Track the Blip

A Real World Science Lesson Plan

BACKGROUND:

A really big theme of WWII is all about the use of electromagnetic radiation to send and receive information. WWII was full of electronics, and much of it was designed to create and receive electromagnetic radiation for radio communication or for radar.

The waves that carry electromagnetic radiation share some similarities to the waves that carry sound. But they also have some important differences. Sound waves are compression waves and require a medium. Electromagnetic waves are transverse waves and do not require a medium (otherwise we wouldn't get light from the Sun).

Electromagnetic waves also travel much faster than sound waves, and they have a constant speed.

OBJECTIVES:

- Students will be able to explain the similarities and differences of sound and electromagnetic waves.
- Students will be able to describe how electromagnetic waves are used to transmit and receive information.
- Students will read about the use of radar in WWII, and practice getting information from text.

GRADE LEVEL:

5-8 with enrichment activities for advanced students

STANDARDS:

3rd-5th grades:

- Waves are regular patterns of motion, which can be made in water by disturbing the surface. Waves of the same type can differ in amplitude and wavelength. Waves can make objects move. **NGSS PS4.A**
- Object can be seen when light reflected from their surface enters our eyes **NGSS PS4.B**
- Patterns can encode, send, receive and decode information. **NGSS PS4.C**

6th-8th grades:

- A simple wave model has a repeating pattern with a specific wavelength, frequency, and amplitude, and mechanical waves need a medium through which they are transmitted. This model can explain many phenomena including sound and light. Waves can transmit energy. **NGSS PS4.A**
- The construct of a wave is used to model how light interacts with objects. impacts on people and the natural environment that may limit possible solutions. **NGSS PS4.B**
- Waves can be used to transmit digital information. Digitized information is comprised of a pattern of 1s and 0s. **NGSS PS4.C**

TIME REQUIREMENT:

Track the Blip could take one hour, but you could also restrict the size of their sampling to make it shorter. **Make a Wave** will take about half an hour, as will **Melting Marshmallows**. **Battle of Britain** will also take about half an hour.

MATERIALS:

Student Handouts: Make a Wave, Melting Marshmallows, and Battle of Britain.

For **Track the Blip**, you'll need shoe boxes set up with grids and a section of ocean with objects in it. You'll also need graph paper for students to record their data on.

For **Make a Wave,** all you need is a slinky and a classroom of students. If you have a slinky for each group it might be more engaging.

For **Melting Marshmallows**, you need a microwave oven, a microwave-save casserole dish, a ruler, and a bunch of marshmallows. You are unlikely to have more than one microwave in your classroom, or near it, so you might plan stations or do this once as a demonstration.

PRIOR KNOWLEDGE:

The activities in this packet will not completely cover what students need to learn about either sound waves or electromagnetic waves. They could be used as an introduction, or as supplements or parts of your teaching about these topics.

INFORMATION FOR TEACHERS:

You'll need to practice with your own microwave, as each make and model is a little different.

OUTLINE OF ACTIVITIES:

1. Students use **Track the Blip** to start developing their ideas about how waves can be used to find out about the world around us. When they have completed the activity you can explain to them about the use of sonar, and then explain how radar uses a different kind of wave, but works in a similar way.
2. In **Make a Wave,** you use the slinky and a student wave to explain the concepts of wave structure, and the concepts of frequency and pitch. With the slinky you can also show reflection.
3. In **Melting Marshmallows** students, with your help, estimate the speed of light. You can discuss the difference between the speeds of light and sound using other more common examples, like fireworks and lightning.
4. Students read the **Battle of Britain** to learn about the role of radar in WWII

ASSESSMENT:

Student responses on **Track the Blip** might help you see where students are in their understanding of waves and related concepts. Student answers on **Make a Wave**, **Melting Marshmallows**, and **Battle of Britain** will help you track their developing understanding.

EXTENSION/ENRICHMENT:

You can also do your normal waves activities. Making a periscope to show use of reflection, or lenses to show optics are great extensions. Review of the electromagnetic spectrum to see how each part of it is used to communicate would be a valuable lesson too.

REFERENCES:

The Invention That Changed the World. Robert Buderi, Touchstone, 1997.

STUDENT HANDOUT

Track the Blip

The box your teacher has given you has one or more hidden submarines in it. You will use a model of sonar to find those submarines.

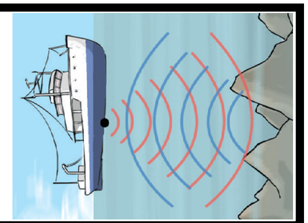
Use the Sonar Beam (the stick) to explore the ocean (the box). Figure out a search strategy to find the submarines. Should you check every hole first? Should you spread out your search?

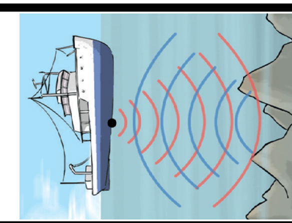
Record your results on the paper your teacher gives you.

The sinking of a Japanese cargo ship, snapped through a US Navy submarine periscope. The National WWII Museum, 2011,102.178

How does sonar work?

How is radar different than sonar?


SONAR beam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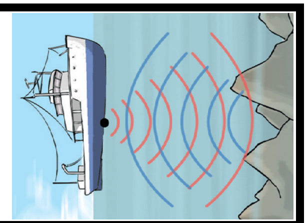
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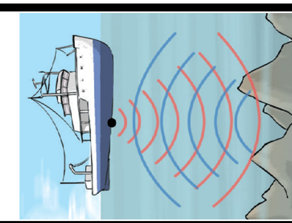
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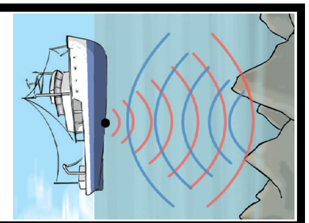
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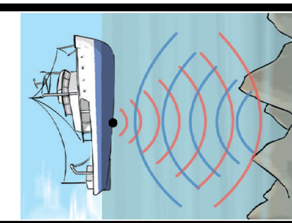
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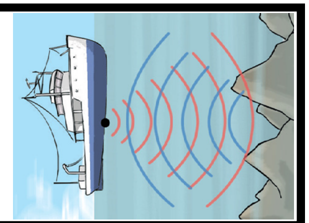
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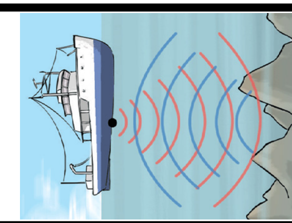
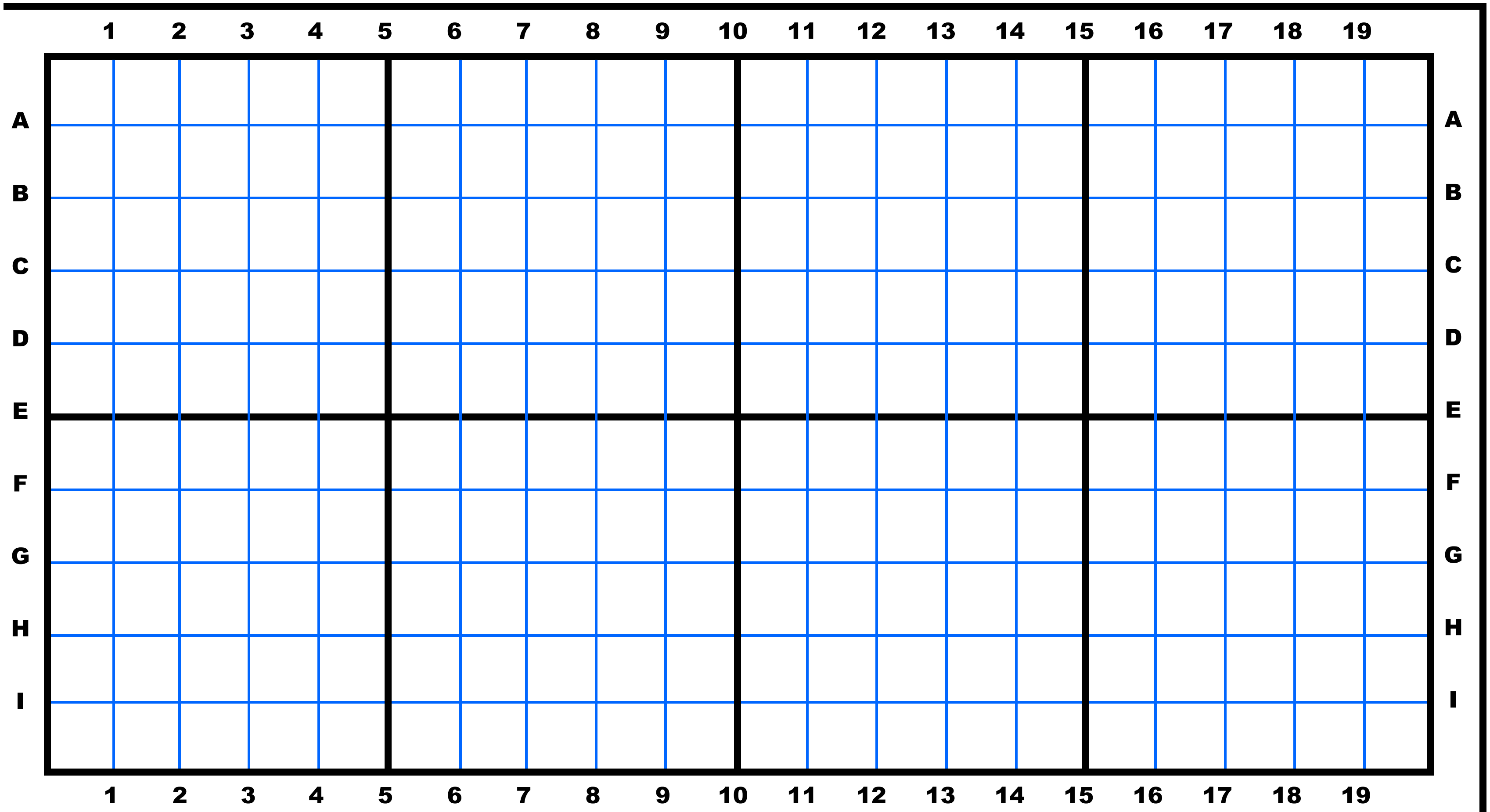

SONAR beam

Sound Navigation and Ranging — SONAR — Seeing with Underwater Eyes



STUDENT HANDOUT

Make a Wave

Draw a diagram of the slinky set up

Draw a diagram of the slinky making a compression wave (label wavelength and other important parts of the wave)

Draw a diagram of the slinky making a transverse wave (label wavelength and other important parts of the wave)

STUDENT HANDOUT

Make a Wave

Now your whole class will model a wave.
Draw a diagram of the class wave:

What are some important ways that light* and sound waves differ? How are they the same?

Did you know? The Slinky is WWII technology! Late in the war, an officer in the Navy was testing out different kinds of springs to use on ships. He became fascinated with this one spring that was not useful on ships, but did all sorts of cool things. Eventually he and his wife turned it into one of the best-selling toys in history.

*Light waves are also known as electromagnetic waves

STUDENT HANDOUT

Melting Marshmallows

You'll put a plate full of marshmallows in the microwave and heat them up. The microwave doesn't heat things evenly, so some spots will melt faster than others.

Take the marshmallows out when some parts get melty. Measure the distance between melty spots. They should all be about the same distance from each other. Record that distance in meters.

Distance = ______________________________ m

That distance is about half of one wavelength of the microwaves used in the oven:

___________________________ x 2 = _________________________ = wavelength in meters

Most microwave ovens make microwaves that have a frequency of 2450 MHz. That means they make 2,450,000 waves every second.
To calculate how fast a wave goes, you multiply its frequency times its wavelength.

2,450,000 x _____________________ = ___________________________ speed of microwave

The speed of a microwave, and any electromagnetic wave, should be about 300,000,000 meters every second.

How close was your calculation? Where do you think the error comes from?

STUDENT HANDOUT

Battle of Britain

World War II started for Great Britain much earlier than it did in the US. Britain declared war in fall of 1939 and France surrendered un June of 1940. Only the English Channel separated England from Germany forces.

British Prime Minister Winston Churchill about to give a speech in Italy, 1944 or 1945. The National WWII Museum, 2007.0048.039.

In a famous speech, the British Prime Minister Winston Churchill said to the British House of Commons on June 18, 1940:

"What General Weygand has called The Battle of France is over. The battle of Britain is about to begin. Upon this battle depends the survival of Christian civilisation. Upon it depends our own British life and the long continuity of our institutions and our Empire. The whole fury and might of the enemy must very soon be turned on us. Hitler knows that he will have to break us in this island or lose the war. If we can stand up to him, all Europe may be free and the life of the world may move forward into broad, sunlit uplands. But if we fail, then the whole world, including the United States, including all that we have known and cared for, will sink into the abyss of a new Dark Age made more sinister, and perhaps more protracted, by the lights of a perverted science. Let us therefore brace ourselves to our duties, and so bear ourselves that, if the British Empire and its Commonwealth last for a thousand years, men will still say,'This was their finest hour'"

Churchill was right. From July 10 until the end of October in 1940, daily attacks on England came from the Luftwaffe (the German Air Force). The Germans had twice as many planes as the British, and they thought by asserting their air superiority they could either convince the British to surrender or weaken their defenses enough that an invasion would be easy. In summer of 1940, the Germans began preparations for the invasion of the Soviet Union, moving most of their ground troops eastward, and kept most of the Luftwaffe to focus on England.

The British had known that war was coming. Political events in Germany had been signaling war for years. To prepare for a hostile Germany, they had developed a radar defense network. Combining radar stations on the coast with an extensive communications network, the British were able to identify incoming targets and send fighters to intercept them.

STUDENT HANDOUT

Battle of Britain

Americans inspecting the wreckage of a crashed British Spitfire, 30 January 1944. The National WWII Museum, 2002.337.081.

These stations sent out electromagnetic waves in the radio and microwave parts of the spectrum, and then analyzed the reflected waves to look for targets. The results were sent by operators to airbases where commanders could quickly send up aircraft. They were also sent to ground defenses which could target the incoming planes.

German aircraft were very good, but they didn't have as good a radar system. On average the British aircraft found 75% of the incoming targets, and some raids found all the targets. This made the RAF very effective even though it had many fewer planes.

RAF bombers and fighters going over to France to attack German airfields and military bases had an advantage too. Without effective radar systems, the German pilots could only patrol the airspace and hope they came across enemy planes. This left a much higher percentage of RAF planes that got through defenses than Luftwaffe got through to England.

Eventually the Germans came to acknowledge that their plan was not working, and ended the daily raids.

After October of 1940 they switched to another strategy. Instead of regular attacks on military targets and defenses, they began daily attacks on the cities of England. The Germans hoped that by killing civilians they would damage the morale of the British, and convince them to surrender.

The British in general, and Winston Churchill in particular, were very effective at rallying citizen support around the war effort. In spite of the hardships of bombings and rationing, and in spite of disheartening losses on the European continent, the British people stayed strong. In fact, turning back the Luftwaffe showed the resilience of the RAF, the wisdom of planning of the last decade, and gave the Germans their first real defeat of WWII. England might not have the strength to defeat the Germans, but they showed they could resist them.

