Global Greatness - Latitude

Student Activity

7 8 9 10 **11** **12**

TI-Nspire™   Investigation   Student   60 min

Aim

To determine the distance along the surface of the Earth between two places that are on the same meridian of longitude.

Equipment

For this activity you will need:

- TI-Nspire CAS
- Ti-Nspire CAS documents:
    - Worldsphere.tns
   - World distance.tns

Introduction

Which city is closer to the equator, Darwin or Cairns? It may surprise you to know that the shortest distance between two points on the Earth lies along a curve, not a straight line. Our planet is approximately spherical having a radius of 6400km. Explore a desktop globe, some software or Apps such as Google Earth. You can build a virtual model using the 3D Graphing feature on TI-Nspire.

The Global Sphere

Open the TI-Nspire file Worldsphere.tns. The sphere that you see can be thought of as a representation of the Earth. The z-axis passes through the north and south pole and represents the Earth's axis of rotation.

The x and y axis plane slice through the equator.

Note: Pages 1.2 to 1.5 contain copies of questions 1 to 5 below.
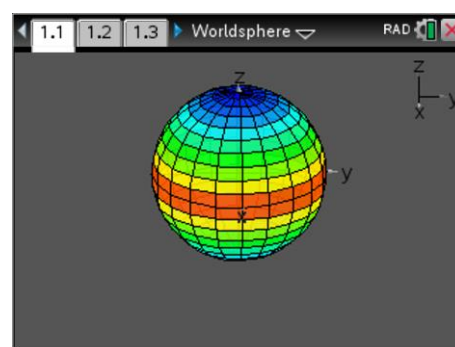
Press the letter **A** on the calculator keypad to see the sphere automatically rotate, just as the Earth rotates on its axis. (Press [ESC] to stop the rotation) The sphere can also be rotated manually by grabbing any region off the sphere.

Question: 1

What colour on the sphere are the north and south poles?

Question: 2

What colour on the sphere is the equator?

Author: B. Lannen

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Question: 3

The lines that run across the sphere from left to right represent:

(A) – Meridians of longitude

(B) – Parallels of latitude

Question: 4

The lines that run between the north and south pole on the sphere (up/down) represent:

(A) – Meridians of longitude

(B) – Parallels of latitude

Question: 5

The direction of the rotation indicates that the Earth spins:

(A) – Towards the East

(B) – Towards the West

Case 1: Calculating distance along a meridian using different latitudes north of the equator

Open the TI-Nspire file World distance.tns, read the introductory pages and navigate to page 1.4.
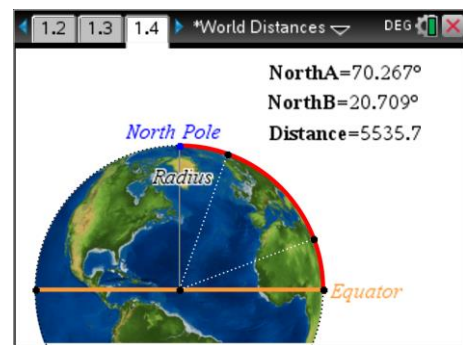
The diagram on this page is a side-on view of the Earth.

Red line: Meridian line (north of the equator)

Orange line: Equator

Pink line: Arc connecting two locations on the same meridian but different latitude, north of the equator.

Grab these points and move them to observe the changing latitude and the distance. (Distance n kilometres)

The distance computed on Page 1.4 uses an extension of the arc length formula:

$$s = r \times \frac{\pi}{180} \times \theta^{\circ}$$

–– **Equation 1**

The formula being used by the calculator is:

$$s = 6400 \times \frac{\pi}{180} \times \left| northa - northb \right|$$

–– **Equation 2**

Question: 6

What is the meaning of the figure '6400' in equation 2?
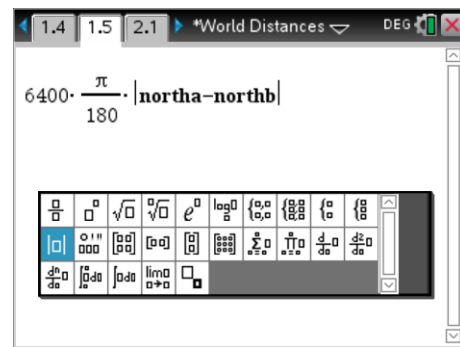
Question: 7

What is the meaning of |northa – northb| in equation 2?

TEXAS INSTRUMENTS

Navigate to page 1.5 and type out the formula.

Note: The variables northa and northb can be obtained by selecting the [VAR] key.

The absolute value sign is available from the maths template.

The result of this calculation shows the distance in km between the two points. Check your answer against the automatic answer produced on page 1.4
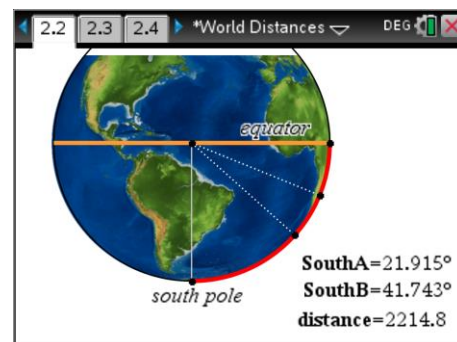

Question: 8

Mobile [Alabama] 30.695°N and Chicago [Illinois] 41.878°N are both located close to the 88°W meridian in the northern hemisphere.

a) Move points A and B on Page 1.4 to angles that approximate these locations and record the corresponding approximate distance.

b) Use the formula (equation 2) replacing NorthA and NorthB with the actual latitudes to obtain a more precise result for the distance between Mobile and Chicago.

c) Use Google Maps to determine the distance between Mobile and Chicago[1].

d) Discuss the differences between the three answers (a), (b) and (c).

Case 2: Calculating distance along a meridian using different latitudes south of the equator

The diagram on page 2.2 is a side-on view of the Earth. In this interactive diagram points A and B are located on the same meridian south of the equator.

$$s = 6400 \times \frac{\pi}{180} \times |southa - southb|$$ —- **Equation 3**

Question: 9

Melbourne [Victoria] 37.8136°S and Cairns [Queensland] 16.9186° S are both located adjacent to the 145°E meridian in the southern hemisphere.

a) Move points A and B on Page 2.2 to angles that approximate these locations and record the corresponding approximate distance.

b) Use the formula (equation 2) replacing SouthA and SouthB with the actual latitudes to obtain a more precise result for the distance between Melbourne and Cairns.

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[1] **Google Maps** returns distances in 'miles' for locations within the United States. To convert miles into metres on the calculator use _mi after the distance, the calculator will automatically return the distance in metres provided your calculator mode is set for SI units.

Case 1 & 2: Calculating distance along a meridian using different latitudes in the same hemisphere.

On page 3.2, edit the latitude values that are in blue immediately following the = signs for latitude 1 (Lat1) and latitude 2 (Lat2). Press Enter after each edit and your value will be confirmed in the green text.

The formula will automatically recalculate using your values and the final output (in green) gives the distance (km) between the two points on the same meridian.
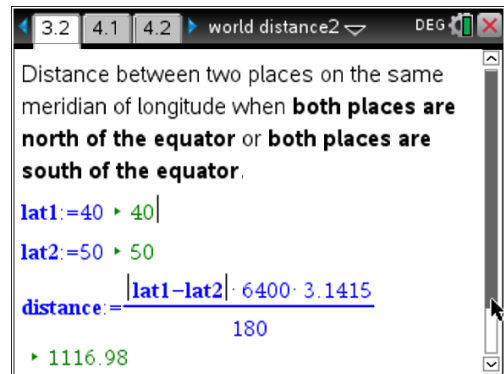
> The automatic calculations on this page are achieved using a "Maths Box" contained on a Notes Application.

Question: 10

Portland, Oregon (USA) is almost due south of San Francisco, California. Portland is located at 45.5231° N, 122.6765° W. San Francisco is located at 37.7749° N, 122.4194° W.

a) Which measurement for the location of Portland and San Francisco represents the longitude? (Meridian)

b) Use the automatic calculation feature on page 3.2 to determine the approximate distance between Portland and San Francisco.

c) Explain, with reference to the locations, why the calculation is approximate.

Question: 11

Bendigo (Victoria) is located at: 36.7570°S, 144.2794°E. Geelong (Victoria) is located at 38.1499°S, 144.3617°E.

a) Determine the approximate distance between Bendigo and Geelong.

b) A sign post just outside Geelong shows the distance to Bendigo. Explain the difference between the calculated result and the sign post.

Case 3: North and South.

A globe is shown on page 4.2. The two points can move around the globe along the same great circle. The red arc continues to show the shortest distance between the two locations, however allowances must be made when a combination of North and South locations are in the same problem.

The light grey dotted lines parallel to the equator represent other locations with the same latitude.

Author: B. Lannen

TEXAS INSTRUMENTS
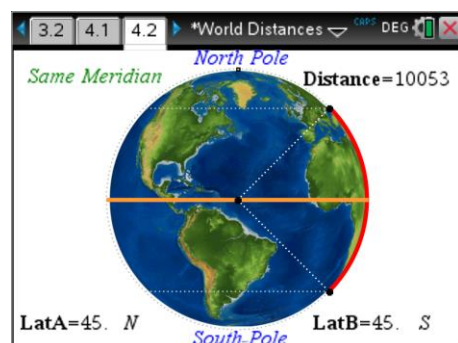
Question: 12

In the previous diagram (Page 4.2), location A is at latitude 45° in the northern hemisphere and location B is at latitude 45° in the southern hemisphere.

a) If 45° was used for both locations, what result would Equation 2 produce?

b) What is the angle between the two locations and how could the angle(s) be 'modified' to make the calculation work? (Justify your answer.)

Question: 13

Perth is located at 31.95^o S, 115.9^oE. Beijing is located at 39.90° N, 116.4°E.

a) To which meridian are Perth and Beijing closest?

b) Use the diagram on Page 4.2 to estimate the distance between Perth and Beijing.

c) Use your 'modified' bearings and an appropriate formula to determine a more accurate distance between Perth and Beijing.

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