Rewarding Learning

Centre Number

Candidate Number

General Certificate of Secondary Education
November 2021

Mathematics

StemUp Model Solution

Unit M3
(With calculator)
Higher Tier



[GMC31]

GMC31

MONDAY 29 NOVEMBER, 9.15am–11.15am

TIME

2 hours.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
You are provided with Higher Tier Additional Support Materials for use with this paper.
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-seven** 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.

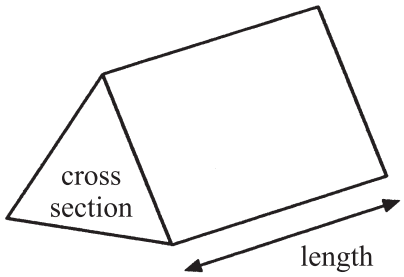
INFORMATION FOR CANDIDATES

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.

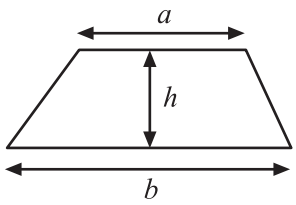
12919

Formula Sheet

Volume of prism = area of cross section × length

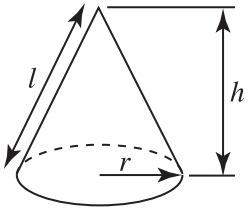


Area of trapezium = $\frac{1}{2}(a+b)h$



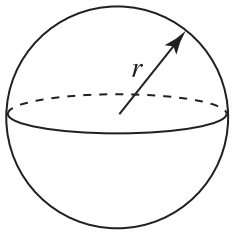
Volume of cone = $\frac{1}{3}\pi r^2 h$

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

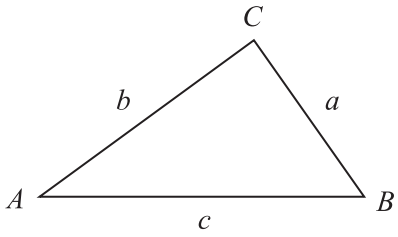


Volume of sphere = $\frac{4}{3}\pi r^3$

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 = $\frac{1}{2}ab\sin C$

12919

1 Dylan needs to get part of his house painted.

He has a budget of £200

He needs to buy 3 tins of paint, each costing £16.75

He employs a painter who is paid £12.30 per hour.

How many **full** hours will the painter have to complete the work without going over Dylan's budget?

Paint: 3 × 16.75 = £50.25

Left for painter: 200 − 50.25 = £149.75

149.75 ÷ 12.30 = 12.17479...

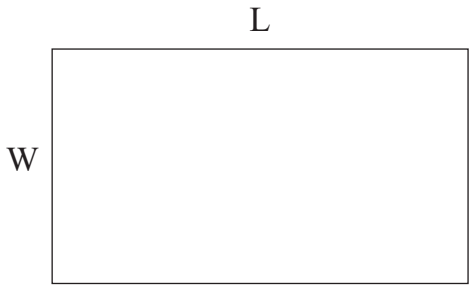
So 12 full hours

Answer 12 [3]

[Turn over

2 Jessica fits guttering around buildings.

She measures the length (L) and width (W) for rectangular sheds in metres.



To work out the total amount (T) of guttering needed, Jessica uses the formula

$$T = 2L + 2W$$

Jessica measured a shed.

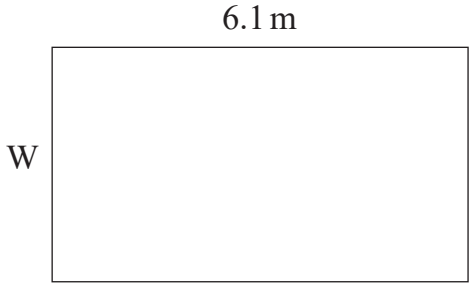


diagram not drawn accurately

The total (T) was 19.9 m.

Work out the width (W) of this shed.

$T = 2L + 2W$

$19.9 = 2 \times 6.1 + 2W$

$19.9 = 12.2 + 2W$

$2W = 19.9 - 12.2 = 7.7$

$W = 7.7 \div 2 = 3.85$

Answer 3.85 m [3]

3

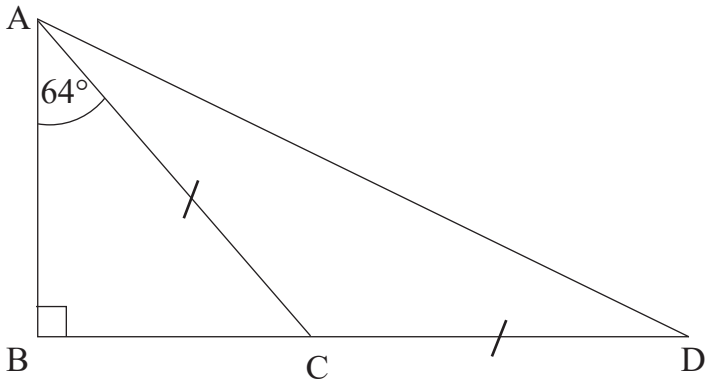


diagram not drawn accurately

ABC is a right-angled triangle.
ACD is an isosceles triangle.
BCD is a straight line.

Calculate the size of

(a) angle ACB,

ACB = 180 − 90 − 64 = 26° (angles in a triangle)

Answer 26 ° [2]

(b) angle ADC.

ACD = 180 − 26 = 154° (angles on a straight line)

ADC = (180 − 154) ÷ 2

= 26 ÷ 2 = 13° (base angles of isosceles triangle)

Answer 13 ° [3]

[Turn over

4 Guttering costs £4.30 per metre.

Martin bought 11 metres of guttering and 7 metres of downpipe.

He paid £66.55 in total.

How much does downpipe cost per metre?

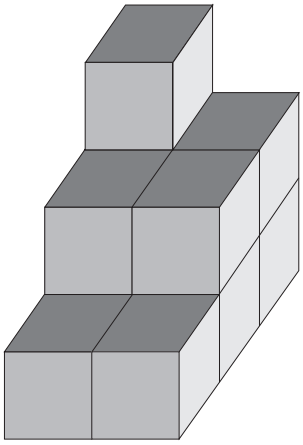
Guttering: 11 × 4.30 = £47.30

Downpipe: 66.55 − 47.30 = £19.25

Per metre: 19.25 ÷ 7 = £2.75

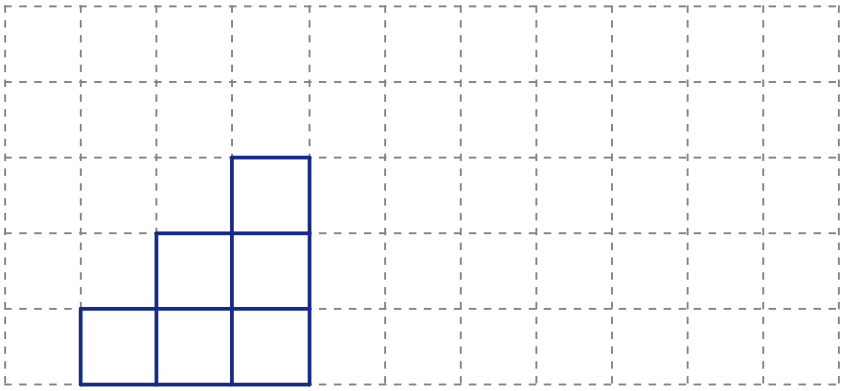
Answer £ *2.75* [4]

5 A solid is made from 1 cm cubes.



side

(a) On the grid below draw the side elevation of the solid.



[2]

(b) What is the smallest number of cubes you would need to add to the solid to make it into a cube?

Smallest cube is 3 × 3 × 3 = 27 cubes

Solid has 6 + 4 + 1 = 11 cubes

27 − 11 = 16

Answer 16 [1]

[Turn over

6 In a group of students,

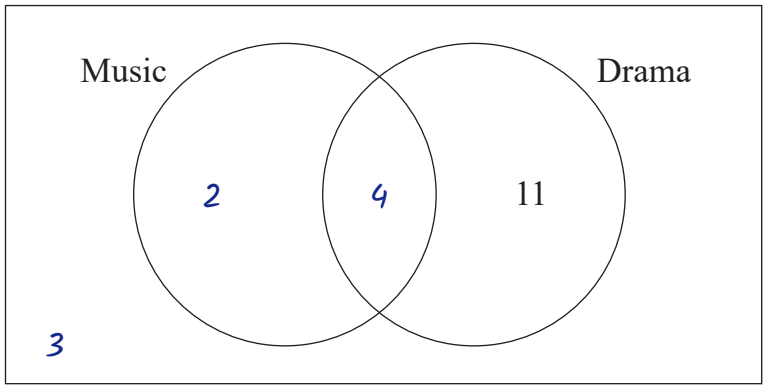
6 study Music

15 study Drama

11 students study only Drama

3 study neither subject.

Complete the Venn diagram to show this information.



[3]

7 A manager is preparing to draw a pie chart to display how 40 workers travel to work.

The table below shows some of her information.

Transport	Number of workers	Angle
Car	5	45°
Bus	12	108°
Walk	7	63°
Train	10	90°
Bike	6	54°
	Total = 40	360°

Use the information in the table to work out what angle will represent those who travel by bike.

Show all your working clearly.

40 workers = 360°, so 1 worker = 360 ÷ 40 = 9°

Car: 45 ÷ 9 = 5 workers, Bus: 108 ÷ 9 = 12 workers

5 + 12 + 7 + 10 = 34 workers

Bike: 40 − 34 = 6 workers

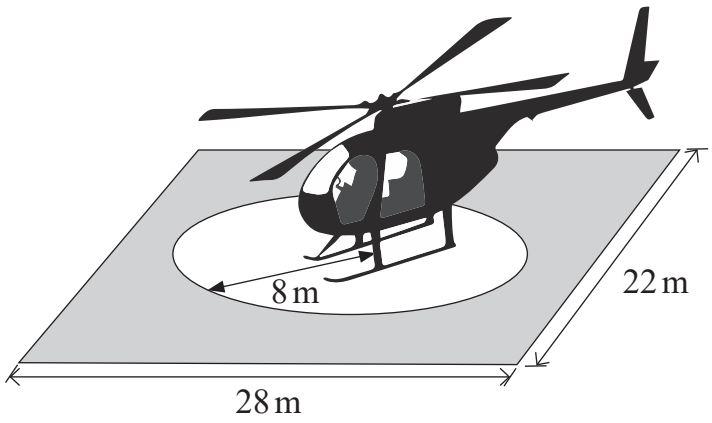
6 × 9° = 54°

Answer 54 ° [4]

[Turn over

8 The landing pad for a helicopter is a white circle of radius 8 m.

It is painted on a black rectangular plot 28 m by 22 m.



What area of the plot is **not** painted white?

Give units with your answer.

Rectangle: $28 \times 22 = 616\ m^2$

Circle: $\pi \times 8^2 = 201.0619298...\ m^2$

Not white: $616 - 201.0619... = 414.9380...\ m^2$

Answer 414.94 m^2 [5]

9 A tracksuit normally cost £75

(a) In a sale the price was reduced by 15%

Calculate the sale price of the tracksuit.

15% of 75 = 0.15 × 75 = £11.25

75 − 11.25 = £63.75

Answer £ 63.75 [3]

(b) The following week the shop displayed this sign.

FINAL STOCK CLEARANCE
A FURTHER 20% OFF ALL SALE PRICES

Show that the tracksuit now costs £51

20% of 63.75 = 0.2 × 63.75 = £12.75

63.75 − 12.75 = £51

[2]

(c) Rhys says, "I am getting 15% off, then 20% off, so I am getting 35% off the £75."

Is he correct?

You must show working to explain your answer.

35% of 75 = £26.25, 75 − 26.25 = £48.75

Answer No because 35% off gives £48.75, not £51

(15% then 20% off is ×0.85 × 0.8 = ×0.68, only 32% off) [2]

[Turn over

10 A girl collects the following data in metres (m) in a Science experiment.

0.32 0.51 0.43 0.64 0.39 0.49 0.62 0.54 0.52 0.36 0.54 0.68 0.48 0.52 0.60

(a) She states, "The median is the one in the middle so my median is 0.54 m."

Explain why she is not correct.

Answer *The data has not been put in order of size, so*

0.54 is not the middle value of the ordered data. [1]

(b) She then decides to show her data in a stem and leaf diagram.

The first three are recorded.

Complete the stem and leaf diagram.

0.3	2 6 9
0.4	3 8 9
0.5	1 2 2 4 4
0.6	0 2 4 8

KEY: 0.3 | 2 = 0.32 m

[2]

(c) Give **one** advantage of displaying the data in a stem and leaf diagram.

Answer *The data is now in order, so the median and range*

are easy to find, and all the original values are kept. [1]

(d) Use the stem and leaf diagram to write down the correct median.

15 values, median = 8th value

Answer *0.52* m [1]

11 The attendance for some classes is shown below.

Class A	17 pupils out of 20 were present.
Class B	21 pupils out of 24 were present.
Class C	19 pupils out of 22 were present.

Which class had the **highest percentage attendance**?

You must show working to justify your answer.

A: 17 ÷ 20 × 100 = 85%

B: 21 ÷ 24 × 100 = 87.5%

C: 19 ÷ 22 × 100 = 86.36...%

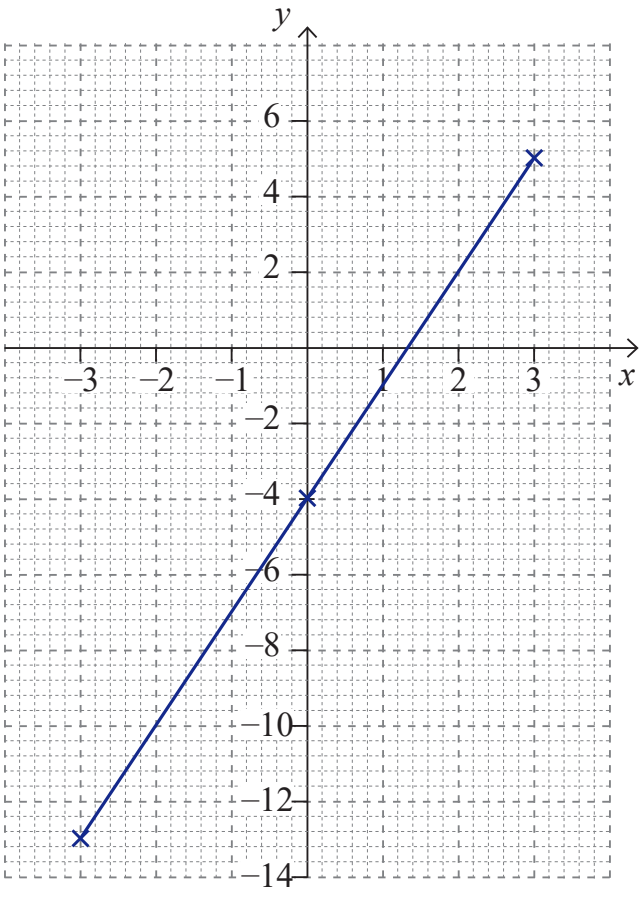
87.5% is the highest

Answer B [3]

[Turn over

12 On the grid below, draw the graph of $y = 3x - 4$

$x = -3$:
$y = -9 - 4 = -13$
$x = 0$:
$y = -4$
$x = 3$:
$y = 9 - 4 = 5$



[3]

13 (a)

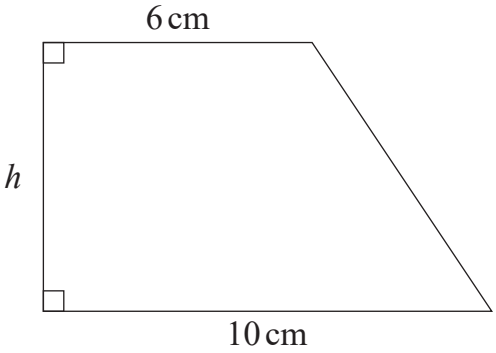


diagram
not drawn
accurately

The area of the trapezium is 36 cm^2
Calculate its height h.

$\frac{1}{2}(6 + 10) \times h = 36$

$8h = 36$

$h = 36 \div 8 = 4.5$

Answer 4.5 cm [2]

(b) A different trapezium is drawn below.

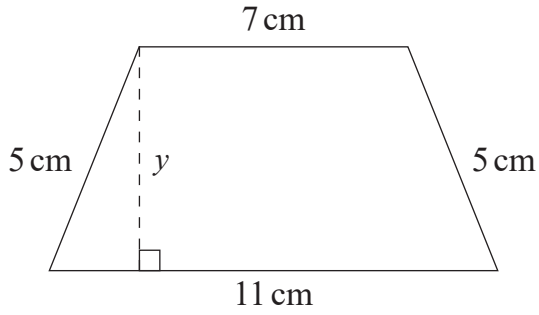


diagram
not drawn
accurately

Calculate its height y.

Base of triangle $= (11 - 7) \div 2 = 2$ cm

$2^2 + y^2 = 5^2$

$y^2 = 25 - 4 = 21$

$y = \sqrt{21} = 4.5825...$

Answer 4.58 cm [4]

[Turn over

14 A number, expressed as a product of its prime factors, is $2^2 \times 3 \times 5^2$

(a) What is the number?

$2^2 \times 3 \times 5^2 = 4 \times 3 \times 25 = 300$

Answer 300 [1]

(b) (i) This number is multiplied by 9

Write the new number as a product of its prime factors.

$9 = 3^2$, so $2^2 \times 3 \times 5^2 \times 3^2$

Answer $2^2 \times 3^3 \times 5^2$ [1]

(ii) Is this new number a square number?

You must explain your answer.

Answer No because the power of 3 is odd (3^3),

so not all powers are even; 2700 is not a square number [1]

15 Jane completes a 5 km race in 24 minutes.

Calculate her average speed in km/hr.

24 minutes = 24 ÷ 60 = 0.4 hours

speed = distance ÷ time

= 5 ÷ 0.4 = 12.5 km/hr

Answer 12.5 km/hr [2]

[Turn over

16 Last year a company made a profit of £152 650

This year the company made a profit of £104 760

Work out the percentage decrease in the company's profit.

Give your answer to 1 decimal place.

Decrease = 152 650 − 104 760 = £47 890

47 890 ÷ 152 650 × 100 = 31.37242...%

Answer 31.4 % [3]

17 James can throw a javelin 49 metres.

His target is to throw it 4% further each year.

If he stays on target, how many years will it be before he can throw the javelin 55 metres?

You must show working to justify your answer.

After 1 year: $49 \times 1.04 = 50.96$ m

After 2 years: $49 \times 1.04^2 = 52.9984$ m

After 3 years: $49 \times 1.04^3 = 55.118336$ m

$52.9984 < 55$ but $55.118... > 55$

So it takes 3 years

Answer 3 years [4]

[Turn over

18 The number of hours of daily sunshine is recorded at a resort during four months.

Hours of daily sunshine	Frequency	Midpoint x	fx
$0 < h \leq 3$	18	1.5	27
$3 < h \leq 6$	45	4.5	202.5
$6 < h \leq 9$	37	7.5	277.5
$9 < h \leq 12$	19	10.5	199.5
$12 < h \leq 15$	4	13.5	54

Calculate an estimate of the mean number of hours of daily sunshine at the resort during the four months.

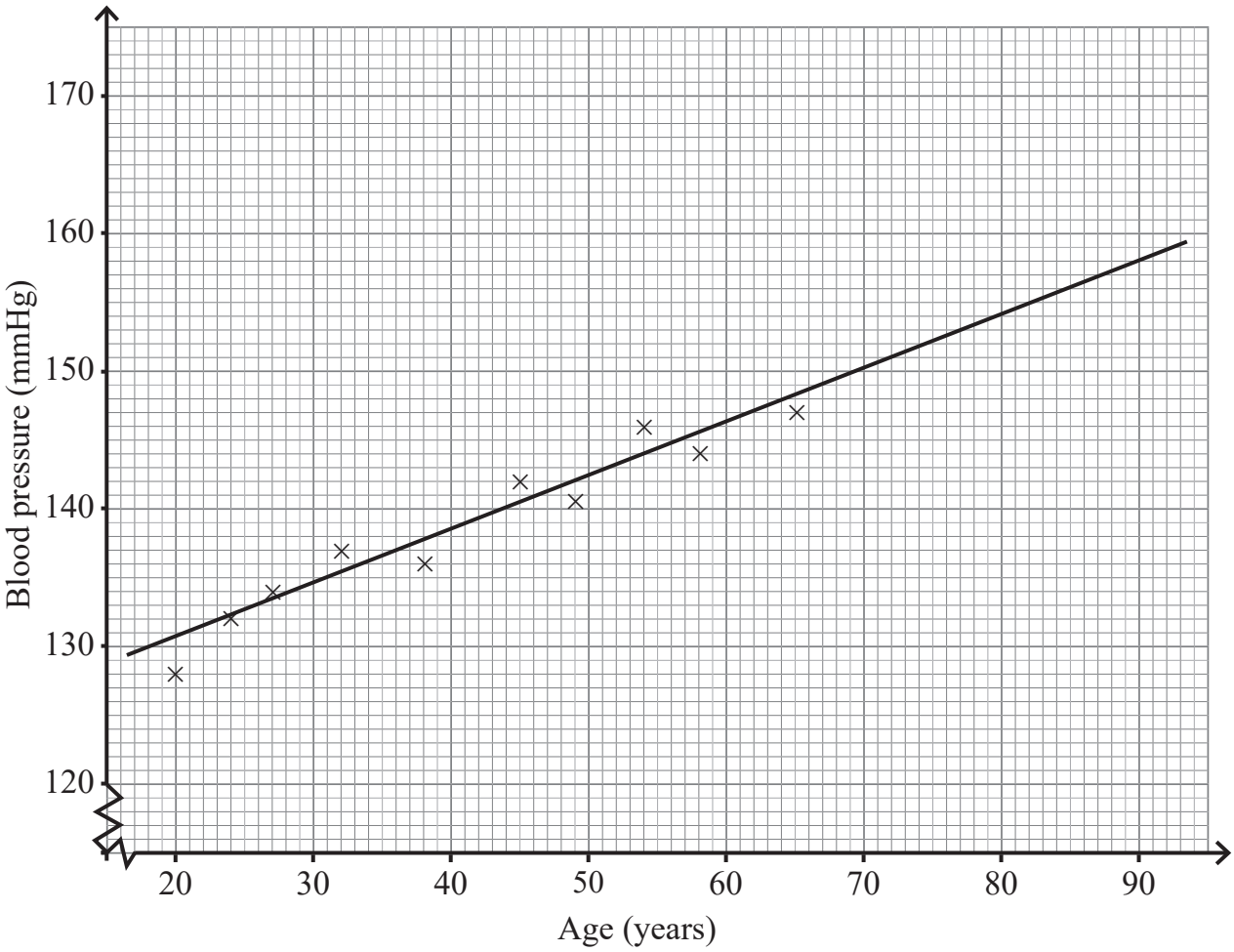
$\Sigma fx = 27 + 202.5 + 277.5 + 199.5 + 54 = 760.5$

$\Sigma f = 18 + 45 + 37 + 19 + 4 = 123$

Mean $= 760.5 \div 123 = 6.18292...$

Answer 6.18 hours [4]

19 Janet sees a scatter graph which displays the age and blood pressure of 10 adults.



Janet is aged 41 and her father is 84

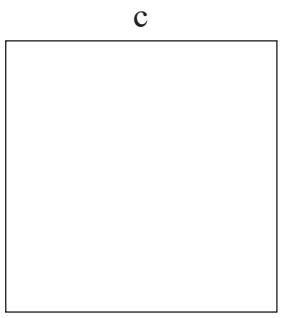
She comments that a good estimate for her blood pressure would be 139 whilst a good estimate for her father's would be 156

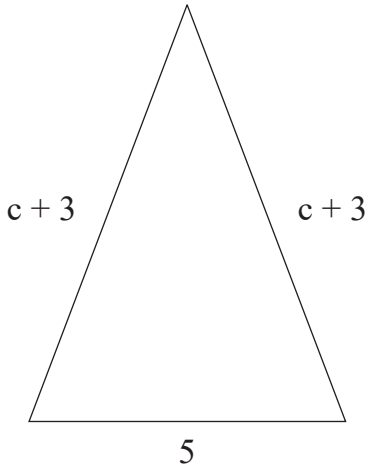
Do you think her estimates are reliable? Explain your reasoning clearly.

Her own estimate (139) is reliable because age 41 lies within the range of the data (interpolation). Her father's (156) is not reliable because 84 is outside the range of the data (extrapolation). [2]

[Turn over

20 The diagrams below show a square and an isosceles triangle.





diagrams not drawn accurately

They have the same perimeter.

By forming and solving an equation, work out the perimeter.

Square: $4c$

Triangle: $c + 3 + c + 3 + 5 = 2c + 11$

$4c = 2c + 11$

$2c = 11$

$c = 5.5$

Perimeter $= 4 \times 5.5 = 22$

Answer 22 [4]

21 Calculate the surface area of a sphere with diameter 12 cm.

$r = 12 \div 2 = 6$ cm

$SA = 4\pi r^2 = 4 \times \pi \times 6^2$

$= 452.3893421...$ cm^2

Answer 452.39 cm^2 [2]

[Turn over

22 Calculate the size of the largest angle in the rhombus.

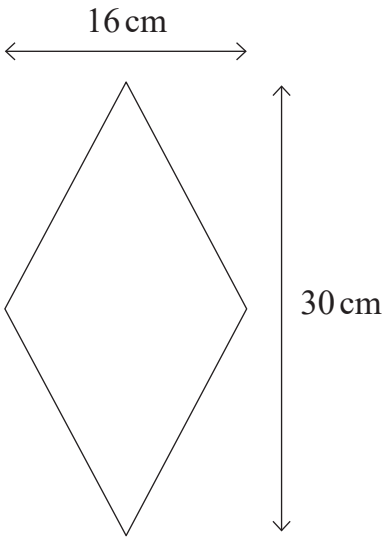


diagram
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accurately

You must show your working.

Diagonals bisect at right angles:

half diagonals are 16 ÷ 2 = 8 cm and 30 ÷ 2 = 15 cm

tan θ = 15 ÷ 8 (θ = half of the largest angle)

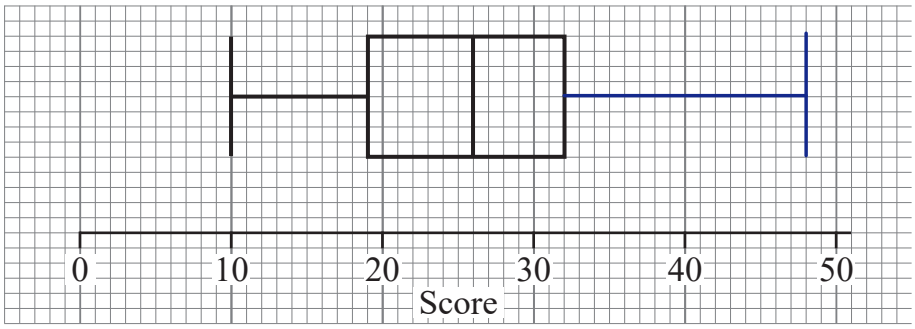
θ = $\tan^{-1}$(15 ÷ 8) = 61.92751306...°

Largest angle = 2 × 61.9275... = 123.8550261...°

Answer *123.86* ° [4]

23 Mr Davison's class did a test.

Their scores are shown on the box plot, but the box plot is incomplete.



(a) The range of scores is 25 more than the interquartile range.

Use this information to complete the box plot.

IQR = 32 − 19 = 13

Range = 13 + 25 = 38

Maximum = 10 + 38 = 48

[2]

(b) Explain why the interquartile range may be a better measure of spread for this distribution than the range.

The range may be affected by an extreme value (outlier);

the IQR only uses the middle 50% of the scores. [1]

(c) Kevin scored 32 marks in the test.

What percentage of the class scored lower than Kevin?

32 is the upper quartile

Answer *75* % [1]

[Turn over

24 A survey was carried out to estimate how many people own a smartphone.

The results of the sample are shown below.

Do own a smartphone	236
Do not own a smartphone	64

(a) Based on this sample, estimate the number of people in a town with a population of 15 000 who might own a smartphone.

236 ÷ 300 × 15 000 = 11 800

Answer 11 800 [1]

(b) The sample data was obtained from a group of 17 year olds.

Do you think your result in **(a)** is an overestimate or an underestimate for the number of people in the town who own a smartphone?

Explain your reasoning.

Answer An overestimate because 17 year olds are more likely to own a smartphone than other age groups (e.g. young children or elderly people), so the proportion is too high. [1]

25 Solve $\frac{2x-1}{5}+\frac{4x+5}{3}=\frac{20}{3}$

A solution by trial and improvement will not be accepted.

Multiply every term by 15:

$3(2x - 1) + 5(4x + 5) = 100$

$6x - 3 + 20x + 25 = 100$

$26x + 22 = 100$

$26x = 78$

$x = 78 \div 26 = 3$

Answer $x = 3$ [4]

[Turn over

26 The value of John's house has risen by 3.5%

It is now worth £150 075

What was the original value of John's house?

103.5% = £150 075

1% = 150 075 ÷ 103.5 = £1450

100% = 1450 × 100 = £145 000

Answer £ 145 000 [3]

27 **(a)** Expand and simplify $(2x - 5)(3x + 2)$

$(2x - 5)(3x + 2) = 6x^2 + 4x - 15x - 10$

$= 6x^2 - 11x - 10$

Answer $6x^2 - 11x - 10$ [3]

(b) Simplify $\dfrac{x^2 - 49}{2x - 14}$

$\dfrac{x^2 - 49}{2x - 14} = \dfrac{(x + 7)(x - 7)}{2(x - 7)} = \dfrac{x + 7}{2}$

Answer $\dfrac{x + 7}{2}$ [2]

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