Instructions:

- In the exam, you are allowed to have
  - A pencil and an eraser
  - A calculator
  - Property tables handout
  - Formula collection (submitted beforehand for review)
- **Each answer should begin from the top of a new page.**

Returning Answers Checklist:

1. Check that on top of every answer sheet is marked:
   - Exam date (9.11.2012) and examiner (J. Maunuksela)
   - Your personal information
   - Name of the study unit (FYSS391) and exam subject (Physics)
   - Checkmark in the box after the item "Lecture course"
   - Number of credits (4 op.)
2. Return with your answer sheets
   - This question paper
   - Formula collection
   - Property tables handout

1. (a) Explain the difference between the steady-, transient- and uniform-flow processes.

   (b) An ideal gas and a block of steel have equal volumes at the same temperature and pressure. The pressure on both is increased quasistatically and isothermally to five times its initial value. Explain with the aid of a p-V diagram why the quantities of work are not the same in the two processes. Which is greater?

2. A *throttling calorimeter* can be used for determining the quality of a two-phase liquid-vapor mixture. Now consider the control volume shown in Fig. 1: A supply line carries a two-phase liquid-vapor mixture of steam at 20 bar. A small fraction of the flow in the line is diverted through a throttling calorimeter and exhausted to the atmosphere at 1 bar. The temperature of the exhaust steam is measured as 120°C. Determine the quality of the steam in the supply line. Show the process on a T-s diagram relative to saturation lines. (1 bar = 100 kPa)

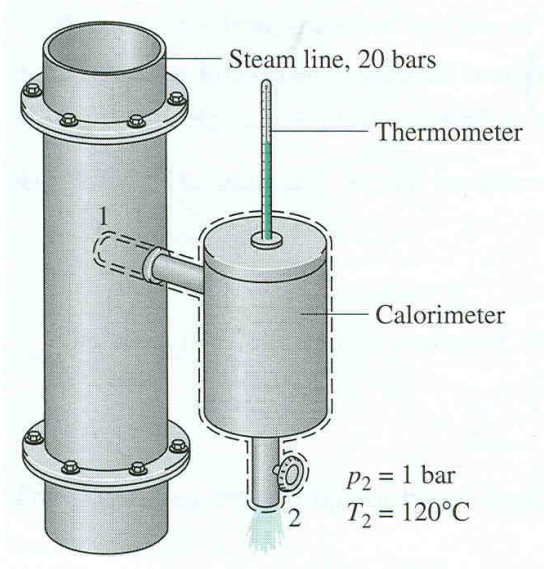

Figure 1. Throttling calorimeter

3. In mountains air cooling can be caused by air flow up a steep slope or mountain side. Using thermodynamic analysis, estimate the change in temperature of rising air-flow with elevation $\Delta T/\Delta z$ under adiabatic conditions.

4. A high temperature reservoir at 538°C is brought into thermal communication with a lower tempetature reservoir at 260°C, and as a result 1055 kJ of heat are transferred from the high to the low temperature reservoir. Determine the change in entropy of the universe, resulting from the heat exchange process between the two reservoirs.

5. Consider a 1 m^3 evacuated rigid tank in thermal equilibrium with surrounding atmosphere at 1 bar. Determine the exergy of the evacuated system.