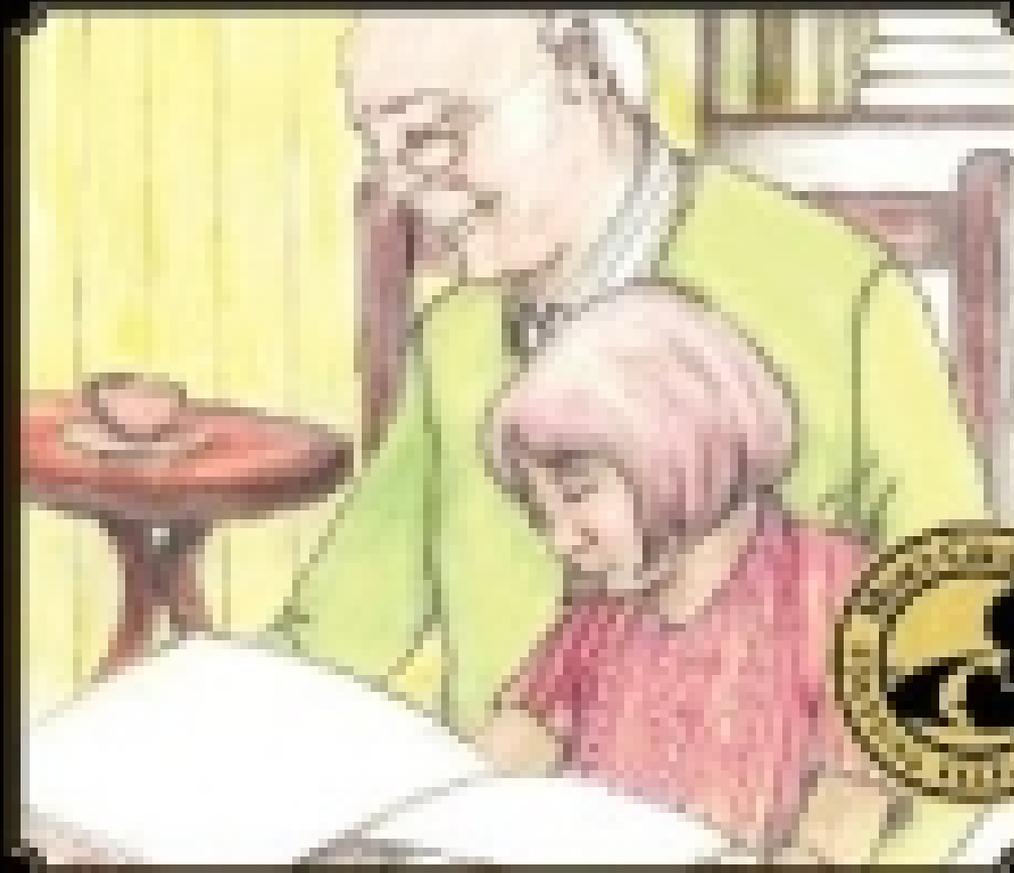


— PART ONE —

Laura and Grandpa

Discovering Science Together

LOOK
INSIDE



by Dr. Robert H. Krupp

Laura and Grandpa—Discovering Science Together

Book 1

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THE RAINBOW



It was a lovely spring afternoon.

Laura and Grandpa were sitting
on the front porch.

A light rain shower had fallen
earlier.



Papa looked up from reading his book and said,

“Look Laura, do you see what I see?”

“I see a rainbow!”
said Laura.



“Isn't it pretty?” she asked.

“Would you like to learn some things about a rainbow?” Papa asked.

“Yes Papa,” said Laura.

“OK, but first let's talk about the light from the Sun.



This light is called **white light** because it contains all the different colors in it.

When this light comes to the Earth from the Sun, all the different colors are moving at the same speed," said Papa.

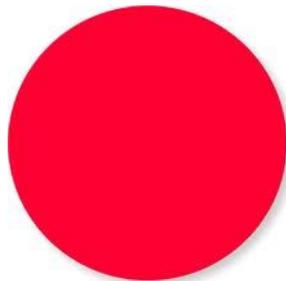
"But when **white light** moves through glass or water, the different colors travel at slightly different speeds.

The speeds of all the colors slow down a little.

Violet light slows down the most.



Red light slows down the least.

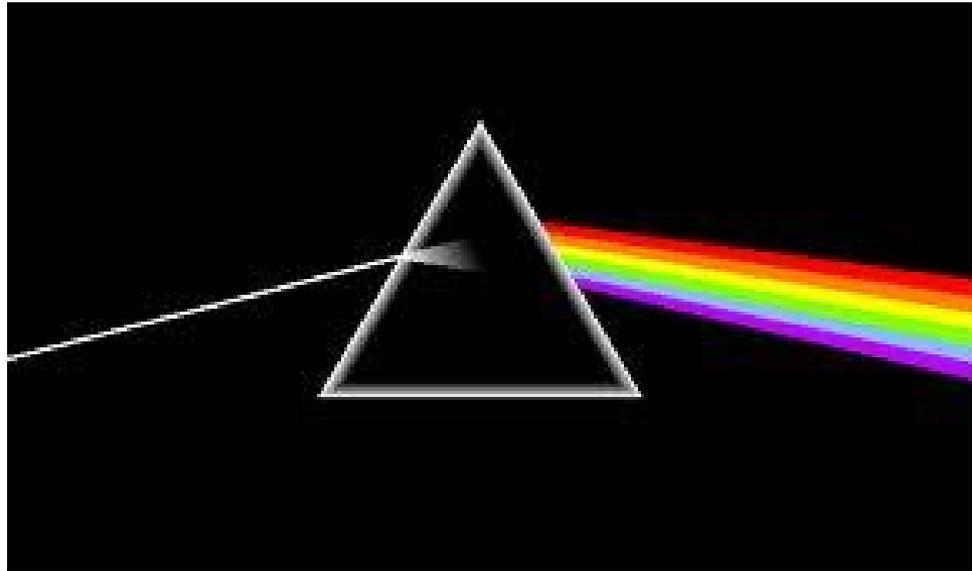


The speeds of all the other colors slow down in between the speeds of violet and red.

The colors separate from each other because of these changes in their speeds," Papa explained.

"Here is a picture of **white light** entering a piece of glass from the left.

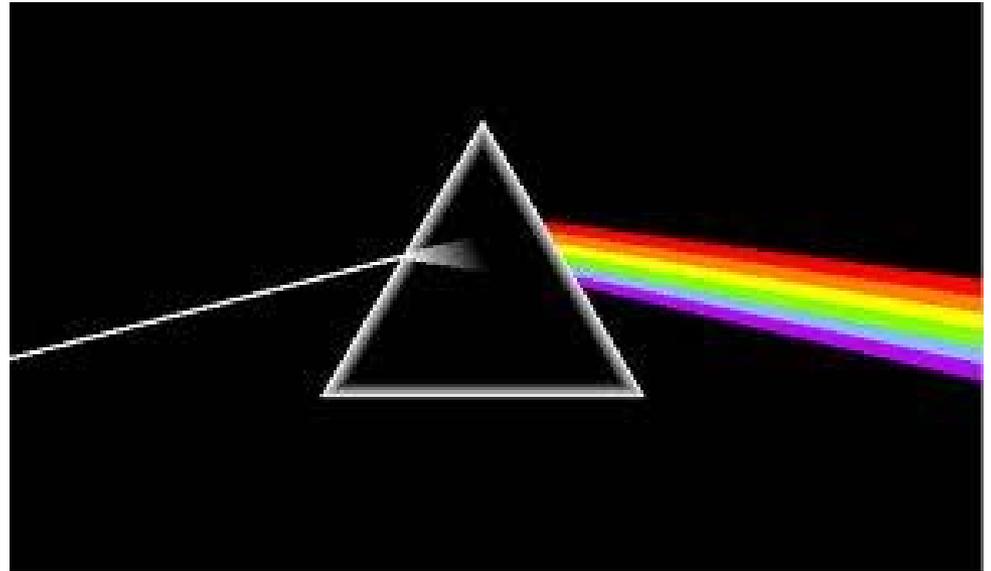
Because the different colors slow down, the picture shows the colors separating from each other.



Since the red light travels the fastest of all the colors, it is not bent very much.

Because the violet light travels the slowest, it is bent the most.

Laura, can you name all the colors starting at the top?" asked Papa.



"Red, Orange, Yellow, Green, Blue, and Violet," said Laura.

“Very Good! Now let’s look at that rainbow again.” said Papa.

“The colors you see there are not as bright as those in the picture with the piece of glass.



Start with the color on the left tell me the colors you see as you look to the right."

"Violet,
Blue,
Green,
Yellow,
Orange, and
Red," said
Laura.



“Excellent!

Now you and I know there are no pieces of glass floating in the sky to slow down the **white light**.

What do you think is in the sky that is slowing down the different colors?” asked Papa.

“Could it be the drops of water from the rain?” asked Laura.

“That’s it!” smiled Papa.

“The rain drops or tiny bits of moisture left over from the rain are floating in the sky.

They are producing the rainbow you see.

Sometimes you can also see a rainbow in the mist around a waterfall,” said Papa.

“Laura, what two things do you need to see a rainbow?” asked Papa.



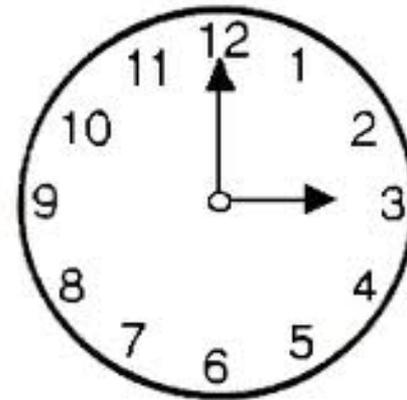
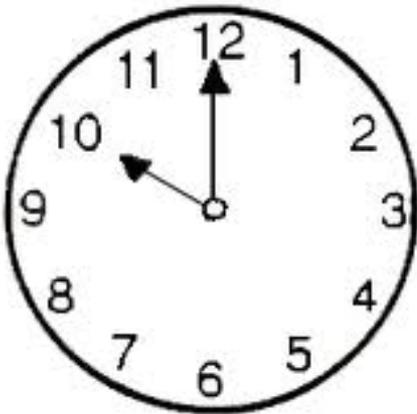
“Do you mean sunlight and raindrops?” answered Laura.

“Yes, that’s it. Now would you like to learn a little more about rainbows?” asked Papa.

“Sure, but I hope it isn’t too hard!” laughed Laura.

“I’ll keep it simple,” smiled Papa.

“You mentioned the need for sunlight. I want to tell you that you will not see a rainbow between 10 in the morning or 3 in the afternoon,” said Papa.



“Between these hours the Sun is too high in the sky.

To see a rainbow the sunlight must come into the moisture drops at a low angle.

This will happen a few hours after sunrise or just before sunset.

Another thing, the Sun will be in back of you as you look at the rainbow," explained Papa.

"Here's something else I want to show you.

See this picture of a rainbow.



Look carefully and tell me if you notice anything else?" Papa asked.

“Is that another rainbow I see, Papa?” Laura asked.

“Absolutely!

The rainbow on the left is called the first or **primary** rainbow.



The rainbow on the right is called the second or **secondary** rainbow.

“OK, I’ve got it,” said Laura.

“Good!

Do you see the **secondary** rainbow is not as bright as the first one?” Papa asked.



“Yes I do,” said Laura.

“Now look only at the first rainbow.

Starting on
the left, tell
me the colors
you see as
you look to
the right,”
directed Papa.



“Violet, Blue, Green, Yellow, Orange,
and, Red,” responded Laura.

“Very good,” said Papa.

“Now I want you to list the colors of the second rainbow, but it may be hard to do because it is so faint.

Starting on the left, tell me the colors you see as you look to the right at this **secondary** rainbow.”

Laura named these colors,

“Red,

Orange,

Yellow,

Green, and

Blue.



But I don't see the Violet.”

“That’s very good,” said Papa.

“It’s OK you didn’t see the violet—its very faint and hard to see.

Is there anything different about how these colors are arranged?” Papa asked.

“They are backwards from each other, Papa,” Laura answered.

“That’s a good way to put it.

I would say the colors are **reversed**," said Papa.

"Why is that?" Laura wondered.

"That's a hard question to answer now—it has to do with the reflections of sunlight and the colors in the raindrop.

When you are older and study science, you will learn more about this.

Is that OK?" asked Papa.

"That's fine with me, Papa," Laura smiled.

"To finish our story about rainbows, I want to ask you to look for something.

You might not be able to see this for many years.

Are you ready for this challenge?" Papa asked.

“I like challenges—they’re fun!
What is it?” Laura asked

“Many years ago, when I was in
college, I read a book about
rainbows.

It said that if the conditions were
just right, I might be able to see a
third or **tertiary** rainbow.

Since then, whenever I see a rainbow, I've always looked for the second and third rainbows, and many times I have seen the **secondary** rainbow," Papa said.

"One time I did see a **tertiary** rainbow, but didn't know it.

This happened because the book I read in college didn't tell me where to look for the third rainbow.

Many years later I learned that the **tertiary** rainbow is not found in the same direction as the **primary** and **secondary** rainbows.

You have to turn around and look towards the Sun to see a **tertiary** rainbow.

So, whenever you see a rainbow, look for the **secondary** rainbow and then turn around and look for the **tertiary** rainbow.

This third rainbow will be very, very faint—in fact you may not see all the colors you find in the **primary** or **secondary** rainbows.

This third rainbow will be harder to see than the second rainbow, but maybe the conditions will be just right for you to see it.

I hope that someday you see this, because it is very pretty!" said Papa.

“This is one of the best pictures taken of a **tertiary** rainbow by Michael Theusner.



Besides the **tertiary** rainbow, one of the hardest rainbows to see is a rainbow made by ice crystals.

Not snow, but tiny crystals of ice.

Here are some very pretty pictures of rainbows made by ice crystals."

Look at this
next picture
of a rainbow.



It was taken
from a
airplane.



After this, Laura gave Papa a hug and kiss and went to her room. There she drew a beautiful rainbow to give her Nana.



If you can't explain it **simply**, you don't understand it well enough.

– Albert Einstein

