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GOETHE

UNIVERSITÄT

Übungen zur Experimentalphysik I (Thermodynamik) Aufgabenblatt 5 von 5 Abgabe im OLAT: Montag, 15.02.2021, 18:00 Uhr

Register for the exam(s). (The deadline for VEX1 is Feb 16th.) Check that the registration(s) worked. It is NOT possible to register on site on the day of exams.

1) Some questions

a) What is the zeroth law of thermodynamics?

b) What is the equation of state for an ideal gas?

c) Van der Waals equation: To describe a real gas two parameters are added to the equation of state of an ideal gas. Which properties of a real gas do these parameters describe?

e) Draw the Carnot process in a T-S-diagram.

2) Cool while entropy increases

You want to make ice tea for a party. You add 0.5 kg of ice with a temperature of -10° C to a large thermos flask, and 3 l of tea with a temperature of 20° C.

a) Which temperature does the mixture have when thermal equilibrium is reached?

b) What is the net increase/decrease in entropy?

(Approximate tea as water. Enthalpy of fusion: 333 kJ/kg; Heat capacity of ice: 2.06 kJ/(kg K), heat capacity of water: 4.18 kJ/(kg K))

3) Advanced cooking

a) Water boils at 373 K at sea level. Use the Clausius-Clapeyron relation to determine the boiling temperature 8,000 m above sea level.

b) What is the boiling temperature of water in a pressure cooker? The pressure in this cooker is 1.8 bar.

4) Radiation

A hot plate with a radius of 10 cm emits 1 kW thermal energy from electrical power.

a) Assume that the energy is completely emitted by thermal radiation. Which temperature is reached in equilibrium? Treat the hot plate as an ideal black body.

b) Which entropy is generated each second when the temperature of a) is reached? ($\sigma = 5.67 \cdot 10^{-8} \text{ W/m}^2/\text{K}^4$)