Temperature Patterns

Objective:	To study global temperature patterns and to explore the reasons for these patterns.
Reference:	Hess, Darrel. *McKnight's Physical Geography*, 11th ed., pp. 94–103.

FACTORS INFLUENCING TEMPERATURE PATTERNS

A number of factors influence the temperature regime of a location. The following factors are among the most important.

Latitude: Latitude is the most basic control of temperature. In general, because of the lower total insolation received at high latitudes compared with low latitudes, temperature decreases as we move away from the equator and toward the poles. In addition, the tropics generally show little temperature change during the year, while the mid- and high latitudes experience variation in temperature from summer to winter. These basic global patterns are apparent in Figure 1, showing average sea-level temperatures in January mapped with isotherms, and in Figure 2, showing average sea-level temperatures in July.

Were latitude the only control of temperature, the isotherms would run exactly east to west, parallel to the lines of latitude. However, this hypothetical pattern is altered by a number of additional factors.

Land-Water Contrasts: Land and water react differently to solar heating, and this exerts a strong influence on the atmosphere. In general, land warms up and cools off faster and to a greater extent than water. This means that the interiors of continents will be hotter in summer and colder in winter than maritime regions at the same latitude. The ocean also significantly moderates the temperatures of the coastal regions of a continent.

In addition to the lower annual temperature range associated with maritime regions, the ocean also exhibits a lag in reaching its coolest point in winter and its warmest point in summer. This means that coastal regions often reach their temperature extremes several months after interior regions.

Ocean Currents: The general circulation of the ocean is a significant mechanism of global heat transfer. Major surface ocean currents move warm water from the equatorial regions toward the poles, and bring cool water from the poles back toward the equator. In each of the main ocean basins, warm water is moving toward the poles off the east coasts of continents, while cool water is moving toward the equator off the west coasts of continents.

Wind Patterns: In many regions of the world, the dominant wind direction strongly influences local temperature patterns. For example, in the midlatitudes the dominant wind direction is from the west, meaning that air masses will tend to move from west to east. As a consequence, the temperature patterns of midlatitude locations along the east coast of a continent can be

quite "continental"—the westerlies can bring the seasonal warmth or coldness of the interior of the continent all the way to the east coast.

Altitude: In general, temperature decreases with increased altitude. A high elevation station will have a very similar annual temperature pattern to a nearby lowland station, although the high elevation station will be consistently cooler throughout the year. On average, temperature in the **troposphere** decreases by approximately 6.5°C per 1000 meters of elevation increase (3.6°F/1000 feet)—this is known as the **average lapse rate**.

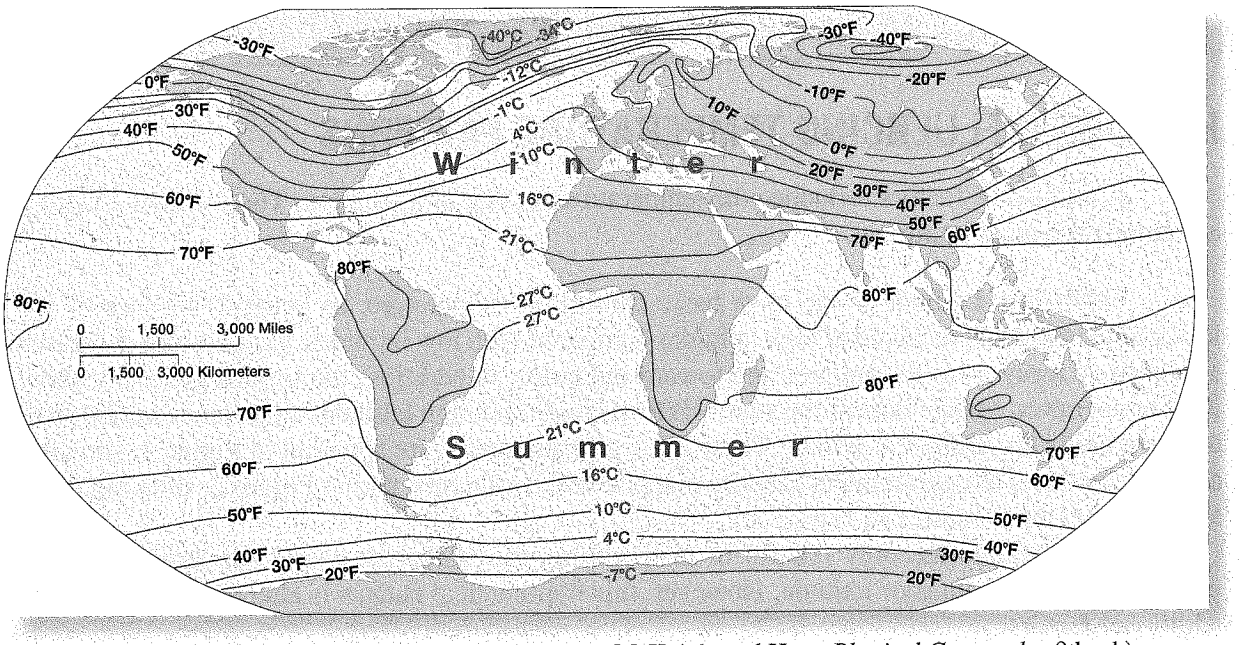

Figure 1: Average January sea-level temperatures. (From McKnight and Hess, *Physical Geography*, 9th ed.)

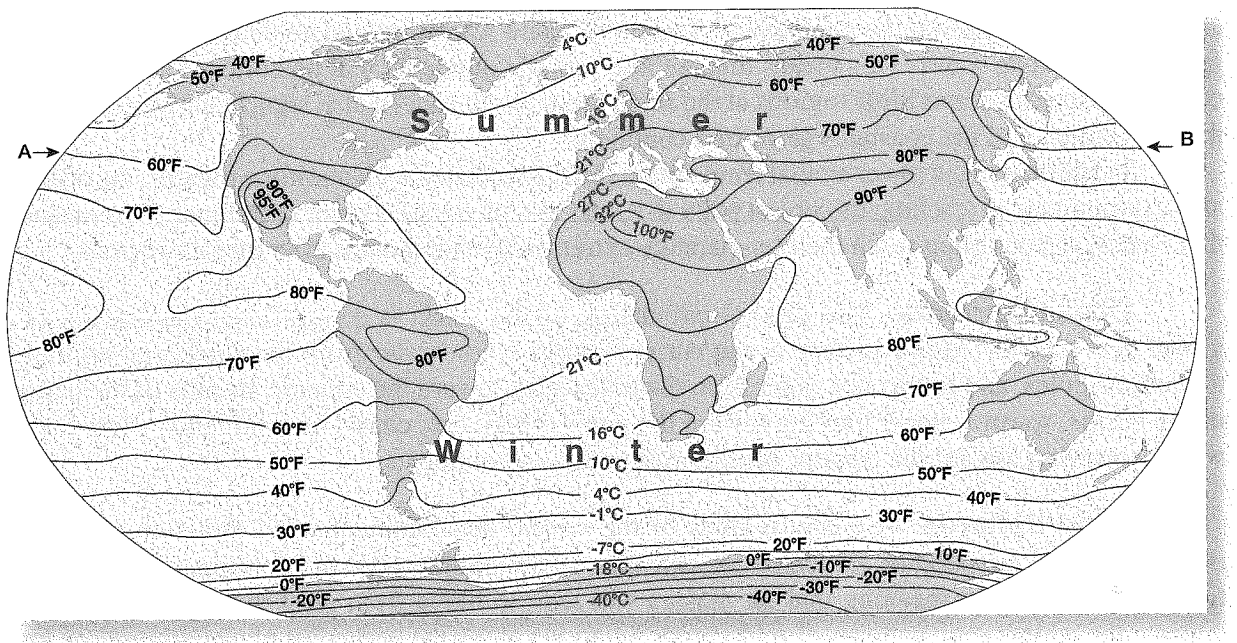

Figure 2: Average July sea-level temperatures. (Adapted from McKnight and Hess, *Physical Geography*, 9th ed.)

Name_____ Section _____

PROBLEMS—PART I

The following questions are based on the maps of average January sea-level temperatures (Figure 1) and average July sea-level temperatures (Figure 2):

1. Is the temperature contrast between the equator and the Arctic region greatest in the winter or summer? _____

2. (a) Were latitude the only control of temperature, the isotherms would run straight across the maps from east to west. Describe one region of the world where this hypothetical isotherm pattern is actually observed.

   (b) Why is the hypothetical pattern seen here?

3. (a) Is the influence of cool ocean currents on coastal temperatures more pronounced in summer or winter? _____

   (b) Why?

4. (a) Comparing the January map with the July map, describe one region of the world that exhibits a large *annual temperature range* (the difference between the January and July average temperatures).

   (b) What explains this large annual temperature range?

   (c) Describe one region of the world that exhibits a small annual temperature range.

   (d) What explains this small annual temperature range?

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PROBLEMS—PART II

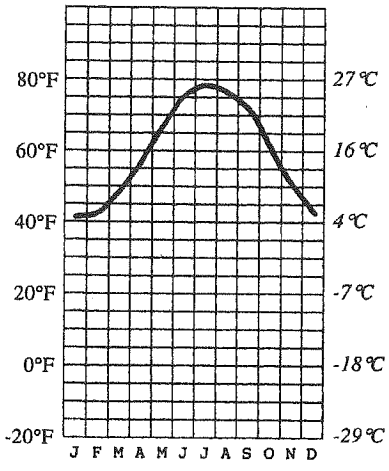
Using a straightedge, draw a line across the July temperature map (Figure 2) from point "A" to point "B." This reference line can be thought of as the "hypothetical" position of the 16°C (60°F) isotherm were there no land–water contrasts, ocean currents, and so on. Compare the actual 16°C isotherm, with the line you have just drawn. In places where the actual 16°C isotherm is south of the hypothetical line temperatures are lower than expected; in places where the actual 16°C isotherm is north of the hypothetical line, temperatures are higher than expected.

Begin in the west and move across the map to the east, briefly explaining why the actual 16°C (60°F) isotherm deviates from the hypothetical.

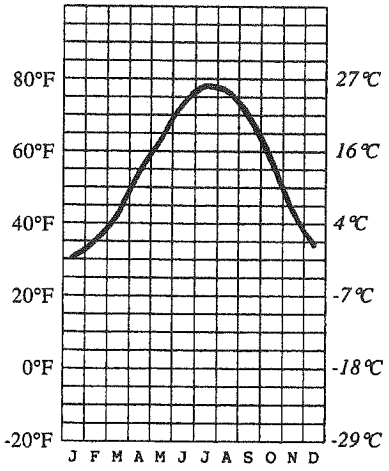
Name_____ Section _____

PROBLEMS—PART III

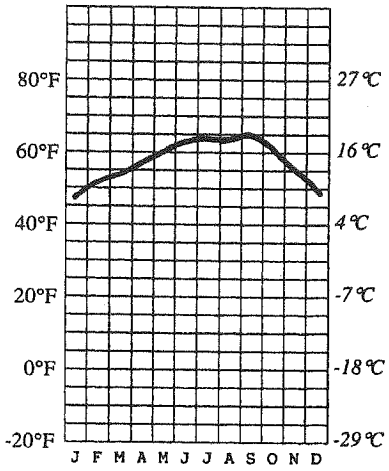
Six charts showing the average monthly temperature (in °C and °F) for seven U.S. cities are provided below. For each of the cities, the latitude and longitude, as well as the elevation, are provided.



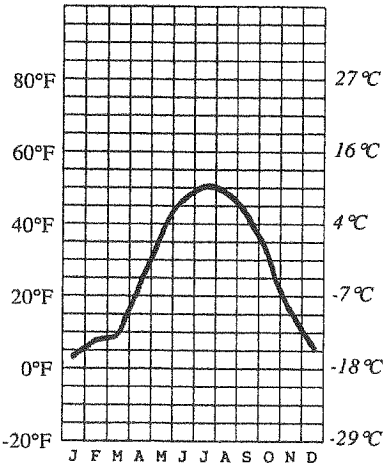
Norfolk, VA
36°55' N, 76°15' W
(8m; 26 ft.)



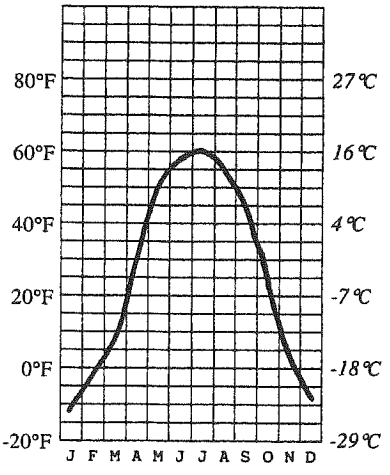
St. Louis, MO
38°39' N, 90°15' W
(133m; 535 ft.)



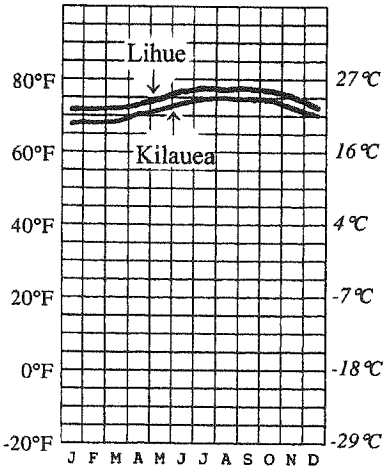
Oakland, CA
37°48' N, 122°16' W
(2m; 6 ft.)



Nome, AK
64°30' N, 165°20' W
(4m; 13 ft.)



Fairbanks, AK
64°50' N, 147°48' W
(29m; 96 ft.)



Lihue, Kaua'i, HI
21°59' N, 159°23' W
(31m; 103 ft.)

Kilauea, Kaua'i, HI
22°12' N, 159°18' W
(346m; 1134 ft.)

Answer the following questions by comparing the temperature charts given under Problems-Part III. In your answers, consider the ***one* temperature control factor that is *most* responsible** for the patterns shown (choose from latitude, land–water contrasts, wind patterns, or altitude). You may use the same answer for more than one question. You should locate each of the cities on a world map before trying to answer the questions. *If altitude is the main factor cited, calculate the expected temperature difference between the two cities based on the average lapse rate.*

1. Which factor primarily explains the different temperature patterns of St. Louis and Oakland?

2. Why is the warmest month of summer different in St. Louis and Oakland?

3. Why does St. Louis have colder winters than Norfolk?

4. Although both are coastal cities, compared to Oakland, Norfolk has a very "continental" temperature pattern. Why?

5. Which factor primarily explains the difference in temperature patterns between Fairbanks and St. Louis?

6. Which factor primarily explains the difference in temperature patterns between Fairbanks and Nome?

7. Why does Lihue have a smaller annual temperature range than Oakland?

8. What explains the difference in temperature patterns between Lihue and Kilauea?