Übungen zur Thermodynamik

Serie 1: Temperatur und ihre Skalen

1. *Die Temperaturskala nach Anders Celsius*

   Studiere im Skript den Abschnitt 1.1 und beantworte anschliessend die folgenden Fragen:

   (a) Welche **natürlichen Gegebenheiten** hat **Anders Celsius** im Jahr 1742 ausgenutzt um darauf aufbauend eine **Temperaturskala** zu definieren resp. ein **Thermometer** herzustellen?

   (b) Weshalb ist es wichtig, dass die "Herstellung" des Thermometers bei **Normdruck** erfolgt?

   (c) Würde anstelle des Normdrucks der Luftdruck in den Bergen, z.B. auf etwa 2000 m.ü.M., verwendet, dann ergäbe sich aufgrund der Methode von Celsius eine andere Temperaturskala.

   Wären $50\,^{\circ}\mathrm{C}$ auf dieser neuen Skala wärmer oder kälter als die $50\,^{\circ}\mathrm{C}$, die auf der Temperaturdefinition bei Normdruck beruhen?

   Denke hinreichend ausgiebig über die Fragestellung nach und liefere anschliessend eine entsprechend begründete Antwort.

2. *Umrechnungen zwischen Temperaturskalen*

   (a) **Yttrium-Barium-Kupferoxid** ist ein Material, das als **Hochtemperatur-Supraleiter** bekannt ist. Unterhalb einer Temperatur von $92\,\mathrm{K}$ leitet es den elektrischen Strom komplett verlustfrei!

   Rechne diese Sprungtemperatur in die Celsius-Skala um und vergleiche sie mit der Siedetemperatur von flüssigem Stickstoff, also mit $-196\,^{\circ}\mathrm{C}$.

   (b) In der **Photosphäre** der Sonne ($\approx$ Sonnenoberfläche) herrschen im Mittel $5500\,^{\circ}\mathrm{C}$.

   Gib diesen Wert als absolute Temperatur an.

   (c) Zwischen dem Schmelzpunkt und dem Siedepunkt von **Quecksilber** herrscht bei Normdruck ein Temperaturunterschied von $396\,\mathrm{K}$.

   Wie gross ist dieser Temperaturunterschied in der Celsius-Skala?

   (d) Im innersten **Kern der Sonne** herrschen Temperaturen von 15 Millionen Grad Celsius. Weshalb hat die Angabe dieser Kerntemperatur in der absoluten Temperaturskala denselben Zahlenwert, also 15 Millionen Kelvin?

3. *"A Day's Wait" – Temperaturskalen in der Literatur*

   In der Kurzerzählung *"A Day's Wait"*, die auf den nächsten beiden Seiten wiedergegeben wird, schildert **Ernest Hemingway** (1899 –1961), wie sein Sohn einen Tag lang mit einem schlimmen Verdacht im Bett liegt.

   Der Geschichte liegt eine Verwechslung verschiedener **Temperaturskalen** zugrunde.

   (a) Finde durch Lektüre und allfällige Recherche heraus, welche Skalen der Junge in der Geschichte unwissentlich verwechselt.

   (b) Gib die Umrechnung von der einen in die andere Skala an, so wie das für die Celsius- und die absolute Temperaturskala auf Seite 4 des Skripts vorgezeigt wird.

A DAY'S WAIT (1950)

Ernest Hemingway (1899 – 1961)

He came into the room to shut the windows while we were still in bed and I saw he looked ill. He was shivering, his face was white, and he walked slowly as though it ached to move.

"What's the matter, Schatz?"

"I've got a headache."

"You better go back to bed."

"No, I'm all right."

"You go to bed. I'll see you when I'm dressed."

But when I came downstairs he was dressed, sitting by the fire, looking a very sick and miserable boy of nine years. When I put my hand on his forehead I knew he had a fever.

"You go up to bed," I said, "you're sick."

"I'm all right," he said.

When the doctor came he took the boy's temperature.

"What is it?" I asked him.

"One hundred and two."

Downstairs, the doctor left three different medicines in different colored capsules with instructions for giving them. One was to bring down the fever, another a purgative, the third to overcome an acid condition. The germs of influenza can only exist in an acid condition, he explained. He seemed to know all about influenza and said there was nothing to worry about if the fever did not go above one hundred and four degrees. This was a light epidemic of flu and there was no danger if you avoided pneumonia.

Back in the room I wrote the boy's temperature down and made a note of the time to give the various capsules.

"Do you want me to read to you?"

"All right. If you want to," said the boy. His face was very white and there were dark areas under his eyes. He lay still in bed and seemed very detached from what was going on.

I read aloud from Howard Pyle's Book of Pirates; but I could see he was not following what I was reading.

"How do you feel, Schatz?" I asked him.

"Just the same, so far," he said.

I sat at the foot of the bed and read to myself while I waited for it to be time to give another capsule. It would have been natural for him to go to sleep, but when I looked up he was looking at the foot of the bed, looking very strangely.

"Why don't you try to go to sleep? I'll wake you up for the medicine."

"I'd rather stay awake."

After a while he said to me, "You don't have to stay here with me, Papa, if it bothers you."

"It doesn't bother me."

"No, I mean you don't have to stay if it's going to bother you."

I thought perhaps he was a little light-headed and after giving him the prescribed capsule at eleven o'clock I went out for a while.

It was a bright, cold day, the ground covered with a sleet that had frozen so that it seemed as if all the bare trees, the bushes, the cut brush and all the grass and the bare ground had been varnished with ice. I took the young Irish setter for a little walk up the road and along a frozen creek, but it was difficult to stand or walk on the glassy surface and the red dog slipped and slithered and I fell twice, hard, once dropping my gun and having it slide over the ice.

We flushed a covey of quail under a high clay bank with overhanging brush and killed two as they went out of sight over the top of the bank. Some of the covey lit the trees, but most of them scattered into brush piles and it was necessary to jump on the ice-coated mounds of brush several times before they would flush. Coming out while you were poised unsteadily on the icy, springy brush they made difficult shooting and killed two, missed five, and started back pleased to have found a covey close to the house and happy there were so many left to find on another day.

At the house they said the boy had refused to let anyone come into the room.

"You can't come in," he said. "You mustn't get what I have."

I went up to him and found him in exactly the position I had left him, white-faced, but with the tops of his cheeks flushed by the fever, staring still, as he had stared, at the foot of the bed.

I took his temperature.

"What is it?"

"Something like a hundred," I said. It was one hundred and two and four tenth.

"It was a hundred and two," he said.

"Who said so?"

"The doctor."

"Your temperature is all right," I said. It's nothing to worry about."

"I don't worry," he said, "but I can't keep from thinking."

"Don't think," I said. "Just take it easy."

"I'm taking it easy," he said and looked straight ahead. He was evidently holding tight onto himself about something.

"Take this with water."

"Do you think it will do any good?"

"Of course it will."

I sat down and opened the Pirate book and commenced to read, but I could see he was not following, so I stopped.

"About what time do you think I'm going to die?" he asked.

"What?"

"About how long will it be before I die?"

"You aren't going to die. What's the matter with you?"

"Oh, yes, I am. I heard him say a hundred and two."

"People don't die with a fever of one hundred and two. That's a silly way to talk."

"I know they do. At school in France the boys told me you can't live with forty-four degrees. I've got a hundred and two."

He had been waiting to die all day, ever since nine o'clock in the morning.

"You poor Schatz," I said. "Poor old Schatz. It's like miles and kilometers. You aren't going to die. That's a different thermometer. On that thermometer thirty-seven is normal. On this kind it's ninety-eight."

"Are you sure?"

"Absolutely," I said. "It's like miles and kilometers. You know, like how many kilometers we make when we do seventy in the car?"

"Oh," he said.

But his gaze at the foot of his bed relaxed slowly. The hold over himself relaxed too, finally, and the next day it was very slack and he cried very easily at little things that were of no importance.