Rewarding Learning

Centre Number

Candidate Number

General Certificate of Secondary Education
2019

Mathematics

StemUp Model Solution

Unit M3
(With calculator)
Higher Tier



[GMC31]

GMC31

TUESDAY 21 MAY, 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 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-six** 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.

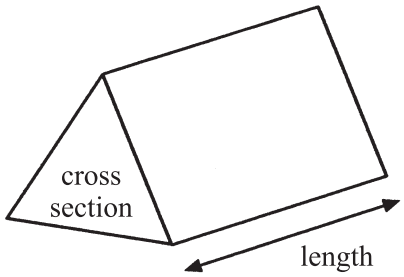
INFORMATION FOR CANDIDATES

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.

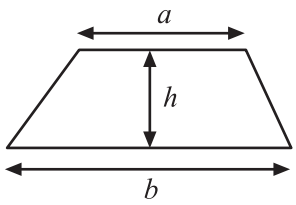
11935

Formula Sheet

Volume of prism = area of cross section × length

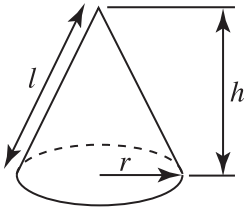


Area of trapezium = $\frac{1}{2}(a+b)h$



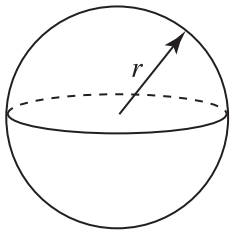
Volume of cone = $\frac{1}{3}\pi r^2 h$

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

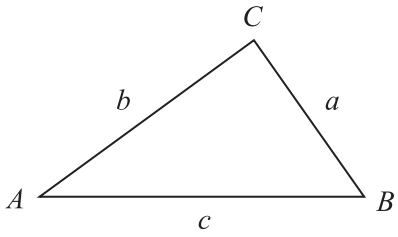


Volume of sphere = $\frac{4}{3}\pi r^3$

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

11935

1 Tickets for a show are priced as shown:

Adult £14	Senior Citizen £8	Child £5

Mrs Evans spent £57 on 6 tickets.

She bought 1 Child ticket.

How many Adult and Senior Citizen tickets did she buy?

£57 − £5 = £52 for 5 Adult and Senior Citizen tickets
Try 2 Adult: 2 × £14 = £28
3 Senior Citizen: 3 × £8 = £24
£28 + £24 = £52 ✓
2 + 3 = 5 tickets, + 1 Child = 6 tickets ✓

Answer Adult 2

Senior Citizen 3 [3]

[Turn over

2 Gary asked some people how many times they went to the cinema last month.

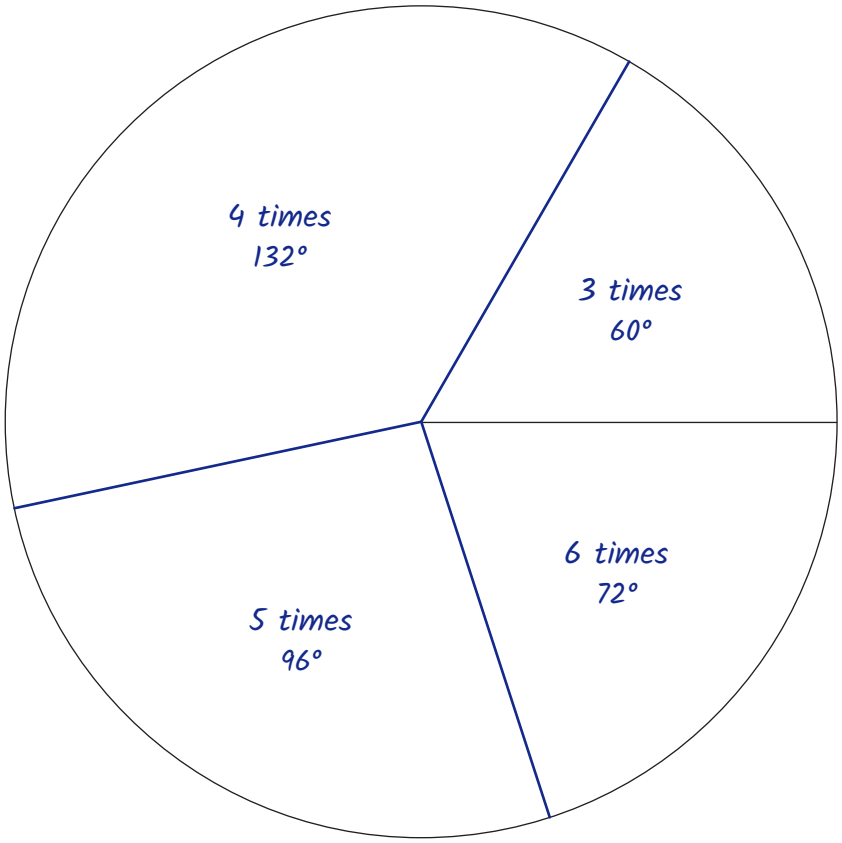
Number of times	Number of people
Less than 3	0
3	5
4	11
5	8
6	6
More than 6	0

(a) How many times did these people go in total?

$3 \times 5 + 4 \times 11 + 5 \times 8 + 6 \times 6$
$= 15 + 44 + 40 + 36$
$= 135$

Answer 135 [2]

(b) Draw a fully labelled pie chart to show the information in the table.



[4]

Total people = 5 + 11 + 8 + 6 = 30
360° ÷ 30 = 12° per person
3 times: 5 × 12 = 60°
4 times: 11 × 12 = 132°
5 times: 8 × 12 = 96°
6 times: 6 × 12 = 72°
Check: 60 + 132 + 96 + 72 = 360°

[Turn over

3 Steven wants to get a T-shirt printed for each member of his running club.

The printer charges a fee of £25 to set up the machine.

He then charges £1.20 per T-shirt for the printing.

The total bill from the printer was £67

How many people are in the running club?

£67 – £25 = £42 for printing
£42 ÷ £1.20 = 35 T-shirts

Answer 35 [3]

4 Jenny opens a "Charity Bank Account". Any interest gained goes to a local charity.

It pays 2% per annum simple interest.

She puts £1500 into the account.

She does not make any deposits or withdrawals.

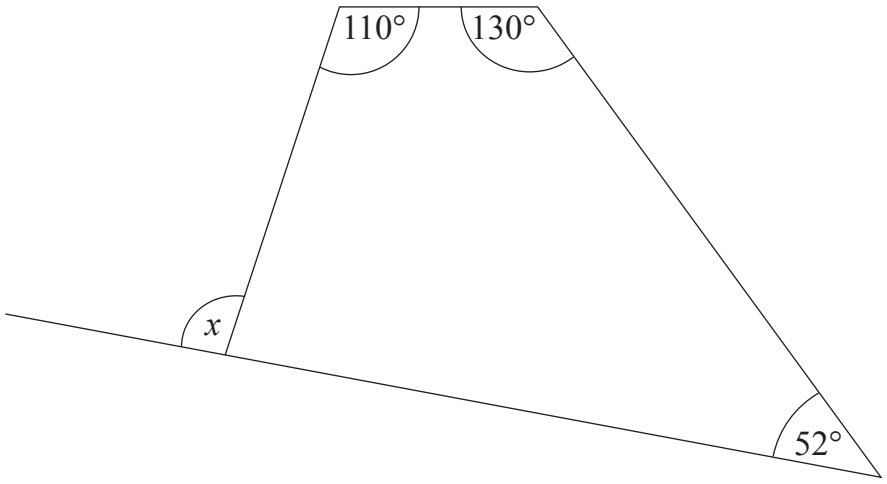
How much interest will the charity have received after 3 years?

2% of £1500 = 0.02 × 1500 = £30 per year
3 × £30 = £90

Answer £ 90 [3]

[Turn over

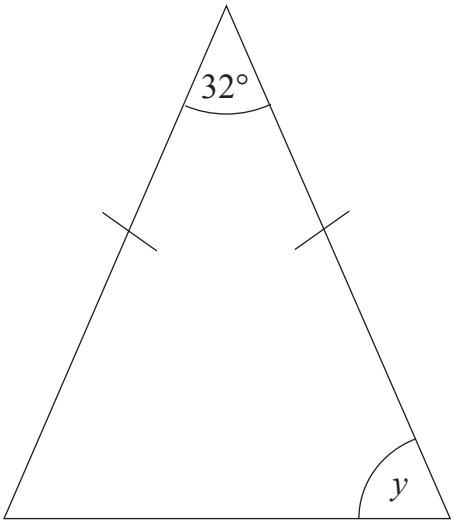
5 **(a)** Work out the size of the angle x in the diagram below.



Angles in a quadrilateral add up to 360°
360 − (110 + 130 + 52) = 360 − 292 = 68°
Angles on a straight line add up to 180°
x = 180 − 68 = 112°

Answer 112 ° [3]

(b) Work out the size of the angle y in the diagram below.



Isosceles triangle, so the base angles are equal
$y = (180 - 32) \div 2$
$= 148 \div 2 = 74°$

Answer 74 ° [2]

6 Peter buys mince and potatoes.

Mince costs £6 per kg.

Peter buys 3.2 kg of mince and 1.8 kg of potatoes.

The total cost is £20.46

How much does it cost for 1kg of potatoes?

Mince: 3.2 × £6 = £19.20
Potatoes: £20.46 − £19.20 = £1.26
1 kg of potatoes: £1.26 ÷ 1.8 = £0.70
= 70p

Answer 70 p [4]

7 Holly did three exams.

Her results were:

Geography	28 out of 40
Music	16 out of 25
English	34 out of 50

Her Mum says "English was your best subject."

Is her Mum right?

You must show your working and explain your answer.

Geography: $\frac{28}{40} \times 100 = 70\%$

Music: $\frac{16}{25} \times 100 = 64\%$

English: $\frac{34}{50} \times 100 = 68\%$

Answer No because Geography 70% is higher than English 68%, so Geography was her best subject. [3]

[Turn over

8 Mr Jackson's car insurance is £840

He can either:

pay the full amount within seven days and receive 5% discount
or
pay by direct debit, which will cost 8% more.

The direct debit is paid in 12 equal monthly amounts.

(a) If he chooses direct debit, how much will his monthly payment be?

8% of £840 = 0.08 × 840 = £67.20
Direct debit total = £840 + £67.20 = £907.20
Monthly = £907.20 ÷ 12 = £75.60

Answer £ 75.60 [3]

(b) How much extra will he pay if he chooses the direct debit instead of paying in full within seven days?

5% of £840 = 0.05 × 840 = £42
Pay in full = £840 − £42 = £798
Extra = £907.20 − £798 = £109.20

Answer £ 109.20 [2]

9 Alice has five cards each with a number on them. Three of the numbers are shown.

3	8	5	5	9

The mode of the five numbers on the cards is 5

The mean of the five numbers on the cards is 6

Work out the range of the five numbers on the cards.

You must show your working.

Mode is 5, so one of the other cards must be 5
Mean is 6, so total = 5 × 6 = 30
Last card = 30 − (3 + 8 + 5 + 5)
= 30 − 21 = 9
Cards: 3, 5, 5, 8, 9
Range = 9 − 3 = 6

Answer 6 [4]

[Turn over

10 Factorise

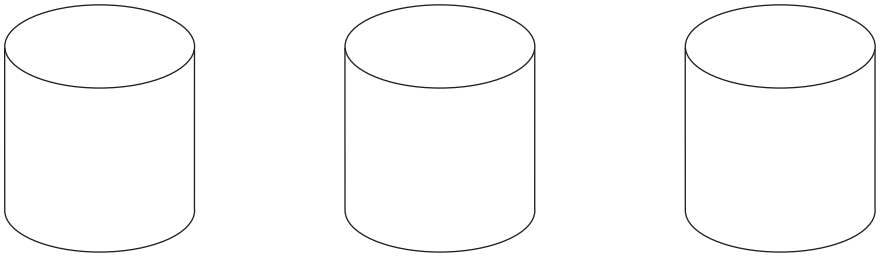
(a) $8b + 12$

Answer $4(2b + 3)$ [1]

(b) $t^2 - t$

Answer $t(t - 1)$ [1]

11 Three identical barrels are collecting rainwater.



A B C

Barrel A is $\frac{3}{4}$ full.

Barrel B is $\frac{5}{6}$ full.

Barrel C is $\frac{2}{3}$ full.

The water in Barrel C is poured into Barrels A and B.

Can Barrels A and B be filled?

You must show working to justify your answer.

Space left in A $= \frac{1}{4}$, space left in B $= \frac{1}{6}$

Space to fill $= \frac{1}{4} + \frac{1}{6} = \frac{3}{12} + \frac{2}{12} = \frac{5}{12}$

Water in C $= \frac{2}{3} = \frac{8}{12}$, $\frac{8}{12} > \frac{5}{12}$

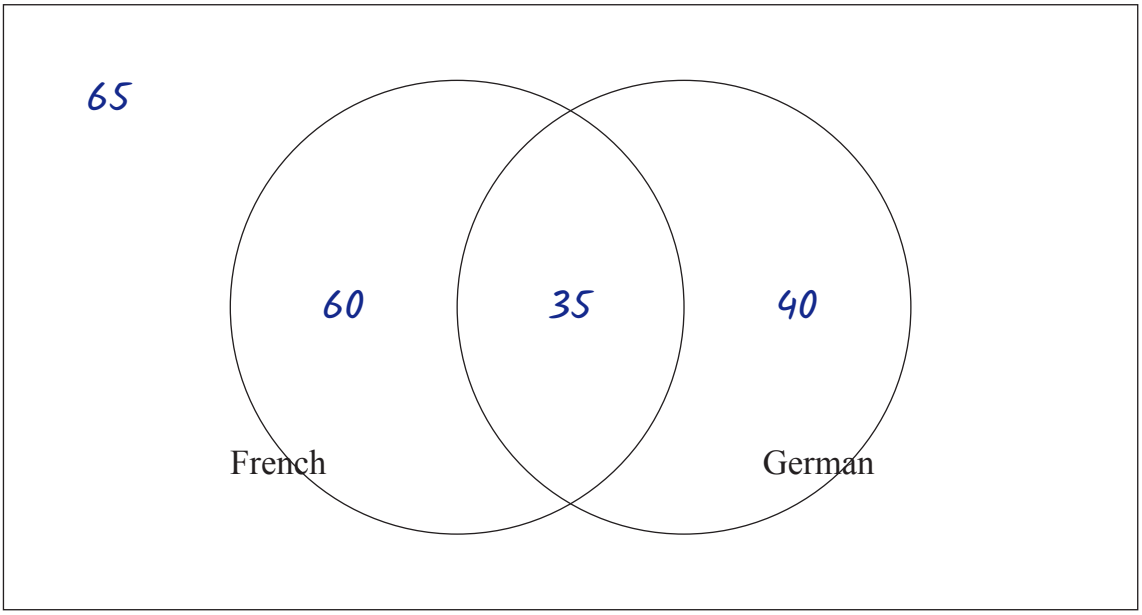
Answer Yes because C has 8 twelfths of a barrel but A and B only need 5 twelfths, and 8 > 5, so there is enough to fill both. [4]

[Turn over

12 In Year 11 there are 200 students.
Students can choose to study French, German, both languages or no language.

95 students study French.
75 students study German.
35 students study both languages.

By completing the Venn diagram below, calculate how many students in Year 11 study no languages.



Both = 35
French only = 95 − 35 = 60
German only = 75 − 35 = 40
No languages = 200 − (60 + 35 + 40)
= 200 − 135 = 65

Answer 65 [4]

13

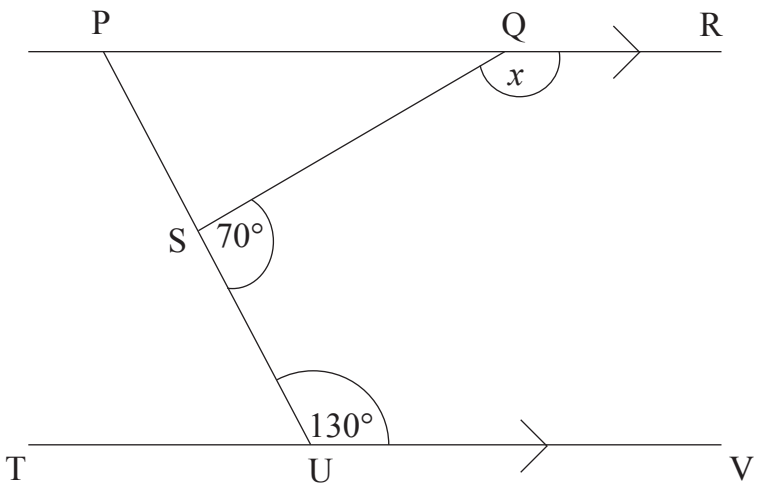


diagram
not drawn
accurately

PR and TV are parallel lines.

Calculate the size of angle x.

Angle QSP = 180 – 70 = 110° (angles on a straight line)
Angle TUS = 180 – 130 = 50° (angles on a straight line)
Angle QPS = angle TUS = 50° (alternate angles, PR parallel to TV)
Angle PQS = 180 – (110 + 50) = 20° (angles in a triangle)
x = 180 – 20 = 160° (angles on a straight line)

Answer 160 ° [3]

[Turn over

14 The waiting times for patients at a surgery are recorded in the table.

Waiting time t (minutes)	Number of patients	mid-point × f
$0 < t \leq 5$	7	2.5 × 7 = 17.5
$5 < t \leq 10$	8	7.5 × 8 = 60
$10 < t \leq 15$	5	12.5 × 5 = 62.5
$15 < t \leq 20$	5	17.5 × 5 = 87.5
$20 < t \leq 25$	4	22.5 × 4 = 90
$25 < t \leq 30$	1	27.5 × 1 = 27.5

(a) Write down the modal class.

Answer 5 < t ≤ 10 [1]

(b) Calculate an estimate of the mean waiting time.

$\Sigma fx = 17.5 + 60 + 62.5 + 87.5 + 90 + 27.5 = 345$

$\Sigma f = 7 + 8 + 5 + 5 + 4 + 1 = 30$

$\text{Mean} = \frac{345}{30} = 11.5$

Answer 11.5 minutes [4]

15 Expand and simplify

$$4(2x - 3) - 2(x - 5)$$

$= 8x - 12 - 2x + 10$
$= 6x - 2$

Answer $6x - 2$ [2]

16 Write 200 as a product of prime factors, using index notation.

$200 = 2 \times 100$
$100 = 2 \times 50$
$50 = 2 \times 25$
$25 = 5 \times 5$
$200 = 2 \times 2 \times 2 \times 5 \times 5$

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

[Turn over

17

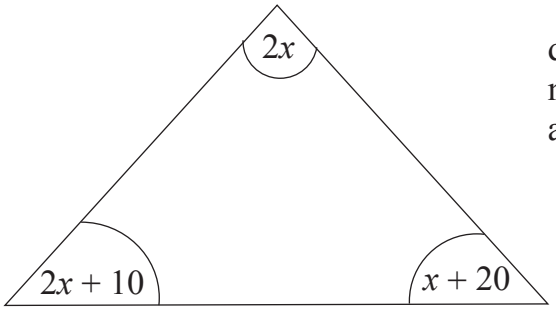


diagram
not drawn
accurately

Form and solve an equation to work out the size of the smallest angle in the triangle above.

Equation $2x + (2x + 10) + (x + 20) = 180$ [1]

$5x + 30 = 180$
$5x = 150$
$x = 30$
Angles: $2x = 60°$, $2x + 10 = 70°$, $x + 20 = 50°$
Smallest angle = $50°$

Answer smallest angle = 50 ° [3]

18 The longest side in a right-angled triangle is 12 cm.

One of the shorter sides is 4 cm.

Calculate the perimeter of the triangle.

Give your answer correct to 1 decimal place.

$4^2 + x^2 = 12^2$

$x^2 = 144 - 16$

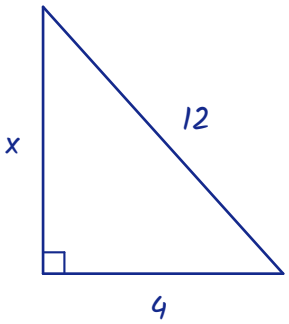
$x^2 = 128$

$x = \sqrt{128} = 11.3137...$

Perimeter $= 4 + 12 + 11.3137...$

$= 27.3137...$

$= 27.3$ cm



Answer 27.3 cm [5]

[Turn over

19 **(a)** The price of a TV is increased by 20%.

In a sale this price is decreased by 20%.

By choosing any starting price for the TV, show that the final sale price is lower than the starting price.

Start price £100

20% increase: 1.2 × £100 = £120

20% decrease: 0.8 × £120 = £96

£96 < £100, so the sale price is lower than the starting price.

[3]

(b) Calculate the overall percentage decrease.

Decrease = £100 − £96 = £4

4 ÷ 100 × 100 = 4%

Answer 4 % [2]

(c) Would the outcome be the same if the 20% decrease was applied first, followed by the 20% increase? Justify your answer.

Yes, the outcome is the same.

20% decrease: 0.8 × £100 = £80

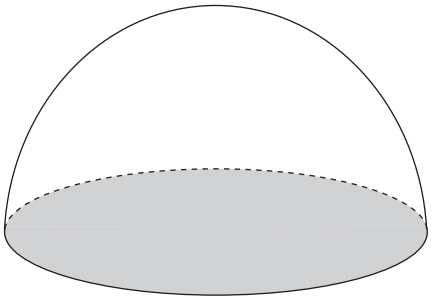
20% increase: 1.2 × £80 = £96

0.8 × 1.2 = 1.2 × 0.8 = 0.96 so the order does not matter;

both give £96, a 4% decrease.

[2]

20 The **solid** hemisphere has a diameter of 12 cm.



Mary says the total surface area is 226 cm^2 to the nearest cm^2

Martha says the total surface area is 339 cm^2 to the nearest cm^2

Explain with reasoning who is correct.

radius = 12 ÷ 2 = 6 cm

Curved surface = ½ × 4 × π × 6^2

= 226.194... cm^2

Base (circle) = π × 6^2 = 113.097... cm^2

Total = 226.194... + 113.097...

= 339.29... = 339 cm^2

Mary forgot the circular base; it is a solid hemisphere,

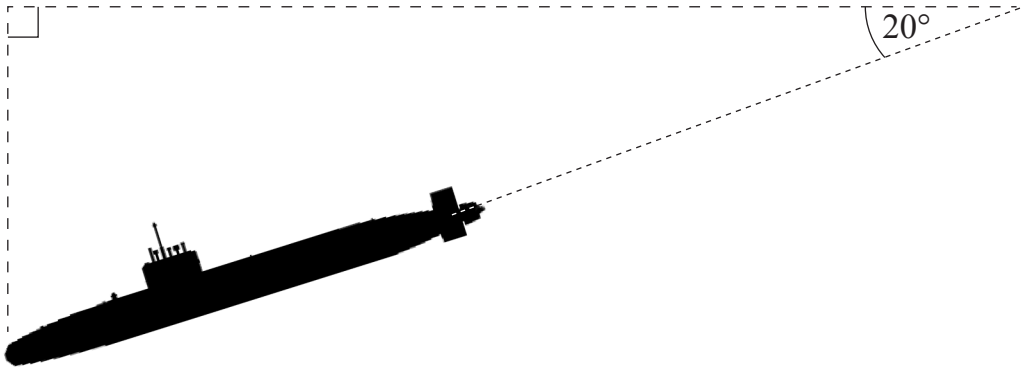
so the base must be included.

Answer Martha is correct [4]

[Turn over

21 A submarine makes a diving angle of 20° below the horizontal as shown.
It travels at a constant speed of 12 m/s.

Work out how deep the front end of the submarine is after one minute.



Distance in 1 minute = 12 × 60 = 720 m

sin 20° = depth ÷ 720

depth = 720 × sin 20°

= 246.2545...

= 246.25 m

Answer 246.25 m [4]

22 Solve the equation $x^2 - x - 12 = 0$

(x − 4)(x + 3) = 0

x − 4 = 0 or x + 3 = 0

Answer x = 4 or x = −3 [3]

23 Solve

$$\frac{a-1}{4} + \frac{a+1}{8} = \frac{3}{2}$$

Give your answer as a mixed number.

Multiply every term by 8:

$2(a - 1) + (a + 1) = 12$

$2a - 2 + a + 1 = 12$

$3a - 1 = 12$

$3a = 13$

$a = \frac{13}{3} = 4\frac{1}{3}$

Answer $a =$ $4\frac{1}{3}$ [4]

24 Write down the equation of a line parallel to the line with equation $y = 3x + 5$

Answer $y = 3x + 2$ [2]

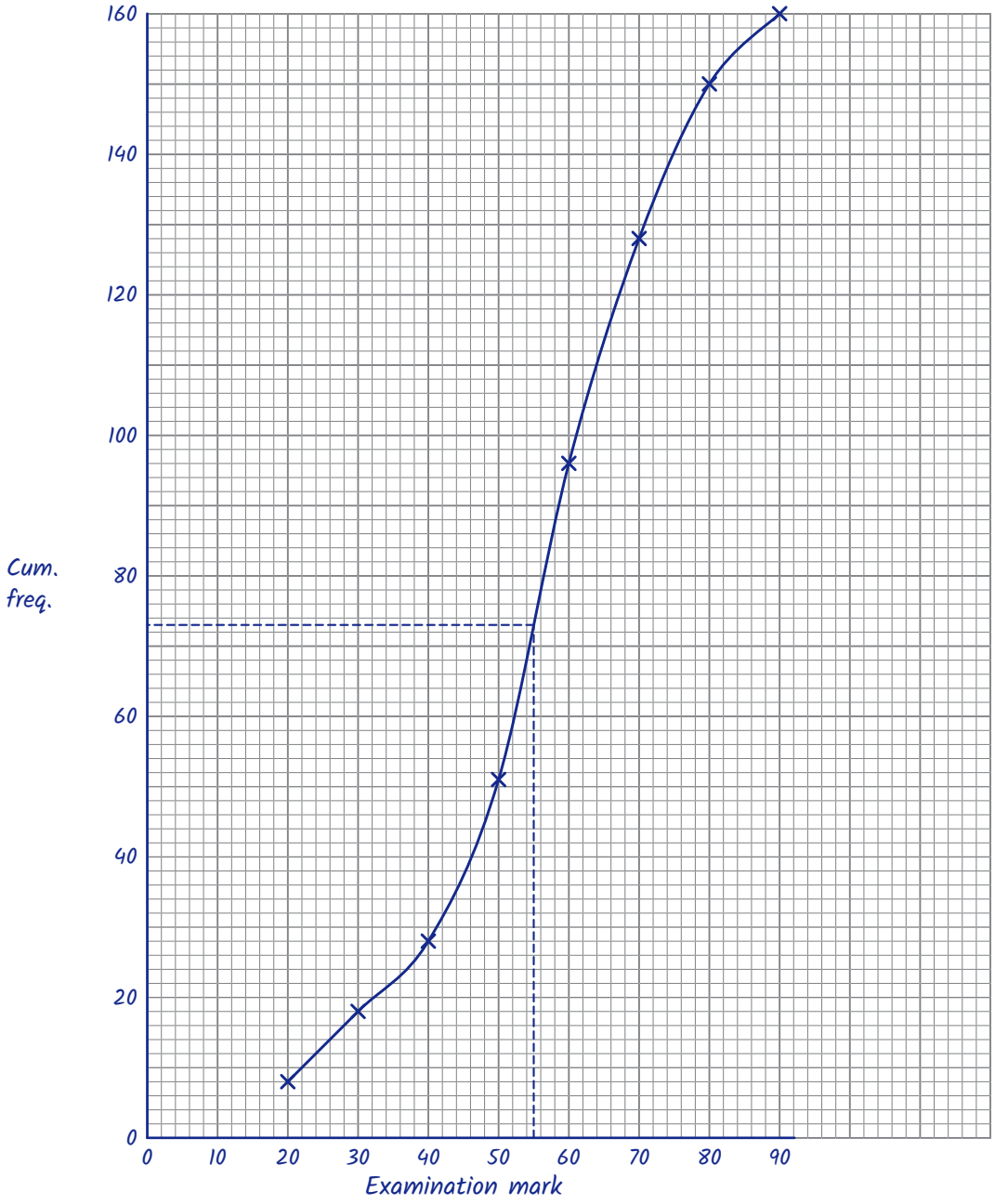
[Turn over

25 160 pupils in Year 8 sat a Science examination at the end of the year.

Their results are given in the cumulative frequency table below.

Examination Mark, x	**Cumulative Frequency**
$x \leq 20$	8
$x \leq 30$	18
$x \leq 40$	28
$x \leq 50$	51
$x \leq 60$	96
$x \leq 70$	128
$x \leq 80$	150
$x \leq 90$	160

(a) On the graph paper below draw a cumulative frequency graph for the data given.



[3]

(b) The pass mark for this examination was 55

Use your graph to estimate the number of pupils who passed the examination.

Reading at 55: 73

160 − 73 = 87

Answer 87 [2]

[Turn over

26 After a 7.5% pay rise Mr Jones' salary was £29 455

What was his salary before the pay rise?

107.5% = £29 455
1% = 29 455 ÷ 107.5 = 274
100% = 274 × 100 = £27 400

Answer £ 27 400 [3]

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