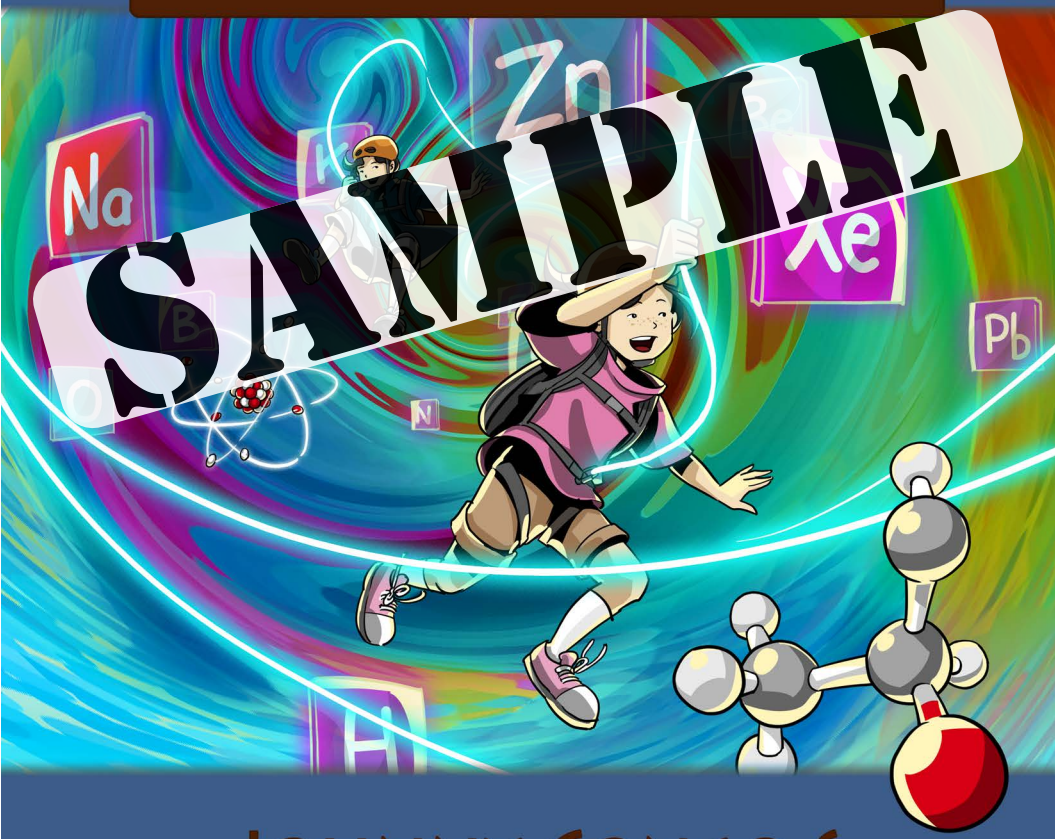
The Sassafras Science Adventures

Volume 7: Chemistry



Johnny Congo &
Paige Hudson

The Sassafras Science Adventures

Volume 7: Chemistry {SAMPLE}

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Email: support@elementalscience.com

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For copies write to :
Elemental Science
PO Box 79
Niceville, FL 32588
support@elementalscience.com

Learn more at
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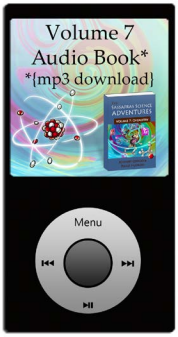
Topics Covered in This Volume

The Sassafras Science Adventures Volume 7: Chemistry covers a variety of chemistry concepts by looking at the following topics:

- Compounds
- Reactions
- Atoms
- Isotopes
- Elements
- The Periodic Table
- Acids
- Bases
- Mixtures
- Solutions
- States of Matter
- Oxidation
- Reduction
- Magnetism
- Nuclear Energy
- Conductivity
- Organic Chemistry
- Minerals
- Bonding
- Electrolysis
- Distillation
- Air
- Hydrocarbons
- Polymers

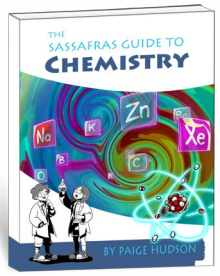
Don't want to do all the reading?



Check out *The Sassafras Science Adventures Volume 7: Chemistry* audiobook! Listen to the talented Christine Myrick take you on a journey to into the periodic table with the Sassafras Twins as they learn about different the elements and more.

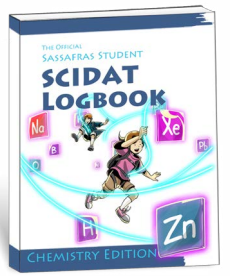
Make the most of your journey with the Sassafras twins!

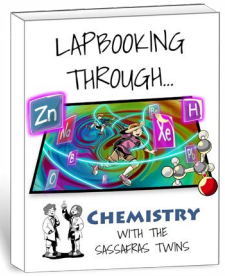
Add our activity guide, logbook, or lapbooking guide to create a full science curriculum for your students!



The Sassafras Guide to Chemistry includes chapter summaries and an array of options that coordinate with the individual chapters of this novel. This guide provides ideas for experiments, notebooking, vocabulary, memory work, and additional activities to enhance what your students are learning about the periodic table!

The Official Sassafras SCIDAT Logbook: Chemistry Edition partners with the activity guide to help your student document their journey throughout this novel. The logbook includes their own SCIDAT log pages as well as lab report sheets and an chemistry glossary.





Lapbooking through Chemistry with the Sassafras Twins provides a gentle option for enhancing what your students are learning about the periodic table through this novel. The guide contains a reading plan, templates and pictures to create a beautiful lapbook on chemistry, vocabulary, and coordinated scientific demonstrations!

Visit ElementalScience.com to learn more!

Authors' Note

The novel you hold in your hands is both a work of fiction and a teaching tool, which creates the need for a delicate balance.

We have taken fictional liberties when it comes to the story line—to our knowledge, no one is traveling around the world on invisible zip lines. But, when it comes to the information shared by our local experts, we have done our best to accurately reflect the current scientific knowledge at the time of writing this book.

We have drawn from our personal experiences and education, as well as the following resources:

- 🕮 *Basher Science: The Complete Periodic Table*
- 🕮 *Basher Science: Chemistry - Getting a Big Reaction*
- 🕮 *Periodic Table by Scholastic*
- 🕮 *DK Children's Encyclopedia*
- 🕮 *DK Encyclopedia of Science*
- 🕮 *Kingfisher Science Encyclopedia*
- 🕮 *The Usborne Children's Encyclopedia*
- 🕮 *Usborne Science Encyclopedia*

In addition to these books, we have drawn on the information found on many different websites.

Please keep in mind that science is ever-changing as our technology advances and our understanding deepens. If you find an issue in this novel, please let us know and take the opportunity to discuss these new developments with your students.

Chapter 1: Celebrating at the Ambidextrous Octopus

Astronomical Bowling

"Spare!" Twelve-year-old Blaine Sassafras shouted in elation with a touch of cockiness as he turned from the knocked-down bowling pins toward his twin sister, Tracey. Tracey sported a good-natured smile as her brother walked past pantomiming pistol shots with his hands accompanied with shooting noises from his mouth like he was a sharp-shooting, cowboy-hero bowler. She grabbed her eight-pound, bright pink bowling ball from the ball rack and stepped forward to face the lane.

Tracey took a deep breath, lifted the ball underneath her chin and side-stepped a little to line her bowling shoes up with the arrows embedded in the glossy, polished wood flooring fifteen feet down the lane. Taking one more deep breath, she eyed the right edge of the number one pin that was her target. She envisioned seeing the pink bowling ball releasing from her hand and then hitting the front pin on its right side, causing it to wildly careen backward, knocking all the other pins down.

The good-natured smile remained on the girl's face. Surely a strike like she had imagined would cause Blaine to holster his pantomime pistols. After one more deep breath, Tracey stepped forward with purpose. She swung her arm behind her and brought it powerfully back to the front of her body in an inverted arch, releasing the fluorescent pink sphere with smooth, strong fluidity. Her bowling ball spun ahead, and to her surprise, it followed the mental trajectory she had traced in her mind.

Solid contact between the ball and the front pin. An explosion of white, red, and pink ensued. One last satisfied deep breath released itself from Tracey's lungs. Not one pin was left standing.

The twelve-year-old girl turned back toward her twin brother, who was now standing with zero elation and not an ounce of cockiness. Instead of pistols, his hands hung limply at his sides.

"Strike!" Tracey said with exclamation.

"Great job, Tracey Trace!" an excited female voice sang out. It was Summer Beach, and she was running toward Tracey with outstretched arms. "That strike puts us on top! That means the girls win and the boys lose! Oh, yeah! Girls rule! Boys drool! Animals schooled!" The female, white-coat-wearing scientist reached Tracey's spot and wrapped her up into a happy jumping dance-hug.

Blaine and his teammate, Uncle Cecil, looked on in dejection. So did the third team of President Lincoln and Ulysses S. Grant, who were a prairie dog and an arctic ground squirrel, respectively.

The group of six was at the bowling alley to celebrate. Blaine and Tracey had successfully finished their study of astronomy, and what better way to celebrate than to hit up the neighborhood's exciting new bowling alley, the Ambidextrous Octopus. It wasn't a big bowling alley; it had only eight lanes, but it was alive with glow-in-the-dark colors, happy electronic music, and decorations featuring its charming mascot, Ollie the Octopus. To everyone's

delight, it only slightly smelled like feet.

It was a fantastic place to celebrate how far the twins had come. Last semester in school, Blaine and Tracey had failed science class. This had both disappointed and worried their parents. So, to address the situation, the twins' mom and dad had stuck them on a long-distance bus and sent them to their uncle's house for the summer. Their uncle, Cecil Sassafras, was a pseudo-famous research scientist, but by the twins' calculations the man was a crazy, mad scientist. When they had first arrived at their uncle's place, they thought he was a crazy, weird scientist. As they spent a little more time with him, their summation moved to a crazy, okay scientist. And now, after spending three-quarters of the summer hanging out with him and experiencing the science he was helping teach them, Blaine and Tracey thought he was a crazy, awesome scientist! They loved their quirky uncle with his wild uncombed red hair, messy lab coat, and bunny house slippers, which he was presently wearing at the bowling alley.

With the help of President Lincoln, his prairie dog lab assistant, Uncle Cecil had invented invisible zip lines that allowed the twelve-year-olds to travel anywhere on the globe at the speed of light. The key to connecting to these zip lines was a specially designed three-ringed carabiner. They needed to slip on a harness, don a helmet, turn the first ring of the carabiner to the desired latitude coordinate and the second ring to the longitude coordinate, and then let the carabiner snap shut. As soon as they did, the carabiner would automatically find the correct invisible zip line. The third ring would tighten and secure them to the line, they would hang with their feet dangling in the air for approximately seven seconds attached to the unseen line, and then they would zip off at the speed of light, traveling through swirls of bright color to their desired location.

At first, Blaine and Tracey had thought invisible zip-line travel impossible, too good to be true, or maybe even just a dream, but now after using this mode of travel for most of the

summer, they were experiential believers. Under the direction and guidance of their uncle, the Sassafras twins had used the unseen lines to zip around the planet. At each location they had learned about fun scientific topics with the help of local experts. So far they had completed studies of zoology, anatomy, botany, earth science, geology, and most recently astronomy, where they were even able to use invisible zip lines to travel in outer space!

After they finished a subject and landed safely back in their uncle's neighborhood, they always spent some time celebrating the completion of a leg of learning with Uncle Cecil and President Lincoln, which is what they were doing at the Ambidextrous Octopus. The twins were enjoying themselves, even Blaine, who had lost the bowling match.

They were joined by Summer Beach and her animal lab assistant, Ulysses S. Grant, the arctic ground squirrel. Ulysses and President Lincoln were buddies. Summer and Cecil were buddies. However, it had become more and more apparent over the course of the summer that Summer was hoping to be much more than buddies with Cecil. To Blaine and Tracey's dismay, their uncle seemed totally oblivious to this fact. The twelve-year-olds really liked Summer. She had served as a local expert on every leg of their adventure so far. She was always overflowing with joy, kindness, and knowledge, and they each had gone so far as to imagine a scenario where Summer would need to change her last name to 'Sassafras' in the future.

Another way they celebrated their science-filled victories was by watching a brief review of what they had learned on the recently completed leg. As strange as it sounded, the one who orchestrated these reviews was President Lincoln, the prairie dog. Normally, they happened in Uncle Cecil's basement lab over in his house on 1104 North Pecan Street, but to the twins' surprise, it looked like this time the presentation was happening right here, right now, in the bowling alley.

President Lincoln scurried to the top of a ball return rack with a small clicker in his paw. After a tap here and a tap there, a projector screen lowered over the bowling lanes, immediately illuminated with a bright, colorful picture of Lincoln himself with words over his head that read, "President Lincoln's Ever-so-brief Presentation on Astronomy."

Uncle Cecil stood and made his way to the center of the lanes. The man was usually eccentric, but not when he was doing these presentations on behalf of his lab assistant. When Cecil was orating for these presentations, he was as serious and put together as a royal butler. He stood, back straight with hands folded in front of his chest, white lab coat flowing above pink bunny house slippers, looking as refined as possible.

The twins smiled as they watched their uncle, anticipating the start of the presentation. Summer Beach also smiled as she watched, her eyes enraptured.

"'President Lincoln's Ever-so-brief Presentation on Astronomy,'" Cecil started in a voice that could have won accolades on Broadway.

Lincoln clicked the clicker, the image on the screen changed, and Uncle Cecil continued, "A solar system includes the sun and anything that orbits around it. This includes the planets, asteroids, moons, comets, and any space debris."

The image on the screen showed a dome-shaped room the Sassafras twins had found themselves inside of in Poland—the Copernicus Code Escape Room—which had proven to be challenging and educational. Embedded in the walls, floor, and ceiling of the room had been moving and sparkly lights that represented many of those things that make up a solar system. The image was a picture the twins had captured using the cameras on their smartphones. Indeed, all the photos they would see during this presentation were images either Blaine or Tracey had captured with their phones while zipping around the solar system studying

astronomy.

President Lincoln clicked again. The next image came up on the screen. Cecil again orated with vigor, "The inner planets, those closest to the sun are Mercury, Venus, Earth, and Mars. The outer planets, larger and out beyond the asteroid belt are Jupiter, Saturn, Uranus, and Neptune."

The picture on the screen now was one the twins had taken while floating out in space a safe distance from the planet Mercury. It had been amazing for the twins to get into their space suits and travel on the zip lines out into outer space.

Click. Next image.

This one was REESE the Robot with the lyrics of a hip-hop song showing on his data screen. The letters of the robot's name stood for 'Robotic Exploration Entertainment, and Scientific Enhancement.' To the twins' delight, REESE had more than lived up to his name.

"On Earth," Uncle Cecil continued, "our closest space neighbor is the moon. As the moon moves, part of it is 'lit' by the sun, which makes it look like the moon is changing shape. We call these different shapes phases, and we call the pattern they follow the lunar cycle."

"Lunar cycle, wooka, wooka, wooka, lunar cycle!" Blaine suddenly shouted the chorus to the hip-hop song that REESE had taught them.

The outburst didn't seem to bother Summer or Cecil at all. But everyone else in the bowling alley, including Tracey, glanced at Blaine as though he were a little crazy.

"Wooka? Wooka?" Blaine sang out a little quieter this time, more as a question, as though asking if anyone wanted to join in with him. No one did, and the presentation continued.

"Stars go through a life cycle," Cecil narrated. "They are born; they burn brightly for a long time; and when their fuel is

burned up, they die."

Now the image was of Starship Ishani, and in a huge window located on her bridge, bright and beautiful constellations of stars shown. In actuality, the window was a green screen, and the starship was the set of a Bollywood TV show. Nonetheless, it had been a perfect location for the twins to learn about the constellations.

President Lincoln used the clicker once more, and the picture changed from a pretend spaceship to a real one. It was a picture the twins had taken on the bridge of the International Space Station. In the picture were six real-live astronauts, one of whom was Yang Bo, a Chinese astrobiologist who had been their local expert.

"Astronauts travel in space with the use of special suits," Cecil spoke in his well-mannered voice. "There is no gravity in space, so life is very different. Astronauts live on the International Space Station to research space."

"*Au la vache*!" This time it was Tracey suddenly blurting out.

"*Au la vache*?" Blaine questioned.

"*Au la vache*," Tracey confirmed and then translated the phrase into English. "Oh, my cow."

It was a statement the French astronaut, Bayard Clemence, had often used in their interactions with him on the International Space Station.

"And last but not least," Cecil stated stately, "we have learned many things about space using telescopes, which magnify faraway objects. We have also gained knowledge about space by using satellites and space probes that travel into space and send information back to Earth."

The last image to come up on the projector screen was one of the telescopes on the summit of Mauna Kea. This picture immediately brought reverent pause to Blaine and Tracey's hearts. They had hiked to the observatory on the summit with their local

expert, an elderly gentleman by the name of J.P. Jungos. Mr. Jungos had used all the energy left in his frail body to make the journey, and then he died peacefully while gazing at the stars.

Both twins wiped away tears from the corners of their eyes as the ever-so-brief presentation concluded. President Lincoln hopped down from the ball return rack, the projector screen rolled back up into the ceiling, and Uncle Cecil reverted from a refined orator to his normal self. "Welly, welly, willikers, these scientific adventures of yours have been amazing-riff-tastic, have they not? There have been so many high-up highs, and I know there have also been some low-down lows."

As the red-headed scientist said this, he wrapped up his niece and nephew in a kind and empathetic hug. He had sensed their sadness over the loss of J.P. Jungos and had responded with compassion. Call the man crazy, but he was a wonderful uncle, and the twins loved and appreciated him.

"And these phones of yours!" Cecil exclaimed as he released the two twelve-year-olds. "They sure do take some fantabulous pictures. The pristinely clear images we saw on President Lincoln's presentation were out of this world!" He said this with big, waving arms like he was reaching for the edge of the atmosphere. Then he brought his arms close to his chest to ask a question, "Are the phones still functioning correctly? All of the doodads, whatchamacallits, ringdingers, whirligigs, doohickeys, gadgets, gizmos, levers, bells, and whistles are still working fine, right?

"You mean the applications?" Blaine and Tracey asked together.

"Persactly, Train and Blaisey. Persactly."

"Yes, our smartphone applications are working great," Blaisey (Tracey) confirmed.

At the beginning of the summer, Uncle Cecil had given each of the twins a smartphone to take on their science-learning

adventures. The phones were inherently tied to the invisible zip lines and so were the apps on the phones. The Sassafras twins were required to gather data as they rode the invisible lines to locations where the zip-lining coordinates on their three-ringed carabiners would land them as closely as possible to their local expert without being detected.

The application that gave them the correct latitude and longitude coordinates to those locations as well as the topics of study and the names of the local experts was called LINLOC, which was short for line locations. Next was an app called SCIDAT, which stood for scientific data. This was the application Blaine and Tracey used to record everything they learned about the scientific topics. They simply texted the information into SCIDAT and pressed "send." That information would then electronically make its way to a data tracking screen in Uncle Cecil's basement laboratory, where he could monitor not only what they were learning but also where they were located.

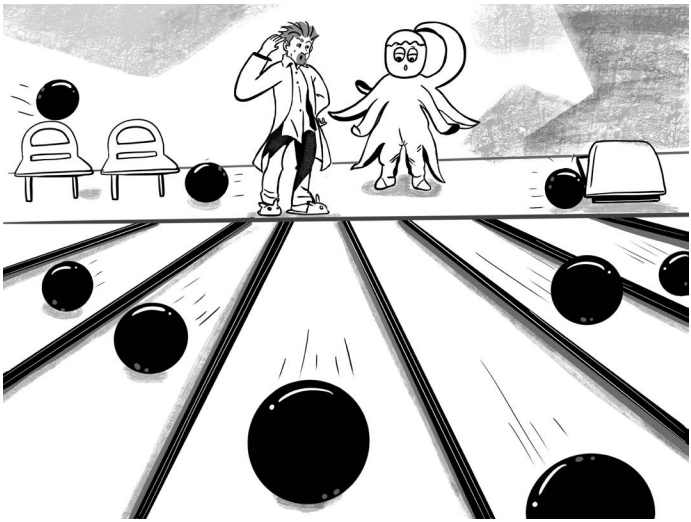
Additionally, there were a few other applications on their phones. There were the microscope app and the archive app. Along with the high-resolution cameras, these two apps were designed for the purpose of capturing images needed to complete their SCIDAT data at each location. Finally, the last two applications were the compass app and the taser app. These served to keep the twins from getting lost and as a last resort of protection, respectively.

Satisfied that his niece and nephew's handheld devices were working properly and their science-learning adventures were progressing smoothly, Cecil let his shoulders fall in a moment of contentedness and leaned over, putting his weight on a shelf full of fluorescent bowling balls. As he did, all eight of the balls clinked to the floor and sprawled in all directions.

Chemical Departure

Bowling balls rolled in multiple directions. The Sassafras

twins were tempted to feel embarrassed, but as they watched, the eight careening spheres spread. They saw the balls bounce around off chair legs, return racks, and people's feet. Amazingly, every ball somehow found its own lane and then started rolling toward the pins.



Everyone stopped to watch what the bowling balls would do. Slowly, each ball rolled, each ball managing to avoid a tumble into a gutter. Each ball was met by a crescendo of excited cheering.

The balls rolled on. The cheering got louder. The lights of the bowling alley flashed with zeal.

Then, to everyone's amazement—each runaway ball bowled a strike in its adopted lanes—one, two, three, four, five, six, seven, eight in succession. Every cheering voice ceased for a stunned second. Every eye sparkled with silent awe and found its way to Cecil Sassafras.

"Well, golly, golly, goodness!" Cecil exclaimed, surprised at what had occurred. "That was highly improbable."

After one more stunned second of silence, the Ambidextrous Octopus crowd burst forth with uproarious cheers for the striking

scientist. Cecil was immediately surrounded by his fan club and greeted with happy handshakes and fervent high fives. The music in the bowling alley got louder. The lights shone brighter. The cheers rang on. And a fluffy, life-sized mascot of Ollie the Octopus ran out to give Cecil Sassafras a merry high forty.

Blaine and Tracey jumped in to celebrate their uncle, adding their own cheers and high fives!

Summer Beach celebrated the man she liked more than anyone else in the solar system in her own unique style. The frizzy blonde-haired, lab-coat-wearing scientist squealed with delight, waved her arms wildly around in the air, and skipped through the small crowd toward Cecil with the intention of wrapping him up in a happy jumping dance-hug. She dodged a fan here, side-stepped a fan there, ducked under the tentacled arms of Ollie, and collided into Cecil. The two friends, colleagues, and former junior-high classmates laughed, jumped, danced, and hugged, hardly noticing that Blaine and Tracey had somehow gotten tangled up in the hug with them.

The Ambidextrous crowd laughed and watched in fondness, slowly backing away from the quartet. Even Ollie, with his permanent smile, stepped back in appreciation of the man and the moment. The lights slowly dimmed, and the music dropped from a fast song to a slow ballad.

The twelve-year-old Sassafras twins noticed the change immediately and quickly pulled out of the dance-hug, but Cecil and Summer continued hugging. They danced on. Their jumping turned into slow steps. Their slapdash hug turned into a meaningful embrace, and as a slowly spinning disco ball lowered out of the ceiling; the dancing duo's eyes matched its sparkle.

Blaine and Tracey looked at each other with mouths open. Was this actually happening? Were Uncle Cecil and Summer . . . falling in love? Summer had never been too shy about her feelings for Cecil. However, with Uncle Cecil it was a different story

altogether. The twins weren't sure if he was even aware at all that his old classmate was crushing on him. But right now, as the two danced under the sparkling glow, and Summer gazed dreamily at Cecil, the twelve-year-olds wondered if possibly their uncle was just now seeing it for the first time. Maybe he was now comprehending and maybe even . . . reciprocating . . . the same feeling.

"Summer, I . . . I . . ." Cecil started to say, rather shakily.

The twins looked at each other again. Tracey reached over and tugged excitedly at her brother's arm. Blaine let his mouth drop open even wider in anticipation. What was Uncle Cecil trying to say?

"Well golly, golly, goodness, Summer, I just . . . well . . . welly . . . I think maybe . . . Summer you are the most . . . whoa . . . wow . . . wow . . . I've . . . Summer, I just wanted to let you know that . . . manny-oh-manny . . . I . . ."

Summer waited, googly-eyed and expectant for her friend's forthcoming words.

"Summer Beach, I . . . it's . . . equation . . . science . . . focus!" Cecil took a deep breath. "I'm feeling a reaction—a bit like a chemical reaction. You know two compounds coming together. A reaction occurs and yields two new compounds, ones that are permanently changed to something new. Molecules are rearranged."

"RING!" The ring of a cell phone suddenly burst unwelcome into the middle of the scene.

"Summer, I'm saying . . . the equation . . ."

"RING!" Again, the phone rang.

"Whose phone was that?" the twins wondered as they instinctively reached for their own smartphones to see if it was them.

"Summer, welly-well, I think it's time to share the equation . . . CS + SB ->L_2F_2. It means . . ."

"RING!" Summer realized it was her phone that was doing

the ringing. "Oh, Cecil, I'm so sorry. I have to get this," the female scientist said as she pulled away from Cecil and looked at the screen of her phone. "It's Wiggles and Fidget."

"Wiggles and Fidget?" Blaine and Tracey wondered silently. "The two short, stocky security guards they had met at the National Air and Space Museum in Washington, DC?" Both were curious why those two might be calling Summer.

"Oh, my," Summer answered as she held her phone up to her ear. "Uh huh, uh huh, I understand."

Now not only Blaine and Tracey but the whole crowd of bowlers at the Ambidextrous Octopus were leaning in to hear what the conversation might be about.

"Well, that's not good," Summer said with a sad sigh. She paused again and then said, "Okay, you two. Thanks for letting me know. I'll see if there's anything I can do to help. Bye."

Summer let the phone fall from her ear.

"It's the *Ranger* spacecraft," the female scientist shared with everyone listening. "It's been stolen."

A gasp released from the small crowd.

"You mean the one that was on display at the museum?" Tracey asked.

Summer nodded her head.

"Why would anyone want to steal that?" Blaine questioned.

Summer shrugged her shoulders and looked like she was about to say something when suddenly her cell phone rang again. Back to her ear the device went, and she immediately nodded in response to whoever was on the other side of the line.

"Yes, sir, I understand, sir," Summer replied respectfully and then listened for another while before responding again. "Yes, sir, I think we can do that, sir." There was more listening by Summer and more listening and curiosity from the Ambidextrous spectators.

"Yes, sir, I understand completely, sir. We will get right on it, sir," Summer confirmed. "Thank you, Captain, sir. Goodbye."

The female scientist again holstered her phone and looked at everyone. "That was Captain Marolf."

"Captain Marolf?" Blaine asked, surprised. "You mean Captain Marolf from the Swiss Secret Service? You know him?"

"Well, of course I do," Summer responded with a laugh. "He's the one who funded the space-worthy science lab you have been to several times on your journey."

"He did?" Blaine blubbered.

"Yes. My underground science lab—the one that doubles as a spaceship—was completely funded by the Triple S, also known as the Swiss Secret Service. At first Captain Marolf wanted to name the craft either *Triple S-2* for Summer's Spaceship or *Triple S-3* for Summer's Science Station. I thought that was too confusing; plus, I wanted to name it after my stellar lab assistant, Ulysses S Grant!"

At the mention of his name, the arctic ground squirrel puffed his chest out a little.

"So, as you already know, the name of my Swiss-funded lab-ship is *Ulysses-1*."

"Yes," Tracey cut in, somewhat flustered and trying to get to the main point, "but why did he call you, Summer? What did Captain Marolf say?"

"He said Triple S spotted the stolen *Ranger* spacecraft via satellite."

Another gasp escaped from the crowd of bowlers.

"He said it looks like it's headed to the moon and . . ." Summer paused and turned toward Cecil. "He asked me to go after it, to use *Ulysses-1* to see if we can stop whoever it is who has stolen the *Ranger* spacecraft to retrieve it. Cecil, will that ruin our plans?"

Cecil stared blankly at Summer for a few long seconds as if

he were still thinking about what he had previously been trying to say. Then he suddenly shook his head with red hair shaking and blue eyes beaming. "No, no, no. I don't think so, sweet Summer Thyme. I think we can movity-move forward with our plans . . . for the twins, right? Our plans for the next leg of their summer science learning—those plans?"

Summer nodded yes with frizzy hair bouncing and her own blue eyes beaming. All at once, Ollie the Octopus realized that the group of six needed some space to finish their conversation. He, along with the Ambidextrous Octopus patrons, who had been enthralled by the miracle bowler, the possible romance, and the unfolding spacecraft mystery, was realizing that the group needed to hash the rest of their plan out alone without the eyes and ears of a crowd of kind but curious bowlers. The mascot used all eight of his tentacled arms to slowly usher the onlookers away, leaving the six standing alone under the still-twirling disco ball.

Summer, who was still looking at Cecil, now asked her friend, "But Cecil, if I now have to go to the moon, how will I be able to . . . you know . . . and teach the twins about . . . all that?"

"I think it will still work fanterrifically!" Cecil answered again, full of his usual excitement. "Because you'll still be in your lab, you know, where you were going to go to do the topic-talking and all. So you can still do that! And what better place than the moon to talk about hydrogen! And because the twins have already earned their space legs, we can be sure that they'll do just fine on the moon!"

Growing excitement now began to bubble over in Summer. "Yes, Cecil, you're right! This could work out perfectly!"

Even President Lincoln and Ulysses S. Grant were nodding in agreement now.

"So, can I tell them, Cecil? Can I tell these two cutie-frasses what we'll be studying next?"

"Of coursety-course, Summer! Gopher it!"

"Chemistry!" Summer blurted out with more than a little energy. "And I get to be your first local expert on this leg!"

A lot of big things had happened today at the Ambidextrous Octopus bowling alley, and Blaine's and Tracey's heads and hearts were reeling, but they were both more than a little excited.

Blaine and Tracey let out squeals of excitement accompanied by a round of clapping.

"During your study of chemistry, you two will get to zip-line all over the globe studying the basics of chemistry solutions, properties, bonding, and more! You'll learn about the elements that make up our world, where they are found, and what they do! You'll learn about how most of the elements are not found in their purest form but instead in compounds. And you'll learn how compounds are substances composed of two or more elements. You'll learn about the two types of compounds found on Earth: organic compounds and inorganic compounds. Organic compounds are those that support life and contain carbon. Inorganic compounds are salts, metals, and so on. Isn't this all so exciting?"

The twins nodded and jumped along with their clapping.

"And as you two super-frasses probably gathered, the original plan was to start chemistry by zipping to my underground lab in Alaska, but now we'll get to do that *and* go to the moon!"

The twins, along with Summer, Cecil, and the two animals, entered a full-on happy jumping dance-hug. There were still quite a few unknowns about what was coming, but the Sassafras twins were starting a new subject of science, and they were beyond happy about that fact. One could even say they were "over the moon" about it.

Chapter 2: 3 . . . 2 . . . 1 . . . Chemistry

Atomic Bits

Swirls of breathtaking exhilarating light surrounded them. The Sassafras twins were traveling on the invisible zip lines with huge smiles on their faces. Summer T. Beach and Ulysses S. Grant were with them, traveling at the speed of light from Uncle Cecil's neighborhood to Summer's lab.

The coordinates the LINLOC app had given them were familiar—longitude 67° 3' 58.91" N, latitude 163° 4' 12.24" W. Alaska had been a learning destination several times this summer. The local expert listed on LINLOC was also familiar because the local expert herself, Summer Beach, had spilled the beans about that already. The four topics for study, however, were not familiar—atoms, elements, the periodic table, and hydrogen. Blaine and Tracey could tell by looking at these topics that the subject of chemistry was going to be much different than anything they had studied thus far.

Suddenly, the four high-flying zip-line riders reached their destination with a jerk. Their carabiners automatically unclipped from the invisible lines, and all four slumped to the ground with tingling bodies, devoid of sight and strength. These sensations were all typical for landing after invisible zip-line travel. Slowly but surely, the normal physical faculties returned to the four travelers.

Blaine and Tracey picked themselves up from the ground. They looked around, took in deep breaths of fresh air, and smiled.

They were in a wide-open field with nothing but trees and mountains in the distance. It looked like the middle of nowhere, but they knew exactly where they were. In a minute, the Earth was going to open up, and they would fall onto a spiral slide that would gently glide them down to the underground lab. Summer and Ulysses also knew what was about to happen, as evidenced by the matching smiles on their faces.

Sure enough, within moments, the ground opened, and down the curves of the slide the four went, smiles intact, laughing. Each hit the bottom of the slide, skipped across a padded landing area, and careened to smooth stops on the glossy, clean, white floor of Summer's lab.

"Home sweet science-y home!" Summer exclaimed in joyful contentment as she jumped to her feet and smoothed her lab coat.

Blaine and Tracey got to their feet and let their eyes take in the familiar amazing space they were in. The circular underground lab was pristinely clean with smooth surfaces and shiny equipment. It was full of cutting-edge technology and eye-catching scientific displays like the cylindrical specimen tubes perfectly spaced out,

showcasing their contents with bubbles and LED lights. There was also the floor-to-ceiling translucent data screen on which information could be read from both sides. Even now, the twins could see data about atoms being displayed on the screen.

"Oh, Summer, it's so good to be back in your lab. And it's so good to be starting another subject!" Tracey swooned.

Blaine agreed with a big nod of the head and then pointed at the data screen, asking excitedly, "What's all this about atoms? Wait, that's our first topic, right?"

"It sure is!" Summer shouted with a smile and outstretched arms. "This info about atoms is going to kick off the super fantastic and adventurous study of chemistry! Do you guys want to jump right into it?"

"Sure!" The Sassafras twins chorused in unison.

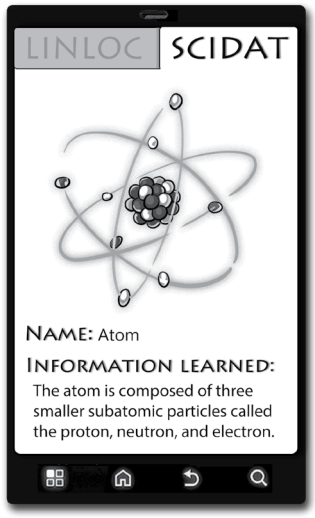
"Yay-yay-yay! Okay then! Yay!" Summer exclaimed at a happy shouting volume as she skipped to the data screen. "Okay, cutie-frasses, I'll read the information about atoms that we can see here on the screen, and when I'm finished, I'll make sure the data is uploaded straight to your smartphones!"

Blaine and Tracey nodded, knowing that as they progressed through their study of chemistry, they would send their Uncle Cecil data and images for each topic studied. He would view their information on his data screen in his basement, making sure they had learned what they needed to at each scientific stop.

"The Greeks are credited with being the first to come up with the concept of an atom," Summer read the data on the translucent screen. "They believed that matter could be cut into smaller and smaller pieces but that eventually you would get to a piece that could not be cut. So the word 'atom' comes from the Greek word '*atomos*,' which means 'uncuttable.'"

Usually, the twins had to add the data into their phones from memory. It was a nice break in Summer's lab because the data

could be directly shared to their phones. However, they still made an effort to commit the information to memory as Summer read it.



"In 1808, John Dalton, an English scientist and schoolteacher, developed a theory about how atoms behave. His theory said that an element is composed of these tiny particles, and that in an ordinary chemical reaction, no atom of an element disappears. He also thought that compounds were formed when atoms of two or more elements combine. On the basis of his theory, scientists said that the atom was the smallest particle that makes up an element. The modern atomic theory is very similar to what Dalton proposed, except now we know the structure of an atom as well as the fact that there are sub particles that comprise an atom."

"Wow, the theory all started with a schoolteacher?" Blaine mused.

Summer nodded.

"That's amazing," Tracey said, impressed. "Maybe when we get back to school after summer break, we should show a little more respect to our teachers."

Blaine agreed as Summer smiled.

"Now, let's take a closer look at the structure of an atom," the scientist started again. "The atom comprises three smaller subatomic particles called the proton, neutron, and electron. A proton is a positively charged particle that resides in the nucleus at the center of an atom. A neutron is a particle with no charge that also resides in the nucleus of an atom. An electron is a negatively charged particle that resides in a cloud around the nucleus, which is

called and electron shell."

"And lastly," Summer paused for a breath and then read the information displayed on the floor-to-ceiling data screen, "atoms have an equal number of protons and electrons, which gives them no net charge. In other words, normally the positive charges from protons are canceled out by the negative charges of the electrons. Regarding protons and neutrons, generally an atom of an element has the same number of neutrons as protons. Of course, there are exceptions to these two rules, called ions and isotopes. Ions are atoms or groups of atoms that have become charged by gaining or losing one or more electron. Positive ions have lost one or more electron, and negative ions have gained one or more electron. Isotopes are . . ." Summer started to say but then she paused and moved in front of the text on the screen, smiling and waving her arms.

"Actually, I'm going to save isotopes for one of your friends to share about later! Even so, let me upload this to your phones." Summer Beach turned and pushed the upload button on the large screen. Immediately, the twins' phones buzzed as the information about atoms was uploaded directly. They resisted the urge to peek at the last bit of SCIDAT and turned to receive the happy jumping dance-hug they were sure was coming.

But before it did, Summer turned and shared more about atoms, "And here's another thing that's cool about atoms—they combine to make molecules and compounds! Molecules are formed when two or more atoms of an element join together. Compounds are formed when two or more atoms from different elements join together. For example, H_2 (hydrogen gas) is a molecule because two atoms of hydrogen are joined together. However, because there is only one type of element present, H_2 is not a compound. In contrast, H_2O (water) is a molecule because the three atoms, one oxygen atom and two hydrogen atoms, have been joined together to form it. It is also a compound because it contains two different elements, hydrogen and oxygen. So, all compounds are molecules, but not all molecules are compounds!"

Now, the twins knew a happy jumping dance-hug was coming their way. However, before it did, Summer's phone rang . . . again.

"Goodness me, this thing is awfully noisy today, isn't it?" Summer said as she answered the call. "Hello? Well, hi there, Paul! I would ask how you're doing, but I heard from Wiggles and Fidget about the stolen lunar module, so I assume you're not doing as great as you could be . . .uh huh, uh huh . . . yes, well, we are actually going to go after it ourselves using *Ulysses-1*…uh huh, uh huh . . . okie dokie, friend, we'll keep you posted! Okay, you too…bye."

"Was that Paul Sims from the Air and Space Museum?" Tracey asked Summer as she hung up her phone.

The scientist nodded in confirmation. "Poor guy," Summer said with a rare frown. "First there was the attempted heist of the guidance component from that old Soviet rocket, and now the lunar module has been stolen. So many unfortunate things have happened to my old buddy and junior high classmate as of late. He's such a nice guy."

In Washington DC, Paul Sims hung up the phone, and immediately the big fake smile on his face faded away completely. His countenance now scrunched up into a mixture of concern and spite. Summer probably thought he was a nice guy. Little did she know how malicious he was.

The door to his office was already closed, but he locked it now for good measure. He didn't want anyone walking in on him as he stewed—especially not those two annoying security guards, Wiggles and Fidget. He stalked from the door to his large mahogany desk and flumped heavily down onto his plush, black leather swivel chair.

"So now Summer knows about the lunar module," he angrily whispered. "And she's going after it. I doubt there's anything she can do to stop them, but she has surprised me before."

Paul began to nervously wring his hands. "Have I gone too far? No, no! It's totally worth it. I'm rich now, but I'm only going to get richer—so much richer."

The thought of money brought a smile to his face, but it was fleeting as anxiety returned. "But are those three trustworthy? More than that, are they capable? Can they pull off this master scheme?"

He threw back his head into the headrest with a thud as he thought about the Rotary Club—not the group of little old neighborhood ladies who met for the purpose of good will and philanthropy but the other Rotary Club, the one made up of the three sinister Slote siblings—Alexander, Graham, and Belle. The two brothers and one sister had joined together to form an evil club, one bent on destroying all the world's cell phones, forcing everyone to go back to using rotary phones.

The wicked trio had attempted to take the guidance component of an SS-20 Soviet missile that was on display right in this museum where Paul sat as curator. Evidently, they were going to use it to complete a missile they were going to launch into space—one that would destroy a satellite, rendering cell phone use impossible. This would usher in the glorious rebirth of rotary telephone use. Their attempt had been thwarted by Summer, the security guards, those kids, the janitors, a few animals, a robot, and himself.

However, the failed heist had given Paul's greedy mind an idea. He knew how wealthy the Slotes were. He knew how badly they wanted that guidance component. And he knew that the destruction of only one satellite would not take out all of the world's cell phones. So he had bailed the Rotary Club out of jail. They had been more than happy to pay him a ridiculous amount of money for the guidance component, which he had secretly taken after the failed heist.

"But why stop there?" Paul had thought. There were many more things at the Air and Space Museum the Rotary Club might be interested in. If they were ready and willing to fire a missile at a satellite, why not fire multiple missiles? Or, better yet, why not travel to the moon and set up a remote station from which to launch their attack against cell phones? They could establish an attack station, while he made a lunar fueling station—that's right, a fuel station on the moon.

Paul had recently heard about the hypothetical idea to establish a fueling station on the moon. He didn't completely understand it, but basically, it's known that sections of the moon are covered in ice, which, of course, is frozen water. Water, H_2O, is made up of two parts hydrogen and one part oxygen. If you split hydrogen and oxygen, and then liquefy those constituents, you have rocket fuel. If there was a station on the moon that could provide rocket fuel for spacecraft, it would significantly lighten the needed fuel loads of the different crafts leaving Earth, greatly cutting costs for the entire space industry and making that fuel station owner mega-rich!

It had been a calculated risk to steal and sell the guidance component to the Rotary Club, but that was small in comparison to the risk of stealing and selling the lunar module. On top of that, he had sold a lunar rover vehicle to them! That act should go unnoticed longer because the rover had been in storage. The Rotary Club, who already had a working and space-worthy rocket, now had a working missile, a way to land on the moon, and a way to travel on the moon. Unfortunately, if you looked hard enough, pretty much everything led back to him. The probability of him being caught was much higher now than it had been when the guidance component had been the only missing item, but even with the raised stakes and anxiety, he still thought it was worth the risk. He was going to be so, so, rich. And, as far as he could tell, everyone around him still thought he was a responsible, law-abiding, nice guy.

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