What do you like best about J.K. Rowling's Harry Potter series of books? Is it the joy of falling head-over-tail into this magnificently crafted tale of good and evil full of charms and enchantments? Or the five fabulous films with more to come? Or maybe it's your pride at slogging through all 4,100 pages of the adventures and getting to read them again a little more slowly once you know what happened?

As for me, I appreciate Rowling's incredible grasp of fable and myth, her wonderful character development, and her ability to tie all of the threads together into a great story. But I really love finding the science in the flash and bang of Harry's school world. My seven Harry Potter books bristle with sticky-notes reminding me where to find recipes for making green fire or an envelope that bursts into flames spontaneously. It's not just magic" that Rowling writes about, although she does that brilliantly. There is also serious science that isn't totally mysterious. Let's see where we can find chemistry in the Harry Potter books.

Flames, fireworks, stars, and elements

Here are three colorful excerpts taken from the Harry Potter book series:

"Harry took the wand. He felt a sudden warmth in his fingers. He raised the wand above his head, brought it swishing down through the dusty air and a stream of red and gold sparks shot from the end like a firework, throwing dancing spots of light onto the walls."
Rowling, J. K. Harry Potter and the Sorcerer's Stone; Scholastic Inc.: New York, 1997, p 85

"They stepped over the threshold, and immediately a fire sprang up behind them in the doorway. It wasn't an ordinary fire either; it was purple. At the same instant, black flames shot up in the doorway leading onward. They were trapped."

"He took a pinch of glittering powder out of the flowerpot, stepped up to the fire, and threw the powder into the flames. With a roar, the fire turned emerald green and rose higher than Fred, who stepped right into it, shouted "Diagon Alley!" and vanished."
Rowling, J. K. Harry Potter and the Chamber of Secrets; Scholastic Inc.: New York, 1998, p 47

Have you ever done an experiment or seen a demonstration of how metal salt solutions give a Bunsen burner flame distinctive colors? If not, ask your teacher to gather the materials and directions for showing colored flames. We often use these flame tests to identify metal ions in solutions. For example, a blue-to-green flame usually indicates the presence of copper, a yellow flame reveals the presence of sodium, and a red flame shows the presence of lithium (Fig. 1).

Figure 1. Flame tests are used to identify chemical elements in a compound. These flame tests show the presence of copper (a), lithium (b), and sodium (c).

You might also have seen red highway flares, which contain strontium salts. And colors in fireworks are due to metal salts heated by a mixture of chemicals that explode the shell.
When we heat a sample of an element hot enough, the heat kicks an electron from its original ground energy state to a higher energy level (Fig. 3). When the excited electron returns to a lower-energy state, light with a particular energy and characteristic color is released. Because many transitions between energy levels are possible, there can be many lines in an element's spectrum.

Incidentally, a number of elements were discovered because their "fingerprint spectra" were like no others yet observed. And the element helium was discovered in the spectrum of our Sun before it was found here on Earth. Since the Sun is a star, you can think of it like a very large gas burner!

You can make your own spectroscope using an old CD and cardboard. The University of Wisconsin–Milwaukee provides simple directions to do so at http://www.umm.edu/~aworschab/specweb_files/specwebinstruct.pdf.

With your own spectroscope, first try looking at an incandescent light, which won't give you a line spectrum because its heated filament isn't hot enough to energize its electrons. Then take a look at fluorescent lights and street lights to see some interesting lines and try to identify chemical elements that are present in these lights. Note: Never look at the Sun through your own spectroscope or with any other optical device.

You can also make your own version of "floof powder". With your teacher's assistance, try sprinkling dry boric acid powder into a burner flame. You will see a brilliant green flame, although I can't promise the unusual transportation effects so common in the wizard world!

In conclusion, although I don't want to totally demystify wizards' colored flames, we have some good scientific clues as to how they work in our world. But I just don't know how to make those black flames!

School supplies at Hogwarts

Wouldn't you love to have these items?

"They stopped to buy parchment and quills. Harry cheered up a bit when he found a bottle of ink that changed color as you wrote."

Table 1. Examples of invisible inks and how to develop messages written with these inks.

<table>
<thead>
<tr>
<th>Paint with this liquid and let dry</th>
<th>Develop message like this</th>
<th>What do you see?</th>
<th>Why does it work?</th>
</tr>
</thead>
<tbody>
<tr>
<td>lemon or orange juice</td>
<td>heat carefully over 100 watt light bulb</td>
<td>message turns brown</td>
<td>charred sugars are brown</td>
</tr>
<tr>
<td>sugar water solution</td>
<td>heat carefully over 100 watt light bulb</td>
<td>message turns brown</td>
<td>heated sugar is brown</td>
</tr>
<tr>
<td>cream of tartar solution</td>
<td>spray or brush with purple cabbage juice</td>
<td>red text appears on pink paper</td>
<td>acid-base reaction of cabbage indicator</td>
</tr>
</tbody>
</table>

Table 2. Examples of color-changing inks and how to develop messages written with these inks.

<table>
<thead>
<tr>
<th>Paint with this solution</th>
<th>Develop with this solution</th>
<th>What do you see?</th>
<th>Why does it work?</th>
</tr>
</thead>
<tbody>
<tr>
<td>phenolphthalein solution, 1% in alcohol</td>
<td>dilute household ammonia or 0.1 M sodium hydroxide solution</td>
<td>red text appears, then disappears</td>
<td>paint is an acid-base indicator</td>
</tr>
<tr>
<td>thymolphthalein solution, .04% in alcohol</td>
<td>dilute ammonia or 0.1 M sodium hydroxide solution</td>
<td>blue characters appear, then disappear</td>
<td>paint is an acid-base indicator</td>
</tr>
<tr>
<td>vinegar, 5% acetic acid</td>
<td>purple cabbage juice</td>
<td>magenta text on pink background</td>
<td>developer is an acid-base indicator</td>
</tr>
<tr>
<td>sodium carbonate solution, 0.1 M</td>
<td>purple cabbage juice</td>
<td>green letters appear on pink background</td>
<td>developer is an acid-base indicator</td>
</tr>
</tbody>
</table>

Brew the tea at least five times its normal strength and let the solution cool. Then soak plain paper in the tea, drain it, and let the sheets dry overnight on newspapers. Any curling or crumbling of the paper adds to its appeal. You can also make an excellent color-changing paper by soaking plain paper in purple cabbage juice. Write with vinegar or baking soda solution when the paper is dry.

The language of spells

Latin is the language of many spells, jinxes, hexes, and curses used in the wizard world. Hogwarts students work hard in all their classes to get the words just right.

"And saying the magic words properly is very important, too..."

Hermione rolled up the sleeves of her gown, flicked her wand, and said, "Wingardium Leviosa!"


With hundreds of languages and dialects in our world, Latin is used for scientific names of plants, animals, and bacteria. Latin is the root language of many chemical element names as well.

Scientists have recently made elements with atomic numbers 112, 113, 114, 115, 116, 118, and 122 in their laboratory, but these elements don’t have permanent names yet because their synthesis has not been confirmed by other scientists. Their provisional names are Latinized forms of their atomic numbers. For example, element 112 is called “Ununbiun” (for “112-iium”) and element 115 is called “Ununpentium” (for “115-iium”).

And in case you were wondering about how to make a Dark Mark, look for molybdenum or lead. Both names are derived from “a black material that leaves a mark on paper”!

Although Harry Potter and his friends are learning how to perform magic, they may be learning about chemistry and physics as well. And so did you (if you read this article). □

SELECTED REFERENCES

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