## MAKING A COMPASS

Materials Needed:

- Non-metallic bowls of water
- Sewing needles
- Small magnets
- Thin pieces of Styrofoam
- Compasses

Procedure:

- Stroke needles with magnet
- Stick needle through Styrofoam
- Float in bowl of water
- Compare to compass magnetic north (keep compass away from needle)

## HISTORY:

- Explorers limited by open seas (shoreline travel)
- Unable to view landmarks
- Trade-expensive abroad, sailors connected world
- Compass;
- Created in 12th century, creator undetermined
- Provided all-weather orientation
- Cut navigation in half
- Opened new trade routes

<u>Developments to Navigation:</u>

1. compass
   12th century, lodestone (magnetite-$Fe_3O_4$) black magnetized iron ore
   Chinese, Europeans floated lodestone; Arabs suspended from string
2. systematic map making
   Practical for captains to share notes. Sailors used altitude of mid-day sun to determine latitude on clear days, but longitude very difficult
3. Chronometer-John Harrison (1700's)
   mid-day sun settings to determine zenith over current position
   time in Greenwich, England, used to determine longitude
4. David Brunton-first pocket transit (1894)
5. GPS late 20th century (released to public 1995)
   military use
   3rd world countries relying on 100 yr-old charts

**MAGNETISM**

Materials:

- Norm's 3-D compass
- Pictures (ppts, transparencies) of
    - Magnetic fields
    - Earth's magnetic fields
    - Magnetic North vs North Pole-Brunton's diagram
    - Isoline Map
    - North Star-how to find
- Magnetic Declanation
    - Variables
    - Website
    - Map location and how to read
- Fossil Hill sample map

Procedure:

Show iron filings on paper
Norm's 3-D compass
Picture of earth's magnetic field
Magnetic North vs North pole Brunton diagram
Show Isoline Map and discuss magnetic declination
Show where to find MG on map-Fossil Hill sample map
Discuss North Star and show diagram
Where to find current magnetic north website

**WHERE AM I? GRID ACTIVITY #1**

Materials: Blank grid

Procedure (Groups of 2-3):

1. Draw classroom objects (landmarks) on grid
2. Place star on "your" location
3. Choose one corner (any corner) of the grid to be (0, 0) and mark the walls that form that corner as $x$ and $y$.
4. Create a numbering system for the $x$ and $y$ walls.
5. Identify the coordinates of the positions of the landmarks from #1
6. Ask someone from another group what one of their coordinates are and identify them on your grid. (Circle their position to distinguish it from your own.
7. Compare your grid with your neighboring group. Are they the same?

**WHERE AM I? GRID ACTIVITY** #2

Materials:
Relative sizes worksheet (paper for students and transparency for me)
Relative sizes grid (paper for students and transparency for me)
Lesson 5: Activity 1-Scale worksheet

Procedures:

1. complete the worksheet together
2. measure classroom dimensions (determine what units to use)
3. decide how dimensions will best fit graph paper
4. draw in the walls
5. decide, as a class, how to set coordinates (i.e. in corner or in center)
6. create a scale
7. go over scale worksheet together, discussion dimensional analysis

**BASEPLATE COMPASS**

Materials:
- Instructor compass
- Compasses with declination set to zero
- Exercise #1 Brunton
- Field area with 100 meters marked in North direction

Procedures:
Identify part of the compass-exercise 1

Field practice:
- Hold compass level, against tummy (skinny rope attached to compass)
- Show magnetic north
- Rotate azimuth ring and baseplate-needle always north
- Walk 100 steps toward North (Place object at starting point)
- Walk 100 steps South (following white part of needle)

**PACING**

Materials:
Compass
Pacing Worksheet

Procedures:
2 steps = 1 pace (every time left foot hits ground, count one pace). Practice can lead to 2-5% accuracy
- Walk normally for 100 meters (should take 50 to 100). Repeat 3 times, keeping track of three totals. Add 3 totals and divide by 3 to get average.
- Determine:_________ Paces = 100 meters
- Walk 50 meters using their pacing as a measuring tool

Pairs:
- Determine an attack point
- Hide object (something small) within 200 meters of attack point, and mark X on map
- Give bearing and distance ( 20 to 200 meters) from attack point to another pair to find object

Run a short orienteering meet (?)

**BASIC MAP READING-1**

**ORIENTING A MAP**

Materials:

- Compasses
- Maps
- Brunton Exercise 2: Bearings and Directions

Procedure:

1. Review 360 degrees in circle, and how to read 0 from the top (North)
2. Adjust the compass for declination.
3. Dial 0 degrees N into the "direction of travel" arrow
4. Place compass along a north/south line on map
5. Without moving compass, rotate map and "box" the magnetic needle with the orienting arrow.

**TAKING A FIELD BEARING**

Materials:

- Compasses
- Maps

Procedures:

- Be sure all compass magnetic declinations are set for 0
- Identify N, S, E. W on azimuth ring
- To take a Bearing:
    1. Point the "direction of travel" arrow at an object
    2. Turn azimuth until aligned "red over red"
    3. Read bearing at the "direction of travel" arrow

**TAKING A MAP BEARING**

Materials:

- Compasses
- Maps

Procedures:

1. Orient the map
2. Place edge of compass along line from current location to destination
3. Rotate azimuth ring to "box" the magnetic needle
4. Hold compass level in your hand and rotate body until needle is boxed with the orienting arrow. You are now facing your destination.

**BASIC MAP READING-2**

Materials:

- USGS topo map symbols
- Riverton 7.5 minute topo map showing CWC
- *Understanding the Language of Maps*
- *Making the Compass and Map Work for You*
- Brunton's Distance Measuring Worksheet
- Electrical Wire
- *Using Your Map's Scale to Estimate Trip Distance*
- *Creating a Trail Profile*

Procedures:

- Discuss USGS map symbols
- Show how to orient map using the sun-KISS theory
- Have students identify two landmarks, and show how to orient map to current location using the 2 landmarks
- Use the scale to find the distance between landmarks
- Use the casual walking time of 3 mph to determine time to travel between landmarks

Homework:

- Find a prescribed course for students (ie, bottom of hill to CWC)
- Use topo map to:
  - Estimate distance
  - Estimate time
- Brunton Quiz

**STAYING ORIENTED, NATURALLY**

Materials:

- Visit http://www.analemme.com
- Brunton's *Staying Found*
- CWC-Riverton topo map
- Brunton's *Body Part Angles Sheet*

Procedures:

1. Review *Staying Found.*
2. On whiteboard demonstrate how earth rotates around the sun, and how the sun moves across our sky: http://www.analemme.com

- Due South at mid-day
- Due North at mid-night
- East at 6 a.m.
- West at 6 p.m.
- Can be 30 min off depending on which side of the time zone you're in
- Sun "moves" 90 degrees through sky every 6 hours, or 15 degrees per hour.
- Balled fist = 15 degrees
- To locate true South at 1 p.m., locate sun and move one fist width to the left along solar arc

**CONTOUR LINES**

Materials:

- Suki's CD showing 3-D contour lines
- Brunton Exercise 3 from Student Handbook
- Local topo map
- USGS topo map symbols
- Brunton *Terrain Features Handouts (3)*
- Brunton's *3-D Terrain Cut Out Models*

Procedure:

- Show CD with 3-D animation, explaining how contour lines are used to add a 3rd dimension to maps.
- Use terrain models to physically demonstrate how contour lines are evenly spaced.
- Review Terrain Feature Handouts (3)
- Look at Fossil Hill and try to identify as many features as possible
- Brunton's *Contour Review* for assessment

**BEARINGS (MAGNETIC DECLINATION ADJUSTED) and TRIANGULATION**

Materials:
Compasses
Topo maps
Brunton's *Triangulation*
Brunton's *Practical Navigation Tips*

Procedures:
Review "Taking a Field Bearing"
Work exercise 6 as written, then add magnetic declination and do again
Demonstrate how to triangulate:

- Find magnetic north
- Determine magnetic declination
- Set compass
- Orient map to north
- Find landmark and determine bearing*
- Set corner new COT arrow and rotate until red arrow in red outline
- Draw line
- Select another landmark
- Repeat and draw line
- Intersection pt locates

*with compass magnetic declination already set, face landmark with DOY pointing toward object. Line up arrow in outline and read compass.

**LATITUDE/LONGITUDE**

$1^{\circ} \approx 69 miles \approx 111 km$

$1'' \approx 100 ft \approx 30 m$

Materials:
Ppt,
Globe,
Topo maps
Lat/long location quiz

Procedure:
Show powerpoint while discussing evolvement of lat/long
Discussion items:
Called GEOGRAPHIC COORDINATE SYSTEM

- $360^{o}$, minutes ('), seconds("), we'll use decimal degrees
- Latitude: uniform, parallel's of latitude, parallel to equator, Equator = 0 degrees
- Longitude: Pole to pole, Prime meridian = $0^{o}$, International Date Line = $180^{o}$ E or W
- Read: latitude, longitude example: N $47^{o}$ 19.56', E $102^{o}$ 42.84'
- How to read on USGS map:
    - Quadrangles: 7.5 x 7.5 min

- Start in lower left corner. Increases 2.5' as going up (north), decreases 2.5' as going right (east) because we are in western hemisphere
- corners, tick marks on side and crosses inside map
- do not confuse with UTM marks

Activity:
- Draw in grid lines (Divide by number that make's fractions easy. i.e. 5) Be sure to do this, as it will emphasize to students that the grid is NOT rectangular.
- Use special ruler-measures time, not distance (Lance's ruler, directions, and ppt)

Assessment:
Lat/Long coordinate location quiz

**UTM's**

Materials:
Orange (grapefruit)
Knife
Ppt
Topo maps
UTM rulers
Trimble website
Brunton's *GPS systems*

Discussion: After WWII a grid system designed based on the metric system. Projection of curved surface onto flat plane. (Cut up orange to demonstrate.) Universal Transverse Mercator. The earth, a sphere, has $360^o$. Divided into 60 zones, each at $6^o$. Each zone runs from $84^o$N to $80^o$S. Show Zone chart. Zone 1 begins at 180 degrees W (or E). We are in zone 12. Referred to as false coordinates. Numbers along top of map called eastings, and provide east-west reading. Numbers along side are called northings. ( Each grid=1km = 1000 m = 0.62 miles)
Each zone has a central meridian, which has a reading of 500 000m. Any point to the left of center is still read as an "easting", and any point to the right of center is still read as "easting". The value of an easting coordinate reveals its distance from the zone meridian (the center of the zone) in meters.

Example: 12 $^{5}\mathbf{01}^{560}$ is in zone 12 and is 1560 meters to the right of center. It is read, "501,560 meters east."

12 $^{4}\mathbf{35}^{210}$ is also in zone 12, and is 500 000 – 435 210 = 64,790 m left of center. It is read, "435,210 meters east."

Easting coordinates always increase as you move east (right) and decrease as you move west (left), but you are never "westing." A valid easting for any given zone will never be less than 166,640 m and will never be greater than 833,360 m. Here's why:

$$1^{\circ} \approx 111km$$
$$6^{\circ} \approx 666km = 666,000m$$
$$\left(\frac{1}{2}\right)(666,000) = 333,000$$
$$500,000 - 333,000 = 167,000$$
$$500,000 + 333,000 = 888,000$$

Northing coordinates always measure the distance from the equator. In the Northern Hemisphere, 00,000,000mN are used. (In the Southern Hemisphere, 100,000,000mN are used.)
Example: 12 $^{42}48^{500}$ N is in zone 12 and is 4,248,500 meters north of the equator.
A valid northing will lie between 0 degrees (the equator) and 9,334,080 meters north of the equator.

Activities: Use UTM rulers to show how to read coordinates on topo maps.

Assessment: UTM coordinate quiz

**USING GPS** (see other materials)