I) A hypothetical earthquake...
Listed below are a series of seismograph stations. For each is given

1) the azimuth (clockwise from north) from the epicenter of one earthquake to the seismograph station
2) the angle of incidence (i) for the incoming ray path (that is, the takeoff angle from horizontal for the ray path at the earthquake focus)
3) a record of the nature of the first arrival at the station.

<table>
<thead>
<tr>
<th>STATION</th>
<th>AZIMUTH</th>
<th>ANGLE (I)</th>
<th>FIRST MOTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>137</td>
<td>18.6</td>
<td>U</td>
</tr>
<tr>
<td>II</td>
<td>111</td>
<td>22.9</td>
<td>U</td>
</tr>
<tr>
<td>III</td>
<td>327</td>
<td>22.4</td>
<td>D</td>
</tr>
<tr>
<td>IV</td>
<td>266</td>
<td>22.8</td>
<td>U</td>
</tr>
<tr>
<td>V</td>
<td>337</td>
<td>22.5</td>
<td>D</td>
</tr>
<tr>
<td>VI</td>
<td>304</td>
<td>22.7</td>
<td>U</td>
</tr>
<tr>
<td>VII</td>
<td>27</td>
<td>22.1</td>
<td>D</td>
</tr>
<tr>
<td>VIII</td>
<td>48</td>
<td>22</td>
<td>U</td>
</tr>
<tr>
<td>IX</td>
<td>168</td>
<td>28</td>
<td>D</td>
</tr>
<tr>
<td>X</td>
<td>195</td>
<td>22.1</td>
<td>D</td>
</tr>
<tr>
<td>XI</td>
<td>230</td>
<td>23</td>
<td>D</td>
</tr>
</tbody>
</table>

1) Determine the first motion of the P-wave recorded at each station. For a dilational first motion, the initial pen motion on the record is down (D). For a compressional first motion the initial pen motion is up (U).
2) On a Schmidt (equal area) stereonet, plot each first motion at the lower hemisphere projection of each ray path relative to the earthquake focus at the center of the stereonet by using the seismic station azimuths and ray path angles of incidence. Use open circles for plotting dilations and filled circles for compressions.
3) Draw the lower hemisphere projection of the two nodal planes to fit the pattern of compressional and dilational first motions. Determine the strike and dip of the nodal planes.
4) Shade the compressional quadrants of your plot.
5) Based on your fault plane solution, what type of fault (normal, thrust, strike-slip) was produced by the stress release associated with this earthquake? What are the possible senses of motion on the nodal planes?
6) For both possible solutions, name one SPECIFIC (i.e. non-generic) location where such an earthquake might occur today.
7) For these data the azimuth and angle of incidence had already been determined. Describe how the azimuth and angle of incidence are determined knowing the location of a seismic station and the focal location of an earthquake. To answer this consider an earthquake (10 km focal depth) in Los Angeles that is received at a seismograph in Amherst.
II) Fault plane solutions from seismograms

1) Go to the IRIS WILBER II site (http://www.iris.edu/cgi-bin/wilberII_page1.pl)
    Look at the map of recent seismicity and choose (double click) on an earthquake. This
    will bring up a new window with a list of recent earthquakes.
    Select one of the these earthquakes. This brings up a window with a list of seismic
    networks that recorded that earthquake, check ALL and PROCEED. This brings up a
    window that lists all of the seismic stations that recorded the earthquake (this number
    may be very large).

    Click on Plot just below Station Map to see a map of seismic station that recorded this
    event. Was the event recorded at seismic stations at a range of epicentral angles and
    azimuths? If so, then close the window with the map and proceed using this earthquake.
    If not, close the window and go back and select another earthquake.

2) My earthquake that was recorded at a range of stations at different epicentral angles and
    azimuths is:
    Approx. Location:
    Long:
    Lat:
    time:

3) Boxes are checked next to the names of the seismic stations. Uncheck ALL of the boxes.
    This is done most easily by selecting DISTANCE from 0 to 5 deg and AZIMUTH from
    0 to 10 deg, then clicking on Apply Filter. This will uncheck most of the boxes, you can
    uncheck the rest manually. By checking boxes, you can download seismograms from
    each of the stations.

4) Select (check the boxes) 5 stations that are relatively close to the focus (within 20-30
    deg), and select the short-period E-W seismogram BHE under CHANNEL. Then click
    on Plot below RECORD SECTION. In selecting seismic stations be sure to choose
    ones with a range of azimuths.

    a) This will bring up another window. Under OPTIONS, select a TIME
       WINDOW from 30 sec before P to 1 min after P. Under LAYOUT, select plot height
       autofit, each trace height 4 cm, vertical spacing stacked. Then click on Plot. This
       should bring up very readable seismograms of the time arounf the P arrival at each
       of your stations.

    b) Examine the seismograms and determine direction the first motions. An
       upward motion should represent a first motion to the E. An downward motion should
       represent a first motion to the W.

    c) For each station record:
       azimuth
       epicentral angle
       first motion: BHE
       degree of confidence (certain, good, poor)
5) Close the window with the seismograms and repeat 4 a) with the short-period N-S seismograms. Select E-W seismogram BHN under CHANNEL. Then click on Plot below RECORD SECTION. This will bring up the seismogram window. Follow the instructions in 4 a) and b). An upward motion should represent a first motion to the N. An downward motion should represent a first motion to the S.

a) For each station record:
- **first motion**: BHN
- **degree of confidence** (certain, reasonable, good, poor)

6) Close the window with the seismograms and repeat 4 a) with the short-period vertical seismograms. Select vertical seismogram BHZ under CHANNEL. Then click on Plot below RECORD SECTION. This will bring up the seismogram window. Follow the instructions in 4 a) and b). An upward motion should represent a compression. An downward motion should represent a dialation.

a) For each station record:
- **first motion**: BHZ
- **degree of confidence** (certain, reasonable, good, poor)

7) Look at the 3d first motions. Do they represent compressions or dialations? Consider a station with an epicentral angle of 12 deg and an azimuth of 122 deg (i.e. the station is to the SE of the focus). From the 3 seismograms seismogram the first motions are:
  - BHE (east component) **UP**
  - BHN (north component) **DOWN**
  - BHZ (vertical component) **UP**
Or putting them all together the first motion was out of the ground and towards the SE. This is away from the focus or a COMPRESSIONAL first motion.

8) You should now have first motions determined for 5 seismic stations close to the focus. Close the seismogram window. Uncheck the boxes for your 5 seismic stations and select (check the box) 5 more that are farther from the focus. Be sure to choose ones that have a range of epicentral angles and azimuths. Examine each of the 3 short period seismigrams (BHE, BHN, BHZ) for each of the stations and determine the direction of first motions (i.e., repeat 4, 5, 6, 7 for these stations).

9) Continue until you have ~20 first motions from stations with epicentral angles as large as ~100 deg (past that you would have to look at PKP which is more complex).

10) From the epicentral angles determine the approximate inclinations. If we ignore refraction due to velocity changes within the mantle: inclination = epicentral angle/2

11) Plot the inclinations/azimuths on a stereonet as you did for Part I (2-5). Were you able to determine a fault plane solution? If not make sure that you are not basing your
conclusions on poorly resolved (low confidence) first motions.

12) Determine the type of fault? Its possible orientations? Find your fault on a geological or bathymetrical map. Is there a fault or topographic scarp there? Does it strike parallel to one of your nodal planes? What type of fault do you have?

**MAP NAME or URL:**