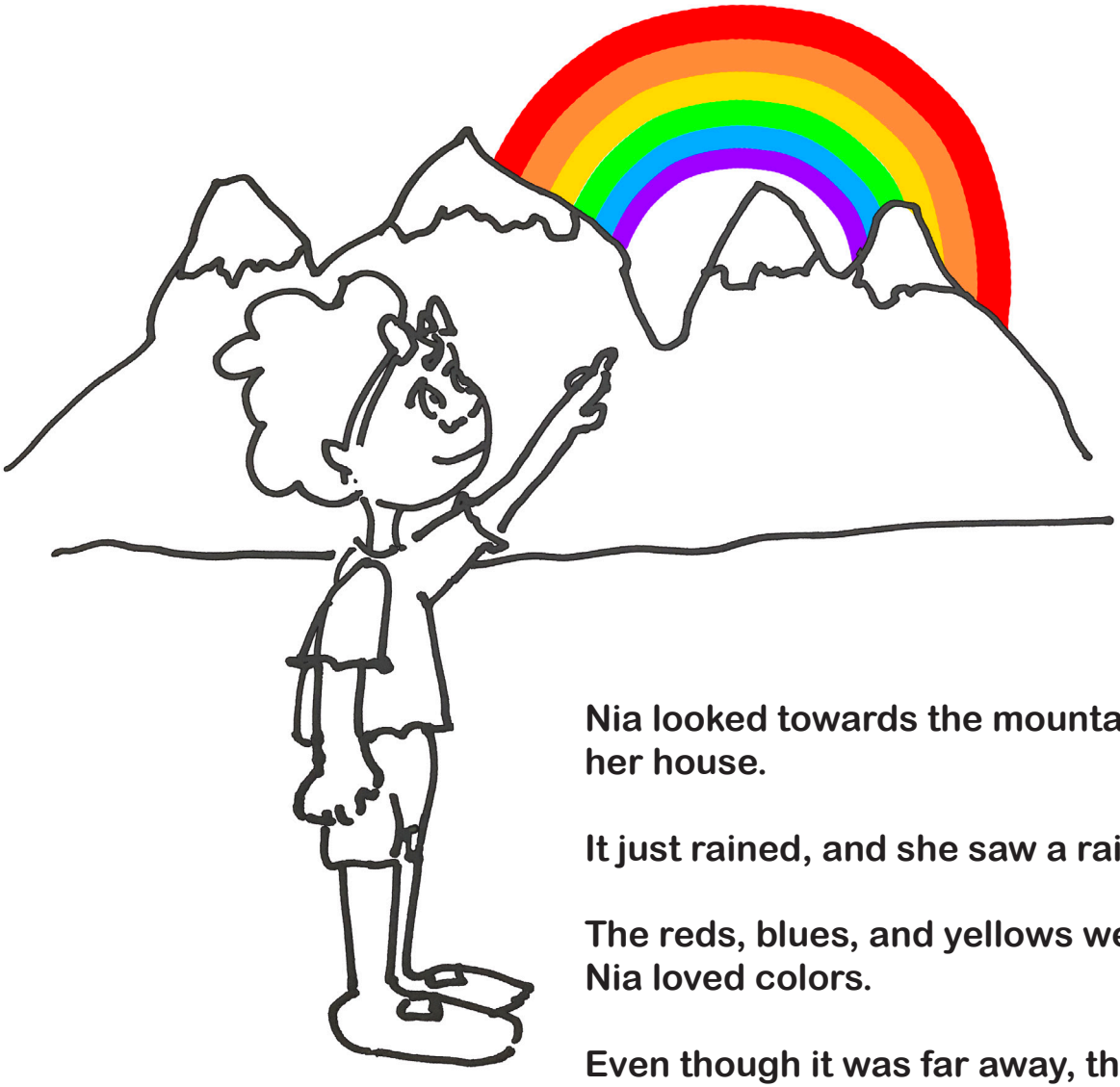
The Colors of the Rainbow: A Children's Guide to Spectroscopy

The spectacular science of light

HORIBA
Scientific

“To shine your brightest light is to be who you truly are.”
- Roy T. Bennett

This book is dedicated
to the children of the world
who will be inspired to make it a brighter
place by pursuing fields in STEM.



Nia looked towards the mountains outside her house.

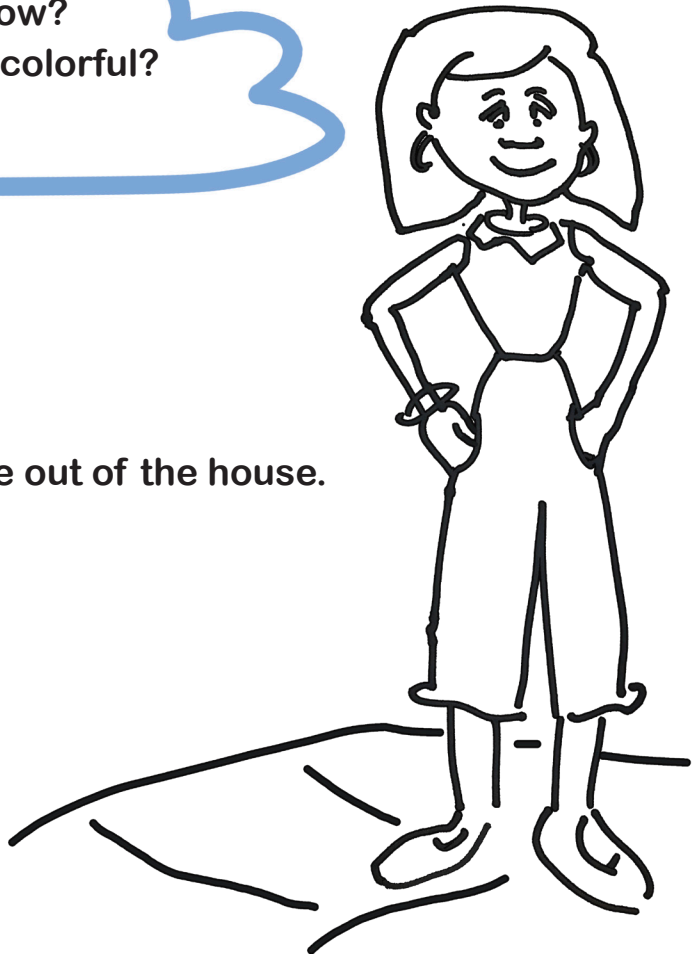
It just rained, and she saw a rainbow.

The reds, blues, and yellows were beautiful. Nia loved colors.

Even though it was far away, the rainbow seemed close enough to touch it.

At just 8 years old,
Nia was a curious
little girl.

Just then, Nia's mom came out of the house.



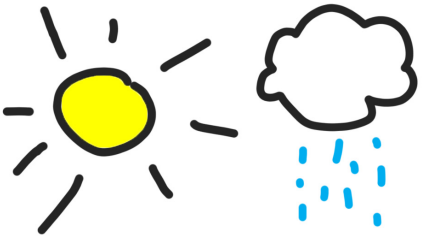
She asked her mom where rainbows come from.

Nia's mom is a scientist.
She explained it to Nia.

“You need two things to make a rainbow,” her mom said.

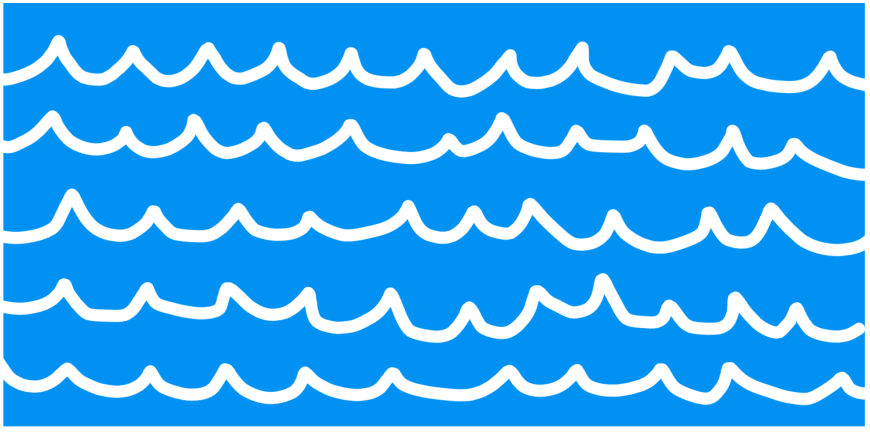
“Sunlight and rain.”

“Rainbows appear when
the rain has passed,
and the sun is shining.”



“Why?” Nia asked.

“Well, although you don’t usually see it, light has many colors in it.
Each color travels in its own wave, like the ocean water,” her mom said.



“Then why don’t I usually see them?”, Nia asked.

“All the waves from the sun together make white light,” her mom said.

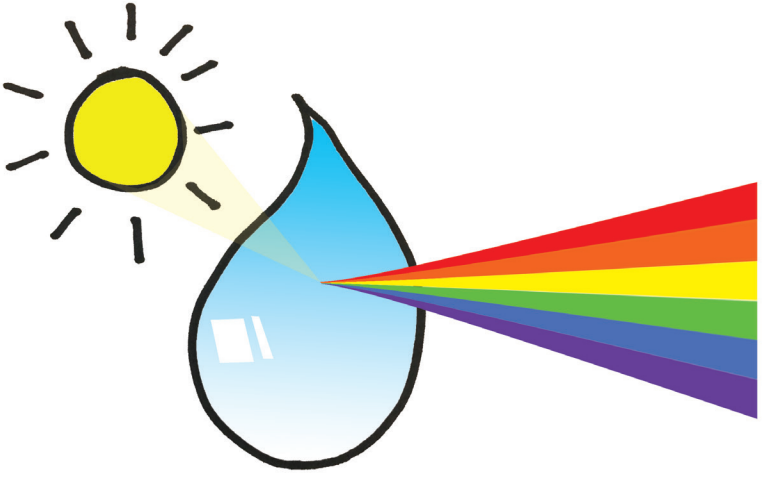
“Huh?” Nia said, with a wrinkled nose.

“When the different waves of light from the sun enter raindrops, the water bends the waves, or colors, in different directions.

It spreads the waves out.

That makes the rainbow.

We call it a color spectrum.”

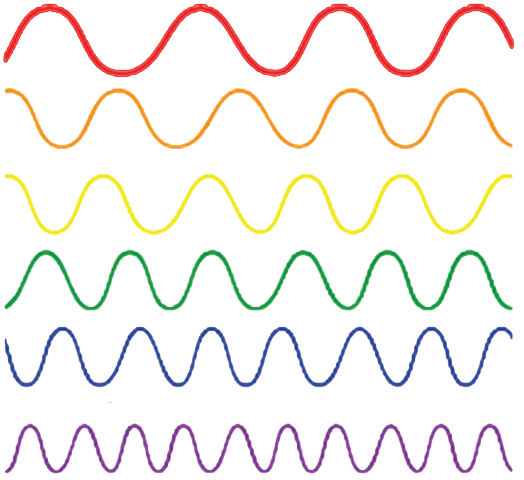


“Why are the waves different colors,” Nia asked, scratching her head.

“Well,” her mom said, “the waves can be short or long, just like at the beach.”

“The shorter waves are blue or purple.”

“If it’s longer, you get red light, and if it’s in between, you get other colors, like yellow and green.”



Nia thought about this and looked at the rainbow again.

“How do you know so much about rainbows?” she asked.

Nia’s mom smiled.

“Because I study light at work,” she answered.

“That’s a job?” Nia asked.

“Yes dear, because we can use light to learn a lot about things.”

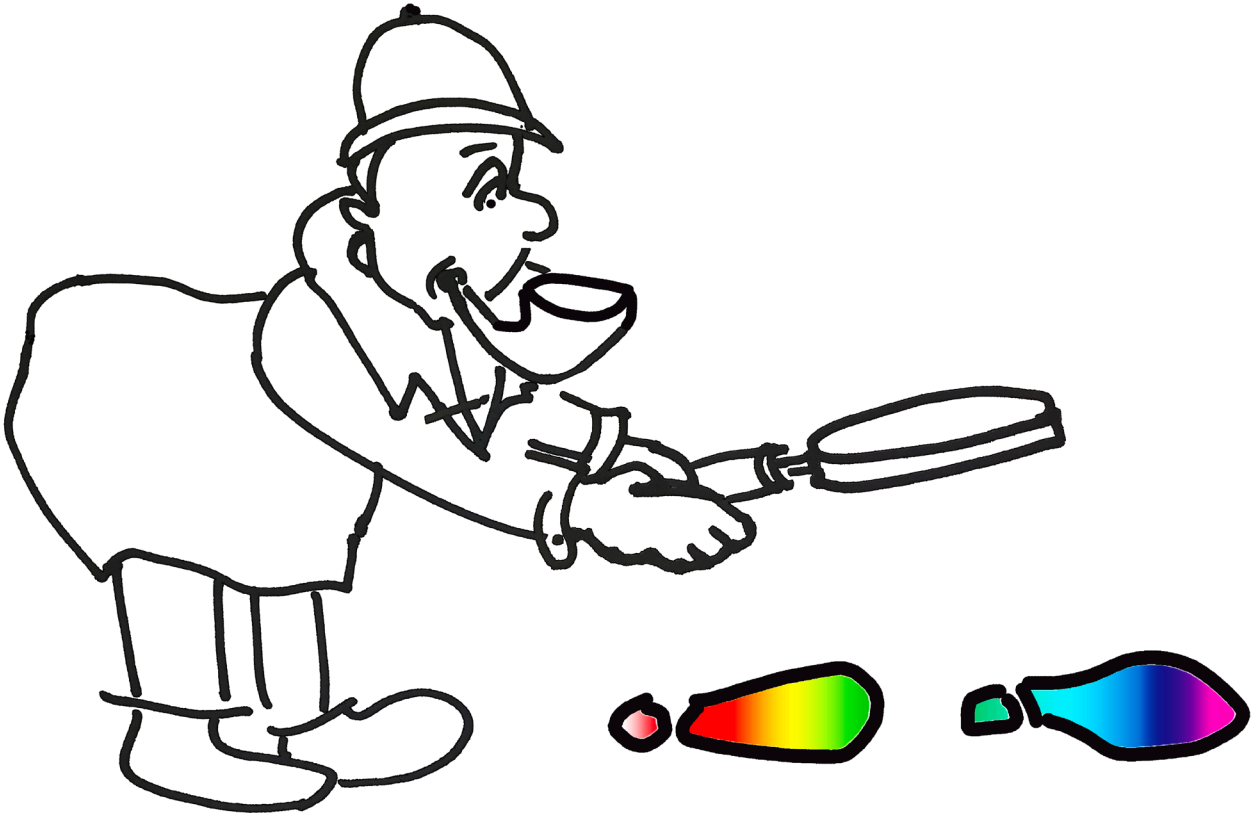
Nia was confused about this.

How could something like her favorite nightlight teach us about things?

“We use light as an investigator,” her mom said.

Nia tilted her head. “Investigator?”

“Yes,” her mom smiled. “Like a detective.”



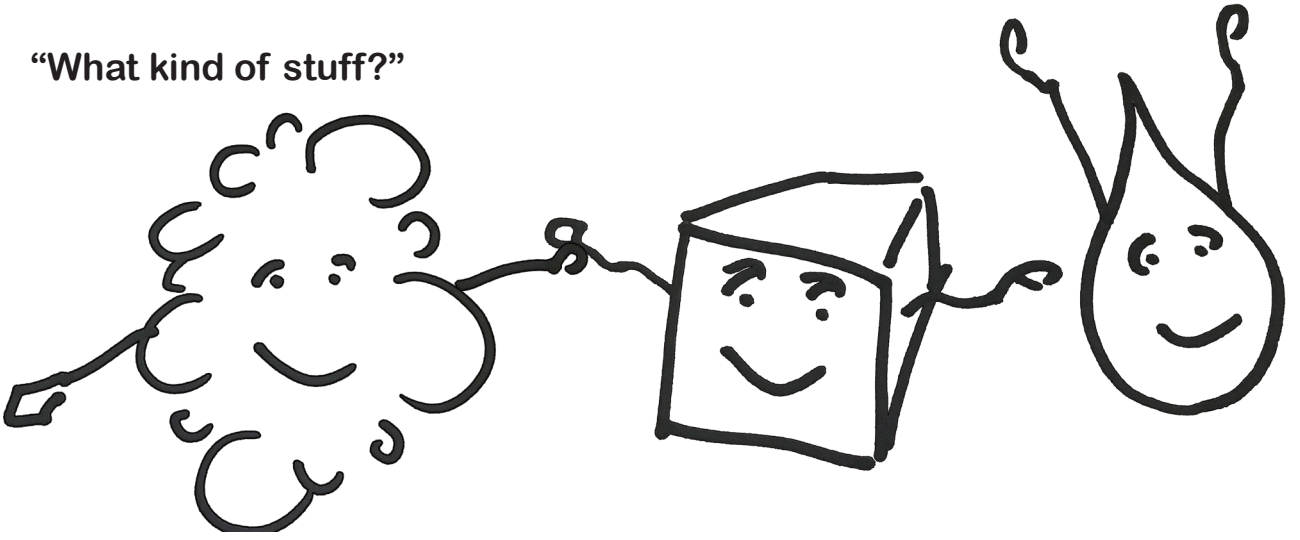
Nia thought about this.

“What are you trying to find out?” she asked.

Her mom gave her a serious look.

“We try to understand what makes stuff different,” her mom said.

“What kind of stuff?”



“Everything in the world is stuff,” her mom replied.

“We call it matter.”

“Matter can be water, a chemical, a rubber ball, or even the sky.”

“It can be a solid, like metal, a liquid, like lemonade, or a gas, like the air we breathe.”

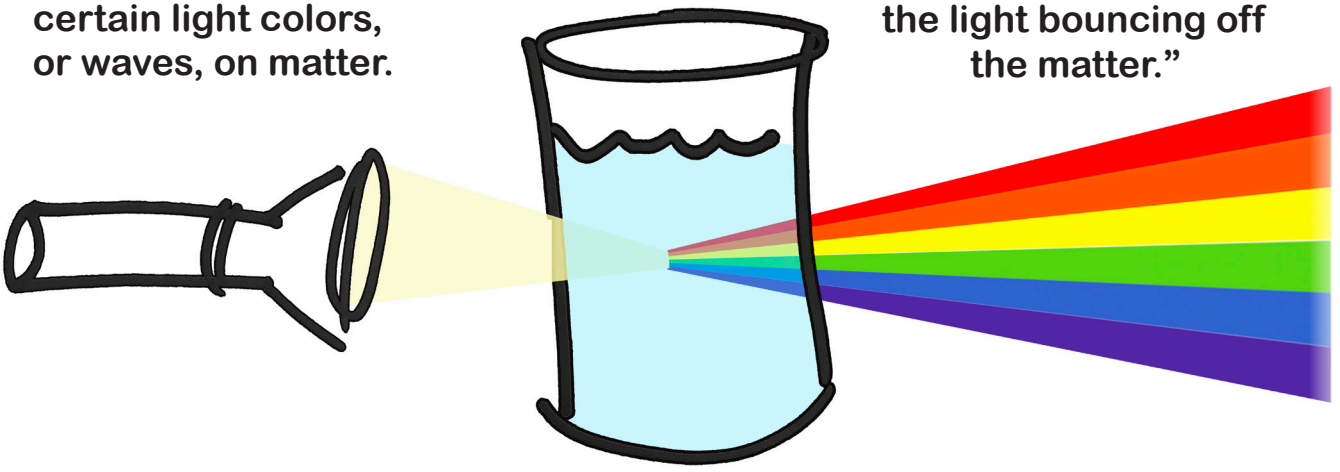
Nia thought for a minute.

“So, how do you understand matter with light?”

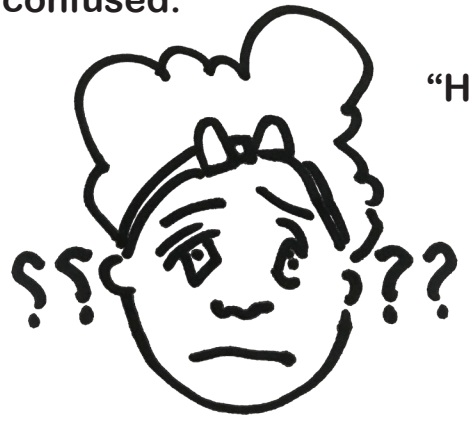
Nia’s mom considered this question.

“Well, we shine certain light colors, or waves, on matter.

Then we measure the light bouncing off the matter.”



Nia was confused.

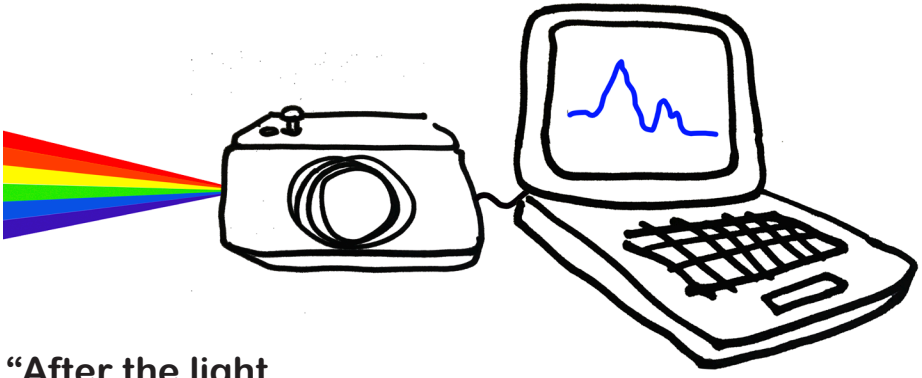


“How do you measure light?” she asked.

“We use things called detectors, which work like cameras.”

“The light lands on these detectors, which record the waves or colors bouncing off the matter.”

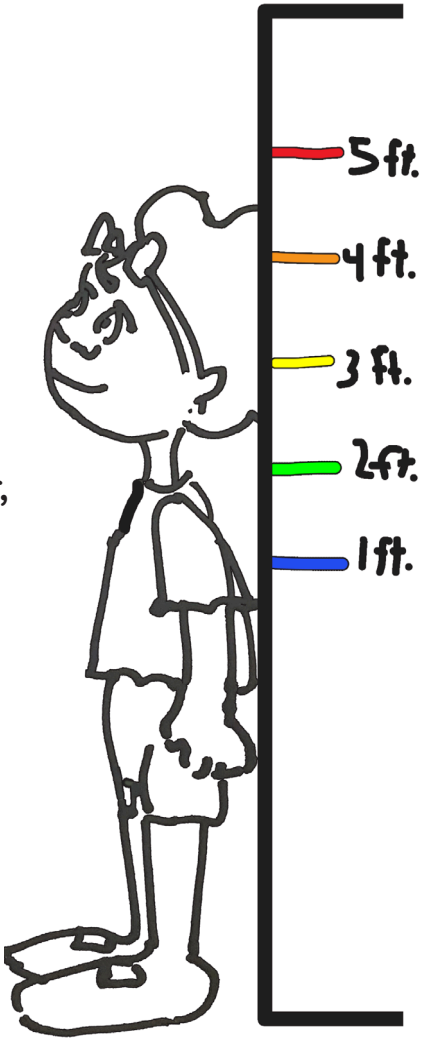
“Those waves or wavelengths are also called energy.”



“After the light
passes over the matter,
it goes to a detector that’s connected to a computer,
and the computer creates a graph.”

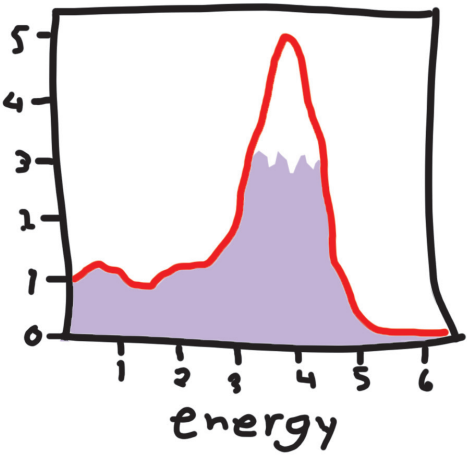
“A graph?” Nia asked.

“Yes, like the one we use to keep track of how tall you’re getting,” her mom said.



“Only, our graphs show where the energy from the light is the highest.”

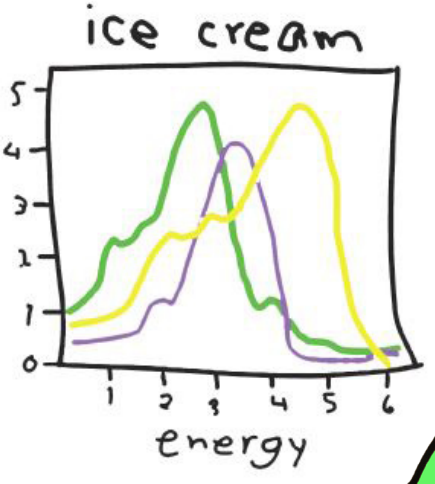
“We call that a peak.”



Nia scratched her chin.
“What does the peak tell you?”

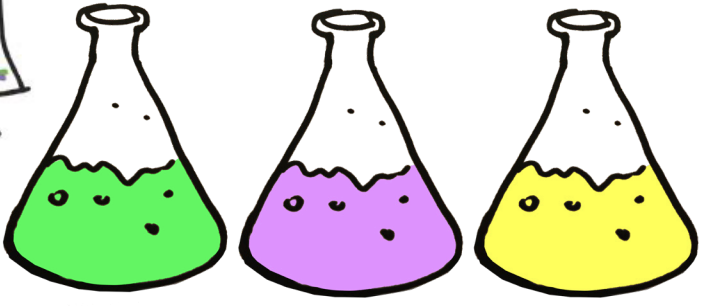
“Well,” her mom smiled,
“the peak tells us what kind of chemical the light is bouncing off.”

“After all, everything, all stuff, is made of chemicals.”



“And each graph is unique for different chemicals.”

“Just like your height graph is unique to you.”



Nia's curiosity was growing.

So, light could tell us what chemicals are in matter.

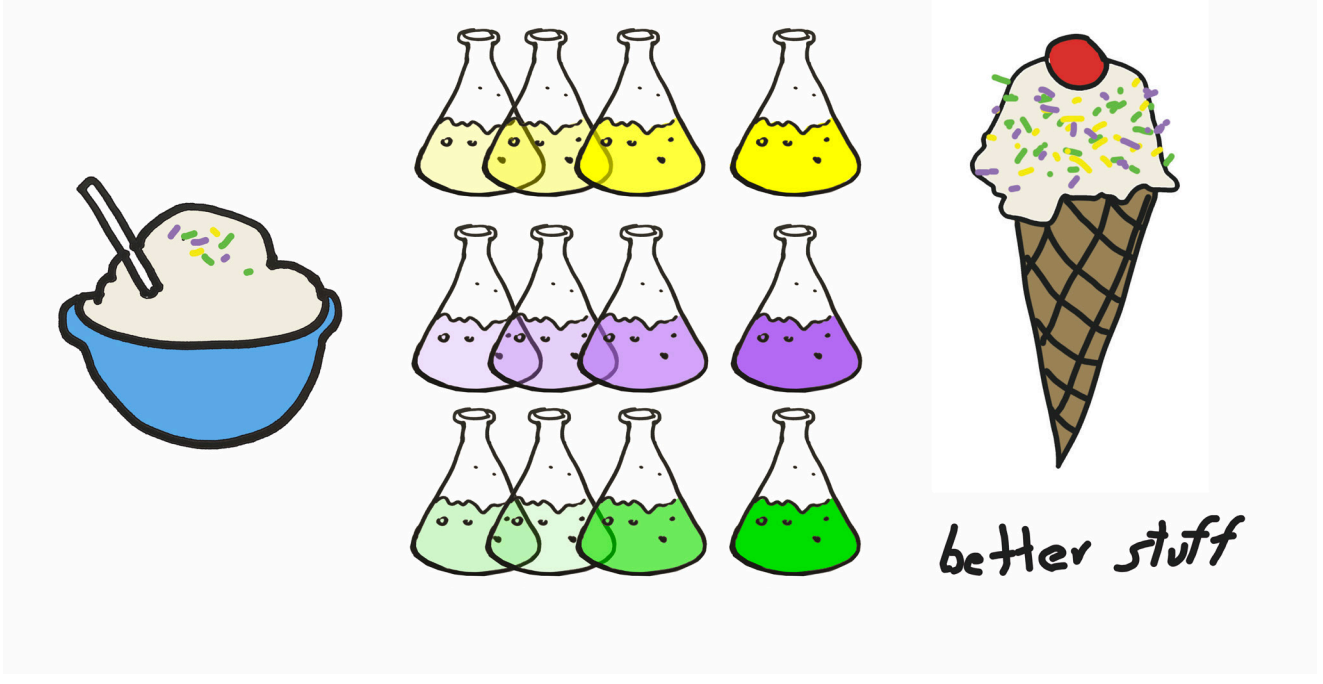
"It can also tell us how chemicals are changing," her mom added.

Now Nia frowned.

"But why does that matter?" she asked her mom.

Now Nia's mom had a big smile.

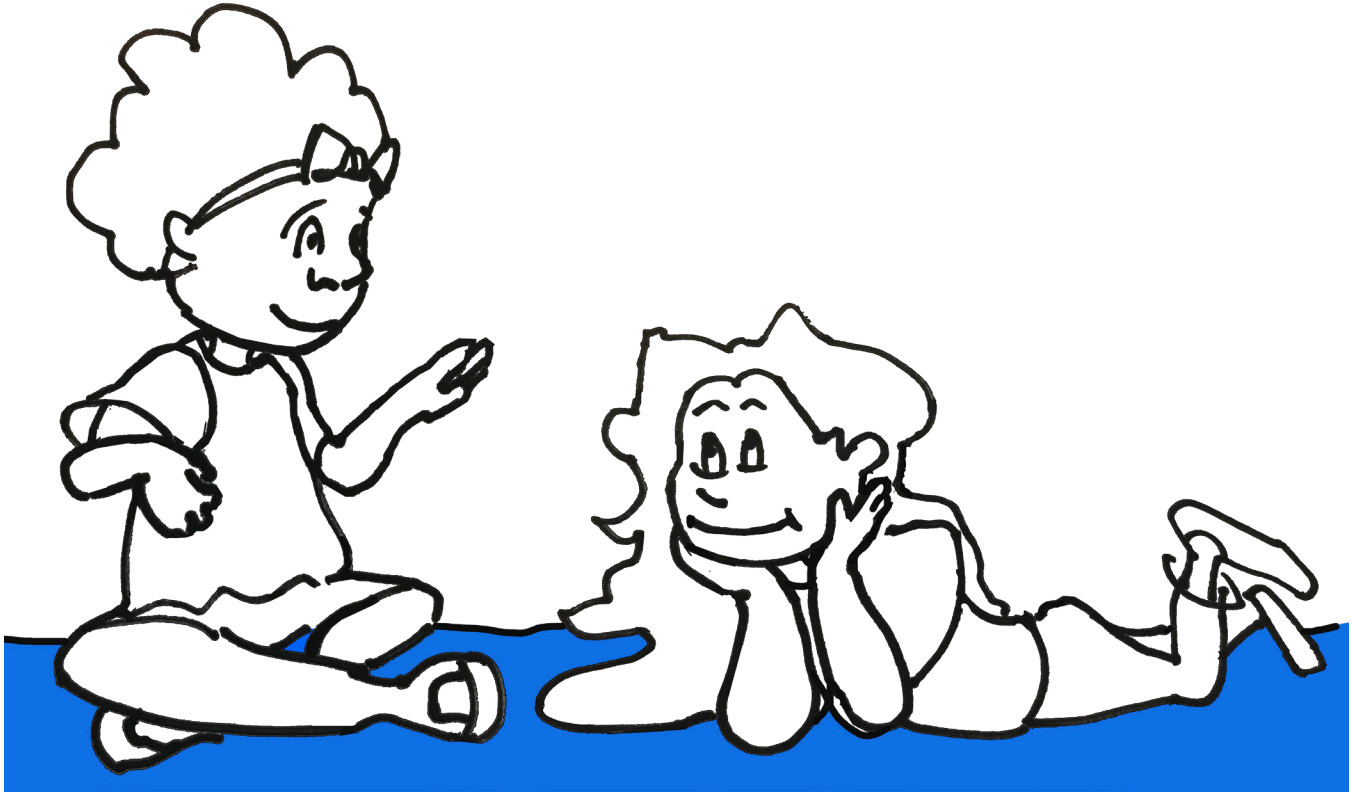
"We want to know what chemicals are in matter
so we can make better stuff."



**“Each chemical has different properties,
just like you and all your friends have different personalities.”**

“Some properties are better for certain uses.”

**“Do you mean how like Katie always says nice things
and makes me feel better when I’m sad?” Nia asked.**



“Yes, exactly,” her mom answered. “And chemicals have different properties which are good at different things.”

“What do you mean?” Nia asked.

“Some chemicals are used in medicines
to make sick people feel better,” her mom replied.

“Others are used to make stronger plastic toys
or cleaner clothes.”

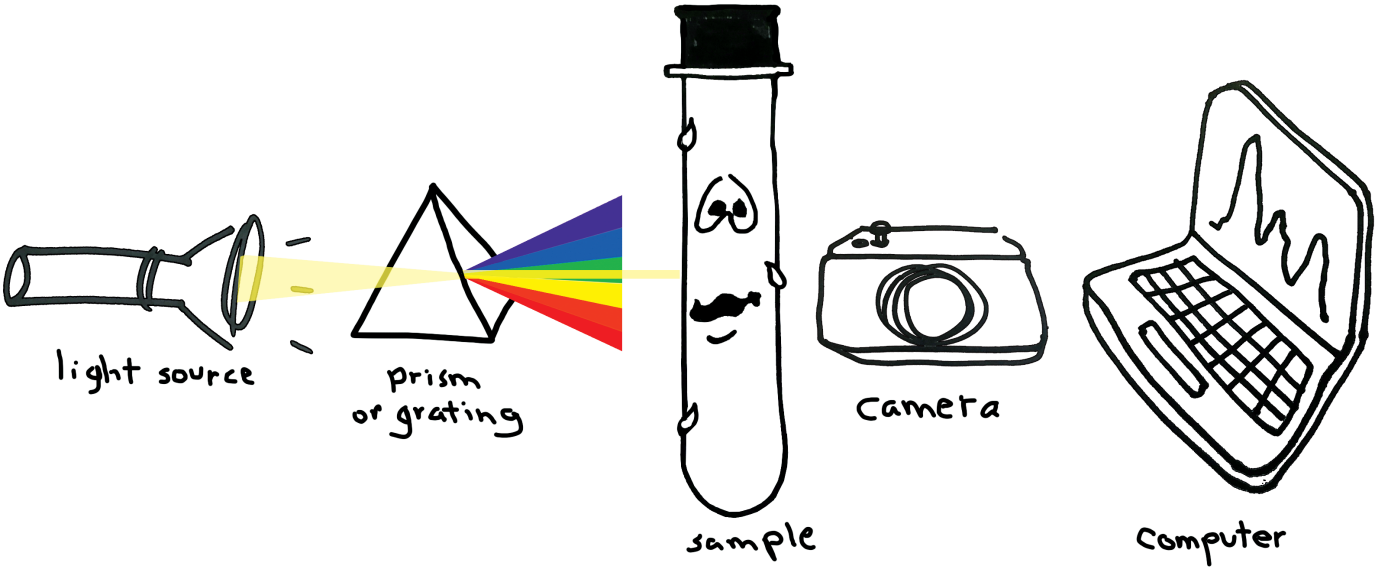
“The light shows us each chemical’s properties, like strength.”

Nia eyes opened wide, then narrowed.

“Is there a machine that uses light to measure matter?” she asked.

“Yes, Nia,” her mom answered.

“We call it a spectrometer. It’s like a meter that measures spectra or light.”



“How does it work?” Nia asked.

“Well,” her mom thought, “it’s really pretty simple.”

“First we shine a light, which we call excitation, through a lens onto something like a prism.”

“The prism separates the light into all the separate wavelengths.”

“What’s a prism?”

Her mom said, “It’s a piece of glass with several flat sides.”

“It bends the light, and because different wavelengths or colors travel at different speeds, it separates the light into a colorful spectrum.”

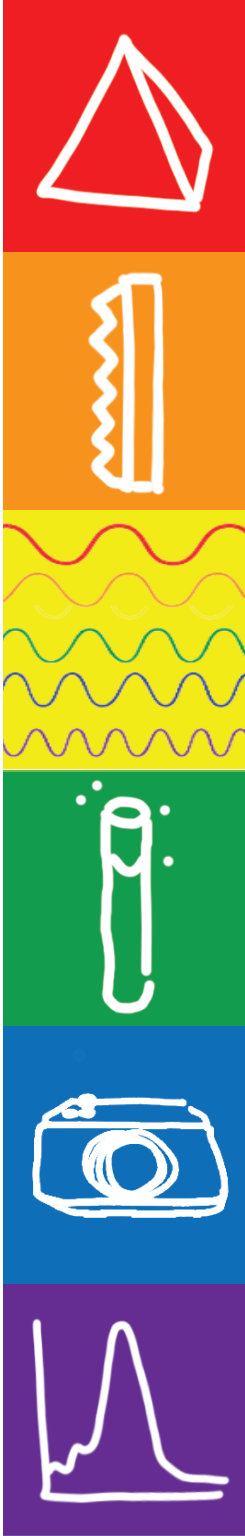
“Like the rainwater does to make a rainbow?” Nia asked.
“That’s exactly right,” her mom said proudly.

Nia wanted to know what happens after the light is separated into the different wavelengths.

“We focus one of those wavelengths onto the matter, or what we call a sample.”

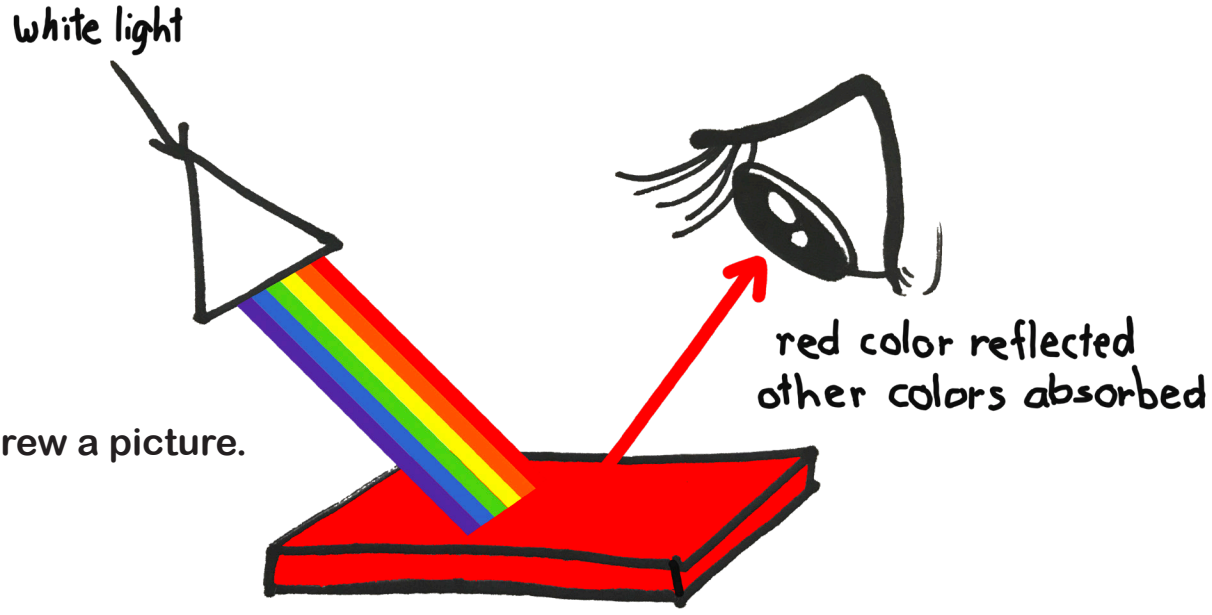
“The light hits the sample and is either absorbed, bounces off, or goes right through it. When it absorbs, or takes in the light, we can measure how much energy or wavelength it absorbs.

“Sometimes, after it absorbs the light, the sample will glow different colors too! We can measure all of these different types of energies and that tells us what we are looking at.”



“If the light is transmitted or travels through the sample, the wavelength changes on the other side.”

“That also tells us about the sample’s properties.”



Her mom drew a picture.

“If the light is absorbed, the stuff sometimes glows, like the glow-in-the-dark stars in your room.”

“We can measure it too,” her mom said.

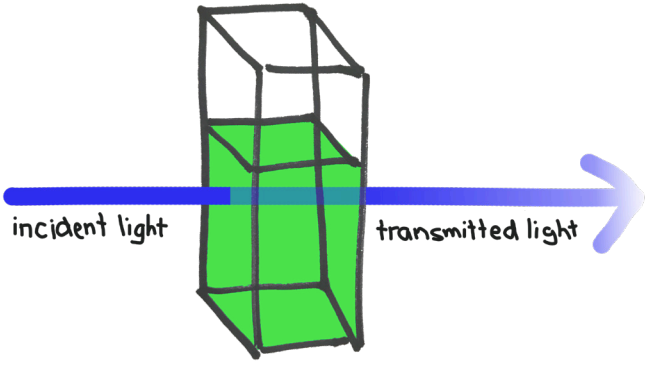
“That would be called luminescence.”

This was getting more interesting for Nia.

“So how do you measure it?” she asked.

“The light passes through the sample, scatters, glows, or is absorbed, and the remaining light or the glowing light projects onto a camera connected to a computer.”

“That computer gives us a graph of what wavelength exits and the properties of the sample.”



“Each chemical produces a different wavelength of light.”

“Scientists can measure the different wavelengths of the light energy to tell what the matter is made of.”

“Also, if scientists change the chemical they are looking at in some way, the light we measure off of the new chemical can tell us more about it.”

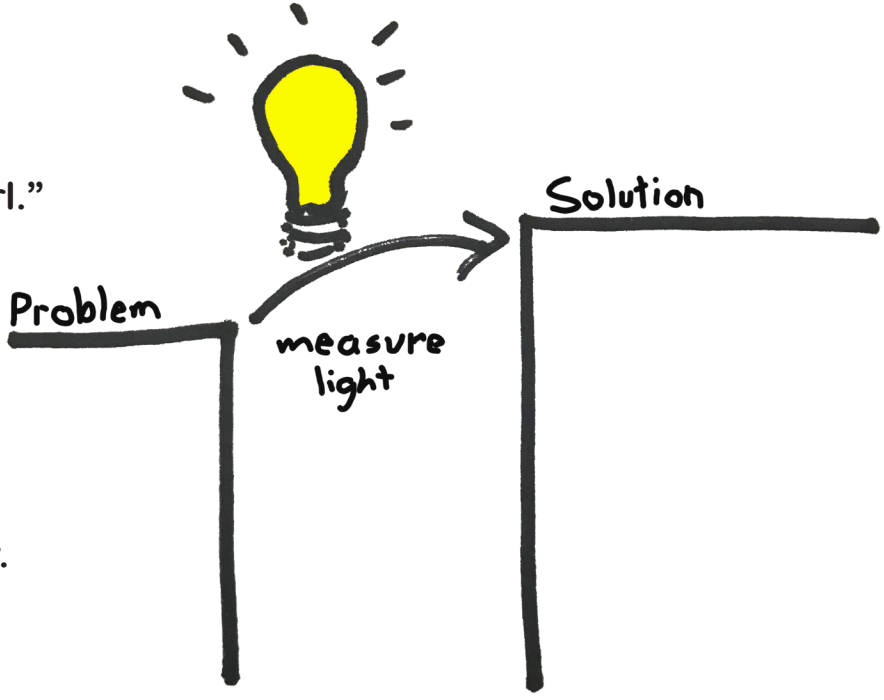
Nia thought about it all for a moment. Then a light went on in her head.

“So, like a detective, after we measure the spectra, we use the information to solve the mysteries of chemistry?”

Her mom grinned.

“That’s right, Nia.”

“You’re such a smart girl.”



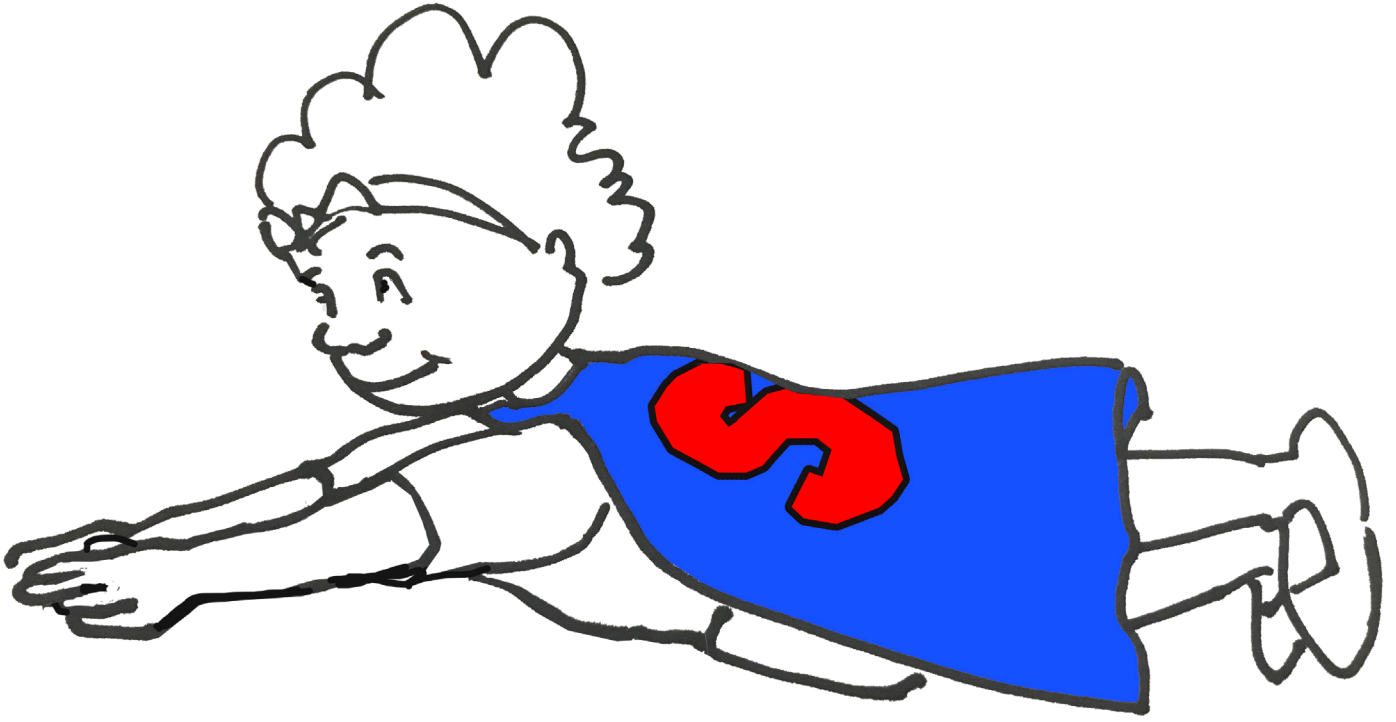
Nia looked up to the sky.

The rainbow was gone.

But now she knew the secrets of the different colors and the magic of light.

And with this knowledge, she began to understand how we can discover properties of matter with light, and scientists can find cures for diseases, make cleaner water and a better world for all of us.

That makes scientists superheroes.



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HORIBA Scientific,
a company dedicated
to the science of spectroscopy,
and committed to inspiring children
to pursue fields in STEM to make a better world.

Never stop chasing those rainbows.

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