

Guidelines for calculating the size of a molecule of soap

Do not print this and hand it in.

We want to see your own version of this.

Remember to lay out your calculation so that it isn't just a list of numbers. Note what the numbers are, and any formulae that you use. Note what the units of measure are, and remember to include significant figures in the final answer.

Calculation

1. Volume of a drop of soap solution:

$$V_{\text{drop}} = 5.0 \text{ ml} \div \text{number of drops that you counted} \\ = \dots \text{ ml}$$

2. Mass of a drop of soap solution:

mass = density x volume (from chapter 1)

The density of water is 1 g/ml, so

$$m_{\text{drop}} = (1 \text{ g/ml}) \times (v_{\text{drop}} \text{ ml}) \\ = \dots \text{ g}$$

*You should have a number much smaller than 1
(Drops are tiny)*

3. Concentration of our soap solution:

The commercial soap is a 1% solution. That means 1 ml of soap for 100 ml of solution. We made it more dilute, by dissolving 5.0 ml soap into 8 x 50.0 ml measuring cylinders of liquid. (1 cylinder of soap solution and 7 of just water). In other words we made a 5.0 ml in 400 ml solution of the already diluted soap.

$$\therefore \text{Concentration} = (1 \div 100) \times (5 \div 400) \\ = \dots \quad (\text{no units})$$

You should have a small number around a ten thousandth

4. Mass of soap in drop:

The soap drop is a mixture of soap and water. We're not interested in the water, just the soap, so

$$m_{\text{soap}} = m_{\text{drop}} \times \text{concentration} \\ = \dots \text{ g}$$

You should have an answer around ... millionths of a gram

5. Molecular mass of soap:

Soap is sodium stearate or $\text{NaC}_{18}\text{H}_{35}\text{O}_2$ and using your periodic table:

$$\begin{aligned} \therefore MM_{\text{soap}} &= (1 \times _) + (18 \times _) + (35 \times _) + (2 \times _) \text{ g/mol} \\ &= \dots \text{ g/mol} \end{aligned}$$

Your answer should be slightly more than 300

6. Number of molecules per drop:

Using the information you studied in chapter 5:

$$n = \frac{m_{\text{soap}}}{MM_{\text{soap}}} \times (6.02 \times 10^{23})$$

$$n = \dots \quad (\text{no units})$$

Should be a very large number perhaps ... x 10¹⁵ but your result could be bigger or smaller – depends on your dropper

7. Area of soap slick:

Area of a circle = πr^2 (from geometry)

$\pi = 3.14159265$ (from geometry)

The soap slick is roughly a circle.

You measured the diameter, not the radius, and the diameter is twice the size of the radius so

$$\begin{aligned} A_{\text{slick}} &= \pi \cdot (\text{diameter} \div 2)^2 \\ &= \dots \text{ cm}^2 \end{aligned}$$

Depending on your soap slick you may have a number between 20 and 150 cm²

8. Approximate width of a soap molecule:

Consider the soap patch as a circle made up of n square molecules w cm wide:

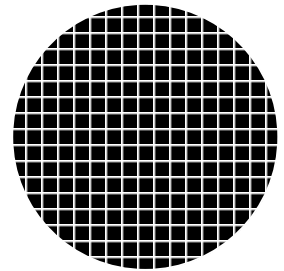
$$A_{\text{slick}} = n \times A_{\text{molecule}}$$

$$A_{\text{molecule}} = w^2 \quad (\text{area of a square})$$

$$\therefore A_{\text{slick}} = n \times w^2$$

We want to know w, the width of a molecule:

$$\begin{aligned} \therefore w &= \frac{A_{\text{slick}}}{n} \\ &= \dots \text{ cm} \end{aligned}$$



Your answer should be around .. x 10⁻⁷ or .. x 10⁻⁸ cm

Remember to use significant figures when you state your final answer..

Conclusion

I estimated the width of a soap molecule to be ____ cm