

Chapter 6

Order of Operations

In mathematics, we have many different operators. There is addition (+), subtraction (-), product (\times), quotient (\div), exponents (3^2) and roots ($\sqrt{16}$) to name a few. So when there are multiple operators in the same mathematics problem, should we just move from left to right or do some of these operators have to be done before others? Consider the following problem:

$$3 + 5 \times 2$$

Lets pretend that we can do either of the operations first. Starting with addition and then multiplication gives:

$$\begin{aligned} & 3 + 5 \times 2 \\ &= 8 \times 2 \\ &= 16 \end{aligned}$$

However now let's look at what happens if we do the multiplication first and then the addition.

$$\begin{aligned} & 3 + 5 \times 2 \\ &= 3 + 10 \\ &= 13 \end{aligned}$$

Depending on how we attempted the problem, we arrived at different answers. To solve this problem, mathematicians have developed an order in which operations **must** be done. This is called the 'Order of Operations'.

Order of Operations

Brackets

Exponents

Multiplication and Division

Addition and Subtraction

At each step, work from left to right

Therefore when looking to solve a problem with multiple operators, we must remember the order of operations and make a decision at each step as to what operation should be done next. Anything inside brackets must be done first. After the brackets have been completed or if there are no brackets in the problem, then any exponents (powers or roots) can be done.

After exponents comes multiplication and division. Working from left to right, we evaluate each multiplication or division as we come to it. Multiplication and division have the same precedence (or order), so you can not do all the multiplications first, and then all the divisions. They must be done at the same time, working from left to right.

Finally addition and subtraction can be done. Addition and subtraction have the same precedence so once again, work from left to right, evaluating each addition or subtraction as you come to it.

To help remember the correct order of operations, it can be helpful to remember it as '**BEMDAS**'.

Brackets
Exponents
Multiplication
Division
Addition
Subtraction

However, care must be used when using BEMDAS to remember the correct order of operations. Multiplication and Division **must** be done at the same time. The same applies to addition and subtraction.

To make the examples easier to follow, the operation that is going to be solved next has been underlined. This does not have to have to be done when working through the exercises.

Example 1 Calculate $9 + 30 \div 6$

$$\begin{aligned}
 & 9 + \underbrace{30 \div 6} \\
 &= \underbrace{9 + 5} \\
 &= 14
 \end{aligned}$$

Example 2 Calculate $5 \times 9 - 54 \div 9$

$$\begin{aligned}
 & \underbrace{5 \times 9} - 54 \div 9 \\
 &= 45 - \underbrace{54 \div 9} \\
 &= \underbrace{45 - 6} \\
 &= 39
 \end{aligned}$$

Example 3 Calculate $7 + 6 \times 3 \div 2$

$$\begin{aligned}
 & 7 + \underbrace{6 \times 3 \div 2} \\
 &= 7 + \underbrace{18 \div 2} \\
 &= \underbrace{7 + 9} \\
 &= 16
 \end{aligned}$$

6.01 Exercise 6.01

1. Calculate the following remembering the correct order of operations

- | | |
|-------------------------------|--------------------------------|
| a) $10 \times 4 + 7$ | k) $72 \div 6 \div 6 \times 4$ |
| b) $42 \div 6 + 15$ | l) $70 - 56 \div 4$ |
| c) $36 \div 2 \div 2 \div 3$ | m) $73 - 44 \div 11$ |
| d) $8 \times 10 - 10 \div 10$ | n) $63 \div 7 + 6 \times 8$ |
| e) $5 \times 3 + 1$ | o) $88 \div 11 \times 5$ |
| f) $4 + 8 \times 9$ | p) $64 - 48 \div 2$ |
| g) $75 - 6 \times 8$ | q) $3 \times 5 + 6$ |
| h) $92 - 7 \times 5 - 22$ | r) $54 + 3 \times 8$ |
| i) $16 + 54 \div 6 - 12$ | s) $11 + 66 \div 11$ |
| j) $53 + 72 - 96$ | t) $40 \div 2 \times 5 \div 4$ |

- u) $25 \times 1 - 3 \times 6$
 v) $64 \div 8 \div 2 \times 7$
 w) $224 \div 8 \times 3 \div 2$

- x) $14 + 5 \times 9 \times 9$
 y) $94 - 67 + 58$
 z) $72 \div 9 - 55 \div 11$

2. Calculate the following remembering the correct order of operations

- a) $87 - 11 + 24 - 39$
 b) $48 \div 4 + 57$
 c) $50 + 50 \times 0 + 1$
 d) $19 + 6 \times 5$
 e) $8 \times 12 - 84 \div 7$
 f) $40 - 40 \times 0$
 g) $3 + 3 + 3 + 3 \times 3$
 h) $24 - 8 \times 3$
 i) $96 - 14 \times 6$
 j) $75 \div 5 \div 5$
 k) $24 \div 3 + 48 \div 6$
 l) $14 \times 1 + 7$
 m) $25 \div 5 \times 4$

- n) $72 \div 8 \times 8$
 o) $9 \times 4 + 6 \times 5$
 p) $24 + 19 - 5 \times 6$
 q) $97 - 27 \times 3$
 r) $128 \div 2 \div 4 \div 2$
 s) $5 \times 9 + 6 \times 4$
 t) $4 + 7 \times 7 - 4 \times 9$
 u) $80 - 6 \times 2 \times 4$
 v) $27 \div 3 \times 9$
 w) $34 - 9 \times 0 + 6$
 x) $8 \times 4 - 72 \div 6$
 y) $13 + 65 \div 5$
 z) $5 + 78 \div 2 \div 3$

Example 4 Calculate $3 + 4^2$

$$\begin{aligned} & 3 + \underbrace{4^2} \\ &= \underbrace{3 + 16} \\ &= 19 \end{aligned}$$

Example 5 Calculate $5^2 - 3^2$

$$\begin{aligned} & \underbrace{5^2} - 3^2 \\ &= 25 - \underbrace{3^2} \\ &= \underbrace{25 - 9} \\ &= 16 \end{aligned}$$

Example 6 Calculate $5 + 28 \div 2^2$

$$\begin{aligned} & 5 + 28 \div \underbrace{2^2} \\ &= 5 + \underbrace{28 \div 4} \\ &= \underbrace{5 + 7} \\ &= 12 \end{aligned}$$

6.02 Exercise 6.02

1. Calculate the following remembering the correct order of operations

- a) $5^2 - 13$
 b) $40 - 6^2$
 c) $13 + 12^2$
 d) $54 \div 3^2$
 e) $23 - 4^2$
 f) $5^2 - 4^2$

- g) $3^3 - 3^2$
 h) $48 \div 2^2$
 i) $65 - 3^2 \times 4$
 j) $50 - 33 \div 11$
 k) $4^3 + 6^2$
 l) $17 - 4^2$

- m) $3^3 \div 9$
 n) $8^2 - 5 \times 7$
 o) $19 + 11^2 - 47$
 p) $6^2 \div 2 \div 2$
 q) $96 \div 2^2$
 r) $91 - 8^2 + 28$
 s) 78×0^3

- t) $37 + 6^2 \div 4$
 u) $135 \div 3^2$
 v) $2^4 \times 3$
 w) $77 \div 11 + 12^2$
 x) $100 \div 2^2 \div 5$
 y) $40 + 8^2 + 9^2$
 z) $135 \div 3^2$

Example 7 Calculate $(4 + 7) \times 5$

$$\begin{aligned} & \underbrace{(4 + 7)} \times 5 \\ &= \underbrace{11} \times 5 \\ &= 55 \end{aligned}$$

Example 8 Calculate $(15 - 3) \div (16 - 14)$

$$\begin{aligned} & \underbrace{(15 - 3)} \div \underbrace{(16 - 14)} \\ &= 12 \div \underbrace{(16 - 14)} \\ &= \underbrace{12 \div 2} \\ &= 6 \end{aligned}$$

Example 9 Calculate $(5 + 48 \div 12)^2$

$$\begin{aligned} & \underbrace{(5 + 48 \div 12)}^2 \\ &= \underbrace{(5 + 4)}^2 \\ &= \underbrace{9^2} \\ &= 81 \end{aligned}$$

6.03 Exercise 6.03

1. Calculate the following remembering the correct order of operations

- | | |
|-------------------------------------|---------------------------------------|
| a) $(15 - 9) \times 4$ | n) $12 \times (10 + 15)$ |
| b) $(42 - 35) \times 8$ | o) $(24 - 15)^2$ |
| c) $5 \times (24 \div 4)$ | p) $(55 \div 5)^2$ |
| d) $6 \times (14 + 7)$ | q) $(76 \div 2 - 29)^2$ |
| e) $2 \times (15 - 8) \times 4$ | r) $9^2 \div (36 \div 12)$ |
| f) $88 \div (86 - 75)$ | s) $(13 + 29) \times (15 - 8)$ |
| g) $(47 + 23) \div 10$ | t) $148 - (250 - 181)$ |
| h) $124 \div (41 - 25 - 14)$ | u) $44 \div (18 \div 9)^2$ |
| i) $(3 + 5) \times (2 \times 6)$ | v) $(5 + 9 \times 7) \div 2^2$ |
| j) $92 \div 4 - (50 - 29)$ | w) $(99 - 8 \times 12)^3$ |
| k) $(24 + 11) \times (44 - 38)$ | x) $(37 + 32) \div (24 \div 8)$ |
| l) $56 \div 7 \div (24 \div 6)$ | y) $18 + (56 \div 8) \times 5$ |
| m) $70 \div (100 \div 10) \times 4$ | z) $(144 \div 12)^2 - (72 \div 12)^2$ |

2. Calculate the following remembering the correct order of operations

a) $8 \times (6^2 \div 4)$

b) $(5 + 7 \times 9) \div 2$

c) $77 \div (11^2 - 114)$

d) $(54 - 7^2)^3$

e) $(90 - 57) \times (4^2 - 13)$

f) $45 \div (30 \div 6)$

g) $40 \div 2 \div (2 \div 2)$

h) $(4 \times 5 + 7 \times 7)$

i) $(36 \div 6 + 14) \div 4$

j) $(20 - 13 + 4)^2$

k) $11 \times (7^2 - 37)$

l) $3 + 9 \times 2 \div 3 \times 5$

m) $4^2 - 2^3 - 2^2$

n) $80 \div 2^3 + 1$

o) $(25 \div 5)^2 \div 5$

p) $32 \div (6^2 \div 9)$

q) $31 - 19 + 48 \div 8$

r) $13 + 12 \times 3 \div 2$

s) $7 + 6 \times 8 + 14$

t) $5 \times 4 + 8 \times 9$

u) $(50 - 4^2) \div 2$

v) $14 - 3 \times (5 - 5)$

w) $(12 - 5)^2 + 6$

x) $45 \div 3^2$

y) $8^2 + 7 \times 4$

z) $5 \times (37 - 14)$

3. Calculate the following remembering the correct order of operations

a) $6 + 9 \times (40 - 33)$

b) $7 \times 6 \times 4 \div 2$

c) $(7^2 - 5) \div 1^3$

d) $6 \times 7 \div 2 \times 5$

e) $18 + 11 \times 3 - 22$

f) $(9 - 6 + 7)^2 \times 5$

g) $88 \div (8 + 3) \times 3$

h) $64 \div 2 \div 2 \div 2$

i) $5 \times (14 \div 2) + 4 \times 6$

j) $(9 + 6) \times (4 + 7)$

k) $(87 - 79) \times 4^2$

l) $40 - (17 - 8) + 9$

m) $68 \div 2 \div 2 - 8$

n) $16 - 4 \times 3 + 8$

o) $72 \div (54 \div 6) + 7$

p) $10^2 - 8 \times 3$

q) $(4 + 5 \times 8) \div 11$

r) $(23 + 13) \div (14 - 5)$

s) $(20 - 4) \div 2^3$

t) $7 + 6 \times 8 - 15$

u) $9 \times 4 \div 3 \times 5$

v) $(7^2 - 14 - 31)^2$

w) $(8^2 - 57) \times 2^2$

x) $35 - 36 \div 4$

y) $21 - (34 - 6) \div 7$

z) $(9 \times 4 - 7 \times 5)^5$

Answers**Exercise 6.01**

1a) 47	n) 57	2a) 61	n) 72
b) 22	o) 40	b) 69	o) 66
c) 3	p) 40	c) 51	p) 13
d) 79	q) 21	d) 49	q) 16
e) 16	r) 78	e) 84	r) 8
f) 76	s) 17	f) 40	s) 69
g) 27	t) 25	g) 18	t) 17
h) 35	u) 7	h) 0	u) 32
i) 13	v) 28	i) 12	v) 81
j) 29	w) 42	j) 3	w) 40
k) 8	x) 419	k) 16	x) 20
l) 56	y) 85	l) 21	y) 26
m) 69	z) 3	m) 20	z) 18

Exercise 6.02

1a) 12	h) 12	o) 93	v) 48
b) 4	i) 29	p) 9	w) 151
c) 157	j) 47	q) 24	x) 5
d) 6	k) 100	r) 55	y) 185
e) 7	l) 1	s) 0	z) 15
f) 9	m) 3	t) 46	
g) 18	n) 29	u) 15	

Exercise 6.03

1a) 24	u) 11	o) 5	i) 59
b) 56	v) 17	p) 8	j) 165
c) 30	w) 27	q) 18	k) 128
d) 126	x) 23	r) 31	l) 40
e) 56	y) 53	s) 69	m) 9
f) 8	z) 108	t) 92	n) 12
g) 7	2a) 72	u) 17	o) 15
h) 62	b) 34	v) 14	p) 76
i) 96	c) 11	w) 55	q) 4
j) 2	d) 125	x) 5	r) 4
k) 210	e) 99	y) 92	s) 2
l) 2	f) 9	z) 115	t) 40
m) 28	g) 20	3a) 69	u) 60
n) 300	h) 69	b) 84	v) 16
o) 81	i) 5	c) 44	w) 28
p) 121	j) 121	d) 105	x) 26
q) 81	k) 132	e) 29	y) 17
r) 27	l) 33	f) 500	z) 1
s) 294	m) 4	g) 24	
t) 79	n) 11	h) 8	