

17 | Hooke's Law

Mr Carey finished giving the instructions and started to walk around the class. It was their science lesson, and he had told them to put some weights on a spring and measure the length of the spring. They had to keep measuring the length of the spring for different weights and then draw a graph showing weight against length.

Luigi was working in a group with Andy, Jenny and Greta. Andy wasn't quite sure what they had to do. "You just put the weight on, write down what it was, measure the spring and write that next to it, Andy," said Luigi. "It's easy."

At the bench where Felicity was working with Marek, Conchita and Tom, they had found a 5 kilogram weight in the drawer. Conchita suggested they hang it from the spring first, instead of the little weights Mr Carey had given them. Felicity and Marek thought they shouldn't, but Tom grabbed it before anyone could stop him. The heavy weight dropped, nearly straightening the spring and snapping it at the top before hitting the floor with a thud.

"What was that?" exclaimed Mr Carey from the other side of the room.

"Nothing," Tom said quickly. "I just knocked my bag off the bench."

"Well, it shouldn't have been on the bench," Mr Carey snapped. "That's why we have rules."

"You'll have to tell him sometime," Felicity hissed. "He'll find out that you broke his spring sooner or later."

At another bench, Sarah, Tessa, Alex and Phong were having some trouble, though they didn't realise it. Each of them was making a measurement in turn, but they did not understand between them just exactly what they were measuring. Sarah measured the spring to its bottom, while Phong was measuring only the spiral part of the spring because, as he reasoned, only that part of the spring was stretching. Alex had broken off the end of his ruler some time ago, so he'd cut it off square at the 1 centimetre mark. Now he'd forgotten about that and just put that end of the ruler at the top. Tessa was measuring with her mum's old ruler that was only marked in inches.

The class was a buzz of activity as everyone worked on the task. Mr Carey went around the room helping, though he tended to answer questions with a question of his own. Some of the students found this really annoying: they wanted to know the *answer*. When the bell rang, Tom managed to stuff the broken spring in the spring box without Mr Carey noticing and they all happily left the room for lunch break.

Alex puzzled over his science homework that night. He was pretty certain that the points on his graph ought to make a straight line, because that's usually what his science experiment graphs looked like. But his didn't. Suddenly he saw that if he drew a sort of flattish M, he could pretty well get all the points on it. As for the conclusion, he knew that Mr Carey was fond of saying: "There is a straight line relationship ...", so he wrote: "There is a zigzag line relationship between weight and length."

In her room, Felicity was also having problems. She had been relieved when Tom had gotten away with having broken the spring, but now she wasn't so sure. Felicity had surreptitiously measured the stretched spring, so at least she had one point to graph, but she wondered: "How can you draw a line with only one point?" Perhaps she could draw it to where the zeros were on the graph? After thinking about that for a while, she thought it wouldn't be right, but she didn't know why.

"OK," Mr Carey said, "get your books out and we'll look at yesterday's experiment." After much shuffling, the students had their books open in front of them. "You should have found that the points on your graph made a straight line. This proves that the more weight there is on a spring, the longer it gets. That's Hooke's Law. What's more, if you double the weight, you double the length of the spring."

"But we didn't get a straight line, Mr Carey." Alex had his hand up, but he blurted out his comment before Mr Carey nodded to him.

"You have to wait until I call on you before you speak, Alex," reminded Mr Carey. "That's the law in this classroom."

"Alex's broken the law twice," sniggered someone at the back of the room.

"And we broke Hooke's Law," added Felicity, "because Tom broke the spring."

"Quiet now. I saw no hands up," barked Mr Carey. "But what's that you're saying, Felicity? Who broke the spring? *Did* you break it, Tom?"

"Yes," Tom glared at Felicity. "I just wanted to try a 5 kilogram weight."

"But Felicity's right," Luigi interjected. "If the spring broke, then they did break Hooke's Law."

"Another one without his hand up," sighed Mr Carey. "I guess we're not going to get on until I let you talk this out. OK, but let's at least try to talk one at a time. Now come on, Luigi, explain yourself."

"Well, you said that Hooke's Law is that a spring gets longer when you apply more weight. And that's what I got. I figured out this relationship ..." There were a few groans around the room. Luigi was always explaining things in figures, not words, like normal people did. "First you have to take 20 millimetres off the length measurements, because that's how long the spring is to start with."

"Uhuh," said Mr Carey, trying to summarise what Luigi was saying on the board. "And then what?"

"Then you multiply the number of grams by 0.3 to get the extra millimetres you have to add on."

"Can you explain that to the others?"

"Sure," said Luigi. "The spring was 20 millimetres long to begin with and if you put x grams on it, it gets longer by 0.3 times x millimetres."

"That's explaining?" wondered Greta.

"Well, we put 500 grams on," continued Luigi, looking straight at Greta, "and it measured 170 millimetres. That's the original 20 plus 150, 'cos 150 is 0.3×500 ."

"Oh," said Greta.

"But the point is," continued Luigi, "when Felicity put ..."

"Tom put!" interjected Felicity.

"I mean, when Tom put the 5 kilogram mass on – that's 5000 grams – then the spring should have been 1520 millimetres long. But it wasn't. It broke. So that means the law is wrong."

"I measured the spring after it broke," said Felicity, "and it was 110 centimetres long."

"Well, that's because the law doesn't hold ..." started Mr Carey.

"Like the spring," muttered Tom.

"... when the weight is too heavy for the strength of the spring," continued Mr Carey, ignoring Tom. "We can't push our results past that point."

"Push our results?" echoed Felicity.

"If we only measure what happens between, say, here and here," said Mr Carey, drawing a straight line on the board, "then we can sometimes predict what will happen here," as he extended the line, "beyond where we did our measurements."

"But how do we know that will work?" asked Andy.

"We don't," interjected Luigi. "In fact with the spring it didn't."

"You're right, Luigi," continued Mr Carey. "We have to be careful whenever we push our results further because some other factor may become important, like the strength of the spring in this case."

Just then the bell went and Mr Carey told the class to pack up and leave. As he went out the door, Luigi turned to Alex and said, "Gee that was great. I wish we could talk more about our experiments. We don't usually get enough time to think about what they mean."

"Well, it didn't seem so great to me," grumbled Alex. "I never did work out why my zigzag relationship wasn't right. The experiment proved it, didn't it?"