BiteScis

Student Handout

Animal Navigation Using Magnetic Fields

Animal Navigation Using Magnetic Fields

Introduction

You know how magnets stick to metals, like a refrigerator door? How do they stay up there? It's not because of a sticky glue. It is through the interaction of the metal in your refrigerator and the **magnetic field** produced by the magnet. The strength of the magnet's magnetic field, and therefore the strength of the repulsive or attractive force it creates, varies with distance.

Magnetic fields are **vector fields**, meaning they have both a direction and a magnitude (strength) that can vary at different positions in space. Vector fields generally extend throughout all of space, but they tend to get weaker as you move away from the source that creates the field. Therefore, the further away the magnet is from another object, the weaker the field and the weaker the force between the objects. The closer the magnet is to the object, the stronger the field and the stronger the force. Hold a magnet up a meter away from a refrigerator door and let go, and it will fall to the ground. But hold that same magnet up a millimeter away and it will lock on to the refrigerator door.

A magnetic field is capable of producing an attractive force, which can pull metals and other magnetic objects together, or a repulsive force, which can push other magnetic objects away. Have you ever flipped magnets over and felt them pushing each other away or pulling towards each other? What you were exploring was the magnets' polarity. Every magnet also has a north pole and a south pole. The poles are equal and opposite: the north pole serves as the source for all magnetic field lines, and the south pole serves as the endpoint for all the lines. The north pole of one magnet, and the outward-directed magnetic field lines it creates, will attract the south pole of another magnet. The opposite is also true: inward-directed magnetic field lines associated with the south pole of any magnet will attract the north pole of other magnets Two north poles or two south poles will repel each other. This property of the magnetic field is known a **polarity**.

A magnet and its magnetic field are shown in **Figure 1** below. We visualize magnetic fields and other vector fields by drawing **field lines**, which show the direction of the force created by the field at any point in space. The closer the field lines are together, the stronger the magnetic force. Notice that the fields lines are coming from the north pole of a magnet and going towards the south pole.

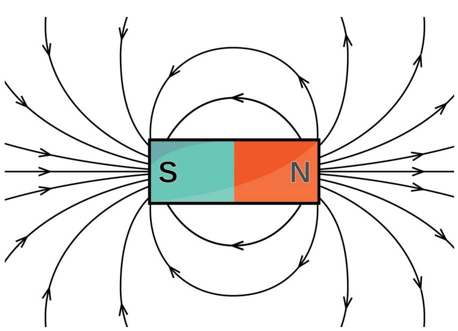


Figure 1. A Bar Magnet's Magnetic Field. The magnetic field lines are closest together near the poles and go from the north pole towards the south pole.

Magnetic fields are generated either by permanent magnets, like the ones that often decorate a refrigerator, or by electric currents. Earth itself has a magnetic field. This field's source is the outer core of Earth—a thick layer of liquid iron surrounding the solid iron ball that is the inner core. Because of the high temperatures at the center of Earth, this liquid outer core is in constant, complex motion which generates the magnetic field. The direction and strength of this magnetic field is different at different points on the Earth's surface as seen in **Figure 2**. In this lesson, you'll explore how worms use magnetic fields to help them navigate through soil.

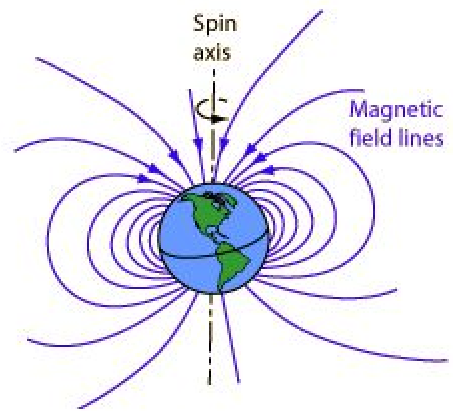


Figure 2. Earth's Magnetic Field. In a magnetic field diagram, you can estimate the field's strength by the closeness of the field lines. Note that in general, the closer you are to the Earth's surface, the stronger the magnetic field. *Source:* Wikimedia Commons

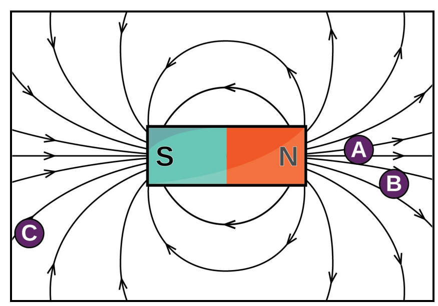
What To Do

Answer the analysis questions below, reading the Bite when instructed.

Analysis Questions

1. Examine the bar magnet with field lines.

At which location (A, B, or C) is the magnitude of the magnetic field the strongest? Explain your answer and refer to the diagram in your response.



2. A compass is a small device used to determine the direction you are going. It contains a very small magnet that rotates easily. The north pole of the magnet inside the compass points towards Earth's magnetic north pole.

   a. Based on this information, in which direction is Earth's magnetic field oriented? Explain your answer and include a drawing in your response.

   b. How does **Figure 2** support your answer to part a?

STOP & read Science Bite:

Magnetic Worms! Kind of…

3. In what ways is the AFD sensory neuron pair in *C. elegans* similar to a compass? In what ways is it different? Justify your response.

4. Using **Figure 2** above, explain why it makes sense that Australian and English worms went in opposite directions when placed in the same magnetic field.

5. Use **Figure 2** and information from the Bite to explain why it makes sense that worms from countries near the Earth's equator were influenced less by magnetic fields than worms from countries near Earth's poles.

6. **Connect to the Big Question**. In this work, scientists were observing the effects of something invisible (magnetic field) on worms. They first observed the worms without any added magnetic field and then with an added magnetic field. Why was it important to observe them without the magnetic field first? Scientists often make comparisons between their observations in order to come to conclusions. Why is comparing observations such a powerful tool?