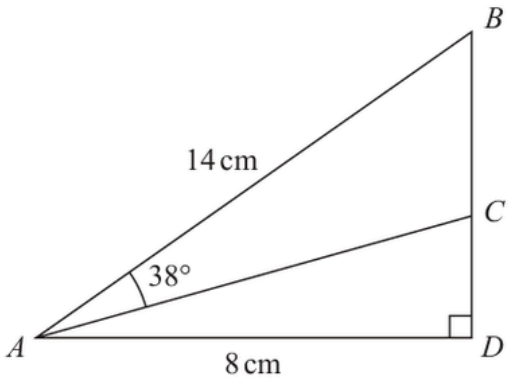


Diagram **NOT** accurately drawn

$AB = 14\,\text{cm}$ $AD = 8\,\text{cm}$

C is the point on BD such that angle $BAC = 38°$

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

..... cm

(Total for Question 12 is 4 marks)

WORKED SOLUTION

Question 12 · 4MA1/2H June 2023

1 Use trigonometry

First find angle DAB:

$$\cos(\angle DAB) = \frac{8}{14}$$

$$\angle DAB = 55.150\ldots°$$

2 Given

Given

$$\angle BAC = 38°$$

3 Use trigonometry

So

$$\angle CAD = 55.150\ldots° - 38° = 17.150\ldots°$$

4 **Use trigonometry**

In right-angled triangle ACD,

$$\tan(17.150\ldots^\circ) = \frac{CD}{8}$$

$$CD = 2.468\ldots$$

✓ **FINAL ANSWER**

$2.47\ \text{cm}$.

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Question 13

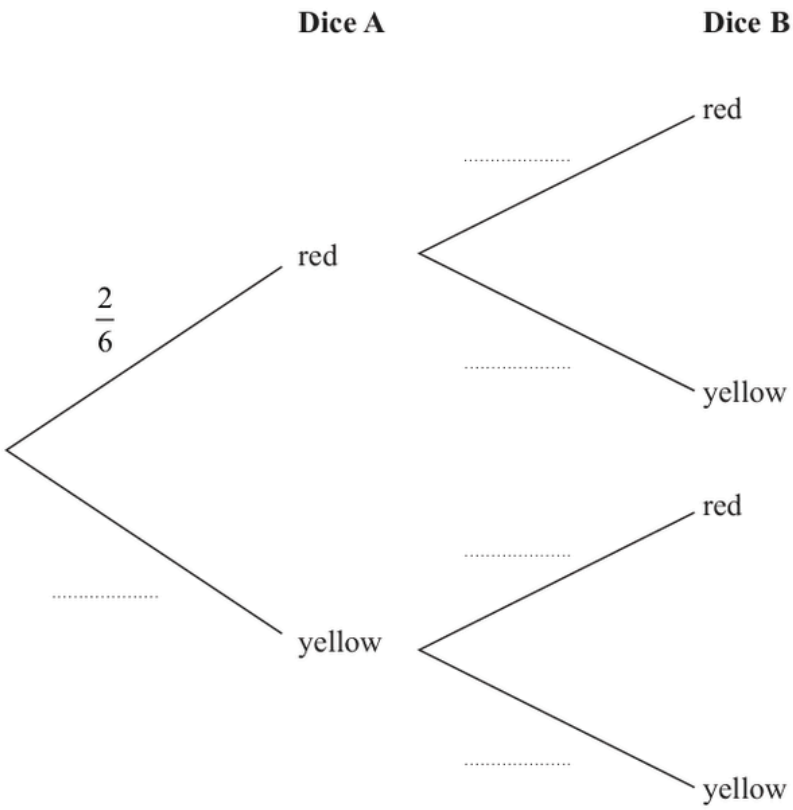
4 marks | Tree Diagrams & Conditional Probability

13 Narin has two fair 6-sided dice.

Dice **A** has 2 red faces and 4 yellow faces.
Dice **B** has 1 red face and 5 yellow faces.

Narin is going to throw each dice once.

(a) Complete the probability tree diagram.



(2)

(b) Work out the probability that both dice land on yellow.

.....

(2)

(Total for Question 13 is 4 marks)

WORKED SOLUTION

Question 13 · 4MA1/2H June 2023

1 **(a) Complete the tree**

Dice A: yellow $\frac{4}{6}$.

Dice B (on both branches): red $\frac{1}{6}$, yellow $\frac{5}{6}$.

2 **(b) Both yellow**

$$\frac{4}{6} \times \frac{5}{6} = \frac{20}{36} = \frac{5}{9}$$

✓ **FINAL ANSWER**

(a) $\frac{4}{6}$; $\frac{1}{6}, \frac{5}{6}$ on both branches (b) $\frac{5}{9}$

Question 14

4 marks | Circle Theorems

14

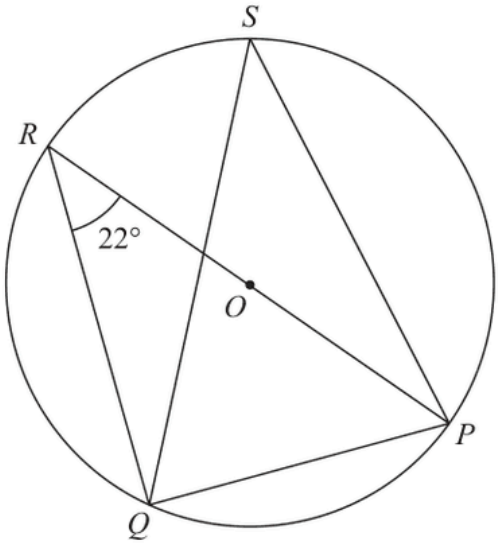


Diagram **NOT** accurately drawn

P, Q, R and S are points on a circle, centre O
ROP is a diameter of the circle.
Angle $PRQ = 22°$

(a) (i) Find the size of angle RQP

.....°

(1)

(ii) Give a reason for your answer.

.....

(1)

(b) (i) Find the size of angle PSQ

.....°

(1)

(ii) Give a reason for your answer.

.....

(1)

(Total for Question 14 is 4 marks)

1 **Use trigonometry**

(a) Since RP is a diameter,

$$\angle RQP = 90°$$

2 **Reason the angle in a**

Reason: the angle in a semicircle is $90°$.

3 **(b) Angles and stand on**

(b) Angles PRQ and PSQ stand on the same chord PQ, so they are equal.

$$\angle PSQ = 22°$$

✓ **FINAL ANSWER**

$\angle RQP = 90°$, and $\angle PSQ = 22°$.

4MA1/2H JUNE 2023

Question 15

7 marks | Algebraic Roots & Indices

15 (a) Simplify fully $\left(32a^{15}\right)^{\frac{3}{5}}$

.....

(2)

(b) Express $\left(\frac{1}{10x}\right)^{-3}$ in the form px^n where p and n are integers.

.....

(2)

(c) Solve $\frac{1-2y}{3} = \frac{4}{5} - \frac{2y-1}{2}$

Show clear algebraic working.

$y =$ .....

(3)

(Total for Question 15 is 7 marks)

WORKED SOLUTION

Question 15 · 4MA1/2H June 2023

1 **Solve equation**

For part (a),

$$(32a^{15})^{3/5} = 32^{3/5}a^{15\times 3/5}$$

$$= 8a^9$$

2 **Solve equation**

For part (b),

$$\left(\frac{1}{10x}\right)^{-3} = (10x)^3 = 1000x^3$$

3 **Solve equation**

For part (c),

$$\frac{1-2y}{3} = \frac{4}{5} - \frac{2y-1}{2}$$

4 **Multiply by**

Multiply by 30:

$$10(1-2y) = 24 - 15(2y-1)$$

$$10 - 20y = 39 - 30y$$

$$10y = 29$$

$$y = \frac{29}{10}$$

✓ **FINAL ANSWER**

(a) $8a^9$, (b) $1000x^3$, (c) $y = \frac{29}{10}$

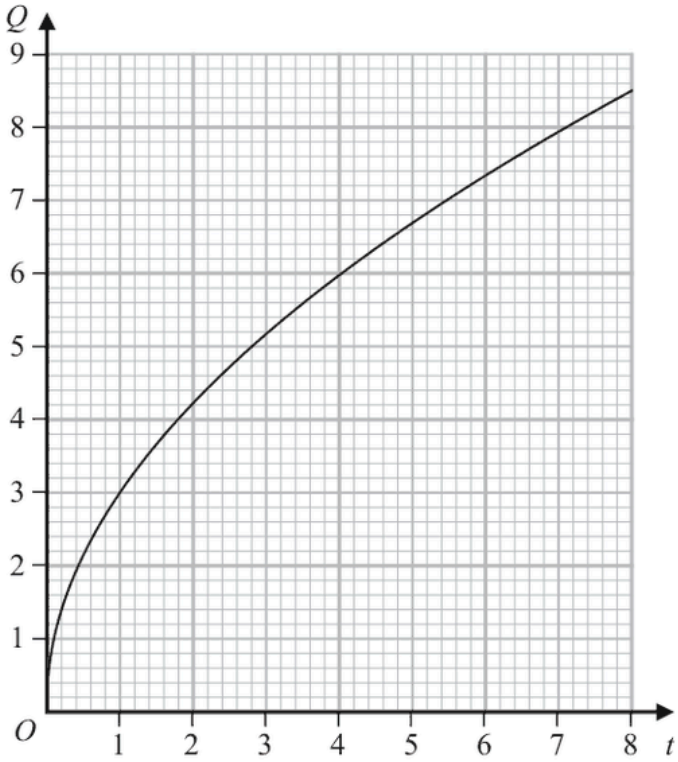
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Question 16

5 marks | Direct & Inverse Proportion

16 Q is directly proportional to $\sqrt{t}$

The graph shows the relationship between Q and t for $0 < t < 8$



(a) Find a formula for Q in terms of t

.....

(3)

Q is increased by 20%

(b) Find the percentage increase in t

.....%

(2)

(Total for Question 16 is 5 marks)

WORKED SOLUTION

Question 16 · 4MA1/2H June 2023

1 **Find inverse function**

$$Q \propto \sqrt{t}$$

2 **Find inverse function**

So

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

3 **Read the graph**

From the graph, when $t = 4$, $Q = 6$.

$$6 = k\sqrt{4}$$

$$6 = 2k$$

$$k = 3$$

4 **Rearrange formula**

So the formula is

$$Q = 3\sqrt{t}$$

5 **Find inverse function**

For part (b), Q is increased by 20%, so Q is multiplied by 1.2.

6 **Find inverse function**

Since $Q \propto \sqrt{t}$,

$$t \propto Q^2$$

7 **Find inverse function**

So t is multiplied by

$$1.2^2 = 1.44$$

8 **This is a increase**

This is a 44% increase.

✓ **FINAL ANSWER**

(a) $Q = 3\sqrt{t}$, (b) 44%

4MA1/2H JUNE 2023

Question 17

7 marks | Rearranging Formulae

17 (a) Expand and simplify $(x + 6)(3x - 2)(x + 6)$

.....

(3)

(b) Make e the subject of $w = \sqrt{\dfrac{e+g}{ef-d}}$

.....

(4)

(Total for Question 17 is 7 marks)

WORKED SOLUTION

Question 17 · 4MA1/2H June 2023

1 **(a)**

(a)

$$(x+6)(3x-2)(x+6) = (x+6)^2(3x-2)$$

$$= (x^2+12x+36)(3x-2)$$

$$= 3x^3+34x^2+84x-72$$

2 **(b)**

(b)

$$w = \sqrt{\frac{e+g}{ef-d}}$$

$$w^2 = \frac{e+g}{ef-d}$$

$$w^2(ef-d) = e+g$$

$$e(fw^2-1) = g+dw^2$$

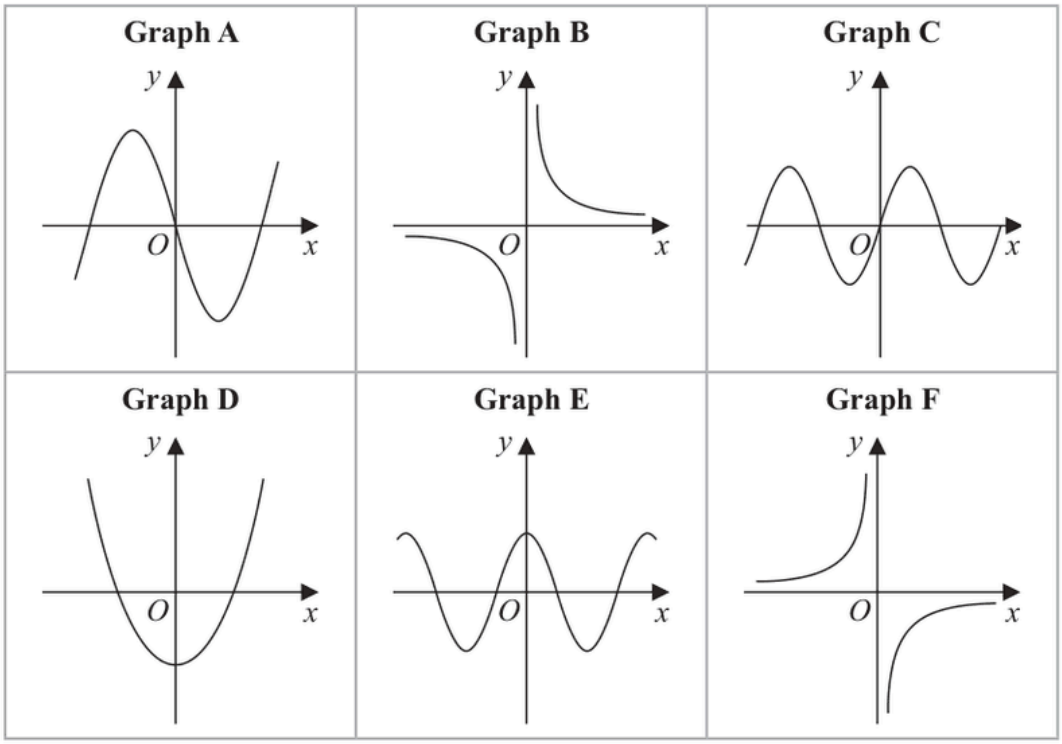
FINAL ANSWER

(a) $3x^3 + 34x^2 + 84x - 72$, (b) $e = \frac{g+dw^2}{fw^2-1}$

Question 18

3 marks | Graphs of Functions

18 Here are 6 graphs.



Complete the table below with the letter of the graph that could represent each given equation.

Write your answers on the dotted lines.

Equation	Graph
$y = \sin x$	.....
$y = -\frac{3}{x}$	.....
$y = 4x^3 - 5x$	.....

(Total for Question 18 is 3 marks)

1 **is the periodic sine shaped**

$$y = \sin x$$

is the periodic sine-shaped graph, so it is **Graph C**.

2 **Read the graph**

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

is the positive reciprocal graph, so it is **Graph B**.

3 **Find turning point**

$$y = 4x^3 - 5x$$

is a cubic graph with two turning points, so it is **Graph A**.

✓ **FINAL ANSWER**

C, B, A.

4MA1/2H JUNE 2023

Question 19

3 marks | Completing the Square

19 Express $3x^2 - 6x + 5$ in the form $a(x - b)^2 + c$

(Total for Question 19 is 3 marks)

WORKED SOLUTION

Question 19 · 4MA1/2H June 2023

1 **Calculate value**

$$3x^2 - 6x + 5 = 3(x^2 - 2x) + 5$$

$$= 3\left((x - 1)^2 - 1\right) + 5$$

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

FINAL ANSWER

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

4MA1/2H JUNE 2023

Question 20

3 marks | Tree Diagrams & Conditional Probability

20 There are 12 counters in a bag.

3 of the counters are red
9 of the counters are green

Ameya, Jack and Ella each take at random one counter from the bag.

Work out the probability that at least one red counter is still in the bag.

(Total for Question 20 is 3 marks)

WORKED SOLUTION

Question 20 · 4MA1/2H June 2023

1 There are 3 red counters

There are 3 red counters.

2 At least one red counter

At least one red counter is still in the bag unless all 3 red counters are taken.

3 Use the complement

So use the complement:

$$P(\text{all 3 red are taken}) = \frac{3}{12} \cdot \frac{2}{11} \cdot \frac{1}{10}$$

$$= \frac{6}{1320}$$

$$= \frac{1}{220}$$

4 Evaluate fraction

Therefore,

$$P(\text{at least one red is still in the bag}) = 1 - \frac{1}{220}$$

$$= \frac{219}{220}$$

FINAL ANSWER

$$\frac{219}{220}$$

4MA1/2H JUNE 2023

Question 21

5 marks | Simultaneous Equations

21 Solve the simultaneous equations

$$2x^2 + 3y^2 = 11$$
$$x = 3y - 1$$

Show clear algebraic working.

(Total for Question 21 is 5 marks)

WORKED SOLUTION

Question 21 · 4MA1/2H June 2023

1 Calculate value

$$2x^2 + 3y^2 = 11$$

$$x = 3y - 1$$

2 Substitute

Substitute:

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

$$18y^2 - 12y + 2 + 3y^2 = 11$$

$$21y^2 - 12y - 9 = 0$$

$$7y^2 - 4y - 3 = 0$$

$$(7y + 3)(y - 1) = 0$$

3 Evaluate fraction

So

$$y = -\frac{3}{7} \quad \text{or} \quad y = 1$$

4 **Find**

Find x:

$$y = -\frac{3}{7} \Rightarrow x = -\frac{16}{7}$$

$$y = 1 \Rightarrow x = 2$$

✓ **FINAL ANSWER**

$(x, y) = \left(-\frac{16}{7}, -\frac{3}{7}\right)$ or $(2, 1)$

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Question 22

5 marks | Sine & Cosine Rules

22 The diagram shows a triangle ABC and a flagpole BF

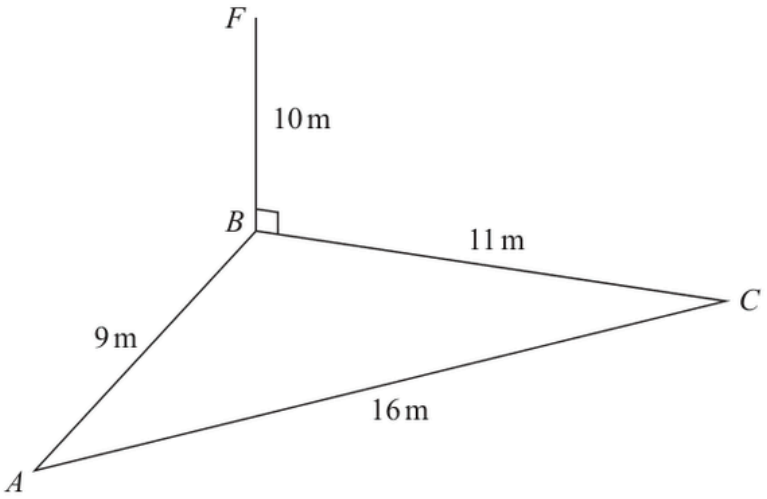


Diagram **NOT** accurately drawn

A, B and C are points on horizontal ground.

BF is vertical.

$AB = 9\,\text{m}$ $BC = 11\,\text{m}$ $AC = 16\,\text{m}$ $BF = 10\,\text{m}$

D is the point on AC such that angle $BDC = 90°$

Work out the size of the angle of elevation of the point F from the point D
Give your answer correct to one decimal place.

.....°

(Total for Question 22 is 5 marks)

WORKED SOLUTION

Question 22 · 4MA1/2H June 2023

1 **Use trigonometry**

In triangle ABC,

$$AB = 9, \qquad BC = 11, \qquad AC = 16$$

2 **Use Heron s formula**

Use Heron's formula.

$$s = \frac{9 + 11 + 16}{2} = 18$$

$$\text{area} = \sqrt{18(18-9)(18-11)(18-16)}$$

$$= \sqrt{18 \cdot 9 \cdot 7 \cdot 2} = 47.6235\ldots$$

---

3 **is the foot of the**

D is the foot of the perpendicular from B to AC, so BD is the height of triangle ABC.

$$\text{area} = \frac{1}{2} \times AC \times BD$$

$$47.6235\ldots = \frac{1}{2} \times 16 \times BD$$

$$BD = 5.9529\ldots$$

---

4 **Use trigonometry**

In right-angled triangle BDF,

$$\tan\theta = \frac{BF}{BD}$$

$$\tan\theta = \frac{10}{5.9529\ldots}$$

$$\theta = \tan^{-1}\left(\frac{10}{5.9529\ldots}\right) = 59.2349\ldots^\circ$$

✓ **FINAL ANSWER**

$\boxed{59.2^\circ}$

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Question 23

4 marks | Surds

23 The diagram shows a cuboid with a square cross section.

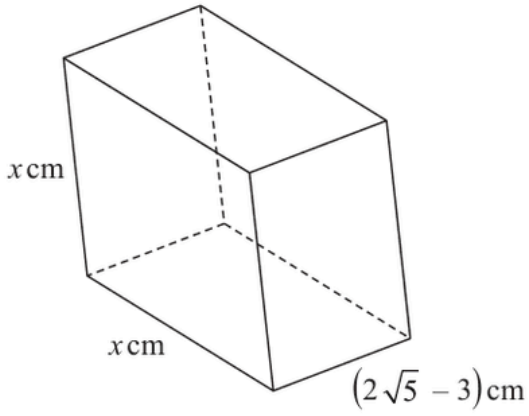


Diagram **NOT** accurately drawn

The volume of the cuboid is $(13 + 6\sqrt{5})\text{cm}^3$

Without using a calculator, find the value of x
Give your answer in the form $a + \sqrt{b}$ where a and b are integers.
Show your working clearly.

$x =$ .....

(Total for Question 23 is 4 marks)

WORKED SOLUTION

Question 23 · 4MA1/2H June 2023

1 The volume is

The volume is

$$x^2(2\sqrt{5} - 3) = 13 + 6\sqrt{5}$$

2 Simplify surd

So

$$x^2 = \frac{13 + 6\sqrt{5}}{2\sqrt{5} - 3}$$

3 **Rationalise**

Rationalise:

$$x^2 = \frac{(13+6\sqrt{5})(2\sqrt{5}+3)}{(2\sqrt{5})^2 - 3^2}$$

$$= \frac{26\sqrt{5}+39+60+18\sqrt{5}}{20-9}$$

$$= \frac{99+44\sqrt{5}}{11} = 9+4\sqrt{5}$$

---

4 **Simplify surd**

Since

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

$$x = \sqrt{5}+2$$

✓ **FINAL ANSWER**

$2+\sqrt{5}$

4MA1/2H JUNE 2023

Question 24

6 marks | Linear Graphs

24 $ABCD$ is a kite with $AB = AD$ and $CB = CD$

A is the point with coordinates $(-2, 10)$

B is the point with coordinates $\left(-\frac{27}{5}, 4\right)$

C is the point with coordinates $(4, -5)$

Work out the coordinates of D

(..... , ...)

(Total for Question 24 is 6 marks)

WORKED SOLUTION

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1 Calculate value

In the kite, $AB = AD$ and $CB = CD$, so AC is the line of symmetry.

2 Apply transformation

Therefore D is the reflection of B in the line AC.

$$A = (-2, 10), \qquad B = \left(-\frac{27}{5}, 4\right), \qquad C = (4, -5)$$

3 A direction vector for is

A direction vector for AC is

$$\begin{pmatrix} 4 - (-2) \\ -5 - 10 \end{pmatrix} = \begin{pmatrix} 6 \\ -15 \end{pmatrix}$$

4 Use the simpler direction vector

Use the simpler direction vector

$$\begin{pmatrix} 2 \\ -5 \end{pmatrix}$$

5 **Find the gradient**

Let H be the foot of the perpendicular from B to AC.

$$\vec{AB} = \begin{pmatrix} -\frac{17}{5} \\ -6 \end{pmatrix}$$

6 **The fraction along to is**

The fraction along AC to H is

$$\frac{\vec{AB} \cdot \begin{pmatrix} 2 \\ -5 \end{pmatrix}}{2^2 + (-5)^2} = \frac{-\frac{34}{5} + 30}{29}$$

$$= \frac{\frac{116}{5}}{29} = \frac{4}{5}$$

7 **Use matrices**

So

$$H = A + \frac{4}{5}\begin{pmatrix} 2 \\ -5 \end{pmatrix}$$

$$H = \left(-2 + \frac{8}{5}, 10 - 4\right)$$

$$H = \left(-\frac{2}{5}, 6\right)$$

8 **Find the midpoint**

Since H is the midpoint of BD,

$$D = 2H - B$$

$$D = \left(-\frac{4}{5}, 12\right) - \left(-\frac{27}{5}, 4\right)$$

$$D = \left(\frac{23}{5}, 8\right)$$

✓ **FINAL ANSWER**

$$D = \left(\frac{23}{5}, 8\right)$$

4MA1/2H JUNE 2023

Question 25

4 marks | Rounding, Estimation & Bounds

25 A solid sphere has a radius of 2.8 centimetres, correct to 1 decimal place.
The sphere has a mass of $M\pi$ grams, where $M = 260$ correct to 2 significant figures.

Work out the upper bound for the density of the sphere.
Give your answer in g/cm^3 correct to 2 decimal places.
Show your working clearly.

..... g/cm^3

(Total for Question 25 is 4 marks)

WORKED SOLUTION

Question 25 · 4MA1/2H June 2023

1 Find upper bound

For the upper bound of density, use the upper bound of the mass and the lower bound of the volume.

2 The radius is cm correct

The radius is 2.8 cm correct to 1 decimal place, so the lower bound is
$r = 2.75$

3 Find upper bound

$M = 260$ correct to 2 significant figures, so the upper bound is
$M = 265$

4 The mass is and the

The mass is $M\pi$ and the volume of the sphere is $\frac{4}{3}\pi r^3$.

5 Rearrange formula

So

$$\text{density} = \frac{M\pi}{\frac{4}{3}\pi r^3} = \frac{3M}{4r^3}$$

6 Upper bound

Upper bound:

$$\frac{3(265)}{4(2.75)^3} = 9.5567\ldots$$

FINAL ANSWER

$9.56\ \mathrm{g/cm^3}$ to 2 decimal places.