SCIENCE·3D

CALIFORNIA WHITE SHARK

In this packet, sample student answers are provided in red and notes to teachers are in blue.

In this **STEM Project**, students will investigate technology in their own lives and how technology is used in the Shark Lab's research. Then, they will design solutions to proposed technological challenges. Finally, they will use their graphing and math skills to help plan how to find the autonomous submarine, *Ecomapper*, if it gets lost.

Activity 1: Shark Tech

Technology is a device people make to meet a need or a want. Some technology, like a smartphone or a television, is digital. Other technology, like a paddle for a canoe, is not digital.

The Shark Lab uses technology to study sharks. What technology do you use in your life?

1. **Complete** the table below. **List** four technologies you use. Then write down what need or want it provides. An example is included for you.

Technology	Need or want
Lamp	Be able to see at night
1. Cell phone	Be able to communicate from distant places
2. Car	Be able to travel quickly and safely
3. Airplane	Be able to fly / travel far distances quickly
4. Oven	Be able to easily cook food

Extend the Lesson: Have students make and present posters of technologies in their lives. Then, have them add ideas for technologies that would allow them to do things they can't do now (for example, jetpacks to fly).

Activity 2: Dream Up a Solution

White sharks are always in motion. They keep swimming so that they breathe. Since they are always moving, they can move far distances. They also live in water that can be very murky, rough, and cold. That makes it hard to study white sharks. Chris, Darnell, and the Shark Lab team need to use technology to learn about them.

Over the years, Chris and Darnell have invented new technology. First, they think of the problem. Then, they think of the features of the solution. These are the criteria. Finally, they think of ideas to solve the problem. The ideas need to meet the criteria.

Solutions have constraints, or limits. A constraint may be how much time or money you can spend. It may also be the materials you can use.

It's time for you to think about possible solutions to some problems of studying white sharks.

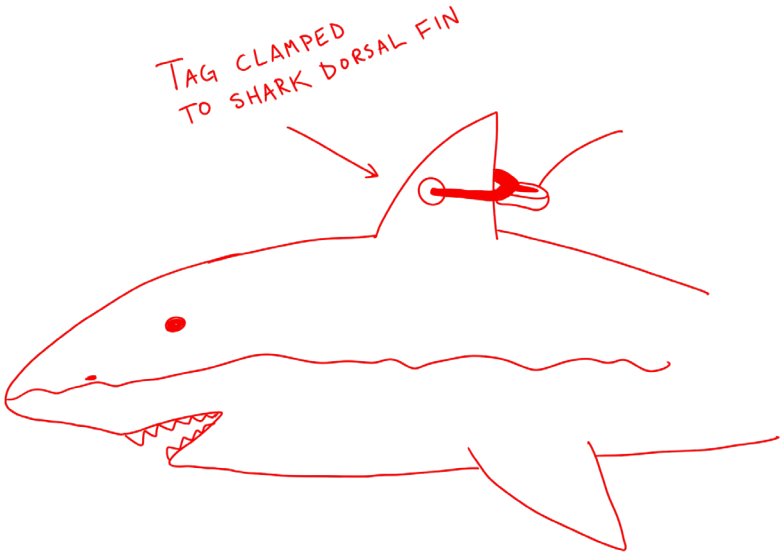
Challenge 1: The team needs to attach a tag to a shark.

Criteria: The tag needs to stay on the shark for a long time.

Constraints: The tag can't be too big for the shark.

1. **Draw** a tag attached to a shark. Show how you would attach the tag.

Answers may vary. Accept anything even remotely possible, no matter how bizarre, expensive, or impractical. This is about brainstorming! Example idea provided below.



2. **Describe** where you attached the tag to the shark.

Should match the drawing. Example from drawing: I attached the tag to the shark's dorsal fin.

3. **Describe** how you attached the tag to the shark.

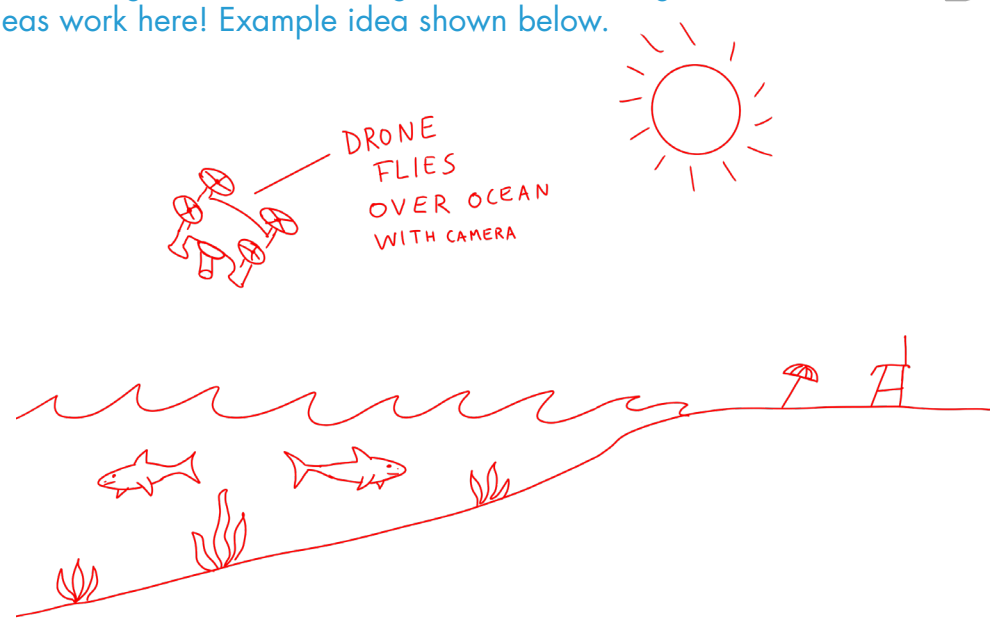
Should match the drawing. Example from drawing: I used a clamp with the tag on it and attached it to the shark.

Challenge 2: The team wants to watch for sharks in the water off one beach.

Criteria:
The water needs to be watched for 6 hours each day.
The water can be watched from the air.
A camera or a person can watch the water.

Constraints: You can't see what is underwater by standing on the beach.

4. **Draw** your solution.
Answers may vary. They could include flying a drone, using a camera on a kite or a balloon, building a tower, or having cameras watching underwater. Many ideas work here! Example idea shown below.



5. **Describe** your solution.

Should match the drawing. Example from drawing: I would fly a drone with a camera pointing straight down over the water to watch for sharks.

6. **Describe** what might make it difficult to make your plan work.

Any reasonable answers are fine. Examples include: enough battery power, cameras might fail, or the weather might get bad.

Activity 3: Track the Sub!

If this activity is too advanced for some students, consider doing it together as a class.

To study white sharks, the Shark Lab team needs to be in motion! So does their self-driving submarine!

When you are working on the ocean, you need to be careful. Conditions can change quickly. It can be difficult to see a small sub at the surface. You need to stay close to the sub so you can get it back at the end of its mission. If something happens, you need to know where to look for it. It might get tangled in an old fishing net and trapped underwater!

To be sure to get the sub back safely, Darnell has programmed it to come to the surface every five minutes. He has programmed it to move in a straight line at the same speed. You can use the motion of an object to predict where it will be at a later time.

Look at Figure 1. Each • shows where the sub came up after 5 minutes, 10 minutes, and 15 minutes. The number next to the • is the number of minutes the sub has been running.

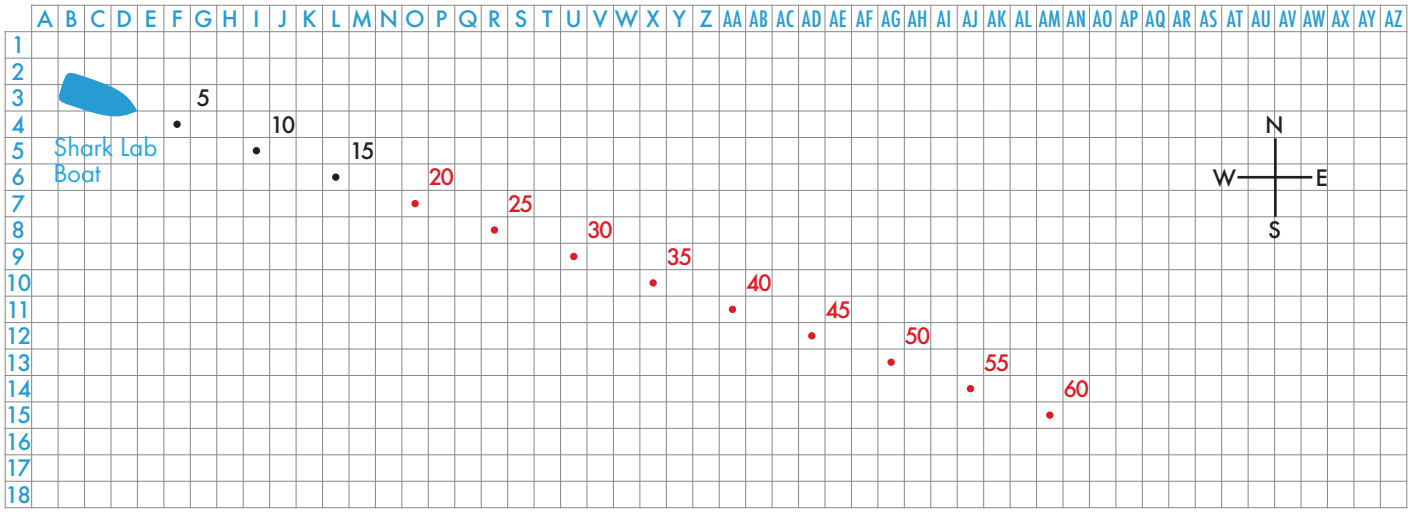


Figure 1. Track of the sub off Long Beach, California

1. **Calculate** the movement pattern. How may blocks south and how many blocks west is the sub moving every five minutes?

   The sub moves 3 blocks south and 1 block west every five minutes.

2. **Predict** where the sub will continue to come up every five minutes until 60 minutes have passed. **Draw** dots on the map to show where the sub should surface. **Write** the number of minutes it has been running next to each dot.

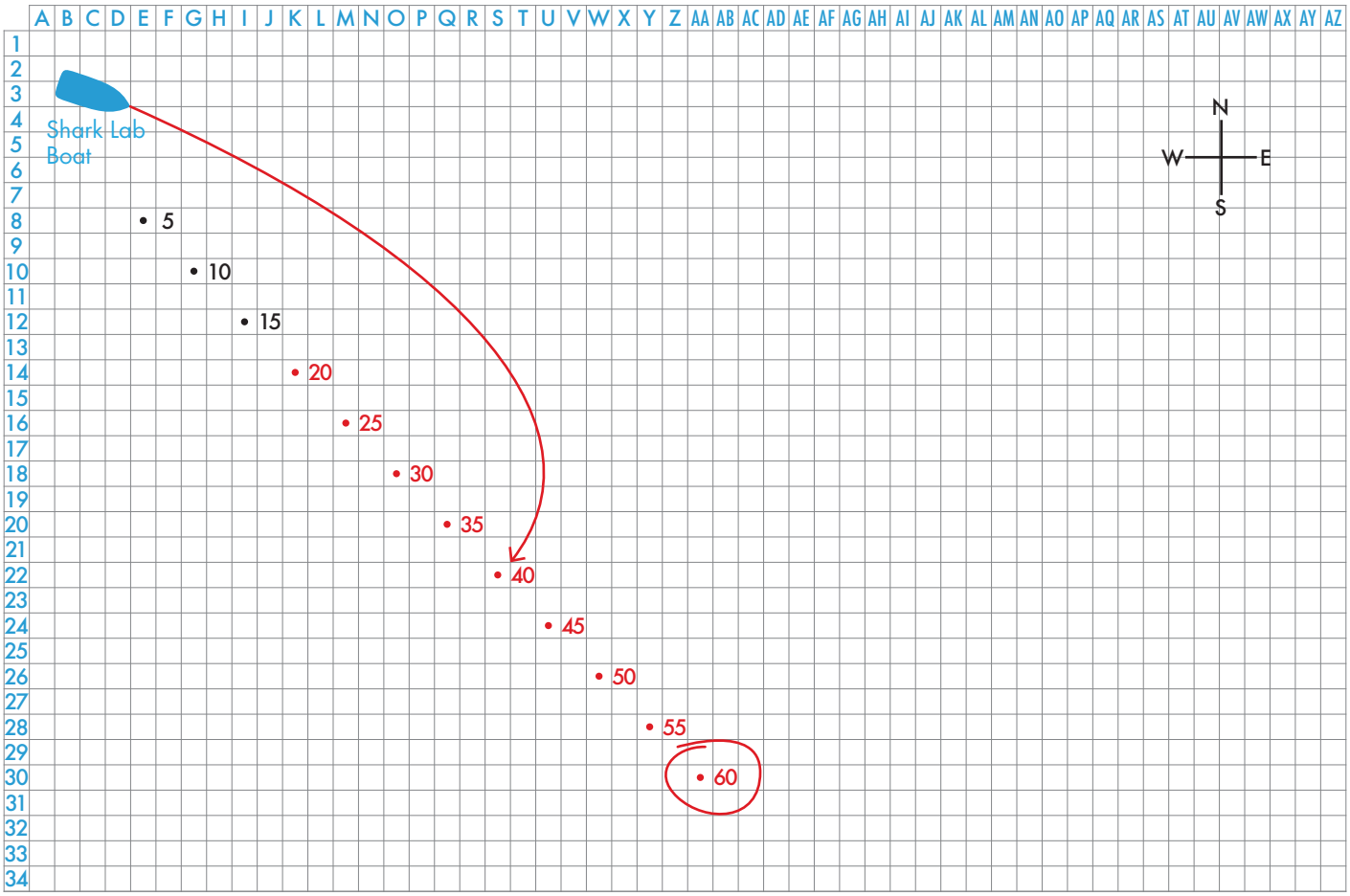
3. The sub will stop moving and surface after 60 minutes. If the Shark Lab team loses sight of the sub, where should they go to pick it up it at the end? **List** the pick-up coordinates from the map above.

   If the Shark Lab team loses sight of the sub, they should go to coordinate (15, AM).

Scientists need to have plans. They need to be ready if things go wrong! The Shark Lab team is great at planning! They are also really good at math. That is why they are able to make and use the latest technology. Let's make a plan in case a sub deployment goes wrong!

4. On the map below, **plot** where the sub should surface every five minutes, from minute 20 to minute 60. It will stop moving after 60 minutes. **Draw** dots on the map. **Write** the number of minutes the sub has been running next to each dot.

5. The Shark Lab boat had to help another boat with a broken motor. The Shark Lab team lost sight of their sub while helping the other boat. It has been 40 minutes since the sub started its track. **Draw** a path from the position of the Shark Lab boat to show where it should go to look for the sub.



6. Let's imagine that the weather got really bad. The waves are big. The fog is heavy. The Shark Lab team can't see the sub anymore. It has been 60 minutes since the sub started its track. **Draw** a circle on the map above to show where the team should start looking for the sub.

An important part of developing a technology is thinking about failure. What might break? What might go wrong? If you know that, then you can work to make sure it doesn't happen. Think about what the sub has to do. It has to navigate in the right direction. It has to sink and rise. It has to collect video. It has to collect data. It has to move through the water.

7. **Describe** things that might go wrong on the sub.

Answers will vary. Consider doing this as a class discussion. Examples include: the propeller breaking, the computer navigation breaking, the sub sinking, the sub not going underwater, video cameras not recording, computers breaking, data not being collected, getting lost in a storm, or getting stuck in a net or kelp.

Great job! Luckily, Chris and Darnell have thought about and planned for many ways the sub could fail. They have used a lot of technology to design the sub to make sure it is ready to go!

Extend the Lesson: Have students think about times in their lives when they might want to know about motion to predict an object's location at a certain time. They might think about riding a bike or driving in a car.