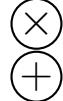# Indices Rules- Practice practice practice

1. *The product ⊗ Rule says to multiply powers add the indices.*

   Due to popular demand we are keeping the × symbol for the Christmas test — but be prepared to let it go afterwards.

   In algebra, multiplication is usually implied: ab, $3x$, and $m^4 m^3$ are all products even though no × is written.
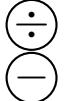
   And in arithmetic the dot notation $2 \cdot 3 \cdot 5 = 30$ gradually replaces the old × because it avoids confusion with the letter x.

$$a^p \times a^q = a^{p+q} \qquad \text{Example: } m^4 \times m^3 = m^{4+3} = m^7$$

a) $2^2 \times 2^3$ $\boxed{2^5}$ b) $b^4 \times b^6$ $\boxed{b^{10}}$ c) $7^5 \times 7^7$ $\boxed{7^{12}}$

d) $m^3 \times m^6$ $\boxed{m^9}$ e) $2^8 \times 2^2$ $\boxed{2^{10}}$ f) $y^9 \times y^4$ $\boxed{y^{13}}$

g) $p^{11} \times p^3$ $\boxed{p^{14}}$ h) $3^6 \times 3^5$ $\boxed{3^{11}}$ i) $k^7 \times k^{10}$ $\boxed{k^{17}}$

j) $w^{12} \times w$ $\boxed{w^{13}}$ k) $\pi^{11} \times \pi^{89}$ $\boxed{\pi^{100}}$ l) $\theta^6 \times \theta^4$ $\boxed{\theta^{10}}$

2. The Quotient ⊘ Rule says to divide powers we subtract the indices. *Write each expression as a single power.*

a) $2^2 \times 2^3$ $\boxed{2^5}$ b) $b^4 \times b^6$ $\boxed{b^{10}}$ c) $7^5 \times 7^7$ $\boxed{7^{12}}$

d) $m^3 \times m^6$ $\boxed{m^9}$ e) $2^8 \times 2^2$ $\boxed{2^{10}}$ f) $y^9 \times y^4$ $\boxed{y^{13}}$

g) $p^{11} \times p^3$ $\boxed{p^{14}}$ h) $3^6 \times 3^5$ $\boxed{3^{11}}$ i) $k^7 \times k^{10}$ $\boxed{k^{17}}$

j) $w^{12} \times w$ $\boxed{w^{13}}$ k) $\pi^{11} \times \pi^{89}$ $\boxed{\pi^{100}}$ l) $\theta^6 \times \theta^4$ $\boxed{\theta^{10}}$

3. *The Quotient ⊘ Rule says to divide powers we subtract the indices.*

$$\frac{a^p}{a^q} = a^{p-q} \qquad \text{Example: } \frac{m^7}{m^3} = m^{7-3} = m^4$$

Write each expression as a single power:

a) $a^9 \div a^3$ $\boxed{a^6}$ b) $b^7 \div b^2$ $\boxed{b^5}$ c) $c^{12} \div c^5$ $\boxed{c^7}$

d) $m^{10} \div m^4$ $\boxed{m^6}$ e) $x^8 \div x$ $\boxed{x^7}$ f) $y^{11} \div y^6$ $\boxed{y^5}$

g) $p^{15} \div p^9$ $\boxed{p^6}$ h) $q^{13} \div q^7$ $\boxed{q^6}$ i) $k^{14} \div k^3$ $\boxed{k^{11}}$

j) $w^{20} \div w^5$ $\boxed{w^{15}}$ k) $t^9 \div t^2$ $\boxed{t^7}$ l) $r^{18} \div r^{10}$ $\boxed{r^8}$

4. *The Power of a Power* ■□ *Rule says that to take a power of a power, we multiply the indices.*

$$(a^p)^q = a^{pq} \qquad \text{Example: } (m^4)^3 = m^{4 \times 3} = m^{12}$$

Write each expression as a single power:

a) $\left(a^2\right)^5$ $\boxed{a^{10}}$ b) $\left(x^3\right)^4$ $\boxed{x^{12}}$ c) $\left(b^7\right)^2$ $\boxed{b^{14}}$

d) $\left(m^5\right)^3$ $\boxed{m^{15}}$ e) $\left(t^9\right)^2$ $\boxed{t^{18}}$ f) $\left(y^4\right)^6$ $\boxed{y^{24}}$

g) $\left(p^{11}\right)^3$ $\boxed{p^{33}}$ h) $\left(q^6\right)^5$ $\boxed{q^{30}}$ i) $\left(k^7\right)^{10}$ $\boxed{k^{70}}$

j) $\left(w^3\right)^8$ $\boxed{w^{24}}$ k) $\left(r^{12}\right)^2$ $\boxed{r^{24}}$ l) $\left(\theta^5\right)^7$ $\boxed{\theta^{35}}$

5. *The zero index rule takes a while to trust. Anything (except 0) raised to the power 0 is defined to be 1. It feels strange at first but becomes routine quickly.*

$$a^0 = 1$$

Evaluate each:

a) m^0 $\boxed{1}$ b) x^0 $\boxed{1}$ c) 7^0 $\boxed{1}$ d) p^0 $\boxed{1}$

e) π^0 $\boxed{1}$ f) θ^0 $\boxed{1}$

6. *Negative powers take a little getting used to. A negative index in the numerator simply means the base belongs on the bottom of a fraction, with the power made positive.*

$$a^{-p} = \frac{1}{a^p}$$

Rewrite each with a positive index:

a) a^{-3} $\boxed{\dfrac{1}{a^3}}$ b) b^{-5} $\boxed{\dfrac{1}{b^5}}$ c) x^{-7} $\boxed{\dfrac{1}{x^7}}$ d) m^{-2} $\boxed{\dfrac{1}{m^2}}$

e) t^{-9} $\boxed{\dfrac{1}{t^9}}$ f) y^{-4} $\boxed{\dfrac{1}{y^4}}$ g) p^{-6} $\boxed{\dfrac{1}{p^6}}$ h) q^{-8} $\boxed{\dfrac{1}{q^8}}$

7. *When the negative power is already in the denominator, it just comes up and becomes positive. One familiar sounding phrase covers both situations — change floors, change signs.*

$$\frac{1}{a^{-p}} = a^p$$

Rewrite each with a positive power and no fraction:

a) $\dfrac{1}{a^{-3}}$ a^3 b) $\dfrac{1}{b^{-4}}$ b^4 c) $\dfrac{1}{x^{-7}}$ x^7

d) $\dfrac{1}{m^{-1}}$ m^1 e) $\dfrac{1}{t^{-9}}$ t^9 f) $\dfrac{1}{y^{-5}}$ y^5

g) $\dfrac{1}{p^{-6}}$ p^6 h) $\dfrac{1}{q^{-8}}$ q^8

8. When a product is inside a bracket, the power applies to the whole product. To see why, look at the square of a product:

$$(ab)^2 = (ab)(ab).$$

Remove the brackets and rearrange the factors:

$$(ab)(ab) = abab = aa\,bb = a^2b^2.$$

Exactly the same pattern holds for any power.

$$(ab)^p = a^p b^p$$

Expand each:

a) $(ab)^3$ a^3b^3 b) $(5b)^4$ 5^4b^4

c) $(pq)^2$ p^2q^2 d) $(t7)^5$ t^57^5

e) $(rs)^7$ r^7s^7 f) $(25)^6$ 2^65^6

g) $(uv)^9$ u^9v^9 h) $(cd)^8$ c^8d^8

Conclusion: The power of a product equals the product of the powers.

9. *The story continues for brackets on a fraction. Once a fraction is inside brackets, the division take priority. Even though division normally has lower priority than powers, the fraction must be dealt with first. That means the outside power applies to the whole fraction.*

The power simply repeats the fraction as many times as needed, and we use the usual rule: multiply the tops together and the bottoms together.

For example,

$$\left(\frac{2}{5}\right)^2 = \left(\frac{2}{5}\right)\left(\frac{2}{5}\right) = \frac{2 \cdot 2}{5 \cdot 5} = \frac{4}{25}.$$

The same structure works for all powers:

$$\left(\frac{a}{b}\right)^p = \frac{a^p}{b^p}.$$

Conclusion: *the power of a fraction equals the fraction of the powers.*

Expand each:

a) $\left(\dfrac{a}{b}\right)^3$ $\boxed{\dfrac{a^3}{b^3}}$ b) $\left(\dfrac{3}{5}\right)^2$ $\boxed{\dfrac{3^2}{5^2}}$ c) $\left(\dfrac{p}{q}\right)^6$ $\boxed{\dfrac{p^6}{q^6}}$

d) $\left(\dfrac{t}{y}\right)^5$ $\boxed{\dfrac{t^5}{y^5}}$ e) $\left(\dfrac{r}{s}\right)^7$ $\boxed{\dfrac{r^7}{s^7}}$ f) $\left(\dfrac{k}{m}\right)^2$ $\boxed{\dfrac{k^2}{m^2}}$

g) $\left(\dfrac{u}{v}\right)^9$ $\boxed{\dfrac{u^9}{v^9}}$ h) $\left(\dfrac{c}{d}\right)^8$ $\boxed{\dfrac{c^8}{d^8}}$ i) $\left(\dfrac{h}{k}\right)^{11}$ $\boxed{\dfrac{h^{11}}{k^{11}}}$

j) $\left(\dfrac{w}{z}\right)^3$ $\boxed{\dfrac{w^3}{z^3}}$ k) $\left(\dfrac{\pi}{3}\right)^2$ $\boxed{\dfrac{\pi^2}{3^2}}$ l) $\left(\dfrac{a}{c}\right)^{10}$ $\boxed{\dfrac{a^{10}}{c^{10}}}$

A note on priority of operations. *Much of this topic is really about understanding how operations line up in order of priority. Without brackets, powers come first, then multiplication and division, then addition and subtraction. But once a bracket appears, the normal priority is reversed — everything inside the bracket becomes the new "first task". That is why multiplication distributes over addition in a bracket, and why a single power outside a bracket distributes over each factor in a product or a quotient. It is the same idea expressed in different ways.*