ELITE MATHEMATICS

Modular Unit 2

Linear to Modular | Standard papers

Worked solutions

28 question entries | 109 marks

Linear questions reorganised for Modular practice. Not an original Pearson Modular examination.

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Student edition | June 2026 | Elite Mathematics

Question 5 | parts c, d

4 marks

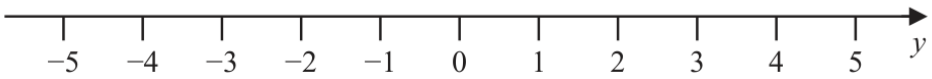
June 2026 | 4MA1/1H | Elementary algebra, formula rearrangement and inequalities

(c) Make x the subject of $t = ax - 2n$

.....

(2)

(d) On the number line, represent the inequality $-1 < y \leqslant 3$



(2)

Question 5 | parts c, d | Worked solution

4 marks

June 2026 | 4MA1/1H | Elementary algebra, formula rearrangement and inequalities

Part (c)

2 marks

STEP 1

From $t = ax - 2n$, add $2n$ to give $t + 2n = ax$. Use the same operation on both sides.

STEP 2

$$x = \frac{t + 2n}{a} \quad (a \neq 0).$$

Divide by the coefficient of x.

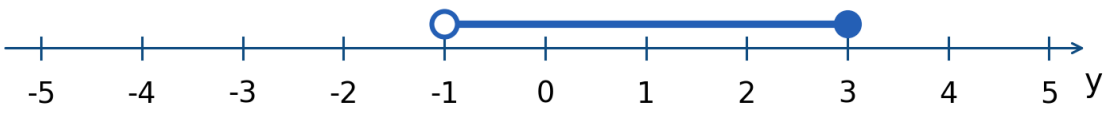
Final answer
$x = (t + 2n)/a$

Part (d)

2 marks

STEP 1

Draw an open circle at $y = -1$, a filled circle at $y = 3$, and a straight segment joining them. The represented interval is $(-1, 3]$. The strict lower inequality excludes -1; the non-strict upper inequality includes 3.



Final answer
$(-1, 3]$

Question 9

3 marks

June 2026 | 4MA1/1H | Standard form

9 (a) Write 0.0651 in standard form.

.....

(1)

(b) Work out $\left(4 \times 10^{56}\right) \times \left(8 \times 10^{74}\right)$

Give your answer in standard form.

.....

(2)

(Total for Question 9 is 3 marks)

Question 9 | Worked solution

3 marks

June 2026 | 4MA1/1H | Standard form

Part (a)

1 marks

STEP 1

$$0.0651 = 6.51 \times 10^{-2}.$$

The coefficient must be at least 1 and less than 10.

Final answer
6.51×10^{-2}

Part (b)

2 marks

STEP 1

$$(4 \times 10^{56})(8 \times 10^{74}) = 32 \times 10^{130} = 3.2 \times 10^{131}.$$

Multiply the coefficients, add the exponents, and adjust the coefficient to standard form.

Final answer
3.2×10^{131}

Question 10

3 marks

June 2026 | 4MA1/1H | Simultaneous linear equations

10 Solve the simultaneous equations

$$4x + 3y = 9$$
$$2x - 2y = -13$$

Show clear algebraic working.

$x =$ .....

$y =$ .....

(Total for Question 10 is 3 marks)

Question 10 | Worked solution

3 marks

June 2026 | 4MA1/1H | Simultaneous linear equations

Solution

3 marks

STEP 1

$$4x + 3y = 9, \qquad 2x - 2y = -13.$$

Use both equations.

STEP 2

Double the second equation: $4x - 4y = -26$. Subtract this from the first: $7y = 35$, so $y = 5$. Equal x coefficients allow elimination.

STEP 3

$$2x - 2(5) = -13 \implies 2x = -3 \implies x = -\frac{3}{2}.$$

Substitute back to find the other unknown.

Final answer

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

Question 14

3 marks

June 2026 | 4MA1/1H | Successive percentage changes

14 In September, the sales in a shop increased by 20%
In October, the sales in the same shop decreased by x%

Over these two months, the sales in the shop decreased by 10%

Work out the value of x

$x =$ .....

(Total for Question 14 is 3 marks)

Question 14 | Worked solution

3 marks

June 2026 | 4MA1/1H | Successive percentage changes

Solution

3 marks

STEP 1

Let the original sales be 100 units. After September they are $100 \times 1.20 = 120$; after both months they are $100 \times 0.90 = 90$. Both overall percentages refer to the original sales.

STEP 2

$$x = \frac{120 - 90}{120} \times 100 = 25.$$

The October decrease is measured relative to the September sales of 120.

Final answer

$x = 25$

Question 19

4 marks

June 2026 | 4MA1/1H | Direct proportion to a square

19 M is directly proportional to p^2

$M = 2$ when $p = 5$

(a) Find a formula for M in terms of p

.....

(3)

(b) Work out the value of M when $p = 15$

$M =$ .....

(1)

(Total for Question 19 is 4 marks)

Question 19 | Worked solution

4 marks

June 2026 | 4MA1/1H | Direct proportion to a square

Part (a)

3 marks

STEP 1

$$M = kp^2, \qquad 2 = k(5^2) \implies k = \frac{2}{25}.$$

Introduce a constant of proportionality and use the given pair.

STEP 2

$$M = \frac{2p^2}{25}.$$

Substitute the constant into the general relationship.

Final answer
$M = 2p^2/25$

Part (b)

1 marks

STEP 1

$$M = \frac{2(15)^2}{25} = 18.$$

Use the formula from (a).

Final answer
$M = 18$

Question 21

5 marks

June 2026 | 4MA1/1H | Maximising cuboid volume by differentiation

21 The diagram shows a solid cuboid.

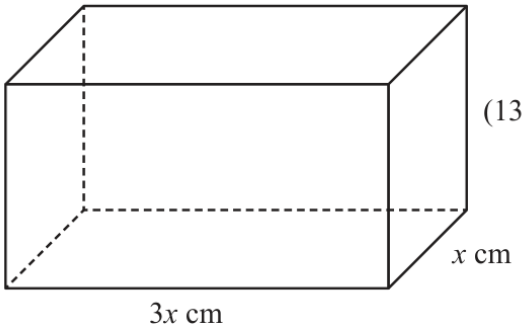


Diagram **NOT** accurately drawn

The volume of the cuboid is V cm^3

Find the maximum value of V
Show clear algebraic working.

$V =$ .....

(Total for Question 21 is 5 marks)

Question 21 | Worked solution

5 marks

June 2026 | 4MA1/1H | Maximising cuboid volume by differentiation

Solution

5 marks

STEP 1

$$V = (3x)(x)(13.5 - 2x) = 40.5x^2 - 6x^3, \qquad 0 < x < 6.75.$$

Multiply the three dimensions and require them all to be positive.

STEP 2

$$\frac{dV}{dx} = 81x - 18x^2 = 9x(9 - 2x).$$

Differentiate each power of x.

STEP 3

At a stationary point, $9x(9 - 2x) = 0$, giving $x = 0$ or $x = 4.5$. Only $x = 4.5$ is inside the domain. A stationary volume has zero derivative.

STEP 4

The derivative is positive for $0 < x < 4.5$ and negative for $4.5 < x < 6.75$. Hence $x = 4.5$ gives the maximum. The volume increases then decreases; its limiting endpoint volumes are zero.

STEP 5

$$V_{\max} = 3(4.5)^2(13.5 - 9) = 273.375 \text{ cm}^3.$$

Substitute the maximising value into the original volume.

Final answer
273.375 cm^3

Question 24

5 marks

June 2026 | 4MA1/1H | Completing the square and a translated maximum

24 (a) Express $10 - 24x - 3x^2$ in the form $a - b(x + c)^2$ where a, b and c are integers.

.....

(3)

T is the curve with equation $y = 10 - 24(x - 1) - 3(x - 1)^2$
The point P is the maximum point on **T**

(b) Use your answer to part (a) to find the coordinates of P

(..... , ...)

(1)

(c) Write down the equation for the line of symmetry of **T**

.....

(1)

(Total for Question 24 is 5 marks)

Question 24 | Worked solution

5 marks

June 2026 | 4MA1/1H | Completing the square and a translated maximum

Part (a)

3 marks

STEP 1

$$10 - 24x - 3x^2 = 10 - 3(x^2 + 8x).$$

Factor -3 from the terms involving x.

STEP 2

$$x^2 + 8x = (x + 4)^2 - 16.$$

Half the coefficient of x is 4.

STEP 3

$$10 - 3\big((x + 4)^2 - 16\big) = 58 - 3(x + 4)^2.$$

Thus a=58, b=3 and c=4.

Final answer

$58 - 3(x + 4)^2$

Part (b)

1 marks

STEP 1

$$y = 58 - 3\big((x - 1) + 4\big)^2 = 58 - 3(x + 3)^2.$$

Use (a) with x replaced throughout by x-1.

STEP 2

Since $(x + 3)^2 \geq 0$, the greatest y is 58, attained at $x = -3$. Thus $P = (-3, 58)$. The negative square term is largest when its square is zero.

Final answer

$P = (-3, 58)$

Part (c)

1 marks

STEP 1

The parabola is symmetric about its maximum, so its line of symmetry is $x = -3$. In $58 - 3(x + 3)^2$, equal positive and negative offsets from -3 give the same y.

Final answer

$x = -3$

Question 1

3 marks

June 2026 | 4MA1/2H | Prime factorisation

1 Write 4500 as a product of powers of its prime factors.
Show your working clearly.

.....

(Total for Question 1 is 3 marks)

Question 1 | Worked solution

3 marks

June 2026 | 4MA1/2H | Prime factorisation

Solution

3 marks

STEP 1

$$4500 = 45 \times 100 = (9 \times 5)(4 \times 25).$$

Split into factors that are easy to prime-factorise.

STEP 2

$$4500 = (3^2 \times 5)(2^2 \times 5^2) = 2^2 \times 3^2 \times 5^3.$$

Express each factor as prime powers and combine powers of 5.

Final answer
$2^2 \times 3^2 \times 5^3$

Question 2

5 marks

June 2026 | 4MA1/2H | Arithmetic sequences

2 The nth term of an arithmetic sequence is given by $8n - 5$

(a) Work out the ratio of the 40th term of the sequence to the 60th term of the sequence.
Give your ratio in its simplest form.

.....

(3)

Here are the first five terms of a different arithmetic sequence.

3 8 13 18 23

(b) Find an expression for the nth term of this sequence.

.....

(2)

(Total for Question 2 is 5 marks)

Question 2 | Worked solution

5 marks

June 2026 | 4MA1/2H | Arithmetic sequences

Part (a)

3 marks

STEP 1

$$u_{40} = 8(40) - 5 = 315, \qquad u_{60} = 8(60) - 5 = 475.$$

Substitute the two term numbers into the given rule.

STEP 2

$$315 : 475 = (315 \div 5) : (475 \div 5) = 63 : 95.$$

Divide both entries by their highest common factor, 5.

Final answer
$63 : 95$

Part (b)

2 marks

STEP 1

The common difference is $8 - 3 = 5$, so the rule has the form $5n + c$. A constant difference gives a linear nth term.

STEP 2

At $n = 1$, $5 + c = 3$, giving $c = -2$. Thus $u_n = 5n - 2$. Use the first term to find the constant.

Final answer
$5n - 2$

Question 3

5 marks

June 2026 | 4MA1/2H | Grouped-data averages

3 The table shows information about the number of hours each of 40 candles burned.

Number of hours (h)	Frequency
$15 < h \leqslant 19$	2
$19 < h \leqslant 23$	5
$23 < h \leqslant 27$	12
$27 < h \leqslant 31$	15
$31 < h \leqslant 35$	6

(a) Write down the modal class.

.....

(1)

(b) Work out an estimate for the mean number of hours.

..... hours

(4)

(Total for Question 3 is 5 marks)

Question 3 | Worked solution

5 marks

June 2026 | 4MA1/2H | Grouped-data averages

Part (a)

1 marks

STEP 1

The greatest frequency is 15, in the interval $27 < h \leq 31$. The modal class is the class with the highest frequency.

Final answer
$27 < h \leq 31$

Part (b)

4 marks

STEP 1

The class midpoints are $17, 21, 25, 29, 33$ hours. Use the midpoint of each class as a representative value.

STEP 2

$$\sum fm = 2(17) + 5(21) + 12(25) + 15(29) + 6(33)$$
$$= 34 + 105 + 300 + 435 + 198 = 1072.$$

Multiply each midpoint by its frequency and add.

STEP 3

$$\text{Estimated mean} = \frac{1072}{2 + 5 + 12 + 15 + 6} = \frac{1072}{40} = 26.8 \text{ hours}.$$

Divide the estimated total by the number of candles.

Final answer
26.8 hours

Question 4

3 marks

June 2026 | 4MA1/2H | Percentage increase

4 Sara sells water bottles.

In July, she sold 450 water bottles.
In August, she sold 612 water bottles.

Work out the percentage increase in the number of water bottles she sold from July to August.

.....%

(Total for Question 4 is 3 marks)

Question 4 | Worked solution

3 marks

June 2026 | 4MA1/2H | Percentage increase

Solution

3 marks

STEP 1

$$\text{Increase} = 612 - 450 = 162.$$

Find the change from the original number.

STEP 2

$$\text{Percentage increase} = \frac{162}{450} \times 100 = 36\%.$$

Express the increase as a percentage of the July value, not the August value.

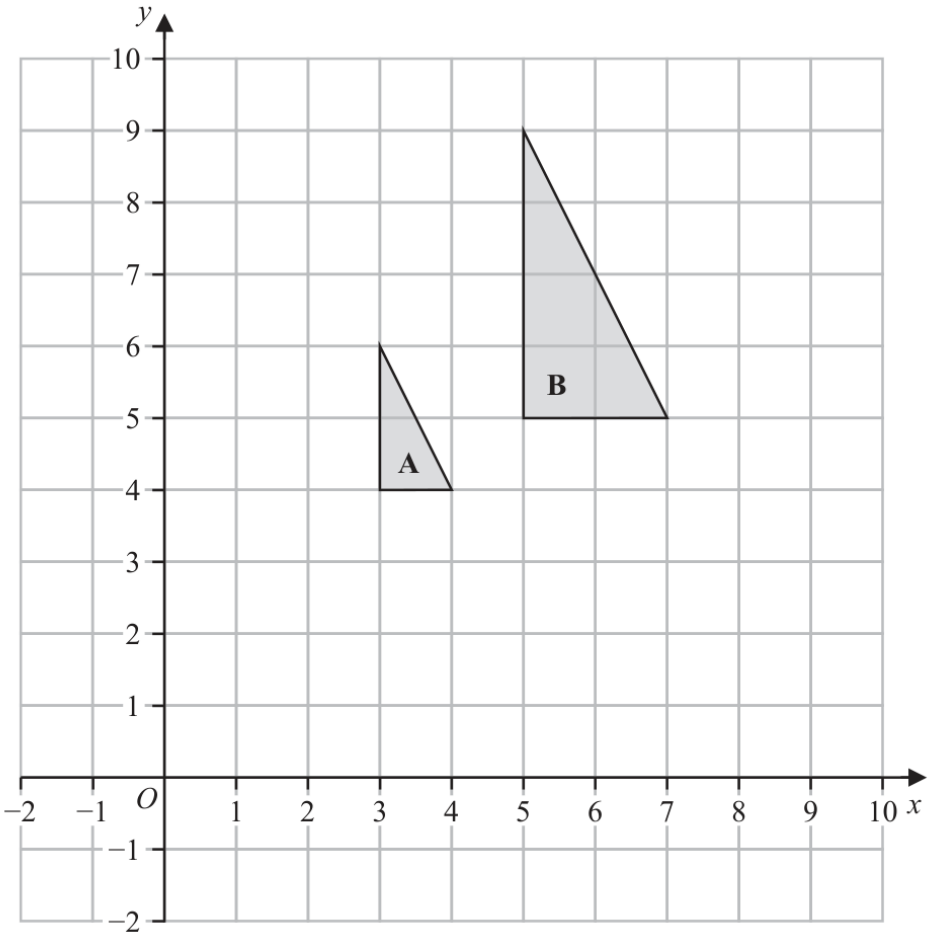
Final answer
36%

Question 5

4 marks

June 2026 | 4MA1/2H | Enlargement and translation

5



(a) Describe fully the single transformation that maps triangle **A** onto triangle **B**

.....

.....

(3)

(b) On the grid, translate triangle **A** by the vector $\begin{pmatrix} 4 \\ -3 \end{pmatrix}$

Label your triangle **C**

(1)

(Total for Question 5 is 4 marks)

Question 5 | Worked solution

4 marks

June 2026 | 4MA1/2H | Enlargement and translation

Part (a)

3 marks

STEP 1

Triangle A has vertices $(3,4),(4,4),(3,6)$; the corresponding vertices of B are $(5,5),(7,5),(5,9)$. The lengths have doubled. Read corresponding vertices and compare side lengths.

STEP 2

For enlargement factor 2, the centre O satisfies $B = O + 2(A - O)$, so $O = 2A - B$. Using $(3,4) \mapsto (5,5)$ gives $O = (6,8) - (5,5) = (1,3)$. Find the fixed centre from a corresponding pair; the other pairs give the same centre.

Final answer

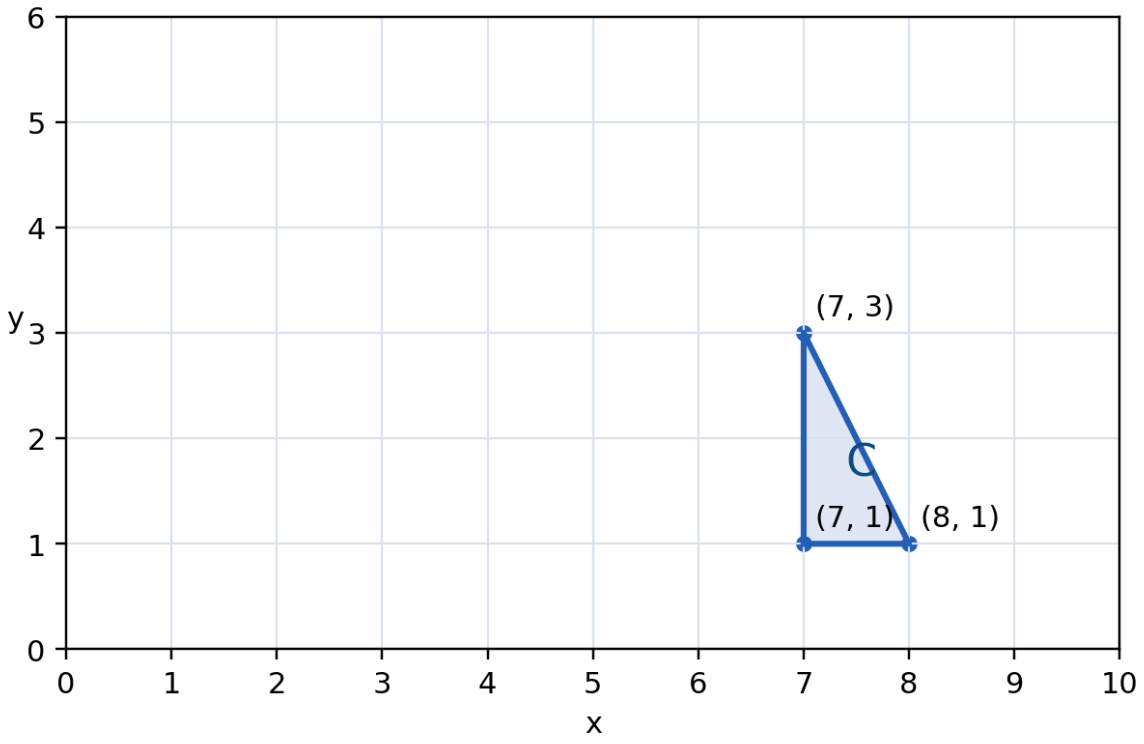
Enlargement with scale factor 2 and centre $(1,3)$.

Part (b)

1 marks

STEP 1

Add $(4,-3)$ to every vertex: $(3,4) \mapsto (7,1)$, $(4,4) \mapsto (8,1)$, and $(3,6) \mapsto (7,3)$. Plot these three points, join them with straight sides and label the triangle C. A translation moves every point by the same vector.



Final answer

$C : (7,1),(8,1),(7,3)$.

Question 6

3 marks

June 2026 | 4MA1/2H | Polygon angle sum

6 $ABCDE$ is a pentagon.

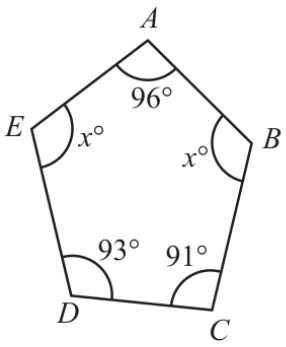


Diagram **NOT** accurately drawn

angle $EAB = 96°$ angle $BCD = 91°$ angle $CDE = 93°$ angle DEA = angle $ABC = x°$

Work out the value of x

$x =$ .....

(Total for Question 6 is 3 marks)

Question 6 | Worked solution

3 marks

June 2026 | 4MA1/2H | Polygon angle sum

Solution

3 marks

STEP 1

The sum of the interior angles of a pentagon is $(5-2)180^\circ = 540^\circ$. Use the interior-angle sum formula.

STEP 2

$$96 + 91 + 93 + x + x = 540 \quad \Rightarrow \quad 2x = 260 \quad \Rightarrow \quad x = 130.$$

Subtract the three known angles and divide the remainder equally.

Final answer
$x = 130$

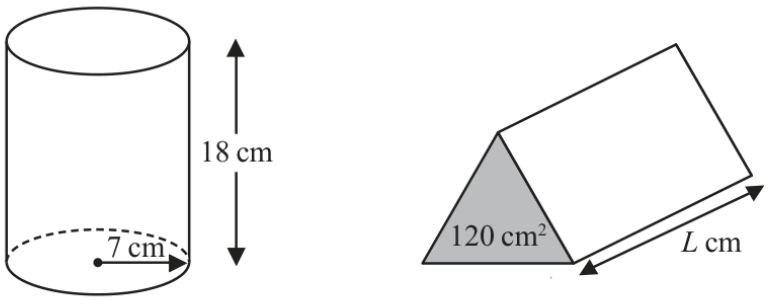
Question 7

3 marks

June 2026 | 4MA1/2H | Volumes of cylinder and prism

7 The diagram shows a cylinder and a prism.

Diagram **NOT** accurately drawn



The radius of the cylinder is 7 cm
The height of the cylinder is 18 cm

The area of the cross section of the prism, shown shaded in the diagram, is $120\ \text{cm}^2$
The length of the prism is L cm

The volume of the cylinder is equal to the volume of the prism.

Work out the value of L
Give your answer correct to 3 significant figures.

$L =$ .....

(Total for Question 7 is 3 marks)

Question 7 | Worked solution

3 marks

June 2026 | 4MA1/2H | Volumes of cylinder and prism

Solution

3 marks

STEP 1

$$V_{\text{cylinder}} = \pi r^2 h = \pi(7)^2(18) = 882\pi \text{ cm}^3.$$

Use the stated radius, not a diameter.

STEP 2

$$V_{\text{prism}} = 120L, \qquad 120L = 882\pi \quad \Rightarrow \quad L = \frac{882\pi}{120} = 23.090706\ldots.$$

Prism volume equals cross-sectional area times length; equate the two volumes.

Final answer
$L = 23.1$ cm (3 significant figures).

Question 8

3 marks

June 2026 | 4MA1/2H | Reverse percentages

8 A golf club increases the cost of membership by 17%
After the increase, the cost of membership is 3276 zloty.

Work out the cost of membership before the increase.

..... zloty

(Total for Question 8 is 3 marks)

Question 8 | Worked solution

3 marks

June 2026 | 4MA1/2H | Reverse percentages

Solution

3 marks

STEP 1

Let the original membership cost be C zloty. After a 17% increase, $1.17C = 3276$. The new value is 117% of the original.

STEP 2

$$C = \frac{3276}{1.17} = 2800 \text{ zloty}.$$

Divide by the increase multiplier.

Final answer
2800 zloty

Question 10

4 marks

June 2026 | 4MA1/2H | Compound depreciation and savings

10 Johan owns a car.

The current value of the car is 32 000 euros.
The value of the car will now depreciate by 15% per year.

Lena is going to save up and buy Johan's car in 3 years' time.
She has already saved 2516 euros.

She will save an equal amount of money each month for the next 3 years.

Work out how much money Lena needs to save each month.

..... euros

(Total for Question 10 is 4 marks)

Question 10 | Worked solution

4 marks

June 2026 | 4MA1/2H | Compound depreciation and savings

Solution

4 marks

STEP 1

The annual multiplier is $1 - 0.15 = 0.85$. After 3 years the value is

$$32000(0.85)^3 = 19652 \text{ euros.}$$

Apply the decrease to each successive year, giving a power of 3.

STEP 2

Lena still needs $19652 - 2516 = 17136$ euros. There are $3 \times 12 = 36$ months. Subtract her existing savings and convert years to months.

STEP 3

$$\text{Monthly saving} = \frac{17136}{36} = 476 \text{ euros.}$$

Divide the remaining target equally over the months.

Final answer
476 euros per month

Question 11

2 marks

June 2026 | 4MA1/2H | Prime factors in standard form

11 Find the highest prime number that is a factor of 3.6×10^{24}

.....

(Total for Question 11 is 2 marks)

Question 11 | Worked solution

2 marks

June 2026 | 4MA1/2H | Prime factors in standard form

Solution

2 marks

STEP 1

$$3.6 \times 10^{24} = 36 \times 10^{23} = (2^2 \times 3^2)(2 \times 5)^{23} = 2^{25}3^2 5^{23}.$$

Rewrite with an integer coefficient, then decompose 36 and 10 into primes.

STEP 2

The only prime factors are $2, 3, 5$, so the highest is 5. A larger composite factor is not a prime factor.

Final answer

5

Question 13

4 marks

June 2026 | 4MA1/2H | Combined mean

13 Leo collects apples from three trees.
The incomplete table gives some information about the apples he collects from these trees.

Tree	Number of apples	Mean weight of apples (grams)	Total weight of apples (grams)
A	12	150	
B	20		2700
C		145	2610

Work out the mean weight of all the apples Leo collects from these three trees.

..... grams

(Total for Question 13 is 4 marks)

Question 13 | Worked solution

4 marks

June 2026 | 4MA1/2H | Combined mean

Solution

4 marks

STEP 1

Tree A contributes $12 \times 150 = 1800$ grams. Total weight equals count times mean weight.

STEP 2

Tree C has $2610 \div 145 = 18$ apples. Number of items equals total divided by mean.

STEP 3

The total weight is $1800 + 2700 + 2610 = 7110$ grams and the total number of apples is $12 + 20 + 18 = 50$. Add weights and counts separately; do not average the three group means.

STEP 4

$$\text{Combined mean} = \frac{7110}{50} = 142.2 \text{ grams.}$$

Divide the total weight by the total count.

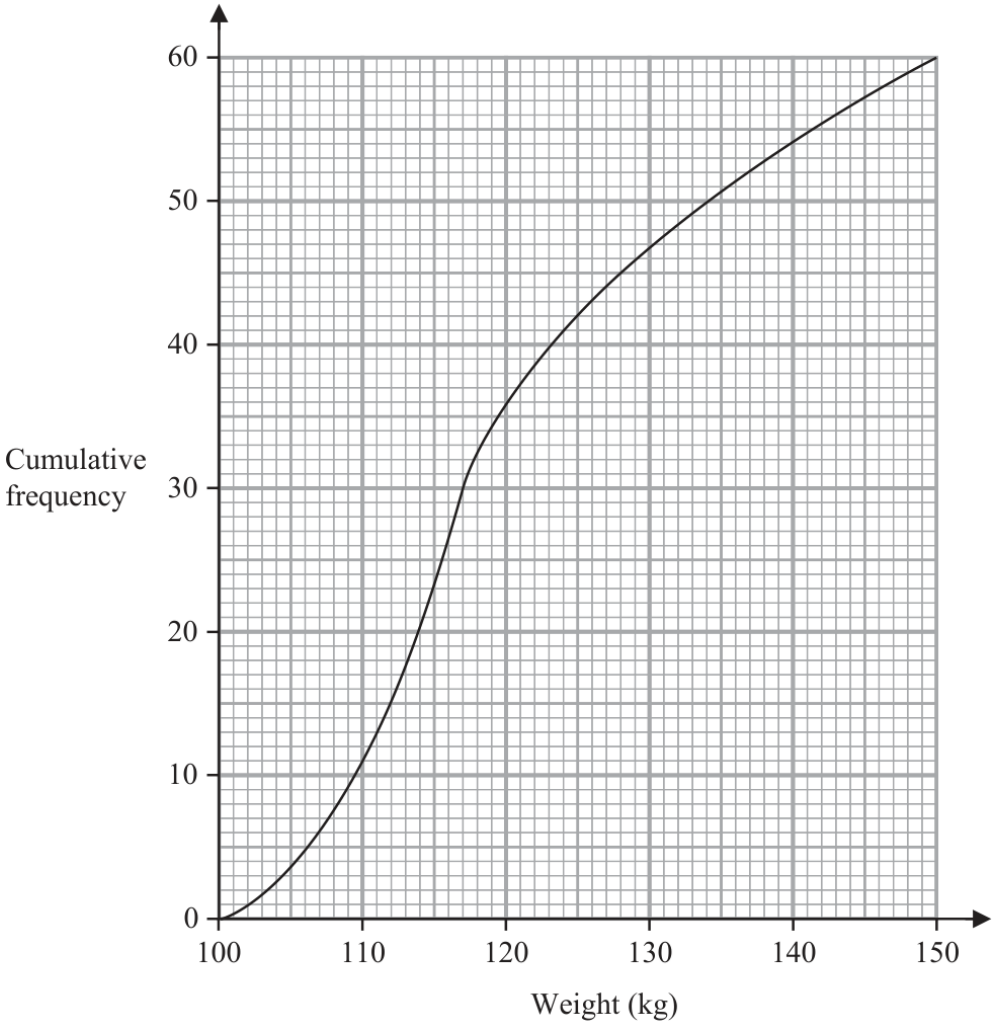
Final answer
142.2 grams

Question 14

3 marks

June 2026 | 4MA1/2H | Cumulative frequency

14 The cumulative frequency graph gives information about the weights, in kg, of 60 crates.



(a) Use the graph to find an estimate for the median weight.

..... kg

(1)

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

..... kg

(2)

(Total for Question 14 is 3 marks)

Question 14 | Worked solution

3 marks

June 2026 | 4MA1/2H | Cumulative frequency

Part (a)

1 marks

STEP 1

The median is the $60/2 = 30$th value. Draw horizontally from cumulative frequency 30 to the curve, then vertically to the weight axis: about 117 kg. The median splits the 60 observations in half.

Final answer
117 kg approximately.

Part (b)

2 marks

STEP 1

Read the lower quartile at cumulative frequency $60/4 = 15$, giving $Q_1 \approx 112$ kg. Read the upper quartile at cumulative frequency $3(60)/4 = 45$, giving $Q_3 \approx 128$ kg. Quartiles occur at one-quarter and three-quarters of the total frequency.

STEP 2

$$\text{IQR} = Q_3 - Q_1 \approx 128 - 112 = 16 \text{ kg}.$$

Interquartile range is upper quartile minus lower quartile.

Final answer
16 kg approximately.

Question 16

5 marks

June 2026 | 4MA1/2H | Functions and composition

16 The functions f and g are such that

$$f(x) = 4 + x \qquad g(x) = 3x^2 + 2$$

(a) Find $g(4)$

.....

(1)

(b) Find $f^{-1}(7)$

.....

(2)

(c) Express $gf(x)$ in the form $ax^2 + bx + c$ where a, b and c are integers.

$gf(x) =$ .....

(2)

(Total for Question 16 is 5 marks)

Question 16 | Worked solution

5 marks

June 2026 | 4MA1/2H | Functions and composition

Part (a)

1 marks

STEP 1

$$g(4) = 3(4)^2 + 2 = 48 + 2 = 50.$$

Substitute 4 for the function input.

Final answer
50

Part (b)

2 marks

STEP 1

If $y = 4 + x$, then $x = y - 4$, so $f^{-1}(x) = x - 4$. Reverse the input-output relationship.

STEP 2

$$f^{-1}(7) = 7 - 4 = 3.$$

Apply the inverse function to 7.

Final answer
3

Part (c)

2 marks

STEP 1

$$gf(x) = g(f(x)) = g(x + 4) = 3(x + 4)^2 + 2.$$

Apply f first and use its whole output as the input of g.

STEP 2

$$3(x^2 + 8x + 16) + 2 = 3x^2 + 24x + 50.$$

Expand and collect the constant terms.

Final answer
$gf(x) = 3x^2 + 24x + 50$

Question 18

4 marks

June 2026 | 4MA1/2H | Rearranging formulae

18 Make x the subject of the formula $a = \dfrac{3w - x^2}{x^2 + 6}$

.....

(Total for Question 18 is 4 marks)

Question 18 | Worked solution

4 marks

June 2026 | 4MA1/2H | Rearranging formulae

Solution

4 marks

STEP 1

$$a = \frac{3w - x^2}{x^2 + 6} \quad \Rightarrow \quad a(x^2 + 6) = 3w - x^2.$$

Multiply by $x^2 + 6$, which is positive for real x.

STEP 2

$$ax^2 + 6a = 3w - x^2 \quad \Rightarrow \quad ax^2 + x^2 = 3w - 6a.$$

Collect both terms involving x^2 on one side.

STEP 3

$$(a + 1)x^2 = 3w - 6a \quad \Rightarrow \quad x^2 = \frac{3w - 6a}{a + 1}.$$

Factor out x^2 and divide by $a + 1$, assuming a is not -1.

STEP 4

$$x = \pm\sqrt{\frac{3w - 6a}{a + 1}} \quad (a \neq -1).$$

For real solutions the radicand must be nonnegative. If $a = -1$, the original equation instead requires $w = -2$; then every real x satisfies it. Taking square roots gives both signs; handle separately the value excluded by division.

Final answer

$x = \pm\sqrt{\dfrac{3w - 6a}{a + 1}}$, for $a \neq -1$ and nonnegative radicand.

Question 19

2 marks

June 2026 | 4MA1/2H | Alternate segment theorem

19 B, D and E are points on a circle.

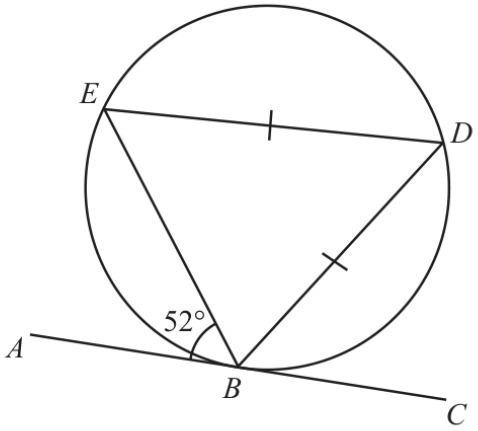


Diagram **NOT** accurately drawn

ABC is the tangent to the circle at B

angle $ABE = 52°$ $ED = BD$

Work out the size of angle BED

.....°

(Total for Question 19 is 2 marks)

Question 19 | Worked solution

2 marks

June 2026 | 4MA1/2H | Alternate segment theorem

Solution

2 marks

STEP 1

$\angle BDE = \angle ABE = 52°$, by the alternate segment theorem for tangent AB and chord BE. The angle between a tangent and chord equals the angle in the opposite segment.

STEP 2

Since $ED = BD$, the base angles $\angle BED$ and $\angle EBD$ are equal. Thus

$$\angle BED = \frac{180° - 52°}{2} = 64°.$$

Equal sides in triangle EBD subtend equal opposite angles, and its angles sum to 180 degrees.

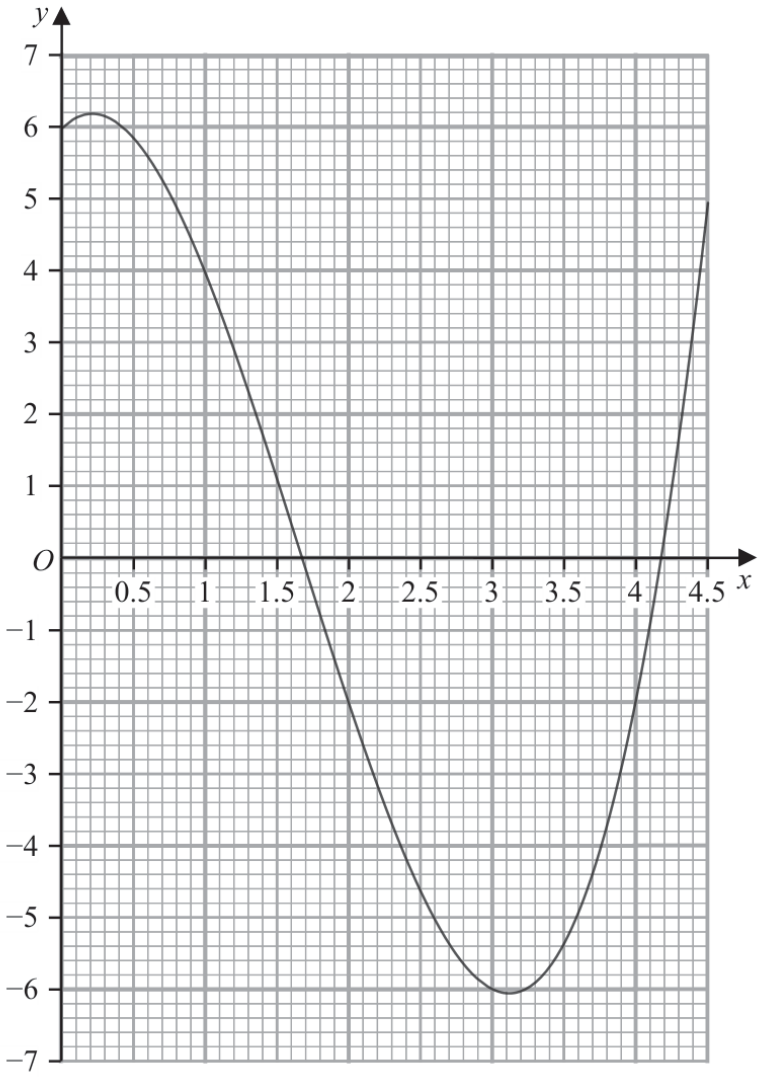
Final answer
$64°$

Question 21

5 marks

June 2026 | 4MA1/2H | Tangent gradient and graphical equations

21 The curve with equation $y = f(x)$ is drawn on a grid.



(a) By drawing a suitable straight line (at least 3 cm long) on the grid, work out an estimate for the gradient of the curve at the point where $x = 1$
Show your working clearly.

.....

(2)

(b) By drawing a suitable straight line on the grid, find the solutions of the equation $x = 3 + \frac{1}{2}f(x)$
Show your working clearly.

.....

(3)

(Total for Question 21 is 5 marks)

Question 21 | Worked solution

5 marks

June 2026 | 4MA1/2H | Tangent gradient and graphical equations

Part (a)

2 marks

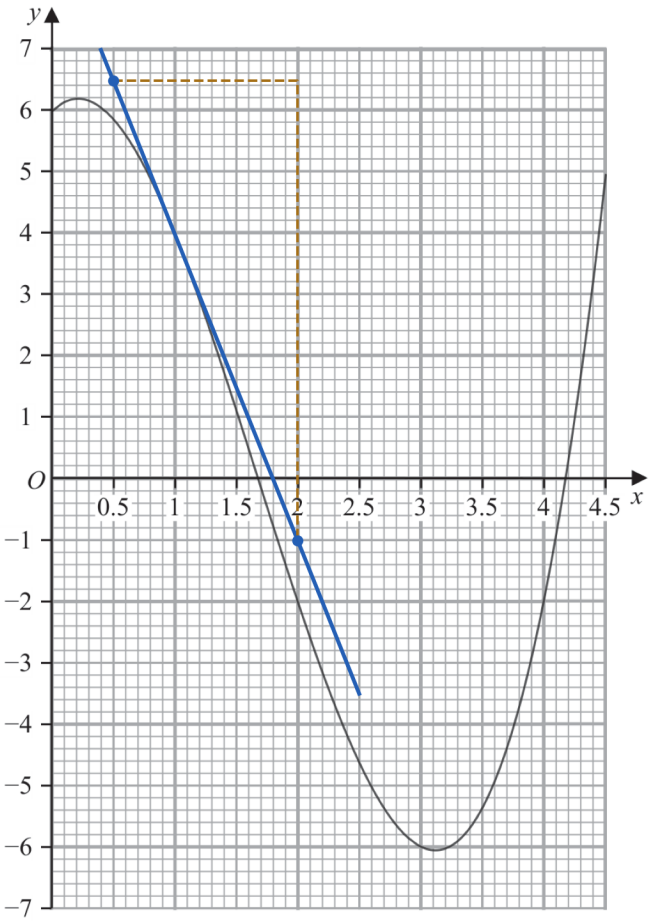
STEP 1

At $x = 1$, the point is approximately $(1, 4)$. Draw a tangent there, extending at least 3 cm. A suitable approximate tangent is $y = -5x + 9$, through $(0.5, 6.5)$ and $(2, -1)$. The gradient at a point is estimated by the gradient of its tangent; use two well-separated points on the line.

STEP 2

$$\text{Gradient} \approx \frac{-1 - 6.5}{2 - 0.5} = \frac{-7.5}{1.5} = -5.$$

Calculate change in y divided by change in x using the axis values.



Final answer

Gradient ≈ -5.

Part (b)

3 marks

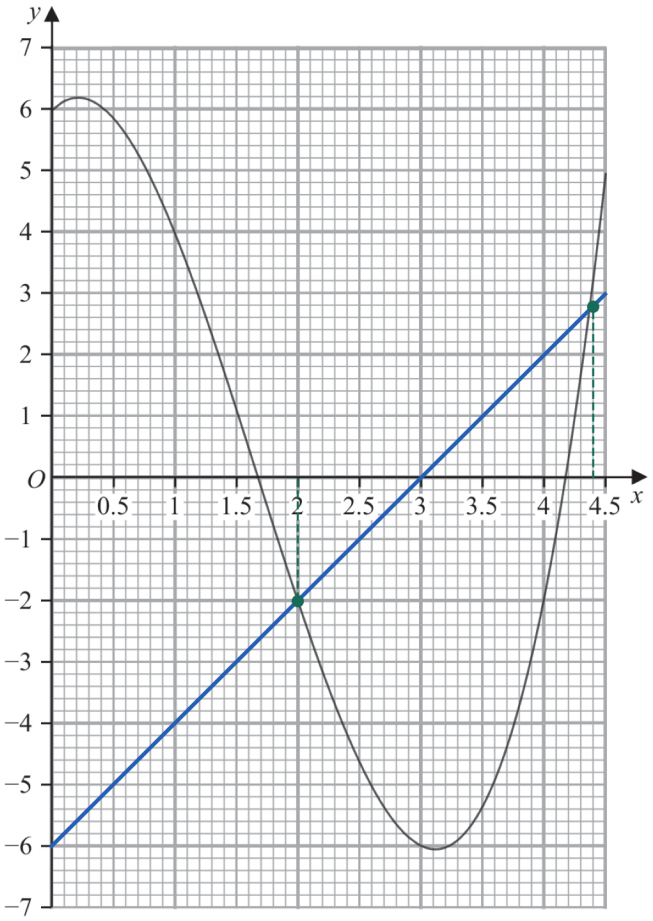
STEP 1

$$x = 3 + \tfrac{1}{2}f(x) \quad \Rightarrow \quad f(x) = 2x - 6.$$

Rearrange so the given curve y=f(x) can be intersected by a straight line.

STEP 2

Draw $y = 2x - 6$ through $(0, -6), (3, 0), (4.5, 3)$ on the same grid. Read the x-coordinates of its two intersections with the curve: approximately 2.0 and 4.4. Each intersection has equal y-values on the line and curve and therefore solves the original equation.



Final answer

$x \approx 2.0$ or $x \approx 4.4$.

Question 22

4 marks

June 2026 | 4MA1/2H | Vectors and route lengths

22 The diagram shows a quadrilateral $OABC$ where O, A, B and C represent the positions of four houses.

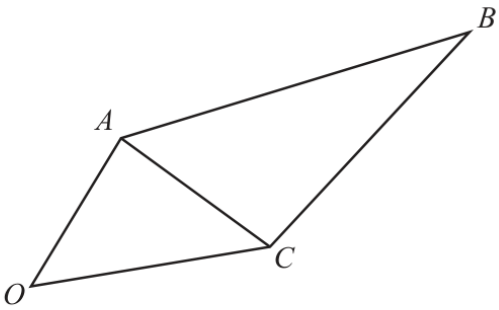


Diagram **NOT** accurately drawn

$\overrightarrow{OA} = \begin{pmatrix} 2 \\ 8 \end{pmatrix}$ $\overrightarrow{OB} = \begin{pmatrix} 21 \\ 14 \end{pmatrix}$ $\overrightarrow{OC} = \begin{pmatrix} 12 \\ 3 \end{pmatrix}$

Ria walks directly from A to B
Anna walks directly from A to C and then walks directly from C to B

$\overrightarrow{OA}$, $\overrightarrow{OB}$ and $\overrightarrow{OC}$ are given in metres.

Work out how much further Anna walks than Ria walks.
Give your answer correct to one decimal place.

..... metres

(Total for Question 22 is 4 marks)

Question 22 | Worked solution

4 marks

June 2026 | 4MA1/2H | Vectors and route lengths

Solution

4 marks

STEP 1

$$\overrightarrow{AB} = \begin{pmatrix}21\\14\end{pmatrix} - \begin{pmatrix}2\\8\end{pmatrix} = \begin{pmatrix}19\\6\end{pmatrix}, \quad \overrightarrow{AC} = \begin{pmatrix}12\\3\end{pmatrix} - \begin{pmatrix}2\\8\end{pmatrix} = \begin{pmatrix}10\\-5\end{pmatrix},$$
$$\overrightarrow{CB} = \begin{pmatrix}21\\14\end{pmatrix} - \begin{pmatrix}12\\3\end{pmatrix} = \begin{pmatrix}9\\11\end{pmatrix}.$$

Subtract the starting position vector from the finishing position vector.

STEP 2

$$AB = \sqrt{19^2 + 6^2} = \sqrt{397}, \quad AC = \sqrt{10^2 + (-5)^2} = \sqrt{125}, \quad CB = \sqrt{9^2 + 11^2} = \sqrt{202}.$$

The modulus of a two-dimensional vector is the square root of the sum of squares of its components.

STEP 3

$$\text{Extra distance} = AC + CB - AB = \sqrt{125} + \sqrt{202} - \sqrt{397} = 5.468151\ldots \text{ m}.$$

Compare Anna's two-stage route with Ria's direct route; do not round the intermediate lengths.

Final answer
Anna walks 5.5 m further (1 decimal place).

Question 23

5 marks

June 2026 | 4MA1/2H | Linear-quadratic simultaneous equations

23 The straight line **L** has equation $y = 3x - 2$

The curve **C** has equation $x^2 + y^2 - 2y = 12$

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

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

(Total for Question 23 is 5 marks)

Question 23 | Worked solution

5 marks

June 2026 | 4MA1/2H | Linear-quadratic simultaneous equations

Solution

5 marks

STEP 1

Substitute $y = 3x - 2$ into $x^2 + y^2 - 2y = 12$:

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

Both equations must hold at an intersection.

STEP 2

$$x^2 + 9x^2 - 12x + 4 - 6x + 4 = 12$$
$$10x^2 - 18x - 4 = 0 \quad \Rightarrow \quad 5x^2 - 9x - 2 = 0.$$

Expand carefully, collect like terms, and divide by 2.

STEP 3

$$(5x + 1)(x - 2) = 0 \quad \Rightarrow \quad x = -\frac{1}{5} \text{ or } x = 2.$$

Use factorisation and the zero-product property.

STEP 4

When $x = -\frac{1}{5}$, $y = 3(-\frac{1}{5}) - 2 = -\frac{13}{5}$. When $x = 2$, $y = 3(2) - 2 = 4$. Substitute each root into the line, preserving the coordinate pairings.

Final answer

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

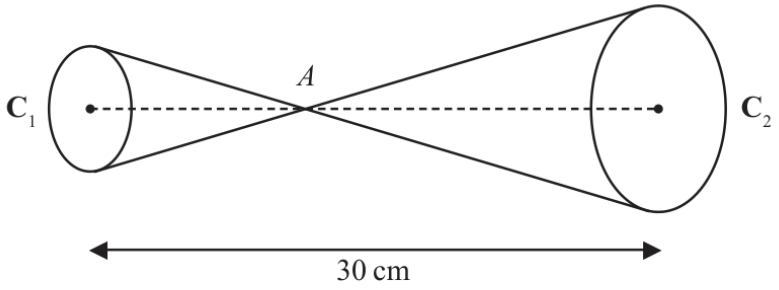
Question 24

5 marks

June 2026 | 4MA1/2H | Similar cones

24 The diagram shows two cones $\mathbf{C}_1$ and $\mathbf{C}_2$

Diagram **NOT** accurately drawn



The vertex of $\mathbf{C}_1$ coincides with the vertex of $\mathbf{C}_2$ at the point A
$\mathbf{C}_1$ and $\mathbf{C}_2$ have the same axis of symmetry.

$$\text{height of } \mathbf{C}_1 + \text{height of } \mathbf{C}_2 = 30 \text{ cm}$$

$$\text{total surface area of } \mathbf{C}_1 : \text{total surface area of } \mathbf{C}_2 = 4 : 9$$

$$\text{volume of } \mathbf{C}_1 = 23.04\pi \text{ cm}^3$$

Work out the radius of the base of $\mathbf{C}_2$
Show your working clearly.

..... cm

(Total for Question 24 is 5 marks)

Question 24 | Worked solution

5 marks

June 2026 | 4MA1/2H | Similar cones

Solution

5 marks

STEP 1

The straight generators shown through A give equal vertex angles, so the cones are similar. The area ratio $4 : 9$ gives length ratio $\sqrt{4} : \sqrt{9} = 2 : 3$. For similar solids, surface areas scale as the square of corresponding lengths.

STEP 2

The heights total 30 cm, so

$$h_1 = \frac{2}{5}(30) = 12 \text{ cm}, \qquad h_2 = \frac{3}{5}(30) = 18 \text{ cm}.$$

Split the total in the common length ratio 2:3.

STEP 3

$$\frac{1}{3}\pi r_1^2(12) = 23.04\pi \quad \Rightarrow \quad 4r_1^2 = 23.04 \quad \Rightarrow \quad r_1 = \sqrt{5.76} = 2.4 \text{ cm}.$$

Use the volume of the first cone and choose a positive radius.

STEP 4

$$r_2 = \frac{3}{2}r_1 = \frac{3}{2}(2.4) = 3.6 \text{ cm}.$$

Radii scale by the same factor as the heights.

Final answer
3.6 cm

Question 25

5 marks

June 2026 | 4MA1/2H | Arithmetic series algebra

25 An arithmetic series has first term 3 and common difference 8

The nth term of the series is U_n
The sum of the first n terms of the series is S_n

Given that $S_{5k} - S_{3k} = 25\,560$

find the value of U_{4k}
Show clear algebraic working.

.....

(Total for Question 25 is 5 marks)

Question 25 | Worked solution

5 marks

June 2026 | 4MA1/2H | Arithmetic series algebra

Solution

5 marks

STEP 1

With first term 3 and difference 8,

$$S_n = \frac{n}{2}[2(3) + (n-1)8] = \frac{n}{2}(8n-2) = 4n^2 - n.$$

Use the arithmetic-series sum formula with the given first term and common difference.

STEP 2

$$S_{5k} = 100k^2 - 5k, \qquad S_{3k} = 36k^2 - 3k.$$

$$(100k^2 - 5k) - (36k^2 - 3k) = 25560 \quad \Rightarrow \quad 64k^2 - 2k - 25560 = 0.$$

Substitute 5k and 3k as the term counts, then subtract the complete expressions.

STEP 3

$$32k^2 - k - 12780 = 0 \quad \Rightarrow \quad (k-20)(32k+639) = 0.$$

The roots are $k = 20$ and $k = -639/32$. Reject the negative root because the numbers of terms must be positive. Factor the quadratic and apply the contextual restriction.

STEP 4

$$U_n = 3 + (n-1)8 = 8n - 5, \qquad U_{4k} = U_{80} = 8(80) - 5 = 635.$$

Use the nth-term formula with 4k=80, not with k=20.

Final answer

$U_{4k} = 635$

Question 26

5 marks

June 2026 | 4MA1/2H | Transformations of functions

26 The curve **P** has equation $y = f(x)$
The coordinates of the minimum point on **P** are $(-5, 4)$

(a) Write down the coordinates of the minimum point on the curve with equation $y = 3f(x)$

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

(1)

The curve ***Q*** has equation $y = 2 - (x + 3)^2$

The curve ***R*** has equation $y = 2 - (3 - x)^2$

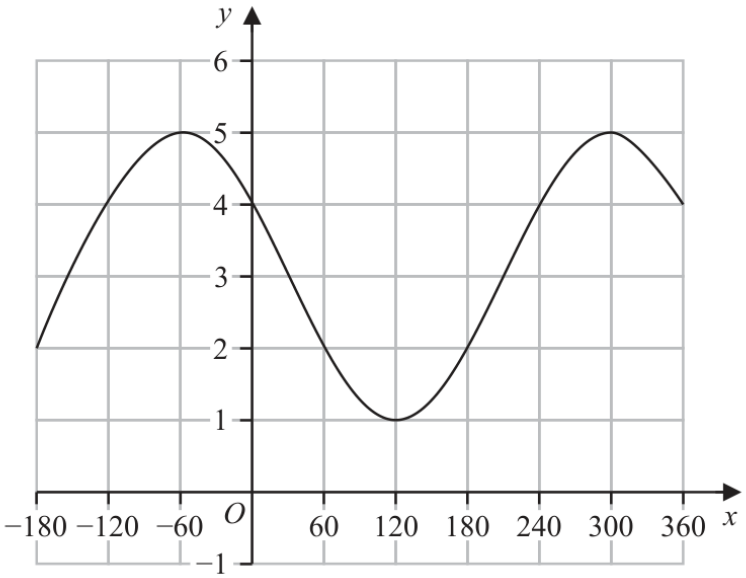
(b) Describe fully the single transformation that maps ***Q*** to ***R***

.....

.....

(1)

The graph of $y = a\cos(x + b)° + c$ for $-180 \leqslant x \leqslant 360$ is drawn on the grid.



Given that $a > 0$ and $0 < b < 360$

(c) find the value of a, the value of b and the value of c

$a =$ .....

$b =$ .....

$c =$ .....

(3)

(Total for Question 26 is 5 marks)

Question 26 | Worked solution

5 marks

June 2026 | 4MA1/2H | Transformations of functions

Part (a)

1 marks

STEP 1

For $y = 3f(x)$, x-coordinates are unchanged and y-coordinates are multiplied by 3. Thus $(-5, 4) \mapsto (-5, 12)$. The vertical scale factor is positive, so a minimum remains a minimum.

Final answer
$(-5, 12)$

Part (b)

1 marks

STEP 1

For $Q(x) = 2 - (x + 3)^2$,

$$Q(-x) = 2 - (-x + 3)^2 = 2 - (3 - x)^2 = R(x).$$

Replacing x by $-x$ reflects the graph in the y-axis. The point mapping is (x,y) to (-x,y).

Final answer
Reflection in the y-axis.

Part (c)

3 marks

STEP 1

The maximum is 5 and the minimum is 1, so

$$a = \frac{5 - 1}{2} = 2, \qquad c = \frac{5 + 1}{2} = 3.$$

The positive amplitude is half the range; the vertical shift is the midline.

STEP 2

A maximum occurs at $x = -60°$. For positive a, cosine is maximal when $x + b = 0°$ modulo $360°$, giving $b = 60$ in the stated interval. Hence $y = 2\cos(x + 60)° + 3$. Read the phase from a maximum and apply 0<b<360.

Final answer
$a = 2, \quad b = 60, \quad c = 3.$