where everyone uses the same clock time. In the continental United States we have five time zones. They are: Eastern, Central, Mountain, Pacific and Alaskan standard time zones. Each time zone has a "central meridian" of longitude and the time at the central meridian is considered to be the time for the entire zone. Ideally each zone is 15° wide i.e., 7.5° each side of the central meridian.

There are a total of 24 time zones. A person traveling eastward could gain 24 hours or one day worth of time zones when he "circles" the earth. To prevent such impossible occurrences the international date line was established. The international date line is approximated by the meridian of longitude (180°). It is adjusted to pass around islands in order to cause the least social disruption. When the international date line is crossed, the calendar date changes. Whenever it is crossed moving from west to east, one day is subtracted from the calendar date. When it is crossed moving from east to west, one day is added to the calendar date.

Many observations made in the world are given in terms of time along the prime meridian. This expression is frequently called Greenwich mean time (GMT) or Zulu time (Z) and has more recently been referred to as coordinated universal time (UTC). The 24-hour clock is commonly used to express the occurrence of events around the world. It begins at midnight and ends 24 hours later. Hours and minutes are expressed in a standard manner, such that 7:25 a.m. would be expressed as 07°25° or simply 0725. However, 3:15 p.m. would be expressed as 1515. Notice the number digits from midnight until noon match our conventional time notation. After noon, 12 is added to the hours part of our conventional time expression to get the correct number digits for the 24-hour time expression.

In order to successfully use a map, it is not only important to understand latitude-longitude, but also orientation given by compass directions. Many types of maps differentiate between true north and magnetic north. True north (geographic north) does not usually coincide with magnetic north. Since the earth "behaves" as if there is a bar magnet passing through it, we can talk about the north or south magnetic poles. The needle of a compass, for example, points toward the magnetic poles. The imaginary points on the earth where the geographic and magnetic poles lie, are more than a thousand miles apart. The difference between the direction to the geographic pole and the magnetic pole is known as magnetic declination or variation. It is expressed in degrees east or west of the reference direction to true north. Topographic maps used by a geologist or geographer usually give information about the magnetic declination for a particular region. There is a single line around the world where the direction to the magnetic north and geographic north are the same. This line is called the Agonic Line and the compass needle would point in the direction of both magnetic and geographic north.

In the world today, there are numerous methods used to aid in accurately locating position. Some of these include systems such as: inertial guidance, LORAN, Area Navigation (RNAV), VOR navigation, and Global Positioning. If you have traveled on passenger ships or aircraft your safe arrival, no doubt, depended on the use of a system that provided accurate tracking from point of departure to destination, regardless of the weather.

QUESTIONS:

1. The diagrams below show various samples of the earth's geographic system. Complete the following parts a - d of this question.

   a. On the bold lines below the two sets of sample, label which set represents parallels of latitude and which set represents meridians of longitude.

   ![Meridians of longitude](image)

   ![Parallels of latitude](image)

   b. The letters A - L are points located on the diagrams. Each diagram above shows only a small region with the orientation matching standard north-south and east-west map convention. On the lines to the left of each degree-arc minute notation below, indicate which lettered point corresponds to the given values.

   - B 20°00'E
   - C 47°30'S
   - D 42°45'N
   - E 38°15'N
   - F 17°30'E
   - G 50°30'S
   - H 49°00'S
   - I 15°45'E
   - J 64°00'W
   - K 66°45'W
   - L 40°00'N
   - M 60°30'W

   c. On the diagrams at the top of the next page are shown points M - R. Determine the latitude-longitude of each point, to the nearest arc minute. Give latitude first, followed by longitude. As an example letter M has been given.
2. The world map on the last page has the location of several major cities marked by letters. Complete parts a-d of this question.

a. Label the following parallels of latitude on the map: Equator, Tropic of Cancer (23.5° N), Tropic of Capricorn (23.5° S), Antarctic Circle (66.5° S), Arctic Circle (66.5° N). Also label the prime meridian.

b. Determine the latitude and longitude of each lettered position to the nearest degree and place it in the table.

c. Using an appropriate map, determine which cities are best approximated by your values and list them.

<table>
<thead>
<tr>
<th>Map Position</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Major City</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>25°N</td>
<td>90°E</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>30°S</td>
<td>180°W</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>30°S</td>
<td>180°W</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>60°N</td>
<td>170°E</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>30°S</td>
<td>140°E</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>60°N</td>
<td>40°W</td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>15°N</td>
<td>30°W</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>30°N</td>
<td>30°E</td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>37°N</td>
<td>90°W</td>
<td></td>
</tr>
<tr>
<td>J</td>
<td>14°N</td>
<td>100°E</td>
<td></td>
</tr>
<tr>
<td>K</td>
<td>32°N</td>
<td>110°E</td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>80°S</td>
<td>120°W</td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>27°N</td>
<td>70°E</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>53°N</td>
<td>110°W</td>
<td></td>
</tr>
<tr>
<td>O</td>
<td>18°N</td>
<td>100°W</td>
<td></td>
</tr>
</tbody>
</table>

Acceptable Error: ± 1° ± 2°

3. Severe weather such as hurricanes/typhoons is a constant threat to certain coastal regions in the world. Complete parts a-f.

a. On the satellite photograph (top of the next page), two prominent hurricanes can be seen. Each appears as a large scale spiral pattern of clouds surrounding a dark central spot, called the "eye". Circle each of these hurricanes on the photograph and provide a general description of their geographic location, using terms such as central Pacific, etc.

- Western Gulf of Mexico
- Off Mexico in Pacific Ocean

b. Based on this photo and its associated grid system showing "marker" latitude and longitude values, determine to the nearest degree, the latitude and longitude of the center or "eye" for each hurricane.

- Western most hurricane: latitude 20°N, longitude 110°W
- Eastern most hurricane: latitude 24°N, longitude 90°W

c. On the satellite photograph plot the position of hurricane Hugo for the dates listed in the table on page 5. Use the hurricane symbol (♀) for each point and then draw a smooth curve through these points.
d. Based on your plot between which dates did Hugo cross the Carolina coast?

9/21 - 9/22

e. In the country of Bangladesh in 1991 a typhoon resulted in great destruction and the death of over one hundred thousand people. Using the letter T, mark on the world map the city of Dhaka, Bangladesh. Briefly describe the geography of the region making it so vulnerable to hurricane damage.

f. Volcanic eruptions are also natural events that can affect regions. A significant event occurred when Mt. Pinatubo erupted in 1991. The eruption was positioned at approximately 15° N and 120° E. Using the letter V, mark this position on the world map and name the country it lies in.

4. Use the concept of time zones to determine the correct times and/or dates for the places below. Remember that dates change whenever we pass through the midnight hour and/or cross the international date line. Before answering these questions carefully review the world time zones in an atlas. Complete parts a - e.

a. If it is 16°00'W on December 20 at Moscow, Russia, what is the time and date at Seattle, USA?
   time _________ date ________________

b. If it is 8 a.m. on July 30 in New York City, USA, what is the time and date at London, England?
   time _________ date ________________

c. If it is 11 a.m. on October 10 in Beijing, China, what is the time and date at Anchorage, USA?
   time _________ date ________________

d. If it is 20°30'W on April 29 at Lima, Peru, what is the time and date at Montreal, Canada?
   time _________ date ________________

e. If it is 9 p.m. on May 21 at Adelaide, Australia, what is the time and date at Honolulu, USA?
   time _________ date ________________
north-south line. Using a map determine their difference in latitude to the nearest arc minute, then convert this to their north-south distance in nautical miles and list below.

\[
\begin{array}{cc}
\text{DIFFERENCE IN LATITUDE} & \text{DIFFERENCE IN NAUTICAL MILES} \\
8030' & 510nm
\end{array}
\]

b. One degree of latitude is equal to approximately 69 statute miles. The statute mile is the commonly used measurement in the United States. Carefully compare the two measurements. Which is larger, the nautical or statute mile?

nautical mile

c. The northern most city in Alaska is 

Borough, its latitude is 710N

d. The southern most city in Florida is 

Key West, its latitude is 250S

e. If these two cities (part c and d) were directly north-south of each other, how many nautical and statute miles apart would they be?

nautical 2760 statute 3174

10. On the sketch below, two travel routes, A and B are shown "connecting" two locations. Which route, A or B, represents the shortest distance between these points? Explain your choice in the space to the right of the sketch.

B. It follows a "Great Circle."

11. During this century, global environmental catastrophes, some natural and some man made, have been all too frequent events. Many of the man made crises continue to bring the planet to the brink of global disaster. Complete the following parts a - f.

a. The expanding southern border of the Sahara Desert has been associated with extreme drought. Countries such as Mauritania, Mali, Niger, Chad, Sudan, and Ethiopia have suffered severe famine. What continent do these countries lie in? AFRICA

Outline and color code these regions by shading them in red, on the world map.

b. Destruction of our planet’s tropical rainforest is a major concern. Its sensitive ecosystem is in delicate balance and its demise would lead to serious climate changes. In South America it can be roughly approximated by a continuous band extending about 10° either side of the equator. Shade in green the approximate location of the rainforest in South America, on the world map.

c. Industrial complexes, although good for regional economics, has environmentally damaging side effects. Burning sulphur rich coals is primarily responsible for the development of acid rains. In many regions entire forests have either been decimated or are on the verge of destruction. Frequently aquatic life has either disappeared or is severely stressed by acid rain affects. Regions that show unquestionable signs of acid rain damage are the Adirondack region of northeastern North America, the southern region of Norway and the Black Forest of Germany. On the world map approximate these regions of acid rain impact by marking in brown.

d. One of the most serious concerns is the destruction of the earth’s protective ozone layer. It appears the emission of chlorofluorocarbons, which have been in common use around the world, is the cause. Upper atmospheric ozone absorbs much of the harmful ultraviolet radiation in sunlight. A well documented "ozone hole" has repeatedly appeared over Antarctica. Evidence exists that the northern hemisphere is developing its own "ozone hole". On the world map approximate the southern "ozone hole" centered on the south pole, and extending outward about 20°. Cross-hatch this region in blue.

e. The oil tanker, the Exxon Valdez, ruptured and spilled millions of gallons of crude oil into pristine regions (Gulf of Alaska region). Land and sea animals were seriously endangered; the environment will take centuries to recover. On the world map approximate the area of the spill in black and blacken the affected coastal regions.

f. Nuclear power plant failures are among the most dreaded catastrophes. Several power plant failures, to various degrees of seriousness, have occurred. Chernobyl (near Kiev) and Three Mile Island (Pennsylvania) are two such examples. Approximate the location for each example on the world map, with a red dot.
a) 8°30' = 8.5° of latitude
   remember 30' = ½°

   \[ 1° = 60\text{nm} \text{ so } 8.5° = (8.5)(60\text{nm}) = 510\text{nm} \]

b) remember 1 nm = 1.15 mi, therefore 1 nm > 1 mi

c) 71°N - 25°N = 46° latitude between Borrow & Key

\[ \begin{align*}
\text{Borrow} & \quad 71°N \\
\text{Key West} & \quad 25°N \\
\text{\{46°\}} & \quad 46° \times 60\text{nm} = 2760\text{nm} \\
& \quad 46° \times 60\text{mi} = 3174\text{mi} \end{align*} \]