Year 9 Indices – Content Summary, Part 2: Converting Numbers into Index Form

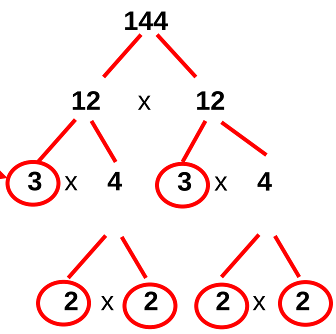
- **Write given numbers in their index form (using integer indices only)**

Do you remember from Year 6 or 7, deriving (working out) the **'prime factorisation' of a number**?

This means taking any large(-ish) composite number, and finding out what it is when expressed as a a series of multiplied-together prime numbers.

We can do this with a 'prime factorisation tree' – like this:

We circle the factor when it's a prime number – it has no further factors and so we can't factorise it any further.



This 'prime factorisation tree' for the number '144' shows us that 144 can be expressed as the following product of prime factors:

144 = 3 x 3 x 2 x 2 x 2 x 2

Grouping these together, we notice that:

144 = (3 x 3) x (2 x 2 x 2 x 2)

Using indices, we can thus say:

$144 = 3^2 \times 2^4$

We can actually do this for any large **composite number**, just by continually dividing by 2 or 3.

We also don't need to use a prime factorisation tree; we can just continually divide and see what happens as we go. If the number is even, divide by 2. If it's not even, try 3, then 5, then 7 then 11... just try larger prime numbers as you go. You can use a calculator!

(If you like, circle the primes as you divide).

Let's look at **66 150**:

66 150 ÷ (2) = 33 075 ← *33 075 isn't divisible by 2… but it is by 3. So, we'll keep going…*

33 075 ÷ (3) = 11 025

11 025 ÷ (3) = 3 675

3 675 ÷ (3) = 1 225 ← *1 225 isn't divisible by 3… but we can see that it is by 5. So, we'll keep going…*

1 225 ÷ (5) = 245

245 ÷ (5) = 49 ← *49 isn't divisible by 5… but we can see that it is by 7. So, we'll keep going…*

49 ÷ (7) = (7) ← *The answer here is 7, which is prime, so we circle that too. We obviously can't factorise any further.*

Thus, we can see from the above that **66 150 = 2 x 3 x 3 x 3 x 5 x 5 x 7 x 7**.

Grouping and using indices, we can express 66 150 as a product of prime factors like this:

$$66\,150 = 2 \times 3^3 \times 5^2 \times 7^2$$

There are other numbers we won't get too far with, because they are a simple product of an already large prime. For example, **62:**

62 ÷ 2 = 31

Both 2 and 31 are prime – so the prime factorisation for 62 is just **'2 x 31**'.

Some numbers are special and when we run this prime factorization process on them, we find that they can be expressed in index form from a single prime number base:

Let's see what happens when we run a prime factorization on the number **729**.

729 ÷ 3 = 243

243 ÷ 3 = 81

81 ÷ 3 = 27

27 ÷ 3 = 9

9 ÷ 3 = 3

So, **729** = 3 x 3 x 3 x 3 x 3 x 3 = $\mathbf{3^6}$

Now, open the GeoGebra file and set the base Number to '3' and slide the Index (Power) along to '^{6}'.

Have a look at the numerical value that shows as the result of 3^6.

Look also at the result on the graph, and in the table of values.

Your turn!

Using Prime Factorisation, convert the following large numbers into their Index form and then use the 'Visualising Powers' GeoGebra file to check your result:

(a) **1024;**

(b) **216;**

(c) **2401;** and

(d) **625.**

Main Reference:

Brown, P., Evans, M., Gaudry, G., Hunt, D., McLaren, R., Pender, B. and Woolacott, B. (2011), *ICE-EM Mathematics, Year 9, Book 1*, Chapter 8. Cambridge University Press : Melbourne, Victoria.