The Science of *The Longest Night of Charlie Noon*

From secret codes to the mysteries of time itself, here's more about the real-life science in *The Longest Night of Charlie Noon.*

Can we do this whole thing in code?

-. --- (That's "No" in Morse code.) However, if we were going to use a code to communicate, then Morse code would be perfect. Invented by Samuel Morse in 1838, Morse code assigns a unique combination of dots and/or dashes to every letter in the alphabet. Using electrical pulses, these dots and dashes can be transmitted via telegraph wires or by radio waves to send messages over long distances.

How did people crack the code?

Telegraph operators translated the messages they sent into the Morse-code signaling alphabet and those they received

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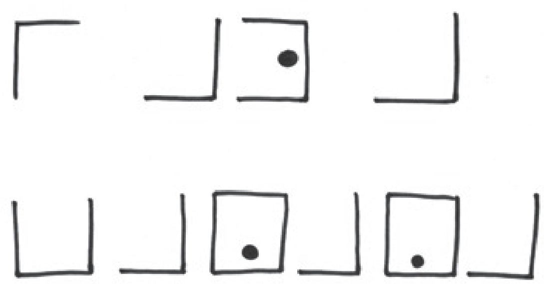
into English letters. Some telegraph operators became so skilled at Morse code that they could work out what a message said just by listening to the clicking of the telegraph. Samuel Morse designed the code so that the most frequently used letters could be entered with the least effort. For example, the letter "E" is coded as a dot and the letter "T" as a dash.

How can I solve this secret message I've been sent?



In *The Longest Night of Charlie Noon,* Johnny shows Charlie and Dizzy the Freemasons' code, also known as the pigpen cipher, and that is what this message has been sent in. It was given this name because the grids look like a drawing of the pens where farmers would keep their pigs!

To work out what this message means without cheating and looking back at chapter seven, here's what you need to do.

You can see that the message seems to be four words long, with two of the words in the first line being single-

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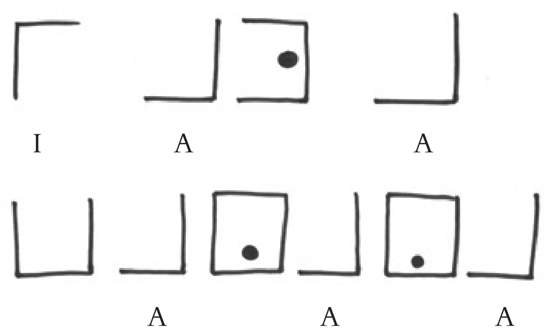
letter words. There are only two single-letter words in the English language—"a" and "I"—so we can guess that the first word of the message might be "A" and the third word "I" or the first word "I" and the third word "a." Let's take a look at the other words for more clues.

The second word starts with the same symbol as the third word, and the fourth word includes this symbol three times. We could try dropping the letter "a" in here to see if this helps us understand the message.



Looking for patterns in secret codes can help you to identify frequently used letters like "A" and "I," and you can then use these to help you to decode the rest of the message. For example, there are not many words in the English language with the pattern "_A_A_A."

I AM A BANANA!

Are you? That's very strange.

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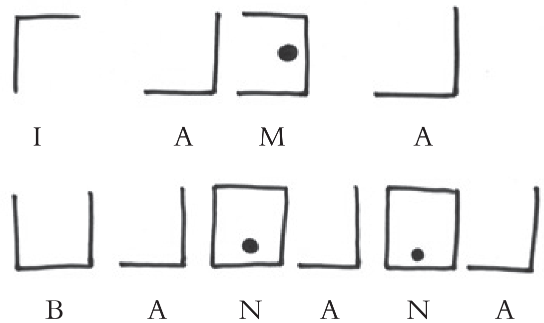
No, that's what the code says! I've worked it out.



Well done. This kind of code-breaking is called *pattern analysis.*

Another technique for solving a cipher is called *frequency analysis.* This means using knowledge about which letters are most commonly found in words to help crack the code. For example, the most common letters found in words in the English language are "E," "T," "N," "O," "R," "I," "A" and "S," while the least common letters are "Z," "Q" and "X." The letter found most often at the beginning of a word is "T," while the most common last letter of a word is "E." Take a look at the following coded message:

XLMW MW E WIGVIX GSHI

This coded message has used a *substitution cipher,* in which new letters have been substituted for the original letters of the uncoded message. In this case, each letter of

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the original message has been moved along four places in the alphabet. This is called the *Caesar Shift,* after its inventor, the Roman emperor Julius Caesar. If you move each letter back four places in the alphabet, the message reads:

THIS IS A SECRET CODE

Discovering the rule that has been used to create the code is the key to deciphering it.

But what if I want to create a code that nobody can crack?

Lots of people have tried to create unbreakable codes. Shortly after World War I, a German engineer named Arthur Scherbius invented the Enigma machine. This machine, which looked like a typewriter in a box, used a set of rotors to change the text of any message typed into the keyboard. The rotors could be swapped around and connected in different ways so that every time a key was pressed, another part of the machine transposed pairs of letters. Messages encrypted by an Enigma machine were almost impossible to crack, as the machine had 158,962,555,217,826,360,000 different settings. If you wanted to crack the code by trying out a different setting every second until you found the right one, this would take you five trillion years!

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Almost impossible?

During the Second World War, a British code breaker named Alan Turing designed a machine for breaking the Enigma codes. This machine worked by electronically testing different possible keys for the messages fed into it. The ticking of the machine's rotors as they copied the Enigma's encryption technique gave the machine its name: "the bombe." As Turing improved the bombe, the Enigma codes could be cracked in just a couple of hours.

From five trillion years to a couple of hours! That's a big time difference!

But according to Einstein's Special Theory of Relativity, time speeds up and slows down according to the speed at which you are moving. He proposed a famous thought experiment called the twin paradox to help explain this. In this, one twin sets off in a spaceship traveling near the speed of light, while the other twin stays at home. Because time passes more slowly for someone traveling near the speed of light relative to—that means compared to—someone standing still, the trip would only take a couple of hours for the twin on the spaceship, but for the twin left behind on planet Earth, many years would pass before the spaceship returned. As Old Crony says, when you move, time and space change too.

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But I still don't understand how this means an event in my future could be in someone's past?

It is complicated, but don't worry! Einstein came up with another thought experiment to help you. Imagine you're standing still on a train platform and another person is standing in the middle of a moving train. As the train speeds through the station, you see two lightning bolts simultaneously striking the front and back of the train at the precise moment you face the person standing in the middle of the train. For you, standing still on the platform, the light from these lightning bolts travels the same distance to reach you at the same time. However, for the person standing in the middle of the moving train, they see the lightning strike the front of the train first because this light reaches them first as they are traveling toward it. Saying when something happens depends on your perspective.

So it's all to do with the speed of light?

Yes, the speed of light is a universal constant, meaning it stays the same—299,792 miles per second—whether the source of light is moving or standing still. For example, if the train is traveling at 100,000 miles per second and turns its headlights on, the beams of light won't be traveling at 399,792 miles per second (the speed of the train + the

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speed of light) but will still only be traveling at 299,792 miles per second. That's still really fast!

When I look up at the North Star, how long has that light taken to reach me?

The North Star or Pole Star is the name commonly given to Polaris, a star in the constellation of Ursa Minor. Astronomers estimate that Polaris is 433 light-years from Earth. This means when you look up at Polaris, the light you see has taken 433 years to travel from the surface of the star and across the depths of outer space until it finally reaches your eyeball and is absorbed.

Wow, that's a long journey!

It looks like a long journey from here on Earth. But time slows and space shrinks the faster you go, and when you get closer to the speed of light these numbers approach zero. So from the viewpoint of the light, the journey has been instantaneous. It is as if time does not exist.

Now that you've read all about this, the most important thing to know about time is that you should use it wisely. I hope you use your time to help build a better world.

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