Homework 13.

Temperature.

We know very well that a hot object has higher temperature than a cold one. So, the higher temperature of *something* the more hot that *something* is. But it is much more difficult to explain what the temperature *is*. What is the physical meaning of this parameter? We know that all of the objects around us consist of small particles – atoms and molecules, which move chaotically all the time. Temperature of the object is proportional to the average kinetic energy of the particles (atoms of molecules) of the object.

If we are cooling down, say, a glass of water, molecules of water are slowing down and losing their kinetic energy (they transfer it to another object – an ice cube, for example). Since there is minimal possible kinetic energy – 0.0J (all the particles stop) we can conclude that there is the minimal possible temperature. In the real world there is not possible to stop the particles completely and cool the object down to absolute zero temperature.

There are four major temperature scales.

1. Fahrenheit temperature scale

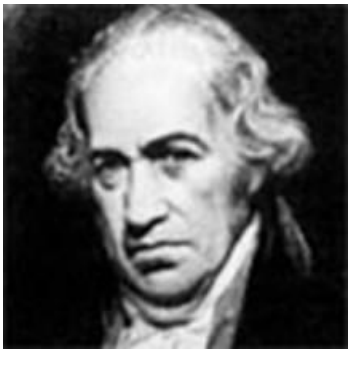
2. Celsius temperature scale

3. Kelvin temperature scale

4. Rankin scale

In our everyday life we often need to measure temperature. It could be the temperature of a human body, or the temperature of food being cooked. The device we use to measure temperature id called thermometer. Operation principle of a simple thermometer is based on the property of some liquids to expand to sufficiently change their volume depending on their temperature.

The property of certain objects to expand or contract depending on temperature was known since ancient times. But first person who produced thermometer with reliable operation and reproducible readings was Daniel Gabriel Fahrenheit – German physicist and engineer. In 1724 he introduced new temperature scale which is now known as Fahrenheit scale.



Daniel Gabriel Fahrenheit (1686-1736)

Fahrenheit used mercury as a working substance in his thermometer and, what is most important, he suggested the way to calibrate the device. For calibration he used three points. One was the temperature of the mix contained water, ice and special salt - ammonium chloride. An interesting property of this mixture

(which is called *frigorific* mixture) is that after being prepared it reaches equilibrium at the temperature which is almost independent on the initial temperatures of the mixture components. Fahrenheit ascribed to this temperature the magnitude of 0 degrees. The other two points were temperatures of water mixed with ice (32^{o}F) and the temperature of a human body (96 ^{o}F). 2

Anders Celsius (1701-1744)

Zero point of the Celsius scale, named after Swedish astronomer Anders Celsius (1701-1744) corresponds to the temperature of melting ice, temperature of hundred degrees corresponds to the temperature of boiling water. To recalculate Fahrenheit temperature into the Celsius temperature we have:
1. Take the temperature in Fahrenheit degrees and subtract 32.

2. Multiply the result by 5 and divide by 9 – you have the Celsius temperature.

In both Fahrenheit and Celcius methods of calibrating the thermometers the zero temperature was chosen arbitrary. In contrast, the zero degrees of the Kelvin scale corresponds to hypothetical temperature at which the atoms and molecules would stop completely. The Kelvin scale is the scale used in physics. One degree of the Kelvin scale is equal to 1 Celsius degree, but 0^{o}C corresponds to approximately 273 degrees at the Kelvin scale (we write 273K). And the last one, Rankin scale has same degree as Fahrenheit scale, but zero point corresponds to absolute zero (Kelvin zero).

Problems:

1. Is 1 Fahrenheit degree equal to 1 Celsius degree?

2. Is there a temperature which is the same on both Fahrenheit and Celsius scales? – (This problem is more about math than physics).

3. What is the temperature of a human body in according to the Kelvin scale?

4. Temperature in the room is increased from 15^{o}C to 39^{o}C. How many times did the average kinetic energy of the air molecules increase?