Guidelines for calculating the size of a molecule of soap

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:
   Volume of a drop of dilute soap = 5.0 ml ÷ number of drops that you counted

   You should get a number that is of the order of about a hundredth of a 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
   mass of a drop = (1 g/ml) x (volume of a drop in ml)

   You should get a number that is of the order of about a hundredth of a gram

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. In other words we made a 5.0 ml in 400 ml solution of the already diluted soap.
   ∴ Concentration = 1 part soap in (100) x (400 ÷ 5) parts water
   = 1 part soap in 8000 parts water

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
   mass of soap = mass of a drop ÷ 8000

   You should have an answer around … millionths of a gram

5. Molecular mass of soap:
   Soap is sodium stearate or $NaC_{18}H_{35}O_2$. Use your periodic table to find the atomic mass:
   Molecular mass of sodium stearate = (1 x __) + (18 x __) + (35 x __) + (2 x __) g/mol

   Your answer should be slightly more than 300

6. Number of molecules per drop:
   Using the information you studied in chapter 5:

number of molecules of soap in a drop =

$$\frac{(mass\ of\ soap within a\ drop)}{(molecular\ mass\ of\ soap)} x (6.02\ x\ 10^{23})$$

Should be a very large number perhaps ... x 10^{15} – depending on your dropper. The answer has no units, it's just a number.

7. Area of soap slick:

Area of a circle = πr^2 (from geometry)
π = 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
Area of a soap slick = π x (diameter ÷ 2)^2

Depending on your soap slick you may have a number between 20 and 150 cm^2

8. Approximate width of a soap molecule:

Consider the soap patch made up of square molecules (an approximation):

Area of a square molecule = (width x width)

Area of a circular slick= (number of molecules) x (area of a molecule)

Or putting these to facts together..

Area of a circular slick= (number of molecules) x (width x width)

We want to know the width of a molecule, and using algebra to rearrange things..

Width of a molecule = $\sqrt{\frac{Area\ of\ the\ slick}{number\ of\ molecules}}$

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 estimate the width of a soap molecule to be ____ cm