Klimawandel verstehen und handeln

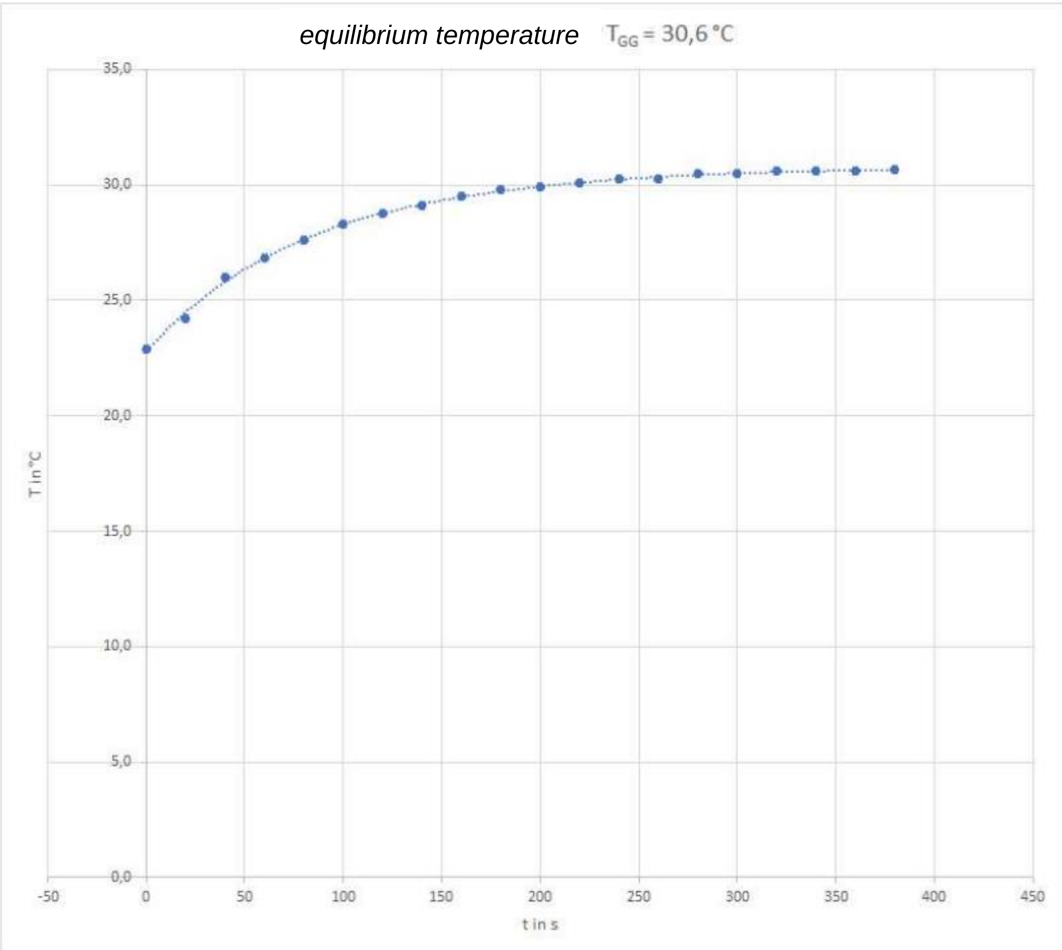
Activity 2 – The Earth is irradiated

Part 1: Why is the Earth not getting hotter and hotter, even though it is constantly exposed to the Sun?

➞ Measure the temperature of the Earth every 30 seconds and note the results in a table.

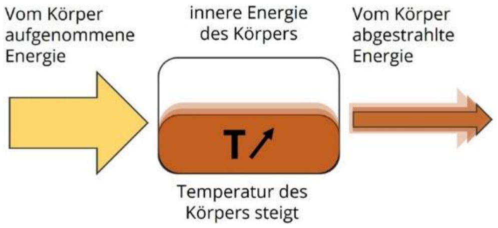
Zeit s	0	20	40	60	80	100	120	140	160	180
T in °C	22,9	24,2	26,0	26,9	27,6	28,3	28,8	29,1	29,5	29,8
Zeit s	200	220	240	260	280	300	320	340	360	380
T in °C	29,9	30,1	30,3	30,3	30,5	30,6	30,6	30,6	30,6	30,7

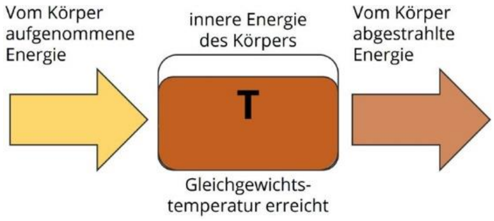
➞ Display the results graphically in the diagram:



➞ Discuss your results and explain why the temperature of the Earth model does not continue to rise.

Use the two figures below for your discussion and interpretation. Use the terms equilibrium temperature and radiation equilibrium.





The warmer a body is, the more energy it emits in the form of thermal radiation (compare, for example, cold and blazing hot iron).
If a body is irradiated, it becomes warmer and warmer and thus emits more radiation.

If the absorbed and radiated energy are equal in a certain period of time, it is in radiation equilibrium and has reached an equilibrium temperature.

With constant irradiation by the heat lamp, the model earth is in radiation equilibrium after some time. Thus, it now radiates as much energy as it absorbs. In this state, its temperature remains constant (equilibrium temperature), so that it does not continue to rise indefinitely.

? Venus is closer to the Sun than the Earth. What would happen to the temperature on Earth if it were moved to the location of Venus (or Mars)?

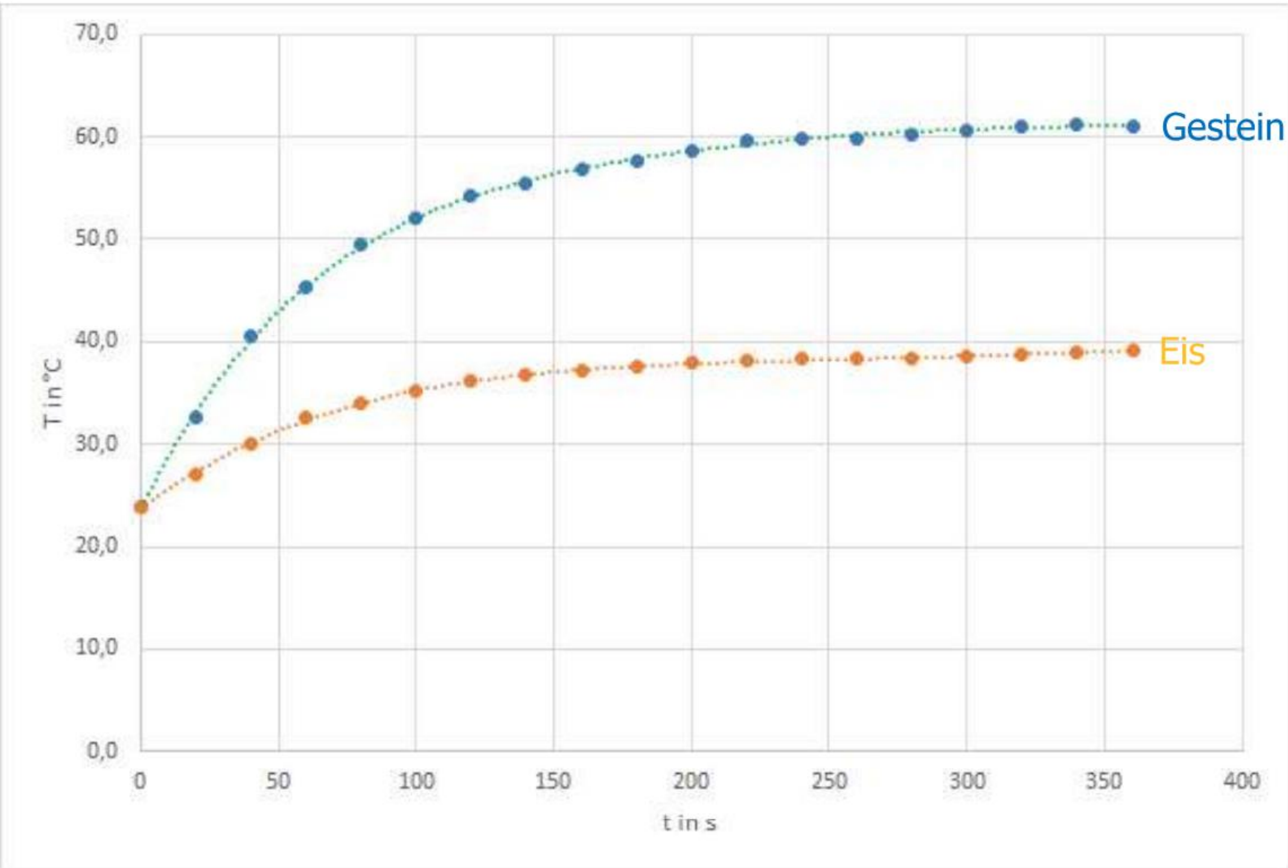
For the Earth, a new radiation equilibrium would be established, since the planet would now be irradiated more strongly due to the shorter distance. For Venus the difference to the present place of the earth would be enormous and the temperature of the earth would be so high that it would not be habitable any more. Since Mars, on the other hand, is still in the life zone (habitable zone), the temperature would rise, but life would theoretically be possible.

Part 2: What role do ice surfaces play in the temperature of the Earth?

➞ Measure the temperature of the two paper bodies every 30 seconds and note the results in the table.

Time in s	0	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340	360
Temperature dark in °C	23,9	32,7	40,5	45,4	49,4	52,0	54,2	55,5	56,9	57,7	58,7	59,7	59,8	59,9	60,3	60,7	61,0	61,2	61,1
Temperature light in °C	23,9	27,0	30,1	32,6	34,1	35,2	36,1	36,7	37,2	37,6	37,9	38,1	38,3	38,4	38,3	38,5	38,8	39,0	39,1

➞ Display the results graphically in the diagram. Use different colours.



➞ Discuss your results and explain the different temperature curves. Use the terms albedo, equilibrium temperature and radiation equilibrium.

Observation:
The temperature of the black paper body increases faster and reaches a much higher final temperature (equilibrium temperature) than the white paper body.

Explanation:
The albedo, i.e. the reflectivity, of the white paper body is higher than that of the black paper body, i.e. more radiation is reflected by the white body than by the black one. Therefore, despite the same irradiation of the bodies, a different radiation equilibrium arises and thus also different equilibrium temperatures!
All in all, it can be concluded that lighter bodies reflect radiation better or absorb radiation worse and thus reach a lower temperature than darker materials.

? Discuss the effects of melting ice and glaciers on the temperature of the Earth. What are the effects of the current melting of the polar ice caps?

Bright surfaces on the earth, such as ice and snow, reflect the incident light of the sun more strongly than, for example, water or the ground. This reflectivity of a surface is called albedo α (Latin for "whiteness"). For the entire earth, α = 0.3, i.e. approx. 30 % of the incident radiation energy is reflected and does not contribute to warming. The loss of white areas due to global warming has devastating consequences for the earth's climate.