National Numeracy Tests

REASONING

9ER17

First name _____

Last name _____

School _____

Class _____

Date of birth ○○ ○○ ○○○○

Date of test ○○ ○○ 2017

Total score ☐ (maximum 20)

150311

Llywodraeth Cymru
Welsh Government

1

Each advert costs
£7.25 for every thousand people watching

One day, 180 000 people watched the television channel from 6pm to 7pm.

During this time there were 15 adverts.

Show that a total of £19 575 was paid for these adverts.

1m

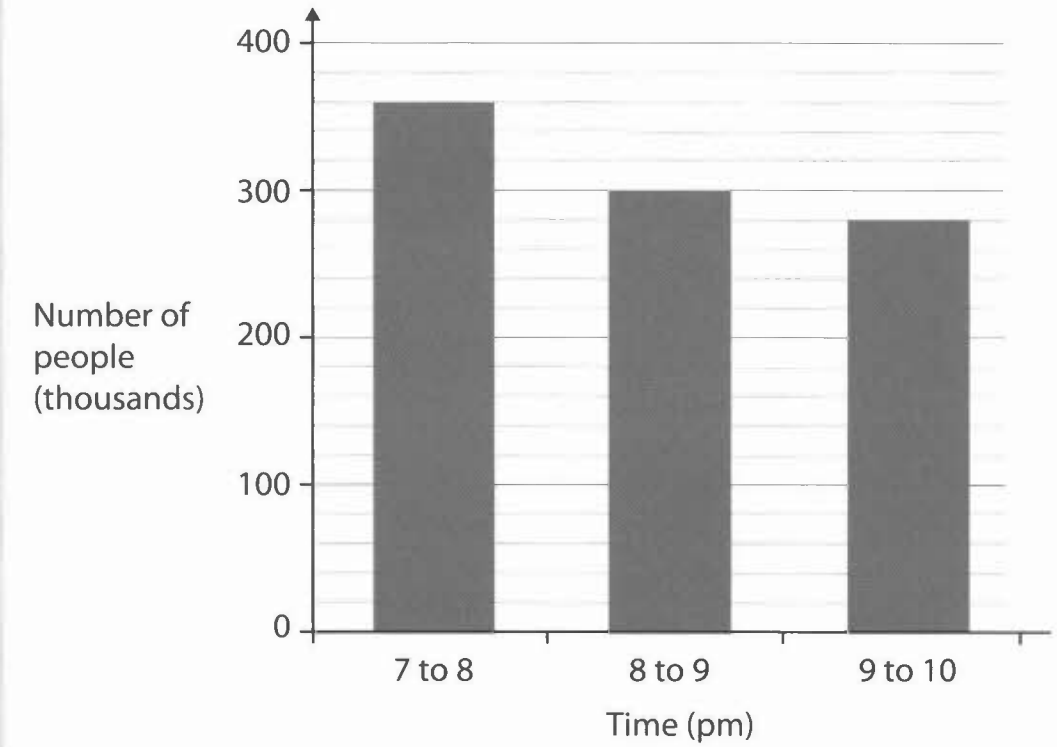
Look at the chart and table in the box on the next page.

Altogether, how much was paid for adverts from 7pm to 10pm?

£

3m

Number of people watching the television channel per hour



Number of adverts shown per hour

24	20	16
7pm to 8pm	8pm to 9pm	9pm to 10pm

The television channel is paid an average of £250 000 per 24 hours.

To the **nearest million pounds**, how much does the television channel get from adverts **in one year**?

£ million

2m

TOTAL

6m

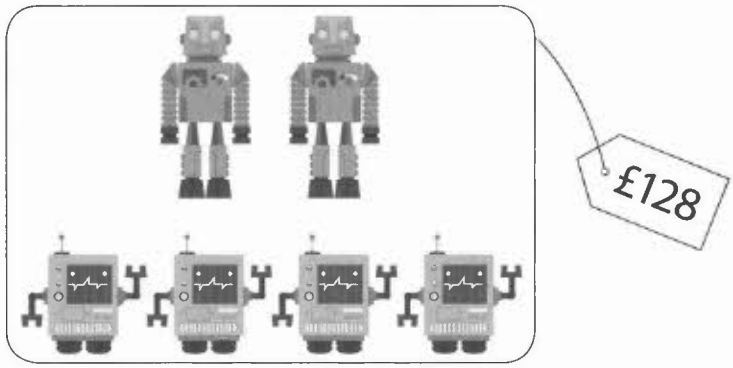
2 If you **add** these two numbers,
then **divide** the result by 5, the answer is 14

18	?

Work out the missing number.

2m

3 The total cost of 2 large robots and 4 small robots is £128



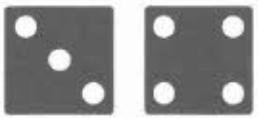
A large robot is **twice** the cost of a small robot.

What is the cost of 1 **large** robot?

£

2m

4 Tomos throws two six-sided dice and **adds** the numbers to find the score.

Example:  scores 7

Show why the **range** (= highest – lowest) of possible scores is 10

1m

What is the range of possible scores for **three** six-sided dice?

1m

Seren has some six-sided dice.

The range of possible scores is 35

How many dice does she have?

dice

2m

TOTAL

8m

5 Facts:

- About 10% of people are left-handed.
- About 56% of left-handed people are boys or men.

There are about 3 100 000 people in Wales.

How many of them are likely to be left-handed boys or men?

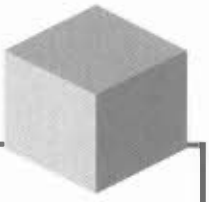
left-handed boys or men

2m

6 Pupils have centimetre cubes that connect to make shapes.

Rhian wants to make a solid cube, 5cm by 5cm by 5cm.

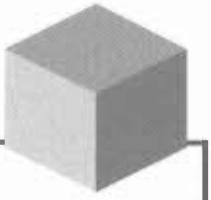
Show why she needs a total of 125 centimetre cubes.



1m

Marc wants to make a 5cm by 5cm by 5cm cube but the **inside** will be **hollow**.

What is the smallest number of centimetre cubes that he needs?



centimetre cubes

3m

TOTAL

6m

National Numeracy Tests

REASONING
9ER17MS

Marking the test

and understanding performance

150312

Llywodraeth Cymru
Welsh Government

Marking the reasoning test

This document comprises:

- the markscheme for the National Numeracy Test (Reasoning) for Year 9 together with marking guidance
- additional information to support teachers' understanding of their learners' responses, providing a platform for growth.

For learners using the modified large print or Braille test materials, some questions have been adapted or replaced. When marking a modified large print or Braille test, please use this markscheme alongside the adapted markscheme which is included in the *Notes for teachers* that accompany the modified tests.

All items within this test require numerical reasoning and therefore most are open, allowing the learner to select what they consider to be an appropriate strategy. This means that there may be a range of ways of arriving at a solution.

As a consequence, marking the reasoning tests may not be as straightforward as simply checking whether or not the final answer is correct since the methods used are also of importance.

Understanding the markscheme

To ensure the accessibility of the markscheme, the focus is primarily on key pointers that indicate the learner's understanding. For example, the markscheme may state 'Shows the value **12**' or 'Links **36** to **9**'.

These values generally credit intermediate stages, showing partial understanding.

Alongside this, commentary is provided as appropriate, to enable markers and teachers to understand their learners' responses and also to support marking.

Common errors are also flagged up, as well as explanations as to why certain responses are awarded partial credit.

Exemplars

To help schools not only with marking but also in interpreting their learners' responses, a range of exemplars is provided for each item, as appropriate.

These exemplars are actual responses from learners (taken from a trial of the reasoning tests) so include spelling mistakes and numerical inaccuracies. They have been typed to ensure anonymity.

Assessing and building on test performance

Marking the test gives teachers an overall score for each learner.

However, this score in isolation is unlikely to provide a great deal of information relating to the strengths of individual learners, or evidence of those areas of numerical understanding and reasoning skills that require improvement.

Equally, comparing learners' scores may mask significant differences in their performance. For example, two learners may both score 12. However, within that overall score Learner A may show a clear ability to communicate effectively but need support to review their work, while Learner B may show the exact opposite.

For this reason, the markscheme and the accompanying materials are designed to provide teachers with a deeper assessment of both individual and class performance.

Diagnostic tool

To assist in interpreting and building on test performance, a diagnostic tool is provided.

This can be accessed via gov.wales/learning

At its simplest level, the diagnostic tool provides markers with a check on the total score for that particular learner.

However, completing the full set of data on each learner gives the teacher an overview of class performance, identifying group or individual strengths and problem areas and hence indicating further teaching needs.

Building on the test: classroom activities

Having assessed learners' ability to apply numerical reasoning and identified areas for both individual and class development, teachers may then wish to build on the test experience and materials through accessing gov.wales/learning

This site provides sample test items and associated markschemes, but also includes additional materials with suggestions for linked classroom activities to extend the learning.

In addition, further activities supporting the learning and teaching of numerical reasoning can be found on gov.wales/learning

Markscheme

General marking rules

It is essential that you apply this markscheme, the marking guidance and the general marking rules given below to your own marking, in order for the standardised scores to be valid.

- The marking guidance shown within the markscheme should be applied to find the relevant score for each question. No half marks are awarded.
- At the end of each double-page spread of marking, record the total number of marks in the 'total' box in the bottom right-hand corner. Check that the mark recorded does not exceed the maximum number of marks available.
- Once the marking has been completed, add up the total number of marks awarded. This is the total score and should be recorded on the cover of the test booklet and input onto the relevant mark sheet on the school's management information system, together with the details and date of the test taken.
- Markers should record their initials on the cover of the test booklet to assist quality assurance.

This data should then be submitted as part of the Welsh National Tests Data Collection (WNTDC). Further details are available from the *National Reading and Numeracy Tests – Test administration handbook 2017* on the Learning Wales website and in *Welsh National Tests Data Collection and reporting arrangements 2016/17* available on the Welsh Government website.

Marking guidance

It is important that the tests are marked accurately. The questions and answers below help to develop a common understanding of how to mark fairly and consistently.

Must learners use the answer boxes?

Provided there is no ambiguity, learners can respond anywhere on the page. If there is more than one answer, the one in the answer box must be marked, even if incorrect. However, if the incorrect answer is clearly because of a transcription error (e.g. 65 has been copied as 56), mark the answer shown in the working.

Does it matter if the learner writes the answer differently from that shown in the markscheme?

Numerically equivalent answers (e.g. eight for 8, or two-quarters or 0.5 for half) should be marked as correct unless the markscheme states otherwise.

How should I mark answers involving money?

Money can be shown in pounds or pence, but a missing zero, e.g. £4.7, should be marked as incorrect unless the markscheme states otherwise.

How should I mark answers involving time?

In the real world, specific times are shown in a multiplicity of ways so accept, for example, 02:30, 2.30, half past 2, etc. Do not accept 2.3 as this is ambiguous. The same principle should be used for marking time intervals, e.g. for two and a half hours accept 2.5 but not 2.5pm.

What if the method is wrong but the answer is correct?

Unless the markscheme states otherwise, correct responses should be marked as correct even if the working is incorrect as learners may have started again without showing their revised approach.

What if the learner has shown understanding but has misread information in the question?

It is important that learners select the appropriate information and review their work. However, for most questions, method marks can still be obtained.

What should I do about crossed-out work?

Working which has been crossed out and not replaced can be marked if it is still legible.

What is the difference between a numerical error and a conceptual error?

A numerical error is one in which a slip is made, e.g. within 86×67 the learner works out $6 \times 7 = 54$ within an otherwise correct response. A conceptual error is a more serious misunderstanding for which no method marks are available, e.g. if 86×60 is recorded as 516 rather than 5160

What if learners use a method that is not shown within the markscheme?

The markscheme shows the most common methods. However, there can be a wide range of approaches to a question and any correct method, however idiosyncratic, is acceptable.

In all questions, the correct answer should be given full marks, whatever the method used, unless the markscheme states otherwise.

Most questions give partial credit for responses that show a correct method but the answer is incorrect or incomplete: a correct method is one that would lead to a correct answer if there were no numerical errors.

9ER17 Reasoning test: Markscheme

Q	Marks	Answer
1i	1m	Shows **180 × 15 × 7.25** or equivalent
1ii	3m	**£138 620**
	Or 2m	Shows at least **two** of the following: **62 640** (or 360 × 24 × 7.25) **43 500** (or 300 × 20 × 7.25) **32 480** (or 280 × 16 × 7.25) Or Shows **19 120** (or 360 × 24 + 300 × 20 + 280 × 16)
	Or 1m	Shows **one** of the following: **62 640** (or 360 × 24 × 7.25) **43 500** (or 300 × 20 × 7.25) **32 480** (or 280 × 16 × 7.25) Or Shows at least **two** of the following: **8640** (or 360 × 24) **6000** (or 300 × 20) **4480** (or 280 × 16)

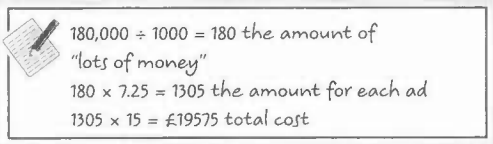
Accept 139 000 or 138 600 provided there is no evidence of an incorrect method

Amount paid for each of the three hours

Number of people (thousands) × number of adverts per hour, in total

Number of people (thousands) × number of adverts per hour, for each of the three hours

Question 1i: Exemplars

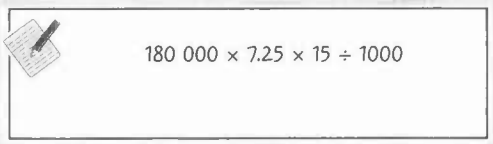


Correct; **1 mark**

- Each step is interpreted: this shows good numerical communication.

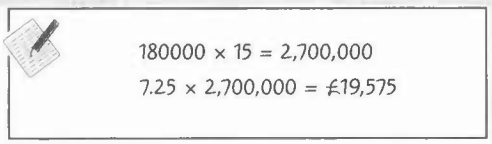
Correct; **1 mark**

- Although rare, this is correct as $180 \times 7.25 \times 15 = 19575$ is equivalent to $180 \times 7.25 = 19575 \div 15$



Correct; **1 mark**

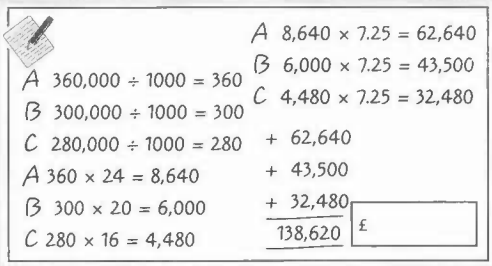
- The calculation is equivalent to $180 \times 7.25 \times 15$ so is accepted for the mark.



Incorrect; **0 marks**

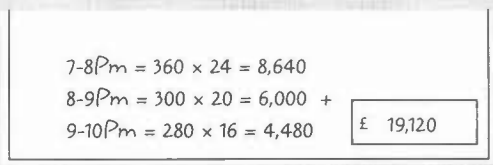
- £19575 is spurious as their calculation would lead to £19575000. Division by 1000 must be explicit.

Question 1ii: Exemplars



Correct; **3 marks**

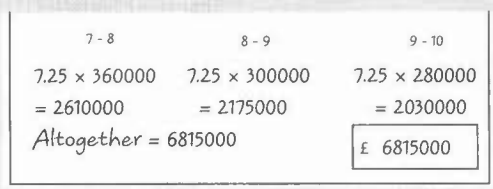
- This learner would benefit from discussion as to how to set out their work more concisely. However, the correct answer is clearly shown in the working.



Shows 19120; **2 marks**

Common error

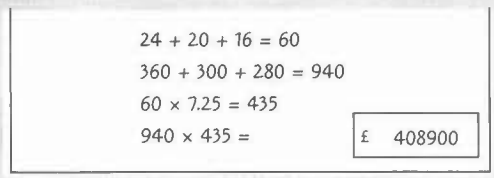
This learner has not engaged with the cost per advert. Had their total been multiplied by £7.25 the correct answer would have been reached, which is why the markscheme gives this 2 marks.



Incorrect; **0 marks**

Common error

This learner has not engaged with the number of adverts shown in each hour. As it is not possible to continue to the correct answer, it is not part of a correct method and scores 0 marks.



Incorrect; **0 marks**

Common error

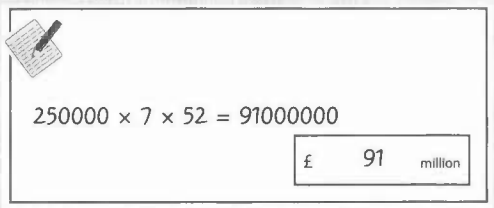
By finding the total number of adverts and the total number of people (in thousands), this learner shows a lack of understanding of how to work with grouped data.

Q	Marks	Answer
1iii	2m	**£91** million
	Or 1m	Shows **91 000 000** Or Answer **90** to **92** inclusive Or Shows **365 ÷ 4** (or $365\frac{1}{4} \div 4$ or $366 \div 4$) Or Shows **250 000 × 365** (or $250\,000 \times 365\frac{1}{4}$ or $250\,000 \times 366$)

Provided there is evidence of learners using 366 days per year (i.e. assuming a leap year) for 2 marks accept £92 million and for 1 mark accept 92 000 000

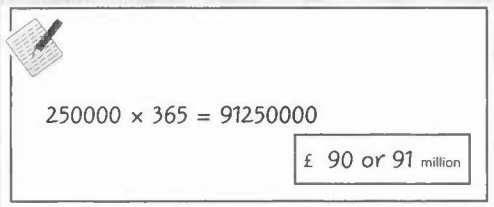
The total from 4 days is 1 million, so 365 ÷ 4 gives the total number of millions

Question 1iii: Exemplars



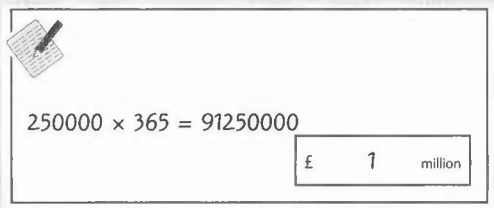
Correct; **2 marks**

- Number of days per week × number of weeks gives an answer of exactly 91 000 000 and 91 in the answer box scores 2 marks.



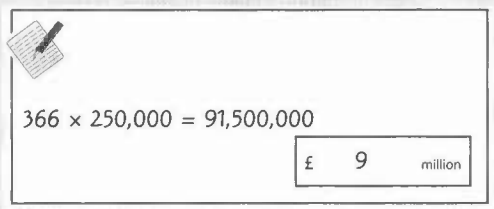
Answer 90 to 92 inclusive; **1 mark**

- In giving two answers the learner shows a lack of confidence in how to round to the nearest million. As both are within the correct range, 1 mark can be given.



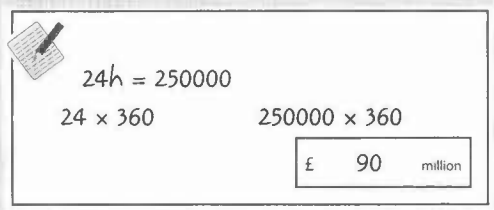
250 000 × 365; **1 mark**

- This learner needs support to understand place value and rounding. However, the correct method scores 1 mark.



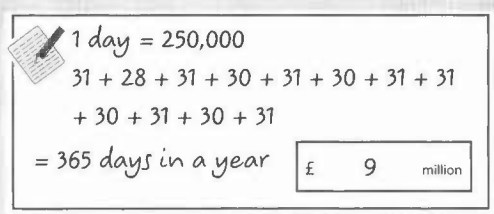
250 000 × 366; **1 mark**

Common error This learner also shows a lack of understanding of place value.



Answer 90; **1 mark**

- The number of days per year, 360, is incorrect but the answer is within the tolerance allowed for 1 mark.



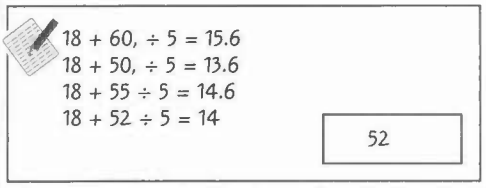
Incorrect; **0 marks**

- Although 365 is shown, it is not multiplied by 250 000 and the answer is incorrect. This learner needs support to understand the importance of showing all of their working.

Q	Marks	Answer
2	2m	**52**
	Or 1m	Shows **70** Or Shows a method (but not trial and improvement) that would lead to 52 if calculated correctly, e.g. • 5×14, then $- 18$

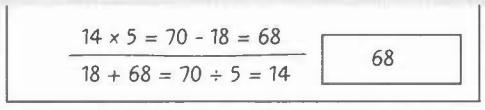
3	2m	**£32**
	Or 1m	Links the cost of a small robot to **16** Or Shows **32** or **128 ÷ 4** (accept 4L = 128 or equivalent where L represents the cost of a large robot) Or Shows **128 ÷ 8** (accept 16 with no evidence of an incorrect method, or 8S = 128 or equivalent where S represents the cost of a small robot)

Question 2: Exemplars



Correct; **2 marks**

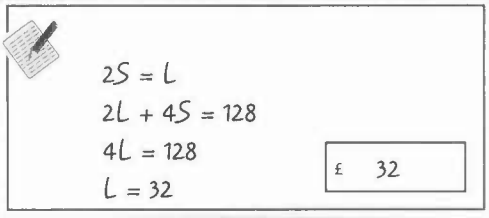
- This learner uses trial and improvement to reach the correct solution. Had their answer been anything other than 52, they would have scored 0 marks as the method is inefficient.



Shows 70; **1 mark**

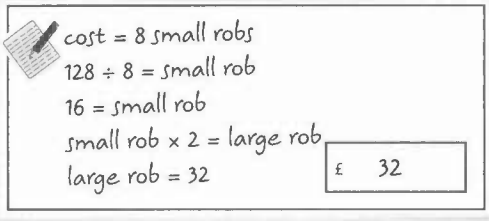
- Their check should have alerted this learner to the error in subtracting 18 from 70 but they have simply repeated numbers used previously.

Question 3: Exemplars



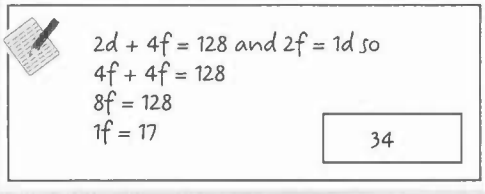
Correct; **2 marks**

- This learner substitutes 2 small robots for 1 large robot, forming a correct equation for the large robots.



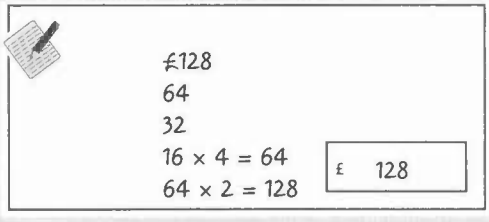
Correct; **2 marks**

- This learner also substitutes 2 small for 1 large robot, forming a correct though informal equation for the small robots.



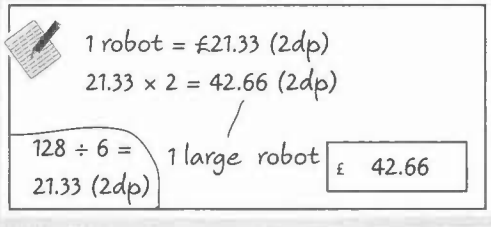
8S = 128; **1 mark**

- Although the terms are not defined, this algebraic method is correct, but there appears to be a slip in dividing 128 by 8. Substituting the values found would have identified that an error had been made.



Shows 32; **1 mark**

- The correct answer is embedded but not selected. Checking what the question asks for would be beneficial.



Incorrect; **0 marks**

Common error This is a very common error. Dividing by 6 would be applicable only if large and small robots were equal in value.

Q	Marks	Answer
4i	1m	Shows **12** and **2** to justify the range of 10, e.g. • Smallest 2, greatest 12, difference 10 • 12 – 2

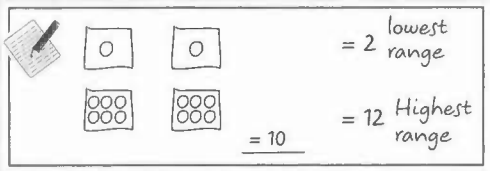
Given the context, accept 2 – 12
Also accept the difference implied, e.g. 2, 12

4ii	1m	**15**

Do not accept 18 – 3 or 3 to 18, etc.

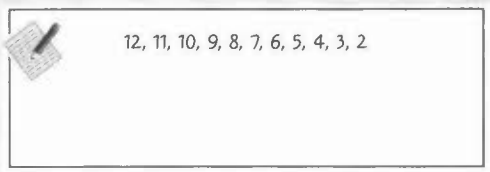
4iii	2m	**7** dice
	Or 1m	Shows or implies that the maximum is **42** and the minimum is **7** Or Shows or implies understanding of the number pattern of + 5 each time a new dice is introduced, e.g. • 35 ÷ 5 • Counting up in 5's

Question 4i: Exemplars



Correct; **1 mark**

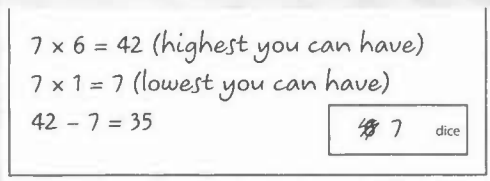
- Although 'lowest range' and 'highest range' is mathematically incorrect, the working is sufficient to justify the range of 10



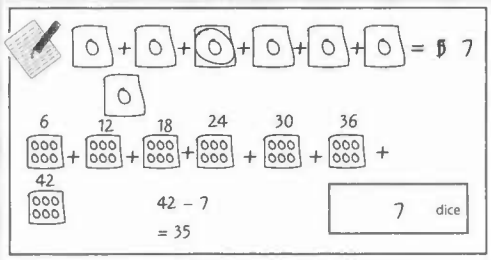
Correct; **1 mark**

- The numerical communication is poor, but maximum 12 and minimum 2 are both clearly implied.

Question 4iii: Exemplars

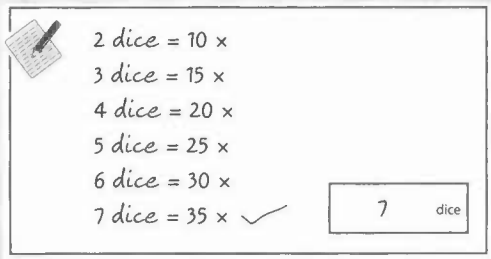


Correct; **2 marks**



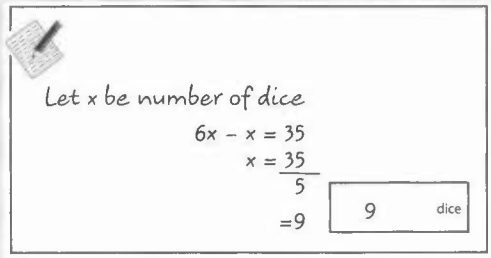
Correct; **2 marks**

- This learner uses the time-consuming approach of drawing dice.



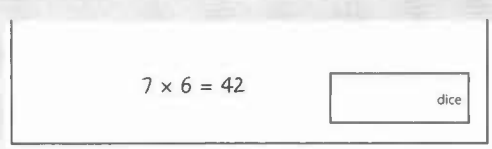
Correct; **2 marks**

- The pattern of adding 5's leads to a correct solution.



Understanding of number pattern; **1 mark**

- 35 ÷ 5 is a correct method but their answer is incorrect.



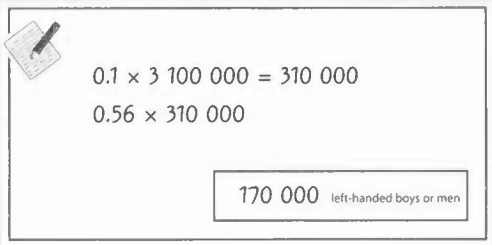
Incomplete; **0 marks**

- 42 is the maximum score (from 7 dice each showing 6) but as there is no indication of the minimum score no marks can be given.

Q	Marks	Answer
5	2m	**173 600**
	Or 1m	Shows the digits **1736** or **174** or **173** or **170** followed by any number of zeros, e.g. • 173.6 • 17 400 • 170 000 000 Or Shows a method that would lead to 173 600, including a correct method for finding 56%, with not more than one numerical error, e.g. • 3 100 000 × 0.1 × 0.56 • 3 100 000 ÷ 10 then × 56 ÷ 100 • 10% = 310 000 50% (÷ 2) = 155 000 5% (÷ 10) = 15 500 1% (÷ 5) = 1 100 (error) 171 600

Provided there is no evidence of incorrect methods, also accept 170 000 and 174 000

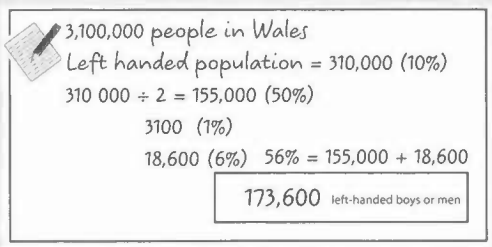
Question 5: Exemplars



Correct; **2 marks**

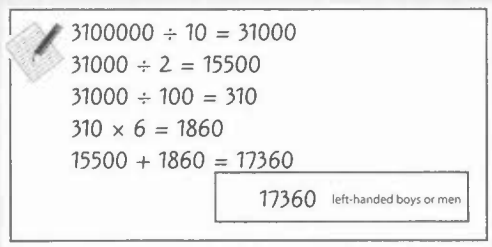
Efficient method

This learner works efficiently, using decimal equivalences of percentages. As the method is correct the rounded answer of 170 000 is accepted for 2 marks.



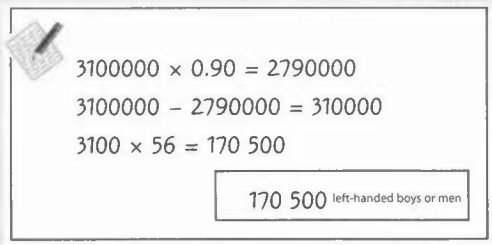
Correct; **2 marks**

- Although this is a less efficient method than multiplying by 0.56, it is correct.



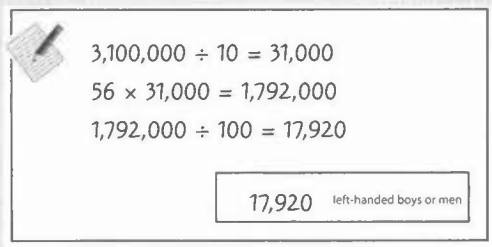
Digits 1736; **1 mark**

- The method is as shown above, but there is an error in finding 10%.



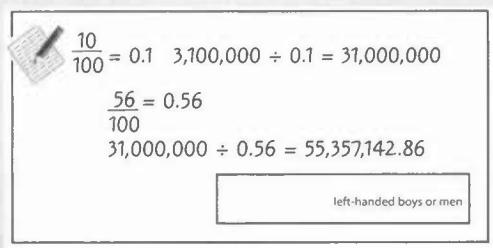
Correct method, one error; **1 mark**

- The method to find 10% is inefficient but correct, and the method to find 56% is also correct (÷ 100 is implied by 3100, then × 56). Had 3100 × 56 been calculated correctly the correct answer would have been found.



Correct method, two errors; **0 marks**

- 10% of 3 100 000 is incorrect, and although the method for finding 56% is correct, the result of 56 × 31 000 is incorrect. As there are two errors, no marks can be given.



Incorrect; **0 marks**

- By dividing rather than multiplying, this learner has worked out that the number of left-handed boys or men in Wales is almost 18 times as much as the overall population! Part of becoming numerate is to consider whether the answer makes sense within the given context.

Q	Marks	Answer
6i	1m	Shows that the dimensions must be multiplied together, e.g. • 5 × 5 × 5 • Length × width = area, then area × height

Do not accept 25 × 5 without justification of 25

Question 6i: Exemplars

$5 \times 5 \times 5 = 125$	Correct; **1 mark**
Volume = ____ × ____ × ____ $5 \times 5 \times 5 = 125cm$ $(5 \times 5 = 25cm, 25 \times 5 = 125cm)$	Correct; **1 mark** • The incorrect units can be ignored.
Because you need 25 cubes for one layer other wise you wouldn't have a solid cube, you would have a hollow cube. $25 + 25 + 25 + 25 + 25 = 125$	Correct; **1 mark** • 25 is linked to one layer, which is sufficient justification for 25, and repeated addition is acceptable when finding 5×25
This is because it's the square root of 5 this will make a perfect square $5 \times 5 = 25 \times 5 = 125$	Correct; **1 mark** • The statement suggests that this learner may be confusing 'square' and 'square root'. However, the calculation shows understanding of $5 \times 5 \times 5$ even though the use of = is incorrect.
$25 \times 5 = 125$ 2 cubes = 25cm $= 5 \times 5$ $25 \times 5 = 125$ 3 cubes = $125cm^3$	Correct; **1 mark** • This learner uses 'cubes' when they mean 'dimensions' but $25 \times 5 = 125$ is shown, with 25 justified by 5×5
$125 = 5 \times 25$	Incomplete; **0 marks** Common error 25 is not justified. No marks can be given.
She needs 125 centimetre cubes altogether because it is volume	Incomplete; **0 marks** Common error 'Because it is volume' is insufficient to show that the dimensions must be multiplied together.
She needs 125cm cubes because she needs to cover all the sides to make it a square.	Incorrect; **0 marks** Common error This learner confuses area and volume. This is another common error.

Q	Marks	Answer
6ii	3m	**98** centimetre cubes
	Or 2m	Answer **61** (or shows $5^3 - 4^3$ or equivalent) Or Shows a method that would lead to 98 if calculated correctly. Methods include the following (brackets inserted for ease of reading): • $5^3 - 3^3$ • $25 + (2 \times 20) + 15 + 18$ • $(2 \times 16) + 12 + (6 \times 9)$ • $(2 \times 25) + (2 \times 15) + (2 \times 9)$ • $8 + (12 \times 3) + (6 \times 9)$ • $25 + 20 + (2 \times 16) + 12 + 9$ • $(2 \times 25) + (4 \times 12)$ • $150 - (2 \times 16) - 20$
	Or 1m	Shows **125** and the intent to subtract the number of cubes in any smaller cube Or Shows **25** and some understanding that because of 'overlaps' not all faces have 25 cubes Or Shows **150** and some understanding that because of 'overlaps' some cubes must be subtracted Or Answer **44**

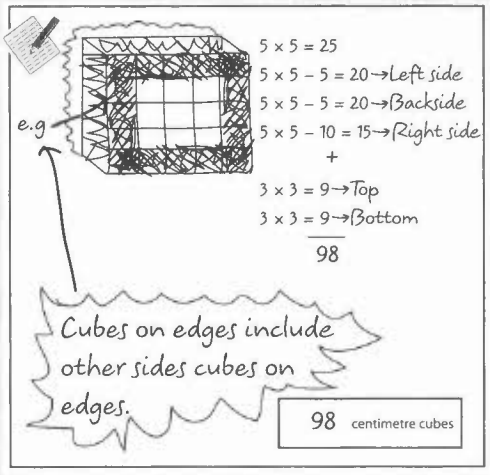
Common error

The hollow inside taken to be 4^3 not 3^3

All these methods are explained on page 22 of the markscheme. However, most are unlikely to be seen

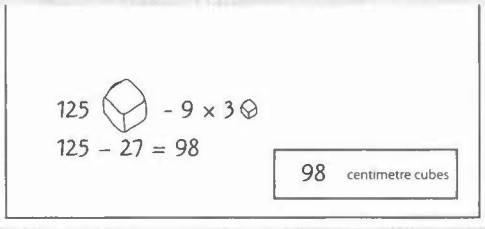
Number of cubes needed to make a skeleton cube

Question 6ii: Exemplars



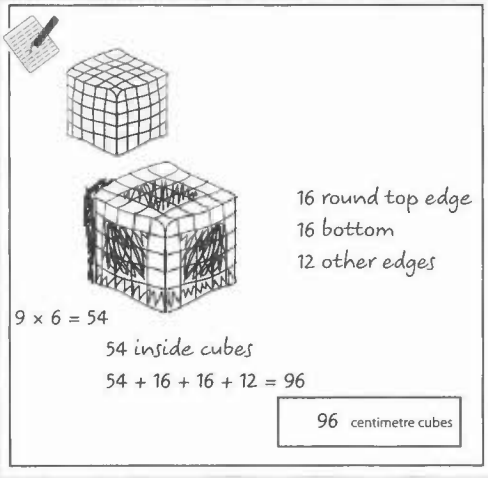
Correct; **3 marks**

- This learner's numerical communication is very clear.



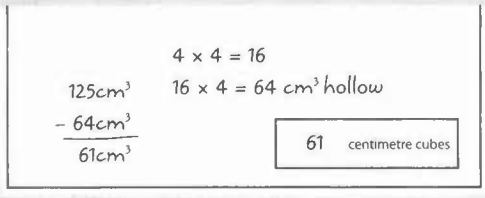
Correct; **3 marks**

Efficient method The method ($5^3 - 3^3$) is both correct and efficient.



Correct method; **2 marks**

- This learner finds the number of cubes required for a skeleton cube (16 + 16 + 12) then works out that each of the six faces needs another 3 × 3 cubes. The method is correct but there is an error in the final addition.



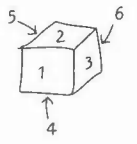
Answer 61; **2 marks**

Common error This is a common error in which a 4 × 4 × 4 cube is subtracted from the 5 × 5 × 5 cube, ignoring that one layer of cubes must remain on each face.

Continued overleaf

Question 6ii: Exemplars (continued)

face side 1 = 25 cubes.
face 2 =(25 - 5) = 20 cubes.
face 3 = (25 - 10) = 15 cubes.



face 4 = (25 - 10) = 15 cubes.
face 5 = (25 - 15) = 10 cubes.
face 6 = (25 - 20) = 5 cubes.

90

90 centimetre cubes

25 and recognises overlaps; **1 mark**

- The method is incorrect as it does not lead to 98 cubes. However, it is clear that this learner understands that not all faces have the same number of cubes.

25
15
11
11
12
9

83 centimetre cubes

25 and recognises overlaps; **1 mark**

- The communication is poor but the six values can reasonably be linked to faces showing that not all are 25

1 face = 25 ← 5 x 5
6 faces = 150 ← 6 x 25
150 - (16 x 4) = 86

86 centimetre cubes

150 and recognises overlaps; **1 mark**

- Although this is not a complete method it implies understanding that some cubes have been double-counted.

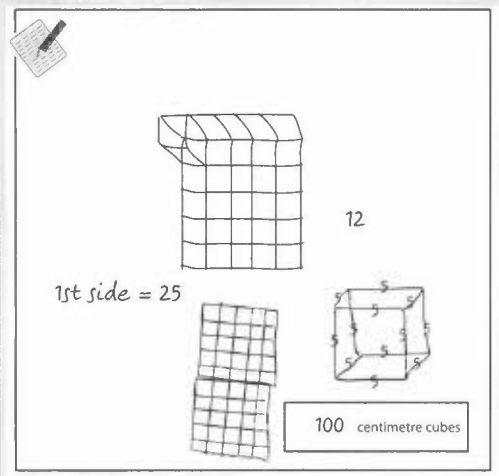
125
- 39
94

94 centimetre cubes

Incorrect; **0 marks**

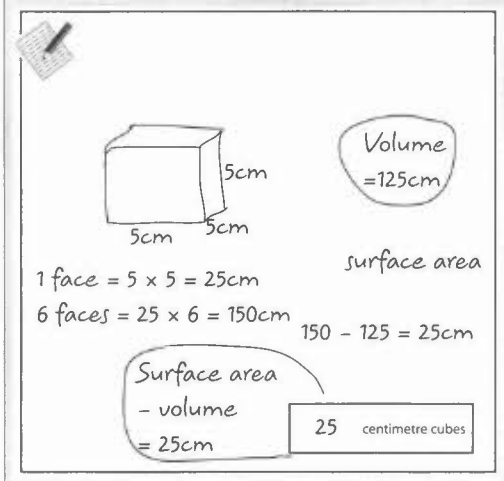
- There is no evidence to support 3^3 miscalculated as 39

Question 6ii: Exemplars (continued)



Incorrect; **0 marks**

- This learner's communication is poor. Although 25 is seen there is no recognition that because of overlaps some faces have other than 25 cubes. No marks can be given.



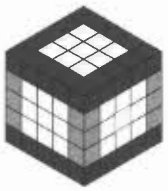
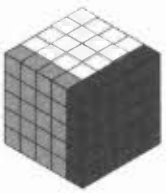
Incorrect; **0 marks**

- The surface area, 150cm^2, is found correctly, though with incorrect units. However, subtracting the volume from the surface area makes no mathematical sense and does not show recognition that because of overlaps some cubes must be subtracted. No marks can be given.

Note: Several correct methods are explained on the next page. A worthwhile classroom-based activity after the assessment is to ask learners to find different ways of showing that there are 98 cubes in total.

Alternatively, give a set of diagrams and a set of calculations, jumbled up, and ask learners to match them. Or give the calculations shown without the accompanying explanatory text and diagrams and ask learners to work together to decide what each component refers to.

Correct methods for question 6ii include . . .

5^3 $-\ 3^3$	solid cube internal 3 by 3 by 3 cube	25 $+\ 2 \times (5 \times 4)$ $+\ 3 \times 5$ $+\ 2 \times (3 \times 3)$	one vertical face, dark grey two adjacent vertical faces, light grey fourth vertical face, black horizontal faces, white 
2×16 $+\ 4 \times 3$ $+\ 6 \times (3 \times 3)$	'top' and 'bottom' edges, dark grey remaining edges, light grey remaining faces, white 	2×25 $+\ 2 \times (3 \times 5)$ $+\ 2 \times (3 \times 3)$	two opposite faces, dark grey two opposite faces, light grey two opposite faces, white 
8 $+\ 12 \times 3$ $+\ 6 \times (3 \times 3)$	vertices, black remaining edges, dark grey remaining faces, white 	25 $+\ 5 \times 4$ $+\ 2 \times (4 \times 4)$ $+\ 3 \times 4$ $+\ 3 \times 3$	one face, dark grey adjacent face, light grey two faces, one shown, white fifth face, not shown sixth face, not shown 
2×25 $+\ 4 \times (3 \times 4)$	two opposite faces, dark grey remaining four faces, partly shown in white and light grey 	150 $-\ 2 \times 16$ $-\ 4 \times 5$	surface area double counting on 'top' and 'bottom' edges, dark grey double counting on four 'struts', partly shown in light grey