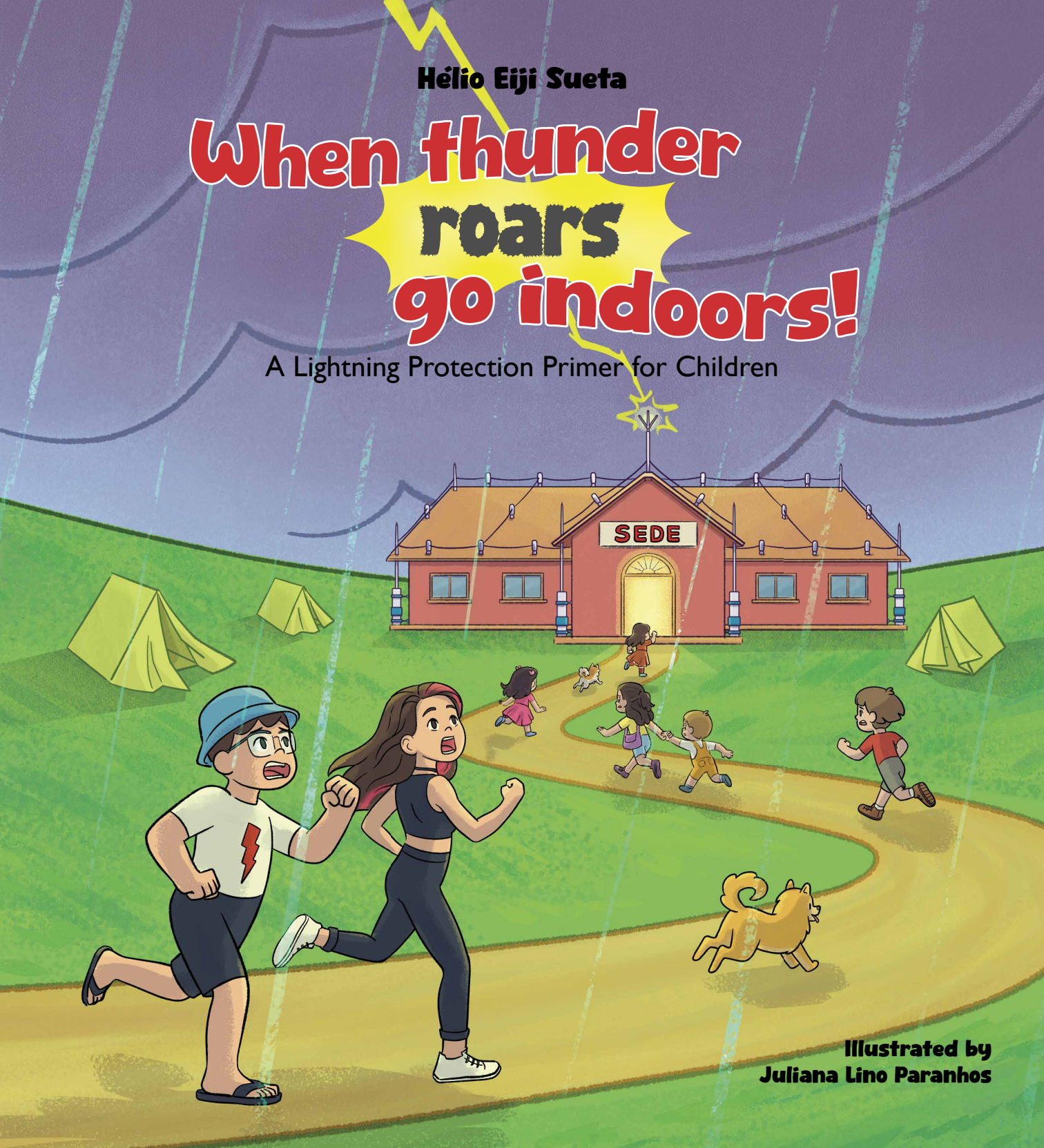
Hélio Eiji Sueta

When thunder roars go indoors!

A Lightning Protection Primer for Children



Illustrated by
Juliana Lino Paranhos

WHEN THUNDER ROARS, GO INDOORS!

1st english edition: april 2025

CATALOG CARD

S944 Sueta, Hélio Eiji
When thunder roars, go indoors! - A lightning protection primer for children. / by Hélio Eiji Sueta; illustrated by Juliana Lino Paranhos. – São Paulo: IEE_USP, 2025
48p: 40 cm

ISBN 978-65-88109-58-8

1. Child education. 2. Lightning protection. I. Paranhos, Juliana. II. Title

CDU 621.316.93

Elaborated by Maria Penha da Silva Oliveira CRB-8/6961

Editorial coordination: Cai-cai Edições
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Institutional support: Instituto de Energia e Ambiente – USP

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05508-010 | São Paulo - SP
www.iee.usp.br

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A Lightning Protection Primer for Children

by
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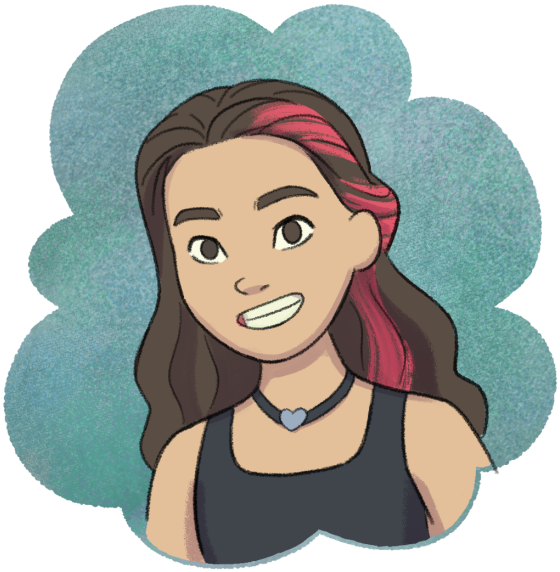
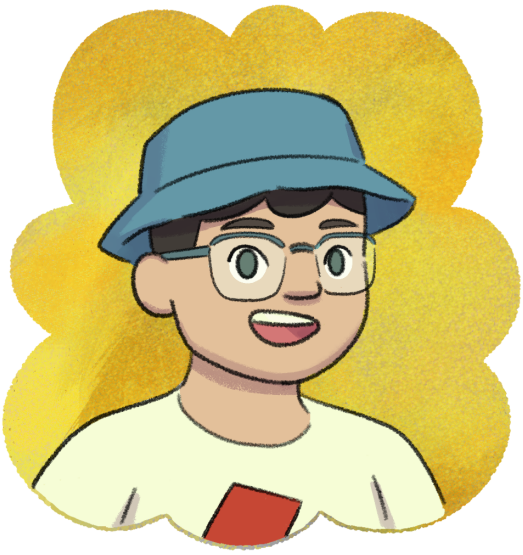
Meet the Group



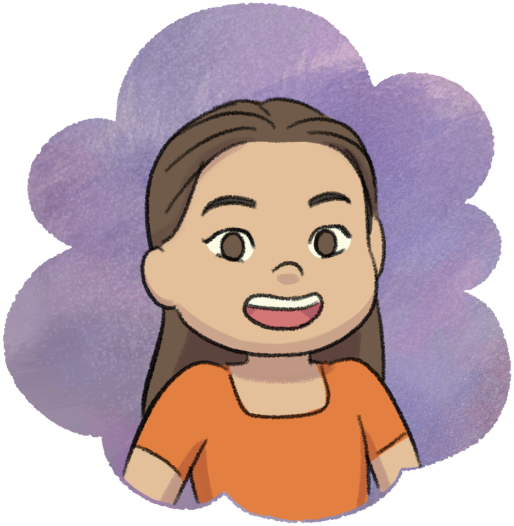
Toya (Maria Vitória)
Young, happy, smart, sister of Sarão.



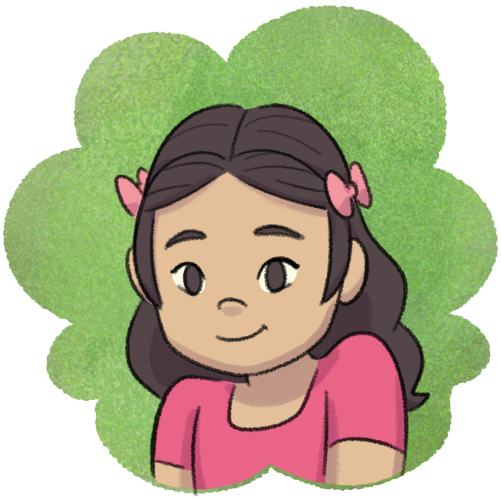
Sarão (Masaru)
Young, genius of the class.

Dindinha (Amanda)
The class organizer.

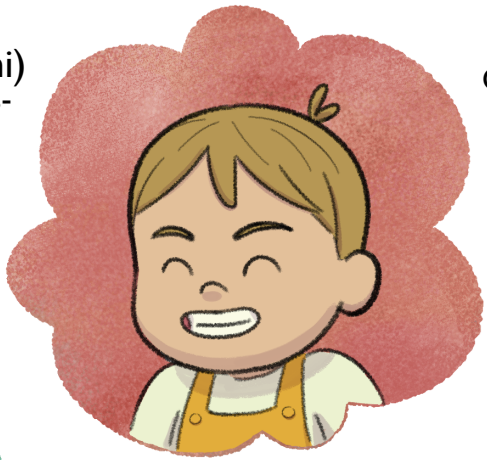
Roninho (Roney)
Brave at video games, but terrified of thunder.



Haruminha (Nina Harumi)
Smart, powerful and quite mischievous.



Iarinha (Iara Kim)
Obedient, intelligent, follows her cousin, Nina, in her mischief.



Nonô (Noah)
Restless and mischievous child.

Hininha Tempestade
Happy, mischievous, but very needy. She's always asking for affection.

Levi Trovão
Lively, playful and a glutton. He can't see anyone eating without begging them for a portion.

It was just another normal day at the "Rising Sun" Farm, until…

— Guys! Where are Hina and Levi?! — shouted Dindinha, startled.

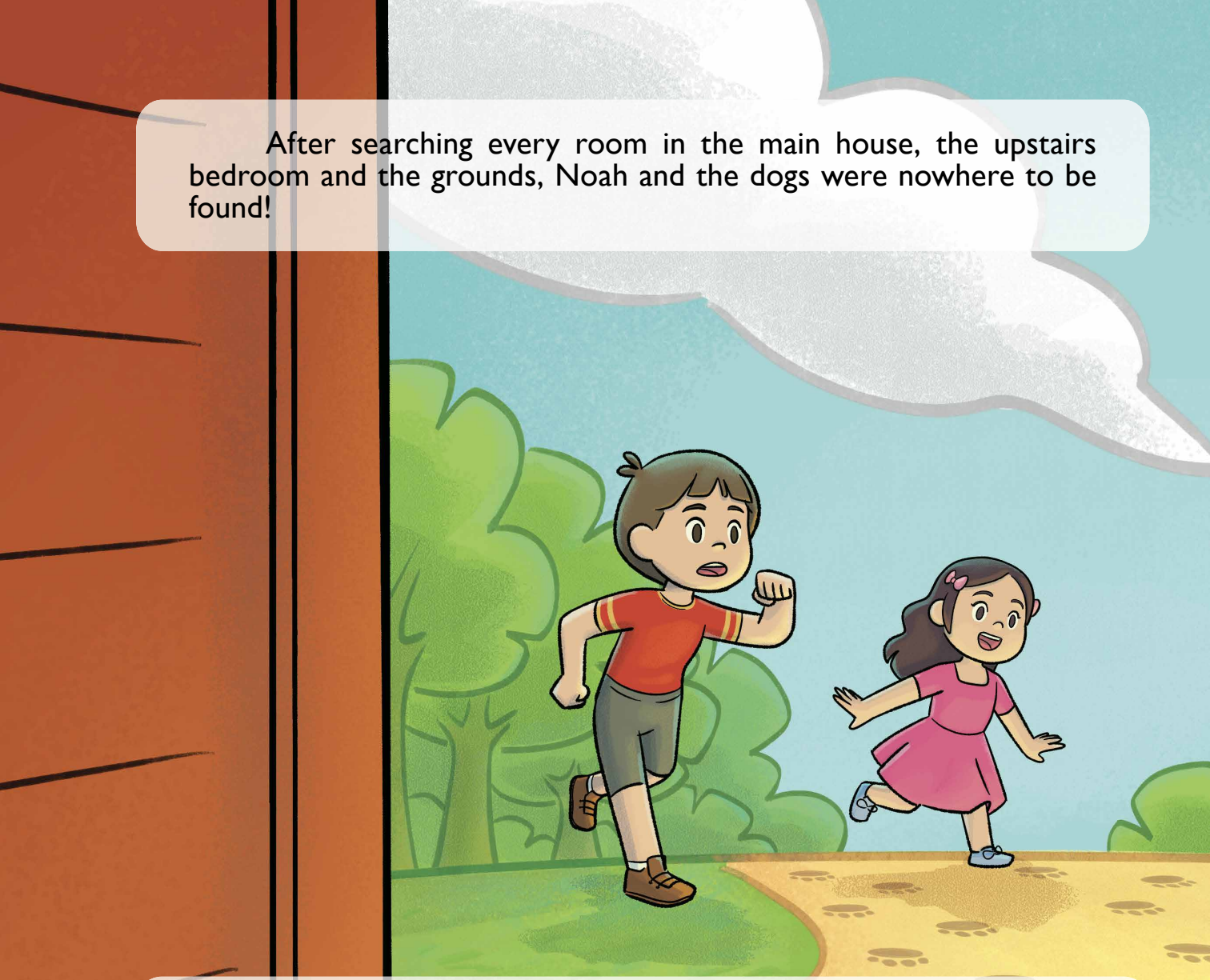
And off they all went to look for the two little dogs.

— Roninho, look under the beds and I'll look near the chicken coop — said Dindinha.

— Haruminha and Iarinha: you go to the little room upstairs to see if they are there — added the girl, the class organizer.

Each one went in a different direction and, in the end, they ended up having another terrible surprise: little Noah had also disappeared!

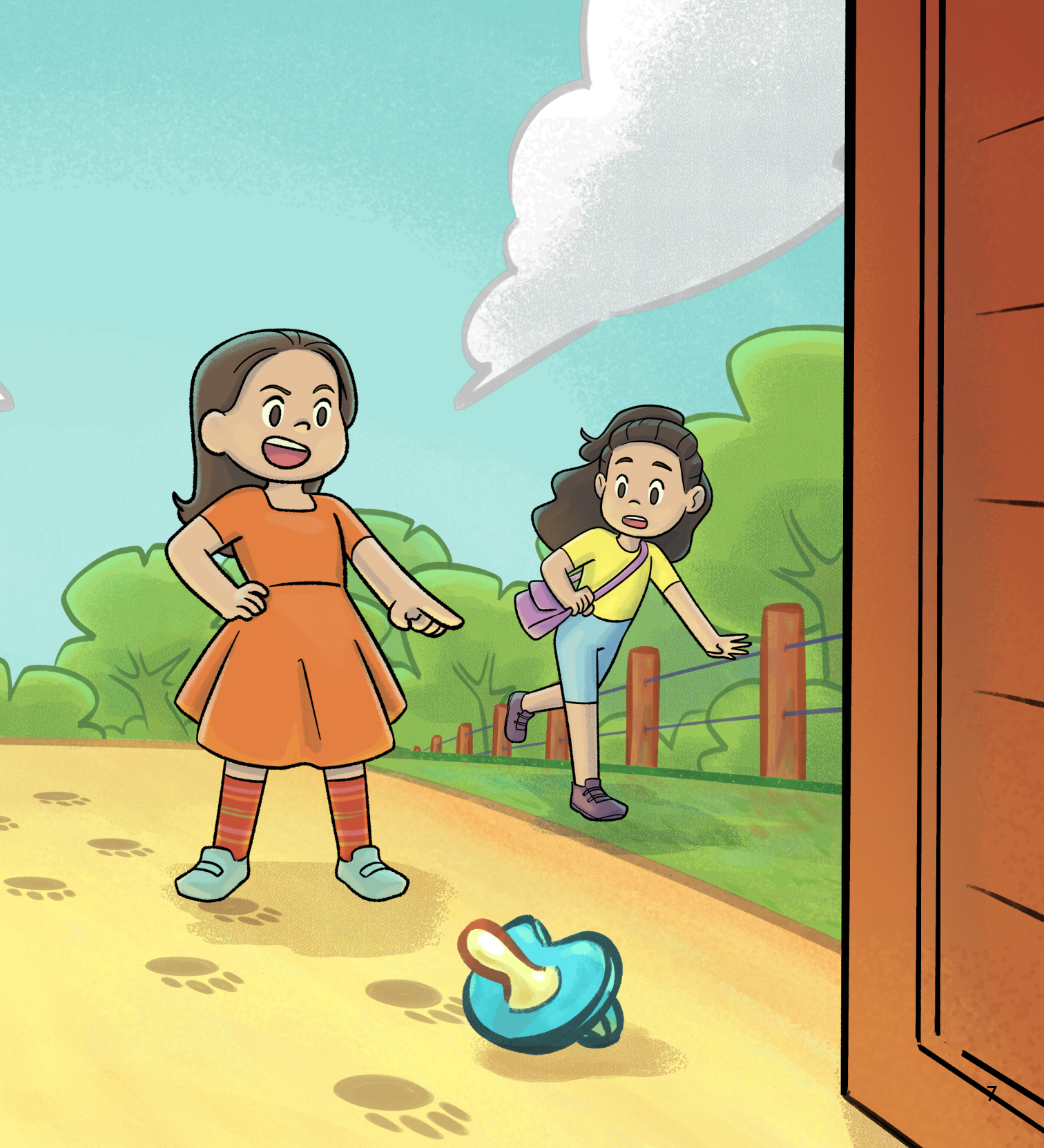
After searching every room in the main house, the upstairs bedroom and the grounds, Noah and the dogs were nowhere to be found!

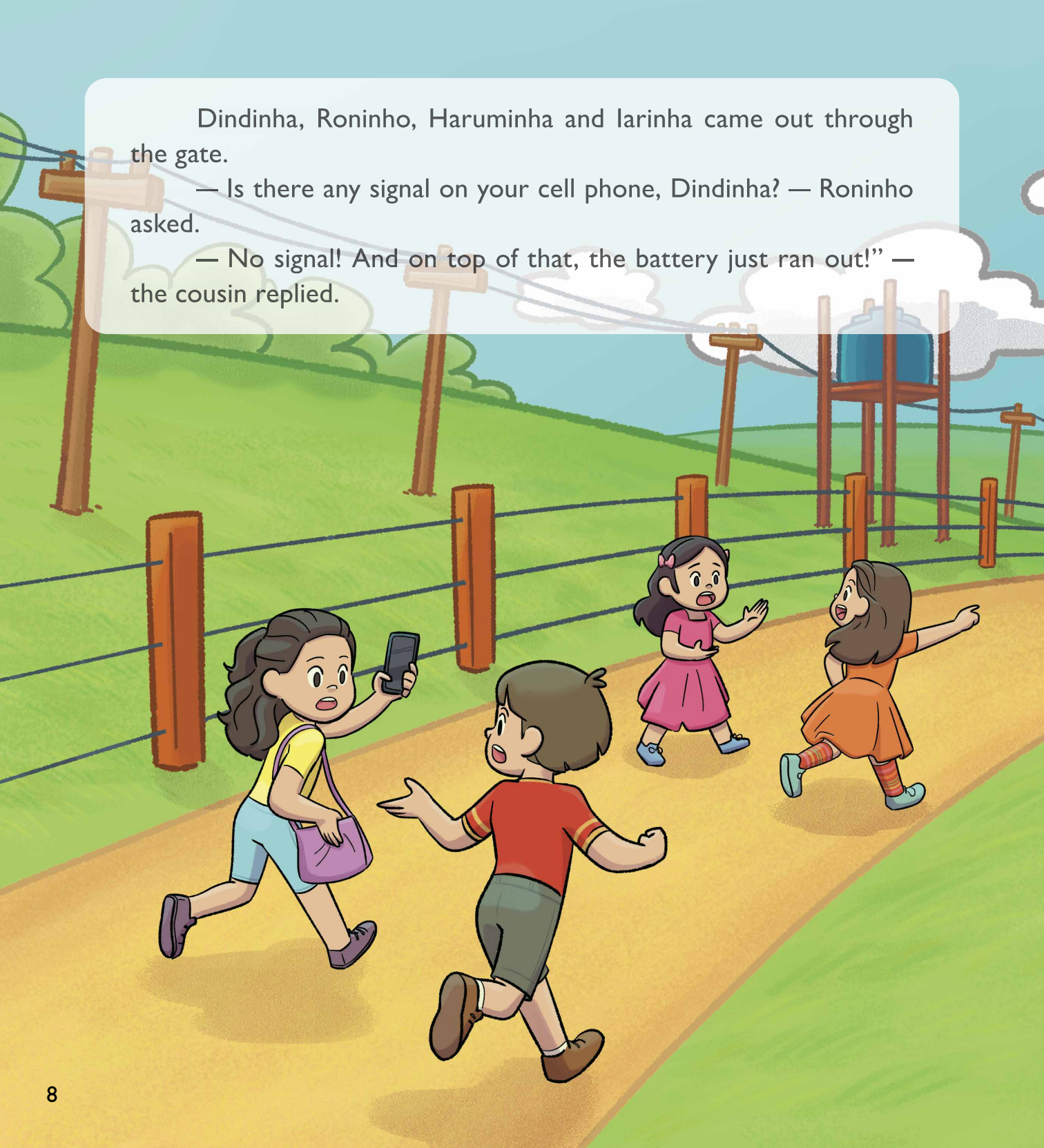


Then, the great detective Haruminha solved the mystery:

— They ran away through the gate! Look at the tracks of Hina Thundestorm and Levi Thunder heading towards the road… And Nonô's pacifier fallen right there in the half-open gate!

And off they all went to the road, looking for the fugitives…





Dindinha, Roninho, Haruminha and Iarinha came out through the gate.

— Is there any signal on your cell phone, Dindinha? — Roninho asked.

— No signal! And on top of that, the battery just ran out!" — the cousin replied.

— We have to tell Toya — said Iarinha. — We can't leave without telling anyone! Mom always says that!

— But we don't have time! — said Haruminha. — They must be far away by now. We can't even see them along the road!

And off the children went towards the neighboring farm to Mr. João's house!

Meanwhile, Toya and Sarão arrived home from the orchard. The two brothers were still fighting over the unwashed dishes from lunch.

— You're such a lazybones, Sarão! All you want to do is play on the computer! Look at all the dirty dishes!

— Toya, forget about the dishes, I think we have a much bigger problem — the teenager realized. — Where is everyone?! The kids and the dogs are gone! Mom is going to kill us!

— Oh, come on! Hurry up, Sarão, let's go look for them!

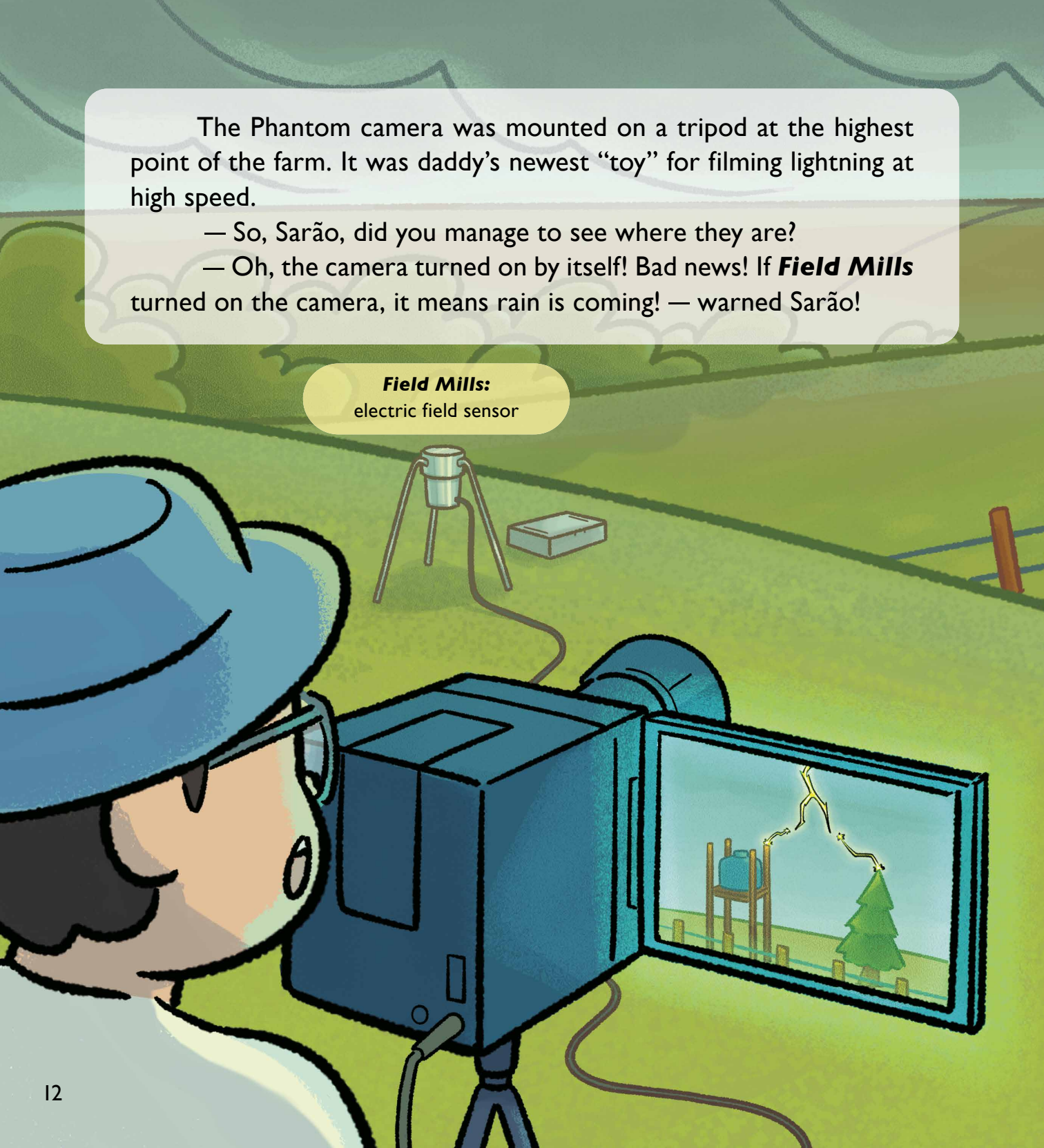
— I'm going to look through Dad's Phantom UHS camera with the telephoto lens to see if I can find them!

The Phantom camera was mounted on a tripod at the highest point of the farm. It was daddy's newest "toy" for filming lightning at high speed.

— So, Sarão, did you manage to see where they are?

— Oh, the camera turned on by itself! Bad news! If ***Field Mills*** turned on the camera, it means rain is coming! — warned Sarão!

Field Mills:
electric field sensor



Looking through the camera's viewfinder, Sarão looked in all directions. He saw a "spark" coming out of the top of a pine tree, another coming out of a water tank…

— Toya, ***upward leaders*** everywhere! There's going to be lots of lightning! — shouted Sarão. — But it looks like the children went towards Mr. João's farm.

Upward leaders are incomplete discharges that appear at high points on objects connected to the ground and travel toward downward leaders of lightning coming from the cloud when lightning is forming. When it joins with a downward leader to form a lightning strike, the phenomenon is called a "connecting upward leader". Those that do not connect are called "unconnected upward leaders".

— Let's go — shouted Toya. — They're out on the road! Look at the open gate!

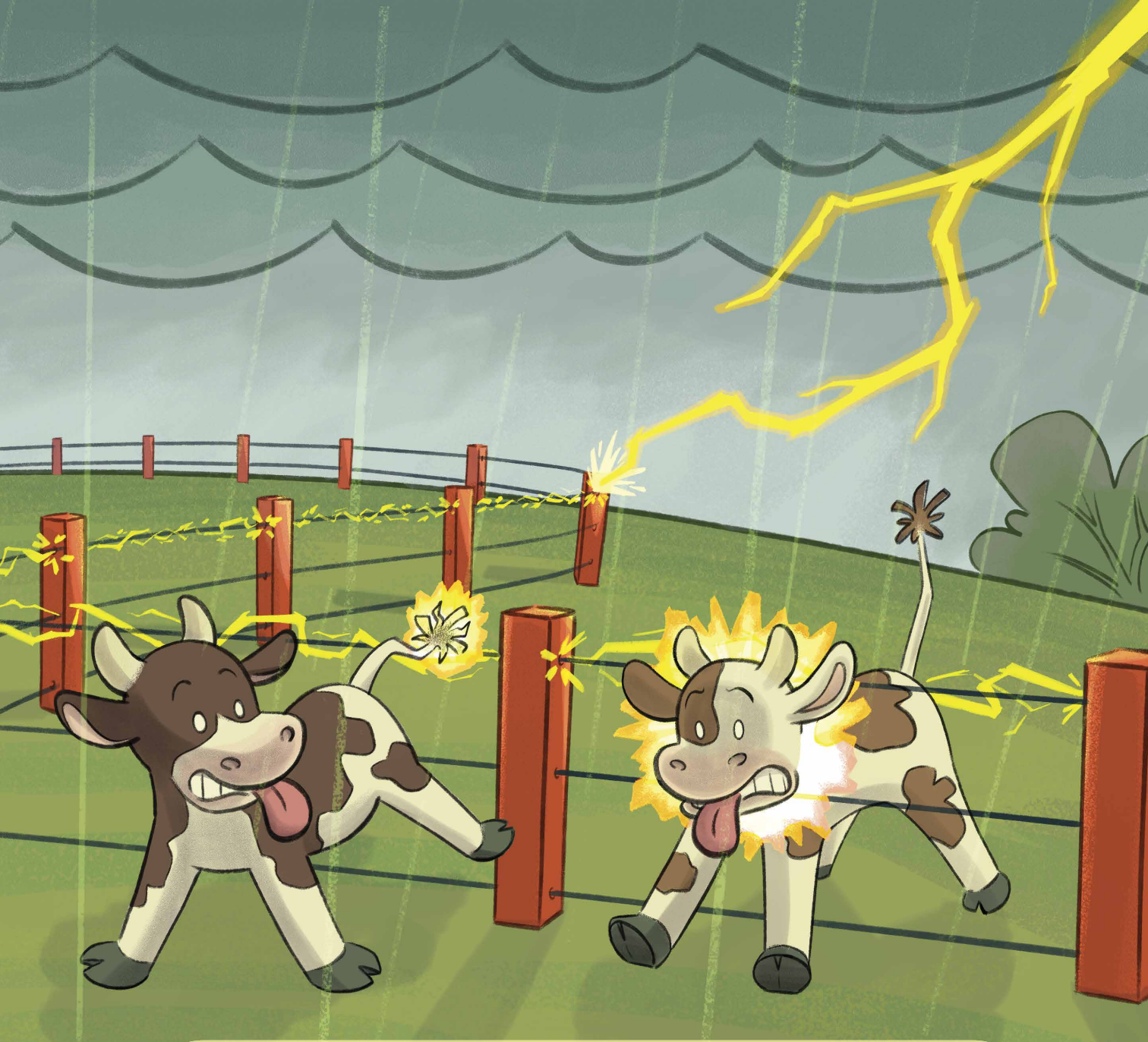
And off the two teenagers went following their cousins along the road to Mr. João's farm. The sky, which had been clear a few minutes ago, darkened suddenly.

Soon, lightning bolts began to appear everywhere!

When they passed near the fence that separates the two farms, they saw two calves being electrocuted!

— Oh my! ***Touch voltage***, poor things! — lamented Sarão.

— That lightning bolt must have hit the fence! — said Toya!



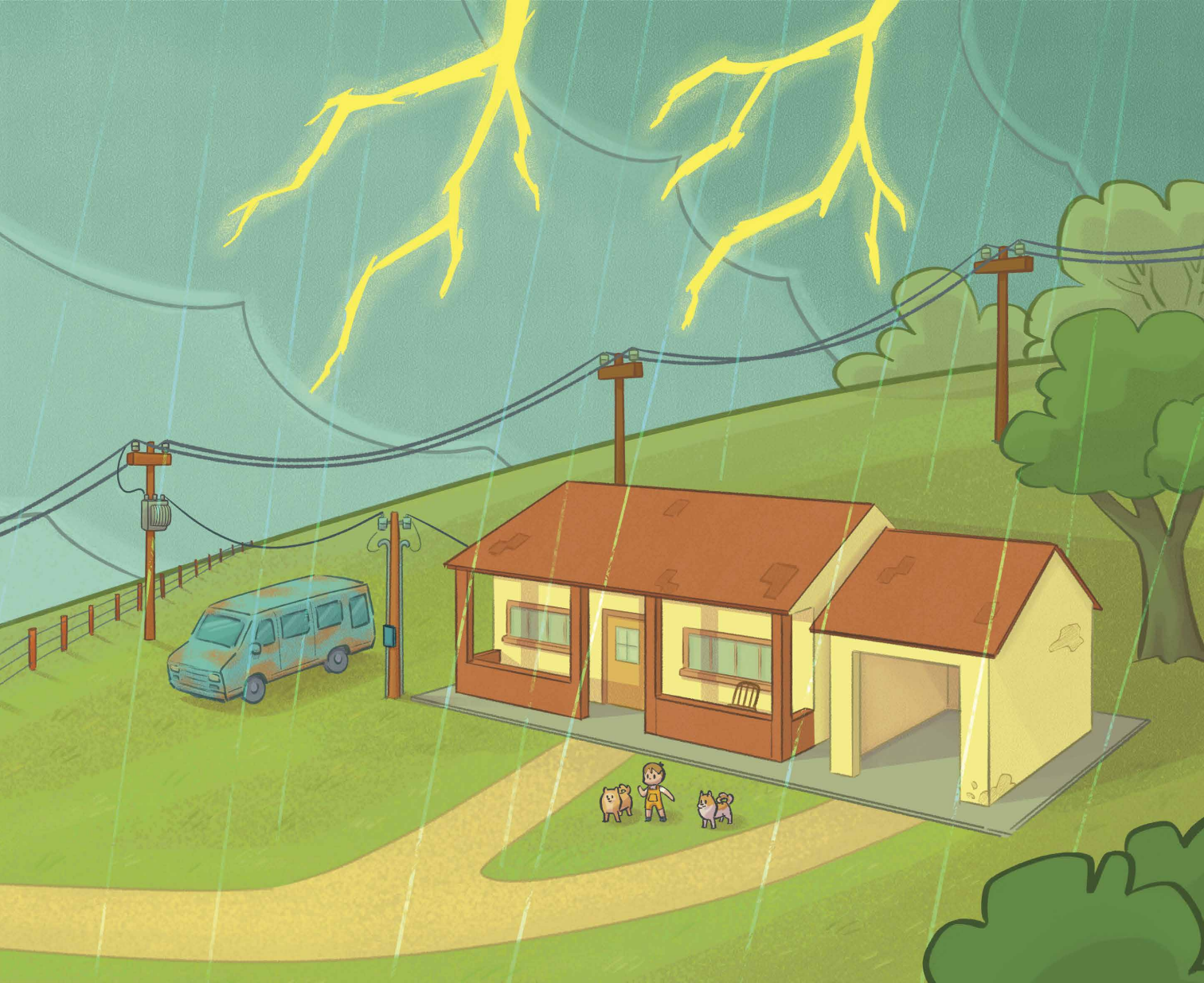
Touch voltage is the voltage that appears between a point energized by lightning where the person (or animal) touch part of their body and their feet (or paws). Here, the lightning may have hit the fence several meters away and traveled down the wires to where the calves were standing nearly touching them.

Already close to Mr. João's house, the other children, fleeing from the rain, saw little Noah.

— Look! — shouted Dindinha. — Nonô is there, near the house!

— Nonô!!! Nonô!!! — shouted Roninho, calling his little brother.

And soon everyone also saw Hininha and Levi gathering around the boy.



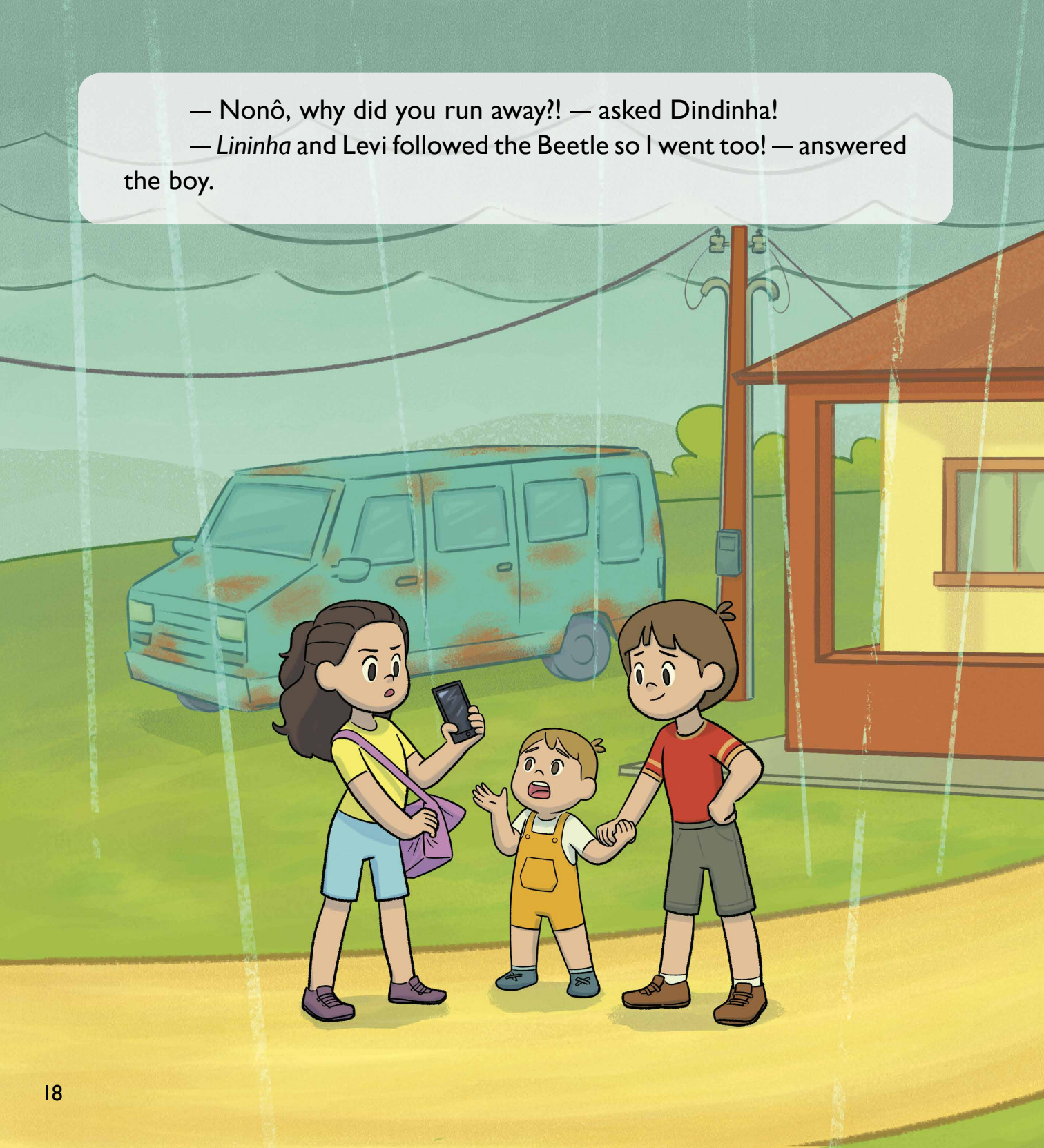
— Is Mr. João home? — asked Iarinha.

— No! — answered Haruminha, when she realized that Mr. João's red Beetle was not in the garage.

Everyone took shelter on Mr. João's porch!

— Nonô, why did you run away?! — asked Dindinha!

— *Lininha* and Levi followed the Beetle so I went too! — answered the boy.



Meanwhile, Hininha was jumping around like crazy and Levi was licking Iarinha, as if an eternity had passed!

— We have to tell Toya that we're here! — Dindinha said, looking for her cell phone in her purse.

With her cell phone in hand, Dindinha found an outlet on the balcony and managed to recharge the battery a little.

— Toya! Toya! We're at Mr. João's house! We came after the dogs and Nonô! — said the girl as soon as she managed to call her cousin.

—Stay there and don't go out! Sarão and I are coming soon! - warned Toya.

Right after talking to Toya, Dindinha placed her cell phone, still charging, on the balcony wall. Seconds later, BOOM!!!! Dindinha's brand new cell phone exploded! Lightning had struck the power pole, traveled through the wires, and destroyed her cell phone!

Total disaster! The damaged cell phone burst into flames!

— We have to get out of here! — Haruminha shouted.

— Aaaaah!! The house is going to catch fire! — Iarinha said with a crying voice.

— Let's take shelter under that tree! — Roninho recommended.

— Never! — Haruminha shouted. — Don't you remember that uncle always tells us about ***side flashes*** and being close to tall things?!

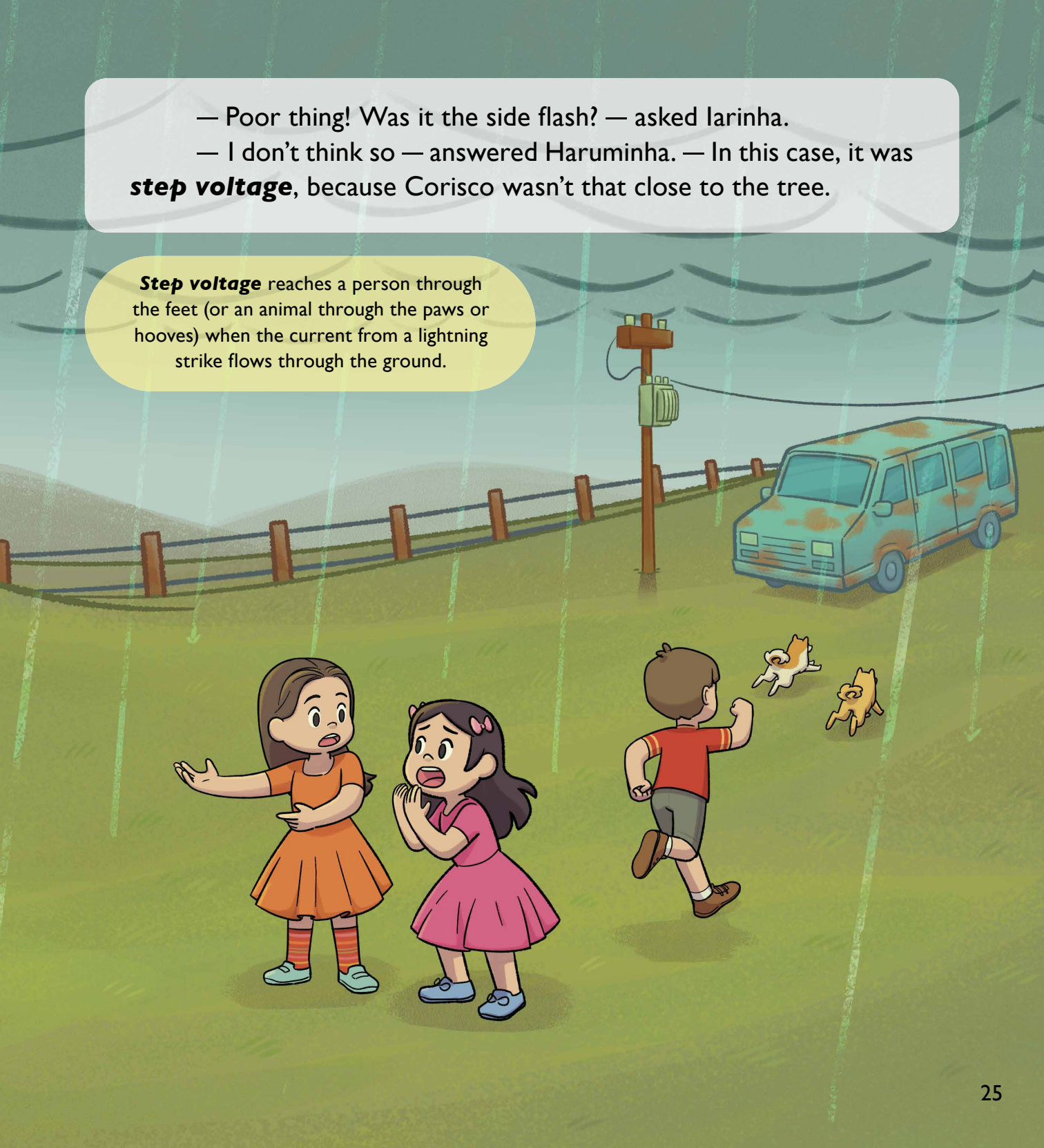
Side flash occurs when lightning strikes an object like a tree and part of the energy escapes to a person (or animal) who is close to the object

As soon as the girl finished speaking, Corisco, Mr. João's horse, went towards the tree.
And then: BOOM!! Lightning struck directly into the tree and everyone saw Corisco fall!

— Poor thing! Was it the side flash? — asked Iarinha.

— I don't think so — answered Haruminha. — In this case, it was ***step voltage***, because Corisco wasn't that close to the tree.

Step voltage reaches a person through the feet (or an animal through the paws or hooves) when the current from a lightning strike flows through the ground.



— Guys! The house is going to catch fire! Let's get into that abandoned van! — shouted Dindinha.

And everyone ran into the old, dirty car.

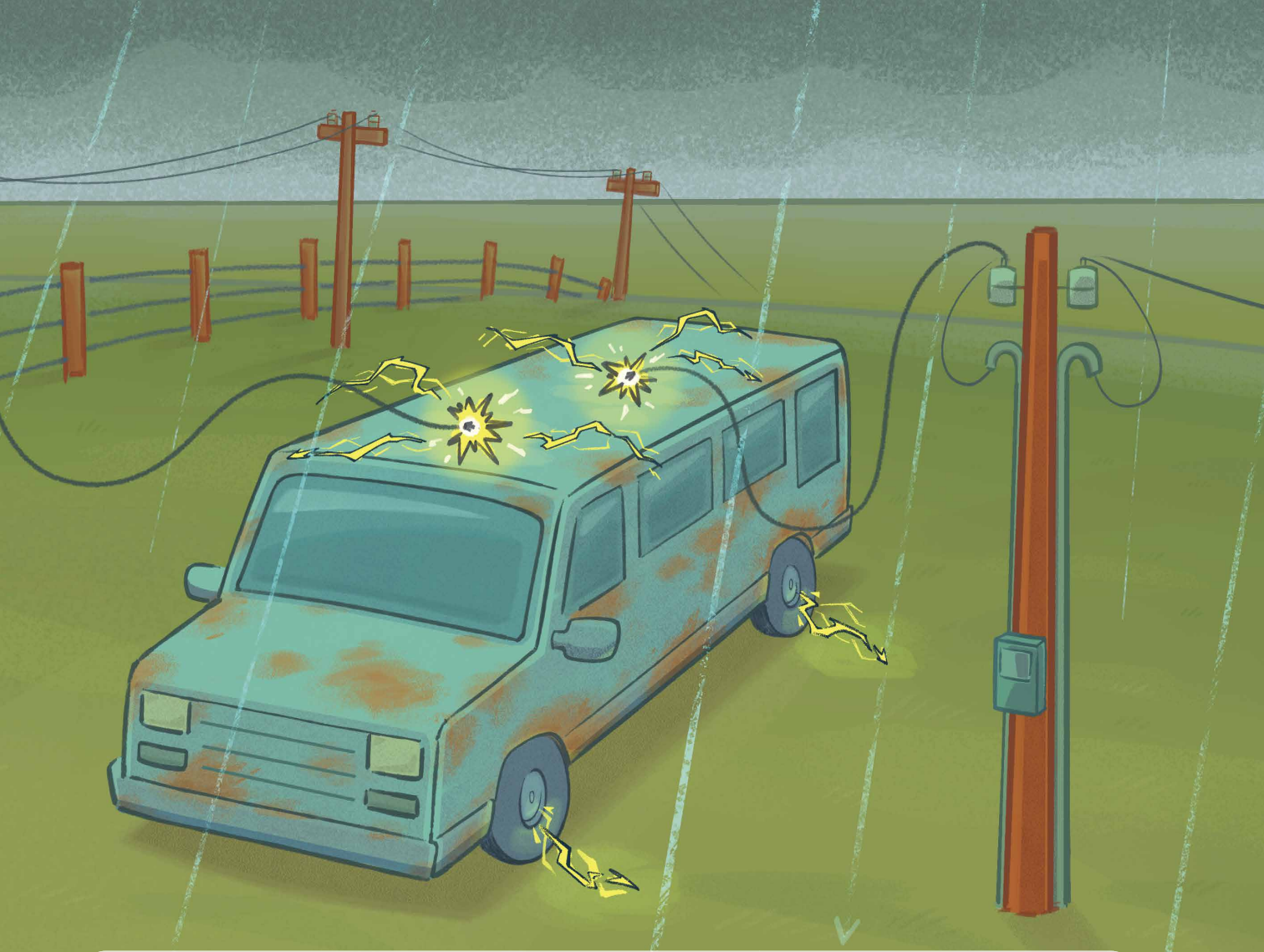
— You're right, Dindinha! Uncle always says that cars are relatively safe from lightning — Iarinha reminded.

Fleeing from the fire, the rain and the lightning, the children got into the abandoned van one by one: Roninho leading his little brother by the hand, then Dindinha carrying Levi, and then Haruminha, Iarinha and the mischievous Hininha, who quickly jumped into the car among the girls.

Wet from the rain, frightened by the ***lightning flash*** and ***thunder***, everyone remained quiet inside the old car and saw, in the distance, Toya and Sarão approaching.

Lightning flash: light emitted by lightning.

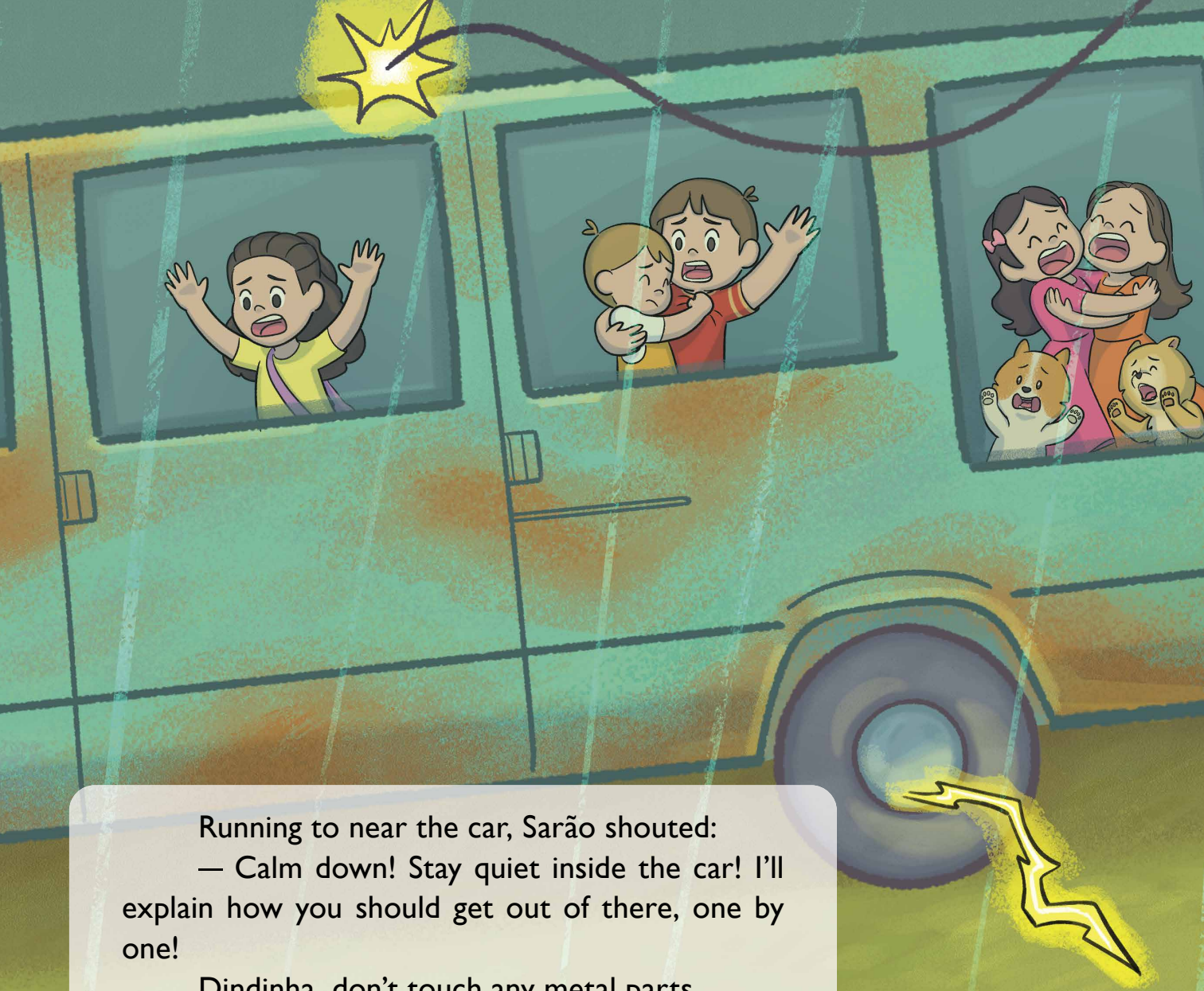
Thunder: sound emitted by lightning.



— Totóóó!! Sarãoooo!!! We're here inside the old van!!! — Dindinha shouted.

And then, another lightning bolt! Hitting the power grid, the lightning bolt broke one of the power lines, which fell on the van and sparked!

From inside the car, the children burst into tears!



Running to near the car, Sarão shouted:

— Calm down! Stay quiet inside the car! I'll explain how you should get out of there, one by one!

Dindinha, don't touch any metal parts and open the door, but don't get out yet! Each one will jump with both legs together to get out of the car. Then, come jumping with them together to here where we are! One at a time, calmly and without touching the body of the car!

One by one, the children got out of the car: first it was Dindinha's turn, with Nonô in her arms, who came jumping like a frog; then Roninho with Hininha; then Haruminha with Levi and finally Iarinha, like a saci.

That was how Toya and Sarão's father, the children's uncle, had taught them to avoid being the conduit for electricity to travel from the electrified body of the car to the ground and the problems with step voltage for short-circuit currents.

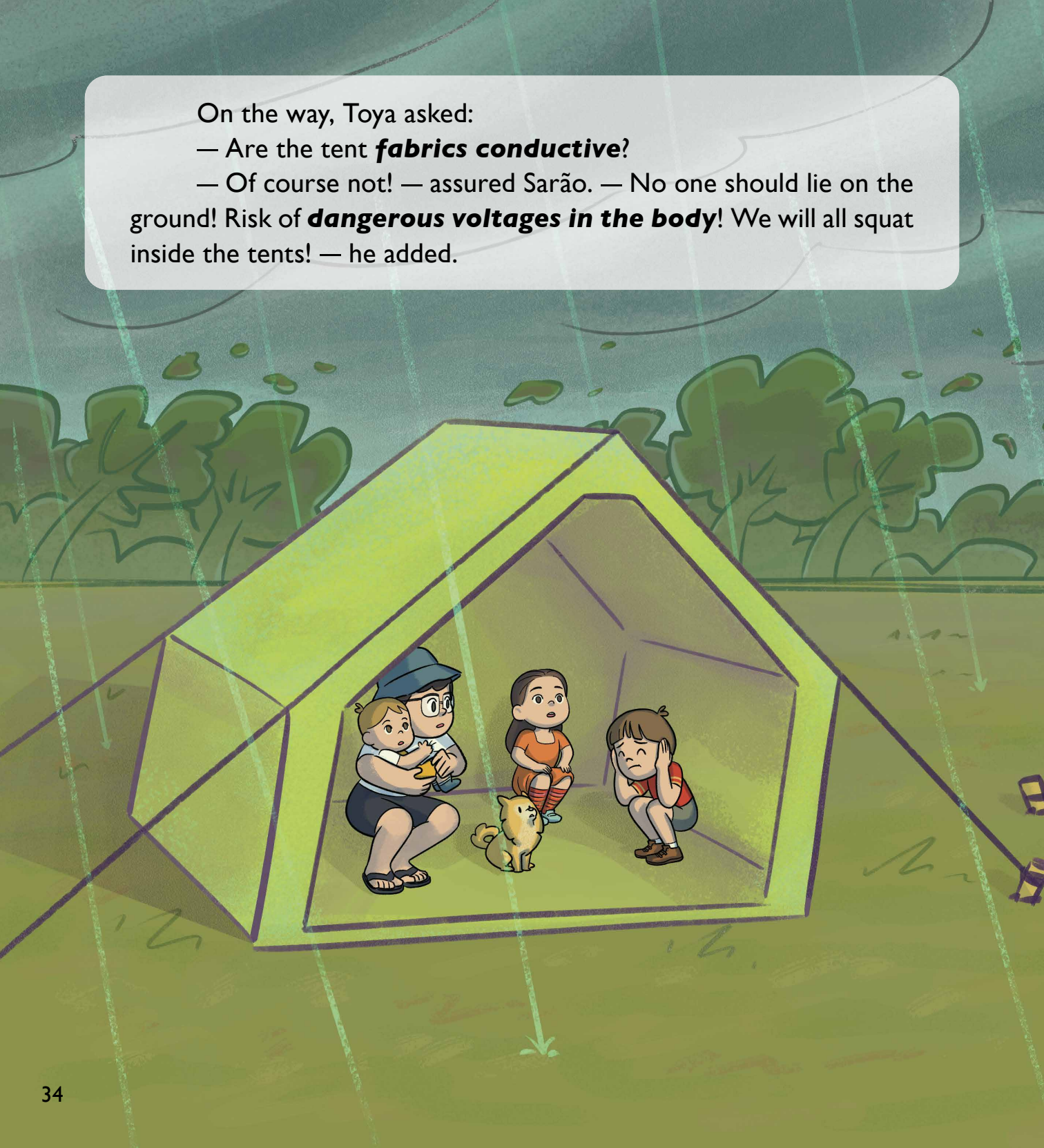
Finally, everyone was together! But were they safe? It was still raining, and lightning was still flashing…

— Let's go to that campsite! — said Roninho. — There are some empty tents where we can take shelter!

On the way, Toya asked:

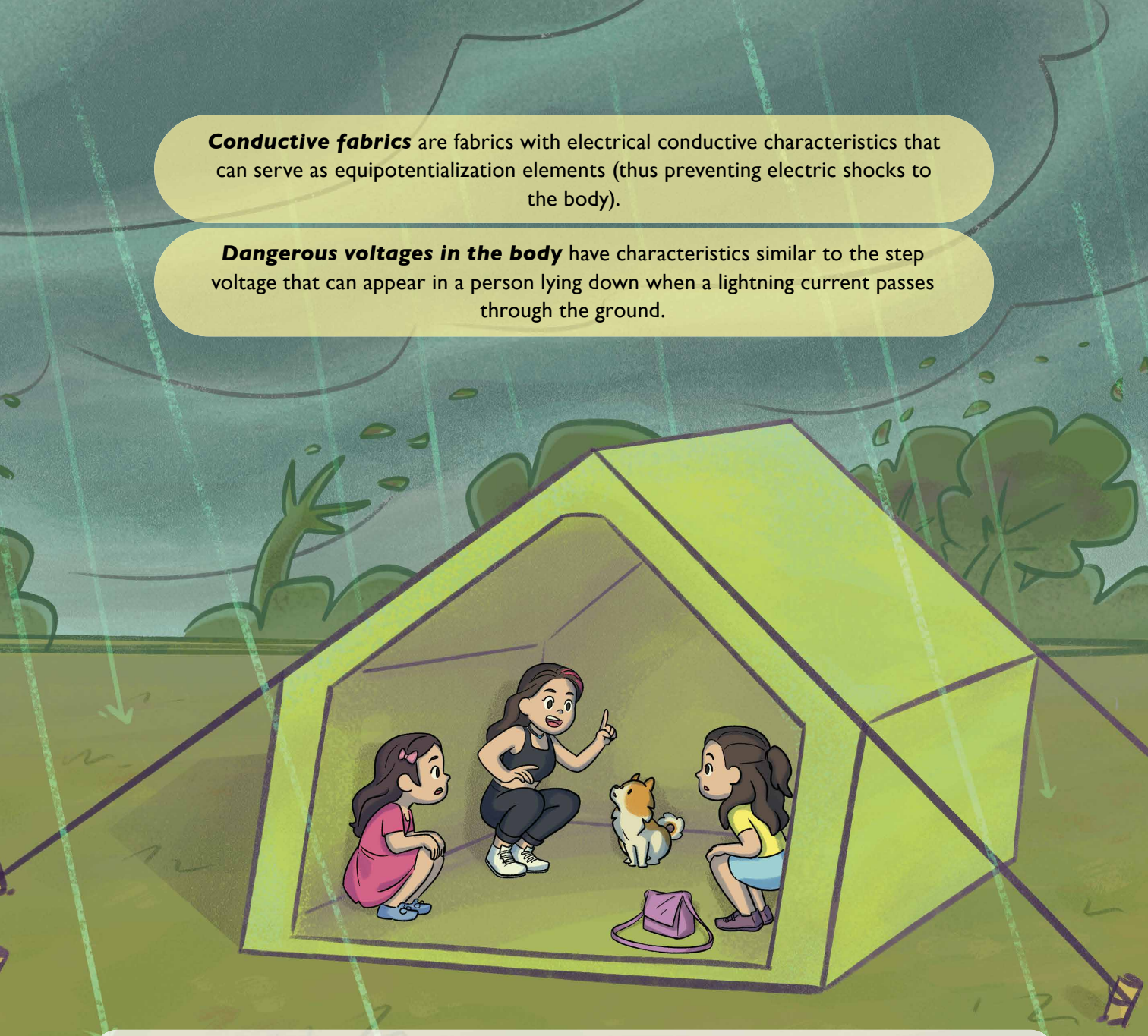
— Are the tent ***fabrics conductive***?

— Of course not! — assured Sarão. — No one should lie on the ground! Risk of ***dangerous voltages in the body***! We will all squat inside the tents! — he added.



Conductive fabrics are fabrics with electrical conductive characteristics that can serve as equipotentialization elements (thus preventing electric shocks to the body).

Dangerous voltages in the body have characteristics similar to the step voltage that can appear in a person lying down when a lightning current passes through the ground.



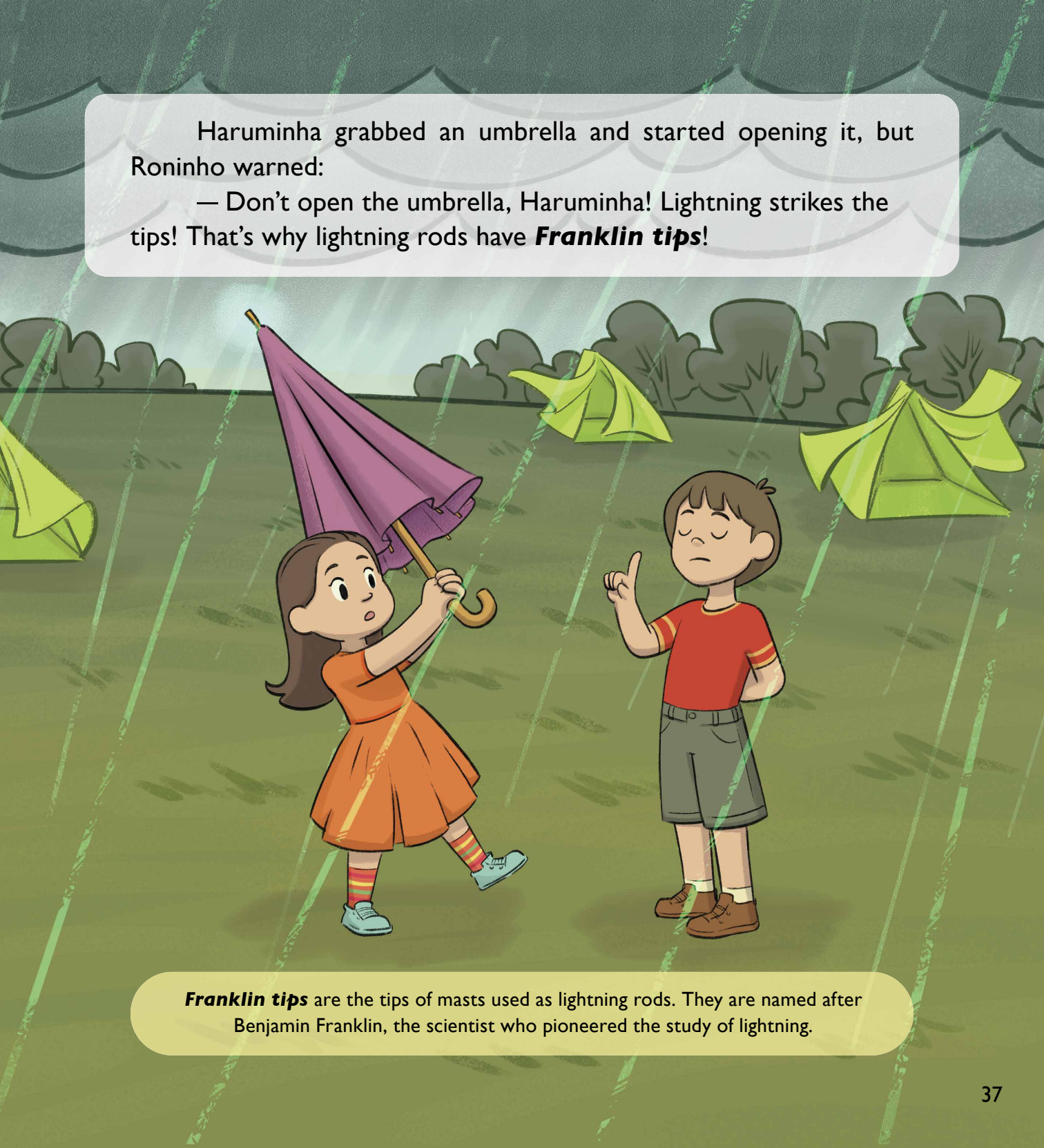
Half of the group went into one tent and half into the other. At that moment, a huge wind completely blew away one of the tents.

The children ran out of the tents! Sarão picked up little Nonô and put him on his shoulders.

— Take Nonô off your shoulders, Sarão! — shouted Toya! — You're getting taller and the lightning like to hit the highest points!

Haruminha grabbed an umbrella and started opening it, but Roninho warned:

— Don't open the umbrella, Haruminha! Lightning strikes the tips! That's why lightning rods have ***Franklin tips***!



Franklin tips are the tips of masts used as lightning rods. They are named after Benjamin Franklin, the scientist who pioneered the study of lightning.

Once again, everyone was unprotected! The rain was easing, but lightning was still occurring.

— Let's go to the campsite headquarters! — Toya advised! — "It is protected by a Lightning Protection System that meets ***IEC standards***!!

— That's right! Wow, why didn't we think of that before? — said Sarão.

And they all went to the campsite headquarters.

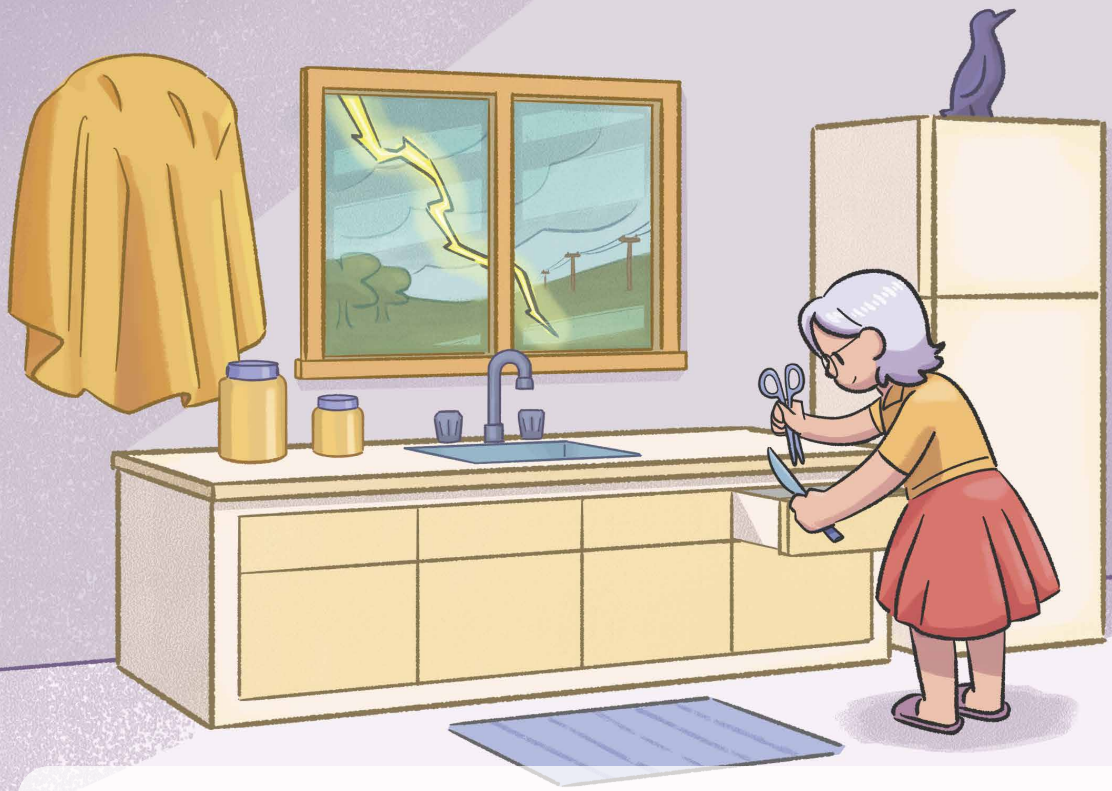
IEC stardards – International Electrotechnical Committee. IEC 62305 is the International Standard that deals with protection against lightning.

When they got there, they joined the other campers who were taking shelter from the rain and the lightning.

— In this region, the ***Ng*** is 18! — said Sarão. — I've already counted about ten lightning strikes in this area, which is about five square kilometers. Since it's already the end of the year and there haven't been many lightning strikes this year, there could still be a lot of lightning strikes today (although each storm occurs in a different way).

Ng is the density of lightning flash to earth per square kilometer per year.

At the campsite headquarters, everyone stayed together, away from the doors and windows. A little old lady put the knives and scissors in a drawer and covered the mirrors with a towel (myths that still exist).



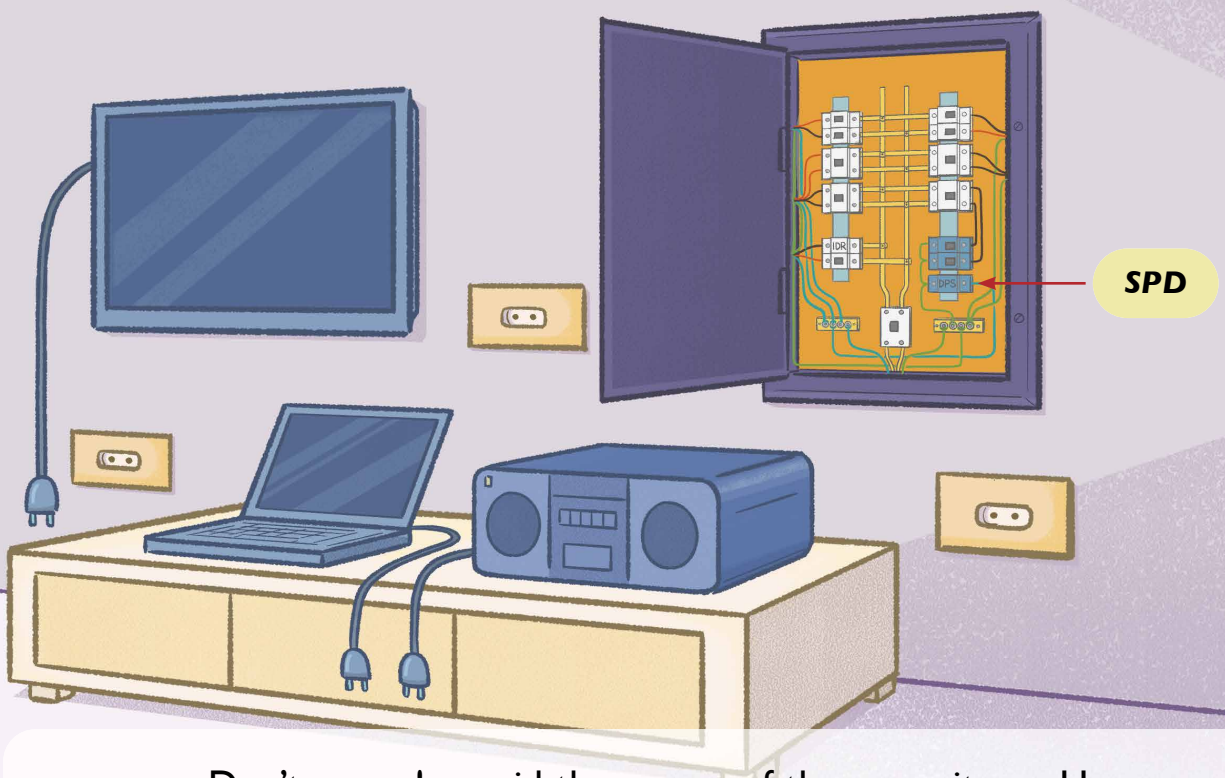
The owner of the campsite warned:

— Everyone, stay away from all electrical equipment, wiring and sockets.

He had already unplugged some of the equipment.

Suddenly, BOOOM!!!! Lightning struck the campsite headquarters!

The light flickered, but soon came back on. The refrigerator, which was still plugged in, also turned off, but soon started working normally again.



— Don't worry! — said the owner of the campsite. — Here we have installed a ***LPS*** and a coordinated ***SPD*** system that will protect the electronics.

LPS = Lightning Protection System

SPD = A system with coordinated Surge Protection Devices, which protect electrical installations and their equipment against voltage transients caused by lightning.

Little by little, the sounds of thunder began to fade away. The campers relaxed and went back to the doors and windows. But Sarão warned:

— Wait, the lightning isn't over yet! Let me see how far away it's happening!

Sarão stood about two meters away from the window and lifted Levi with his hands, so that the little dog could see the field.

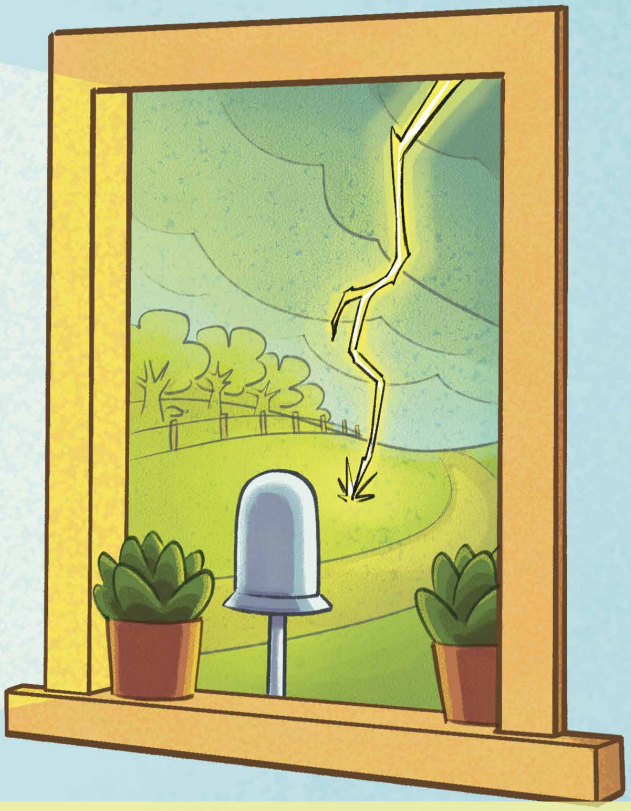
When he saw a flash of lightning, Levi began to bark slowly:

— Woof, woof, woof, woof, woof, woof, woof, woof, woof!

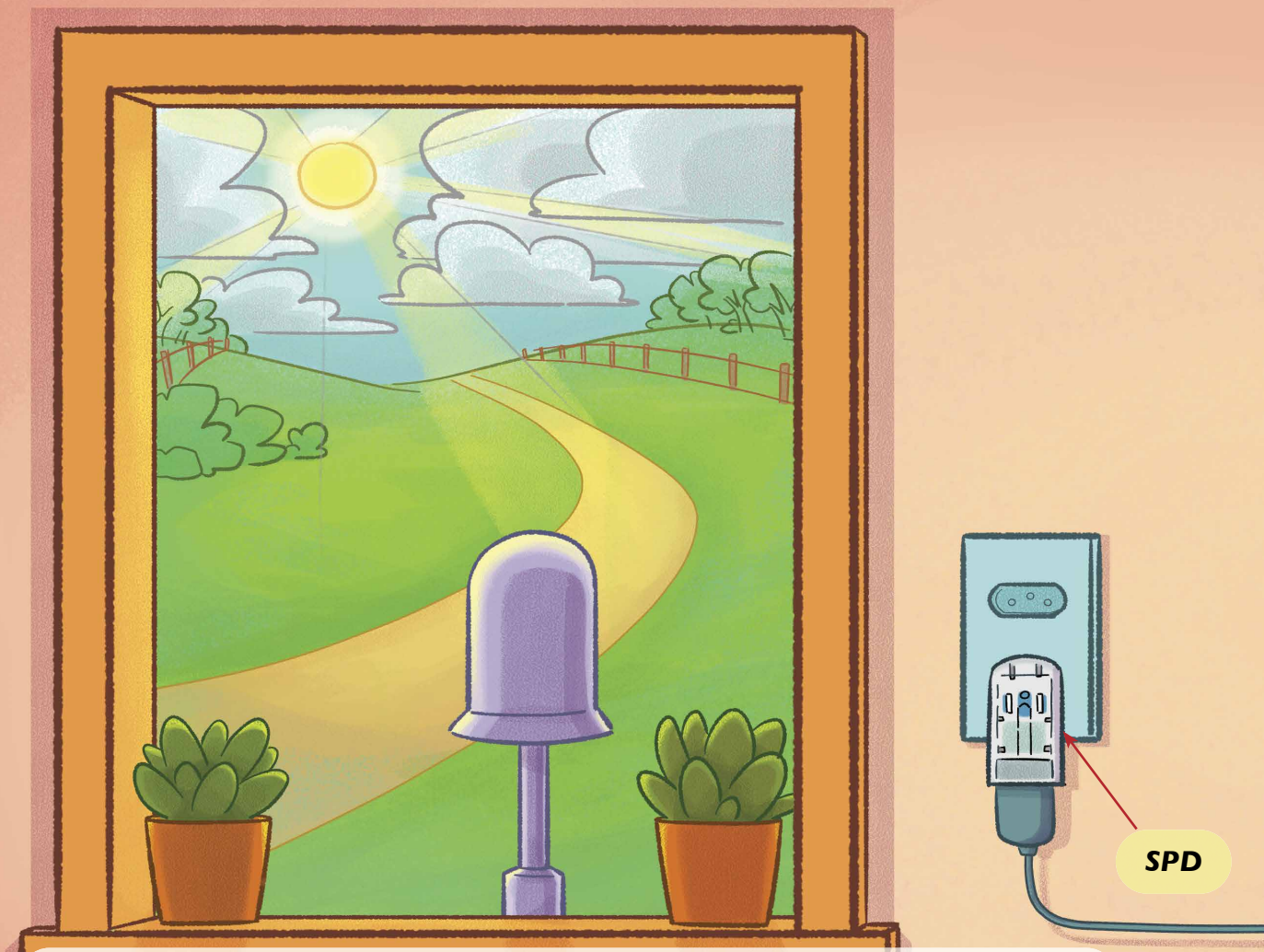
Then, when he heard the thunder, he started howling angrily:

— Aiiuuuiiuuu!!!

Sarão counted mentally: there were nine barks until the howl began. In other words, there were nine seconds between the lightning and the thunder! Dividing by three, the lightning had occurred three kilometers from where they were, he explained.



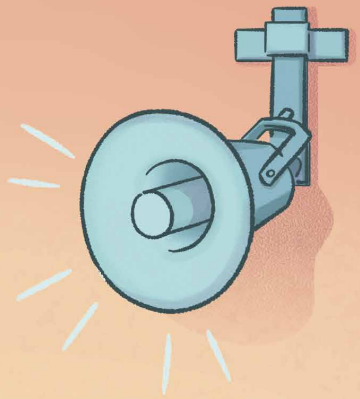
Estimating the distance of the lightning: Light has an approximate speed of 3×10^8 m/s and sound has an approximate speed of 340 m/s. Considering that we see the lightning at practically the same instant that it happened and counting the seconds, in this case 9, we see that the sound of the thunder "traveled" for $340 \times 9 = 3{,}060$ meters, that is, approximately 3 kilometers.



That was the last lightning of the storm. Iarinha then remembered:

— Uncle always says to wait half an hour after the last lightning to be able to go out again!

So everyone waited another thirty minutes, following the girl's instructions.



After half an hour, an alarm rang. It was the Storm Warning System alarm (specified according to ***IEC 62793***) warning that campers could safely return to their tents.

IEC 62793: International Standard for Protection against lightning - Thunderstorm Warning Systems.

Finally, everyone was safe and could go home. The rain had also stopped and there was no more lightning!

When they arrived, the adults were terrified by the children's disappearance, but all the children wanted to hug their uncle, who had given them the correct information for protection against lightning!

MAIN GUIDELINES FOR PROTECTION IN CASE OF LIGHTNING

Outdoor areas (outdoors)

Leave the exposed area immediately, stopping any activity you are doing (work, sports, walking, etc.).

Go to a protected area, i.e. a concrete or masonry building. Ideally, this building should have a Lightning Protection System (LPS). The inside of a car is also a safe place.

Do not take shelter under trees, towers, or open shelters (e.g. bus stops, sun shelters, golf shelter, etc) as these are not safe.

Avoid riding horses, bicycles, motorcycles, convertibles, tractors without a roof, or in the back of trucks and vans.

In open areas, stay at least 3 metres away from metal posts, fences, railings, gates, metal towers, vehicles, and LPS down-conductors.

When walking to a safe place, avoid using any object that could increase your body height, for example, an umbrella or carrying a child on your shoulders.

Internal areas (inside buildings)

Avoid staying close to windows, external doors, roofs, and balconies, especially if they have metal frames.

Try not to touch equipment that is connected to the electrical power, such as refrigerators, stoves, televisions and other household appliances.

Avoid taking a shower, especially if the shower is electric and/or has metal pipes.

Do not use devices plugged into the outlet, such as cell phone charges, corded telephones, hair dryers, straighteners, vacuum cleaners, etc.

Do not perform maintenance work on electrical installations (power, network, telephone), even if you are inside a building.

If you are going to remove the plugs of appliances (TV, stereo, etc.) from the outlet, try to do so before lightning strikes begin. IF you know a thunderstorm is coming unplug all appliances and computers.

Outside of stormy weather, check for SPDs (Surge Protection Devices) in the power panels.

In this thrilling adventure, cousins Roninho and Dindinha, Haruminha and Iarinha get into trouble while trying to rescue little Noah and the family's two puppies in the middle of a storm. Luckily, brothers Toya and Sarão understand everything about lightning and electrical discharges and rush to help their younger cousins. But how will they get out of this?

This booklet is an educational initiative by Dr. Hélio Eiji Sueta and the Institute of Energy and Environment (IEE-USP) to teach children and adolescents how to protect themselves from the dangers of lightning both indoors and outdoors.

ABOUT THE AUTHOR

Hélio Eiji Sueta is an electrical engineer who graduated in 1981 from the Polytechnic School of the University of São Paulo, where he also received his master's and doctorate degrees. He has worked since 1982 at the Institute of Energy and Environment of USP, where he currently holds the position of deputy head of the Scientific Division of Energy Planning, Analysis and Development.

As his main line of research, he has been studying the protection of structures and people against lightning, serving on the Study Commission CE.64.10 of the Brazilian Electricity Committee of ABNT (COBEI) and on the Technical Committee TC 81 of the International Electrotechnical Commission (IEC). He is the author of almost three hundred articles in national and international journals and events.

ISBN: 978-65-88109-58-8
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