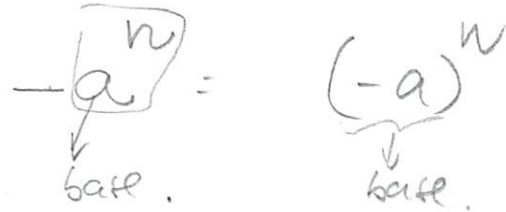
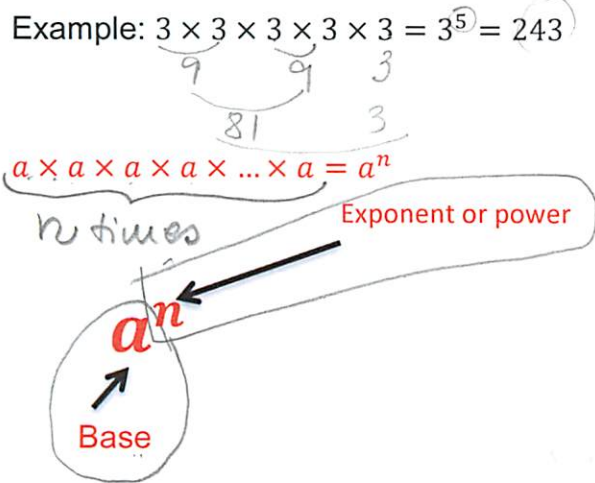


Exponents and Order of Operations Agreement

Exponential Expressions

Exponents are a repeated multiplication of a number by itself.

Example: $3 \times 3 \times 3 \times 3 \times 3 = 3^5 = 243$



n is any positive integer.

Exponents of positive numbers

Exercise 1: Evaluate

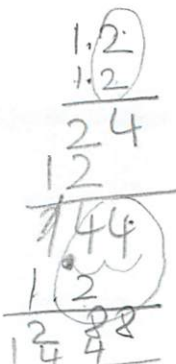
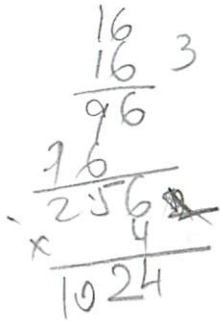
a) $4^5 = 4 \times 4 \times 4 \times 4 \times 4 = 16 \times 16 \times 4 = 256 \times 4 = 1024$

b) $2^5 = 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 = 4 \cdot 4 \cdot 2 = 32$

c) $28^2 = 28 \cdot 28 = 784$

d) $\left(\frac{1}{3}\right)^4 = \left(\frac{1}{3}\right) \times \left(\frac{1}{3}\right) \times \left(\frac{1}{3}\right) \times \left(\frac{1}{3}\right) = \left(\frac{1}{9}\right) \times \left(\frac{1}{9}\right) = \frac{1}{81}$

e) $(1.2)^3 = (1.2) \times (1.2) \times (1.2) = (1.44) \times (1.2) = 1.728$



Exponents of negative numbers:

Exercise 2: Evaluate

→ a) $(-2)^2 = (-2)(-2) = 4$

b) $(-2)^3 = \underbrace{(-2)(-2)}_4 (-2) = -8$

→ c) $(-2)^4 = \underbrace{(-2)(-2)}_4 \underbrace{(-2)(-2)}_4 = 16$

d) $(-2)^5 = \underbrace{(-2)(-2)}_4 \underbrace{(-2)(-2)}_4 (-2) = -32$

e) $\left(-\frac{3}{5}\right)^3 = -\left(\frac{3}{5} \cdot \frac{3}{5} \cdot \frac{3}{5}\right) = -\frac{27}{125}$

Remark:

1. A negative number to an even exponent gives a positive number.
2. A negative number to an odd exponent gives a negative number.

Exercise 3: Evaluate:

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

b) $-3^2 = \downarrow 3 \cdot 3 = -9$

c) $(-3)^3 = (-3)(-3)(-3) = -27$

d) $-3^3 = \downarrow 3 \cdot 3 \cdot 3 = -27$

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

Remark:

If the base has a negative sign in front of it, without parentheses, then the negative is not part of the base. In this situation we keep the negative in the final answer and ONLY the number will be raised to the exponent

Exercises 4: Evaluate:

$$a) 8(-3)^5 = 8 \left[\underbrace{(-3)(-3)}_9 \underbrace{(-3)(-3)}_9 \underbrace{(-3)}_{(-3)} \right] = 8 (-243) = -1,944$$

$$\begin{array}{r} 25 \\ 25 \\ \hline 125 \end{array}$$

$$b) 5^3(-1)^2 = \overset{25 \cdot 5}{\underset{125(1)}{5 \cdot 5 \cdot 5}} \cdot \overset{1}{\underset{1}{(-1)(-1)}}$$

$$= 125$$

$$c) \left(\frac{1}{3}\right)^2 \div \frac{2}{3} = \left[\frac{1}{3} \cdot \frac{1}{3} = \frac{1}{9} \right] \quad \frac{1}{9} \div \frac{2}{3} = \frac{1}{9} \cdot \frac{3}{2} = \frac{3 \cdot 1}{18 \cdot 3} = \frac{1}{6}$$

$$d) \left(-\frac{1}{2}\right)^3 \cdot 8 = \underbrace{\left(-\frac{1}{2}\right)\left(-\frac{1}{2}\right)\left(-\frac{1}{2}\right)}_4 \cdot 8 = \frac{1}{4} \cdot \underbrace{\left(-\frac{1}{2}\right)}_{-8} = \underbrace{-\frac{1}{8} \cdot 8}_1 = \frac{-8}{8} = \textcircled{-1}$$

$$e) (0.5)^2 \cdot 3^2 = (0.5)(0.5) \cdot (3 \cdot 3)$$

$$= 0.25 \cdot 9 = 2.25$$

$$f) \left(\frac{3}{4}\right)^2 \cdot 2^3(-4) = \left(\frac{3}{4}\right)\left(\frac{3}{4}\right) \cdot \underbrace{2 \cdot 2 \cdot 2}_{4 \cdot 2} (-4) = \frac{9}{16} \cdot 8 \cdot (-4)$$

$$= \frac{9}{16} \frac{(-32)}{1} = \frac{9 \cdot \overset{4 \cdot 2}{(-32)}}{\cancel{16}_2} = 9(-2) = -18$$

The Order of Operations Agreement

Order of operation rules:

- 1) Parentheses, Brackets, Absolute Values, and Complex Fractions.
- 2) Exponents.
- 3) Multiplication OR division as they occur from left to right. \overline{MD}
- 4) Addition OR subtraction as they occur from left to right. \overline{AS}

\overline{DM}
 \overline{SA}

Exercise 5: Evaluate the following expression using the Order of Operations Agreement.

a) $2(3-7) - (-3)^3 =$

$$= 2(-4) - (-3)^3$$

$$= 2(-4) - (-27)$$

$$= -8 - (-27)$$

$$= -8 + 27 = 19$$

b) $34 - 24 \div (-2^3) =$ $34 - \frac{24}{-8}$

$$= 34 - \left(\frac{24}{-8} \right) = 34 - (-3)$$

$$= 34 + 3$$

$$= 37$$

c) $-14^2 + 5[4 \div (4-2)] =$

$$= -14^2 + 5[4 \div (2)]$$

$$= -14^2 + 5(2)$$

$$= -196 + 5(2)$$

$$= -196 + 10$$

$$= -186$$

$$14 \cdot 14 = 196$$

$$d) 12 \div \frac{3^2}{10-7} - (-10) =$$

$$12 \div \frac{9}{3} - (-10)$$

$$12 \div 3 - (-10)$$

$$4 - (-10)$$

$$14$$

$$e) 49(-343) \div [7(10-3)^3] = 49(-343) \div [7(7)^3]$$

$$= 49(-343) \div (7 \cdot 343)$$

$$= \frac{49(-343)}{7 \cdot 343}$$

$$= 7(-1) = -7$$

$$\frac{49}{343} = \frac{7}{6}$$

$$f) \left(\frac{1}{3}\right)^2 - \left(\frac{2}{3}\right)^3 \div \left(\frac{4}{5}\right) = \left(\frac{1}{3}\right)\left(\frac{1}{3}\right) - \left(\frac{2}{3}\right)\left(\frac{2}{3}\right)\left(\frac{2}{3}\right) \div \frac{4}{5}$$

$$= \frac{1}{9} - \frac{8}{27} \div \frac{4}{5} = \frac{1}{9} - \frac{8 \cdot 5}{27 \cdot 4} = \frac{1}{9} - \frac{10}{27} = \frac{1 \times 3}{9 \times 3} - \frac{10}{27}$$

$$= \frac{3}{27} - \frac{10}{27}$$

$$= \frac{-7}{27}$$