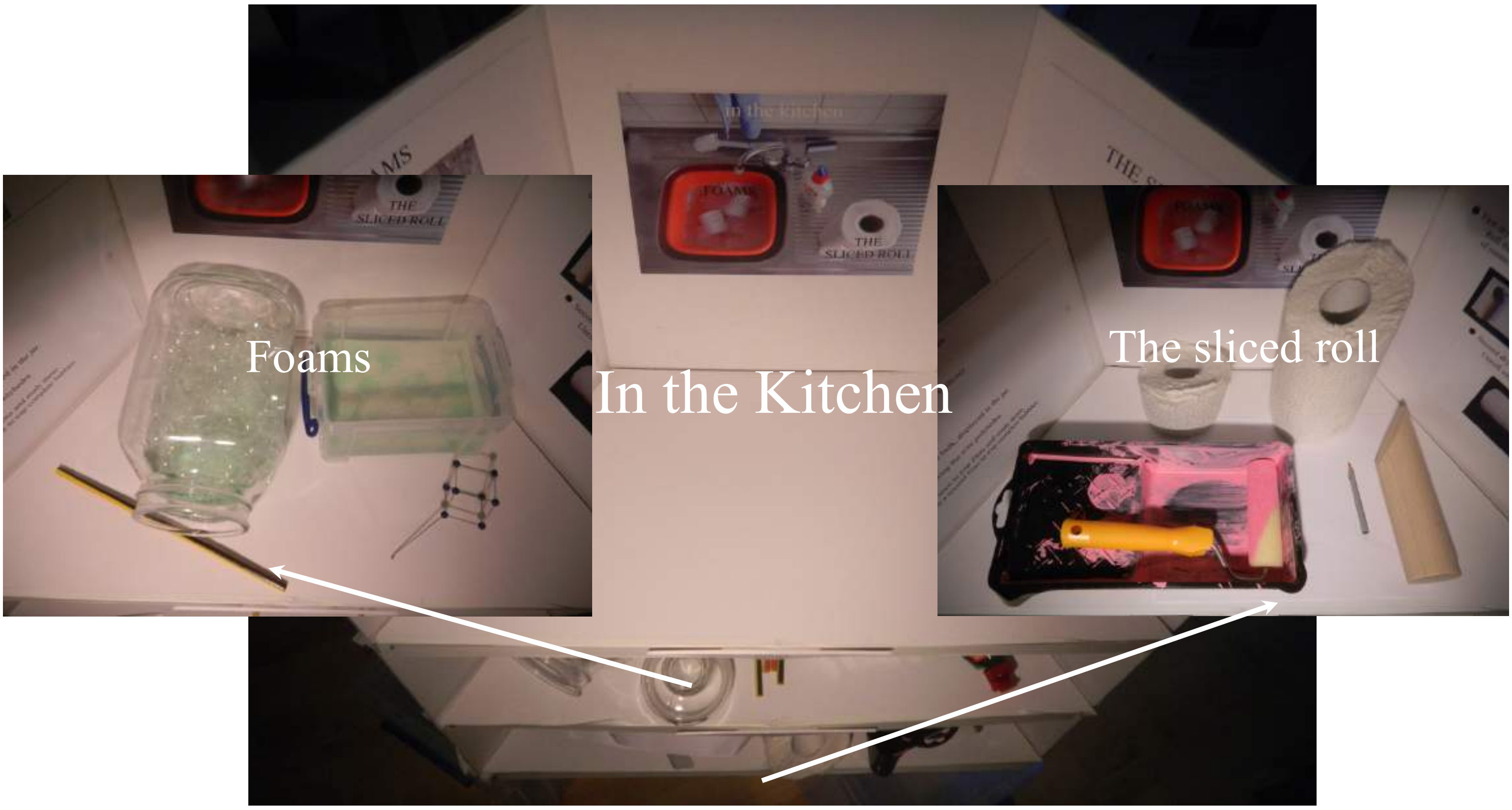


FOAMS

What seems to be true of the bubbles

- the walls (faces)
- the face junctions (edges)
- the junctions-of-junctions (vertices)

- sometimes?
- always?
- never?

Study them in the bulk, displayed in the jar.

Isolate them using the wire polyhedra.

- Dip them once to trap films and study those.

- Dip them a second time to trap complete bubbles.

Notes

The following features are easier to spot in films spanning the wire frames:

1. 3 walls meet symmetrically in an edge, and are mutually inclined at $2\pi/3 = 120°$ therefore.

2. 4 edges meet symmetrically in a vertex, and are mutually inclined at $\arccos(-1/3)$, $\approx 109\frac{1}{2}°$ therefore.

3. The principal curvatures at every point are equal and opposite and lie in perpendicular planes.

When a film encloses a single bubble in equilibrium, the bubble is spherical and there is a pressure excess on the inside proportional to the curvature, preventing the bubble collapsing. Deep inside a foam, where the bubble is surrounded by others, the pressures are equal on all sides so play no part in determining the bubble's shape. This is governed therefore by conditions **1**, **2** & **3**. If the foam is perfectly uniform, what we have, to quote the title of Lord Kelvin's paper of 1887, is 'The division of space with minimum partitional area'. Kelvin's ideal bubble was a truncated octahedron, distorted. It was more than a century before the Irish physicists Aste and Weaire derived a more economical structure ('A counterexample to Kelvin's conjecture on minimal surfaces', 1994). This is a packing of two bubble shapes. The biologist Matzke made careful observations of actual foams to find the proportions of (distorted) n-gons of different n. His numbers agree better with the Weaire-Aste than the Kelvin model. Interestingly, neither Kelvin nor Aste & Weaire had set out to study foams. Kelvin sought a structure for the aether, the medium then supposed necessary to carry electromagnetic waves. Aste & Weaire were studying metal alloys.

A good starting point is Rachel Thomas' piece 'Swimming in mathematics' (http://plus.maths.org/latestnews/sep-dec08/watercube . See also ch. 3 of www.magicmathworks.org/maths-club projects/docs/thescottishbubbleandtheirishbubble.pdf .

THE SLICED ROLL

One experiment, three versions

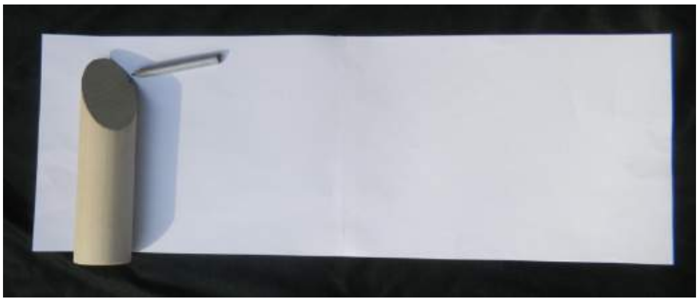
Predict the results before making the experiments.

Wet version (thought experiment):

The roller lies obliquely in the tray.
Paint.

First dry version:

Roll the obliquely sliced wooden cylinder, marking the points of contact.



Second dry version:

Unroll either half of the paper Towel roll.

Notes

The border of the painted patch, successive points of contact of the oblique section of the wooden cylinder with the paper, the frayed edge of the paper towel roll, all trace a sine curve.

You can find the paint tray experiment in 'New horizons in geometry' by M. Mnatsakanian & T. Apostol; the sliced roll experiment in Hugo Steinhaus' 'Mathematical Snapshots'. (Steinhaus wrote before there were paper towel rolls. He wrapped a candle in paper.) For a derivation go to www.magicmathworks.org/geomlab3.pdf .