

## Theoretical questions

1. Turbulence has no definition, but properties of turbulent flows can be explained. What are turbulent flows?
2. Which hydrodynamic instabilities may lead to turbulence?
3. Relative importance of terms in incompressible Navier-Stokes equations can be expressed by non-dimensional numbers. Explain these numbers and their meaning.
4. Explain Reynolds decomposition of Navier-Stokes equations.
5. Explain Reynolds averaging, discuss assumptions.
6. Explain Reynolds stresses.
7. Explain turbulent fluxes (of e. g. momentum, heat, humidity).
8. Explain Reynolds equations closure problem.
9. Describe terms in turbulent kinetic energy equation.
10. Which terms of TKE equation vanish in stationary turbulence?
11. Explain the role of buoyancy term in the TKE budget.
12. Explain Richardson number.
13. How in practice we estimate turbulent fluxes ?
14. Explain paradox of uniform, stationary and isotropic turbulence.
15. Explain Kolmogorov hypotheses.
16. Explain cascade of turbulent kinetic energy..
17. Explain TKE production and integral scale of turbulence.
18. Explain TKE dissipation and Kolmogorov microscale.
19. Explain Taylor microscale.
20. Why distribution of velocity increments is important in turbulence description?
21. Why velocity structure functions are important in turbulence description?
22. Explain weak points of Kolmogorov theory of turbulence.
23. Describe atmospheric boundary layer and its sublayers.
24. Explain TKE equation for stationary and horizontally homogeneous atmospheric boundary layer.
25. Describe diurnal evolution of the atmospheric boundary layer.
26. What is friction velocity?
27. Explain Obukhov length.
28. Explain logarithmic wind profile in ABL.
29. Universal similarity functions in ABL – what for?
30. Explain entrainment into ABL.
31. Explain processes at the top of stratocumulus.
32. Discuss organization of convection in ABL.
33. Discuss problems related to nocturnal boundary layer.
34. Explain nocturnal jet and katabatic flow.