

The Chemical Adventures of Sherlock Holmes: The Baker Street Burning

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The following story describes a chemical mystery with an emphasis on forensic chemistry, physical properties, and qualitative organic analysis. This is the ninth article in a series presenting a scientific problem in mystery form in the context of the popular and beloved characters Sherlock Holmes and Dr. Watson (1–8). There is a break in the story where the reader (students and teachers) can ponder and solve the mystery. Sherlock Holmes provides his solution in the paragraphs following this break.

The Story

“Watson! Wake up! Fire!” Sherlock Holmes had burst into my bedroom at 221B Baker Street and was violently shaking me as I struggled out of a dream-filled sleep into the real world. “Fire, Watson! Come with me, now!” He was fully dressed and his tall, thin form cast angular shadows on the walls as the light of dawn dimly illuminated my room. I scrambled to my feet, still reeling from being awakened so suddenly.

“Here, Holmes? Our flat?” It had immediately occurred to me that Holmes’s dubious habit of doing chemical research in our rooms had finally yielded the result I had feared for years.

“Nonsense, Watson,” he replied. “Not here, but nearby. Come!” Indeed, I glanced out my window and, without seeing the flames themselves, saw the black smoke of a fire drifting down Baker Street and heard the shouts of a few pedestrians who were present at this hour. The clanging of a bell announced that the fire brigade had arrived at the scene.

I hurried into my clothes and we flew down our staircase and into the street. It was August and overcast. During the night there had been a thunderstorm with fierce lightning. Dressed as always in our woolen tweed suits, we found the humidity stifling.

“At Gruner’s!” Holmes called out, and we ran down the block toward the conflagration, which had been consuming Gruner’s living quarters on the second floor of the two-story building. The smell of charred wood was intense. Nathan Gruner himself, the owner of the meat and sausage shop on the ground floor, stood on the street in his sleeping gown puffing nervously on a fragrant cigar. Next to him was a tall, uniformed police inspector whom I did not recognize, and beside the inspector was our well-known milk-delivery man, Jeremy Devon, a short, hairy man whose open and friendly manner had brightened for many years the early mornings of our Baker Street neighbors. Jeremy watched intently the activities of the firemen. I noticed that he was carrying a kerosene lantern, which he undoubtedly used to light his way on his predawn delivery runs. Holmes strode over to the group.

“Well, well, Inspector Merivale!” he said, cordially. “It has been a long time.”

“It has, Mr. Holmes, it has. It is a pleasure to see you again,” he replied. “However, I do wish that the occasion were a happier one.”

“Watson, Inspector Merivale has been one of my favorites at Scotland yard. He shines as a rare ray of light in the darkness that abounds!” Holmes smiled and bowed slightly in the direction of the Inspector. We exchanged the usual pleasantries, whereupon the mood immediately turned grave as we focused our attention to the fire. It had not taken long for the brigade to bring the blaze under control.

“Well, Mr. Gruner,” the Inspector inquired, “please tell us how this disaster came about.”

In his gown, the figure of the meat shop owner appeared squat and undignified. “I was sleeping, sir, sleeping very well for a change, and all I can tell you is that I heard our milkman shouting from the street ‘Fire! Fire!’ I was able to escape, as you can see. There’s no doubt that Jeremy here saved my life.”

“Weren’t a thing, Mr. Gruner,” replied the milkman. “Just doing my regular rounds, as usual. I’m always on the lookout for things.”

Holmes interjected, “So, Mr. Gruner, when you awoke the fire was already in your bedroom. Is that correct?”

“Correct, sir. I presume that the fire started there. When I escaped it was the only room in my building that was burning. I can’t think how it might have started. I had time only to grab my slippers and a fresh cigar. I am quite a heavy smoker, I am. Can never do without my stogie! How could the fire have started?”

“Well,” Inspector Merivale replied. “We don’t have to think too hard about that, do we?” He glared intently at Nathan Gruner and his cigar. Had Gruner himself started the fire by smoking in bed?

“What do you mean?” Gruner asked innocently.

Holmes interrupted. “The fire is out in your rooms, Mr. Gruner. Gentlemen, shall we inspect the damage?” Leaving the milkman in the street, Holmes and I, along with Gruner and Inspector Merivale, carefully ascended the stairs to the burned living quarters on the second floor. The fire had surely started there, since the lower staircase and first floor had not been touched by the flames. We entered the bedroom. Holmes glanced around at the blackened walls. The roof had burned through and the overcast sky was visible above us.

“Holmes,” I said. “Could last night’s lightning storm have caused this?” My friend ignored me. He was examining the door to Gruner’s flat.

“Mr. Gruner,” he asked, “do you lock this door at night?”

“No, Mr. Holmes, I don’t,” Gruner replied. “I like to have Jeremy put my milk bottles inside the door. They have been stolen a few times when they were left outside.”

“Ah,” said Holmes. “Not a good practice, I must say, not in these times. Hello! What have we here?” Holmes dropped to his knees, oblivious of the charred floor and of

his expensive woolen suit. He whipped out his glass and examined before him a narrow trail of darker soot, clearly discernible upon the bedroom floor. He crawled furiously along the trail leading toward the window, sniffing vigorously like a bloodhound. Suddenly Holmes stopped and produced an envelope and a penknife from his pocket. He scraped and collected a generous quantity of the soot. As we watched the Great Detective work, with my companions not hiding their astonishment, through the burned-out roof poured a new drenching rain that smothered the last of the fire's coals.

"I have all that I need here," Holmes exclaimed, and we descended the stairs to the first floor. Upon passing the entrance to the meat shop, Holmes inquired, "Mr. Gruner, I have been admiring your most excellent cigar, and I wonder if you would be so kind as to let me have one of the same brand? They are Cuban, are they not? Of the finest quality, I believe?"

"You flatter me, Mr. Holmes" he replied. "I shall be glad to give you a sample." Whereupon Nathan Gruner went into his shop and came out holding a Cuban cigar for Holmes.

Leaving Gruner at his shop, Holmes, Inspector Merivale, and I proceeded out onto Baker Street. But the wind had increased and the sudden summer storm pounded the pavement with pebble-sized rain drops. We were forced to enter an establishment a few doors down to escape the weather and found it to be occupied by a carpenter's workshop. The carpenter himself ceased a flurry of hammering and welcomed us.

"Gentlemen! Come in out of this storm! My name is Ian Northumberland. I am carpenter and proprietor. May I interest you in a fine cabinet?"

Holmes replied. "Thank you, Mr. Northumberland, but I am afraid not. We are still shaken by the tragedy up the block. Mr. Nathan Gruner very nearly lost his whole livelihood."

Mr. Northumberland's polite manner changed abruptly. "I do not care a wit about Gruner," he sneered. "That miser owes me and everyone in this neighborhood money, lots of it. Don't tell me about his so-called tragedy. I know that he owes Jeremy Devon for two months' worth of milk. And he owes me four pounds for three cherry-wood chopping blocks I made for his shop."

Embarrassed by this outburst I gazed about the shop, where I observed the usual array of saws, hammers, and planing tools. On his long bench were arranged thick bottles of varnish, a glass retort, and various wood-crafted projects half completed. The floor was scattered with high piles of wood shavings and sawdust. As Holmes picked up and examined the sawdust, his eyes met mine and I noticed the familiar gleam. He was in his element. He was on a case.

"The storm has abated, gentlemen!" he cried. "Shall we proceed to 221B?" The storm *had* stopped, but the humidity was even more stifling. Nevertheless, Sherlock Holmes was in an unusually good humor.

"Holmes," I said, "you are up to something. We have worked together too long for me to miss it."

"Good old Watson," he cried cheerfully. "Always the keen observer! Not much to tell yet. Too soon. But the game is afoot, my good fellow. The game is afoot."

Soon we had settled in at 221B, accompanied by Inspector Merivale. Holmes was energetic. "I must perform a chemical analysis this moment, Watson, before the...well, never mind that now. However, please observe the steps of my experiments. Inspector, you will be especially interested in the results. I will dictate this aloud to you, Watson, so that it can be accurately recorded for your readers."

Holmes lit up the cigar which he had obtained from Nathan Gruner and began his work. He pulled from his jacket pocket the envelope containing the sooty residue from Gruner's room. "Note please, gentlemen, how I now extract this soot with 25 mL of plain water. I stir it thusly and I filter it through this cloth, like so. Now, I add to the filtrate this solution containing potassium dichromate and sulfuric acid. Quite an orange color, Inspector? Yes. Well, I now distill a portion of this solution through this retort."

With a flaming burner, and with the cigar hanging from the corner of his mouth, Holmes performed the distillation. The orange liquid boiled furiously in the round flask. The vapors rose through the curved glass of the retort and rolled colorless into the receiver jar. Curiously, I smelled something very familiar. It was a preservative odor, as from a hospital anatomy laboratory.

"Here is the distillate. Now I add to it, just 1 mL of purified dimethylaniline. I have that right here. Now, gentlemen, if I am correct in my suppositions, we will have something interesting to talk about in a few hours!"

During this time, Holmes ignored us and stood in his music corner playing his precious violin passionately. Inspector Merivale and I occupied ourselves well enough discussing the recent series of outrages in London, where vile criminals had been releasing scores of rats into crowded opera houses.

"Now!" Holmes stopped playing abruptly and clapped his hands together. "We may proceed. I concentrate our solution to about a third of its volume and I add this dark powder of lead dioxide. Watch, gentlemen."

Holmes added the powder and swirled the contents of his flask. A deep blue color developed before our eyes.

"What does it mean, Holmes?" I asked. "Did the lightning storm cause the fire? Was it an act of God? Was it an accident from Gruner's smoking? Did a criminal start this fire?"

"It means, my good friends, that this case is solved," he replied.

Stop Here and Solve the Mystery

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This mystery can be solved with careful observation and by applying some principles of qualitative analysis and forensic chemistry. Can you answer these questions? Sherlock Holmes reveals his solution on the following page.

1. Why did Holmes collect the fire ash in the particular place that he did?
2. What chemical reaction would be caused by a potassium dichromate solution?
3. What did the chemical analysis of the soot reveal?
4. Who or what started the fire in Gruner's flat?

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The Solution

"Solved, Mr. Holmes? Solved?" the Inspector queried. "It's not much of a case, really. A chain smoker lights afire his own flat!"

"Not possible, Inspector. I am afraid you have missed the mark this time," Holmes replied.

"I yield to you then, Mr. Holmes. Do enlighten me." I was impressed that the Inspector's tone was, indeed, that of admiration and respect.

"When we investigated Gruner's flat and examined the damage, you noticed that my attention was drawn to the darkened trail of soot, a narrow trail leading to the window. What does this suggest?" The Inspector and I were silent, transfixed by Holmes's startling revelations.

"It suggests—no, proves, gentlemen—*proves* that the fire was deliberately started with a flammable liquid. The liquid was splashed around the bedroom and then poured in a narrow trail across the floor *to the window curtains*, where the fire would be accelerated. Gruner's cigar did not start this fire, nor did lightning! The existence of this trail speaks clearly of a crime."

Inspector Merivale rose from his chair. "I will begin an investigation, Mr. Holmes. We will find the culprit."

"Inspector, Inspector!" Holmes laughed loudly. "I have spared you the trouble. When I told you that the case was solved, I meant it." He chuckled merrily and I could tell that Sherlock Holmes was enjoying the moment. Holmes waved away an exclamation from Merivale and continued.

"I had my suspicions as to what the flammable liquid might be. My nose, gentlemen, is by now quite discriminating in distinguishing chemicals. It is a trait common to most chemists of our day. In any case, I proceeded assuming that the accelerant was what I thought it was, and water soluble. It turned out to be so. Moreover, the volatility of the substance required immediate analysis of the soot."

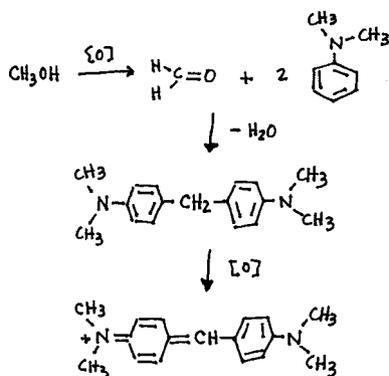
"Holmes," I interjected, "did you notice the kerosene lantern that the milkman carried with him? Kerosene is of course flammable and very volatile."

"Excellent, Watson!" my friend replied. "Had my analysis turned out otherwise, the lantern of Jeremy Devon would have received immediate attention. However, as I have said, the liquid in question is water soluble, whereas kerosene is decidedly not!"

Holmes clapped me on the back, adjusted the cigar in his mouth, and continued.

"I extracted it with water and filtered off the remaining ash. Potassium dichromate is an *oxidizing agent*, which will convert any methyl alcohol present in the extract to formaldehyde, which is readily separated from the mixture by distillation. Formaldehyde is known to slowly condense with dimethylaniline. Hence our long wait. Upon further oxidation of the condensation product with lead dioxide, a blue dye is formed for all to see! This is a recently published procedure for detecting wood alcohol, also known to the chemist as *methyl alcohol* (9, 10). It is very important to keep up with current results in chemical research. I recommend it. Here, Watson, I have written the chemical equations in my notebook if you care to examine them.

(The equations from Holmes' notebook are reproduced in the Figure.)



Jottings in Sherlock Holmes's own hand showing his equations for the detection of methyl alcohol. Note the oxidation of methanol to formaldehyde, the condensation of formaldehyde and dimethylaniline, and the final oxidation to produce the blue dye.

"Yes, all right, Mr. Holmes," the Inspector said thoughtfully, "but who is the arsonist? Was it Gruner? It could have been him."

"The evidence leads in another direction, Inspector," Holmes replied. "Tell me, did you notice anything out-of-the-ordinary in Ian Northumberland's shop? Which, by the way, we were very fortunate to enter; there is an element of luck in any criminal investigation."

"Unusual, Mr. Holmes? No, I can't say that I did."

"Watson," Holmes turned to me, "what would a carpenter use a retort for in his work?"

I thought for a moment. "I do not know, Holmes."

"Neither do I," he replied. "A carpenter certainly does not have a need to do distillations in his woodworking."

"What is the significance of this line, Mr. Holmes?" the Inspector said. "What is the connection to the fire?"

Holmes tented his fingers in front of him and replied, "A most convenient source of methyl alcohol is the destructive distillation of wood—sawdust and wood shavings, deep piles of which we find in every corner of Northumberland's shop. Wood alcohol, Watson, is quite distinct from *grain* alcohol, which is ethyl alcohol. By the way, the chemical test that I performed will nicely distinguish between the two of them. So, the case is solved. We even learned of a motive, since the carpenter most unwisely volunteered his animosity toward Nathan Gruner. Did Northumberland have the opportunity to start the fire? Of course. As you recall, we noted that Gruner did not lock the door to his flat. Means, motive, opportunity. You may take it from there, Inspector!"

"One more thing, Holmes," I asked. "Why the attention to Gruner's cigar? Why did you procure a sample of his Cuban stock at such an inopportune time?"

"Because, Watson," replied Sherlock Holmes, "I like a good cigar."

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