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The Chemical Adventures of Sherlock Holmes

The Hound of Henry Armitage

Thomas G. Waddell and Thomas R. Rybolt

University of Tennessee at Chattanooga, Chattanooga, TN 37403

The following story describes a chemical mystery with an emphasis on physical properties and balancing reaction equations. This is the sixth 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(1-5). 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

The case that I am about to relate shall not be called an "adventure", as are so many of the exploits of my friend and colleague Sherlock Holmes. In thinking about it as I have done so many times since those days, I am drawn to a passage of Dostoevsky "What Is Hell? It is the suffering of being unable to love." Enough time has passed and it is now fitting to reveal this story, where once again Sherlock Holmes the Chemist figures predominantly, and taste, aroma, and the absence of kindness and understanding are featured. To call such a report an "adventure" would itself deny the basic horror of the tale and the tragic reality of human nature.

Death and misery found center stage on a beautiful and cool spring day in April. I had purchased a new coat and set out upon my morning rounds which included a visit to an elderly man named Henry Armitage. I was returning to 221B Baker Street from the home of this elderly patient, a retired London policeman. His despondency at living alone had taken an acute turn that very morning when he discovered that his hound, his only companion, had been poisoned. I intended to take special care of this patient, Mr. Henry Armitage, and I intended to place the brutal poisoning in the hands of Sherlock Holmes.

"What is it, Watson?" he said, looking up at me from a dusty manuscript spread out before him. "What calamity has befallen you on a day such as this?"

I was irritated at his levity. "Why, Holmes!" I replied sarcastically, "this is a perfect opportunity for you to use your deductive powers. Note the tear on my cheek; observe my red and angry eyes. Check, if you will, how the hand upon my cane shakes. Really, Holmes, I ... please" I could not finish.

He arose from his chair. "Watson, I do apologize. Relate to me what has occurred."

"It's all right, Holmes. You could not have known. I am a bit taken by this one. It is a situation, a crime. I shall need your assistance in this matter."

"I am at your service, my friend. As always, to be sure."

"My elderly patient, Holmes, Henry Armitage. Someone poisoned his dog. He is alone now. This cannot happen. I am sorry, but..."

"Relate the facts, Watson." Holmes penetrating eyes appeared to be unmoved by my emotion.

"It is true, I suppose, that Mr. Armitage is not a popular man amongst his neighbors. But he is alone and angry, Holmes. His wife died years ago. I know that he is impatient and belligerent. He curses children that play on his

steps; he has called the police when the roomer in the cellar flat has a friend in. Also, he complains frequently to the publisher when the boy throws the *Times* too far from his door."

"When was the dog found? Dead, I presume?"

"Yes, Holmes, yes. Just an hour or so ago. As far as I know, the poor man is still grieving over the corpse of his last friend."

"Shall we go back to visit him, Watson? You can provide your usual counsel, and I, as you know, have varied experiences with poisoning cases."

We took a cab to Edmonton Street near Curzon Square where Henry Armitage lived. As we clattered to a stop at our destination, Holmes told the cabby to wait for us and advanced him a generous fare. The door to Mr. Armitage's flat was ajar and I called in to him. Not a sound could be heard in reply. Holmes quickly stepped into the living quarters and we immediately saw in the back of the house the old man himself on his knees beside the dark body of his hound.

"Mr. Armitage, this is Sherlock Holmes. We have come to help you."

"Holmes?" he said looking up. "Thank you for coming. I think that ..." But Holmes was not listening. He had picked up the dog's bowl, now empty, and was vigorously sniffing, not unlike the hound itself, at the crusted remains of the last meal.

"Mr. Armitage," he said kindly. "Would you be able to tell us who in your neighborhood might be angry or upset with you?"

"I knew it," the old man snapped. "He was poisoned, wasn't he? It was someone in the neighborhood. I am not surprised."

"It is definite that your dog has been poisoned, sir. Again, can you tell me with whom you have had differences lately?"

"Oh yes," Mr. Armitage replied. "That confounded football player who lives downstairs. He invites his rowdies in late at least once a week. People have so little consideration. The *Times* delivery boy will not listen to me when I tell him where to place the paper. Curse them all! And the man across the street who owns the cleaners, always carrying on about a new method he has of cleaning clothes. His adolescent son, a school dropout, gambles on my steps every afternoon. An evil child." The very thought of the adolescent seemed to terrorize Mr. Armitage and I could sense his anger rising.

I tried to console him. "People can be difficult, but you must take care to be patient."

"And that teacher down the block, Dr. Watson, the music teacher. His horn can be heard at all hours day and night, I tell you, day and night."

Suddenly Holmes interjected, "Watson, let me borrow your coat."

"My new coat, Holmes? Whatever for?"

"I need to wrap the body of Mr. Armitage's dog. We are going to take it with us," he replied matter-of-factly.

"What!" I exclaimed. "Holmes, this is really too much. My good coat is quite new. This is not appropriate at all." But it was useless to argue with him as he quickly slipped the coat off my shoulders and rolled the cadaver of the hound upon it.

"We will take very good care of your departed friend, Mr. Armitage. And if it is any consolation to you, we will soon report your tormentor to Scotland Yard. I am sure that laws have been broken and perhaps we will realize some justice yet from all of this cruelty."

"Do you know who did it, Holmes?" I asked.

"I have a notion, good fellow, but, of course, at this point it is only a hypothesis. A very good one, to be sure."

Holmes lifted the bundle from the floor and held it to his chest as if it were an infant. As we climbed into the waiting cab, the driver looked back over his shoulder.

"'Pon my word, sah! Two gents such as yourself should best learn to carry a baby! The missus would tell ya that the blood'l all run to its ed, it will!"

The beauty of the cool Spring day, the insolence of the cabby, and the cruel reality of life swirled in my head. I did not know how to feel. I looked over at Holmes who only looked back at me, smiling.

An hour later I was in my chair at 221B Baker Street. Holmes was in his laboratory corner and I could hear him humming. In the background was the usual clattering and clanking of laboratory equipment. I did not want to know what he was doing with the hound of Henry Armitage.

Time passed. I do not know how long I sat in my chair. I could not read. I could only stare at the old bullet holes in the wall above the mantle where Holmes recorded the results of his target practice. Suddenly, Holmes called to me.

"Watson, come here. I need you." These familiar words were so welcome that I jumped from my chair and rushed to him in the darkened laboratory.

"Hold this flask, Watson. I ain doing a steam distillation."

"What are you distilling, Holmes?" I asked tentatively.

"Will you be recording this case for your readers?" he replied. "If so, I shall whisper in your ear the source of this vile fluid." Holmes leaned toward me and said quietly. "It is only the dog's urine, Watson. Hardly a subject of genteel discourse, I admit, but nevertheless a common encounter in forensic chemistry. Your *Journal* will not object I am sure."

Horrified, I held the flask as the first few milliliters of distillate flowed into it. "We can stop at this point," he said, rubbing his hands together. "Hold it up to the light and tell me what you see."

"Why, Holmes, look! There are distinct droplets of a heavy liquid at the bottom of the aqueous distillate. Something more dense than water and not miscible with it."

"Quite so, Watson." Using a long, bulbed pipet, Holmes drew up a quantity of the dense droplets and transferred the liquid to a test tube.

"Describe the aroma of this liquid, Watson. Take a little sniff of it."

"No, Holmes, I will not. That liquid is ..."

"No, no, my good fellow," he replied. "It is no longer dog urine! Heavens, Watson, where is your scientific curiosity?" He took the test tube from me, sniffed the contents and, incredibly, placed a drop of it on his thumb and tasted it!

"A sweet and unpleasant taste and aroma, Watson. Quite overpowering and sickeningly sweet. ***Do not ever taste chemicals. This one in particular is especially dangerous.*** The readers of your *Journal* must not follow my example in this. Some of my habits are bad indeed. I am now going to add some aniline and potassium hydroxide. This is not dangerous, Watson, but if I am right, it is again rather unpleasant."

Indeed, upon addition of these chemicals, a penetrating, repulsive odor filled our flat. I was overcome; I covered my face with a handkerchief and made my way to the door.

Throughout his life Holmes seemed unaffected by the tragedies of the world and maintained, as Melville has said, a temperature of his own. Even now, as I coughed and hacked in the cloud of lachrymatory gas, he calmly scribbled an equation on a slip of paper and handed it to me. "If you can balance this equation, Watson, you can solve this mystery." I looked at the page as best I could and saw the following equation with the formula of a reactant clearly missing.



Holmes paced back and forth with his hands clasped behind his back. "One part aniline, three parts potassium hydroxide, and one part unknown poison yields one part phenylisocyanide, three parts potassium chloride, and three parts water. The missing reactant can be identified by balancing the equation with respect to all atoms involved. The product phenylisocyanide is what caused your coughing, Watson, and it is derived by this reaction from that missing chemical which was the poison deliberately placed in the hound's food."

"But is the case solved? How could you know the vandal?"

"You know my methods, Watson," he replied. "Apply them now. All the information lies before you."

Stop Here

This mystery can be solved by application of the principles of physical properties and balancing of chemical equations. Can you answer these questions? Sherlock Holmes reveals his solution in the paragraphs that follow.

1. What chemical compound was used to poison Mr. Armitage's dog?
2. What physical properties led Holmes to suspect the presence of this compound?
3. Of course, the four suspects are the football player, the gambling adolescent, the music teacher, and the newsboy. Which one poisoned the hound?

The Solution

"I can follow you part of the way," I submitted. "You undoubtedly detected a foreign substance in the dog food due to a characteristic aroma."

"Correct, Watson," Holmes replied. "And as a chemist I knew immediately that the poison was *volatile*, confirmed by its steam distillation. We observed the compound to be a liquid at room temperature, immiscible with water, and having a density greater than 1.00! The unpleasant sweetness of it was also very helpful. The possibilities were quite limited at that point, Watson."

"I would think, Holmes," I added, "that you would be looking for a chemical that might be available to someone in a special circumstance not shared by all the suspects."

"Capital, Watson! On target again, my good fellow," Holmes declared. "I formed a working hypothesis and performed a known chemical test for such a poisonous liquid meeting all these criteria. Did you balance that equation, Watson? The equation confirms it!"

"I can do it, Holmes. I remember that much chemistry. Let me see ... the missing reactant must have chlorine ... 3 units to balance Cl in the product!"

"Very good, Watson. Go on with it."

"It gets more complex now, but look, there is one extra carbon atom in the products! Is CCl_3 the compound?"

"Carbon makes **four** bonds, Watson, not three," said Holmes with a frown.

"I have it! CHCl_3 balances the equation! That's *chloroform*, Holmes! Of course. It all is consistent." My mood was elevated with my contribution to solving this part of the case. But suddenly I remembered Mr. Armitage and his tragic life. "Who did it, Holmes? What kind of a person are we dealing with?"

"A person without a conscience I am afraid," he replied. "While you dozed in your chair (yes, you did sleep) I spoke with Chappy, a sub-lieutenant in our Baker Street Irregulars. He knows the vandal, Watson."

"But how can you know who it is from the evidence? I do not follow you."

"Let us assume," he continued, "that Mr. Armitage named for us the four neighbors representing the most serious conflicts. That is very likely I think. If we accept this, we are then looking for the one person with easy access to chloroform. If we find such a person among the four suspects, we have our vandal."

I recalled the suspects. "The music teacher, the football player, the gambling adolescent, and the newsboy. I still do not see it, Holmes. What am I missing?"

"The cleaner," he said softly. "The cleaner."

"The gambler's father!" I saw it all now. "Chloroform is an organic compound that could be used as a grease spot remover, Holmes! The cleaner's new method Armitage referred to. The school dropout poisoned the old man's dog."

"Chappy told me about him, Watson. He is 15 years old and an habitual criminal. Mr. Armitage crossed the path of the wrong person. The boy is dangerous. Scotland Yard is watching him but I am afraid that we can expect no happy ending for the players in Henry Armitage's neighborhood."

"They all suffer, Holmes. I see no kindness and understanding in any of them. Is there no hope for us?"

"I think there is hope for you and your coat," said Holmes as he handed me a foul smelling lump of cloth—my coat. "Dark stains on cloth may be cleaned more easily than the darkness in our souls. I suggest a cleaner for the coat and a long walk for you. I hear that the Edmonton street cleaners near Curzon square is recommended, but if I were you I shouldn't take any tea while there."

"And you, Holmes?"

"While your coat is cleaned and you walk, I shall play."

Before I could reply, he had turned and picked up his violin. He tightened the bow and tucked the instrument under his chin. As music filled the room, I could tell that his thoughts were already far away.

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