Rewarding Learning

Centre Number

Candidate Number

General Certificate of Secondary Education
2024

Mathematics

StemUp Model Solution

Unit M3
(With calculator)
Higher Tier

[GMC31]



GMC31

THURSDAY 16 MAY, 9.15 am–11.15 am

TIME

2 hours.

INSTRUCTIONS TO CANDIDATES

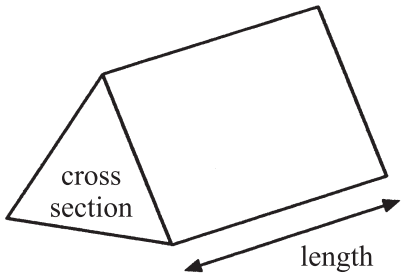
Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
You must answer the questions in the spaces provided.
Do not write outside the boxed area on each page or on blank pages.
Complete in black ink only. **Do not write with a gel pen.**
Answer **all twenty-eight** questions.
All working should be clearly shown in the spaces provided. Marks may be awarded for partially correct solutions.
You **may** use a calculator for this paper.

INFORMATION FOR CANDIDATES

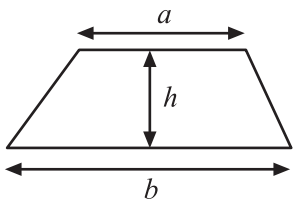
The total mark for this paper is 100.
Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.
You should have a calculator, ruler, compasses and a protractor.
The Formula Sheet is on page 2.

Formula Sheet

Volume of prism = area of cross section × length

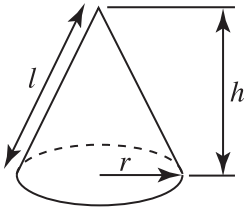


Area of trapezium = $\frac{1}{2}(a+b)h$



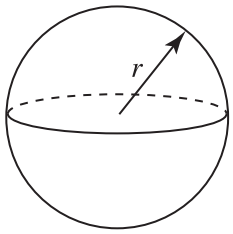
Volume of cone = $\frac{1}{3}\pi r^2 h$

Curved surface area of cone = $\pi r l$

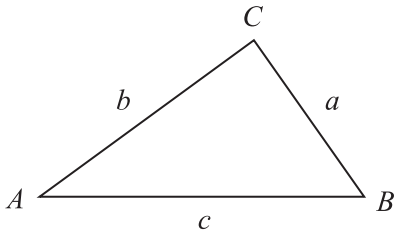


Volume of sphere = $\frac{4}{3}\pi r^3$

Surface area of sphere = $4\pi r^2$



In any triangle *ABC*



Quadratic Equation

The solutions of $ax^2 + bx + c = 0$ where $a \neq 0$, are given by

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Sine Rule: $\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$

Cosine Rule: $a^2 = b^2 + c^2 - 2bc\cos A$

Area of triangle = $\frac{1}{2}ab\sin C$

1 Calculate

$$\frac{8.84 + 24.6}{9.2 - 4.8}$$

8.84 + 24.6 = 33.44

9.2 − 4.8 = 4.4

33.44 ÷ 4.4 = 7.6

Answer 7.6 [2]

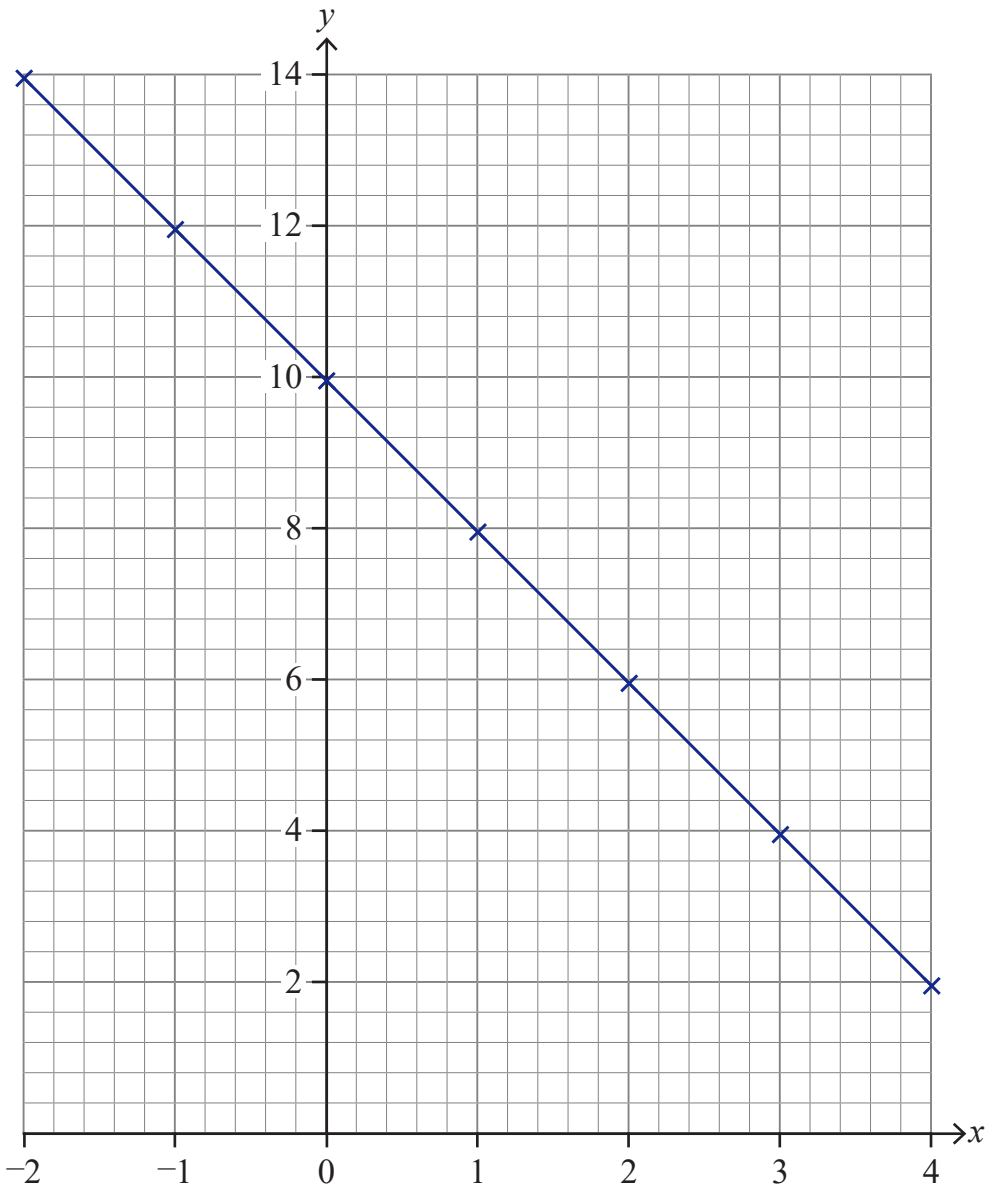
[Turn over

2 **(a)** Complete the table of values for the equation $y = 10 - 2x$

x	–2	–1	0	1	2	3	4
$y = 10 - 2x$	14	12	10	8	6	4	2

[1]

(b) Hence draw the graph of $y = 10 - 2x$ on the grid below.



[2]

3 Gavin ordered carpet for his living room and bedroom.

The living room carpet cost £37.20 per square metre.

He ordered 24.5 square metres of living room carpet.

The bedroom carpet cost £14.30 per square metre.

He paid a total price of £1068.70

How much bedroom carpet did he order?

Living room: 24.5 × 37.20 = £911.40

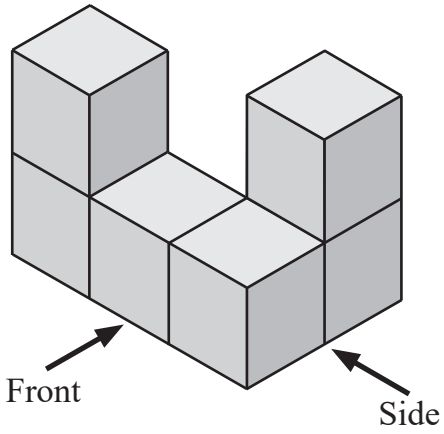
Bedroom cost: 1068.70 − 911.40 = £157.30

Bedroom carpet: 157.30 ÷ 14.30 = 11

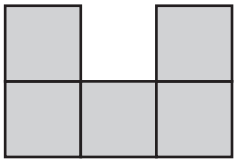
Answer 11 square metres [4]

[Turn over

4 A 3D shape is shown.



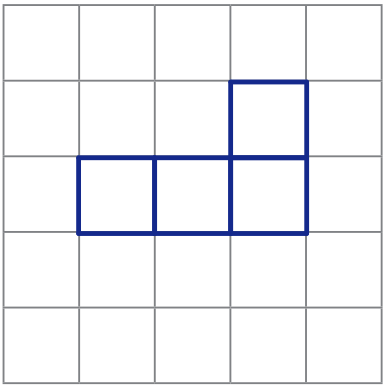
(a) Which elevation is drawn below?



Circle the correct response.

side **front** **neither** [1]

(b) Draw the **plan** of the 3D shape on the grid.



[1]

(c) Rosie is painting the exterior of the 3D shape, including the base.

How many squares will Rosie have to paint?

Circle the correct response.

13 **26** **30** **31** [1]

5 Calculate angle x.

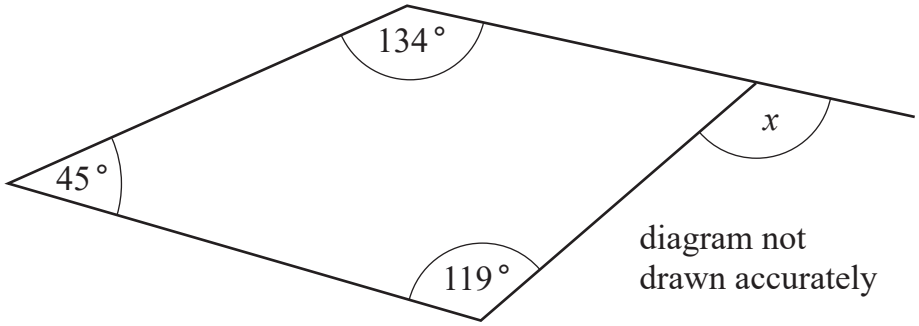


diagram not drawn accurately

Angles in a quadrilateral add to 360°

134 + 45 + 119 = 298

Interior angle = 360 − 298 = 62°

Angles on a straight line add to 180°

x = 180 − 62 = 118°

Answer x = 118 ° [3]

[Turn over

6 Stacey is going to invite some friends round for a pizza party.

To work out how many pizzas to order, she uses the formula

$$p = \frac{ne}{s}$$

where

p = number of pizzas to order

n = number of people at the party

e = number of slices each person gets

s = number of slices per pizza

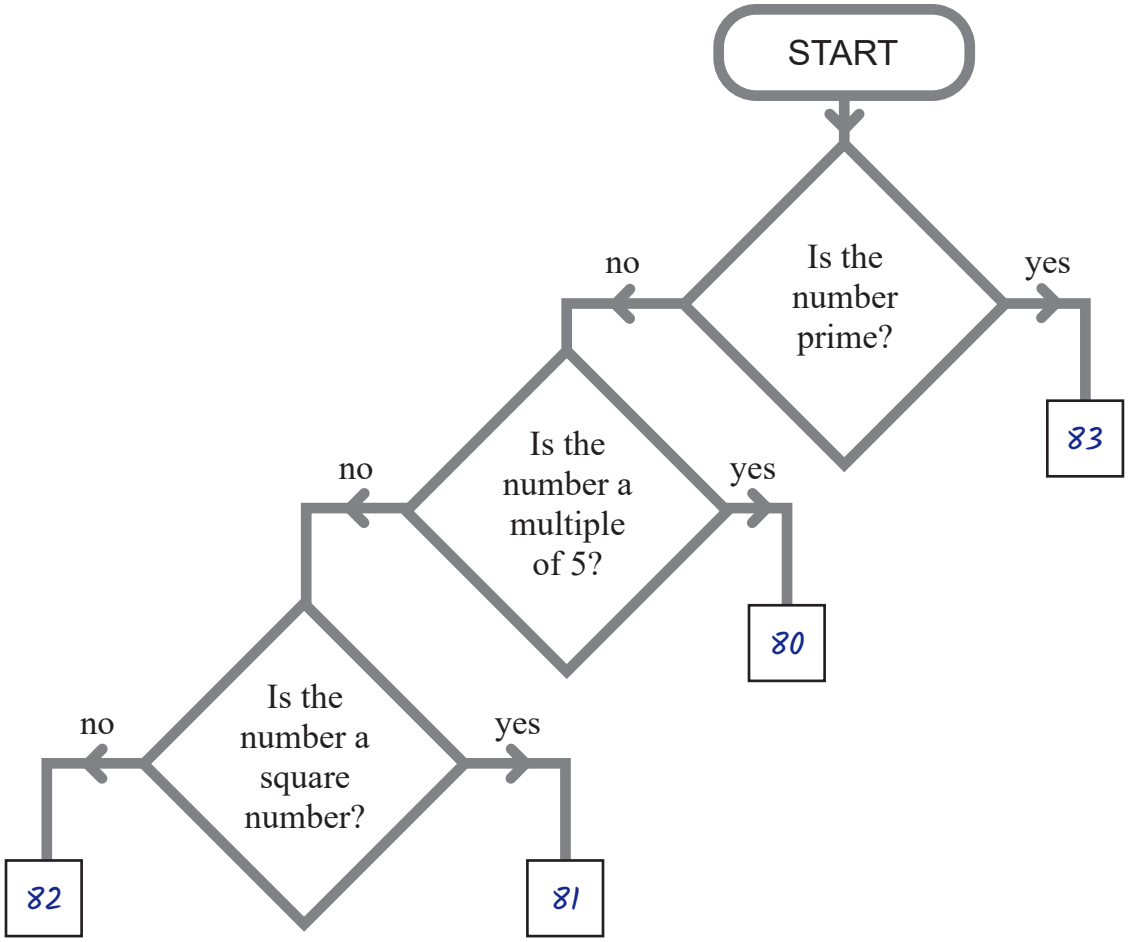
How many pizzas, each with 8 slices, are needed if there are 16 people at the party and each person gets 3 slices?

$p = \frac{16 \times 3}{8} = \frac{48}{8} = 6$

Answer 6 pizzas [3]

7 Look at the diagram below.

Place the numbers **80**, **81**, **82** and **83** in the correct boxes on the diagram.



[2]

[Turn over

8 **(a)** Two farmers grow apples.

Farmer Jack's apples have a mean weight of 116.85 g and a range of 19.1 g.

Farmer Brown weighs ten of his apples, picked at random.

Their weights, in grams (g), are

113.2 114.5 116.7 118.1 114.0 116.9 115.3 117.3 114.6 115.7

Whose apples are heavier on average?

You must give a mathematical reason with your answer.

Brown: 113.2 + 114.5 + 116.7 + 118.1 + 114.0

+ 116.9 + 115.3 + 117.3 + 114.6 + 115.7 = 1156.3 g

Mean = 1156.3 ÷ 10 = 115.63 g

Jack 116.85 g > Brown 115.63 g

Brown range = 118.1 − 113.2 = 4.9 g

Answer Farmer *Jack* because *his mean weight is*

greater (116.85 g > 115.63 g) [3]

(b) A supermarket prefers their apples to be similar in size.

Why might this supermarket prefer to buy Farmer Brown's apples?

Answer *The range of his apples is smaller,*

4.9 g < 19.1 g, so they are more similar in size [1]

9 Claire wants to buy a new watch.

She looks at special offers for this watch in two different shops.

Shop	Normal price	Special offer
Every Second	£135	15% discount
Minutes Matter	£174	$\frac{1}{3}$ off all prices

Which shop is now selling the watch at the cheapest price?

You must show working to explain your answer.

Every Second: 135 ÷ 100 × 15 = £20.25

135 − 20.25 = £114.75

Minutes Matter: 174 ÷ 3 = £58

174 − 58 = £116

£114.75 < £116

Answer *Every Second* [4]

[Turn over

10 A car travels at an average speed of 30 miles per hour for one hour.

It then travels at an average speed of 54 miles per hour for half an hour.

Calculate the average speed for the **whole** journey.

Distance 1 = 30 × 1 = 30 miles

Distance 2 = 54 × 0.5 = 27 miles

Total distance = 30 + 27 = 57 miles

Total time = 1 + 0.5 = 1.5 hours

Average speed = 57 ÷ 1.5 = 38

Answer 38 miles per hour [3]

11 A wedding venue has circular tables of diameter 2 m.

The bride wants to put ribbon round the edge of each table.

There are 15 tables.

The ribbon is only sold in a **whole number of metres** and costs £1.25 per metre.

What is the minimum total cost of the ribbon?

Circumference = π × 2 = 6.283185307... m

Ribbon needed = 6.283185307 × 15 = 94.24777961... m

so 95 m must be bought

Cost = 95 × £1.25 = £118.75

Answer £ 118.75 [4]

[Turn over

12 Steve bought a box of 200 hats for £120

He decided to sell them at a local market.

It cost him £20 to hire a stall at the market.

Steve sold 70% of the hats at £3 each.

He sold a quarter of the hats at £2.50 each.

The remaining hats were sold at £1 each.

How much profit did Steve make?

70% of 200 = 140 hats: 140 × £3 = £420

¼ of 200 = 50 hats: 50 × £2.50 = £125

Remaining = 200 − 140 − 50 = 10 hats: 10 × £1 = £10

Total income = 420 + 125 + 10 = £555

Total costs = 120 + 20 = £140

Profit = 555 − 140 = £415

Answer £ 415 [5]

13 Solve the equation $5(2y + 3) = 79$

$5(2y + 3) = 79$

$10y + 15 = 79$

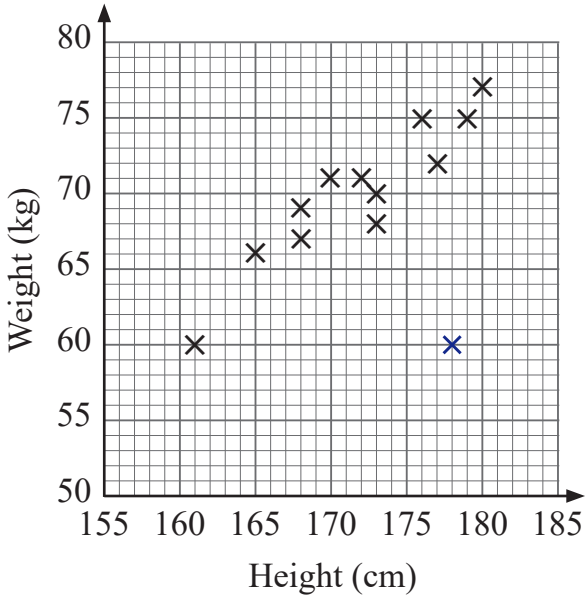
$10y = 79 - 15 = 64$

$y = 64 \div 10 = 6.4$

Answer $y =$ 6.4 [3]

[Turn over

14 The scatter graph shows the heights and weights of players on a rugby squad.



(a) Describe the relationship between the heights and weights of the players.

Answer *Positive correlation: as height increases, weight increases* [1]

(b) Jack Morris joins the squad.

The manager records Jack's height as 178 cm.

The manager records Jack's weight as 60 kg.

Plot this information on the scatter graph above. [1]

(c) The manager made an error in reading Jack's weight.

Use the scatter graph to say whether Jack's weight is likely to be lower or higher than 60 kg.

Answer *higher* [1]

15 A primary school has a Choir (**C**) and a Drama Club (**D**).

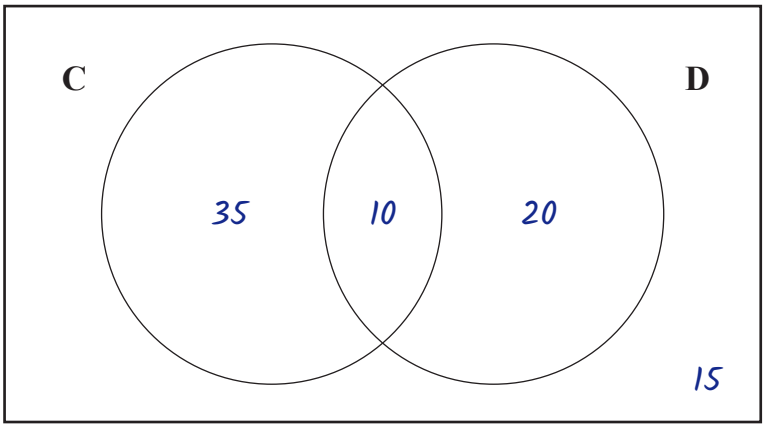
The school has 80 pupils.

45 pupils attend Choir.

30 pupils attend Drama.

15 pupils attend neither.

(a) Complete the Venn diagram using this information.



[3]

45 + 30 = 75, 80 − 15 = 65, both = 75 − 65 = 10

(b) What fraction of the pupils attend **only** the Drama Club?

Drama only = 30 − 10 = 20

$\frac{20}{80} = \frac{1}{4}$

Answer $\frac{1}{4}$ [1]

[Turn over

16 ABC is a right-angled triangle.

AC = 15 cm.

BC = 7.5 cm.

Work out the length of AB.

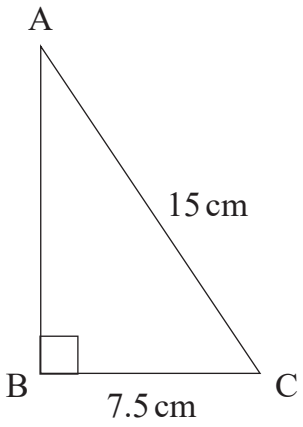


diagram not
drawn accurately

$AC^2 = AB^2 + BC^2$

$15^2 = x^2 + 7.5^2$

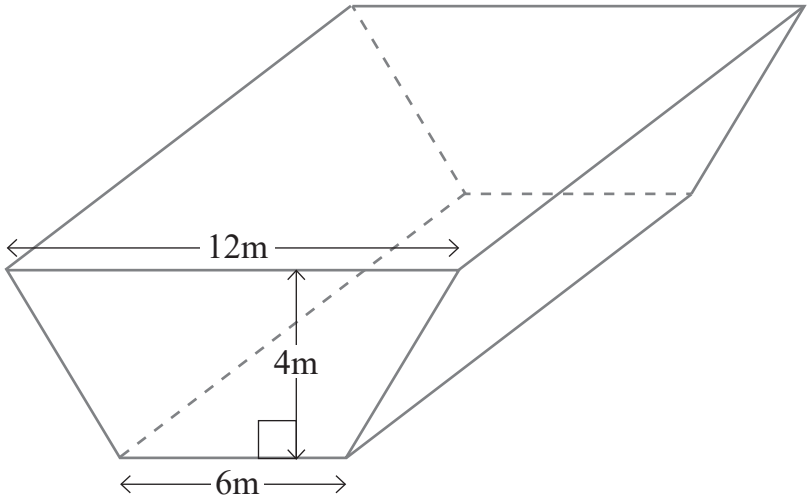
$225 = x^2 + 56.25$

$x^2 = 225 - 56.25 = 168.75$

$x = \sqrt{168.75} = 12.99038106...$

Answer 12.99 cm [3]

17 A water tank has the dimensions as shown.



The cross-section is a trapezium.

The volume of the tank is 522 m^3

Calculate the length of the tank.

Area of trapezium = ½ × (12 + 6) × 4 = 36 m^2

Volume = area × length

36 × length = 522

length = 522 ÷ 36 = 14.5

Answer *14.5* m [3]

[Turn over

18 The heights, in metres, of a number of trees is recorded for a science experiment.

The results are shown in the table below.

Height h (m)	Frequency
$100 \leqslant h < 110$	6
$110 \leqslant h < 120$	13
$120 \leqslant h < 130$	12
$130 \leqslant h < 140$	15
$140 \leqslant h < 150$	3
$150 \leqslant h < 160$	1

(a) Calculate an estimate for the mean height.

Midpoints: 105, 115, 125, 135, 145, 155

$\Sigma fx = 6 \times 105 + 13 \times 115 + 12 \times 125 + 15 \times 135 + 3 \times 145 + 1 \times 155$

$= 630 + 1495 + 1500 + 2025 + 435 + 155 = 6240$

$\Sigma f = 6 + 13 + 12 + 15 + 3 + 1 = 50$

Mean $= 6240 \div 50 = 124.8$

Answer 124.8 m [4]

(b) In which class interval does the median lie?

$50 \div 2 = 25$, so 25th/26th values: $6 + 13 = 19$, $19 + 12 = 31$

Answer $120 \leqslant h < 130$ [1]

19 Alan wants to invest £2400 for 2 years.

He sees the following offers for compound interest.

Bank A	Bank B
3% for the first year 1% for each extra year	4% for the first year 0.5% for each extra year

Calculate, for each bank, the value of the investment after 2 years.

Bank A: 3% of £2400 = £72, Year 1 = £2472

1% of £2472 = £24.72, Year 2 = £2496.72

Bank B: 4% of £2400 = £96, Year 1 = £2496

0.5% of £2496 = £12.48, Year 2 = £2508.48

Answer **Bank A**: £ 2496.72

Bank B: £ 2508.48 [4]

[Turn over

20 **(a)** Write 126 as a product of its prime factors.

$126 = 2 \times 63$

$63 = 3 \times 21$

$21 = 3 \times 7$

Answer $2 \times 3^2 \times 7$ [2]

(b) Find the HCF of 126 and 90

$90 = 2 \times 3 \times 3 \times 5$

$126 = 2 \times 3 \times 3 \times 7$

$HCF = 2 \times 3 \times 3 = 18$

Answer 18 [2]

21 A rectangular basketball court is x metres wide.

The length of the court is 13 metres longer than its width.

The perimeter of the court is 86 metres.

Form and solve an equation to find the value of x.

Length = $x + 13$

$2x + 2(x + 13) = 86$

$4x + 26 = 86$

$4x = 60$

$x = 15$

Answer $x =$ 15 m [3]

[Turn over

22 (2, 5) is the midpoint of the line joining (a, b) and $(3a, 3)$.

Find the values of a and b.

$\frac{a + 3a}{2} = 2, \quad 4a = 4, \quad a = 1$

$\frac{b + 3}{2} = 5, \quad b + 3 = 10, \quad b = 7$

Answer $a =$ 1 , $b =$ 7 [3]

23 A stepladder with sides of 2.3 m is opened so that the feet are 1.4 m apart.



Source: © Getty Images

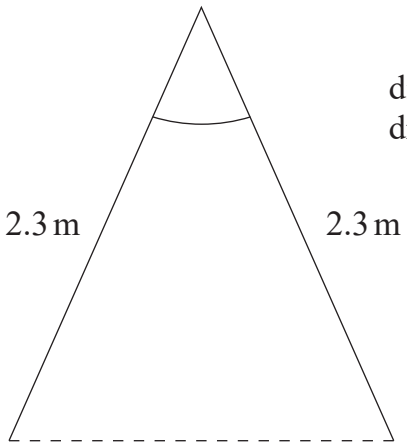


diagram not drawn accurately

Calculate the angle to which the stepladder has been opened.

Split into two right-angled triangles: half of base = 0.7 m

$\sin\theta = \frac{0.7}{2.3}$

$\theta = \sin^{-1}(0.7 \div 2.3) = 17.71893187...°$

Angle = $2 \times 17.71893187 = 35.43786375...°$

Answer 35.4 ° [4]

[Turn over

24 A cylindrical flask has diameter 12 cm and height 25 cm.

The flask is full of coffee.

A coffee cup is a hemisphere of diameter 9 cm.

Each coffee cup is filled to 90% capacity.

How many cups of coffee can be poured from the flask?

Volume of flask = $\pi \times 6^2 \times 25 = 2827.433388...\ cm^3$

Volume of cup = $\frac{2}{3} \times \pi \times 4.5^3 = 190.8517537...\ cm^3$

90% of 190.8517537 = 171.7665783... cm^3

2827.433388 ÷ 171.7665783 = 16.46090535...

so 16 full cups

Answer 16 cups [5]

25 A rectangle has length $(4x - 5)$ and width $(3x + 4)$.

What is the quadratic expression for its area?

$(4x - 5)(3x + 4)$

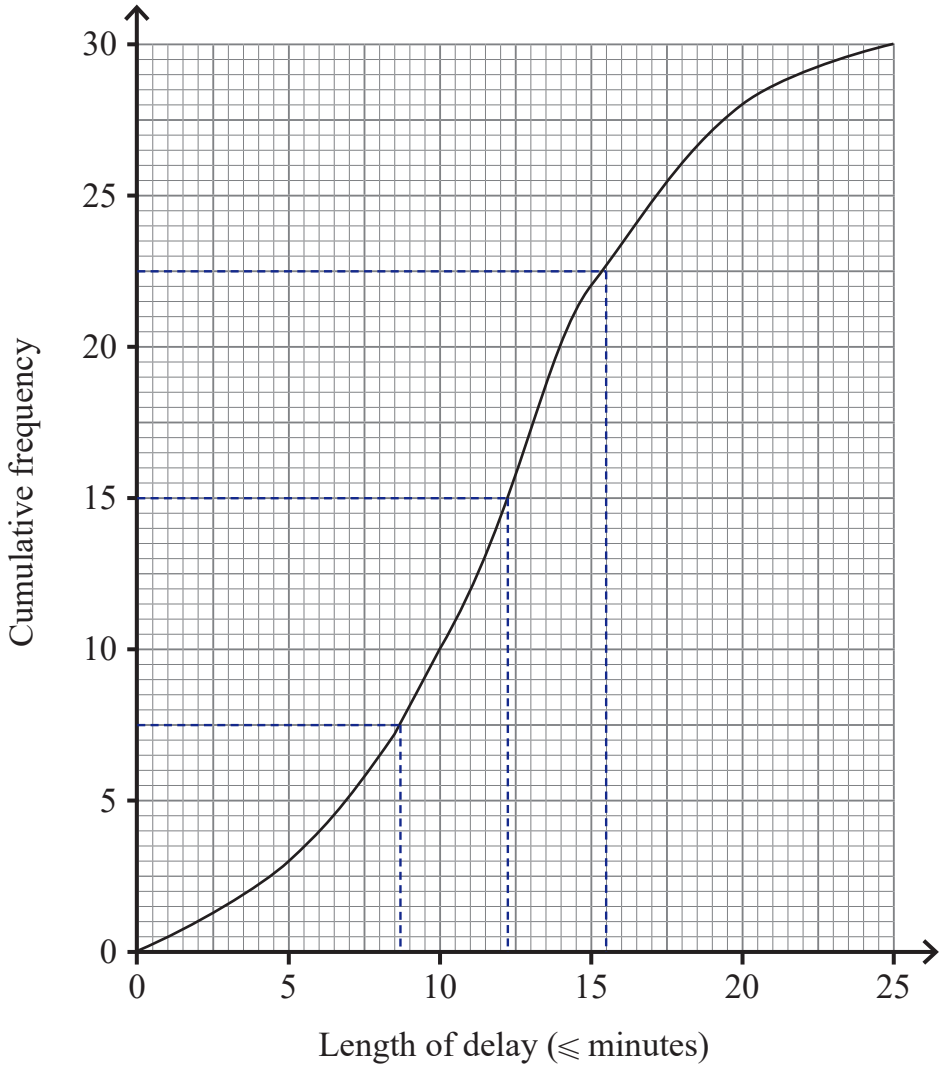
$= 12x^2 + 16x - 15x - 20$

$= 12x^2 + x - 20$

Answer $12x^2 + x - 20$ [2]

[Turn over

26 **(a)** The cumulative frequency diagram illustrates the lengths of delays to trains at Northside Station.



(i) Find the median.

30 ÷ 2 = 15

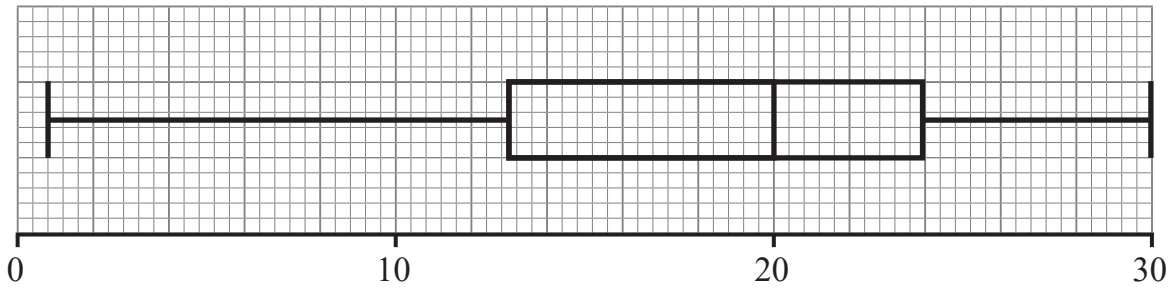
Answer 12.25 minutes [1]

(ii) Find the interquartile range.

UQ = 15.5, LQ = 8.7
15.5 − 8.7 = 6.8

Answer 6.8 minutes [2]

(b) The box plot illustrates the lengths of delays to trains at Southend Station.



Make two comparisons between the lengths of delays at Northside Station to those at Southend Station.

1st comparison The median delay at Southend (20 min) is much greater than at Northside (12.25 min).

2nd comparison Delays at Southend are more varied: IQR 11 min compared with 6.8 min at Northside. [2]

27 The price for 900 litres of oil increased by 28%

The new price for 900 litres of oil is £736

How much did 900 litres of oil cost before the increase?

128% = £736

1% = 736 ÷ 128 = £5.75

100% = 5.75 × 100 = £575

Answer £ 575 [3]

[Turn over

28 **(a)** The diagonal of a rectangle is 26 cm.

The width of the rectangle is x cm.

The length of the rectangle is $(34 - x)$ cm.

Show that $x^2 - 34x + 240 = 0$

Pythagoras: $x^2 + (34 - x)^2 = 26^2$

$x^2 + 1156 - 68x + x^2 = 676$

$2x^2 - 68x + 1156 - 676 = 0$

$2x^2 - 68x + 480 = 0$

$\div 2$: $x^2 - 34x + 240 = 0$

[4]

(b) Solve the equation to find the possible values of x.

$(x - 10)(x - 24) = 0$

$x - 10 = 0$ or $x - 24 = 0$

Answer $x =$ 10 or 24 [2]

THIS IS THE END OF THE QUESTION PAPER

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Question Number	**Marks**
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