Name: _____ Laboratory Section: _____

Date: _____ Score/Grade: _____

Video
Exercise 3
Pre-Lab Video

http://goo.gl/L5b275

LAB EXERCISE

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3 Directions and Compass Readings

Earth's coordinate grid system was covered in Lab Exercise 2, so you are familiar with using latitude and longitude to find a point's absolute location on Earth's surface. There are times when relative direction between two places is desired—for example if you want to navigate from one point to another. There are two systems used to indicate relative direction on maps: compass points and azimuths.

Understanding and being able to use these direction-finding methods is important, whether you are reading a street/road map or are interpreting specialized maps such as topographic maps, which are discussed and used in later exercises. These systems are all measurements of horizontal direction, as if you were in the air looking down at Earth from above.

Compasses are useful for finding directions, but corrections must be made for deviation from true or geographic north. Lab Exercise 3 has four sections.

Key Terms and Concepts

azimuths
cardinal points
compass points
geographic north
geographic south
grid north
isogons
isogonal map
magnetic compass
magnetic declination
magnetic north
topographic map
true north
true south

KEY LEARNING concepts

After completion of this lab, you should be able to:

1. *Describe* the method of indicating direction using compass readings and *apply* that method to compass directions.
2. *Define* magnetic declination and *determine* differences in "north" readings on a map.
3. *Explain* any difference between a local topographic map and the isogonal map relative to magnetic declination.

Materials/Sources Needed

color pencils
compass
local topographic map
protractor
ruler

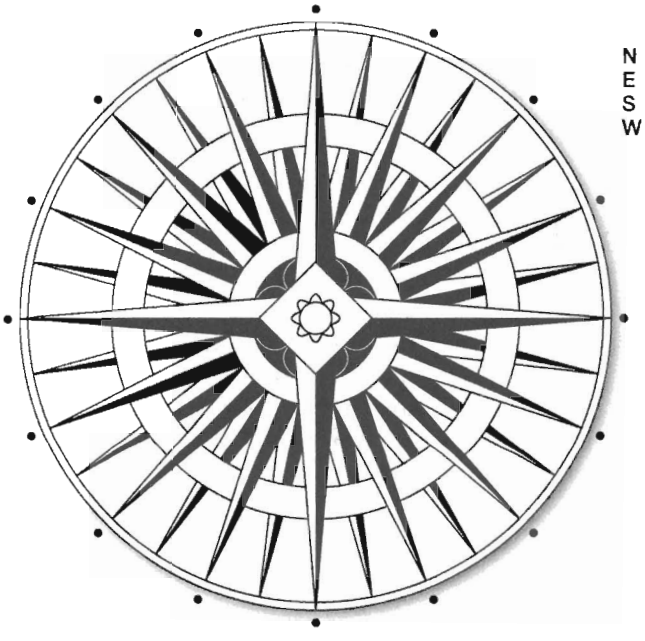
Lab Exercise and Activities

SECTION 1

Compass Points

The directional system familiar to most people is that of **compass points**. The symbol below is a *compass rose.* Cartographers often included elaborate compass roses as a decorative, as well as a functional, part of antique maps. The compass rose has four **cardinal points**—in a clockwise direction—north, east, south, and west, separated by four intermediate points: NE, SE, SW, NW. These are split into 16 and then, sometimes, again into 32 compass points. You may not be familiar with compass points such as NNE and ENE. These points are used when greater precision is needed. NNE (read north northeast), is north of NE, while ENE (read east northeast), is east of NE.

1. Label 16 compass points on Figure 3.1, using color pencils on the compass rose to distinguish the categories of division. (Include a legend for your color scheme.) In each division, the points are listed clockwise.



▲ Figure 3.1 **Compass points**

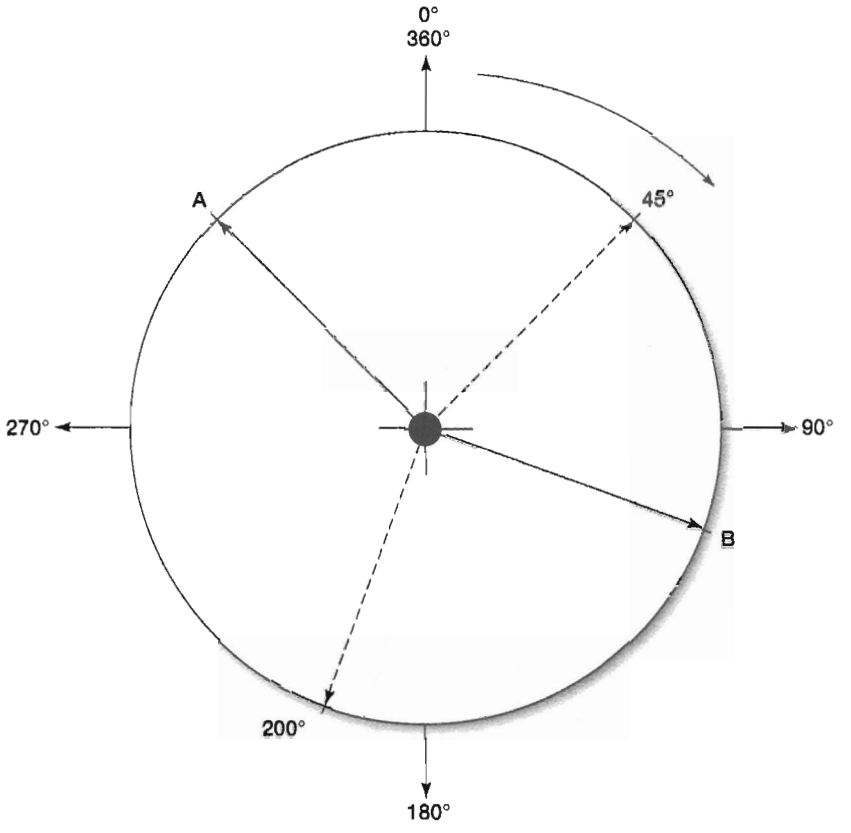
SECTION 2

Azimuths

While useful, compass points are not extremely accurate, and most often the direction between two points does not fall exactly on one of the 32 points. Degrees of an arc are used for more precise directions.

Azimuths are read from the north in a clockwise direction, from 0° to 360° (with 0° and 360° being the same point—north). For further precision, the degrees can be broken down into minutes (′).

1. Figure 3.2 has a few azimuths drawn and labeled as examples. Using your protractor, determine the azimuth readings for *A* and *B*, and label the value for each on the diagram.
2. Measure, draw, and label the following azimuths on the diagram: 230°, 78°, 145°.



▲ Figure 3.2 **Azimuths**

3. Using Figure 3.1, Figure 3.2, and your protractor, answer the following questions.

   Which azimuth is found at the following compass points: NE [45°] SW _____

   W _____ ESE _____ NNW _____

   Which compass point is found at the following azimuths: 135° [SE] 247.5° _____

   180° _____ 315° _____ 225° _____

SECTION 3

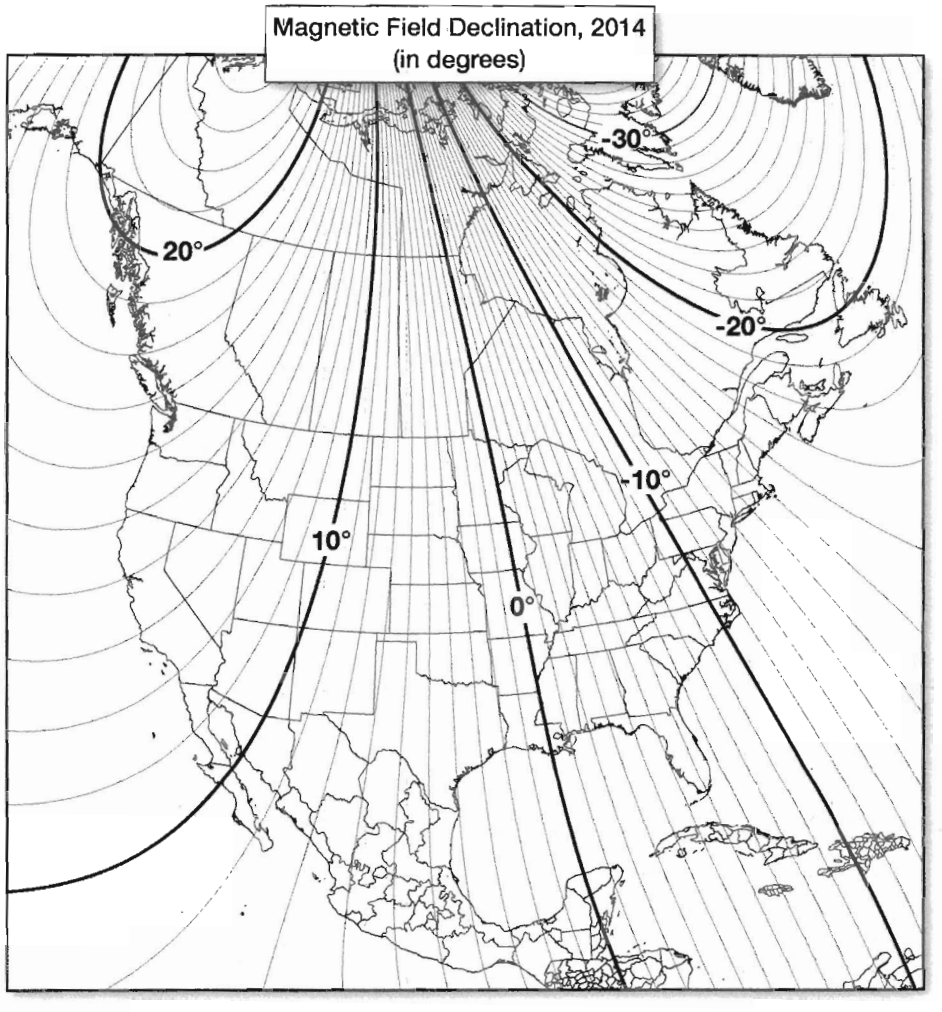
Compass Declination

Earth rotates around an axis that is marked by the **geographic North** and **South Poles**, also referred to as **true north** and **true south**. Meridians of longitude converge at these geographic points.

A **magnetic compass**, an instrument used to determine direction, points to the **magnetic North Pole**, which does not coincide with true north and the geographic pole. The difference between the north

arrow on a magnetic compass and true north is the **magnetic declination**. A compass needle that points west of true north indicates a *west declination*, and a compass needle that points east of true north indicates an *east declination*. When using a magnetic compass, you must make adjustments for the difference between magnetic north and true north.

Isogons, lines connecting points of equal magnetic declination, are shown on ***isogonal maps***, such as in Figure 3.3. The magnetic poles change over time, slowly migrating, so that adjustments for these magnetic pole changes need to be considered if map navigation is to be up-to-date.



▲ Figure 3.3 **Magnetic field declination, 2014 (in degrees)**

1. Using the isogonal map in Figure 3.3 and your atlas, in what city would you have to stand during 2014 to get a compass reading with zero magnetic declination (where magnetic north aligns with true north, or an agonic line). Mark the city with a dot and a label on the map.
2. Using your atlas, turn to the pages featuring the polar regions and find the latitude/longitude coordinates for the:
   - **a)** Magnetic North Pole _____
   - **b)** Magnetic South Pole _____

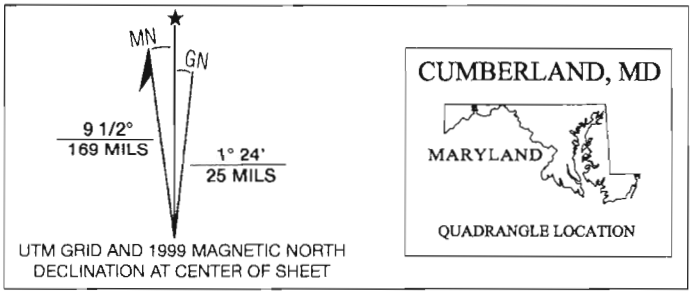
3. Find the linear distance in km and miles between the latitude of the:

   a) Magnetic North Pole and true north _____

   b) Magnetic South Pole and true south _____

Topographic maps (or topo maps) are a set of maps covering the entire United States that show the horizontal position (latitude/longitude) of boundaries, land-use aspects, bodies of water, and economic and cultural features. Topographic maps also have a vertical component to show topography (configuration of the land surface), including slope and relief (the vertical difference in local landscape elevation). These fine details are shown through the use of elevation contour lines. A contour line connects all points at the same elevation. Elevations are shown above or below a vertical datum, or reference level, which usually is mean sea level. The contour interval is the vertical distance in elevation between two adjacent contour lines. Inside the front cover of this manual are the standard symbols commonly used on these topographic maps. These symbols and the colors used are standard on all USGS topographic maps: black for human constructions, blue for water features, brown for relief features and contours, pink for urbanized areas, and green for woodlands, orchards, brush, and the like. The margins of a topographic map contain a wealth of information about its concept and content. In the margins of topographic maps, you find the quadrangle name, names of adjoining quads, quad series and type, position in the latitude-longitude and other coordinate systems, title, legend, datum plane, symbols used for roads and trails, the dates and history of the survey of that particular quad, magnetic declination (alignment of magnetic north) and compass information, and more.

Magnetic declination is shown by a declination diagram or arrow in the margin of a topographic map, as shown in Figure 3.4. True north is indicated by the star, and the magnetic declination is shown by the arrow marked MN. You work further with magnetic declination in Lab Exercise 23 (topographic map reading). **Grid north (GN)** refers to the relation of the topo map to the Universal Transverse Mercator system (UTM). GN is another reference system based on rectangular map zones, so that as meridians taper toward the pole, the GN shows the relation of these converging lines and the rectangular grid.



▲ Figure 3.4 **Declination arrow on topographic maps**

4. According to Figure 3.4, what is the magnetic declination between:

   a) True north and magnetic north (MN)? _____

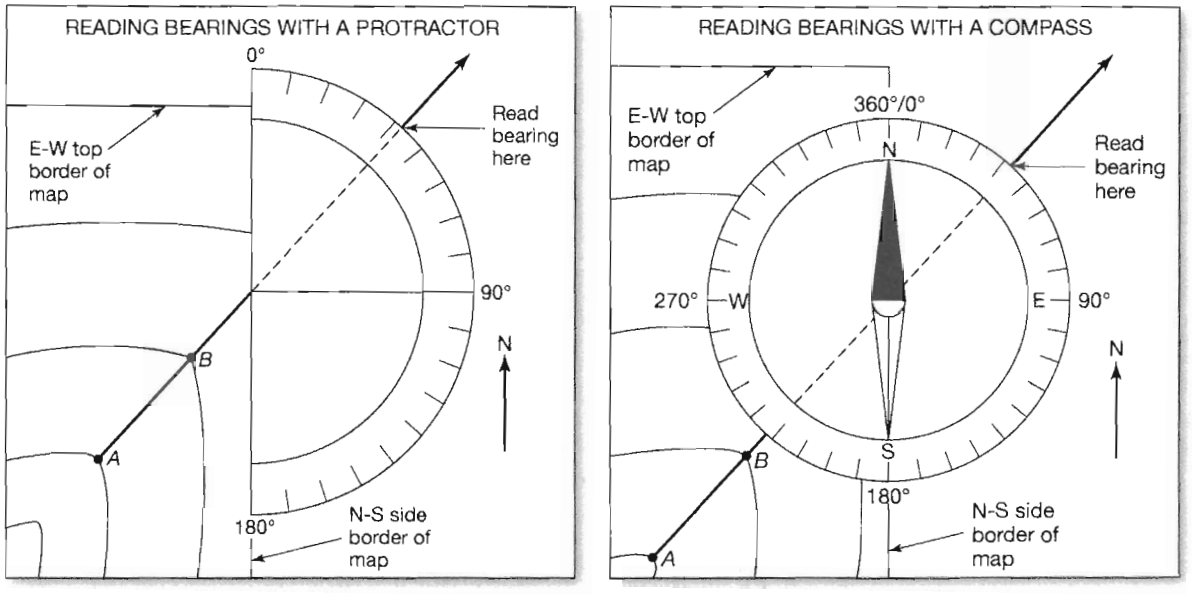
   b) True north and grid north (GN)? _____

5. Look for the declination arrow in the margin of the topographic map provided by your instructor. What is the magnetic declination between true north and magnetic north on the topographic map provided by your instructor? What is the magnetic declination between true north and magnetic north shown for this location in Figure 3.3? Any discrepancies you find relate to the migrating magnetic pole and the dates of the topo map and the isogonal map (2014). (Keep this topo map handy for the next section.)

SECTION 4

Compass Bearing

The compass bearing between two points on a map may be determined by using a protractor or a magnetic compass. To accomplish this, lightly draw a line through the specified points and extend the line to the edge of the map. To use a protractor, place the straight edge of the protractor along the margin of the map, with the origin of the protractor at the point where the line intersects the map margin. The extension of the drawn line indicates the compass bearing (Figure 3.5a). To use the compass, simply align the margin of the map with the 0°/360° and 180° points on the compass. The bearing can be read from the compass dial (Figure 3.5b). (Pay no attention to the compass needle.)

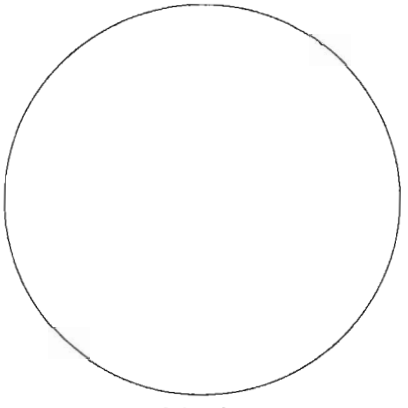


▲ Figure 3.5 Reading compass bearings on a map using a protractor (a); using a magnetic compass (b). (From Busch, Richard M. editor, *Laboratory Manual in Physical Geology*, 3rd ed., Macmillan Publishing Company © 1993.)

Using the local topographic map from the last section, complete the following.

1. Find the compass bearing between two points on the map indicated by your instructor. Give the reading as an azimuth.

On the circle provided below, sketch your determination of the azimuth.



Azimuth

2. What is the highest elevation on the local topographic map? (Indicate a geographic feature that is at or adjacent to that elevation.)

3. What is the lowest elevation on the map? (Indicate a geographic feature that is at or adjacent to that elevation.)

4. What is the relief (highest elevation minus lowest elevation in a local landscape) of the area portrayed on this map? Perhaps compare two or three areas of the topographic map if relief varies across the region.

   (Show your work.)