# Equations with Indices (Harder)

**Starter**

1. **(Review of last lesson)** Solve: (a) $2^{4x-1} = \frac{1}{16}$ (b) $4 = 64^{3x+1}$

**Notes**

Questions become more difficult when one number cannot be raised to an integer power to get the other number.

For example, in the equation $4^{x-2} = 32$, $4$ cannot be raised to an integer power to get $32$.
Remember: $4^2 = 16$ and $4^3 = 64$.
What we need to do is find the number that links 4 and 32.

What is the number that links $4$ and $32$?

The number is 2 because $4 = 2^2$ and $32 = 2^5$

So… $4^{x-2} = 32$
…becomes… $\left(2^2\right)^{x-2} = 2^5$

We can now solve the equation:

| | |
|---|---|
| ***3rd law of logs*** | $2^{2x-4} = 2^5$ |
| ***Equating powers of 2:*** | $2x - 4 = 5$ |
| | $2x = 9$ |
| | $x = \frac{9}{2}$ |

***Success criteria — solving harder equations with indices***

1. Find the number that links the two base numbers
2. Express the base numbers as the link number raised to a power and replace in the equation.
3. Equate powers of the link link number to form an equation.
4. Solve the equation.

**E.g. 1** Solve: (a) $4^{3x} = 8^{7x+1}$ (b) $9^{2x+1} = 27^{7-5x}$ (c) $8^{2x-1} = \left(\frac{1}{16}\right)^{3x+5}$

***Working:*** (a) ***The number 2 connects 4 and 8.***

| | |
|---|---|
| ***Replace $4$ by $2^2$ and $8$ by $2^3$:*** | $\left(2^2\right)^{3x} = \left(2^3\right)^{7x+1}$ |
| ***3rd law of logs:*** | $2^{6x} = 2^{21x+3}$ |
| ***Equating powers of 2:*** | $6x = 21x + 3$ |
| | $-15x = 3$ |
| | $x = -\frac{1}{5}$ |

**Video: Equations with indices**

**Solutions to Starter and E.g.s**

**Exercise**

9-1 class textbook: p48 E2.3 Qu 5-6
A*-G class textbook: p45 E2.4 Qu 5-6
9-1 homework book: p16 E2.3 Qu 3bi, 4-7
A*-G homework book: p12 E2.4 Qu 3bi, 4, 5

**Summary**

Solving harder equations with indices:

1. Find the number that links the two base numbers
2. Express the base numbers as the link number raised to a power and replace in the equation.
3. Equate powers of the link link number to form an equation.
4. Solve the equation.

Homework book answers (only available during a lockdown)