The following questions are for you to check whether you have understood the contents of the lecture. Please reply to the questions alone (for yourself) and by writing on this sheet of paper. As soon as you and your neighbor are both done, you might want to discuss your answers. Your answers will not be collected or graded. It’s a pure self-test for your convenience. If you are not able to easily answer the questions or if you have doubts regarding the correctness of your replies, please take a few minutes to read in the book or the slides in order to revisit the corresponding points.

1. Write the differential operators gradient, divergence, curl, and Laplace in Nabla notation! (K1)

2. Use the definitions of the differential operators to prove that \( \text{curl} (\text{grad}(f)) = 0 \). Restrict yourself to Cartesian coordinates in three dimensions. (K3)
3. Try to write down the integral theorems of Gauss and Stokes without consulting your notes. This exercise is a lot easier if you remember the physical interpretation of the theorems (the stuff about fluxes and work) and then assemble the mathematical symbols according to that. (K2)

Gauss:

Stokes:

4. What does the term “potential field” mean and by which property is such a field defined? Write a couple of sentences in your own words and give the definition in mathematical terms (but not necessarily equations)! (K2)

5. Assume your model gives you a source density of the production of a chemical in space. You want to determine the stationary concentration field. Which partial differential equation governs this concentration field? Give the name and the mathematical form of the equation! (K2)