Analytical and Bioanalytical Chemistry (2023) 415:3051–3052
https://doi.org/10.1007/s00216-023-04732-5

ANALYTICAL CHALLENGE

Best measurement challenge

Juris Meija[1]

Accepted: 3 May 2023 / Published online: 5 July 2023

We would like to invite you to participate in the Analytical Challenge, a series of puzzles to entertain and challenge our readers. This special feature of "Analytical and Bioanalytical Chemistry" has established itself as a truly unique quiz series, with a new scientific puzzle published every three months. Readers can access the complete collection of published problems with their solutions on the ABC homepage at http://www.springer.com/abc. *Test your knowledge and tease your wits in diverse areas of analytical and bioanalytical chemistry by viewing this collection.*

In the present challenge, measurement is the topic. And please note that there is a prize to be won (a Springer book of your choice up to a value of €100,- given to one winner selected randomly). Please read on...

Meet the challenge

Metrology, which is the science of measurement, focuses on evaluating the uncertainties associated with measurement results. It can also identify experimental designs that lead to better measurements.

Consider the example of weighing three bananas with a single-pan balance [1]. A trivial approach would be to weigh each banana separately. However, if the uncertainty associated with each weighing is unaffected by the mass of the objects being weighed, it is more efficient to weigh the three bananas in pairs. First, we weigh bananas #1 and #2 together, then bananas #1 and #3, followed by #2 and #3. In this way, the uncertainty associated with the estimates of the three individual masses is 13% smaller compared to what one would obtain by weighing the three bananas separately [2]. This simple example illustrates the benefits of a clever experimental design that takes into account the characteristics of the measurement device.

✉ Juris Meija
juris.meija@nrc-cnrc.gc.ca

[1] National Research Council Canada, Ottawa, ON K1A 0R6, Canada

The challenge

This Analytical Challenge invites us to think about the best way to measure the isotopic abundance of bromine-81. For this purpose, we use tribromobenzene and obtain its mass spectrum using gas chromatography coupled with electron impact mass spectrometer. The molecular ion of this compound (Fig. 1) shows the familiar 1:3:3:1 pattern which is a signature of three bromine atoms [3].

From this mass spectrum we obtain two peak area ratios: A_{314}/A_{312} and A_{316}/A_{312}. Both of these ratios have the same numerical value, approximately 2.9, and both of them involve signals of the same intensity. Therefore, we expect the measurement uncertainty for both peak area ratios to be identical. Although these two ratios are of equal quality, it turns out that they give very different quality results for the isotopic abundance of bromine-81.

Which of these two peak area ratios gives the best estimate of the isotopic abundance of bromine-81? Why?

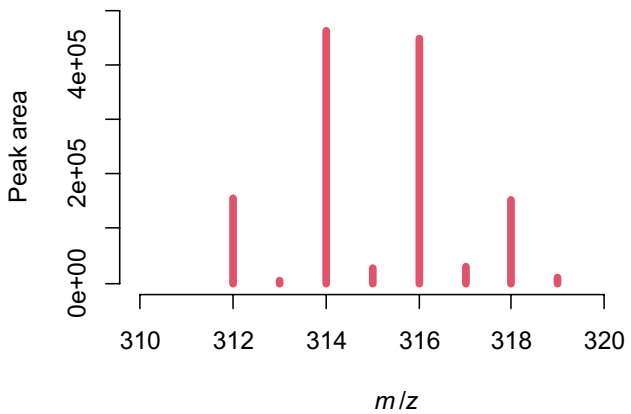

Fig. 1 Electron impact ionization mass spectrum of tribromobenzene showing the molecular ion, $C_6H_3Br_3^+$

Declarations

Conflict of interest The author declares no competing interests.

We invite our readers to participate in the Analytical Challenge by solving the puzzle above. Please send the correct solution to abc@springer.com *by October 1, 2023. Make sure you enter "Best measurement challenge" in the subject line of your e-mail. The winner will be notified by e-mail and their name will be published on the "Analytical and Bioanalytical Chemistry" homepage at* http://www.springer.com/abc *and in the journal (volume 416/issue 1) where readers will find the solution and a short explanation.*
The next Analytical Challenge will be published in 415/24, October 2023. If you have enjoyed solving this Analytical Challenge you are invited to try the previous puzzles on the ABC homepage.

References

1. Zare RN, Fernandez FM, Kimmel JR. Hadamard transform Time-of-Flight Mass Spectrometry: More Signal, More of the Time. Angew Chem Intl Ed. 2003;42(1):30–5. https://doi.org/10.1002/anie.200390047.
2. Possolo A, Meija J. Measurement Uncertainty: A Reintroduction, 2nd ed. Montevideo: Sistema Interamericano de Metrologia; 2022. https://doi.org/10.4224/1tqz-b038.
3. Meija J. Solution to Isotope Pattern Geometry Challenge. Anal Bioanal Chem. 2004;381:13.