Quiz 3 November 15, 2010 Properties of Materials

a) The Einstein-Stokes equation includes the shear viscosity which is defined by, $\tau_{x,y} = \eta \dot{\gamma}_{x,y}$. Explain what the subscripts x and y refer to in $\tau_{x,y}$ and in $\dot{\gamma}_{x,y}$ using a sketch of shear flow with Cartesian coordinates (define the directions of force and velocity).

b) For two plates the attractive potential that is derived from van der Waals interactions is $-A_H/(12\pi h^2)$ while the attractive potential between two spherical particles (Derjaguin approximation) is $-A_H R/(12h)$. At what separation distance h do the attractive potential of plates with an area of 10nm diameter and spheres of 10nm diameter equal each other? Explain this answer.

c) For colloidal silica spheres with no surface charge calculate the force attracting two 10 nm spheres at 1 micron, 100 nm and 10 nm separation distance (use A_H from the table below).

d) The Hamaker Constant varies when colloidal particles are immersed in a solvent.

10^{20} x Hamaker Constant (J)

Material	Vacuum	Water	n-Dodecane
6H-SiC	25	13	1
tetra-ZrO_2	20	8.8	6.8
β-Si_3N_4	18	7.0	5.0
Al_2O_3	15	5.2	3.6
Y_2O_3	13	4.0	2.6
MgO	12	3.2	1.9
$MgAl_2O_4$	13	3.5	2.1
SiO_2	6.5	0.83	0.15

$A_H \cong \pi \times 10^{-20}$ J

Explain why the Hamaker constant changes with solvent and why the values is lower in dodecane when compared to water for silica particles.

e) If one were interested in a stable colloidal dispersion of silica what solvent would be useful? Explain why.□□□□□□□□□□□□□□□□□□□
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