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A5_8 The Chalk Is Mightier Than The Board

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Abstract

Using experimental data collected about the rate of use of chalk when drawing on a chalkboard, found to be $0.01886 \pm 4 \times 10^{-5}$ g/m, and the mean size of characters in the English alphabet we were able to determine that each stick of Crayola writing chalk could write 549.4 ± 1.4 m and it would require 0.69 ± 0.10 sticks of chalk to write out the complete Wikipedia page for ‘Chalk’.

Introduction

Chalk is a commonly used writing instrument on chalkboards, especially by lecturers here at the University of Leicester. This poses the question: how many uses does a piece of chalk have? Using experimental data collected first-hand we calculate the rate at which a piece of chalk is used up, how many characters you can write with a single piece of chalk, and finally use this knowledge to determine how many sticks of chalk would be needed to write out the Wikipedia web page for ‘Chalk’ [1].

Method

We started off by measuring the mass of a stick of Crayola chalk before it was used, then drawing 10 sets of 1 m lines on a chalkboard using a meter ruler stick. This gave each line an error of ± 0.01 m, which when compounded together over 10 m sums to ± 0.03 m, using the linear error analysis methods detailed in [2]. The results of this are shown in Table 1.

After this we then wrote out a sentence in order to calculate the mean mass of chalk needed to write out a character from the English alphabet. We chose the sentence “The quick brown

Length drawn (m) ± 0.03 m	Mass (g) ± 0.01 g
0.00	7.74
10.00	7.58
20.00	7.35
30.00	7.18
40.00	7.01
50.00	6.82
60.00	6.66
70.00	6.42

Table 1: Mass of chalk measured after every 10 m drawn on a chalkboard.

fox jumps over the lazy dog” because it contains every letter in the English alphabet, with a total of 35 characters. This gives us an accurate model for the length of each character drawn on a chalkboard. Each of the 9 participants wrote in a font size that was approximately 4 cm high, which is an approximate font size of 114 pt [4].

Results and Discussion

The mass of brand new sticks of chalk were measured to be 10.33 ± 0.02 g (using a mean of 3 measurements) and the rate of use of a stick of chalk calculated to be 0.01886 g/m, with an

uncertainty of $\pm 4 \times 10^{-5}$ g/m. This means that each stick of chalk can write for a total of 549.4 ± 1.4 m, assuming that the writing pressure is constant and that the chalk is usable at all lengths that are non-zero.

The average mass difference for the chalk calculated using Table 2 is -0.03 g, with an uncertainty of $\pm 4 \times 10^{-3}$ g, after writing the example sentence. Dividing this by the number of characters in the example sentence (35 characters) gives a mass difference per character of $7.62 \times 10^{-4} \pm 1.09 \times 10^{-4}$ g/character, which means you would be able to write 1313 ± 187 characters per gram of chalk used.

Participant number	Mass of chalk (g) ± 0.01 g		
	Before	After	Difference
1	5.79	5.74	0.05
2	5.74	5.70	0.04
3	5.70	5.67	0.03
4	9.80	9.77	0.03
5	5.67	5.64	0.03
6	9.77	9.75	0.02
7	5.63	5.62	0.01
8	5.60	5.58	0.02
9	5.56	5.55	0.01

Table 2: Mass of chalk measured before and after writing out a set sentence. Mass difference for each participant included.

Multiplying the number of characters per gram by the rate of use (g/m) gives us the number of characters written per meter of chalk, 24.81 ± 3.54 characters/m. If we divide the number of characters in the Wikipedia page for ‘Chalk’, shown to be 9,338 in Figure 1, by the number of characters written per meter of chalk we obtain the total length that would be drawn on the chalk board by the chalk, which is 376.4 ± 53.7 m. This is equal to 0.69 ± 0.10 sticks of chalk, or 5.55 ± 0.79 cm of the 8.1 cm standard Crayola chalk stick [3].

In hindsight the measurements taken in Figure 1 should have been taken at more frequent intervals as an interval of 10 m was not needed. We chose 10 m between measurements as our prior belief was that 1 m would make a measurable

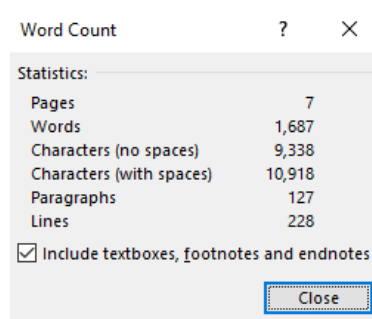


Figure 1: Number of characters in the Wikipedia article for ‘Chalk’ when copied into Microsoft Word [1].

change, however if we had done a trial run we would know this to be false.

Conclusion

Using experimental data collected about the rate of use of chalk when drawing on a chalkboard and the mean size of characters in the English alphabet we were able to determine that it would require 0.69 ± 0.10 sticks of chalk to write out the complete Wikipedia page for ‘Chalk’. Some unmentioned associated errors include chalk dust falling on the floor as opposed to sticking on the board, differences in pressure applied to the writing chalk and variations in the mass of chalk per stick. However, these errors are consistent with the usage of chalk if somebody were to actually write out the Wikipedia page, so it was felt that it made the paper more accurate. All error calculations were made using the equations relevant to the relation between the variables from [2].

References

- [1] <https://bit.ly/2E5J5GG> [Accessed 20/11/19]
- [2] <https://bit.ly/2E2jE93> [Accessed 20/11/19]
- [3] <https://amzn.to/2LD6u6r> [Accessed 20/11/19]
- [4] <https://bit.ly/2PujUD7> [Accessed 20/11/19]