**Grade Level:** 3-5
**Time Estimate:** 2-3 days

# ORDER OF OPERATIONS / INSTRUCTOR INFO

## Summary

This lesson includes vocabulary, content, examples, and activities to aid students in understanding the functionality of the order of operations.

**Part 1.** Introduction
**Part 2.** Basic Operations
**Part 3.** The Order of Operations
**Part 4.** Real World Applications
**Activity 1.** Creating Word Problems

## Goals & Objectives

**The students will:**
- Review the four basic operations;
- Solve numerical expressions using the order of operations;
- Create numerical expressions when presented with a word problem;
- Relate their knowledge to real world situations.

**Grade Level: 3-5**

# // STANDARDS

**This lesson aligns with the following TEKS:**
Grade 3 Math: 1A, 1B, 1C, 1F, 1G, 4A, 4J, 4K, 5A, 5B, 5C, 5D
Grade 4 Math: 1A, 1B, 1C, 1F, 1G, 4A, 4B, 4H, 5A,
Grade 5 Math: 1A, 1B, 1C, 1F, 1G, 3A, 3K, 4B, 4E, 4F,

**STEM**
This lesson plan aims to assist teachers in implementing a STEM-based program into their classroom while inspiring the next generation of explorers, scientists, and stewards of the ocean. Based on real science and the Global Shark Tracker™, "Order of Operations" is intended to promote environmental awareness and to prepare students for STEM careers.

## Helpful Tips

**1.** The content in this lesson is related to OCEARCH and the Global Shark Tracker. Spend a few minutes getting familiar with the website and the tracker if you have not done so already. The Global Shark Tracker is also available as an app for iPhone and Android.
**2.** This lesson plan is designed to be adaptable to suit your specific needs. Use the entire lesson plan or just parts of it. This material can be expanded to be an entire unit or condensed for just one day in the classroom.
**3.** Vocabulary words will be underlined as they appear in the lesson plan. A complete list of vocabulary words is included as well.
**4.** Answers to questions and prompts for discussions will appear in italics.
**5.** Optional activities and content (side notes) will appear in a box. Use these to enhance your lesson and adapt it to suit your needs!
**6.** Have questions for OCEARCH Expedition Leader, Chris Fischer? Email info@OCEARCH.org to schedule a Skype session and let your students/child talk directly to Chris and the OCEARCH crew!
**7.** Email all questions about this lesson to info@OCEARCH.org.

**Grade Level:** 3-5

# ORDER OF OPERATIONS / VOCABULARY

**Addition** – The total, or sum, of two or more integers.

**Division** – The operation of determining how many times one quantity is contained in another.

**Equation** – A statement that two mathematical expressions are equal. Indicated by the equal sign (=).

**Exponent** – A mathematical notation that implies the number of times a number is to be multiplied by itself.

**Expression** – A representation of a number. Example: 5+3 and 10-2 are both expressions that represent the number 8.

**Multiplication** – The process of adding a number to itself a certain number of times.

**Order of Operations** – The order in which to carry out operations when evaluating an expression – parenthesis, exponents, multiplication, division, addition, subtraction.

**Parentheses** – The symbols used in pairs to group things together.

**PEMDAS** – The order of operations. Stands for parentheses, exponents, multiplication, division, addition, subtraction.

**Subtraction** – The operation of finding the difference between two quantities or integers.

**Grade Level:** 3-5

# ORDER OF OPERATIONS / LESSON PLAN

## PART 1. INTRODUCTION **5-10 mins**

Galileo once said, “The great book of nature can be read only by those who know the language in which it was written. And that language is mathematics.”

Mathematics has always been the language of science. And if you think about it, math is used in almost every aspect of your everyday life. Whether you are measuring ingredients for a recipe or counting your savings for a new bike, a basic knowledge of mathematics is required.

The researchers aboard the M/V OCEARCH regularly use math during their expeditions. When they lift a shark out of the water using the hydraulic lift, they have 15 minutes to perform a series of tests on that shark. In many ways, math is involved in this process. To begin with, when engineering the hydraulic lift they needed to determine how much weight the lift would be able to hold. Once the shark is on the lift the team counts and measures parasites they find on the shark. They also take body measurements to determine its size and compare it to other sharks with the same or different reproductive maturity. When blood samples are being collected, the team must ensure they are measuring the appropriate amount of blood into the syringe. As part of their research, the crew also attaches a S.P.O.T (smart position temperature) tag to the shark’s dorsal fin. With this they are able to track the shark’s migratory pattern and calculate the distance it travels through the world’s oceans.

# PART 2. BASIC OPERATIONS **10-20 mins**

Basic operations are very important to marine scientists who study sharks and the ocean. It is important to be able to use addition, subtraction, multiplication, and division in different scenarios to solve complex problems. Before exploring the rest of this lesson, make sure students understand the four basic operations.

-Addition is the total, or sum, of two or more integers.
-Subtraction is the operation of finding the difference between two quantities or integers.
-Multiplication is the process of adding a number to itself a certain number of times.
-Division is the operation of determining how many times one quantity is contained in another.

## Fast Math!

Practice mental math with this card game.
(10 – 15 minutes)

Materials: One deck of playing cards.

Instructions: Gather everyone in a circle. The teacher will start the game off by calling out one of the operations. The first student with the deck of cards will flip the top two cards over and use mental math to add, subtract, multiply, or divide the two numbers*. For example: If the teacher calls out "addition" and the student flips over a 5 and a 2, he or she will answer with "seven".* When the correct answer is said, the student passes the deck to their neighbor. After the deck of cards completely goes around the circle, the teacher will call out a different operation and play continues.

* Face cards can either be taken out of the deck or used as "wild cards".
* Students may not be able to divide some numbers evenly; instead, students can multiply their numbers.
* For more of a challenge, time how long it takes the deck to make it around the circle. Try to beat the time during the next round.

In school we often see math problems as a bunch of simple, unrelated equations that are pretty straightforward to solve.

$2 + 2 = 4$
$10 - 1 = 9$
$2 \times 5 = 10$
$8 \div 2 = 4$

However, marine researchers collect so much data that they usually encounter complicated problems requiring different combinations of addition, subtraction, multiplication, and division. These complex problems can only be solved with strategy and planning ahead.

# PART 3. THE ORDER OF OPERATIONS? **30-45 mins**

Math is a very exact subject and there is no room for flexibility

In Class Activity (5 – 10 minutes)

Write the following expression on the board for the whole class to see.

$$4 + 6 \div 2$$

1. Ask half of the class to solve the expression using addition first.
2. Ask the other half of the class to solve the expression using division first.

What answer did everyone get? Which answer is correct?

The order of operations eliminates the mistake of solving an equation containing multiple operations incorrectly. It dictates the order in which each operation is carried out. The order is as follows:

**P**arentheses
**E**xponents
**M**ultiplication
**D**ivision
**A**ddition
**S**ubtraction

Students can remember the six step process with the phrase **P**lease **E**xcuse **M**y **D**ear **A**unt **S**ally.

When following this order, you must first solve what is in the parentheses, then calculate the exponents. After that, you can multiply and divide, then finally add and subtract.

When it comes time to multiply/divide and add/subtract, you don't necessarily have to multiply before you divide or add before you subtract. You can simply do whichever comes first in the expression when reading from left to right. For example, when trying to solve 47 ÷ 5 ⍰ 8 + (6 + 3) – 22, divide 47 by 5 before multiplying by 8 since that is the order we read the expression. The same applies for addition and subtraction as well.

**Example 1.** Using the order of operations, solve (5 + 6) - 1 × 32

Step 1: Solve everything in the parentheses. (PEMDAS)
(5 + 6) = 11

This makes our new equation 11 – 1 × 32

Step 2: Solve the exponent. (PEMDAS)
32 = 3 × 3 = 9

This makes our new equation 11 – 1 × 9

Step 3: Multiply (PEMDAS)
1 × 9 = 9

This makes our new equation 11 – 9

Step 4: Subtract (PEMDAS)
11 – 9 = 2

(5 + 6) - 1 × 32 = 2

**Example 2.** Using the order of operations, solve 7× (22 – 4)

Step 1: Solve everything in the parentheses. (PEMDAS)

Since there are multiple operations in the perenthesis, we follow the rules of PEMDAS to solve the exponent first, then subtract.

(22 – 4)
22 = 4
(4 – 4) = 0

This makes our new equation 7 ⍰ 0

Step 2: Multiply (PEMDAS)

7 × 0 = 0

7× (22 – 4) = 0

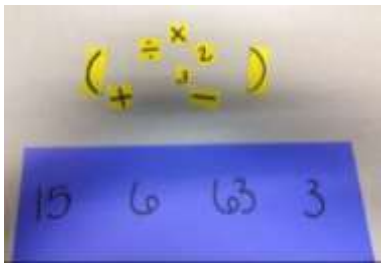
**In Class Examples:** Use the order of operations to solve the following:
*Note, a student worksheet is provided on pages 12 and 13.*

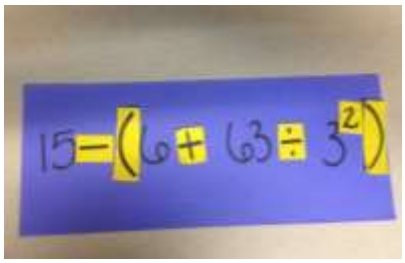
| | | |
|---|---|---|
| 1. | 31 – 22 + 1 | *Answer: 28* |
| 2. | 63 – 93 + 6 | *Answer: -660* |
| 3. | 5 × (53 + 2) | *Answer: 635* |
| 4. | (7 + 3) × (7 – 5) | *Answer: 20* |
| 5. | 42 + 2 × (5 + 3) ÷ 4 – 7 | *Answer: 13* |
| 6. | (9 + 4) ÷ (5 – 5) | *Answer: does not exist; cannot divide by 0* |
| 7. | (9 + 4) × (1 – 5) | *Answer: -52* |
| 8. | (70 – (1 + 3)) × 2 | *Answer: 132* |
| 9. | (25– (1 + 8)) × 4 | *Answer: 64* |
| 10. | 43 – (8 × 2) ÷ 4 | *Answer: 39* |
| 11. | 22 – 5× (3 + 7) ÷ 2– 4 | *Answer: -25* |
| 12. | (11 + 53 – 62) ÷ (4 – 2) | *Answer: 14* |

In Class Activity – Illustrating the Order of Operations

The following activity is intended to help your students learn the proper use of mathematical signs and the order of operations. Prior to beginning the activity, you will need to create the necessary materials (Image 1). Numbers do not have to be as shown.

Give students time to create and solve equations by reorganizing the operations, exponents, and parentheses (Images 2, 3, and 4). This activity can be done individually, in groups, or as a class.





# PART 4. REAL WORLD APPLICATIONS **30-45 mins**

When marine researchers are working in the field or analyzing data, calculations are rarely presented in the straightforward, organized way that the previous examples were presented to you. Scientists have to analyze their data and figure out how to set up their own calculations to get the answers they are looking for. Let's look at some examples.
Ask some questions to review the lesson material:

**Example 3.**

Blue shark Beamer swam 30 miles less than tiger shark Esperanza, who swam 92 miles. Silky shark Encantada swam half as many miles as Beamer. How many miles did Encantada swim? Create an equation and solve.

Step 1: What is the question?

"How many miles did Encantada swim?" Let's represent this unknown number with "X".

Step 2: The problem tells us Encantada swam half as many miles as Beamer. We can use this to start building our equation.

# of miles Beamer swam ÷ 2 = X

Step 3: If we figure out how many miles Beamer swam, we can solve the equation.

According to the problem, "Blue shark Beamer swam 30 miles less than tiger shark Esperanza, who swam 92 miles." This tells us everything we need to complete the equation.

(92 – 30) ÷ 2 = X

Step 4: Solve!

(92 – 30) ÷ 2 = X
62 ÷ 2 = X
31 – X

The equation (92 – 30) ÷ 2 = X tells us Encantada swam 31 miles!

**Example 4.**

Researchers aboard the M/V OCEARCH tagged 2 sharks in the first week, 3 sharks in the second week, and 1 shark in the third week of an expedition. The researchers have only 15 minutes to tag and conduct as many tests as possible before releasing the shark back to the ocean. Each test takes 3 minutes to complete. The OCEARCH researchers need to know how many tests they performed total, between all of the sharks they tagged in the first three weeks of their expedition. Create an equation and solve.

Step 1. The first thing we are given is the amount of sharks tagged in the first three weeks.

> "…researchers aboard the OCEARCH vessel tag 2 sharks in the first week, 3 sharks in the second week, and 1 shark in the third week…"

2 + 3 + 1 = # of sharks tagged in the first three weeks.

Step 2. Next, we find out that the researchers have only 15 minutes total to work on each shark.

> "The researchers have only 15 minutes to tag and conduct as many tests as possible before releasing the shark back to the ocean. Each test takes 3 minutes to complete."

15 ÷ 3 = # of tests per shark

Step 3. Now we bring it all together!

> "The OCEARCH researchers need to know how many tests they performed total, between all of the sharks they tagged in the first three weeks of their expedition."
>
> We know (2+3+1) sharks were tagged and each shark had (15 ÷ 3) tests performed. Now, we multiply the number of sharks by the number of tests to find how many tests total were performed. Let's represent this unknown number as "X".
>
> (2+3+1) × (15÷3) = X
> 6 × 5 = X
> 30 = X
>
> The equation (2+3+1) × (15÷3) = X tells us researchers were able to perform 30 tests total, between all sharks tagged in the first three weeks of their expedition.

**Example 5.**

There are 104 sharks off the coast of Cape Town, South Africa. From Cape Town, 3 sharks moved to Lambert's Bay, 10 sharks moved to Pearly Beach, and 14 sharks moved to Betty's Bay Marine Protected Area. Of the sharks remaining in Cape Town, one shark gave birth to 3 pups, two sharks gave birth to 4 pups each, and 11 sharks gave birth to 2 pups each. How many sharks total are now off the coast of Cape Town? Create an equation and solve.

Step 1. The first piece of information we are given is how many sharks left Cape Town.

"From Cape Town, 3 sharks moved to Lambert's Bay, 10 sharks moved to Pearly Beach, and 14 sharks moved to Betty's Bay Marine Protected Area."

3 + 10 + 14 = # sharks left Cape Town

Step 2. The next piece of information we are given is how many sharks were added to Cape Town.

"Of the sharks remaining in Cape Town, one shark gave birth to 3 pups, two sharks gave birth to 4 pups each, and 11 sharks gave birth to 2 pups each."

$1 \times 3 + 2 \times 4 + 11 \times 2$ = # sharks born in Cape Town

Step 3. Now we bring it all together!

"How many sharks total are now off the coast of Cape Town?" Let's represent this unknown number as "X".

We know there were originally 104 sharks living near Cape Town. To find out how many sharks are currently there we need to subtract the number of sharks that left and add the number of sharks that were born.

$104 - (3 + 10 + 14) + (1 \times 3 + 2 \times 4 + 11 \times 2) = X$
$104 - (3 + 10 + 14) + (3 + 8 + 22) = X$
$104 - 27 + 33 = X$
$110 = X$

The equation $104 - (3 + 10 + 14) + (1 \times 3 + 2 \times 4 + 11 \times 2) = X$ tells us there are 110 sharks now living off the coast of Cape Town.

## Grade Level: 3-5

**In Class Examples**

Use the problems to create an equation and solve for the unknown.
Note, a student worksheet is provided on pages 12 and 13.

1.Beatriz, a silky shark, eats 1.7 kg each time she feeds. Cyndi, a great white, eats 18 times as much as Beatriz. If each shark feeds twice a day, how many kilograms are they eating between the two in a week?

Answer: (2 × 1.7) □ 7 + 2 □ (18 × 1.7) × 7 = 452.2 kg

2.The OCEARCH crew prepares four, 60 lb. barrels of chum, daily. Due to choppy water, they lost a barrel and a half of chum. How many pounds of chum did they have left?

Answer: (4 × 60) – (60 + (60 ÷ 2)) = 150 lbs

3.Chris had 50 cupcakes that he brought aboard the M/V OCEARCH for a crew member's birthday. Six of the crew members wanted three cupcakes each. The birthday boy wanted five cupcakes for himself. Then, one of the six crew members gave back two of her cupcakes. How many cupcakes did Chris have left to pass out after the crew member gave hers back?

Answer: 50 – (6 × 3 + 5 – 2) = 29 cupcakes

4.How many yards of material from a 64 yard length of fishing line remain after two pieces, each four yards long, and five pieces, each three yards long are removed?

Answer: 64 – ((2 × 4) + (5 × 3)) = 41 yards

**Grade Level: 3-5**

**Name:** _____

**Date:** _____

# Order of Operations

Use the order of operations to solve the following:

1. 31 – 22 + 1 =

2. 63 – 93 + 6 =

3. 5 × (53 + 2) =

4. (7 + 3) × (7 – 5) =

5. 42 + 2 × (5 + 3) ÷ 4 – 7 =

6. (9 + 4) ÷ (5 – 5) =

7. (9 + 4) × (1 – 5) =

8. (70 – (1 + 3)) × 2 =

9. (25– (1 + 8)) × 4 =

10. 43 – (8 × 2) ÷ 4 =

11. 22 – 5 × (3 + 7) ÷ 2– 4 =

12. (11 + 53 – 62) ÷ (4 – 2) =

**Grade Level:** 3-5

**Name:** _____

**Date:** _____

# Order of Operations

Use the problems to create an equation and solve for the unknown.

1.Beatriz, a silky shark, eats 1.7 kg each time she feeds. Cyndi, a great white, eats 18 times as much as Beatriz. If each shark feeds twice a day, how many kilograms are they eating between the two in a week?

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4.How many yards of material from a 64 yard length of fishing line remain after two pieces, each four yards long, and five pieces, each three yards long, are removed?

**Grade Level:** 3-5
**Time Estimate:** 30-45 mins

# ORDER OF OPERATIONS / ACTIVITY 1. CREATING WORD PROBLEMS

## INTRODUCTION

This activity will allow students to use the Global Shark Tracker™ to collect information and then create and solve their own word problems using the order of operations. Students may work individually or in groups.

As an added activity, students can trade and solve each other's word problems.

## MATERIALS

- Computer with internet access
- Paper and pencil
- Calculator (optional)

## INTRUCTIONS

Give students time to explore and familiarize themselves with the Global Shark Tracker™ (www.ocearch.org). They can use any information they find to create their word problems as long as they include the necessary numbers to answer their question.

## TIPS

- Possible questions could relate to shark weight, length, species, etc.
- Students can always use examples from class as a template.

After writing their problem, students will need to solve and show their work. If you choose to have students trade problems for added practice, solutions can be written on the back or on a separate piece of paper.