

Negative indices

Starter

1. (Review of last lesson)

Simplify: (a) 125^0 (b) $8x^6 \times 5x^9$ (c) $(a^3)^4 \div a^9$

Working: (a) $125^0 = 1$

(b) $8x^6 \times 5x^9 = 40x^{6+9} = 40x^{15}$

(c) $(a^3)^4 \div a^9 = a^{3 \times 4} \div a^9 = a^{12} \div a^9 = a^{12-9} = a^3$

2. (Review of last lesson)

Find the value of x in the following expressions:

(a) $a^x \div a^7 = a^9$ (b) $(6^{3x})^4 = 6^{48}$

Working: (a) $a^x \div a^7 = a^9 \Rightarrow a^{x-7} = a^9$
Equating powers of a : $x - 7 = 9 \Rightarrow x = 16$

(b) $(6^{3x})^4 = 6^{48} \Rightarrow 6^{12x} = 6^{48}$
Equating powers of 6: $12x = 48 \Rightarrow x = 4$

2. With a partner, decide whether the answer of the following is A, B, C or D. Justify your answer with working or an explanation.

2^{-3} A. -6 B. -8 C. $\frac{1}{8}$ D. -1

Working: For example: $2^{-3} = 2^{2-5} = \frac{2^2}{2^5} = \frac{\cancel{2} \times \cancel{2}}{2 \times 2 \times 2 \times \cancel{2} \times \cancel{2}} = \frac{1}{2^3} = \frac{1}{8}$

Integers raised to negative powers

E.g. 1 Without using a calculator, simplify the following:

(a) 7^{-1} (b) $\frac{1}{9^{-1}}$ (c) 5^{-3} (d) $\frac{1}{6^{-2}}$

Working: (a) $7^{-1} = \frac{1}{7}$

(b) $\frac{1}{9^{-1}} = 9$

(c) $5^{-3} = \frac{1}{5^3} = \frac{1}{125}$

(d) $\frac{1}{6^{-2}} = 6^2 = 36$

Exercise

9-1 class textbook: p42 M2.7 Qu 1, 2ace..., 3-6
A*-G class textbook: p39 E2.1 Qu 1, 2ace..., 3-5
9-1 homework book: p13 M2.7 Qu 1-4
A*-G homework book: p10 E2.1 Qu 1-4

Fractions raised to negative powers

E.g. 2 By using division by a fraction, and without a calculator, state the value of:

(a) $\left(\frac{1}{4}\right)^{-1}$

(b) $\left(\frac{2}{3}\right)^{-1}$

Working: (a) $\left(\frac{1}{4}\right)^{-1} = \frac{1}{\frac{1}{4}}$ *negative indices \equiv "one over..."*
 $= 1 \div \frac{1}{4}$ *dividing by fraction*
 $= 1 \times \frac{4}{1}$ *flip fraction and multiply*
 $= 4$

(b) $\left(\frac{2}{3}\right)^{-1} = \frac{1}{\frac{2}{3}}$ *negative indices \equiv "one over..."*
 $= 1 \div \frac{2}{3}$ *dividing by fraction*
 $= 1 \times \frac{3}{2}$ *flip fraction and multiply*
 $= \frac{3}{2}$

E.g. 3 Without a calculator, find the value of:

(a) $\left(\frac{1}{12}\right)^{-1}$ (b) $\left(\frac{7}{8}\right)^{-1}$ (c) $\left(\frac{1}{3}\right)^{-2}$ (d) $\left(\frac{3}{5}\right)^{-2}$

Working: (a) $\left(\frac{1}{12}\right)^{-1} = \frac{12}{1} = 12$

(b) $\left(\frac{7}{8}\right)^{-1} = \frac{8}{7}$

(c) $\left(\frac{1}{3}\right)^{-2} = \left(\frac{3}{1}\right)^2 = 3^2 = 9$

(d) $\left(\frac{3}{5}\right)^{-2} = \left(\frac{5}{3}\right)^2 = \frac{5^2}{3^2} = \frac{25}{9}$

E.g. 4 Without a calculator, find the value of:

(a) $\left(1\frac{1}{5}\right)^{-3}$

(b) $\left(2\frac{1}{4}\right)^{-2}$

Working: (a) $\left(1\frac{1}{5}\right)^{-3} = \left(\frac{6}{5}\right)^{-3} = \left(\frac{5}{6}\right)^3 = \frac{5^3}{6^3} = \frac{125}{216}$

(b) $\left(2\frac{1}{4}\right)^{-2} = \left(\frac{9}{4}\right)^{-2} = \left(\frac{4}{9}\right)^2 = \frac{4^2}{9^2} = \frac{16}{81}$

Exercise

9-1 class textbook: p43 M2.7 Qu 7,8

A*-G class textbook: p40 M2.7 Qu 6, 7

9-1 homework book: p13 M2.7 Qu 5-7

A*-G homework book: p11 E2.1 Qu 5, 7

Negative Indices involving algebra

E.g. 5 Simplify: (a) $\frac{1}{a^{10}} \times a^7$ (b) $g^6 \div g^{-6}$ (c) $(b^{-5})^{-1}$

Working: (a) $\frac{1}{a^{10}} \times a^7 = a^{-10} \times a^7 = a^{-3} = \frac{1}{a^3}$

(b) $g^6 \div g^{-6} = g^{6-(-6)} = g^{12}$

(c) $(b^{-5})^{-1} = b^{(-5) \times (-1)} = b^5$
...or... $(b^{-5})^{-1} = \left(\frac{1}{b^5}\right)^{-1} = \frac{b^5}{1} = b^5$

Video: [Negative indices](#)

[Solutions to Starter and E.g.s](#)

Exercise

9-1 class textbook: p42 M2.7 Qu 9-14

A*-G class textbook: p37 E2.1 Qu 8-10

9-1 homework book: p13 M2.7 Qu 8-10

A*-G homework book: p10 E2.1 Qu 6