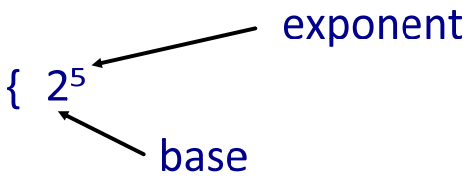
1.8 Exponents



$2^5 = 2 \times 2 \times 2 \times 2 \times 2$

Exponent Form

Expanded Form

Ex. 1 Evaluate

a) 4^3 $= 4 \times 4 \times 4$ $= 64$

b) 2^4 $= 2 \times 2 \times 2 \times 2$ $= 16$

c) $(-3)^2$ $= (-3)(-3)$ $= 9$

What is the difference?

d) -3^2 $= -3^2$ $= -3 \times 3$ $= -9$

Base is -3, because of the brackets

Base is 3, the negative is NOT part of the base

e) $(-3)^3$ (odd) $= (-3)(-3)(-3)$ $= (9)(-3)$ $= -27$

f) $(-1)^5$ (odd) $= (-1)(-1)(-1)(-1)(-1)$ $= (1)(1)(-1)$ $= -1$

g) 4^2 $= 16$

h) $(-2)^3$ (odd) $= (-2)(-2)(-2)$ $= 4(-2)$ $= -8$

i) -5^2 $= -5^2$ $= -5 \times 5$ $= -25$

j) $(-4)^2$ $= (-4)(-4)$ $= 16$

When the base is negative...
Even exponent--> positive answer
Odd exponent--> negative answer

Ex. 2 Evaluate

a) 5^1

$= 5$

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

$= \left(\frac{1}{2}\right)\left(\frac{1}{2}\right)\left(\frac{1}{2}\right)\left(\frac{1}{2}\right)$

$= \frac{1}{16}$

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

$= \left(-\frac{1}{3}\right)\left(-\frac{1}{3}\right)$

$= \frac{1}{9}$

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

$= -\left(\frac{2}{3}\right)\left(\frac{2}{3}\right)\left(\frac{2}{3}\right)$

$= -\frac{8}{27}$

e) -1^{99}

$= -1$

f) $(-1)^{27}$ ODD

$= -1$

g) $(-1)^{98}$ EVEN

$= 1$

h) -1^{98}

$= -1^{98}$

$= -1$

$= -1$

i) $2(-5)^2$

$= 2 \cdot (-5)(-5)$

$= 2(25)$

$= 50$

BEDMAS!

j) $4 \cdot 5^2 + (3+1)^2$

$= 4 \cdot 5^2 + (4)^2$

$= 4 \cdot 25 + 16$

$= 100 + 16$

$= 116$

k) $(-3)^3 - (-5)^2$ ODD EVEN

$= (-3)(-3)(-3) - (-5)(-5)$

$= -27 - 25$

$= -52$

$- (-5)^3$

$- (-125)$

$+125$

.

Ex. 3 Write as single power.

a) $(2^3)(2^4)$

$= 2\cdot2\cdot2 \cdot 2\cdot2\cdot2\cdot2$

$= 2^7$

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

$= 5^7$

c) $(-2)^5(-2)^1$

$= (-2)^6$

Multiplying Powers

To multiply powers with the same base, add the exponents.

The Product Rule

$m^a \times m^b = m^{a+b}$

Ex. 4 Write as a single power.

a) $4^5 \div 4^2 = \frac{4\cdot4\cdot4\cdot4\cdot4}{4\cdot4}$

$= 4^3$

$\frac{4^5}{4^2} = 4^{5-2}$

$= 4^3$

Dividing Powers

To divide powers with the same base, subtract the exponents.

The Quotient Rule

$m^a \div m^b = m^{a-b}$, $m \neq 0$

b) $\frac{3^4}{3} = \frac{3\cdot3\cdot3\cdot3}{3}$

$= 3^3$

$\frac{3^4}{3} = 3^{4-1}$

$= 3^3$

c) $\frac{(-2)^4}{(-2)^3} = (-2)^{4-3}$

$= (-2)^1$

$= -2$

d) $\frac{1.5^{16}}{(1.5^2)(1.5^3)}$

$= \frac{1.5^{16}}{1.5^5}$

$= 1.5^{16-5}$

$= 1.5^{11}$

Ex. 5 Simplify.

a) $(2^2)^4$

$= (2^2)(2^2)(2^2)(2^2)$

$= 2^{2+2+2+2}$

$= 2^8$

$(2^2)^4$

$= 2^{2\times4}$

$= 2^8$

b) $(3^4)^5$

$= 3^{4\times5}$

$= 3^{20}$

c) $-(5^3)^2$

$= -(5^3)(5^3)$

$= -5^6$

Raising a Power to an Exponent

To raise a power to another exponent, multiply the exponents without changing the base.

Power of a Power Rule

$(m^a)^b = m^{a \times b}$

Exponent Laws

Multiply powers

$2^3 \cdot 2^4$

$= 2^{3+4}$

$= 2^7$

⇨ add exponents

Divide powers

$2^6 \div 2^2$

$= 2^{6-2}$

$= 2^8$

⇨ subtract exponents

Power of a power

$(2^6)^3$

$= 2^{6 \times 3}$

$= 2^{18}$

⇨ multiply exponents

Ex. 6 Simplify

a) $6^3 - 2 \cdot 5^2 - (1+2)^3$

$= 216 - 2 \cdot 25 - (3)^3$

$= 216 - 50 - 27$

$= 139$

Keep as a base of 2

b) $\dfrac{(2^2)^3 \bullet (2^3)^4}{(2^4)(2^5)} - 2^9$

$= \dfrac{2^6 \cdot 2^{12}}{2^9} - 2^9$

$= \dfrac{2^{18}}{2^9} - 2^9$

$= 2^9 - 2^9$

$= 0$