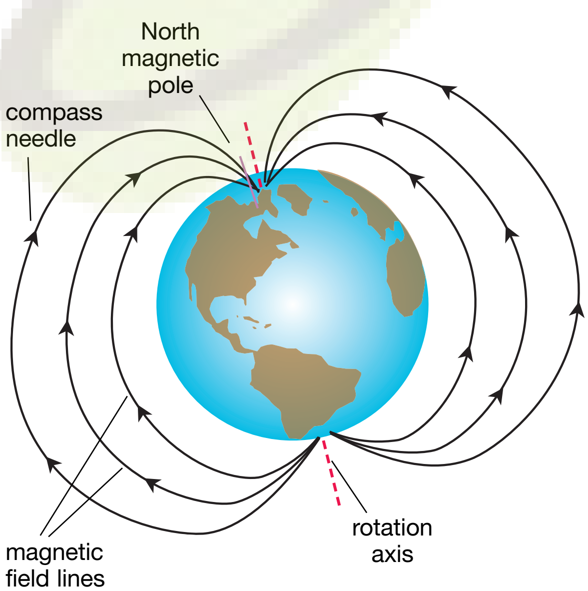
MAP AND COMPASS

Background Information

A compass is an instrument that people use to find a direction in relation to the earth as a whole. The **magnetic needle** in the compass, which is the freely moving needle in the compass that has a red end, points north. More specifically, this needle points to the **north magnetic pole**, the northern end of the **earth's magnetic field**, which can be imagined as lines of magnetism that leave the south magnetic pole, flow north around the earth, and then enter the north magnetic pole.

Any **magnetized object**, an object with two oppositely charged ends, such as a magnet or compass needle, will naturally align itself with the lines of earth's magnetic field, with one end pointing north and the other south. Once north is known, all other directions are easy to find.

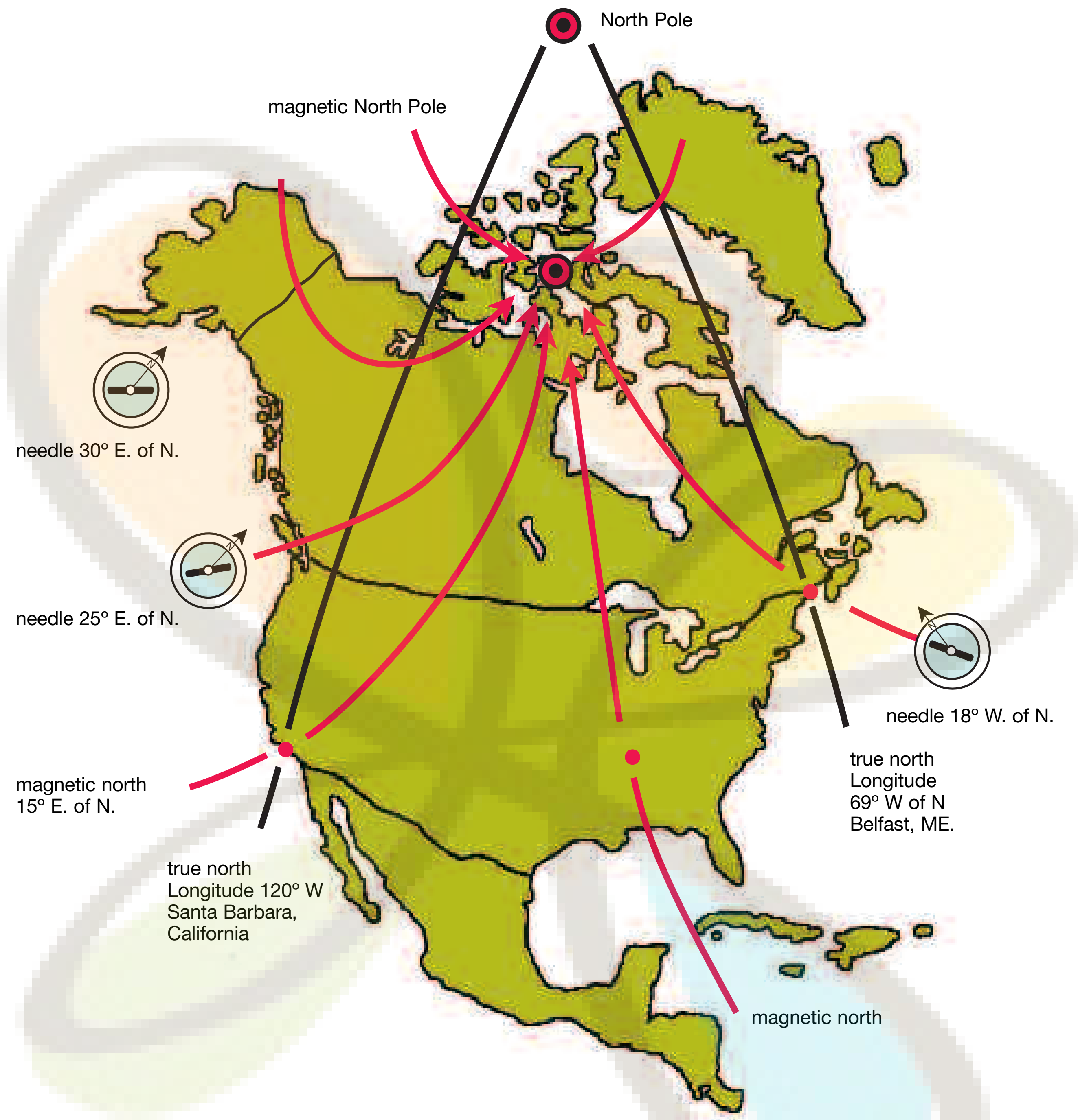


Earth's magnetic field

The north magnetic pole is not the same as the geographic North Pole, also known as **true north**, which is the northern end of the axis around which the earth spins. In fact, the north magnetic pole currently lies approximately 800 mi (1300 km) south of the geographic North Pole, in northern Canada. And because the north magnetic pole migrates at 6.6 mi (10 km) per year, its location is constantly changing.

The meridians of longitude on maps and globes are based upon the geographic North Pole rather than the north magnetic pole. This means that **magnetic north**, the direction that a compass indicates as north, is not the same direction as maps indicate for north. **Magnetic declination**, the difference in the angle between magnetic north and true north must, therefore, be taken into account when navigating with a map and a compass. The amount of declination between magnetic north and true north varies across the world, so high-quality maps always give the amount of declination.

An area of zero declination runs up the center of North America. Along that line, true north on a map and magnetic north on a compass are the same. Because the north magnetic pole is currently to the south of the geographic North Pole, a compass to the east of the line of zero declination will point to the west of true north, toward the line of zero declination. A compass to the west of the line of zero declination will point to the east of true north, again toward the line of zero declination.



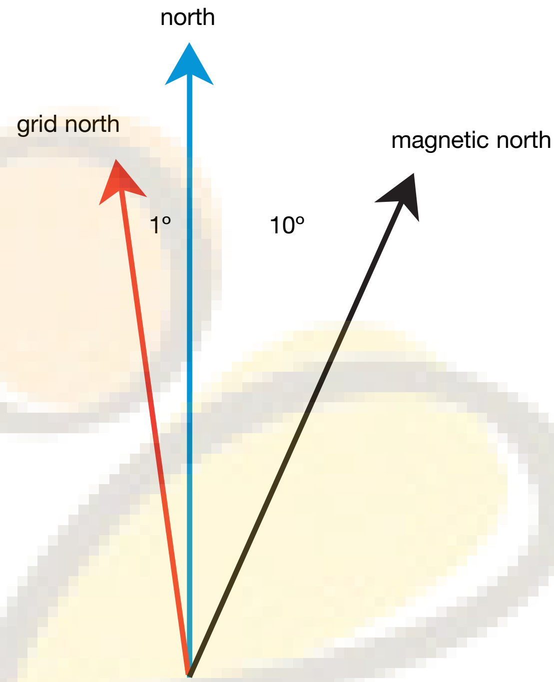
Geographic North Pole and north magnetic pole

The error caused by magnetic declination can be very significant. For every degree of declination, the error is approximately one-sixtieth of the distance traveled. This means that in an area of 10 degrees of declination, the error is ten times greater, or one-sixth of the distance traveled. This means that a person using a compass to navigate in an area of 10 degrees declination will travel one-sixth of a mile (kilometer) off target for every mile (kilometer) traveled if declination is not taken into account. If the destination is 6 mi (10 km) to the north, the person would end up 1 mi (1.6 km) east or west of the destination. Given that the declination in western North America can reach 30 degrees, it is clearly necessary to take declination into account.

There is a third type of north called **grid north**, which is the northward direction of grid lines as given on a map. Grid north exists because flat paper maps cannot represent the spherical earth accurately. Meridians of longitude on a globe converge toward each other steadily as they approach each pole, but on a flat map, meridians are shown as parallel. This means that meridians of longitude do not point toward true north. The difference in direction between grid north and true north gives rise to **grid declination**, the difference in the angle between grid north and true north.

Generally, the difference between grid north and true north is fairly small except close to the poles, so for general directions over short distances in most of North America, grid declination can be ignored (as it is in the activities of this section). However, grid declination is usually shown beside magnetic declination on high-quality maps, so it is necessary to be able to recognize what it means.

True north, magnetic north, and grid north are traditionally shown on a map in a single diagram. The accompanying diagram, True, magnetic, and grid north, shows a magnetic declination of 10 degrees east of north because the magnetic north arrow is to the east, or the right, of the true north arrow. In the area shown on the map, a compass arrow will always point 10 degrees further to the right, or east, than the map shows as north, because the north magnetic pole is 10 degrees to the east of true north from that position Therefore, to compensate for the 10 degree declination, it is necessary to subtract 10 degrees from the compass reading in order to find the true north direction shown on the map.



True, magnetic, and grid north

There are two main types of compass:

- **magnetic compasses** that respond to the magnetic poles of the earth, the compass with which most people are familiar
- **gyrocompasses** are specialized compasses for demanding environments such as ships and aircraft

The type of magnetic compass used for finding the way with a map is called a **baseplate compass** (or **orienteering compass**). The parts of a baseplate compass include:

- a **baseplate**, the base to which the other compass parts are attached
- a magnetic needle

ACTIVITY 1

Measuring Pace Length and Distance Traveled

Purpose

To discover how to calculate a distance traveled by using the measurement of one's pace.

Material

Topographic map, with a one-directional route 330 ft (100 m) long drawn in pencil.

Measuring tape.

Masking tape.

Calculator.

Cultural Geography journals and pencils.

Presentation

- Most Montessori teachers introduce these concepts in Year 4.
- Announce to the students that they will have an opportunity to measure how far they travel when taking one pace, which can be very useful information when walking or hiking in the wilderness.
- Discuss why knowing a distance traveled is important, especially when in the wilderness.
- Suggest an example of a walking route of 330 ft (100 m) in one direction, then demonstrate the route on the map. Invite the students to say how they might know when they have traveled that distance.
- Explain that one solution is to measure the length of each pace they take, and then figure out how many how many paces it takes to cover a measured distance.
- Invite a student to each take seven or eight normal paces across the classroom, counting the paces and marking the start and end point with masking tape. Invite the students to use the tape measure to determine the distance covered. Work with the students and the calculator to divide the total distance by the number of paces to get the length of each pace. Calculate the length to two decimal places, such as 2.45 ft (0.74 m).
- Ask students to work in pairs to calculate their unique pace lengths.

- Once students have determined individual pace length, ask them to each calculate how many paces it would take to cover the walking route of 330 ft (100 m) shown on the map, by dividing 330 ft (100 m) by the length of a single pace.

- Explain that for true accuracy, it is important to repeat the measurement of one's pace several times and over different types of terrain, and then to average the results. Invite the students to each repeat the activity twice more in the classroom, then average their results.

- Ask the students to use their journals to record their average pace length and how they calculated it, and why knowing pace length is important when walking in unfamiliar territory.

Extensions

- If other terrain is safely available, measure pace length on different types of terrain, including uphill and downhill, in sand or mud, and in various combinations of terrains. Average the pace lengths, and record how pace length varies with types of terrain.

- Use the scale on a local map to measure the distance around an area that is safe to walk, such as the perimeter of the school grounds. Calculate how many paces it will take, walk the route, then compare predicted paces and actual paces.

- Draw a simple course of several stages, such as 100 ft (30 m) in one direction, 33 ft (10 m) in another direction, and 66 ft (20 m) in a third direction. Calculate how many paces it will take to cover the course.

- If a mixed-terrain area is available, measure a course around it, calculate pace measurements, complete the route, then compare predicted and actual paces.

