Tfy-0.3252 Soft Matter Physics / Pehmeän aineen fysiikka
Exam 3.9.2014 (5 problems / 2 pages).
No auxiliary written material is allowed (tables, notes etc.) A standard calculator accepted in the Finnish matriculation examinations (yo-kirjoitukset) is allowed.
Since the language of the course was English, the exam problems are in English as well. You can write your answers either in English or Finnish.

Note: For those who took the course in fall semester 2013, please write clearly at the beginning of your exam paper whether you would like to include the project assignments in your grading or have your grade determined solely on the basis of this exam.

Problem 1. (6 points)
Describe the basic physical molecular interactions in soft matter systems: what are their physical origins, relative magnitudes, directionalities, and distance dependences?
The convenient energy scale for interactions in soft matter systems is $k_B T$ (where k_B is Boltzmann's constant and T is usually the "room temperature", something between 290 – 300 K). What is the significance of this in view of free energies of soft matter systems?

Problem 2. (6 points)
Give a short explanation of the following concepts. Use illustrations if possible.
a) Debye screening length
b) Critical micelle concentration (CMC)
c) Hamaker coefficient

Problem 3. (6 points)
a) Explain the basis of the hydrophobic effect, that is, thermodynamic properties and molecular-scale interpretation, in the case of small hydrophobic molecules.
b) For such small solutes, how does increasing the temperature affect the tendency of the solutes to aggregate (hydrophobic attraction). Explain the physics behind your reasoning clearly.

Problem 4. (6 points)
a) Define the surfactant packing parameter P and explain its physical meaning.
b) What physicochemical factors determine the values of the different quantities in P?
c) How could one control the value of P in the case of some pre-determined anionic surfactant?
d) Show that surfactants form cylindrical micelle aggregates when $\frac{1}{3} < P \leq \frac{1}{2}$.

Turn the page.