The Physics of Magnetism

Respective blueprint	The Compass
Description	In this pedagogical sequence students will learn the power of magnetism, and a principle of physical force using a home-made compass.
Learning Objectives	Students will: - Learn how to create a home-made compass - Understand how magnetism/physic force works - Learn more about the history of the compass and its use

Related curricular subject(s)	Physics, History
Prerequisites / preparatory actions for teachers	Teachers should gather the materials for the blueprint
Prerequisites / preparatory actions for students	Understand the basics of physics, know how to make a compass work. Have basic knowledge on the principles of magnetism
Age of students	8 to 12
Duration	1-2 hours
Level of difficulty	Intermediate

Step by step description of the tasks

Figure 1 Source: Photo by unknown author – Published by Aaron Burden, 2018-21-01, Public Domain,

Figure 2 Source: Photo by unknown author – Published on Wikipedia, Public Domain,

Step 1: Where does the compass come from?

The teacher introduces the origin of the compass to the class.

The first invention most resembling a compass appeared in China around the 4th century AC, but historians have never been able to agree on a precise date.

The first version of the present-day compass looks like a large spoon made from a polished natural magnet made of iron oxide, magnetite.

Initially, the compass was not used for orientation. In fact, its purpose was to harmonize environmental energies according to the well-known principle of Feng Shui.

It was not until a little over a century later, during the Song Dynasty, that it began to be used as an orientation/navigation tool.

Thanks to the compass, sailors could continue to navigate even when they could no longer see the sky. Since this tool allowed them to constantly know where north was and therefore where to go.

Step 2: The principle of magnetism

Magnetism is the name given to one of the forces that attract certain materials to each other or repel them.

These forces occur when electrical charges are in motion:

- They occur between electric currents: Two parallel wires with currents in the same direction attract each other.
- They are also created by movements of electrons in the nucleus.

Application to the compass:

Pierre de Maricourt was the first scientist to study magnetism and to explain the repulsion and attraction of a magnet.

He discovered that when a magnetised needle was placed around a magnetised stone, the needle drew longitudinal curves that converged at the poles. He then called the two ends of the magnet magnetic poles.

Caution: it is important to know that the indications provided by the compass are not absolutely accurate. The magnetic north does not

correspond to the geographical north, whose position is not stable. It varied by 2 degrees between 1834 and 1848!

Indeed, planet earth does not stand straight up on its axis. The Earth has an axial tilt, or “the obliquity of the ecliptic” which is of about 23.5 degrees. As it is a sphere, the earth is divided in degrees. At the extremities of it, you will find the geographic North and South poles, which do not move much. That means that the earth turns on itself at an angle while also turning around the sun. It is because of this axial tilt that the sun shines at different angles on different latitudes during the year. This is the reason why we have seasons. This axial tilt is also the reason why we often represent the earth as in this picture: at a 23.5° angle.

Figure 3 Source: Pixabay

The magnetic North Pole, however, varies depending on the magnetic field of the earth, and is about 11 degrees more towards Canada at the moment. The magnetic field of the earth is caused by the movement of the liquid rock that surrounds the core of the planet, which is rich in iron particles and creates electric currents. This, in turn, creates a magnetic field around the planet like a giant dynamometer. However, depending on the movement, the magnetic pole can vary a little bit. These last few years, they have varied much more than before, up to 50km per year.

Step 3: Small reminder of how the earth works

To understand how a compass works, it is important to start with how the Earth works. As we said, the Earth has two geomagnetic poles and a magnetic field, which acts like a magnet. This field interacts with the **magnetic field** in the compass to give the **magnetic north**. Thus, the magnetic north of the Earth attracts the south pole of the magnet. The opposite direction will therefore be **magnetic north**, which is to be distinguished from the **geographic North Pole**. The South Magnetic Pole is located off the coast of Adelie Land, while the North Magnetic Pole is more than 1000 kilometres from the **geographic North Pole**, towards Canada.

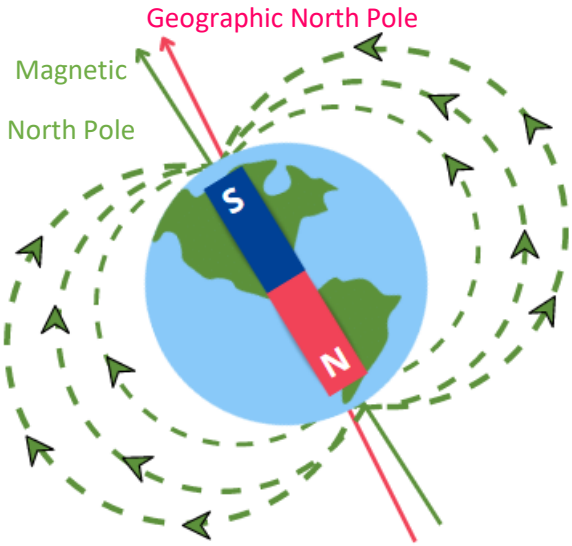

Figure 4 Graphic by Logopsycom using Canva

Step 4: What constitutes a compass

The simplest compass consists of a magnetic needle resting freely on a pivot. This is placed in the centre of a dial divided into 32 parts or 360°, called a compass rose. Under the effect of the earth's magnetic field, the needle indicates the magnetic North and South poles.

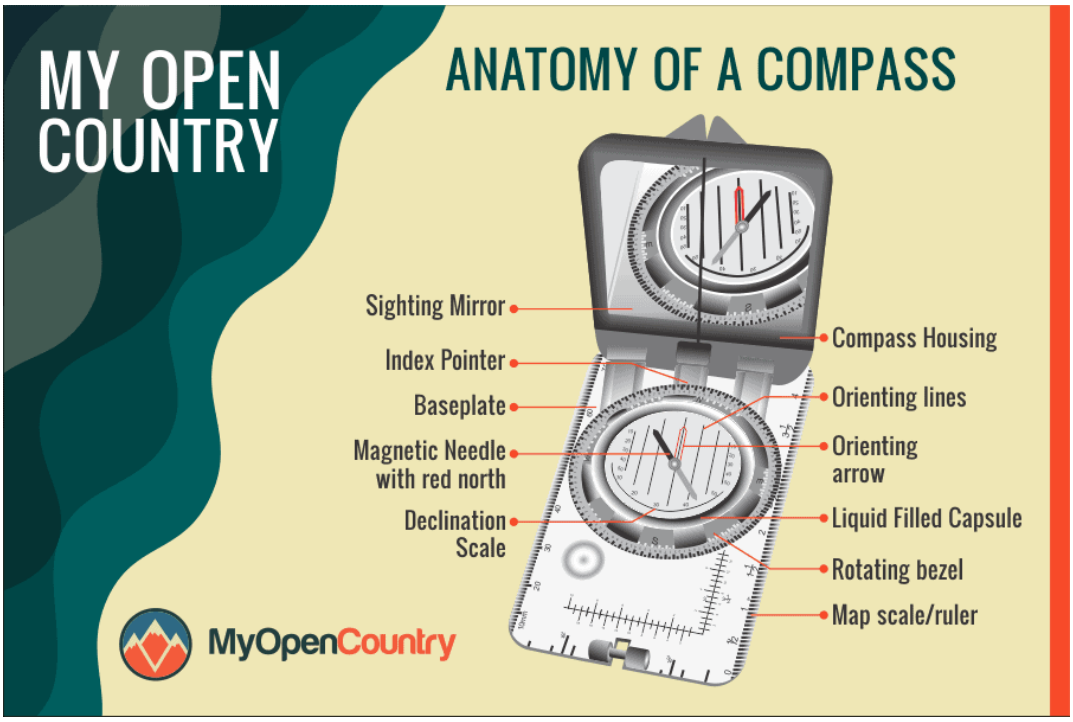

Figure 5 Photo by unknown author, taken from https://www.myopencountry.com/how-to-use-a-compass/

The teacher can make a link between the components of the compass and the material used to make the hand-made compass:

- **the needle = magic needle with red north**
- **the magnet = magnetic field**
- **the cork = float for the needle**
- **etc…**

Step 5: How to read a compass.

1. Hold your compass flat, at a height near your stomach. Your elbow should be slightly bent and your arm relaxed.
2. Look down and see which way the needle is pointing.

3. Turn around until the needle points in front of you.

4. That's it! Magnetic north is in front of you.

5. To follow a heading, orient the compass to the desired heading and turn the ruler until the ruler and needle are on top of each other, then make sure they stay on top of each other[1]

Conclusion

In this lesson the students learn about the use of a compass and magnetism. They learn what they were used for when they were created and how they are used offshore. They also learn how to create and use a home-made compass.

Assessment activities

Activity 1. Find information about the compass and its components and present them to the class.

Activity 2. Search for information on how magnetism works.

Activity 3. make a game using the principle of magnetism. Idea of an exercise: **https://www.rookieparenting.com/magnetic-field-science-experiment/**

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