Teaching Learning Materials to Understand Some Geographical Concepts

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Understanding the true shape of the earth

The earth is defined as being round but in fact the true shape of the earth is described by the term *Geoid* which means the Polar regions are flat while the Equatorial region bulges out. The spinning of the earth develops a *centrifugal force* which forces the mass to spread out while simultaneously another counterforce, the *centripetal force* comes into play. Both the forces work in a coordinated manner. The centrifugal force throws out the mass, thereby creating a space around the central part of the earth. Consequently, the mass in Polar regions tend to fill up this space or vacuum. This causes the Polar regions to be flat. This is because the rpm (rotational speed per minute) of spinning is slower at the Polar regions when compared to the Equatorial region.

Model-1: Understanding the effect of the earth's spinning on its shape

Things needed: (Refer to Diagram 1)

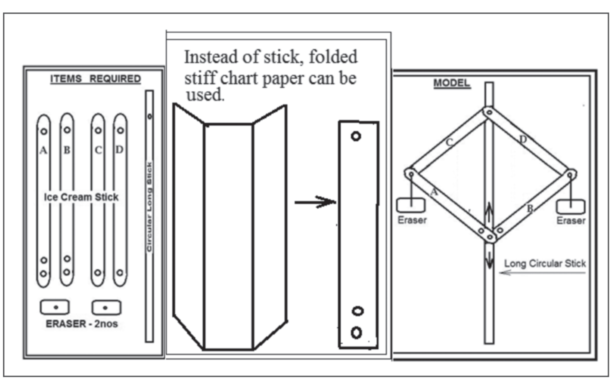


Diagram 1

Four ice cream sticks – A, B, C, and D - each 11cm in length; one smooth wooden stick -30 cms. in length; two erasers; strong thread to tie the ice cream sticks.

Steps:

1. Make two holes at each end of the ice cream sticks A, B, C and D, Make one more hole in both A and B, close to the hole already made. The space between two consecutive holes in A and B should have a distance of little more than the diameter of the wooden stick so that the rod can rotate freely, when tied with the ice cream sticks.

   Make holes in the centre of the two easers as well as at the top of the wooden stick.
2. To attach the wooden stick with the two ice cream sticks C & D, put a thread through the holes of the wooden sticks, C and D and tie a knot firmly so that it is fixed. Tie C&A and D & B with threads.
3. Use a longer thread now and take it through the two consecutive holes of both A and B. While doing so place the wooden stick carefully between A and B and tie loosely. Remember that the ice cream sticks should freely go up and down along the wooden stick.
4. Loosely tie A & C. as well as B & D. Put slightly longer threads through the holes of the erasers. Hang the erasers from the junction of A & C and B & D. Erasers must hang freely.
5. Spin the wooden stick now in one direction moderately.

What do you see?

Due to the centrifugal force, the erasers representing the mass of the earth move away, while the polar mass moves towards the central part (equatorial region) bringing the sticks closer towards each other. Refer to Diagram 1, given above.

Understanding the inclination of the Earth's axis at an angle of 23 ½^0

It is always found in textbooks that the earth is inclined at an angle of 23 ½^0 to its orbital plane. This phenomenon is hardly ever explained. To me teaching is complete only when the learner can visualise what the concept means: in this case learner must visualise how planets and the sun are positioned in the orbital plane. And how the angle of inclination is measured.

The learner must remember that a plane has a perpendicular. To understand this, consider:

i) the earth in an upright, not inclined position

ii) the orbital plane as one to be passing through the equator of the earth

iii) the perpendicular to be an imaginary line passing through the centre of the earth, North Pole and South Pole, coinciding with the upright axis of the earth. Refer to Diagram 2.

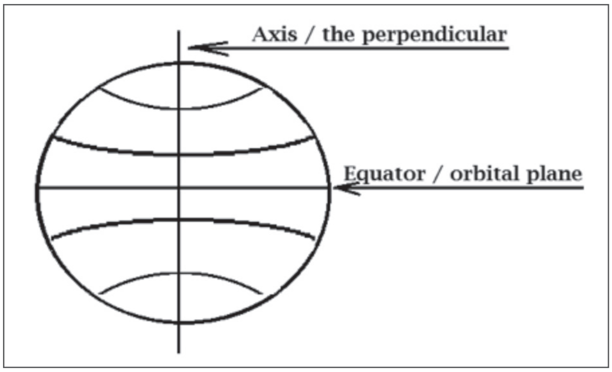


Diagram 2

The earth is tilted at an angle of 23½^{0} from this perpendicular of the ecliptic or the straight line passing through centre of the earth and the poles. To visualise this lets make a model.

Model 2

To show the orbital plane, the position of the sun and the earth in this plane (not to scale) and the inclination of the earth's axis

Things needed: (Refer to Photographs 1a, b, c)

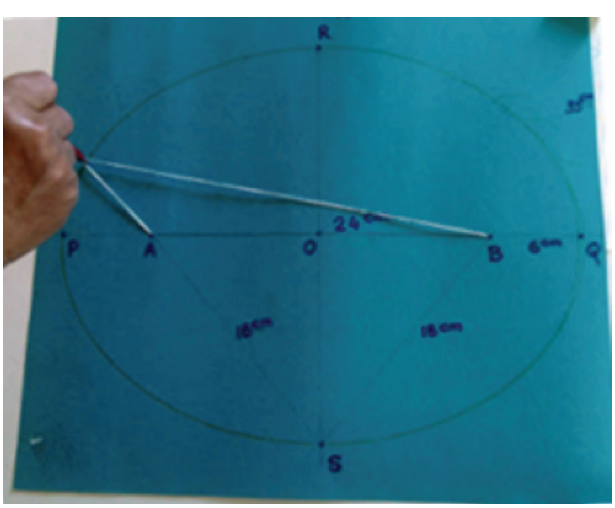
I. A rubber ball cut into half, represent the sun.

II. Another similar ball of any different colour representing the earth.

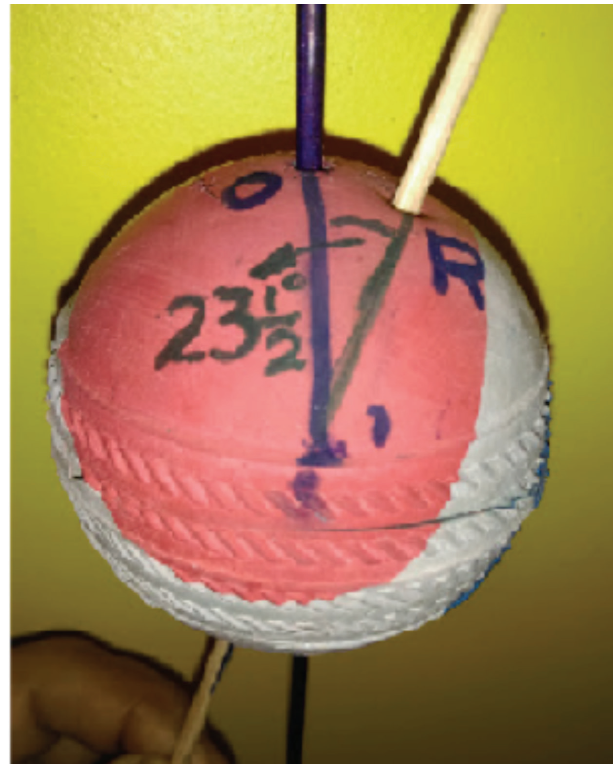
III. Two sticks, one black, the other white.

IV. A KG cardboard- 35×40cm

V. 36 cm thread, needle, pencil, ruler



Photograph 1a



Photograph 1b

Photograph 1c

Steps

1. Take the earth ball and slit it halfway horizontally. Hold the earth in an upright position and pass the black stick through O&P, passing through the centre of the earth. This black stick now represents the perpendicular. Measure 23½^{0} from the perpendicular at point T and pass the white stick through this point. (Photograph 1b)

2. Drawing of the orbital plane

   Take a piece of KG cardboard 40 cm by 35cm. Draw a straight line AB 24 cm in length, at the middle of the paper. To make an elliptical arc, take a thread and fix each the ends at A and B respectively. Now insert a sharp pointed pencil in the loop created by the thread. Move the pencil around points A & B; keep the pencil tight to maintain the tension throughout and draw the ellipse. This is the orbit of the earth around the sun. (Photograph 1a)

Point A will be the position of the sun and position of the earth will be close to point B-Q, along the edge. (Photograph 1c)

Demonstration in class

Now the critical part: with your left hand hold the sun (in two parts) half on the top of the plane of orbit and the other half below it. Position the sun at point A and the earth near point B-Q. Very carefully insert the slit in the earth ball, into the edge of the plane.

This model will clearly show:

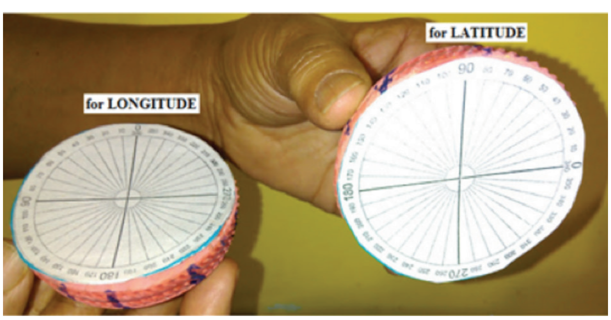
- The position of the sun and the earth in the elliptical plane of ecliptic.
- The tilt of the earth at an angle of $23½^0$.

Understanding the angular measurement of latitude and longitude

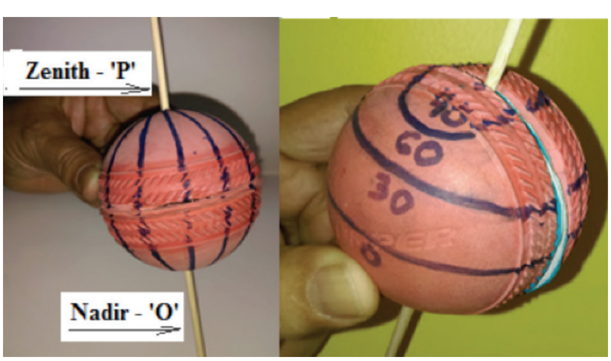
Students of geography are always taught to draw the important lines of latitudes and longitudes on a circle representing the earth, followed by numbering them. While some books say that these are angular measurement, that is an incomplete explanation.

Model-3 (i): To explain how the latitudes and longitudes are measured

Things needed: (Refer to Photographs 2a and b)



Photograph 2a



Photograph 2b

1. Take two balls, cut into halves to get four hollow hemispheres.
2. Two printouts of paper protractors of 360 degrees, matching the circumference of the ball- hemisphere.

Measuring latitude

Steps:

1. Paste a 360^0 paper protractor on a hemisphere, holding the hemisphere in a vertical position, so that 90^0 is at the top and 270^0 at the bottom. Mark 0^0, 30^0, 60^0, 90^0 (only a point) on the vertical periphery of the hemisphere. Join this one with the other hemisphere; insert a bamboo stick, which represents the axis of the earth, through the centre vertically and extend the already marked degrees on the vertical periphery making complete circles, representing latitudes of corresponding degrees.

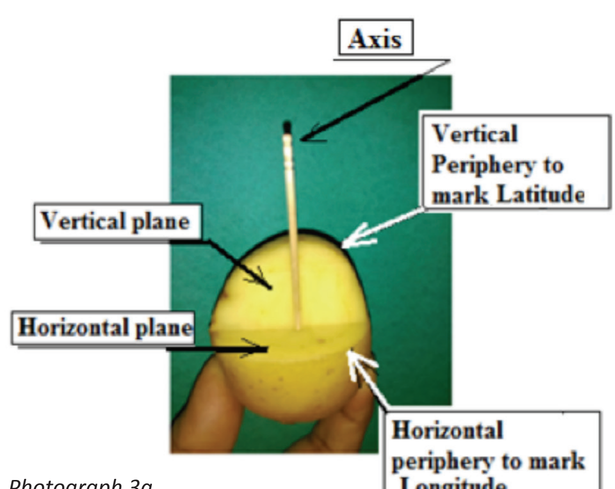
Measuring longitude:

2. Paste the 360^0 protractor on a hemisphere holding the hemisphere horizontally so that 0^0 should be at the top and 180^0 at the bottom. Mark 0^0, 30^0 E, 60^0 E, 30^0 W and 60^0 W along the horizontal periphery of this hemisphere. Put the other half of the ball on top covering the paper protractor. Insert the bamboo stick through P and O, representing the axis of the earth. Extend the already marked degrees on the horizontal periphery towards the zenith and nadir meeting at P & O, representing the longitudes.

Model 3 (ii)

To show that the angular measurement of latitude and longitude is the inter-section of horizontal and vertical planes

Things needed: (Refer to Photographs 3a and b)



Photograph 3a

Photograph 3b

1. A medium sized potato.
2. Three toothpicks, one red and the other green

Steps

1. The potato represents the earth. With a sharp knife make a vertical and horizontal slits to out a quarter of the potato. At the mid-point of the intersectional line, created by the vertical and horizontal slits, fix a toothpick vertically. This represents the axis of the earth.

Longitude: Align a green toothpick along the line from the centre of the earth and 0^0 horizontally. This represents the reference line for measurement of longitudinal angles. Measure 30^0 by moving the toothpick clockwise from the reference line of 0^0 horizontally. This angle is a longitudinal angle.

Latitude: Similarly, place a red toothpick as stated above, move this stick upward/anticlockwise to 30^0 from the 0^0, the angle formed by the stick with the same reference line is the latitudinal angle.

In both the cases the measurement of angles are estimations only.

Tapasya, who is passionate about geography, is presently working for Azim Premji Foundation as a geography resource person for Field Institutes. Prior to this, she was a geography teacher at the middle and senior school level for a long time. She may be contacted at tapasya@azimpremjifoundation.org