

Storm Lab: What Makes a Thunderstorm?

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

Your child makes a thunderstorm in a weather simulator, then takes it apart one ingredient at a time to find out what a storm needs: moisture, rising air that stays warm, and something to push the air up. Then they fix days that make no storm, saying what will happen before each test.

What you need

- A computer or Chromebook with a current browser.
- The lesson link: mytekdev.com/try/stormlab?lesson=what-makes-a-thunderstorm&ref=fam-stormlab-1. No account, no email and nothing to install.
- Optional: the activity sheet at the end of this plan, printed, and a pencil, for writing each prediction down first.

Before you start: try it once yourself

Make the storms and fix the days yourself once before you start, about ten minutes.

1. **Open the lesson.** Go to mytekdev.com/try/stormlab?lesson=what-makes-a-thunderstorm&ref=fam-stormlab-1. The app opens on the Storm bench with a summer afternoon set. Press Make the storm: a tall cloud grows and the result reads **An ordinary thunderstorm**.
2. **Read the ingredients.** Scroll to **The ingredients** under the result. Moisture, instability, lift and the push through the cap are green; wind shear is not.
3. **Take one away.** Drag **Humidity near the ground** a little toward dry, a notch or two past where the word changes from humid, and make the storm: **The cap held**. Further toward dry: **Small clouds, no storm**. Press Undo until the humidity is back.
4. **Fix The cap holds.** Pick **The cap holds** under Start from a real kind of day and make the storm: **The cap held**. Press **wind blowing up a hillside** under What pushes the air up and make the storm again: **A supercell**.
5. **Look at Desert heat.** Pick **Desert heat** and make the storm: **No cloud**. Under the result, **What would make a storm** lists the one change that works alone: much damper air near the ground, about 45 percent humidity.



The Storm bench: the sky on the left, the example days, the result and the ingredients list on the right.

Every slider change clears the result, so you have to press Make the storm again. Run it again keeps the same sky and rolls the dice again, which can change whether a supercell makes a tornado, but not what kind of storm forms. Undo and Redo are at the top right.

The ideas, in plain words

A thunderstorm starts when a bubble of air near the ground rises and keeps rising. Forecasters check three ingredients. Moisture: damp air makes a cloud soon after it starts rising, and turning vapor into cloud gives off heat that keeps the bubble warm. Instability: the air high up has to be cold enough that the rising bubble stays warmer than the air around it, so it keeps going up on its own. Lift: something has to push the air up to start it, such as the sun heating the ground, wind blowing up a hill, a sea breeze, a dry line or a cold front.

The cap is a layer of warmer air partway up. A bubble that reaches it is suddenly cooler than the air around it and stops, unless the lift pushes it through. Above the cap, the bubble is warm again and rises fast. That is why a capped day can have plenty of fuel and no storm, and why forecasters watch the cap all day: when something finally pushes through, the storms can be strong. How hard each kind of lift pushes in the app is the lab's own rule; the order, with the sun weakest and a cold front strongest, follows how forecasters describe them (cold fronts lift the air most abruptly). In the real air, the sun mostly works a different way: it warms the air near the ground through the day until rising bubbles can get through the lid on their own.

Wind shear, wind that changes with height, decides what kind of storm forms rather than whether one forms. With little shear, a storm stands straight up, its rain falls into its own updraft, and it dies within about an hour. With strong shear the storm tilts and can last for hours; the strongest kind, the supercell, rotates.

YOUR CHILD MIGHT ASK	A GOOD ANSWER
Why does drier air stop the storm?	Drier air has to rise higher before it makes a cloud, so it stays cool longer and has less fuel. With less fuel, the sun's push is no longer enough to get it through the cap.
The desert is so hot. Why no storm?	Heat is not the same as moisture. The air is so dry that a bubble would have to rise about 15,600 feet before it made a cloud.
Why is wind shear not green, when there is a storm?	Shear is not needed to start a storm. It organizes storms and helps them last.
Is a stronger push always better?	It breaks the cap more easily, but what forms also depends on the wind. On The cap holds, a cold front makes a squall line and a hill makes a supercell.

Do it together

1. Open mytekdev.com/try/stormlab?lesson=what-makes-a-thunderstorm&ref=fam-stormlab-1 together. The app opens on a hot, humid summer afternoon. A short guide runs along the bottom; follow it together. It has your child press Make the storm, move the humidity slider and make the storm again. Then ask: what did the air need to make the first storm?

You'll know it worked when: A tall cloud grows and the result reads **An ordinary thunderstorm**.

2. Put the humidity back with Undo and make the storm again. Scroll to **The ingredients** under the result and read the lines together. Green means this sky has it. The first three are the ingredients forecasters check: moisture, instability (fuel) and lift.

If you get stuck: **Wind shear** is not green, yet there is a storm. Shear organizes storms and helps them last, but a storm can form without it.

You'll know it worked when: Your child can name the three ingredients and say what each one does.

3. Take one away. Your child predicts what drier air will do, drags **Humidity near the ground** a little toward dry, a notch or two past where the word changes from humid, and presses Make the storm. Then drags it further toward dry and tries again. Put it back afterward.

If you get stuck: A slider change clears the result, so press Make the storm after every change.

You'll know it worked when: First **The cap held**, then **Small clouds, no storm**.

4. Take the lift away: under What pushes the air up, press **nothing pushing the air up**, and make the storm.

You'll know it worked when: **No storm yet**: there is fuel, but nothing starts the air rising.

5. Fix a day. Under Start from a real kind of day, pick **The cap holds** and make the storm. Read why it failed. Your child changes one thing, says what will happen first, and makes the storm again. Then try **Desert heat** the same way.

If you get stuck: When a day makes no storm, **What would make a storm** appears under the result. Read it only after your child has said their own idea; it lists the smallest single changes that work, each with a Try it button.

You'll know it worked when: The cap holds makes a storm with a stronger lift (a hillside, a dry line or a cold front), a weaker cap, or a little more humidity. Desert heat needs the humidity raised from 10 percent to about 45 percent.

6. Finish with one question: there was plenty of fuel under the cap, so why did nothing happen until something changed?

You'll know it worked when: Your child explains that a rising bubble has to be pushed through the warm lid first, and the sun alone was not enough push.

Talk about it

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

- Which three ingredients does a thunderstorm need? Point to them on the screen.
- You made the air drier. Which ingredient did that change?
- The desert day is very hot. Why does it make no storm?
- There was plenty of fuel under the cap. Why did nothing happen until something changed?
- Before you press Make the storm: what will this change do?

The fourth one is the real test. A child who can explain why fuel is not enough on its own understands the cap, which is the part forecasters watch most closely on a stormy afternoon.

For younger and older kids

Younger: For ages 9 and 10, do the take-one-away test side by side and fix The cap holds together, and save Desert heat for another day.

Older: For teens, turn on the All checkbox and record the fuel (CAPE) and the push needed (CIN) for each change, then explain the cap in a few sentences using those two numbers.

Keep going

- Try `Cool gray day`. No single change makes a storm there. Find two changes that do, and explain why it needed both.
- Turn on the All checkbox and read the fuel (CAPE) and the push needed (CIN) under the result. How do they change when you weaken the cap?
- On The cap holds, try each kind of lift in turn. Which ones break the cap, and what do they make?

Bring it into other subjects

- Math: the app's cloud base comes from a forecasters' rule of thumb, about 125 meters of rise for each degree Celsius between the temperature and the dew point. If the air is 30 degrees and the dew point is 20, about how high is the cloud base? (About 1,250 meters.)
- Science: a dry line is where hot, dry desert air meets warm, moist air. Why would that push air up? (The dry air is denser and lifts the moist air ahead of it.)
- Science: look up a weather forecast for a stormy day and find the words they use: unstable, a cap, a front. Which ingredients is the forecaster talking about?
- Writing: write a weather forecast for one of the example days, using the three ingredients to explain your forecast.

For your records

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

LESSON	Storm Lab: What Makes a Thunderstorm?
SUBJECTS	Science
TIME	45 minutes
WHAT WE DID	Built thunderstorms in a weather simulator and tested what each ingredient does by removing it: moisture, instability and lift. Explained how a cap of warm air can hold off a storm that has plenty of fuel, and fixed days that made no storm by changing one ingredient at a time, predicting each result first.
SKILLS PRACTICED	the ingredients of a thunderstorm; how a capping inversion works; predicting before testing; changing one variable at a time

Activity sheet (optional)

Name: _____ Date: _____



Open the app: scan the QR code, or go to mytekdev.com/try/stormlab?lesson=what-makes-a-thunderstorm

Essential question: What does the air need to make a thunderstorm?

1. **Make the storm.** Press Make the storm. The result says: _____
2. **Read the ingredients.** The three ingredients are _____, _____ and _____.
3. **Predict, then test.** Change one thing at a time. Write your prediction before you press Make the storm.

CHANGE	I PREDICT	THE RESULT SAYS	MISSING INGREDIENT
Summer afternoon: a little drier			
Summer afternoon: no lift			
The cap holds: my change			
Desert heat: my change			

1. There was plenty of fuel under the cap. Why did nothing happen until something changed?

2. Why did Desert heat need so much more humidity than The cap holds?

Quick check

Name: _____

- 1. Which of these is NOT one of the three ingredients of a thunderstorm? (A) moisture, (B) lift, (C) wind shear, (D) instability.
- 2. A day has plenty of fuel, but a strong cap. The only lift is the sun heating the ground. What is most likely? (A) a thunderstorm, (B) no storm, (C) a hurricane.
- 3. A very hot day makes no cloud at all. Which ingredient is most likely missing, and what would you change?

Answers

Measured in the app with the lesson's starting settings: the summer afternoon makes an ordinary thunderstorm; a little drier, the cap held; drier still, small clouds and no storm; with nothing pushing the air up, no storm yet. The cap holds makes a storm with a hillside, a dry line or a cold front, with the cap weakened to a weak lid, or with a little more humidity. Desert heat makes no cloud, and humidity alone has to rise from 10 percent to about 45 percent before a storm forms.

QUESTION	ANSWER	WHY
1	C	Wind shear organizes storms but is not needed to start one. The three ingredients are moisture, instability and lift.
2	B	The bubble has to be pushed through the warm lid first, and the sun alone is not enough push under a strong cap.
3	Moisture. Make the air near the ground damper	A good answer names moisture and a change that adds it. Very dry air has to rise very high before it makes a cloud.

If your state or umbrella school asks, this lesson covers NGSS MS-ESS2-5.

Terms of use

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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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