CLL 763: Fundamentals of Capillarity and Wetting

Minor examination

Date: 15-Sep-2023 (3:30 pm to 5:30 pm); LH410 & LH416

Total Marks: 35 **Duration: 2:00h**

Instructions: Any assumptions need to be stated explicitly. All steps need to be explained clearly for derivation.

1. Short Answer: (1.5 x 6)
   a) While calculating the total interaction energy of one molecule with all other molecules in the system, during integration the lower limit is taken as particle diameter. Explain why?
   b) Why does a liquid drop bounce before it spreads on a solid surface?
   c) What are the components of Van der Waals force, and which one is temperature dependent?
   d) Why can't we measure the surface tension of water using pendent drop method in International Space Station? Explain with the equation.
   e) Why does the sliding friction decrease on moderately wet sand?
   f) What is imbibition parameter (I) and spreading coefficient (S)? How are they related?

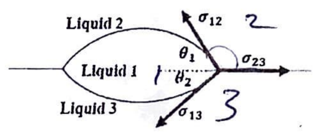
2. How does a gecko stick and walk efficiently on the walls? Why does it fall if a large amount of water is sprayed on it? (1.5+0.5)

3. Conceptually explain the design of a surface with sketch where water droplets can move against gravity spontaneously? (1.5+1.5)

4. Derive Cassie-Baxter relation. (3)

5. Equilibrium configuration of a liquid droplet on another liquid is shown below. Show that: (2)

$$\sigma_{12} \sin\theta_1 = \sigma_{13} \sin\theta_2$$



6. A water droplet is resting on a rough surface in Cassie-Baxter (CB) state. Transition from CB to Wenzel state could happen due to enhanced Laplace pressure inside the drop during evaporation. Show that, in case of depinning scenario:

$$R_c = -\frac{a}{\cos\theta_A}$$

Where, R_c is the critical radius of the drop, θ_A is the advancing contact angle and '2a' is the spacing between two pillars. (5)

7. From the understanding of work of adhesion (W_{12}) and cohesion (W_{11}), show that the interfacial energy (σ_{12}) can be approximated as: (5)

$$\sigma_{12} \approx \sigma_1 + \sigma_2 - 2\sqrt{\sigma_1^d \sigma_2^d}$$

8. Equilibrium contact angle of water on a surface is 60°. After creating random microscopic roughness, the contact angle reduces to 30°. If the actual surface area between water and the rough surface is 10 mm², calculate the apparent projected area and the height of the drop. Assume circular contact area. (2.5+3.5)

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