Edexcel GCSE

Mathematics

Foundation/Higher Tier

Number: Index Notation

Information for students

The marks for individual questions and the parts of questions are shown in round brackets: e.g. **(2)**.
There are 19 questions in this selection.

Advice for students

Show all stages in any calculations.
Work steadily through the paper. Do not spend too long on one question.
If you cannot answer a question, leave it and attempt the next one.
Return at the end to those you have left out.

Information for teachers

The questions in this document are taken from the 2009 GCSE Exam Wizard and include questions from examinations set between January 2003 and June 2009 from specifications 1387, 1388, 2540, 2544, 1380 and 2381.

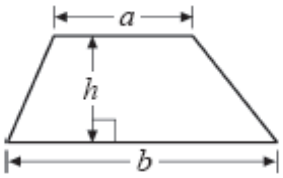
Questions are those tagged as assessing "Index Notation" though they might assess other areas of the specification as well. Questions are those tagged as "Foundation/Higher" so could have (though not necessarily) appeared on either a Foundation, Intermediate or Higher tier paper.

GCSE Mathematics

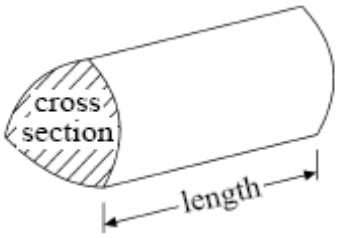
Formulae: Foundation Tier

You must not write on this formulae page.
Anything you write on this formulae page will gain NO credit.

Area of trapezium = $(a + b)h$



Volume of prism = area of cross section × length



1. Simplify

(i) $p^2 \times p^7$

……

(ii) $x^8 \div x^3$

……

(Total 2 marks)

2. (a) Simplify

(i) $p^2 \times p^7$

……

(ii) $x^8 \div x^3$

……

(iii) $\dfrac{y^4 \times y^3}{y^5}$

……

(3)

(b) Expand $t(3t^2 + 4)$

……

(2)
(Total 5 marks)

3. (a) Simplify

(i) $\frac{x^6}{x^2}$

.....

(ii) $(y^4)^3$

.....

(2)

(b) Expand and simplify $(t + 4)(t – 2)$

.....

(2)

(c) Write down the integer values of x that satisfy the inequality

$$–2 \leq x < 4$$

.....

(2)
(Total 6 marks)

4. Write as a power of 5

(i) $5^4 \times 5^2$

……..

(ii) $5^9 \div 5^6$

……..

(Total 2 marks)

5. The table shows some rows of a number pattern.

Row 1	$2^2 - 0^2 = 4 = 4 \times 1$
Row 2	$3^2 - 1^2 = 8 = 4 \times 2$
Row 3	$4^2 - 2^2 = 12 = 4 \times 3$
Row 4	

(a) Complete Row 4 of the number pattern.

(1)

(b) Use the number pattern to find the answer to $121^2 - 119^2$

……

(2)
(Total 3 marks)

6. (a) Simplify

(i) $x^4 \times x^5$

……

(ii) $\frac{p^8}{p^3}$

……

(iii) $3s^2t^3 \times 4s^4t^2$

……

(iv) $(q^3)^4$

……

(5)

(b) Expand $3(2g - 1)$

……

(1)

(c) Expand and simplify $(x + 2)(x + 3)$

……

(2)

(Total 8 marks)

7. (a) Simplify $p^7 \times p^2$

.....

(1)

(b) Simplify $\frac{q^8}{q^3}$

.....

(1)

(c) Simplify $(t^3)^4$

.....

(1)

(d) Expand and simplify $2(3m + 4) + 3(m – 5)$

.....

(2)
(Total 5 marks)

8. (a) Write as a power of 7

(i) $7^8 \div 7^3$

.....

(ii) $\dfrac{7^2 \times 7^3}{7}$

.....

(3)

(b) Write down the reciprocal of 2

.....

(1)
(Total 4 marks)

9. (a) Work out the value of

(i) 4^2

.....

(ii) $\sqrt{64}$

.....

(iii) 3×2^3

.....

(3)

(b) Work out

(i) $-2 + 5$

.....

(ii) $-2 - 3$

.....

(2)

(Total 5 marks)

10. (a) Simplify $p^3 \times p^2$

.....

(1)

(b) Simplify

$$\frac{q^3 \times q^4 \times q}{q^2}$$

.....

(1)
(Total 2 marks)

11. Work out the value of $3^3 \times 10^2$

……..

(Total 2 marks)

12. Work out the value of

$$\frac{5.4 - 6.3^2}{0.3}$$

……

(Total 2 marks)

13. $7^5 \times 7^6 = 7^3 \times 7^k$

Find the value of k.

$k =$ ……

(Total 2 marks)

14. Find the value of $\dfrac{5^5 \times 5^7}{5^{10}}$

……..

(Total 2 marks)

15. (a) Use your calculator to find the value of 13^4

.....

(1)

(b) Use your calculator to work out the value of $\frac{30.9}{27.1+4.79}$

.....

(2)
(Total 3 marks)

16. Simplify

(a)

$3^4 \times 3^6$ .....

(1)

(b)

$\frac{3^5}{3^{10}}$ .....

(1)
(Total 2 marks)

17. Simplify

(i) $a^6 \times a^3$

.....

(ii) $\dfrac{c^8}{c^2}$

.....

(iii) $(e^4)^5$

.....

(Total 3 marks)

18. Express 300 as a product of its prime factors.

3×100	$2^2 \times 3 \times 25$	$4 \times 3 \times 25$	$2^2 \times 3 \times 5^2$	$4 \times 3 \times 5^2$
☐	☐	☐	☐	☐
A	**B**	**C**	**D**	**E**

(Total 1 mark)

19. (a) Write down the exact value of 3^{-2}

.....

(1)

(b) Simplify fully $\frac{7^2 \times 7^4}{7^3}$

.....

(2)

(c) Expand $(2+\sqrt{3})(1+\sqrt{3})$

Give your answer in the form $a+b\sqrt{3}$, where a and b are integers.

.....

(2)
(Total 5 marks)

01. (i) p^9 2

B1 cao

(ii) x^5

B1 cao

[2]

02. (a) (i) p^9 3

B1 cao

(ii) x^5

B1 cao

(iii) y^2

B1 cao

(b) $3t^3 + 4t$ 2

B2 for $3t^3 + 4t$
(B1 for either $3t^3$ or $4t$ seen or $3t^3 + 4t$ then an error)

[5]

03. (a) (i) x^4 1

B1 cao

(ii) y^{12} 1

B1 cao

(b) $t^2 + 2t - 8$ 2

B2 for fully correct
(B1 for 3 out of 4 terms from $t^2 + 4t - 2t - 8$)

(c) $-2, -1, 0, 1, 2, 3$ 2

B2 for fully correct
(B1 for –2, –1, 0, 1 , 2, 3 with either –2 omitted or 4 included, or both, or any five integers correct only and no incorrect integers)

[6]

04. (a) (i) 5^6 1

B1 accept 15625, 5^{4+2}

(ii) 5^3 1

B1 accept 125, 5^{9-6}

[2]

05. (a) $5^2 - 3^2 = 16$
$= 4 \times 4$ 1

B1 cao

(b) 120×4

121	1071
2420	1190
12100	11900
14641	14161

other methods are also permissible.

480 2

M1 for 4×120 or 2×240
A1 cao 480
Or
M1 14641 – 14161 condone one arithmetic error
A1 cao 480

[3]

06. (a) (i) x^9 1

B1 cao

(ii) p^5 1

B1 cao

(iii) $12\ s^6\ t^5$ 2

B2 cao
(B1 for two of 12, s^6, t^5 in a product)

(iv) q^{12} 1

B1 cao

(b) $6g - 3$ 1

B1 cao

(c) $x^2 + 3x + 2x + 6$ 2
$x^2 + 5x + 6$

B2 for $x^2 + 5x + 6$
(B1 for 3 out of 4 parts correct in working)

[8]

07. (a) p^9 1

B1 cao

(b) q^5 1

B1 cao

(c) t^{12} 1

B1 cao

(d) $6m + 8 + 3m - 15$
$= 9m - 7$ 2

M1 for correct expansion of at least one term
A1 for 9m – 7

[5]

08. (a) (i) 7^5

B1 cao

(ii) 7^4 3

B2 cao
(B1 for sight of 5 or 7^{2+3} or 7×7^3 or $7^1 \times 7^3$ or $7^2 \times 7^2$ or 7^{2+3-1})

(b) $\frac{1}{2}$ 1

B1 for $\frac{1}{2}$ or 0.5 or 2^{-1}

[4]

09. (a) (i) 16 1

B1 cao

(ii) 8 1

B1 cao

(iii) 24 1

B1 cao

(b) (i) 3 1

B1 cao

(ii) –5 1

B1 cao

[5]

10. (a) p^5 1

B1 cao

(b) q^6 1

B1 cao

[2]

11. 2700 2

27×100

M1 for $3 \times 3 \times 3 \times 10 \times 10$ or 27 seen
A1

[2]

12. –114.3 2

B2 for –114.3
[B1 for –34.29 seen or –114]

[2]

13. 8 2

$5 + 6 = 3 + k$

M1 for $5 + 6 = 3 + k$
A1 cao

[2]

14. 25 2

5^{5+7-10}

M1 for 5^{5+7-10}
A1 cao

[2]

15. (a) 28561 1

B1

(b) 4.12 2

$\frac{30.9}{7.5}$

B2
(B1 for 7.5 seen)

[3]

16. (a) 3^{10} 1

B1 for 3^{10} oe

(b) 3^{-5} 1

B1 for 3^{-5} oe

[2]

17. (i) a^9 3

B1

(ii) c^6

B1

(iii) e^{20}

B1

[3]

18. D

[1]

19. (a) $\frac{1}{9}$ 1

B1 for $\frac{1}{9}$ (accept 0.1 recurring)

(b) $\frac{7^6}{7^3}$ 2

7^3

M1 for $\frac{7^{2+4}}{7^3}\left(\frac{7^6}{7^3}\right)$ *or* $\frac{7^4}{7^{4-3}}\left(\frac{7^4}{7}\right)$ *or* $\frac{7^2}{7^{3-4}}\left(\frac{7^2}{7^{-1}}\right)$

A1 for 7^3 *(accept 343)*

(c) $2\times1+2\times\sqrt{3}+1\times\sqrt{3}+\sqrt{3}\times\sqrt{3}$ 2

$5+3\sqrt{3}$

M1 for $2\times1+2\times\sqrt{3}+1\times\sqrt{3}+\sqrt{3}\times\sqrt{3}$

A1 for $5+3\sqrt{3}$ *cao*

[SC: B1 for $a+3\sqrt{3}$ *or* $5+b\sqrt{3}$ *if M0 scored]*

[5]

01. Part (i) was answered correctly by many candidates. Common incorrect responses were 'p^{14}' and '$2p^9$'. Part (ii) was answered less well with about half of the candidates giving the correct answer. Some added the indices, others attempted to divide them.

02. This was another good source of marks for those candidates who had a good understanding of the rules of indices. Although all the usual misconceptions were seen, for example p^{14} and $x^{\frac{8}{3}}$, most candidates gained marks in this question.
Although the brackets in part (b) were usually expanded correctly it was disappointing to see some candidates 'simplifying' the correct answer to a single term.

03. In part (a) more than half of the candidates gained at least one of the two marks. Common incorrect answers were x^3 and y^7. A quarter of candidates managed to obtain three or four correct terms in part (b) but mistakes were often made in multiplying out the brackets. Part (c) was answered quite well. Some candidates omitted –2 from the solution and others included 4.

04. **Specification A**

Higher Tier

Most candidates did well, with slightly more correct responses for (i) than (ii). A large proportion of candidates were able to apply the rules for indices and simply write down the answers.

Intermediate Tier

This question proved a good discriminator. The common errors were to write the answers as 5^8 in (i), and $5^{1.5}$ or $5^{3/2}$ in (ii). There were many correct answers.

Specification B

In part (i) 5^8 and 25^6 were common errors whilst in part (ii) $5^{1.5}$, 1^3 were often seen.

05. The few who did not give the correct answer in part (a) usually confused their numbers in the expression. In part (b) many did not use the number pattern already identified. Some who did spot the connection failed to use 120, choosing 119 instead. Many tried two sets of long multiplication, but arithmetic errors were common.

06. In part (a) more than 70% of candidates answered (i) correctly. Common incorrect answers were a^{12} and $2a^7$. Candidates were less successful in (ii) with $p^{2.6}$ seen often. The answer given in (iii) was usually a product but common errors were to add 3 and 4 or to multiply the indices so that $7s^6t^5$ and $12s^8t^6$ were common incorrect answers. Almost 50% of candidates expanded the bracket correctly in part (b). $5g - 3$ and $6g - 1$ were common incorrect answers and $6g$ was sometimes written as $3 \times 2g$. Candidates found part (c) difficult with less than 30% gaining full marks. Many could not start and simply added to give $2x + 5$. For those that did start, common errors were $x \times x = 2x$ and $2 \times 3 = 5$.

07. All parts of this question tested algebraic processes. Most candidates were successful in showing that they could do this. The most common error was to write the answer to $(t^4)^3$ as t^7. In part (d), some candidates went on to multiply the 2 expansions rather than add them.

08. **Higher Tier**

A large number of candidates were able to score at least 1 mark in part (a), usually in (i). In part (a)(i) most candidates knew that they needed to subtract the powers, and virtually all of these were able to do this successfully. Many candidates were able to get part (a)(ii) correct, but a final incorrect answer of 7^5 was very common. This was usually achieved by either an error in simplifying the numerator, e.g. $\frac{7^2 \times 7^3}{7} = \frac{7^6}{7} = 7^5$, or by an error in dealing with the denominator, e.g. $\frac{7^2 \times 7^3}{7} = \frac{7^6}{7^0} = 7^5$.

In part (b), less than half the candidates were able to write down the reciprocal of 2. The most popular incorrect answers were $\frac{2}{1}$, 2^2, $\sqrt{2}$,.-2

Intermediate Tier

Few candidates gained full marks in part (a). Part (i) was frequently answered correctly but success in part (ii) was much more elusive. Common errors were $7^2 \times 7^3 = 7^6$, $7^5 \div 7 = 7^5$ and $7^5 \div 7 = 1^5$. Correct answers were extremely rare in part (b) as very few candidates knew the meaning of 'reciprocal'. A common incorrect answer was 4.

09. Candidates found this question quite difficult. Common wrong answers for part (a) were 8 for part (i), 32 for (ii) and 6 cubed for (iii). There was more success with part (b) with about half the candidates gaining both the correct answers.

10. Part (a) was usually answered correctly by many candidates. Answers of p^6 and $6p$ were predictable errors made. A correct answer of q^6 was seen quite often in part (b) however many candidates got as far as $\frac{q^8}{q^2}$ and then could either go no further or gave an answer of q^4, dividing the indices. Occasionally a solution of $\frac{q^{12}}{q^2} = q^6$ was seen and care was taken to ensure that this scored no marks.

11. It was good to see many candidates show $3 \times 3 \times 3 \times 10 \times 10$ in their working showing an understanding of the powers in both 3^3 and 10^2. What was less successful was the calculation of $3 \times 3 \times 3$ which often produced 9 rather than 27. Perhaps more surprisingly, 10^2 was often calculated as 20. For those attaining both the 27 and 100, combining them together sometimes gave $100 + 27 = 127$ or $100 \times 27 = 270$ rather than the anticipated 2700.

12. Many candidates gained full marks. Those who worked out the numerator and denominator separately usually gained 1 if not both marks. Sadly many candidates omitted the negative sign giving an answer of 114.3 and often showing 34.29 in their working. A common wrong answer was –126.9 found by dividing only the 6.3^2 by 0.3

13. This question was well attempted with the majority of the students obtaining the correct answer although not always by the correct method. If an incorrect method was used then candidates scored no marks. Incorrect methods seen included $7^5 \times 7^6 = 49^{11}$ and $7^5 \times 7^6 = 14^{11}$. Some example of poor arithmetic were seen with 11 – 3 = 7 or 9.

14. A common error was to equate the numerator to 25^{12} rather than 5^{12} and then cancel by 5 to reach the correct answer. Candidates who used this incorrect method to obtain the correct answer scored no marks. More able candidates were able to use the correct method but then frequently left the answer as 5^2 instead of the required 25. There were signs of some poor arithmetic in answers to this question with 5 + 7 sometimes evaluated as 11 or 13.

15. (a) Using a calculator to find '13 to the power 4' didn't seem to be too difficult for those who understood what it represented. Writing it as '13 × 13 × 13 × 13' gave a clear indication of what was required. There was, however, some misunderstanding of what it represented and this was shown by an attempt to evaluate '13 × 4' with the resulting answer as '52'. Only 31% achieved the correct solution.
(b) The second part of the calculator question needed an understanding that the numerator had to be divided by the sum of the denominator. Where partial working was written down it helped to secure a correct final answer. The denominator sum of '7.5' earned the first mark in 40% of the responses but only 23% of these went on to score the final mark. The main error for the second mark involved an addition, rather than a division, such that '30.9 + 7.5' produced '38.4'.

16. The majority of candidates were able to answer part (a) correctly. Part (b) proved more difficult for candidates.

17. Candidates were generally able to apply the correct laws of indices. Candidates had an 88% success rate in part (a), a 79% success rate in part (b) and a 65% success rate in part (c). Some basic arithmetic errors were seen such as writing 6 + 3 as 8 in (a). In part (b) c^4 was a common incorrect answer as was e^9 in part (c).

18. No Report available for this question.

19. In part (a), only a minority of candidates showed any understanding of negative indices; ±9 and –6 being the most common answers. Many candidates, in part (b), gained at least one mark for writing 3677however a great many went on to simplify this incorrectly to 7^2. Some weaker candidates wrote $\frac{49^6}{7^3}$, whilst others tried to evaluate each of the powers of 7 and then wasted valuable trying to compute a solution using long multiplication and division. A correct answer of 343 would have gained full marks but this was rarely the result of this method.

In part (c), many candidates correctly expanded the brackets but then failed to accurately collect resulting terms. Answers of 3 (2 × 1) and √6 (2 × √3) were common errors in the expansion.