

Project: Build A Compass

OVERVIEW & PURPOSE

Follow the adventures of George AKA Jorge in *The Rise of the Legends* as he uses a compass for navigation. Learn about the earth's magnetic fields and how a compass works. Build a compass and use it to navigate.

EDUCATIONAL STANDARDS

1. Common Core ELA Standards: CCSS.Math.Content.6.EE.A.2 Write, read, and evaluate expressions in which letters stand for numbers.
2. Common Core Math Standards: CCSS.Math.Content.6.EE.A.2.c Evaluate expressions at specific values of their variables. Include expressions that arise from formulas used in real-world problems. Perform arithmetic operations, including those involving whole-number exponents, in the conventional order when there are no parentheses to specify a particular order (Order of Operations)
3. Next Generation Science Standards: MS-PS2-3: Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.

OBJECTIVES

1. Learn about compass use in *The Rise of the Legends*
2. Learn how a compass works
3. Build a compass
4. Use a compass

MATERIALS NEEDED

1. A dish to hold water
2. A straight pin or a straightened paper clip
3. A pool noodle, piece of cork, or plastic lid
4. 2 magnets
5. Tape or glue
6. A marker
7. A map of your location



STORY

At the end of chapter 22, George is preparing for his trip to the mysterious, fog enshrouded island of Anu-he. He prepares for the journey by studying nautical charts so that he can find the island in the fog and a safe place to beach his boat. The island is very rocky and there are few sandy beaches, so navigating with precision will be key. George realizes that he'll need to know the direction he's going, his speed and keep track of time to successfully navigate through the fog. He uses a compass to determine direction, a sailing app to track his speed, and his watch to measure time. How do these tools allow George to navigate with precision?

George studies the map and finds the sandy beach where he wants to land. He'll need to sail south, then change direction, and sail to the west. He sets off for Anu-he using his compass to set his course, also known as a heading. With that information, and by tracking his speed and elapsed time, he can determine where to make his turn to the west. George also uses his compass and a nautical chart to check his position. He does this by finding two visible landmarks that are also referenced on the chart and finding the "bearing" or compass direction to them from his position. Knowing this, allows him to "triangulate" his position.

ACTIVITIES

Math

Let's pretend George was sailing at a speed of 5 knots (nautical miles per hour). After 1 hour of sailing he would have traveled 5 nautical miles. After 2 hours of sailing he would have traveled 10 miles. After 3 hours of sailing he would have traveled 15 miles, as seen in the table below.

Speed	Time	Distance
5 mi/hr	1 hour	5 miles
5 mi/hr	2 hours	10 miles
5 mi/hr	3 hours	15 miles

What pattern do you notice when you look at the speed, time, and distance?

The distance a boat has traveled can be calculated by multiplying the speed of the boat by the time it's traveled.

Distance = speed x time

This pattern can be written as an equation. It can also be written as a formula. A formula and an equation are almost the same thing, but a “formula” usually represents a mathematical pattern found in science. Formulas are expressed in numbers, letters, and symbols.

Replacing distance with the variable D, speed with the variable S, and time with the variable T, we get the following formula.

$$D = ST$$

(Note that when writing a formula, if there is no operation between two variables, multiplication is implied.)

Questions to ponder:

How far would George have traveled if he'd sailed 5 mi/hr for 4 hours?

Is there only one pattern in the table?

Is there a proportional relationship in the table?

What is the rate of change of the proportional relationship?

Science

Magnetism is a Force

Magnetism is a force that attracts or repels certain objects with an invisible force that acts on the electrical charges within them. Magnets have two sides, or poles, most often labeled “north” and “south.” In some cases, the poles are referred to as “positive” and “negative.”

You’ve likely heard the phrase “opposites attract”. This phrase is true for magnets. The north pole of one magnet will be attracted to, or pull on, the south pole of another magnet. The positive side of one magnet is attracted to, or pulls on, the negative side of another magnet.

Similar poles repel each other or push each other away. The north pole of one magnet will repel, or push away, the north pole of another magnet, and the positive side of one magnet will repel the positive side of another magnet.

The Magnet Earth

The earth is a giant magnet. Like any other magnet, the earth has two poles, a north pole, and a south pole. The magnetic forces that travel between these two poles create a magnetic field around the earth called the magnetosphere, which protects our planet from the sun’s radiation. Magnetism is an invisible force, but we know it’s there because we can see it in action. One fun fact and very cool example of this is the Aurora Borealis, or Northern Lights. This vivid display of colored light is a visual representation of our magnetic field at work as it funnels charged particles from the sun toward the earth’s magnetic poles where they interact with our atmosphere. Another way we can

see the earth's magnetic field at work is with the action of magnets, such as a compass. If you place a magnet on a surface, like your kitchen counter, a force called friction holds it in place. It's the same force that keeps you from sliding across the room! But, if we can "float" a magnet, reducing the amount of friction on it, it will naturally align itself to the earth's magnetic field. This is why the needle in a high-quality compass is always suspended in liquid. No matter what direction the compass is facing, its needle will point geographic north.

This is very helpful for getting around because when you know which direction is north, you can figure out which direction is south, east, and west.

Magnetic vs Geographic Poles

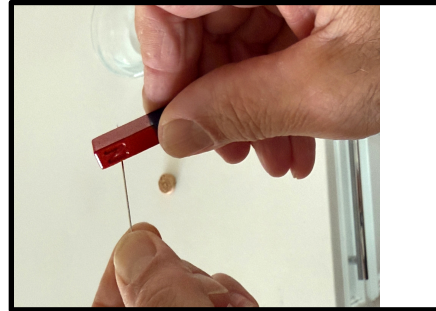
You may be wondering why the north pole of a magnetized needle points toward the north pole of the giant magnet of earth. Shouldn't the north pole of one magnet be attracted to the south pole of the other? Yes! And an interesting bit of trivia is that what we call the North Pole on a map, or geographic north, is actually the magnetic south pole of planet earth!

Engineering

Use a kit, or follow the steps below, to build a magnetic compass.

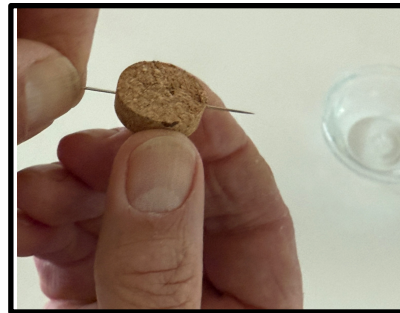
Step 1: Magnetizing the Needle

- Hold the needle or pin at one end.
- Stroke the magnet along the needle in one direction only, from the center to the tip. The tip will become the pointer on the compass. Repeat 20–30 times.
- Explain how this aligns the molecules in the needle, giving it magnetic properties.



Step 2: Preparing the Floating Platform

- Carefully push the needle through a small piece of cork or tape it securely onto a bottle cap.
- Make sure the needle is balanced and doesn't tilt the cork or cap.



Step 3: Creating the Compass

- Fill a small bowl with water and gently place the cork or cap in the center so it floats.
- Wait a few seconds and observe as the needle aligns itself along a north-south axis.
- Use a map to compare and validate the direction.



3. Discussion and Questions (10 minutes)

- Ask students to observe and share what happened.
- Discuss why the needle points in a specific direction (interaction with Earth's magnetic field).
- Challenge students: "What might affect the accuracy of this compass?" (e.g., nearby magnets, metal objects).

4. Extension Ideas (Optional, 5 minutes)

- Mark the cork or bottle cap with the cardinal directions (N, E, S, W).
- Experiment with different materials to float the needle and observe any changes.

APPLICATION

Create a treasure map

Direction: Use your homemade **or any** compass to determine direction.

Distance: Count steps to determine distance traveled.

1. Choose 3-5 locations outdoors.
2. Determine the starting point of the treasure hunt.
3. Point your compass in the direction of the second location. Record the compass reading and then count out your steps as you walk in the direction of the compass from the first location to the second location. Record both the number of steps and the compass reading.
4. Point your compass in the direction of the third location. Record the compass reading and then count out your steps as you walk in the direction of the compass from the second location to the third location. Record both the number of steps and the compass reading.
5. Point your compass in the direction of the fourth location. Record the compass reading and then count out your steps as you walk in the direction of the compass from the third location to the fourth location. Record both the number of steps and the compass reading.
6. Continue until you have arrived at the final location.
7. Share your treasure map with a fellow student, family member, or friend and see if they can follow it.
8. Analyze challenges and issues with this format of a treasure map.
 - a. The size of each person's step is not consistent
 - b. The compass doesn't have exact readings. It can show you North, South, East, and West. From that you can figure out Northeast, Northwest, Southeast and Southwest. But it's hard on a homemade compass to do more.

CONCLUSION

George was able to create a compass after his compass was destroyed during his shipwreck. Knowing science saved him. In chapter 26, he makes his own compass using objects he finds in a cave.

EXTENSION ACTIVITY

Research "geocaching". Participate or create your own geocaching event