LAB A - THE INTERNATIONAL SYSTEM OF UNITS (SI), STATISTICAL DATA, GRAPHS, and CONTOUR ANALYSIS

Introduction

The United States has been slow to adopt the International System of Units (SI), called the Metric System prior to 1960, though science and business throughout most of the world employ it exclusively. Global integration and the desire for standardization have accelerated conversion to the SI, though remnants of the English System still remain. In order to understand and use scientific data presented by the global community, it is important for the student of geography to be able to use both the SI and English systems interchangeably. This lesson will present the student with a general understanding of the International System of Units (SI) and the formulas necessary to convert from the English System to SI and vice versa.

Materials needed: pencil, ruler and calculator

Part I. SI Conversion - Length and Area

Using the formulas below, solve problems A-P.

\[ 1 \text{ mile (mi)} = 1.609 \text{ kilometers (km)} \]
\[ 1 \text{ square mile (mi}^2\text{)} = 2.59 \text{ square kilometers (km}^2\text{)} \]
\[ 1 \text{ kilometer (km)} = 0.621 \text{ miles (mi)} \]
\[ 1 \text{ square kilometer (km}^2\text{)} = 0.386 \text{ square miles (mi}^2\text{)} \]
\[ 1 \text{ foot (ft)} = 0.3048 \text{ meters (m)} \]
\[ 1 \text{ kilometer (km)} = 0.621 \text{ miles (mi)} \]
\[ 1 \text{ inch (in)} = 2.54 \text{ centimeters (cm)} \]
\[ 1 \text{ square kilometer (km}^2\text{)} = 0.386 \text{ square miles (mi}^2\text{)} \]
\[ 1 \text{ inch (in)} = 2.54 \text{ millimeters (mm)} \]
\[ 1 \text{ kilometer (km)} = 1,000 \text{ meters (m)} \]
\[ 1 \text{ hectare (ha)} = 2.471 \text{ acres (ac)} \]
\[ 1 \text{ meter (m)} = 3.281 \text{ feet (ft)} \]
\[ 1 \text{ acre (ac)} = 0.4 \text{ hectares (ha)} \]
\[ 1 \text{ centimeter (cm)} = 0.39 \text{ inches (in)} \]
\[ 1 \text{ mile (mi)} = 5280 \text{ feet (ft)} \]
\[ 1 \text{ yard (yd)} = 3 \text{ feet (ft)} \]
\[ 1 \text{ meter (m)} = 100 \text{ centimeters (cm)} \]
\[ 1 \text{ meter (m)} = 1000 \text{ millimeters (mm)} \]
\[ 10 \text{ millimeters (mm)} = 1 \text{ centimeter (cm)} \]

Be sure to show your work on a separate piece of paper!!

A. 15 miles = ___________ kilometers

B. 80 hectares = ___________ acres

C. 5 inches = ___________ centimeters

D. 77.44 meters = ___________ feet

E. ___________ meters = 87 yards

F. 80 inches = ___________ millimeters

G. 485 millimeters = ___________ inches

H. 842 kilometers = ___________ meters

I. 625 kilometers = ___________ miles

J. __________ kilometer(s) = 3,281 feet

K. 48.5 centimeters = ___________ inches

L. 385.25 hectares = ____________ acres

M. 153 kilometers = ___________ miles

N. 127 millimeters = ___________ inches

O. 25 acres = ___________ hectares

P. 45,000 millimeters = __________ kilometers
**Part II. SI Conversion - Temperature**

Using the formulas below, solve problems A-H.

**To convert to Fahrenheit:** If given a temperature in °C, convert to °F using this formula:

\[ °F = \left( \frac{9 \times °C}{5} \right) + 32° \]

**To convert to Celsius:** If given a temperature in °F, convert to °C using this formula:

\[ °C = \frac{5 \times (°F - 32°)}{9} \]

A. 72° F = __________ °C

B. __________ °F = 30 °C

C. 32° F = __________ °C

D. 212° F = __________ °C

E. __________ °F = 37 °C

F. -40 °F = __________ °C

G. __________ °F = 12 °C

H. 122° F = __________ °C

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**Part III. Statistical Data and Graphs**

Statistics are pieces of information, also referred to as data. Statistics are often represented in graphic form, such as a line or bar graph. These graphic portrayals are of great value for displaying temperature and precipitation changes over time, changes in elevation over space, and a whole range of other subjects. Statistics are collected in a variety of ways and from a variety of different sources. The ability to interpret the information presented in statistical/graphic form will be extremely useful for understanding spatial and temporal changes and many of the processes that shape the Earth.

One of the most useful graphics for physical geographers is the climograph. The **climograph** is a simple graphic representation of monthly temperature and precipitation values for a specific location. Climographs for a variety of world locations are provided in Chapter 8 of the textbook. Each has twelve columns, one for each month of the year, a temperature scale on the left side and a precipitation scale on the right. Average monthly temperatures are connected by a curved line and the average monthly precipitation is represented by bars extending upward from the bottom of the graph. **After reviewing several of the climographs in Chapter 8, the student should complete parts A - D of this section. You don't have to do anything in Ch. 8 now, just look at some examples of climographs.**
A. Given monthly temperature values for an unspecified location, construct a two variable line graph for this location using Figure A-1. The X axis (horizontal axis) represents time - the twelve months of the year. The Y axis (vertical axis, left side of the graph) measures temperatures in degrees Celsius. Place a dot for the appropriate temperature (T °C) for each month centered in the column of the appropriate month, then connect the dots to form the line graph.

<table>
<thead>
<tr>
<th>Months of the Year</th>
<th>J</th>
<th>F</th>
<th>M</th>
<th>A</th>
<th>M</th>
<th>J</th>
<th>J</th>
<th>A</th>
<th>S</th>
<th>O</th>
<th>N</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>T °C</td>
<td>0</td>
<td>0</td>
<td>3.5</td>
<td>9.5</td>
<td>15.5</td>
<td>21</td>
<td>24.5</td>
<td>23.5</td>
<td>20</td>
<td>14.5</td>
<td>8</td>
<td>1.5</td>
</tr>
</tbody>
</table>

![Figure A-1: Line Graph Displaying Temperature Only](image)

Now answer the following questions (remember to use the units of measure where appropriate):

1. What is the temperature range (high minus low) for this location? ________________
2. Which three months are the warmest? ________________
3. From the information on this graph, do you believe this location is situated in the northern or southern hemisphere? ________________. How does the line graph support this fact? ________________
4. From the information on this graph, do you believe that this location is situated in the tropics, mid-latitudes or polar regions? ________________. How does the line graph support this fact? ________________
B. Given monthly precipitation values for the unspecified location, construct a **bar graph** for this location using Figure A-2. Again, the **X axis** *(horizontal axis)* represents the twelve months of the year. The **Y axis** *(vertical axis, right side of the graph)* represents the amount of **precipitation (P mm)** received each month. **Center the bars for each month directly above the abbreviation for each month.** Make each bar approximately ¼ inch in width and shade in each with a pencil.

### Months of the Year

<table>
<thead>
<tr>
<th></th>
<th>J</th>
<th>F</th>
<th>M</th>
<th>A</th>
<th>M</th>
<th>J</th>
<th>J</th>
<th>A</th>
<th>S</th>
<th>O</th>
<th>N</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>P mm</strong></td>
<td>81</td>
<td>74</td>
<td>107</td>
<td>89</td>
<td>94</td>
<td>87</td>
<td>102</td>
<td>127</td>
<td>107</td>
<td>81</td>
<td>89</td>
<td>81</td>
</tr>
</tbody>
</table>

Figure A-2: Bar Graph Displaying **Precipitation Only**

Now answer the following questions *(remember to use the units of measure where appropriate)*:

1. Which month is the wettest and how much precipitation is received?  
   **Month =** _________  
   **Amount =** _________

2. Which month receives the least precipitation and how much is received?  
   **Month =** _________  
   **Amount =** _________

3. What season receives the most precipitation?  
   _________
C. Now integrate the monthly temperature and precipitation values for the unspecified location into one graphic, a *climograph*, using Figure A-3. Again, use a line graph to display temperatures and a bar graph for precipitation.

<table>
<thead>
<tr>
<th>Months of the Year</th>
<th>J</th>
<th>F</th>
<th>M</th>
<th>A</th>
<th>M</th>
<th>J</th>
<th>J</th>
<th>A</th>
<th>S</th>
<th>O</th>
<th>N</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>T (°F)</td>
<td>32</td>
<td>32</td>
<td>39</td>
<td>49</td>
<td>60</td>
<td>70</td>
<td>76</td>
<td>74</td>
<td>68</td>
<td>58</td>
<td>46</td>
<td>35</td>
</tr>
<tr>
<td>P (inches)</td>
<td>3.2</td>
<td>2.9</td>
<td>4.2</td>
<td>3.5</td>
<td>3.7</td>
<td>3.4</td>
<td>4.0</td>
<td>5.0</td>
<td>4.2</td>
<td>3.2</td>
<td>3.5</td>
<td>3.2</td>
</tr>
</tbody>
</table>

**Figure A-3: Climograph Displaying Both Temperature and Precipitation**

D. Of the following cities, choose the likely location for the above climograph (Hint: examine the temperatures over the year and the annual temperature range. Then look at the amount of precipitation received at this location). Circle the correct city.

a. Fairbanks, Alaska  
b. Honolulu, Hawaii  
c. Miami, Florida  
d. New York, New York  
e. Phoenix, Arizona
E. Using the climograph below (Figure A-4), answer the following questions using proper units of measure where appropriate.

Figure A-4: Climograph

1. In which hemisphere is this station located? ______________________________________
2. How did you determine your answer to question 1? ________________________________
   __________________________________________________________________________
3. What is the temperature of the coldest month? _____________; Which month? __________
4. How much precipitation is received during the wettest month? _______________________
5. Estimate the temperature range for this location (highest minus lowest)? _______________
6. What form of precipitation would be received during the coldest month? _______________
7. How did you determine your answer to question 6? ________________________________
Part IV. Isopleth Analysis

A useful method that depicts pattern or distribution of quantities on a map is the technique of isopleth analysis. An isopleth is a line that connects points with the same numerical value. The word comes from the Greek: *iso* – equal; *pleth* – value. There are many different types of isopleths such as *isotherms*, lines of equal temperature; *isobars*, lines of equal barometric pressure; *isotachs*, lines of equal wind speed; and *isohyets*, lines of equal annual average precipitation, just to name a few. These maps are quite common in that they appear everyday in the newspaper or on television in the weather report. Hikers are familiar with topographic maps, which have contour lines (a type of isopleth) that show constant elevations.

Observations are not made everywhere so contouring data can be difficult. Where there are gaps, we must interpolate between existing values. There are some basic rules associated with contour (isopleth) analysis and these must be followed:

1. isopleths should never cross, merge, touch, branch or fork
2. values of the data points on one side of the line should all be greater (or less than) the value of the isopleth
3. contour the map only where you have data – stop lines when you run out of data at map margins or over large bodies of water (for land-based data sets)
4. label isopleths with values and units (e.g., 65°F)
5. draw smooth lines interpolating between given values to correctly position the line

*A helpful hint:* use a pencil with a good eraser.

Before you begin, it is always wise to look over the values on the map identifying 1) where are the highest and lowest values on the map; and 2) places where the values are changing quickly over short distances (large gradient in the variable) or where there is little variation.

Example: Isotherm analysis (equal temperatures) with 10°F interval.
A. Construct isotherms at $5^\circ$F intervals (for example, 40°F, 45°F, 50°F, etc.) on the weather map in Figure A-5. Examine the temperatures on the map noting the lowest and highest values. This will assist you in determining the value of the first line (we recommend that you can start with the coldest or warmest isotherm for the map).