# Statistical Physics II Problem Set 3 

Due: Tuesday, April 29, before the lecture

## 4. Depletion interaction

(8 points +1 additional point)
a) Use the low-density approximation for $\Delta w\left(r_{12}\right)$ given in the lecture,

$$
\beta \Delta w\left(r_{12}\right)=-n \int f\left(r_{13}\right) f\left(r_{23}\right) \mathrm{d}^{3} \mathbf{r}_{3}
$$

to calculate the effective interaction potential of two testing spheres with diameter $\sigma_{2}$ solved in a dilute fluid of hard spheres with diameter $\sigma_{1}$. Consider in particular the marginal case $\sigma_{1} \ll \sigma_{2}$ and sketch for it the potential with specification of the scale.
b) Give a physical reason for the effective attraction of the testing spheres.
c) Consider three testing spheres in the hard-sphere fluid. Which value may the ratio of the radii $\sigma_{1} / \sigma_{2}$ not exceed, so that the depletion interaction $\Delta w\left(r_{12}\right)$ is presentable as pure pair interaction?
$d^{*}$ ) Which qualitative changes do you expect for higher densities? (Sketch of $\Delta w(r)$ with specification of the scale!)
Hint: Consider at first the case $\sigma_{1}=\sigma_{2}$, for which you know the qualitative form of $g(r)$.

