“Unmixing” experiment to demonstrate laminar flow

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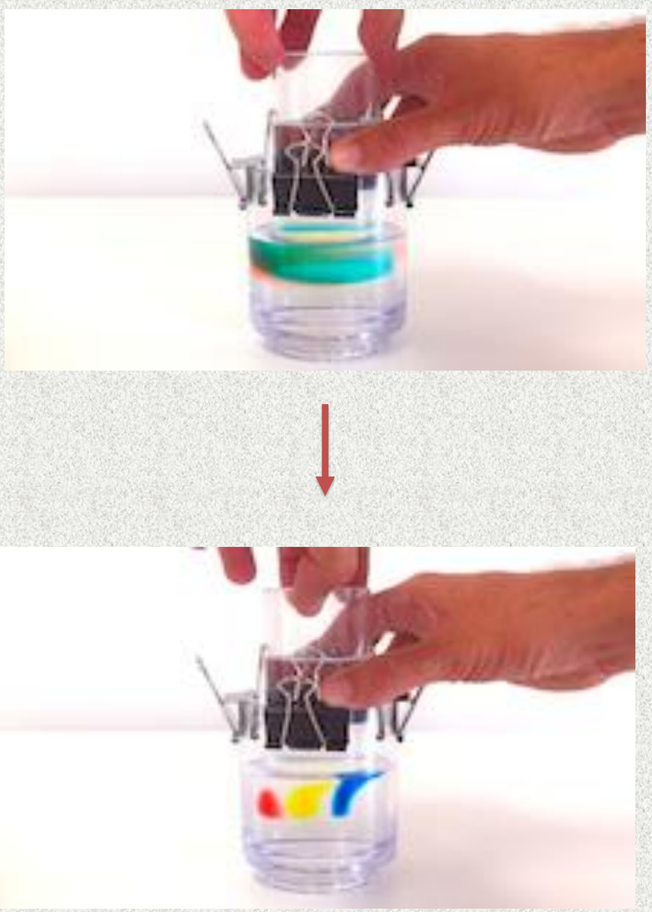
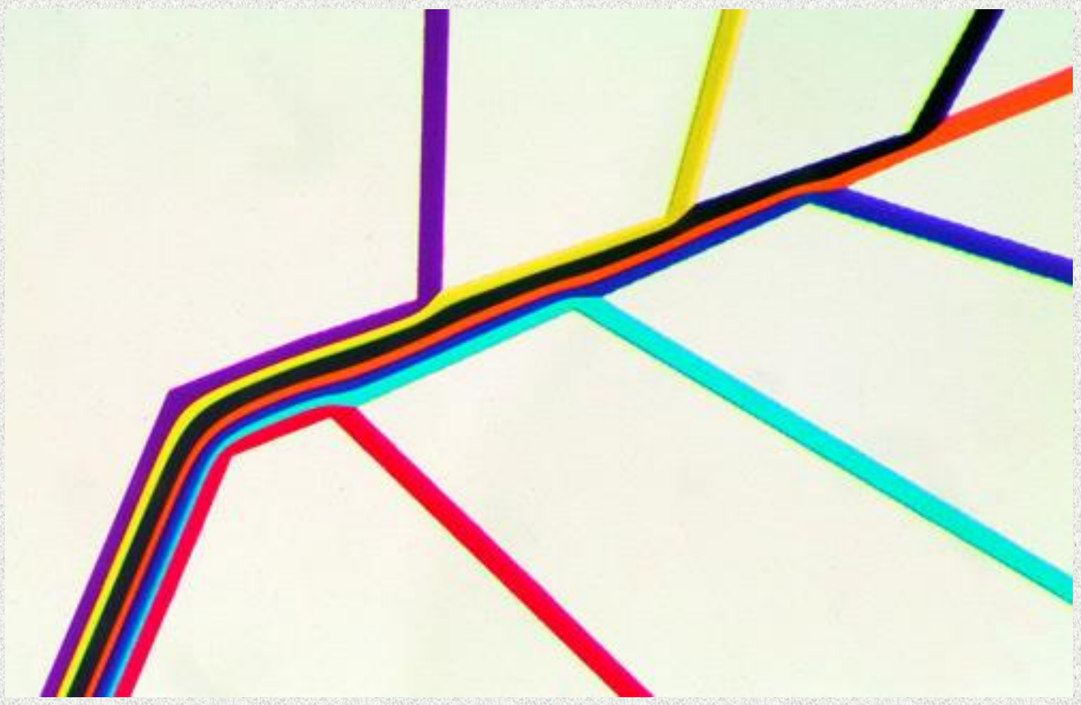
Objective

In this activity we introduce kids to laminar flow – one of the peculiar characteristics of liquids at the microfluidics scale – using a homemade Couette cell to perform an “unmixing” experiment. This experiment was first performed in 1960 [1] and there are now numerous versions of this demonstration available online [2].



Procedure

The activity starts with prompts like “Have you ever mixed milk into a cup of tea? Were you able to separate the milk from the tea after you stirred it?“ Students respond that one can’t “unmix” the milk from the tea. Viscous liquids like dish soap allow separation of mixed food dyes, provided the mixing/unmixing is done without wobbling.



P.J.A. Kenis et al., “Microfabrication Inside Capillaries Using Multiphase Laminar Flow Patterning,” Science 285 (1999): 83-85

Conclusions

This activity is an accessible way to illustrate one of the ways liquids behave differently at the micro-scale. Liquids in microchannels exhibit laminar flow, like more viscous liquids like dish soap at the macro-scale (see the illustration of laminar flow in the image above). This difficultly in achieving mixing is an important factor to consider when designing microfluidic devices. This activity is simple to perform using easily accessible materials: dish soap, food dye, paper clips, and two glasses (one smaller, thinner, and taller than the other). However, take care to avoid wobbling or turbulence when performing this experiment, as such disturbances may result in smudging of the individual food dye spots. Also, leaving the food dye for too long before or after mixing may result in significant diffusion that prevents proper unmixing. Feel free to try and modify this activity at outreach events near you. Have you tried this activity or something similar, or do you have ideas for improving the demo, please contact us (ayo.olan@gmail.com)!

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[1] J.P. Heller, Am J Phys 28, 348-353 (1960). "An Unmixing Demonstration”

[2] Australian Broadcasting Corporation (ABC) Science, http://www.abc.net.au/science/articles/2013/01/30/3679522.htm