

## **5th Grade Lesson Plan**

### **Alvin Engineer: Equip Your Submersible**

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**1. Title & Grade Level**

Alvin Engineer: Equip Your Submersible (5th Grade)

**2. Lesson Summary**

Students will design the equipment basket on HOV (Human-Occupied Vehicle) Alvin using the provided information on equipment capabilities and the basket's limitations. Given three different research missions with varying collection and sampling objectives, students will consider the “budget” or limits of the submersible’s capabilities as well as the known purposes of the equipment to prepare Alvin for each dive. Each mission's basket must be within the space and weight limits and include the necessary equipment to complete the research goals.

**3. Objectives**

- a. Students learn about different equipment used on HOV Alvin.
- b. Students learn about different research objectives in the deep sea.
- c. Students generate multiple possible solutions to equip a submersible to meet the research goals and constraints of each dive mission.
- d. Students create their own dive with research goals, including constraints and specified criteria for success.

**4. Estimated Time**

45-60 minutes

**5. NGSS Standards Addressed**

**3-5-ETS1-1 Engineering Design:** Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

Performance Expectation Grade: 3-5, 3, 4, 5

**3-5-ETS1-2 Engineering Design:** Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

Performance Expectation Grade: 3-5, 3, 4, 5

**6. Ocean Literacy Principles**

OLP 7: The ocean is largely unexplored.

OLFC 7B: Understanding the ocean is more than a matter of curiosity.

Exploration, experimentation, and discovery are required to better understand ocean systems and processes. Our very survival hinges upon it.

OLFC 7D: New technologies, sensors, and tools are expanding our ability to explore the ocean. Scientists are relying more and more on satellites, drifters, buoys, subsea observatories, and unmanned submersibles.

OLFC 7F: Ocean exploration is truly interdisciplinary. It requires close collaboration among biologists, chemists, climatologists, computer programmers, engineers, geologists, meteorologists, physicists, animators, and illustrators. And these interactions foster new ideas and new perspectives for inquiries.

**7. Focus Question:** Can you equip Alvin's sampling basket to meet the research objectives of multiple deep-sea dives?

**8. Materials**

Included:

- a. Research dive sheets
- b. List of available equipment and capabilities

Not included:

- c. Pencils and erasers
- d. Colored pencils or crayons
- e. Projector or screen for showing video

**9. Preparation**

- a. Print out work packets for all students

**10. Lesson Steps**

**Step one:** View the Deep Sea Equipment video on the Born in the Abyss website to hear from Alvin crew members and deep-sea biologists about the technology that allows for exploration and research. <https://youtu.be/BchtWodGDL4>

**Step two:** Allow students time to independently read about the capabilities of the equipment that can be used on Alvin dives (pages 5-7 of the work packet).

**Step three:** Explain that each student is now an Alvin engineer and their job is to equip their sampling basket for a specific research mission to meet defined objectives. Remind students to consider the constraints on the basket and equipment, as defined in the work packet.

**Step four:** Each student equips the sampling basket for one of the three dives (pages 1-3) by using the weights and grids on pages 5-7 to fill their sample baskets. Remind students that deep-sea research is costly, difficult, and special, therefore it is best to maximize the amount and variety of information collected on each dive. Encourage students to use as much equipment as possible while staying within the constraints and meeting the research objectives.

**Step five:** Encourage students to share their solutions with each other in small groups or as a class.

**Step six:** On page 4, students will propose their own research mission with defined objectives and then design an equipment basket based on these research goals.

## 11. Extensions

- a. Watch these videos on the Born in the Abyss Website to learn more about deep sea research, get to know engineers, scientists, and submersible pilots, and hear behind-the-scenes stories about life at sea.
- b. View the [Alvin Sampling Equipment](#) page to read more about Alvin technology and equipment, including how the submersible has been upgraded throughout its career.
- c. View the [Alvin Virtual Tour](#) to learn more about the vehicle.

## 12. References

Born in the Abyss Deep Sea Equipment Video: <https://youtu.be/BchtWodGDL4>

Alvin Sampling Equipment: <https://ndsf.whoi.edu/alvin/systems/>

Alvin Virtual Tour: <https://ndsf.whoi.edu/alvin/>

# Alvin Engineer: Equip Your Submersible

## SOLUTIONS FOR INSTRUCTORS

5th Grade

The solutions below include the equipment students must have to meet the research objectives of each dive. Students must explain their equipment choices and show that they met the constraints and objectives.

Note: Encourage students to use as much equipment as possible while staying within the constraints and meeting the research objectives. If they still have space in their basket, suggest that they bring multiples of equipment when available or think outside of the research objectives.

### Dive #1

#### Research Objectives

1. Collect temperature data near hydrothermal vents
2. Collect footage of the vent site
3. Collect data of dissolved oxygen content in the seawater near hydrothermal vents
4. Collect samples of the ash near hydrothermal vents

#### Solution:

1. Heat flow probe
2. Cameras and Lights
3. Niskin Bottles
4. Push Corers

### Dive #2

#### Research Objectives

1. Collect deep sea tube worms
2. Sample the vent fluid
3. Collect the rock material that the tube worms are living on
4. Sample water to look for plankton

#### Solution

1. Standard Bio Boxes or Sensitive Sample Bio Box AND Scoop Nets
2. Major Water Samplers
3. Rock Collection Baskets
4. Niskin Bottles or Slurp Samplers

Note to engineer: Collecting plankton will allow scientists to look for the microscopic babies of the tube worms

### Dive #3

#### Research Objectives

1. Collect a deep-sea coral that is spotted on this dive but has never before been described or documented by a scientist
  - a. Make sure the deep-sea coral is returned safely to the surface
2. Collect data on the nutrient content of the water near the site of the deep-sea coral
3. Sample the sediment near the coral
4. Collect footage of the site
5. Search for the microscopic babies of the coral

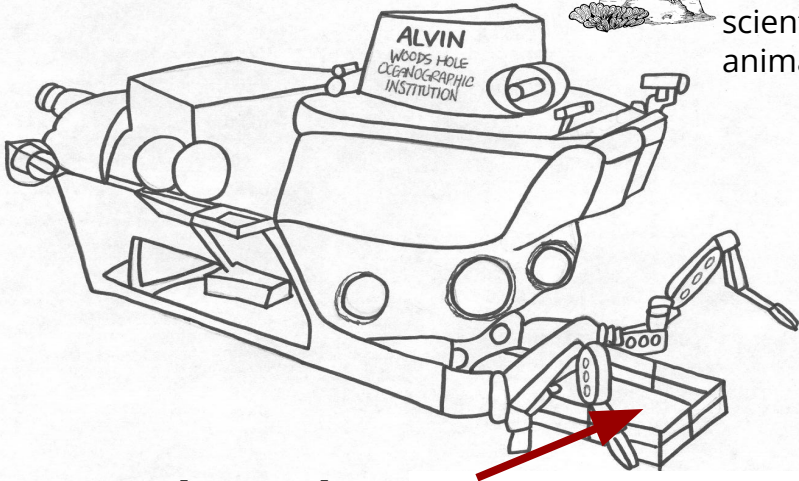
#### Solution:

1. Sensitive Sample Bio Box AND Scoop Nets
2. Niskin Bottles
3. Push Corers
4. Cameras and Lights
5. Niskin Bottles or Slurp Samplers

# Alvin Engineer: Equip Your Submersible

Page 1

## Dive #1

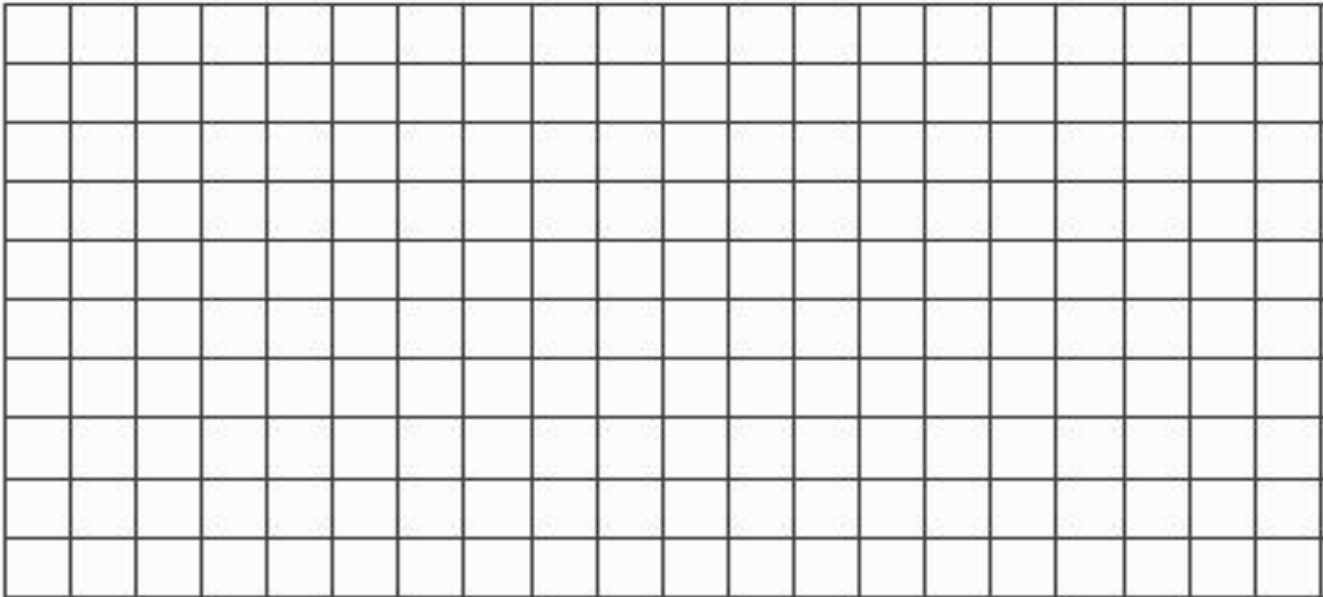


An underwater volcano has just exploded near a hydrothermal vent field. The entire site is covered in ash. This is an event that is very rarely witnessed by scientists. How will this ash affect the communities of animals living on the hydrothermal vents?

### Research Objectives

- 1. Collect temperature data near hydrothermal vents
- 2. Collect footage of the vent site
- 3. Collect data of dissolved oxygen content in the seawater near hydrothermal vents
- 4. Collect samples of the ash near hydrothermal vents

**Sample Basket** A large basket on the front of the submersible carries a variety of instruments and collected samples. It can hold up to 400 pounds. Note: for this exercise, assume all collected samples fit within the sample containers and their listed weights.



The graph above represents your sample basket. Select equipment from pages 5-7. Shade in the squares on this graph according to the number and shape of squares listed with each piece of equipment. They have to fit without overlapping. Along with space limits, remember to consider the total weight limit for the sample basket. Below, explain how your choices meet the research objectives for the dive.

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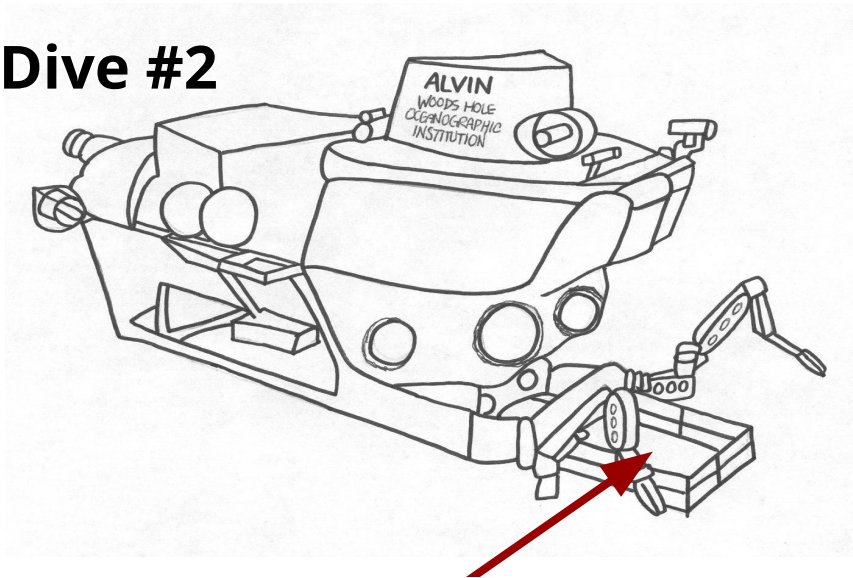
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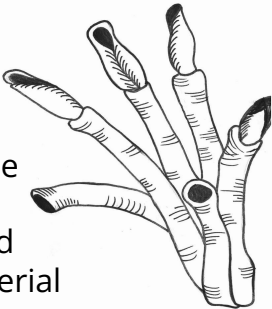
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Dive #2



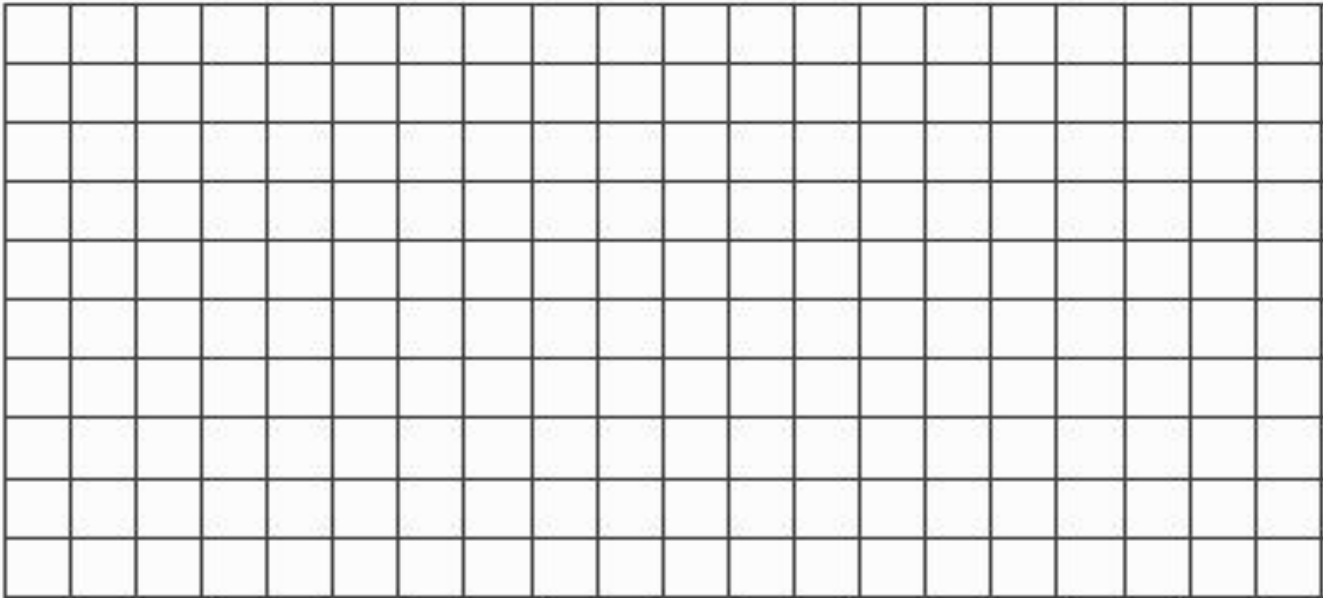
Research Objectives

- 1. Collect deep sea tube worms
- 2. Sample the vent fluid
- 3. Collect the rock material that the tube worms are living on
- 4. Sample water to look for plankton



Note to engineer: Collecting plankton will allow scientists to look for the microscopic babies of the tube worms

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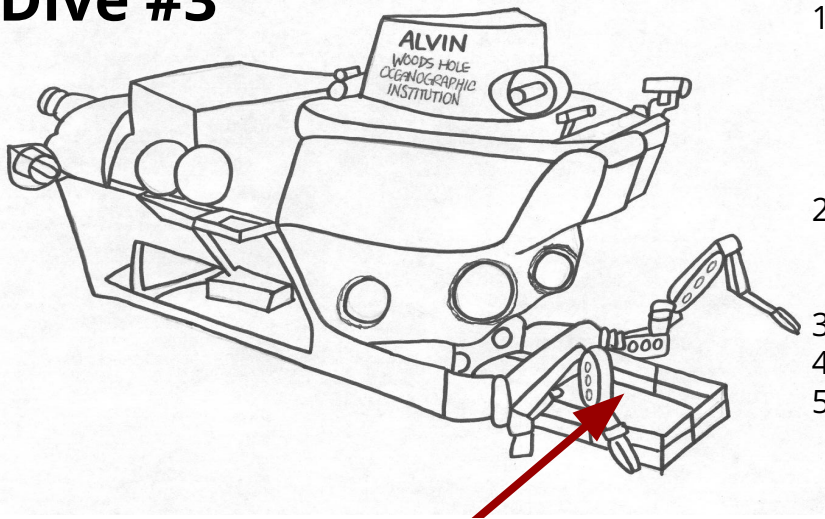
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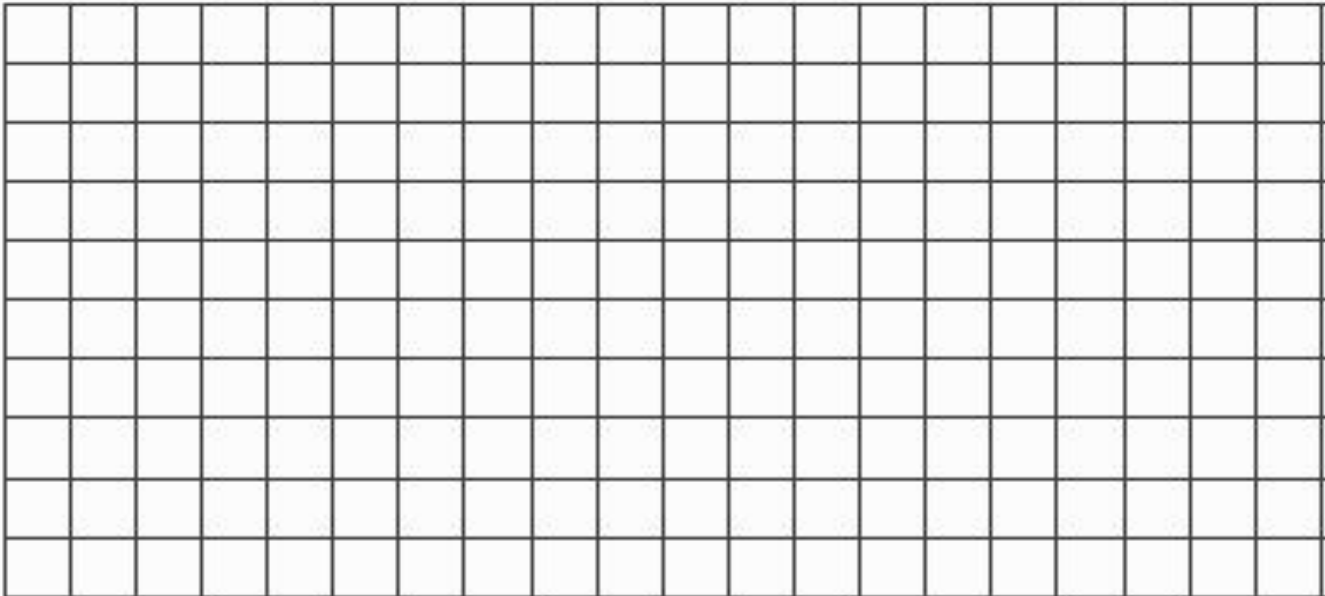
Research Objectives

Dive #3



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  - a. Make sure the deep-sea coral is returned safely to the surface
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- 4. Collect footage of the site
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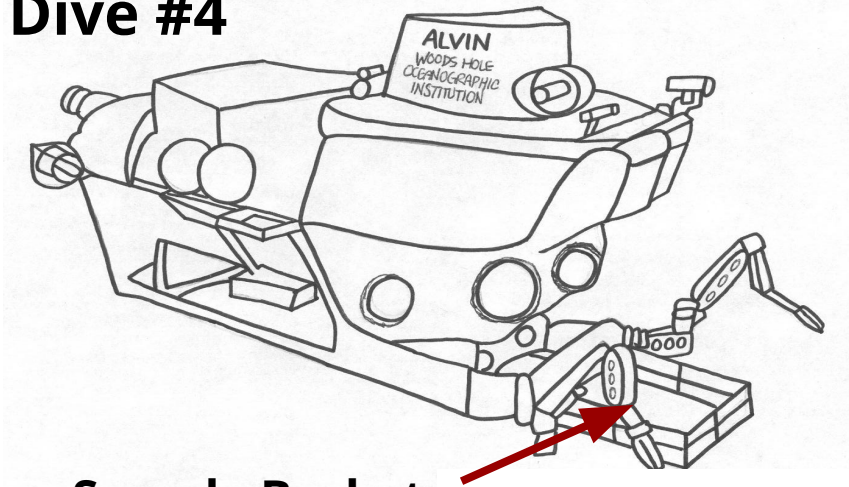
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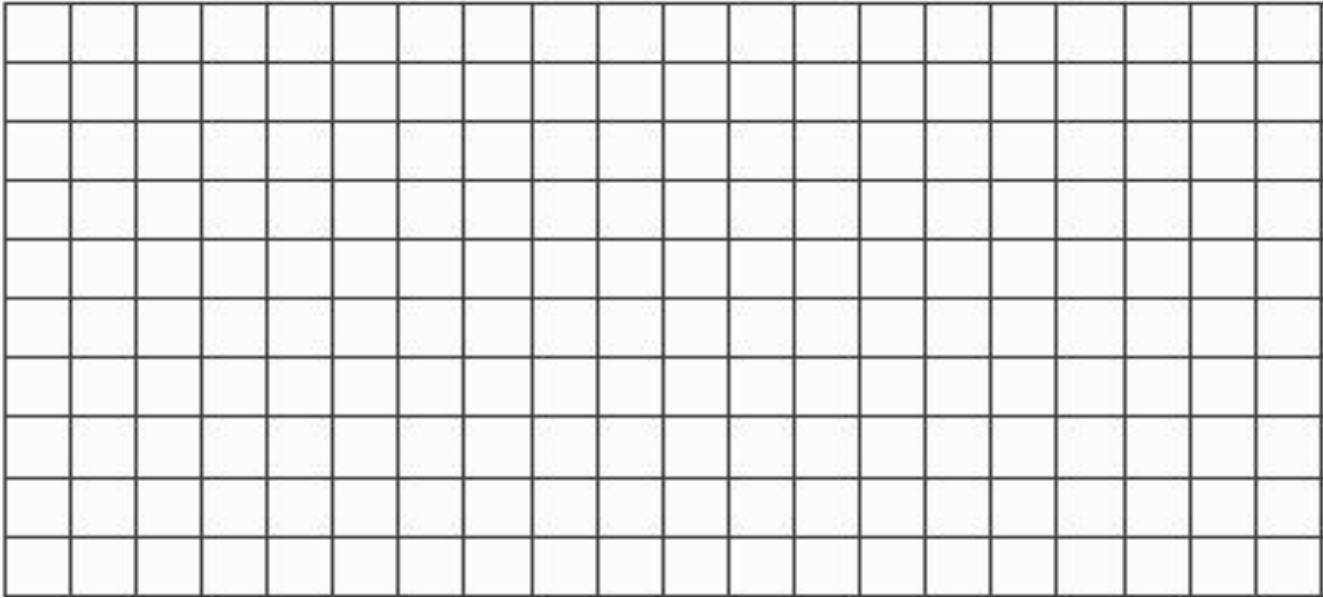
Create your own research objectives

Dive #4



- 1.
- 2.
- 3.
- 4.

**Sample Basket** A large basket on the front of the submersible carries a variety of instruments and collected samples. It can hold up to 400 pounds. Note: for this exercise, assume all collected samples fit within the sample containers and their listed weights.



The graph above represents your sample basket. Select equipment from pages 5-7. Shade in the squares on this graph according to the number and shape of squares listed with each piece of equipment. They have to fit without overlapping. Along with space limits, remember to consider the total weight limit for the sample basket. Below, explain how your choices meet the research objectives for the dive.

# Alvin Engineer: Equip Your Submersible

Page 5

**Note: listed weights include the equipment and collected samples**

## Heat Flow Probe

This probe is a 0.6-meter long, highly-sensitive temperature sensor. It is used to measure temperature gradients when inserted into soft sediments. Measurable temperature range is 0 to 40 °C, with high accuracy. There is one available.

**Weight = 4 lbs**

## Niskin Bottles

These instruments are used to collect ocean water at different depths. Each of these bottles seals off its sample and allows it to be brought to the surface without mixing with water from different depths. The water collected by Niskin bottles is used to study plankton (including the larvae or babies of marine animals) or measure many physical characteristics such as salinity, dissolved oxygen, nutrient concentrations, and dissolved organic and inorganic carbon.

There are two size options:

a) 1.2-liter Niskin bottles are mounted in a 5-pack arrangement and can be triggered individually by the manipulator arm. There is one 5-pack available.

**Weight = 41 lbs**

b) Individual 5-liter Niskin bottles, 2 are available

**Weight = 18 lbs each**

## Major Water Samplers

These syringe-style instruments are used to sample high-temperature hydrothermal vent fluid (greater than 400°C). They are typically configured in pairs on Alvin.

A total of six pairs are available.

**Weight = 28 lbs per pair**

## Scoop Nets

Scoop nets are used to collect animals or rocks with the manipulator arm. Typically these are open mesh bags or canvas rock bags. There are 5 of each type available.

a) **Small scoop net**

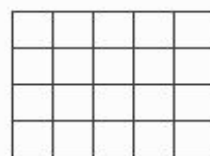
**Weight = 2 lbs each**

b) **Large scoop net**

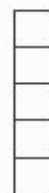
**Weight = 10 lbs each**



a) 5 pack



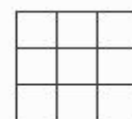
b) 1 bottle



a) Small



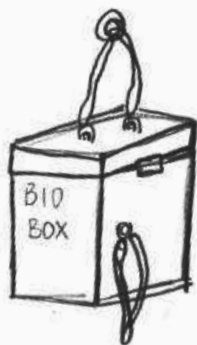
b) Large



# Alvin Engineer: Equip Your Submersible

Page 6

**Note: listed weights include the equipment and collected samples**



## Biological Sample Collection Boxes (Bio Boxes)

### Standard Bio Boxes

Alvin's standard biological sample boxes are used to bring back animals. They are constructed of 1 inch thick plastic and have a fully-hinged lid with a relatively tight seal. These boxes provide a reasonable measure of insulation and sample integrity. They are best used for sturdy animals.

2 boxes available

**Weight = 138 lbs each**

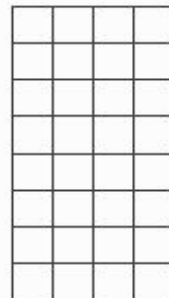
### Sensitive Sample Bio Box

This box is used for sensitive samples and is not intended for general use. Alvin's sensitive sample bio box is constructed of 1 inch thick plastic and has a fully-hinged latching lid with a highly effective watertight seal. This bio box is built for sensitive samples that require a specific temperature and a high degree of protection of the sample.

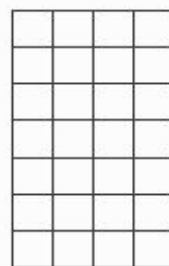
1 box available

**Weight = 117 lbs**

Standard



Sensitive



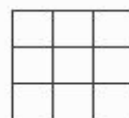
### Push Corers

Push corers are used to sample soft sediment and are deployed using Alvin's manipulator arms. They are commonly stowed in either a 3x3 or 3x4 rack for a total of 9 or 12 corers, respectively. Alvin can carry two of these racks for a maximum of 24 corers per dive.

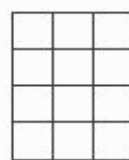
**Weight per 3x3 = 39 lbs**

**Weight per 3x4 = 48 lbs**

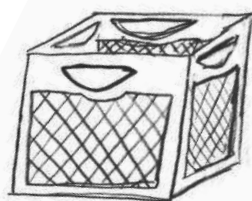
3x3 rack= 9 corers



3x4 rack= 12 corers



### Rock Collection Baskets



Alvin can be equipped with crates to transport rocks or other bulky items collected using the manipulator arm. If desired, the crates can be divided in order to help distinguish rocks taken from multiple sites.

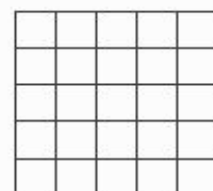
a) 6 small crates **Weight = 36 lbs each**

b) 1 large wire basket with sections **Weight = 150 lbs**

a)



b)



## Slurp Samplers

Slurp samplers are used to collect smaller, mobile animals. These slurp samplers work like a vacuum to pull water and animals including some plankton into a collection chamber. Two styles of collection chambers are available; single chamber and 5-chamber.

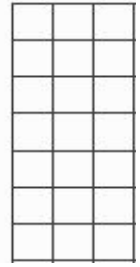
Single chamber: a large single collection chamber into which all samples are deposited.

**Weight = 27 lbs**

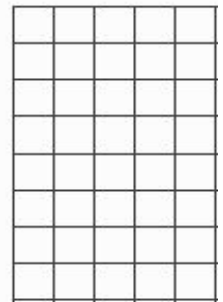
5-chamber: five separate, smaller collection chambers. One chamber is used at a time and the chambers are rotated.

**Weight = 140 lbs**

### Single chamber



### Five chambers



**The following equipment does not need to be included in your sample box, but should be mentioned in your explanation if you plan to use them on a dive.**

## Lighting

Alvin has twelve independent lights mounted around the sub to illuminate the work area. At least four lights are mounted around the basket with others mounted on the light bar on the front of the sub. Lighting can be configured as needed based on dive objectives. They are fully dimmable from the computer inside of Alvin. There are two optional green LED lights on the light bar, which increase visibility at a distance.

## Cameras

4K Ultra High Definition cameras are located below the light bar on either side of the front of Alvin. The cameras feature zoom capabilities that take stunning close-up images including small details, and can capture footage at a distance of 21,325 feet (6500 meters). All camera settings can be adjusted by the scientists and engineers inside of Alvin during the dive.

Along with cameras, Alvin has a pair of parallel lasers which can be used to help determine the size of animals or features observed. The beams are 10 cm apart.