Exercise 01

Name:	Matriculation number:
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The exercise is due on Wednesday, April 25, 8 am.

1.1 Text book

Read sections 1.1 to 1.3 in G.H. Findenegg, T. Hellweg „Statistische Thermodynamik".

1.2 Two dice

Consider the following random experiment: two dice are thrown and the total number of pips are counted.

(a) What is the sample space Ω, the set of events X and the event probability p_X of this random experiment?

(b) Plot a histogram of p_X.

(c) Calculate the mean, the variance, and the standard deviation for this probability distribution.

(d) Take two dice and carry out the experiment 30 times. Record the outcome and the total number of pips in each round.

(e) Calculate the probability of the sequence of outcomes and the probability of the sequence of events for your particular series of experiments.

(f) Calculate the mean, the variance, and the standard deviation from your. list of total number of pips.

(g) Construct a histogram from the list of total number of pips. Plot the histogram. (You can plot it into the same graphs (b).)

(h) Compare your experimental result with the expected result. Are there deviations? Why? Are the deviations higher or lower than expected?

1.3 Birthdays

Ignoring leap years, calculate the probability that, among 25 randomly chosen people, at least two have the same birthday.

Hint: Consider the probability that everyone has a unique birthday.

1.4 Thermodynamic ensembles

With which thermodynamic ensemble would you model the following simulations. Explain.

(a) a closed reaction flask in an ice bath

(b) an open reaction flask in an ice bath

(c) a reaction flask on a heater with reflux condenser (Rückflusskühler)

(d) the reaction flask in a destillation set up before the Liebig condenser (Liebig Kühler)

(e) a balloon the cargo bay of an airplane

1.5 Car tyre

(a) Calculate the number of molecules per 1 cm^3 in car tyre with an absolute pressure of 3.7 bar at room temperatur ($T = +25\,^\circ$C). Assume that the tyre is filled with an ideal gas.

(b) What is the number of molecules per 1 cm^3 in the same tyre in a cold winter night at $T = -20\,^\circ$C?

(c) What is the pressure in the tyre in a cold winter night at $T = -20\,^\circ$C?

(d) After driving for some time, the tyre is heated to $T = +45\,^\circ$C. What is the pressure in the tyre now?

Hint: you can assume that the thermal expansion coefficient of rubber is zero.