Background: Time zones around the Earth are bounded by imaginary lines called lines of **longitude**, or meridians. On a globe or map of the world, they are the lines that are perpendicular to the equator. They are farthest apart at the equator and gradually come closer together, finally meeting at the North and South Poles. Meridians are numbered in degrees east and west from the **prime meridian**, which is 0° longitude, and which passes through Greenwich, England.

Meridians divide the Earth's surface into 24 time zones. In general, each time zone is 15° of longitude wide and represents one hour of time. The lines that bound the time zones sometimes show indentations to allow for geographic regions. Time zones can be numbered, starting at the prime meridian (0° longitude), which extends through the center of time zone 1. Halfway around the Earth, 180° from the prime meridian is the International Date Line (IDL). Points on the west longitude side of the IDL are one day earlier than the point on the east longitude side. Because the IDL should not pass through populated areas, it zigzags to avoid countries and islands.

Materials: Compass (for drawing circles)ProtractorMetric rulerScissorsBrass brad2 pieces of light-colored construction or copy paper

SOLs: ES 1, ES 3

Objective: To calculate the time and day in selected major cities in the Northern Hemisphere by constructing and using a world time-day calculator.

Procedure:

- 1. Using one piece of the colored paper, cut out a circle with an 8.5 cm radius. This is circle A.
- 2. On circle A, draw a diameter. Place a protractor on the line and mark off 15° intervals. Draw diameters through these points. See Figure 1.



Figure 1. Follow these steps to make circle A.

3. Number circle A as shown in Figure 2. Shade in the midnight hour zone, the *time* the day changes.



- 4. Using the other piece of colored paper, cut out another circle with a 7-cm radius. This is circle B.
- 5. On circle B, draw a circle with a radius of 6 cm. Repeat step 2, marking off 15° intervals on circle B, but when you draw the lines, end them on the 6-cm radius circle. See Figure 3.



6. Mark circle B as shown in Figure 4. Parts of the circle are labeled in Figure 4 to help you understand the marking but the labels do not need to be marked on your circle. Write the longitude markings. The prime meridian is located at the center of the zone that starts at 0° longitude. Each 15 degrees of longitude is therefore marked at the center of each zone. The meridians are drawn 7.5° on either side of the degree mark. Draw a darker line to represent the International Date Line at 180° to indicate the *place* the day changes. Mark the locations of the four cities on the circle. Number the 24 times zones. Draw a counterclockwise arrow to show the direction the Northern Hemisphere is rotating.



- 7. Fasten circle B on top of circle A with a brass fastener through their centers. Circle B represents the Northern Hemisphere, the head of the fastener is the North Pole, and the 6-cm circle is the equator. The 15° interval lines on circle B divide the circle into 24 time zones. Circle A is the hour circle.
- 8. Using the world time-day calculator you have constructed and the data in Table 1, answer the questions on the Lab Response Form. Remember the following points:
 - a. The new day begins on the east longitude side of the IDL and exists clockwise around the world to the midnight hour.
 - b. When using the calculator, always set the time zone directly *in line* with a hour zone, disregarding any minutes involved in the calculation. The minutes can be added on to any other cities' hour zones.
 - c. During daylight savings time (from April to October), subtract one hour when calculating time between a U.S. city and a non-U.S. city.

9. Suggested extra credit: Show the world time-day calculator you have constructed to an adult at home and explain how it works and what the parts represent. Have them verify your explanation on the back of your response form

Zana	City	Zama	Cite	7	0.4
Lone	City	Zone	City	Zone	City
1	Accra, Ghana	9	Los Angeles, Calif., U.S.	18	Saigon, Vietnam
10	Anchorage, Alaska, U.S.	24	Madrid, Spain	9	San Francisco, Calif., U.S.
23	Athens, Greece	17	Manila, Philippines	9	Seattle, Wash., U.S.
24	Berlin, Germany	7	Mexico City, Mexico	16	Seoul, South Korea
23	Cairo, Egypt	6	Miami, Fla., U.S.	17	Shanghai, China
7	Chicago, Ill., U.S.	6	Montreal, Quebec, Can.	24	Stockholm, Sweden
8	Denver, Colo., U.S.	22	Moscow, U.S.S.R.	19	Tashkent, U.S.S.R.
8	Edmonton, Alberta, Can.	7	New Orleans, La., U.S.	23	Tel Aviv-Jaffa, Israel
5	Halifax, Nova Scotia, Can.	6	New York, N.Y., U.S.	5	Thule, Greenland
5	Hamilton, Bermuda	10	Nome, Alaska, U.S.	16	Tokyo, Japan
6	Havana, Cuba	24	Paris, France	6	Washington, D.C., U.S.
23	Helsinki, Finland	17	Peking, China	7	Winnipeg, Manitoba, Can.
17	Hong Kong, China	6	Philadelphia, Pa., U.S.	9	Vancouver, B.C., Can.
11	Honolulu, Hawaii, U.S.	1	Reykjavik, Iceland	15	Vladivostok, U.S.S.R.
1	London, England	24	Rome, Italy		

Notes: Time-zone numbers for the cities were derived from information in the *Hammond World Atlas* (Maplewood, N.J.: Hammond, 1988). The standard time followed in some countries does not always coincide with zone time.

Lab Student Response Form

Name	Block Date
1.	It is 4 a.m. on Friday, May 12, in Philadelphia.
	What is the time and day in Paris?
	Peking?
	Los Angeles?
	Honolulu?
	Reykjavik?
2.	It is 6:22 p.m. on Wednesday, February 20, in Moscow.
	What time and day in Philadelphia?
	London?
	San Francisco?
	Vladivostok?
3.	It is noon at the IDL.
	If it is Wednesday in Honolulu, what day is it in Moscow?
	Philadelphia?
	Tokyo?
	Manila?
4.	It is noon on Wednesday, November 25, at the Prime Meridian. If it is 10 p.m. on Wednesday at
5.	When it is midnight in Philadelphia and the new day, Saturday, begins, approximately what
	percentage of the Earth is already experiencing Saturday?

6. It is 4 p.m. on Thursday in Philadelphia, and you catch a flight to Paris that takes six hours. What time and day will it be in Paris when you land?