CLIMATE

NAME _____SCHOOL _____

DATE STARTED_____DATE COMPLETED_____

PREREQUISITE: Basic math, including simple algebra. Weather course recommended.

HOW TO DO THIS COURSE: Do the steps one at a time, in order. When you finish a step, put your initials and the date on the sign-off line on the right. A split line means to get a pass (and an initial) from another student (or your Academic Supervisor if it says that). Essays are turned in to the Academic Supervisor.

PURPOSE: Learn the elements of and reasons for climate, and gain the ability to identify climates from physical geography.

ESTIMATED TIME: 20 hours.

MATERIALS NEEDED FOR THIS COURSE

Study booklet, *Climate*, with these data sheets (DS):

1105	315	366	363	364	513	223	1106	1107
733	1108	9151	1109	1110	1111	1112	9152	

Exam: 7334, 9153 (answers)

Other materials:
A thermometer (preferably a maximum-minimum thermometer), barometer, operational flashlight, a match, world globe; access to internet. A notebook or computer file for recording data and calculations.

NOTE TO STUDENT AND ACADEMIC/LAB SUPERVISORS

During this course, all data and calculations should be recorded in a notebook or computer file (or both if that is more convenient). It is standard practice in science for a researcher to keep a detailed and dated sequential record of what is done and the exact results obtained, for later reference by himself and others. This viewpoint should be kept in mind and practiced throughout the course when compiling these records. The course record will be shown to the supervisor for review after various steps at the end of the course.

A. INTRODUCTION AND REVIEW

1. PRACTICAL APPLICATION: Start this now so that you can have the data ready when you need it—it will be used for later steps on this course. Measure and note in your course record the maximum and minimum air temperature each day for one week. Take the measurements at six feet above the ground in the shade. If available, use a maximum-minimum thermometer (one that shows the highest and lowest temperatures of the day). If not, use the fact that the minimum temperature for the day is usually just before sunrise and the maximum is around 3:00 P.M. (Note: It may be possible to also get this data from a school weather station or your local TV weather channel or website. If it is, do the measurements yourself anyway (as many of them time permits) and compare the two sets of data.) _____

2. READ: Data Sheet (DS) #1105 Climatology. _____

3. DEMONSTRATION: Show the five basic elements of climate. _____

4. READ: DS #315 Climate and Weather Factors. _____

5. DEMONSTRATION: Show the difference between relative and absolute humidity. _____

6. DRILL:
   a) Change the following temperatures to Celsius: 75°F; 32°F; 100°F; 60°F. ___
   b) Change the following temperatures to Fahrenheit: 39°C; 20°C; –5°C; 13°C. ___ _____

7. DEMONSTRATION: Show why insolation is listed as an important element under climate but is not listed among the weather factors. _____

8. READ: DS #366 The Greenhouse Effect. _____

9. DEMONSTRATION: Show how the greenhouse effect captures heat energy. _____

B. SOLAR RADIATION AND AIR TEMPERATURE

1. READ: DS #363 Radiation. _____

2. READ: DS #364 Heat and Temperature. _____

3. READ: DS #513 Heat Transfer. _____

4. DEMONSTRATION:
   a) Heat transfer by conduction. ___
   b) Heat transfer by radiation. ___
   c) Heat transfer by convection. ___ _____

5. DEMONSTRATION: In your course record, make a sketch showing:
   a) The relationship between heat and temperature. ___
   b) An example of each of the three means of heat transfer in the environment, showing what the heat is flowing from and to and how the temperature changes. ___ _____

6. DEMONSTRATION: (If the weather permits) Go outside and observe, and note in your course record, two examples of:
   a) The effect solar radiation has on plants. ___
   b) The effect solar radiation has on animals. ___
   c) Some other effects solar radiation has on you or your environment. ___ _____
7. READ: DS #223 Seasonal Variations, to heading "Why Summer is Warmer." _____
8. DEMONSTRATION: Use a world globe to represent the earth. You represent the sun. Show what part of the earth the sun "sees" at each of the four seasons (or you may show this with a flashlight if you prefer). _____
9. READ: DS #223, section "Why Summer is Warmer." _____
10. DEMONSTRATION: Use a world globe to represent the earth. You represent the sun. Show what part of the earth the sun "sees" most directly and through the least atmosphere during the summer season (or show this with a flashlight if you prefer). _____
11. READ: DS #223, section "Seasonal Lag." _____
12. DEMONSTRATION: Show what seasonal lag is and why it occurs. _____
13. READ: DS #223, section "Earth Zones and the Slant of the Sun's Rays." _____
14. DEMONSTRATION: Use a world globe to show:
   a) Each of the five earth zones based on solar radiation. ___
   b) The different angles of sunlight in each of the different zones during each of the different seasons. ___ _____
15. READ: DS #1106 Distribution of Solar Radiation. _____
16. DEMONSTRATION: Show:
   a) The different factors that affect the annual amount of solar energy received at any point on the earth's surface. ___
   b) Why total annual solar radiation received at the earth's surface is less at the equator than at 20° latitude. ___ _____

17. DRILL: Using the seasonal maps of solar radiation distribution found in DS #1106 Distribution of Solar Radiation:

    a) Determine the approximate average solar radiation received and include it in your course record, labeling each with the correct units:

        1) During the entire year at your location. ___
        2) During June at your location. ___
        3) During December at your location. ___
        4) During the entire year in Portugal. ___
        5) During June in England. ___
        6) During December in South Africa. ___

    b) Determine at what latitude belt:

        1) The maximum monthly solar radiation occurs in December. ___
        2) The maximum monthly solar radiation occurs in June. ___
        3) The maximum yearly solar radiation occurs. ___

        Include this data in your course record. _____

18. READ: DS #1107 Distribution of Temperature. _____

19. DRILL: Using the two maps in the "Isotherm" section of DS #1107 Distribution of Temperature:

    a) Determine the approximate average temperature of the following:

        1) During the entire year at your location. ___
        2) During July at your location. ___
        3) During January at your location. ___
        4) During the entire year in Portugal. ___
        5) During July in England. ___
        6) During January in South Africa. ___

        Include this data in your course record, labeling each with the correct units.

    b) Determine at what latitude belt:

        1) The maximum monthly temperature occurs in January. ___
        2) The maximum monthly temperature occurs in July. ___
        3) The maximum yearly temperature occurs. ___

        Include this data in your course record.

c) Compare this data with your data for step #17 above, to see what correlation there is between temperature data and solar radiation data. ___

Include this comparison in your course record. _____

20. DEMONSTRATION: Include the following in your course record:
    a) Draw a map of a small hill located in a plain. Imagine that at midnight it is colder on top of the hill than in the plain. Draw isotherms that show how you imagine the temperature to be distributed right at midnight. ___
    b) Do a rough sketch of North America and draw in the 75° and 65° isotherms for average sea level temperatures in July (using the map in DS #1107). ___ _____

21. PRACTICAL APPLICATION: If you have not already done so, organize the maximum and minimum air temperature data you have recorded each day into a table in your course record, with the daily temperatures in columns and additional columns for mean daily temperature and the range for each day. _____

22. DRILL: From the data obtained for the previous step:
    a) Compute the mean daily temperature for each day. ___
    b) What is the mean weekly temperature for this period? ___
    c) What is the range (variation) of temperature for each day? ___
    d) What is the mean daily range of temperature for the last week? ___

    Compare your figure for daily temperature range with Fig. 2. in DS #1107. Remember that $°C = 5/9 \times (°F - 32°)$. Does the data for your location agree with the chart as to how far from the ocean a location with the temperature range you measured would likely be?

    Write all your results in your course record. _____

23. PRACTICAL APPLICATION: On the internet, find a weather site that shows maps with isotherms, and learn at least one thing that interests you from one of them. Write what you learned in your course record. _____

C. WINDS AND PRESSURE SYSTEMS

1. READ: DS #733 The Source of Wind. _____

2. DEMONSTRATION:
    a) Go outside and find out which way the wind is blowing. See how the local wind direction compares to the prevailing wind direction for your

location predicted by the data sheet. Remembering that on the global scale wind does not flow directly from the high pressure to the low pressure region, stand with your back to the prevailing wind and use the global wind-map data found in DS #733 The Source of Wind to point out the directions to those regions from your location.

b) Imagine two locations nearby each other, with one being heated while the other cools. Draw the wind and pressure situation showing as many of the important factors as you can. _____

3. DEMONSTRATION:

   a) Using a globe or atlas or other world map, find your location on the earth. Determine what direction the prevailing winds should come from for this location. ___

   b) Determine in what direction (north, south, east or west) the pressure is generally higher for your location and point this direction out to your supervisor or another student (remember the wind-curving data). ___

   c) Using the diagram in DS #733 The Source of the Wind, choose two different latitudes where you could live to have prevailing east (or northeast) winds. Then look at a globe and choose three different countries where you could experience prevailing west winds. ___ _____

4. DEMONSTRATION: Show where the energy of the wind comes from. Use a diagram to show each step from the source of the energy to the wind. _____

5. READ: DS #1108 Air Pressure in Climate. _____

6. PRACTICAL APPLICATION: Include in your course record the barometric pressure daily for the remainder of your time on this course. Record also the weather type for each day (sunny, partly cloudy, overcast; temperature, etc.). Note and record any relationship between weather type and pressure tendency. If you don't have a barometer, you can call your local weather station daily for this data, or get it off the internet. Sign off this step when you record your data for the first day. At the end of the course, you will write a complete report on what you've observed. _____

7. READ: DS #9151 Cyclonic Storms. _____

8. DEMONSTRATION: Sketch a map of a Low and the isobars around it. Indicate with arrows which way the winds would blow (assume there is no factor curving the winds). Now sketch your map again and show how the rule about wind curves (from DS #733) would change the arrows. See if you can show how this might lead to a circular wind pattern or storm around this low. Include this in your course record. _____

9. DEMONSTRATION:
   a) Show how cyclones get started over warm areas of land or sea. ___
   b) Show how cyclones are driven by condensation. ___ _____
10. READ: DS #1109 Local Winds. _____
11. DEMONSTRATION: Show two types of geographic locations where local winds are found, and why. _____
12. (Optional) DEMONSTRATION: Are either of the land types you demonstrated above found in your area? If so, go to a location where the local wind should blow at about 4:00 P.M. and just before sunrise in the morning, and notice the difference in direction of the breeze at these two times. If the wind is light, use a match and observe its smoke to determine wind direction. If possible, choose times when the sky is clear, since local winds will be more pronounced under this condition. _____
13. PRACTICAL APPLICATION: On the internet, find a weather site that shows maps with isobars, and learn at least one thing that interests you from it. Write what you learned in your course record. _____

D. MOISTURE AND PRECIPITATION

1. READ: DS #1110 Water in the Earth-Atmosphere System. _____
2. DEMONSTRATION: Show the cycle of water in the earth-atmosphere system. Include all three phases of water. _____
3. DEMONSTRATION:
   a) Show how the water cycle also transports heat. ___
   b) Show the interplay between the warming and cooling effects of water in the atmosphere as discussed in DS #1110. ___ _____
4. DEMONSTRATION:
   a) Look at the figures on the 2nd page of DS #1110 and verify the relationship between relative humidity and precipitation. ___
   b) From the wind patterns shown in the figure on the 3rd page of DS #733 The Source of Wind, estimate from what latitude belts most of the moisture delivered to high rainfall regions is coming. ___ _____
5. READ: DS #1111 Distribution of Condensation and Precipitation. _____
6. DEMONSTRATION: Show the three conditions necessary for condensation to occur. _____

7. PRACTICAL APPLICATION: Cause condensation to occur by creating the necessary three conditions. _____

8. DEMONSTRATION: Draw a diagram that illustrates the effect that mountains have on climate, including the "rain shadow effect." Include this in your course record. _____

9. DEMONSTRATION: Using the map of the world in DS #1111 and a globe or other map, find several towns, cities and, if possible, countries that are located in each of the zones on the map. _____

E. CLIMATE PATTERNS AND CLIMATE CHANGE

1. READ: DS #1112 Classification of World Climate. _____

2. DEMONSTRATION: Using a world globe or atlas, locate three cities in each of the six climate regions and list them in your course record under the heading of the climate group where they are found. Then note down in which climate region you are located. _____

3. DRILL: Remembering the influence of mountains on climate, calculate how far up a mountain you would have to climb in order to experience a climate equivalent to a climate 2,500 kilometers further poleward? How far north would you have to go to experience the same climate as that at the top of a 3,200-meter-high mountain? Write your calculations and results in your course record. _____

4. READ: DS #9152 Climate Change, section "Introduction." _____

5. DEMONSTRATION: On the internet, search for data on "Climate Change." Look briefly through several articles and see if you can find at least two that have somewhat opposing viewpoints. Try to recognize from what you read something that you know you don't know enough about. _____

6. READ: DS #9152, section "The Origin of Climate." _____

7. DEMONSTRATION: On the internet, search for data on "Climate Cycles." Briefly look at the list of articles presented, and also click on Images to see the variety of graphs, displaying climate cycles on many different time scales. Spend enough time looking over the data to get your own initial opinion regarding whether there is reliable evidence that the past cycles of warming and cooling happened. _____

8. READ: DS #9152, section "What Happens Next?" _____

9. ESSAY: Do some additional research about climate change, using the references cited at the end of the data sheet or others that you find. Then write a reasoned presentation about how your views have developed so far on the importance of climate and climate change, including your own reasoning on at least these points:
   - How stable is earth's climate, short-term and long-term?
   - What factors do you think are most important in causing changes in climate?
   - What approaches, if any, would you support in addressing current questions of climate change?

   Supervisor pass. ____ ____

F. FINAL APPLICATIONS

1. PRACTICAL APPLICATION: Using the data you have collected on maximum and minimum temperatures, construct a chart that shows the trend over the days you recorded the data. Examine the chart and decide if it would have enabled you to predict what the maximum and minimum temperatures would be for the final two days before they happened. Include your chart, your predictions and the results in your course record. **Supervisor pass.** ____ ____

2. PRACTICAL APPLICATION: In your course record, write a complete report on your observations about barometric pressure and weather type, using the data you started recording at step C.6. Include an assessment of whether your data helps explain why the Pacific Northwest (especially the coastal regions of Oregon and Washington) receives such heavy rainfall. **Supervisor pass.** ____ ____

3. PRACTICAL APPLICATION: Pick at least one location on the planet that would be particularly suitable for each of the following activities. Write your choices and your reasons for picking them in your course record:

   a) Operation of a solar heated house. ___

   b) Operation of a windmill. ___

   c) Operation of a water ski resort. ___

   d) Operation of a snow ski resort. ___ _____

4. PRACTICAL APPLICATION: At what geographical latitude would you expect to experience the extremes of the following climatic elements? Write your answers in your course record. Explain why in each case.

   a) The most rainfall per year. ___

b) The most solar radiation per year. ___

c) The highest seasonal temperatures. ___

d) The highest annual humidity. ___

e) The least amount of wind. ___

Supervisor pass. ____ ____

5. PRACTICAL APPLICATION: Using a world globe or atlas, choose a city on each of the major continents, i.e., North America, South America, Africa, Europe, Asia and Australia. From climate data included in the course or available on the internet, decide which climatic region this city is in, then describe the climate of that city in detail, mentioning each of the five climatic variables. Also, describe the difference in seasons at the cities. Be sure to note whether these cities are in the mountain regions or not.

   For each city, carry out an analysis on the basis of your understanding of the causes of climate, to see if you can use them to explain in detail the actual climate of the city that you previously determined.

   Write the complete report on what you have found in your course record.
   Supervisor pass. ____ ____

I have completed the steps of this course. I understand what I studied and can use it.

Student _____ Date _____

The student has completed the steps of this course and knows and can apply what was studied.

Academic Supervisor _____ Date _____

This student has passed the exam for this course.

Examiner_____ Date _____

Drill Answers:

A6. DRILL:
   a) Change the following temperatures to Celsius: 75°F; 32°F; 100°F; 60°F.
      [75°F ≈ 24°C; 32°F = 0°C; 100°F ≈ 38C; 60°F≈ 16°C.]
   b) Change the following temperatures to Fahrenheit: 39°C; 20°C; –5°C; 13°C.
      [39°C ≈ 102°F; 20°C ≈ 68°F; –5°C ≈ 23°F; 13°C ≈ 55°F.

B17. DRILL: Using the seasonal maps of solar radiation distribution found in DS #1106 Distribution of Solar Radiation:
   a) Determine the approximate average solar radiation received and include it in your course record, labeling each with the correct units:
      1) During the entire year at your location. [In Oregon, 140 calories per cm^2× 1000]
      2) During June at your location. [In Oregon, 600 calories per cm^2× 1000]
      3) During December at your location. [In Oregon, 80 calories per cm^2× 1000]
      4) During the entire year in Portugal. [140 calories per cm^2× 1000]
      5) During June in England. [400 calories per cm^2× 1000]
      6) During December in South Africa. [700 calories per cm^2× 1000]
   b) Determine at what latitude belt:
      1) The maximum monthly solar radiation occurs in December. [30°S]
      2) The maximum monthly solar radiation occurs in June. [40°N]
      3) The maximum yearly solar radiation occurs. [0° to 10°N]

B19. DRILL: Using the two maps in the "Isotherm" section of DS #1107 Distribution of Temperature:
   a) Determine the approximate average temperature of the following:
      1) During the entire year at your location. [In Oregon, 55°F]
      2) During July at your location. [In Oregon, 70°F]
      3) During January at your location. [In Oregon, 40°F]
      4) During the entire year in Portugal. [60°F]
      5) During July in England. [60°F]
      6) During January in South Africa. [70°F]

      Include this data in your course record, labeling each with the correct units.
   b) Determine at what latitude belt:
      1) The maximum monthly temperature occurs in January. [Southern Hemisphere]
      2) The maximum monthly temperature occurs in July. [Northern Hemisphere]
      3) The maximum yearly temperature occurs. [0° to 10°N]

      Include this data in your course record.
   c) Compare this data with your data for step #17 above, to see what correlation there is between temperature data and solar radiation data. [Appears to correlate fairly well.]

E3. DRILL: Remembering the influence of mountains on climate, calculate how far up a mountain you would have to climb in order to experience a climate equivalent to a climate 2,500 kilometers further poleward? How far north would you have to go to experience the same climate as that at the top of a 3,200-meter-high mountain? [From the data sheet, "…we can derive a general rule of thumb that for each 100 yards increase in elevation, the climate change will be equivalent to the change you would see in moving 55 miles poleward (an elevation increase of 100 meters would be equivalent to moving almost 100 kilometers poleward)." Thus to experience the equivalent to moving 2,500 kilometers poleward one would have to climb about 2,500 meters upward.]