I didn't respond. The answer seemed a little too close to a truth that I was not yet ready for.

Maxwell, however, moved on. "Can you craft some methods that integrate changes in temperature and pressure over time for the gases on both sides of the membrane, and then link these changes to the numbers of molecules that must pass through the membrane in order to achieve equilibrium on both sides?" he asked.

Despite my muddled head, I must have mumbled that I would do my best, as I was soon put on the case.

In later years, of course, the "gatekeeper" membrane between the warm and cold quantities of gas became known, among scientists as "Maxwell's Demon."

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Soon after our discussion on the movements of gas molecules, I asked Maxwell to describe his equations of electricity and magnetism and what exactly he was trying to measure.

"Of course," Maxwell replied. "I'll put them on the board for you." He hastened over to the blackboard and snatched up a bit of chalk.

"Start by thinking of things that float or move in space without any visible connection to the ground, or to any other nearby physical object," he said. "Your imaginary object could be a hot air balloon, an arrow in flight, a cloud, or a puff of smoke. The question is: what force or forces causes each of those objects to change? In the balloon you might think the gradual loss of heat would eventually cause it to collapse and fall to the ground. The arrow will eventually fall from the sky, but from what cause? The air it must push against. The speed it will lose with time as it flies.

"How about the cloud? What causes the cloud or the puff of smoke to change its shape or its color? Is it the sun? Is it changes in the cloud's moisture content? Is it the pressure of the changing wind? Actually, it is probably all of those things in some complex and unmeasurable combination."

He paused to gather his thoughts. "Think about the clouds again. This time think about the dark, windblown thunderclouds in the late spring. Of all the things that are roiling about inside the cloud, what will cause the tornado spout to drop to the ground, or the lightning to come down from the cloud to strike the ground, possibly catching something on fire, or even killing some person or animal? The power of that lightning bolt, the force of it, the heat of it, and the bright flash of light can all be measured over time using Newton's calculus, and an extension of that calculus called a 'vector,' which has measurable values for both direction and force.

"Now think of a bar magnet that you move slowly toward a piece of metal plate. Depending on the size of the magnet, you might not be able to ultimately stop it from hitting the metal and sticking to it in a way that may be stronger than your ability to pull it back.

"The power of that magnet, the force that draws it inexorably to the metal plate—like the lightning bolt, but without the flash, the noise, and the drama—can be measured over time using Newton's calculus, and the same vector extension, but with a math that works for magnets.

"To link an electric force and a magnetic force to create an electromagnetic force with a given magnitude, you must use the partial differential equations that I have developed while at King's College."

Maxwell then took me through a deep thicket of calculus. In that way he hoped to get me started on a path to a true understanding of his work. I scribbled furiously along behind him.

At the end of it he finished with: "Curl H can be read as 1 over the constant c—c, Eirian, is defined as a gearing ratio between the E and M force—times the change in E over the x, y, and z axes over time.

"I'll assume you have got all that," Maxwell said. "I'll emphasize the fundamentals once again, just in case."

He turned away from the blackboard and winked at me.

"The terms 'div,' short for divergence, and 'curl' are ways of representing how the forces E and H—the EM force I mentioned earlier—vary in the space immediately surrounding the point of our inquiry. Div is either more outwards than inwards, and is called div greater than zero, or more inwards than outwards, and is called div less than zero. Curl, on the other hand, measures the tendency of the force to curl, or loop, around the point of inquiry, and gives the direction of the axis about which it curls."

Maxwell sat down in a chair facing me. I felt more than saw this as my head was down as I quickly tried to capture all the insights into the magic of electromagnetism that Maxwell had so willingly and effectively given me over these past few minutes. When I realized he was watching me intently, I stopped my scribbling and looked at it. The page was an overwhelming maze of numbers, letters, and signs I felt I could lose myself in.

"I don't know if I will ever understand this," I said, resignedly. "Don't feel alone in that," Maxwell said. "I don't think that either I or Faraday have a deep enough understanding of these forces to explain them well, even to those of my professional colleagues who believe, following Newton, that the universe is a finely tuned machine. Newton's comforting machine is very much like a Swiss watch—a machine with gears and winding mechanisms and hands to show the time, each connected one to the other with no empty space between.

"Faraday and I are talking about those spaces, the empty spaces where the power of these forces of electricity and magnetism reside and do their work. To proceed from a lifetime of belief in a clockwork universe to a universe where forces work at a distance with nothing connecting one object to another is hard for anyone to grasp, scientist or not.

"The introduction of these ideas of field and of actions at a distance disconnects the forces of the universe from the movements of the objects these forces are thought to influence. Our case will be a very difficult one to make in the face of such thinking, entrenched as it has become.

"Even so," he continued, "it will be your job to carefully watch and record the details of my experiments with electricity and magnetism. Then, though I won't require it of you, I'd like it best of all if you would at least try to repeat them without any guidance from me, to see if you can get the same results.

"Whether you try to do your own tests or not, your final task for me on each experiment will be the preparation of text and illustrations describing each of the experiments as you saw them. Expect my very careful review because it is in these descriptions that we may all find the best way to present our findings on electromagnetism to the very large group of my skeptics in the scientific community."

And so it is that I found myself in January 1866 that I find myself working at Glenlair. Charles Ludwig Dodgson, whom Bethan and I met at Oxford in 1864, published a book titled *Alice's Adventures in Wonderland*. He published the book in November 1865, using the pen name Lewis Carroll. Maxwell alerted me to the publication and asked if Bethan and I would like to travel to England in March with him and his wife.

"I will be at Cambridge, but I can make travel arrangements for you both to go to the Oxford campus for a day or two," he said. "Perhaps you can meet with Dodgson there and have him autograph his book for you. Then you can come down to Cambridge to join Katherine and me for dinner with some friends of ours."

Maxwell said later that he thought he saw an actual glow in my eyes. In any case, he noted that I did seem briefly incapable of speaking.

"Oh, thank you, Dr. Maxwell," I said, once I'd recovered. "I am overwhelmed by your kind and generous offer. Are you sure?"

He smiled at me, so I did not wait for an answer.

"I must go today to discuss this with Bethan. We have so many things to prepare for before we leave!"

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Before returning to Glenlair, Maxwell, his wife Katherine, Bethan, and I were invited to a London dinner party at the house of Maxwell's longtime mentor and friend, Michael Faraday. According to Dr. Maxwell the party would honor Benjamin Disraeli. Though not yet resolved, the collapse of the Gladstone government was virtually assured. Gladstone, a bitter enemy of Disraeli, would clearly be dispatched from office, along with his liberal party in the upcoming elections of June 1866.

Disraeli was now sixty-one years old. He was a friend of Queen Victoria, a novelist, a member of Parliament, and a continuing supporter of Tory governments and politics. He would soon be appointed chancellor of the exchequer, and Conservative leader of the House of Commons in the third minority government to be organized by Lord Derby, a Tory, as soon as he was sworn into office.

The dinner took place at Faraday's home in Hampton Court, Middlesex. Though without formal education beyond the eighth grade, the elderly Faraday had been greatly honored by his scientific peers and by Queen Victoria herself. He had been offered an opportunity to be buried at Westminster Abbey among the resting places of England's royalty, but he refused, preferring to remain with the common man even in his final resting place.

In fact, this particular get-together was Queen Victoria's idea in the hopes of exposing the conservative and sometimes prickly Disraeli to some liberal thinking in advance of the coming change of governments. The choice of other guests at the party, the queen suggested, would be up to Faraday.

Faraday had been living in Middlesex for the seven years following his retirement. When told of my visit to hear a lecture by Dodgson, Faraday insisted that I invite the man and whoever else might be good company for him. Charles Babbage, another of Faraday's guests, had recently read Dodgson's new novel. He expressed delight at the prospect of his joining us at dinner.

"Dodgson's novel is the talk of London," Babbage said. His eyes were all aglitter at the thought of Dodgson with his stumbling speech arguing with the articulate Disraeli about the parliamentary intrigues of the day. Apparently, when he thought of Disraeli parrying Dodgson's literary wit with some parliamentary and political fantasies that Disraeli would try to promote, Babbage could not restrain himself and broke into gales of laughter.

At one point, Babbage even excused himself to go to another room where he gave in to bouts of uncontrollable laughter and fits of coughing. Other members of our dinner party began to worry about his health, but he returned after a few minutes, waving away any health concerns.

"I apologize to my host for my behavior. I hope you will all forgive me for my ill-mannered behavior regarding a guest who may not be as fully articulate as others of us. Please trust me when I say that it is not the impediment that I find comical, nor the speaker, whom I admire and consider a friend and professional colleague in mathematics. The problem is that I imagined the sounds and conversational tension such a debate would carry to the rest of us. It tickled my funny bone, and my imagination got the better of me."

Though I found such a joke odious in its humor, I nodded my approval of his conciliatory remarks along with the other dinner guests. We all turned back to our conversations.

Shortly after, an aide to Faraday, acting as butler, announced the arrival of Charles Dodgson and Sean McCabe of Christ Church, Oxford. All of us rose to congratulate the new author on the publication of his very successful first novel. Though we had all been together on the Oxford campus over the past two days, Bethan and I approached Sean and asked that he join us at the table when convenient after introductions.

"Th-th-thank you," Sean said. "I will join you sh-sh-shortly."

In an aside to Bethan on our way back to the table, I noted that Babbage would not find the speech problems of the guests so entertaining if we reminded him of his many crusades against minor issues of minimal public interest.

Sean had told us of Babbage being denounced during debate in Parliament two years ago for "commencing a crusade against the popular game of tip-cat and the trundling of hoops."

The issue was a serious one having to do with interference with traffic along crowded roads, and with frightening horses pulling carriages into public rights-of-way. But the tabloid press in London has, historically, liked to bring public celebrities down to size with humiliation. They are always looking for targets. They picked up on the issue of 'trundling of hoops' from the parliamentary debate and turned it into a riotous play on language. This had caused Babbage to become a laughingstock—one that I was feeling at the time, with righteous anger on the behalf of my friend, was well deserved.

We waited patiently while Sean explained all this in his halting voice. He was very grateful to us for our kind of patience with his speaking. As a matter of fact, we were both wonderfully entertained by the way Sean manipulated his speech defect into comedic descriptions of the popular news of the day.

I privately noticed that Sean's speech improved as he spent more time with Bethan. When I asked her about it later, she gave a coy smile and said, "Why, yes. Sean's stutter seemed to go away after a while. I think the stutter is only really there as long as he is under the spell of Dodgson. He is really quiet an unusual young man."

"I am delighted to hear it," I said.

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The next day, we Scottish travelers began our three-day journey back to Glenlair and Corsock. We all agreed that it had been a wonderful trip. The stories we could tell about all the wonderful people we met and the events we participated in would last us the rest of our lives.

I was mulling over the ideas in the book *Alice's Adventures in Wonderland*, though I was not sure I could see any value in them that would benefit my work for Maxwell. I did love the book, though, and all of the fantastic imagery and wordplay in it. I resolved to keep thinking about ways to link the magic of the Cheshire Cat or the Mad Hatter or the March Hare to the hard realities of Newtonian math.

Maxwell would later share with me all of the things he had been told in his business meetings at Cambridge. The university wanted him to have a leading role to play in the rapidly emerging sciences of the Industrial Age. The development of new industrial materials and sources of energy were moving fast across all of Europe, and Cambridge wanted to build a science laboratory worthy of that role.

More important to Maxwell, they recognized his lifelong dedication to all aspects of science and, in particular, his collaborative work with Faraday to perfect the scientific understanding of electromagnetism. The leaders, statesmen, and financiers putting the project together proposed to hire Maxwell to build and run it. It would be called the Cavendish Laboratory, after our nation's acclaimed chemist and physicist Henry Cavendish.

"James Clerk Maxwell will build the lab, and, once built, he will become the first Cavendish Professor of Physics," they said. "If, of course, he decides to take the job."

But first, Maxwell had an obligation to his beloved father, John, to complete the expansion of Glenlair. Other than our work together, there would not be much new science at Glenlair during the next few years.

Katherine, Maxwell's wife, an accomplished scientist in her own right and indispensable helpmate, was not at his meetings at Cambridge in 1866, but she confided in me later that she could see the faraway look in his eyes. She knew that big things were brewing, as they always were with her husband, and she would find out more about them in due course.

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Maxwell spent the rest of his life developing the Cavendish Laboratory, particularly the pioneering physics labs that would move physics out from under the unbending intellectual influences of pure mathematicians and into the hands of experimenters like us, in materials, objects, light, and the fundamental forces of nature. I stayed in his employ the entire time, helping with the design, development, contractor management, and high-level staff recruiting through the Cavendish opening in 1874 and his appointment as first Cavendish Professor of Experimental Physics.

Maxwell died in 1879. Because of my deep association with him over so many years and my deep understanding of his work the Cavendish has kept me on until now, as a teaching and lab associate.

But I feel it in my bones. Each winter, even if it is one of these puny, balmy English ones, is harder on them. It is time to enjoy the spaces in between, while there's still time left to do so.

As I finish packing, I consider seeking out the beautiful, bluish violet stone that held a special place on Maxwell's most favored library shelf in his office, wherever that office happened to be. Perhaps the stone is just down the corridor, fallen behind a cabinet or stacked between two books, as had been my beloved "Flyology."

Many visitors commented on its' rare beauty. No one had ever seen a stone like it. When asked about the origins of the stone Maxwell had to beg ignorance. It had been given to him by a neighboring family of wealthy sheep herders in Corsock in celebration of his Cavendish appointment. They had held the stone for several generations after the founder of the family's fortune had acquired it from the owner of an art studio partner of Leonardo da Vinci in Florence during the early years of the Renaissance.

That is as much as anybody knew, or knows, of the stone's provenance.

But I am sorry to say, my wish to find the stone is not to be. The stone disappeared shortly after Maxwell's death, lost, it was thought, in the general scramble to gather all of his scientific papers for safe-keeping.

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