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http://exp-astro.de/mechanik

Übungen zur Experimentalphysik I (Thermodynamik)
Aufgabenblatt 4 von 5
Abgabe im OLAT: Montag, 08.02.2021, 18:00 Uhr

GOETHE UNIVERSITÄT FRANKFURT AM MAIN

1) Entropy, again...

There are two solid bodies with equal mass m and the same specific heat capacity c_V (c_V does not depend on the temperature). Body 1 has a temperature of T_1, body 2 has T_2, and $T_1 > T_2$. With thermal contact, thermal energy flows from body 1 to body 2 until the mixing temperature T_m is reached. (Thermal energy is not lost. Neglect the change in volume of the bodies.)
a) What is the mixing temperature T_m?
b) What are the entropies of the bodies, how do they change?
c) What is the total change in entropy ΔS of the whole system?

2) Circles

An ideal gas goes through a cyclic process with two isochors and two isobars. Volume and pressure increase by a factor of two, respectively.
a) Draw the p-V-diagram.
b) Determine the ratio of maximum and minimum temperature.
c) The system being a thermal engine, what is the efficiency? (Think about: In which steps is thermal energy absorbed/emitted and when is mechanical work performed at/by the system?)
d) Compare the efficiency to the Carnot process with T_max and T_min.

3) More power!

You add a thermal engine to your bicycle: an ideal gas, e.g. helium, at 800 K and 1.2 MPa at the beginning, expands isothermic from 2 litres to 12 litres (contact to heat bath). In the second step it is compressed isobaric (contact to cold bath). In the third step, it returns to the initial condition isochoric (contact to heat bath).
a) Draw the p-V-diagram.
b) Calculate the thermal energy taken from the heat bath in a circle, and the delivered energy (for the additional power of your bike).
c) What is the efficiency of the motor? Compare to the Carnot process.
d) Draw the T-S-diagram of the process. Compare to the Carnot process.

4) In the end it is warm

You pour 300 ml of ice tea (without ice) into a glass. Water from the air condenses at the outer side. Estimate how many ml of water condense on the glass if the released energy is used completely to increase the ice tea's temperature by 2 K.
(Enthalpy of evaporation of water: 2257 kJ/kg, aproximately independent of the temperature.)