

The Case of the Cooling Cadaver

It was a dark and stormy night. The three members of **Math Iz Us** huddled in their sleeping bags and listened to the cold rain lashing against the outside of their tent. When Heather had first suggested it, the idea of using their very generous fee from the Government of Mediocria to finance a vacation spent cycling across Britain had appealed to them all. But the soggy British weather was not cooperating, and now they found themselves marooned in a tent on the grounds of a large old country estate. When they had arrived bedraggled at the door of the mansion, the elderly manservant who answered had taken pity on them - not enough pity to invite them in to warm dry beds, but enough to allow them to pitch their tent on the lawn a short distance from the building. "Lord Boddy is having some guests here this weekend," he quavered, "and there isn't any room, you know. Professor Prune and Colonel Catsup have the Regency bedrooms on the second floor, and Miss Carmine is occupying the vice-regal suite. There just isn't any room." The students accepted their fate stoically, and lay with their eyes open listening to the patter of the rain.

After an hour or so Sasha was roused from a light sleep by the sound of a heavy old door creaking on its hinges and then slamming shut. This was followed by the sound of jocular male voices and strange dull thuds. The rain had tapered off to a light drizzle, and Sasha could not contain his curiosity. Glancing at his watch, which read 10 PM, he unzipped the door of the tent and looked out. Two men were engaged in a game of croquet. They seemed to be in high spirits, even though the rain soon began to come down harder. For a full hour they played, joked, and smoked enormous cigars, oblivious to the foul weather. Finally, just as the hands of Sasha's watch read 11 PM, a large chunk of masonry, loosened by the incessant rain, slid off the edge of the roof and landed with a wet thud on top of a recently played croquet ball. This seemed to startle the croquet players, and they vanished into the mansion.

Not more than a moment later the door opened and one of the croquet players re-emerged, accompanied by a young woman. They went into a gazebo, sat down, and began a low, animated conversation. By now Li was awake. "What's going on?" he asked Sasha. "For a wet night there's a lot of traffic outside," replied Sasha. "First there were two guys played croquet, and now one of them is back with a woman." "Let's watch," said Li; and they did. But there was little to see; after an hour of earnest conversation the gazebo occupants abruptly got up and disappeared into the house at midnight.

Almost immediately thereafter a light switched on in a ground story room. Through the slightly open window came sounds of chatter punctuated by silence, together with clinking glasses. By now Heather was awake too. The rain had stopped, and all of them were restless, so they crept out of the tent and carefully made their way to a position just below the open window. Raising themselves carefully so as not to be observed, they looked in. A man and a woman were playing cribbage, drinking, and laughing. Sasha recognized the players as the woman in the gazebo, together with the croquet player who had not accompanied her to the gazebo. Crouching in cold wet bushes watching other people play cribbage is not an enjoyable way to pass time, and soon our heroes were back in their tent. But Heather could not sleep, and she lay listening to the sounds of the game until finally, at 1 AM (according to her watch), the noise ceased and the lights went out.

Almost immediately the trio was startled by the wail of sirens. Looking out of the tent, they saw that the mansion was ablaze with lights and police officers were swarming across the property. One of them approached the tent. "There's been an incident," he said. "You had better get dressed and come inside. You may need to assist us with our inquiries."

Inside they were led to a small wood-paneled room. Two sides held floor-to-ceiling bookshelves, while a third was lined with glass cases containing displays of insects. A large oak desk was pushed against the fourth wall. On the desk were a tensor light, a microscope, and some slides with mounted insects. The elderly manservant stood in the doorway wringing his hands. On the floor was the corpse of a large, white-haired man with a massive gash on the back of his head, surrounded by a pool of blood. A heavy brass candlestick lay nearby.

"As you can see, Lord Boddy has been murdered in the study with the candlestick," said an officer. "We don't know by whom. Our pathologist will be here soon, but in the meantime we must detain everyone."

"Perhaps we can help," said Li. "It will be important to know the time of the murder, and that can sometimes

be determined by the temperature of the corpse. Is there a thermometer about?"

"I'll get one," said the manservant, and disappeared.

"Poor Sherlock," said the officer. "He's devastated. Old Sherlock Marples has been Lord Boddy's personal servant for the last 47 years. He's devoted his life to Boddy's welfare. And before you ask, no, he isn't a suspect. He's much too frail to deliver a blow like that. Besides, everyone knows he holds - held - Boddy in high esteem."

"I've checked the entire building," said another officer, poking his head in the door. "As Sherlock told us, all entrances are locked and there is no sign of forced entry. It must have been an inside job. Unless one of these..." he added, nodding towards the trio.

"No," said the first officer, "they aren't suspects. Sherlock says they were outside when he locked up, and only one door has been used since then. They had no access to it when the others were going in and out. There are only three suspects. We have them under guard in the drawing room."

"And those are..." began Sasha.

"Colonel Catsup, Professor Prune, and Miss Carmine. When you investigate a murder, you look for those with both motive and opportunity. Without going into the distasteful details, we happen to know that each one had a motive. And each is strong enough to have struck the fatal blow. So, we must decide who had the opportunity. Unfortunately there are no fingerprints on anything."

Sherlock returned with a rectal thermometer. "His Lordship always spent his evenings the same way," he said. "At 10 PM he would say goodnight, and then he would come here to his study to work on his collection of rare Peruvian beetles. Tonight I saw him enter the study myself, exactly at 10 PM. And then when I came by later and looked in because the light was still on, I found him. It's awful..."

"What time was that?" asked the officer. "About 1:00 AM," replied Sherlock.

"Perhaps I could have this," said Li, taking the thermometer. "Now let me see..." Selecting a convenient orifice, Li took the internal temperature of the corpse. "Let's see, it's 1:30 AM and the temperature is 32° C. Now we ought to be able to use Newton's law of cooling to determine the time of death. Because at that time, if Lord Boddy's physiology was normal..."

"Oh, it was, it was!" interrupted Sherlock. "His physician always said that he was exactly normal in every way!"

"...was normal, then his body temperature was 37° C when he died, and began to cool according to Newton's law of cooling," finished Li. "So once we know what temperature the study is kept at, we can..."

"Is there a wall thermometer in here?" asked Sasha.

"I'm afraid not," muttered Sherlock. "And in fact the temperature in this room seems to vary according to what direction the wind is blowing, what the outside temperature is...lots of things. This building is centuries old, you know. It takes a long time for the temperature to change, and in fact it seems exactly the same now as it was when I saw Lord Boddy into here at 10 PM."

"In that case everyone must leave immediately," exclaimed Heather. "We don't want the temperature of the study to be warmed by our collective body heat. We want it to stay exactly where it is. Otherwise the mathematics we're going to have to do will become impossibly complicated. Everyone out! But Li, you need to come back later and get some more data - preferably at well separated times..."

"I'm sorry, ma'am," said the police officer, clearly impressed by the trio's knowledge, "but we can't detain the guests in the drawing room for too long. Already they are getting restless, and Colonel Catsup is threatening to call his lawyer. Our best hope is to determine the time of murder quickly, confront them with it, and see what happens."

"Can you wait for just two more hours?" pleaded Heather. "That way we can get two more readings separated by hour intervals - I hope that will be long enough - and do our calculations."

“I think we can manage two or three more hours,” replied the policeman, “but that’s the limit.”

So the study lay empty and undisturbed for another two hours, except when Li took another pair of readings. At 2:30 AM the corpse’s temperature was 30° C, while by 3:30 AM it had sunk to 28.25° C.

“Now comes the tough part,” said Sasha. “We don’t know when the murder occurred, although Sherlock has assured us that we do know Lord Boddy’s temperature at that time. But we have three sets of readings, and three unknowns - the temperature of the study, the time of the murder, and the proportionality constant in Newton’s Law. From what I know of matrix algebra, that should be enough.”

“But we want to use some ingenious algebraic manipulation, not matrix algebra,” said Li.

Each of the trio scribbled. When they compared notes and saw they had reached the same conclusion, they let out a sigh of relief.

“You young people have done an excellent job!” came a voice from just outside the door. “Allow me to introduce myself. I’m Inspector Vance McFrito from Scotland Yard. Now that you have the essential piece of the puzzle in place, please accompany me to the drawing room.”

When they entered the drawing room, our heroes were startled to see the three house guests in formal evening dress. McFrito wore the same under his trench coat. Sherlock served glasses of port, and McFrito leaned against the mantelpiece, warming himself in front of a blazing fire.

“You are probably wondering why I asked you all here,” began McFrito. “These young people have pinpointed the time of the murder. All we need to know now is who has no alibi for that time. First, please introduce yourselves.”

When the guests did so, our heroes immediately recognized that Catsup and Prune had played croquet, while Catsup had conducted the *tete-a-tete* with Carmine in the gazebo. Carmine and Prune had been the cribbage players. When Heather announced the time of the murder, one of the guests leapt up. “Yes, I did it, and I’m glad! I was going to do it in the kitchen with the knife but I missed my chance - that’s the way the dice roll. I wasn’t counting on a trio of snotty math students messing up my plans.”

“Take this pathetic creature away,” said McFrito to his officers. “And, if you would be so kind,” he added, turning to the students, “I would appreciate....”

“A complete written report, including a detailed justification of the mathematical analysis that we used to determine the time of murder. Because, of course, you’re something of a math freak,” chorused the members of **Math Iz Us**.

“Why, yes,” responded McFrito. “How did you know?”

1. Whodunnit? When?
2. Give a detailed explanation of how you arrived at your conclusion. All the mathematical reasoning should be presented and justified. Your explanation should be in the form of a report to McFrito.

Due: Monday, December 2nd.