Theoretical Concepts and Simulations
for Materials Scientists
Summer term 2009

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Exercises 1

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1. Calculate the gradients of the following scalar fields:

   (a) $\varphi(\mathbf{r}) = \mathbf{a} \cdot \mathbf{r}$,

   (b) $\varphi(\mathbf{r}) = |\mathbf{r}|$,

   (c) $\varphi(\mathbf{r}) = \dfrac{1}{|\mathbf{r}|^2}$,

   (d) $\varphi(\mathbf{r}) = f(|\mathbf{r}|)$.

2. Consider a system of non-interacting electrons in d dimensions, which occupy states with energy
$$\varepsilon_{\mathbf{k}} = \frac{\hbar^2 |\mathbf{k}|^2}{2m} \ .$$
Calculate the corresponding density of states.