2.25

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11 Surface Tension

11.1 Surface tension—its molecular origin and its characterization by means of a surface tension coefficient based on either energy (σ=energy/area) or mechanical (σ=force/length) concepts. Simple derivation of the Young-Laplace equation for the pressure jump at the surface of a spherical liquid drop, based on energy considerations as well as force considerations. Generalization to arbitrary bounding surfaces.

11.2 Drops and bubbles. Effect of gravity: the Bond number. Effect of flow: the Weber number (for Re>>1) and the Capillary number (for Re<1).

11.3 The contact angle—an "equilibrium property" of a line of separation between a solid and two immiscible fluids. Wetting and non-wetting conditions. Advancing and receding contact angles; contact angle hysterisis. Young's equation for the contact angle in terms of the three interfacial energies (derivations based on force balance or energy minimization).

11.4 Equilibrium capillary rise derived from either the pressures distribution, the control volume, theorem, or energy minimization. Examples: Wicking; sap in trees rising to leaves (where it evaporates); startup of flow through a pinhole in the bottom of a bucket being filled.

11.5 Thickness of liquid puddles at equilibrium on a solid horizontal surface. (Solution by control volume method as well as energy method). Capillary rise or fall of liquid level adjacent to a vertical wall.

11.6 Adhesion or repulsion between partially wetted solid surfaces. Why wet plates stick together, why one can pick up grains of sand with a wetted finger, etc.

11.7 Attraction or repulsion of bodies touching or penetrating a liquid surface. The pond-skater and other examples from insect life.

Read:	Fay, pp 11-13, 53-55; Kundu Sections 1.6/1.7; 4.16/4.17
General Reference:	A. W. Adamson, Physical Chemistry of Surfaces, Wiley
Problems:	Shapiro & Sonin, 2.2, 2.4, 2.5, 2.6, 2.7