Family edition

Sun and Seasons Lab: Opposite Seasons

Ages 11-14 · about 45 minutes, in one sitting

Your child spends one December day in four places in Sun and Seasons Lab: Denver, Sydney, Quito on the equator, and Tromso in Norway. The point is that Earth's tilted axis keeps pointing the same way, so the two halves of Earth have opposite seasons.

What you need

- A computer or Chromebook with a current browser.
- The lesson link: mytekdev.com/try/sunseasonslab?lesson=opposite-seasons&ref=fam-sunseasonslab-4. No account, no email and nothing to install.
- Optional: a globe, or a ball with a pencil pushed through it.

Before you start: try it once yourself

Open mytekdev.com/try/sunseasonslab?lesson=opposite-seasons&ref=fam-sunseasonslab-4. Denver on December 22 at noon, with every control showing: the heading says Winter in Denver, 9 hours 21 minutes of daylight, the noon Sun 27 degrees up.

1. **Sydney.** Pick Sydney, Australia in the Town list. The same day: Summer in Sydney, 14 hours 24 minutes, the noon Sun 80 degrees up. Look north to see it.
2. **Quito.** Pick Quito, on the equator: No big seasons, 12 hours 8 minutes of daylight, the noon Sun 67 degrees up.
3. **Tromso.** Pick Tromso, Norway: the Sun does not rise today. Press `June solstice`: daylight all 24 hours.
4. **Break the model.** Open `Tilt and Orbit`, turn on `The wrong axis` (summer all year in the north), turn it off, and drag the tilt slider to 0 (about 12 hours of daylight everywhere).
5. **The size test.** Press `Real tilt`, open `Sunlight`, and pick each town. Denver: a summer day gets 3.1 times the sunlight of a winter day. Sydney: 2.7 times. Quito shows only the distance row. Tromso: winter gets none.

> Moving to another town keeps the date and the clock time, in that town's own time zone, so every town is on the same calendar day.

The ideas, in plain words

Earth's axis is tilted about 23.4 degrees and keeps pointing the same way, toward the North Star, all year. In December the south end leans toward the Sun, so the southern half of Earth has the high Sun and the long days: summer. In June it is the other way round. One Earth at one distance has two opposite seasons.

Near the equator the noon Sun is high all year and the day stays close to 12 hours, so there are no big seasons; Quito's day runs from 12 hours 7 minutes to 12 hours 8 minutes. Near the poles the tilt is extreme: in Tromso, at 69.6 degrees north, the Sun stays up from mid-May to late July and does not rise from late November to mid-January.

Two tests of the cause. An axis that always leaned toward the Sun, which is what children mean by "the axis flips", would give the north a June day every day: 14 hours 59 minutes and a 74 degree noon Sun in Denver on December 22. With no tilt at all, almost every place would get about 12 hours of daylight all year and there would be no real seasons, only the small 7 percent change from distance, for the whole Earth at once.

Do it together

1. Open mytekdev.com/try/sunseasonslab?lesson=opposite-seasons&ref=fam-sunseasonslab-4 together. Pick Sydney, Australia from the Town list, then Quito.

   > **You'll know it worked when:** Summer in Sydney on December 22; no big seasons in Quito, with about 12 hours of daylight.

2. Pick Tromso, Norway, then press `June solstice`.

   > **You'll know it worked when:** No sunrise in December; in June the Sun stays up all 24 hours.

3. Open `Tilt and Orbit` and turn on `The wrong axis`, then turn it off and drag the tilt slider to 0.

   > **If you get stuck:** The tilt slider is under What if the tilt were different?, below the switches.
   >
   > **You'll know it worked when:** The wrong axis gives summer all year; no tilt gives about 12 hours of daylight all year.

4. Press `Real tilt`, open `Sunlight` and read the size test for each of the four towns.

   > **You'll know it worked when:** Your child can say why Sydney has summer in December, using the words axis and tilt.

Talk about it

Ask these while you work together. A child who has understood it can answer them without help:

- Which end of the axis leans toward the Sun in December? How can you tell in the picture?
- Why does Quito have no big seasons?
- Why does Tromso get no sunrise in December and no sunset in June?
- What did the wrong axis do to Denver's year?

- With no tilt, what would Denver's seasons be like?

> The first question is the real test: a child who points to the arrow toward the North Star and says it never turns has the model.

For younger and older kids

Younger: For a younger child, use a globe and a lamp: keep the axis pointed at one wall and walk the globe around the lamp. Which half gets more light in each place?

Older: For a teenager, solve the Puzzles What season is it?, Place Earth and Midnight sun, and explain each answer.

Keep going

- Solve Midnight sun and No tilt in Puzzles, and explain each answer.
- Drag the tilt slider to 60 degrees and describe Denver's year. Where would the midnight sun reach?
- Pick your own town and Sydney and compare the year graphs: when are the two lines the same?

Bring it into other subjects

- Math: in the size test, Denver's summer day gets 3.1 times the sunlight of a winter day. Is that more or less than Sydney's 2.7? Why might that be?
- Geography: find three cities near the equator and say what their year is like.
- Social studies: how do people in Tromso live through two months with no sunrise?
- English: write a postcard from Sydney on December 25 to a friend in Denver.

For your records

Ready to copy into an hour log, a portfolio or a transcript.

LESSON	Sun and Seasons Lab: Opposite Seasons
SUBJECTS	Earth and space science
TIME	45 minutes
WHAT WE DID	Used a model of the Sun and Earth's tilted axis to compare the seasons in Denver, Sydney, Quito and Tromso on one day, and tested what an axis that turns to the Sun or no tilt would do.
SKILLS PRACTICED	Seasons in both hemispheres; Using a model; Comparing places

Activity sheet (optional)

Name: _____ Date: _____

Open the app: scan the QR code, or go to mytekdev.com/try/sunseasonslab?lesson=opposite-seasons

Essential question: Why do Sydney, Quito and Tromso have such different seasons on the same day?

Warm-up: Is it winter everywhere on December 22? Where might it be summer? _____

1. **Vocabulary.** Hemisphere, equator, midnight sun, polar night, tilt: write each in your own words.

2. **Four towns.** For Denver, Sydney, Quito and Tromso: the season on December 22, daylight on December 22 and on June 21, and the size test in Sunlight.

3. **Break the model.** With the wrong axis, Denver on December 22 had _____ of daylight. With a tilt of 0, it had _____.

1. Why does Sydney have summer in December? Draw Earth, its axis and the Sun.

2. Which of the four towns has the biggest difference between summer and winter, and why?

Quick check

Name: _____

1. On December 22, Sydney, Australia has (A) winter (B) summer (C) no seasons at all

2. If Earth's axis were not tilted at all, Denver would have (A) bigger seasons (B) about 12 hours of daylight all year and no real seasons (C) summer all year

3. Why does Quito, on the equator, have no big seasons?

Answers

QUESTION	ANSWER	WHY
1	B	In December the south end of the axis leans toward the Sun: 14 hours 24 minutes of daylight and a noon Sun 80 degrees up.
2	B	With no tilt the Sun would sit over the equator every day. The puzzle No tilt and the slider both show it.
3	The Sun is high all year	The noon Sun stays high and the day stays close to 12 hours all year, so the sunlight hardly changes. A full answer names the day length.

If your state or umbrella school asks, this lesson covers NGSS MS-ESS1-1, Texas TEKS 112.26(b)(9)(A).

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The app this lesson uses is free and runs in the browser, with nothing to install and no account needed. It is at mytekdev.com.

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