AMP IT UP

Advanced Manufacturing & Prototyping Integrated to Unlock Potential

6^{TH} GRADE MATH

Data Representation

DATA SAVED THE WHALES!

Whale Challenge

6DVM

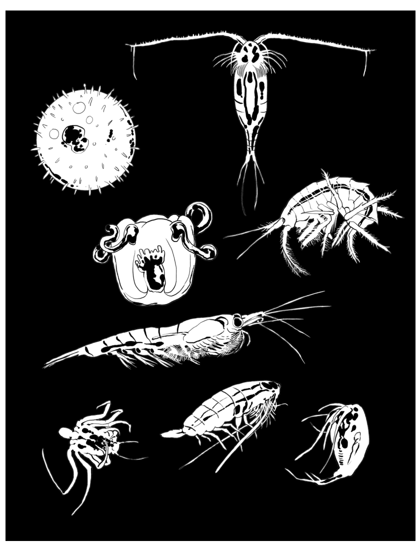
SECTION 1 – DATA SAVES THE WHALES!

1.1 INTRODUCTION

The research ship ODEN travels to the Antarctic to study the environment and the animals that live there. The scientists on board made a video to show what that environment looks like.

Watch ***ODEN*** video #1.

Plankton are one of the organisms in the ocean that scientists study. Plankton play an important role in the aquatic ecosystem (water environment) and food web. Plankton are a valuable food source for fish, birds, and mammals, including whales. They also eat millions of little algae, which helps keep the algae population from getting too high. A high plankton population is an indicator of a healthy ecosystem and means that other animals will have food to eat.



Aquatic Plankton

One scientist who studies oceans and plankton is Dr. Ellery Ingall. He is a professor in the Georgia Tech School of Earth and Atmospheric Sciences. To understand the marine (ocean) environment, Dr. Ingall and his graduate students collect data about many parts of the environment. Watch the video of Dr. Ingall's graduate student, Julia Diaz, as she conducts her research on the ODEN.

Dr. Ellery Ingall and Julia Diaz

Watch ***Julia's Research*** video #2.

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The scientists on the Antarctic ship ODEN use an instrument called a CTD (Conductivity, Temperature and Depth) robot to collect data from the ocean. The robot has many canisters that are open at the ocean's surface and close when the CTD is at a certain depth beneath the surface of the ocean. Each canister is pre-labeled with the depth where the water was collected. The water sample contains organisms that live at that depth. Watch the CTD video to see how the robot is used to collect water under the ocean's surface. As you watch, think about what factors might affect how deep the plankton live in the water.

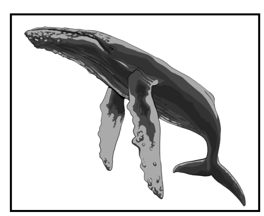
Watch ***CTD Video*** #3.

After the CTD is brought aboard the ODEN, scientists prepare the contents from each canister so they can study it. The water is evaporated and scientists study what remains. One of the remaining items is dried plankton. When alive, the size of each individual plankton ranges from 200 micrometers (half a hair width) to 2 centimeters (the width of a nickel). The dry plankton is a solid mass at the bottom of the container that is a greenish color.

1.2 YOUR CHALLENGE: SAVE THE WHALES WITH DATA!

Whales around the world feed on plankton. One common danger to whales swimming near the surface is that they are sometimes struck by passing ships. This can hurt or even kill the whale and can even cause the boat to sink. Dr. Ingall would like to predict how deep whales usually are when they eat in order to ensure ships like the ODEN do not hit feeding whales. Your challenge is to determine the depth where whales will most likely feed on plankton when they are in the waters around Antarctica.

The ODEN also sails in warmer climates than Antarctica. Dr. Ingall thinks this might affect how deep the whales are when they feed. The second part of your challenge is to find out what temperature water the plankton prefer.



SECTION 2 – THE OCEAN DATA SIMULATION

2.1 UNDERSTANDING THE SIMULATION

Part A: Simulations

The leader of your research trip has decided the goals for your team. You will try to determine at what depth whales are most likely to feed and determine the water temperature where the plankton live. Your team will not be on board the ODEN to conduct the experiments. Instead, you will use a simulation to explore the relationships among the water temperature, plankton, and water depth.

KEY TERMS

Simulation: An imitation of a real process or thing.

Simulated experiment: An experiment where you collect evidence so that you can draw conclusions.

A **simulation** is an imitation of a real process or thing. In this case, you will conduct a **simulated experiment**, in which you collect evidence so that you can draw conclusions. The evidence you collect is based on evidence collected through real experiments aboard Antarctic research ships like the ODEN. The results from your simulated experiment are the same as those from experiments run by people like Julie Diaz.

Part B: Simulated Research from the ODEN

In your simulation, you will have plastic canisters that will represent the containers used by the CTD robot when it collects water samples. Each canister is pre-labeled with the depth where the sample was collected. That number indicates how many feet below the surface of the water the CTD was when the canister closed.

Simulation Canister

The thermometer read-out inside the canister indicates the water temperature reading at the depth labeled on the outside of the canister. The bag inside contains the dried plankton that was in the canister, which is represented by split green peas.

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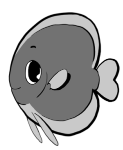
2.2 VISUALIZING DATA: CREATING WHALE CHALLENGE PICTOGRAPHS

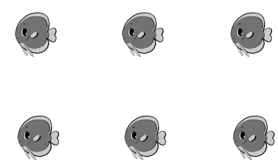
Part A: Graphing a Pictograph

Graphs are a visual way to display data. Graphs are valuable because they make trends easier to see than if the data is just shown in a chart of numbers. A **pictograph** uses pictures or symbols to show the value of the data. One picture can represent more than one object or occurrence of an event. Pictographs use different size pictures, or repetitions of the same picture, to show a comparison. For example, a large picture of a fish might represent 100 fish, while a small one represents 10 fish. Another example could be each picture of a fish might represent 10 fish, and you would use 6 pictures to represent 60 fish.



Represents 100 fish

Represents 10 fish



Represents 60 fish

Part B: Creating Individual Pictographs

Please follow this procedure with your group to collect and analyze your data. Each member of your group will create two pictographs of your group's canister data—one of temperature and one of plankton weight.

<u>Material Collection</u>

Collect the following materials:

- A set of CTD canisters for the group.
    a. Each canister is labeled with the depth where it was collected measured in feet.
    b. Inside each canister is a temperature read-out and a small plastic bag with spilt peas (dried plankton).
- One Temperature Data Sheet, Plankton Weight Data Sheet, and Pictograph Sheet for each student in your group.
- One digital scale.

Graph Your Temperature Data as a Pictograph

Procedure:

1. Read the number that is labeled on the outside of your first CTD canister, which represents the depth where it was collected. Record the number in Data Table #1 on your *Temperature Data Sheet* in the canister number 1 row.
2. Open the first canister and empty the contents onto your desk. Leave the peas in the small bag. Do not open the small bag.
3. Find the slip of paper that was inside of the canister. This is the temperature where the sample was collected. Record the temperature of the canister in Data Table #1 on your *Temperature Data Sheet* in the column marked "T."
4. Follow the procedure on your *Temperature Data Sheet* to calculate how many thermometers you will need to draw if each round thermometer symbol represents 1^{o}F, and your pictograph scale starts at 14^{o}F. Show your calculation and record this number in Data Table #1.
5. Make a pictograph for the temperature of your first canister on your *Temperature Pictograph Sheet*.
    a. Record the depth where Canister 1 was collected on your *Temperature Pictograph Sheet* by circling the depth number of that canister on the y-axis of the Temperature Pictograph.
    b. Draw the appropriate number of round thermometer symbols for your canister, placing one thermometer symbol per box on the line next to the depth of your canister.

Graph Your Plankton Weight Data as a Pictograph

Procedure (Continued):

6. Record the canister depth in Data Table #2 on the *Plankton Weight Data Sheet*.
7. The split peas in your bag represent the dry weight of the plankton. Place the bag containing the plankton (split peas) on the scale and record the total weight in grams of the bag and the plankton in Data Table #2.
8. Sometimes you need to analyze your data before graphing it. Follow the directions on your *Plankton Weight Data Sheet* to calculate and record the following values:
    a. Because you want the weight of the plankton, not the bag, subtract .5 g (the weight of the bag) from the total weight to get the weight of just the plankton in grams.
    b. The weight of the plankton is given in grams. On this pictograph, you will graph the weight in centigrams. One gram is equal to 100 centigrams. To convert your plankton weight from grams to centigrams, multiply your number by 100.
9. Transfer your centigram data from Data Table #2 to Data Table #3 on the back of your *Plankton Weight Data Sheet*.
10. As shown on your *Plankton Weight Data Sheet,* calculate how many plankton symbols you will need to draw if each plankton symbol represents 5 cg of dried plankton. Show your calculation and record this number in Data Table #3.
11. Make a pictograph for the dried plankton weight of your first canister on your *Plankton Weight Pictograph Sheet*.
    a. Record the depth where canister 1 was collected on your *Plankton Weight Pictograph Sheet* by circling the depth number of that canister on the y-axis of the Plankton Weight Pictograph.
    b. Draw the appropriate number of plankton symbols for your canister, placing one plankton symbol per box on the line next to the depth of your canister.
12. Put the temperature readout and bag of split peas back into the container and set that container aside.
13. Repeat this procedure for the rest of your canisters.

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Part C: Creating a Class Pictograph

Mathematicians, scientists, and engineers analyze data and graphs to understand trends and relationships between variables. This allows them to make smarter decisions about things like the environment. They also need to be able to communicate the data effectively to the public. Scientists use visual representations of the data to help people focus on important information, to see patterns, to make connections, and to draw conclusions from data.

In the previous section, you created individual pictographs by drawing multiple symbols to depict your group's temperature and plankton data. The symbols created bars that displayed the data from your canisters.

You will now create a class pictograph with the data collected by all the teams in your class. Your teacher will guide the class in this activity.

Procedure:

1. As your classmates share their data, record the temperature and plankton weight for each depth on your *Whale Challenge Data Tables* student sheet. Use the temperature data rounded to the nearest degree and the plankton weight rounded to the nearest multiple of 5.
2. Complete your pictographs on your *Temperature Pictograph Sheet* and *Planton Weight Pictograph Sheet* to include the data you recorded from each canister depth on your *Whale Challenge Data Tables* student sheet. This class pictograph will be a complete record of the data collected at each depth.

Discuss these questions as a class:

1. Where do you think the whales will feed?
2. What is your evidence?
3. Do you think that ships might hit the whales at this depth? Why or why not?
4. What trend or pattern do you see in the temperature data?

2.3 ADD TO YOUR UNDERSTANDING: INDEPENDENT AND DEPENDENT VARIABLES

The data included with your canisters (depth, temperature, and plankton weight) are all examples of experimental variables. A variable is any feature of the experiment that can change, or vary. Two examples of experimental variables important in math and science are **independent variables** and **dependent variables**.

KEY TERMS

Independent Variable: A variable that you intentionally change in order to see an effect on another variable.

Dependent Variable: A variable that is being studied and is expected to change when you change the independent variable.

In your challenge, you have been asked to determine at what depth whales will most likely feed on plankton and what the temperature is at that depth. In this example, the depth at which the sample was taken is an **independent variable**. You are investigating how the ocean temperature and plankton mass are affected by depth. Ocean temperature and plankton mass are both examples of **dependent variables**. A dependent variable is what is being measured in an experiment.

SECTION 3 – CARTESIAN COORDINATE GRAPHING

3.1 ADD TO YOUR UNDERSTANDING

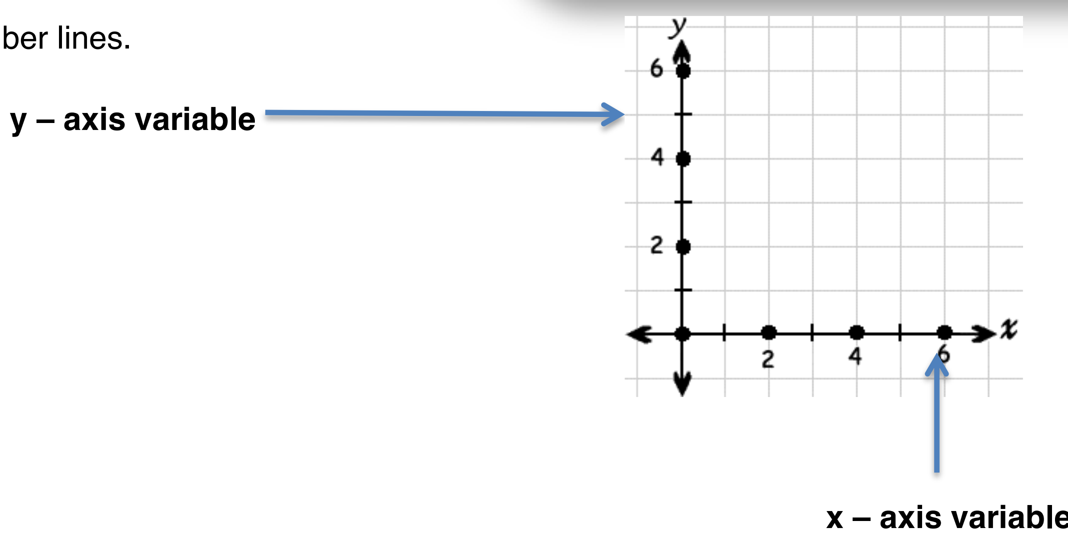
The pictographs that you created showed you a snapshot of where plankton are under the water. You also investigated what the temperature was at each depth. That was one way to look at, or visualize, your data. It is useful to look at your data in more than one way because it can better help you understand what the data means. You will now learn about how mathematicians would visualize the data from your pictographs.

KEY TERMS

Coordinate of a point: A pair of numbers defining the position of a point on a two-dimensional plane. The coordinate is written as an ordered pair.

Ordered Pair: A pair of numbers used to locate a point on a coordinate plane, the first number (x) tells how far to move horizontally and the second number (y) tells how far to move vertically.

Mathematicians sometimes use a **Cartesian Coordinate Graph** to represent data. A Cartesian Coordinate Graph is a coordinate system that specifies a point on the graph as a unique representation of a relationship between two things. The graph is made using two fixed perpendicular number lines.



It is a mathematical practice to graph the <u>independent</u> variable on the x-axis and the <u>dependent</u> variable on the y-axis. The independent variable and the dependent variable form a coordinate pair (independent variable, dependent variable). The coordinate pair makes a point.

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3.2 WORKING WITH DATA

Please follow this procedure independently.

Create Your Ordered Pairs

Procedure:

1. From the data on your *Whale Challenge Data Tables* student sheet, fill in the depth and temperature values on the Relationship #1 Ordered Pairs chart on your *Whale Challenge Ordered Pairs* student sheet. An example has been provided for you.
2. From the data on your *Whale Challenge Data Tables* student sheet, fill in the depth and planton weight on the Relationship #2 Ordered Pairs chart on your *Whale Challenge Ordered Pairs* student sheet. An example has been provided for you.

Create Your Cartesian Coordinate Graph

Mathematicians, scientists, and engineers often like to visualize two dependent variables on the same graph. This allows them to see if there is any relationship between the dependent variables. You will now graph your plankton weight data on the same graph with the temperature data.

3. Using the ordered pairs of numbers on your *Whale Challenge Ordered Pairs* student sheet, plot your temperature data on the graph. You should plot your independent variable (depth) on the x-axis, and your dependent variable (temperature) on the y-axis, using the temperature scale on the left-hand side of the graph. Use circular marks on the graph when you plot this data.
4. Using the ordered pairs of numbers on your *Whale Challenge Ordered Pairs* student sheet, plot your plankton weight data on the graph. You have already plotted the independent variable (depth) on the x-axis. Now, you will plot your dependent variable (plankton weight) on the y-axis. Use the weight scale on the right-hand side of the graph. Instead of using circular marks like the temperature data, this time use an X when you plot the plankton weight data so that you can tell them apart.

3.3 INTERPRETING GRAPHS

People make graphs of data so that they can better understand what the data means, and so they can make claims and predictions based on evidence or data. If you connect the data points on your Cartesian Coordinate Graph, you will create either a line or a curve.

The shape of the data line can provide you with important information. If the data forms a straight line, it is called a **linear relationship**. If the data forms a curve, instead of a straight line, it is called a **non-linear relationship**.

Using your *Whale Challenge Coordinate Graph* student sheet, complete the *Interpreting Graphs* student sheet.

SECTION 4 – RETURN TO THE CHALLENGE

4.1 DR. INGALL'S QUESTIONS

Dr. Ingall initially asked you to figure out two things:

1. Will ships hit whales as they feed on plankton in the Antarctic?
2. Which temperature water do plankton prefer?

In your group, discuss your answer to these two questions. The following information might help you make a decision: "Wikipedia has an entry about the icebreaker ship the Oden. The bottom of the ship is at 39 feet below the surface of the water."

4.2 COMMUNICATING YOUR RESULTS

In the initial challenge, Dr. Ingall was worried about ships hitting whales. He wanted to know how deep whales feed in the Antarctic and what temperature the water is at that depth. It is important that you communicate your results to him, and tell him what relationships you found when you analyzed the data. On your *Letter to Dr. Ingall* student sheet, write him a letter explaining your results.

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