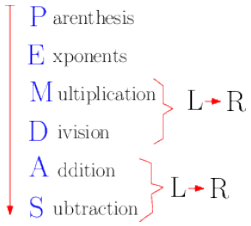
1.4 Order of Operations

1. Parenthesis (including implied parenthesis surrounding the numerator and denominator of fractions
2. Exponents
3. Multiplication and division, left to right
4. Addition and subtraction, left to right



Examples Simplify the following.

1. $3 + 5 \cdot 7$
   Multiplication first before the addition.

$$\begin{aligned} 3 + 5 \cdot 7 &= 3 + 35 \\ &= 38 \end{aligned}$$

2. $5 \cdot 3^2$
   Exponentiation first, the multiplication.

$$\begin{aligned} 5 \cdot 3^2 &= 5 \cdot 9 \\ &= 45 \end{aligned}$$

3. $10 - 5 - 3$
   Left to right.

$$\begin{aligned} 10 - 5 - 3 &= 5 - 3 \\ &= 2 \end{aligned}$$

4. $\dfrac{13 + 5}{3}$
   There is an implied parenthesis about the entire numerator and about the entire denominator for all fractions.

$$\begin{aligned} \frac{13 + 5}{3} &= \frac{18}{3} \\ &= 6 \end{aligned}$$

5. -2^2
   Square the 2, then apply the negative.

$$\begin{aligned} -2^2 &= -2 \cdot 2 \\ &= -4 \end{aligned}$$

   This case seems to cause the most confusion of any. If you really want to square negative 2, then you need

$$\begin{aligned} (-2)^2 &= (-2)(-2) \\ &= 4 \end{aligned}$$

6. $\dfrac{4 + 3}{4}$
   Add in the numerator first.

$$\frac{4 + 3}{4} = \frac{7}{4}$$

   Nothing left to do, and $\dfrac{7}{4}$ is a fine number.

Example Carry out the operations then simplify: $3(10 - 3) + 9$.

$$\begin{aligned} 3(10 - 3) + 9 &= 3(7) + 9 \\ &= 21 + 9 \\ &= 30 \end{aligned}$$

Example Carry out the operations then simplify: $(5 + 2)^2 - 10 + \dfrac{20 + 12}{4} + 6$.

$$\begin{aligned} &= (5 + 2)^2 - 10 + \frac{20 + 12}{4} + 6 \\ &= (7)^2 - 10 + \frac{32}{4} + 6 \\ &= 49 - 10 + 8 + 6 \\ &= 39 + 8 + 6 \\ &= 53 \end{aligned}$$

Exercises

Perform the operations then simplify.

1. $\dfrac{3}{10} \cdot (5)^2$
2. $\dfrac{1}{3} \cdot (6)^2$
3. $\dfrac{1}{2} \cdot (4)^2$
4. $-5^2 - 3^2 + (-2)^2$
5. $(7 - 4)^2 + 10$
6. $\dfrac{5^2 - 2^2}{5 - 2}$
7. $\dfrac{8 + 3}{8^2 - 3^2}$
8. $4 - 3[6 + (2 - 7)] + 5^2$

9. $10 - 5[6 + (8 - 11)] + 7^2$
10. $64 \div 8 \div 4$
11. $3 - 16 \div 8 \cdot 2 - 10 + 35 - 3^2$
12. $625 \div 25 \div 5$
13. $\dfrac{3-8}{25} \cdot (43 - 12 - (-4))$
14. $\left(\dfrac{-2}{3}\right)^3 \cdot \left(\dfrac{9}{4}\right)^2$
15. $3^2 - 3^3$
16. $(-2)^3 + (-2)^4 - 2^2$
17. $5 - [3 - 2(5 - 8)] + (-9)$