Sun height and seasons

FizziQ activity · Elementary · 45-60 min

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Using the tablet inclinometer in FizziQ Junior, primary pupils measure solar elevation, compare it with ephemeris data and connect its changes to Earth's tilt.

Learning objectives

- Experimentally measure the sun's height in the sky using the FizziQ Junior inclinometer.
- Use the Sun-Moon ephemeris to determine sun elevation at different dates.
- Identify solstice and equinox dates from maximum elevation data.
- Understand the link between sun height, seasons, and Earth's axis tilt.
- Discover the difference between solar time and legal time.

Instruments and sensors

Vertical inclination (inclinometer) · Accelerometer

Materials

- Smartphone or tablet with FizziQ Junior
- A rigid notebook or flat surface to place the tablet
- FizziQ Junior experiment notebook (to record measurements and photos)
- Note: the protocol remains adaptable to any comparable inclination/angle measurement tool.

Protocol

1. Explain to students that the sun's height varies in the sky during the day due to Earth's rotation. Indicate that maximum height also depends on the observer's position and seasons.

2. Divide students into groups of 3-4. SAFETY WARNING: students must never look directly at the Sun, this can cause irreparable damage to eyesight.

3. Open FizziQ Junior and access the Vertical Inclination instrument. Place the tablet flat on the ground then raise the left side: the inclination is shown in degrees.

4. To measure sun height, place the tablet on a notebook on the ground and orient it toward the sun. By progressively raising the tablet, observe that its shadow shrinks. When the shadow is smallest, the tablet is oriented toward the sun and the displayed angle corresponds to sun height.

5. Students add this measurement to the experiment notebook and take a photo of the setup.

6. Ask them to find on FizziQ Junior the Sun-Moon ephemeris which provides the sun's position in the sky for each day of the year. Explore the information provided by this instrument.

7. Students verify if ephemeris data matches their experimental sun height measurement.

8. Ask them at what time of day the sun is highest in the sky. By comparing with the time shown on the tablet, they will discover a difference between solar time and legal time.

9. Ask them if the sun's maximum height is the same for different dates. By changing the date on the tablet and consulting the ephemeris, they explore different dates of the year.

10. Students determine the dates when the sun is highest (summer solstice) and lowest (winter solstice) in the sky. What time of year do these dates correspond to?

11. Encourage students to reflect on the importance of understanding these variations for practical applications: energy-efficient house design, solar panels, understanding climate variations.

Expected results

Students will observe that the sun's maximum height varies considerably with seasons. In France (latitude 48°N approximately), the sun reaches a maximum height of about 65 degrees at the summer solstice and only 18 degrees at the winter solstice. At equinoxes, the maximum height is about 42 degrees.

Students will also discover that the sun is at its highest around solar noon, which doesn't correspond exactly to 12:00 legal time due to time zone differences and the equation of time. The experimental measurement with the tablet shadow will be approximate with precision of a few degrees, which is sufficient to observe general trends.

Questions

- Why is the sun higher in the sky in summer than in winter?
- What would happen if Earth's axis were not tilted relative to its orbit?
- Why doesn't solar noon correspond exactly to 12:00 on our watches?
- Is the sun's maximum height the same in New York and Miami?
- How do architects use knowledge of sun height to design energy-efficient buildings?

Going further

- Measure sun height at several times of day to trace its trajectory in the sky.
- Compare maximum elevation data between two cities at different latitudes using the ephemeris.
- Build a simple sundial using collected data.
- Theoretically calculate the sun's maximum height and compare with ephemeris data.
- Study the influence of sun height on shadow length by measuring a vertical stick's shadow.