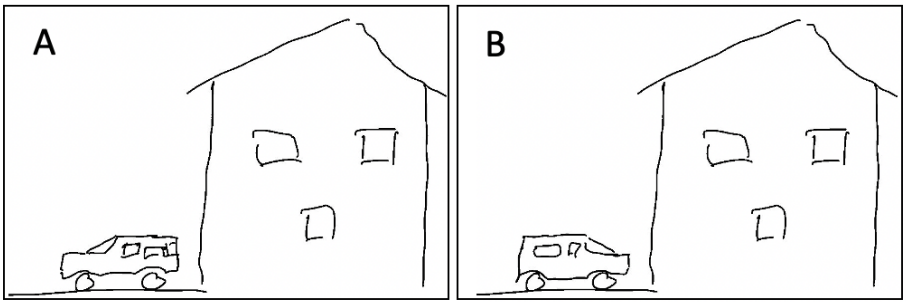
Exercise week 34: FYS2160, Thermodynamics and statistical physics, Fall 2023

1 Icy windshield



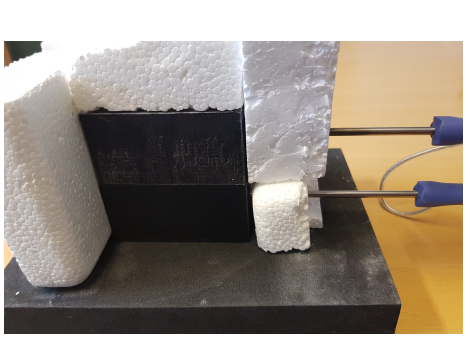
I park my car in front of my house and leave it overnight when there is a clear sky in winter. When the car has the front facing away from the house the windshield is icy in the morning, but not when the front is facing the house. Why does the windshield become icy? Why does it matter which way the car faces?

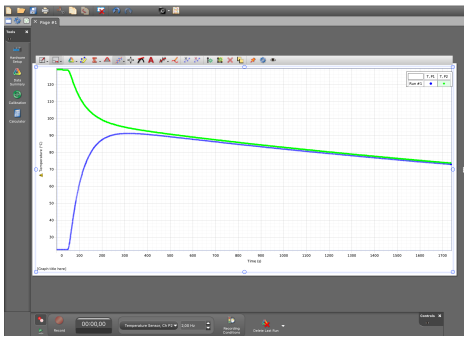
Make sketches of the different processes at work this winter night. Include symbols for the relevant fluxes, temperatures, etc. Making sketches is an important tool in simplifying a problem, defining how you intend to solve it.

2 Thermal Concepts Inventory quiz

On the the lecture webpage you will find your answers to the quiz with comments and further questions. For many of the questions there was serious disagreement about what the correct answer was. For each of these, discuss whether there was one correct answer or if several answers were acceptable. Answer the questions on the webpage.

3 Heat conduction experiment





In the second lecture a heat conduction experiment was performed, placing a hot metal block on top of a cold metal block. Both metal blocks have dimensions 38 mm x 38 mm x 75 mm. One metal block was made from S235JR steel and the other from lead. The temperature was measured by thermometers inside the metal blocks starting before the blocks were put into thermal contact. The thermometers were in the middle of the metal blocks.

Make a sketch of the experiment with the essential information needed to model it and explain which simplifying assumptions you make.

Solve the thermal diffusion equation

$$\frac{\partial T}{\partial t} - \frac{\lambda}{c\rho}\nabla^2 T = 0$$

with the appropriate boundary and initial conditions and compare your result with the data from the experiment In the thermal diffusion equation T is temperature, t is time, λ is the thermal conductivity, c is the specific heat capacity, ρ is the density and z is the position coordinate. You may choose to solve the diffusion equation analytically or numerically. Try to explain the sources of deviation of the model data from the experiment.

4 Work and pressure

Problem 1.34 in Schroeder