International Young Naturalist's Tournament

Problem № 10

Greenhouse

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The task

A hot object placed in the open air would gradually cool down. We can slow down this process by containing the object in a greenhouse. Compare different mechanisms of heat loss by the object and explain how the presence of a greenhouse affects them.

Goal

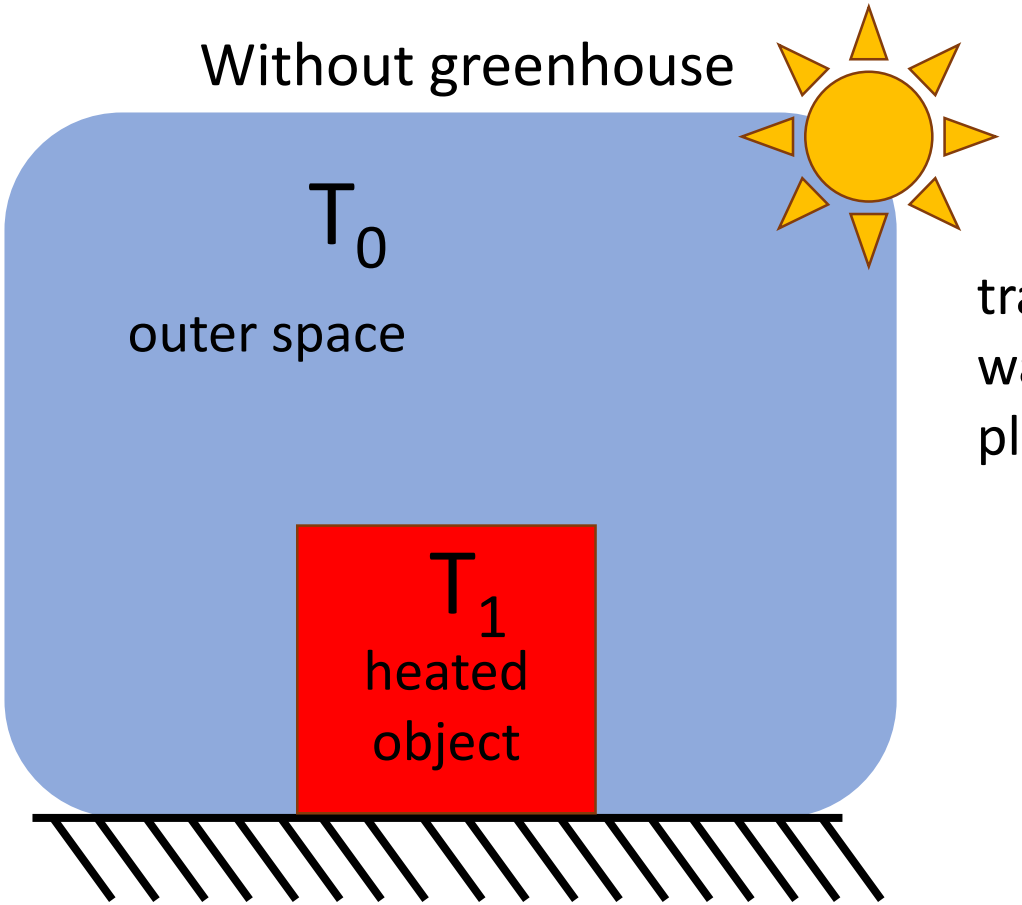
Compare different mechanisms of heat loss by the object and explain how the presence of a greenhouse affects them

Tasks

- Investigate the heat loss due to mechanisms of
  - Convection
  - Conduction
  - Radiation
- Conduct the experiment in lab and outside

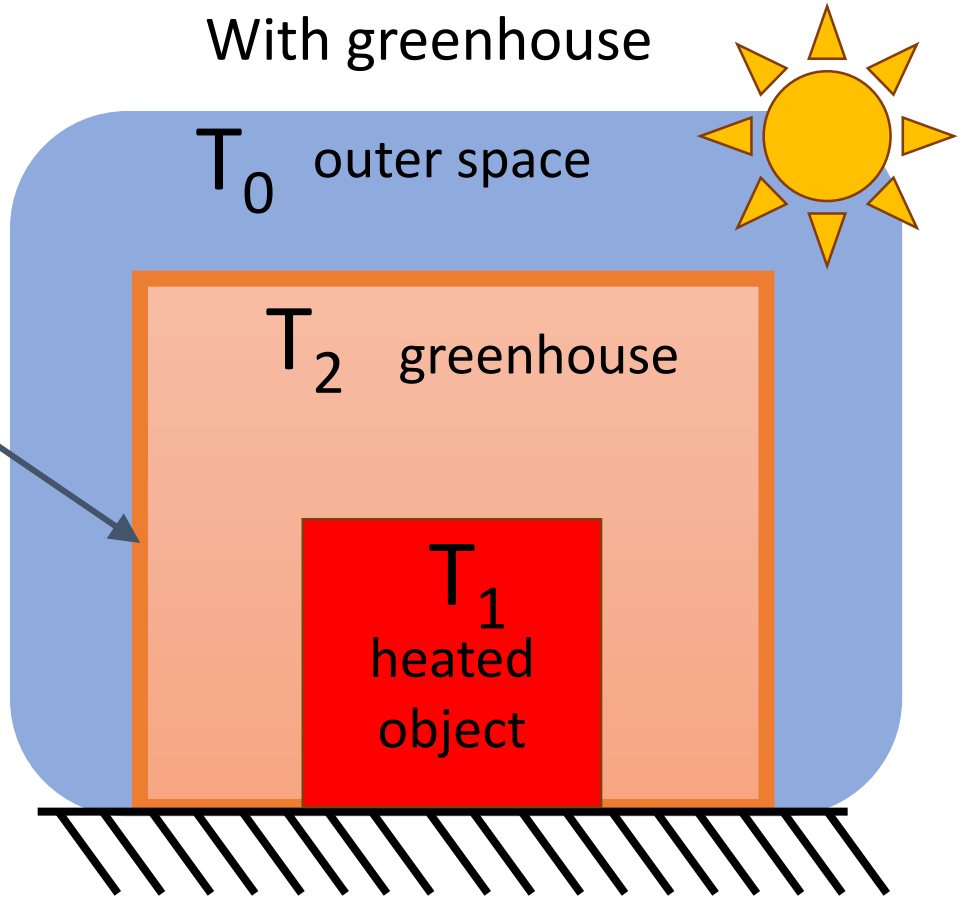
Theoretical part

The greenhouse



Object loses heat

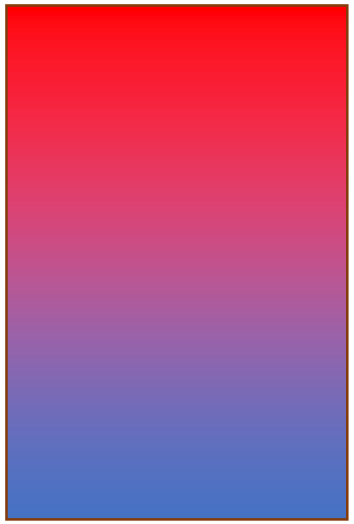
transparent walls from plastic film



Greenhouse slows down the cooling

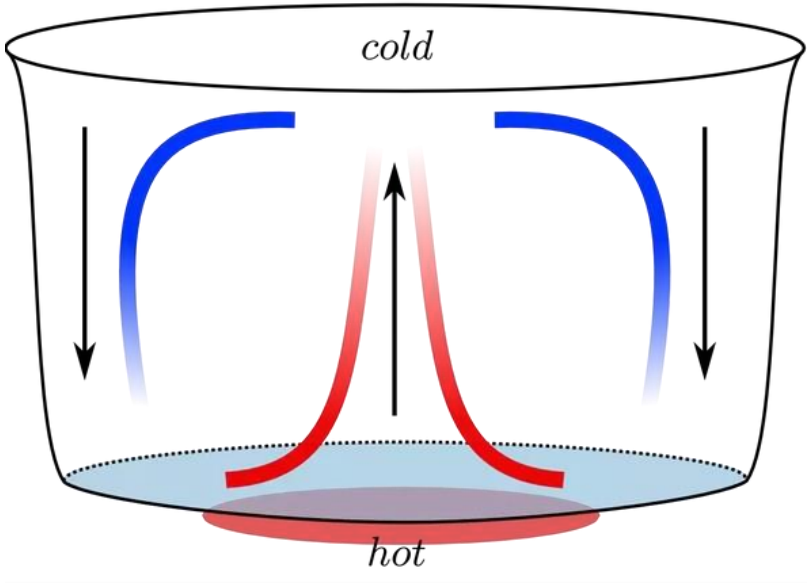
The mechanisms of heat transfer

Conduction



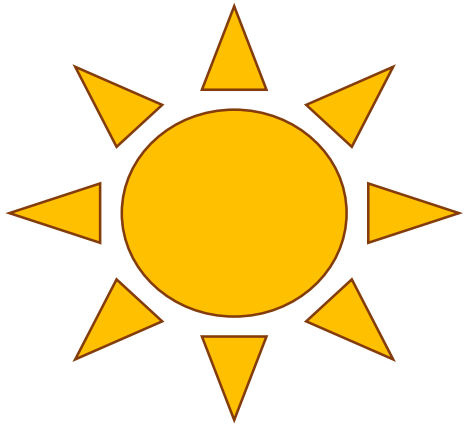
Contact between molecules

Convection



Motion of molecules in liquid or gas

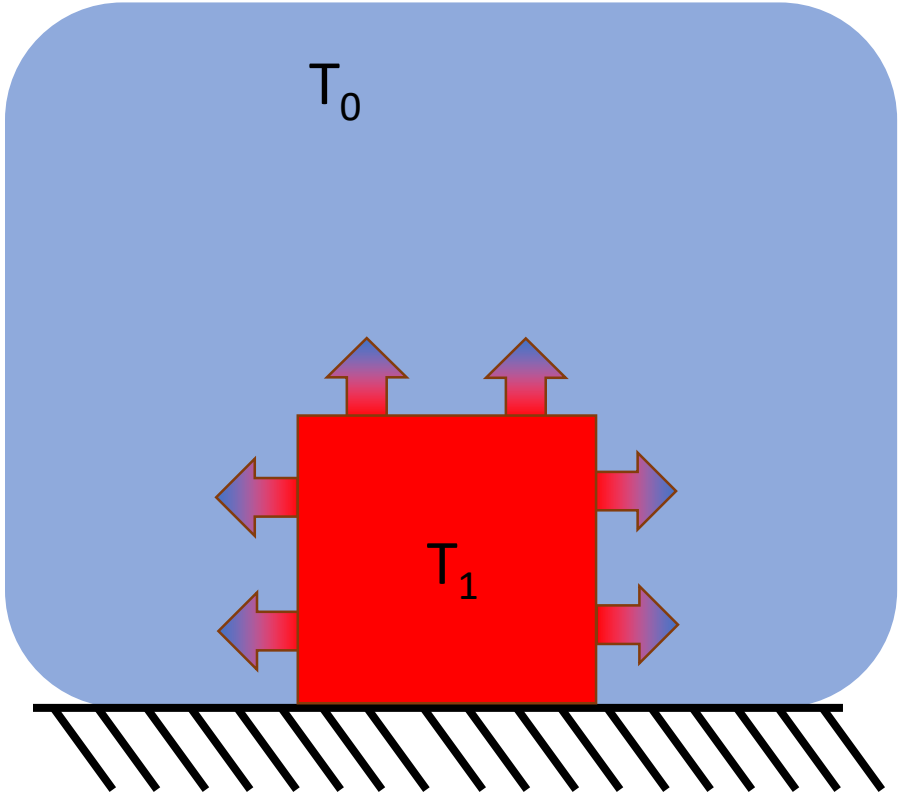
Radiation



Electromagnetic waves

Conduction

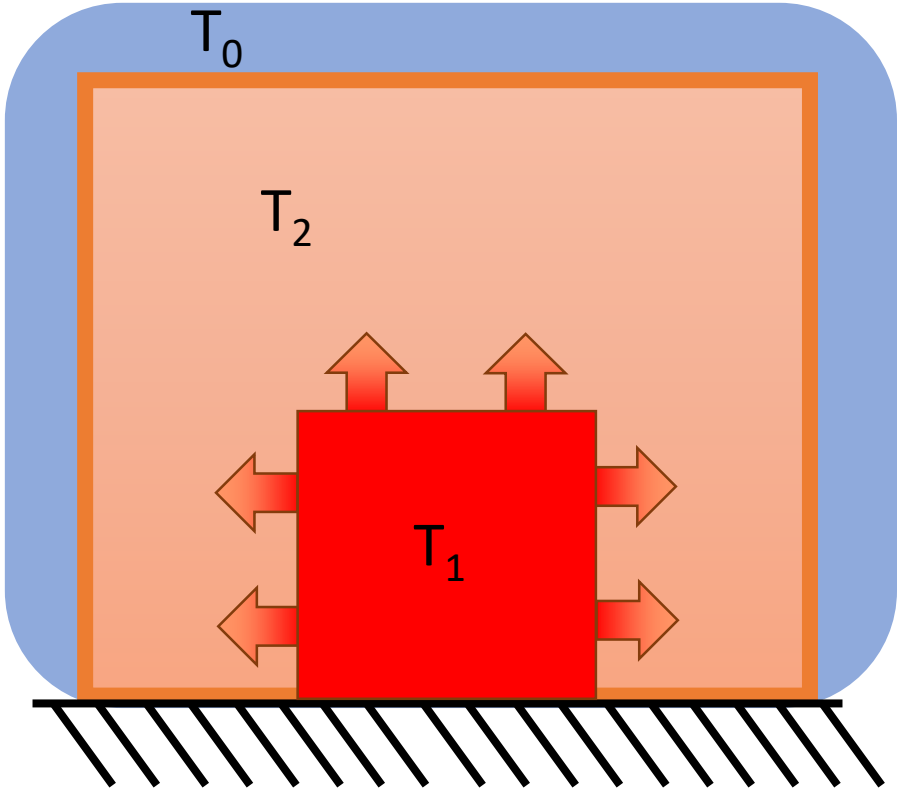
Without greenhouse



$$Q = kS\Delta T$$

Q – heat loss
k – coefficient of conductivity
S - area
ΔT - difference in temperatures

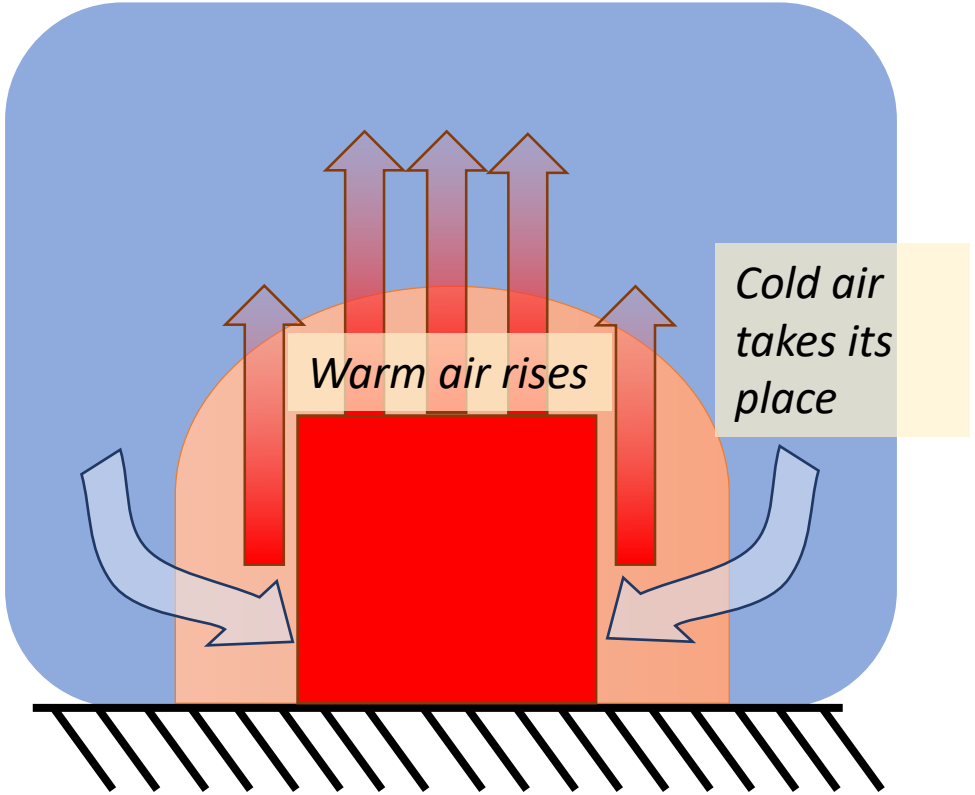
With greenhouse



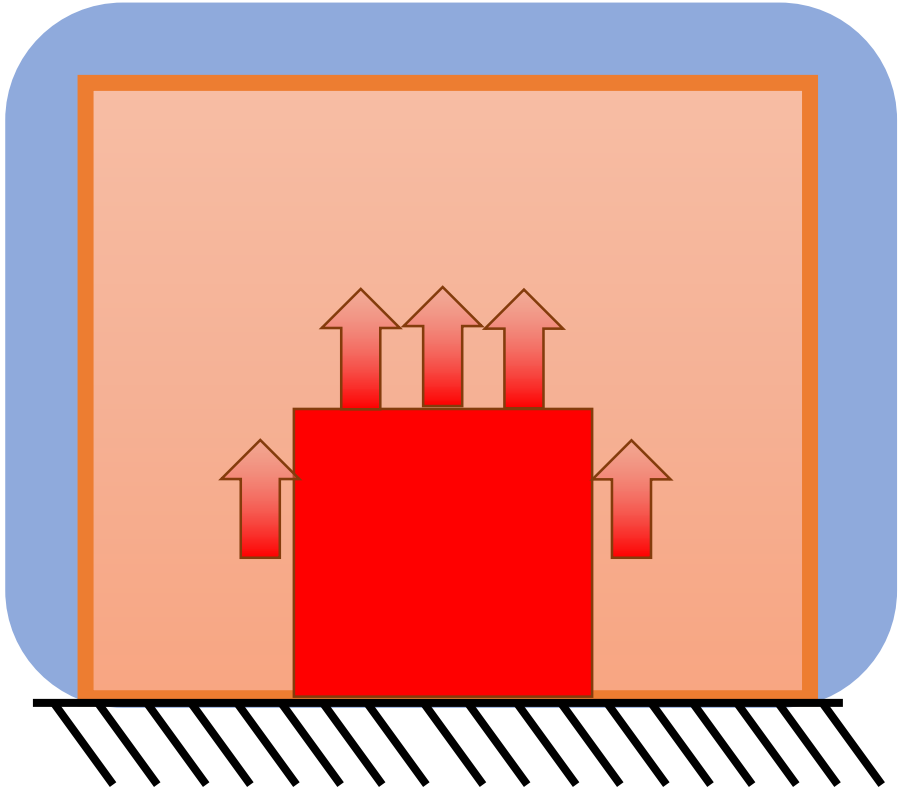
The rate of heat loss due to conduction decreases because the difference of temperature $T_1 - T_2 < T_1 - T_0$

Convection

Without greenhouse



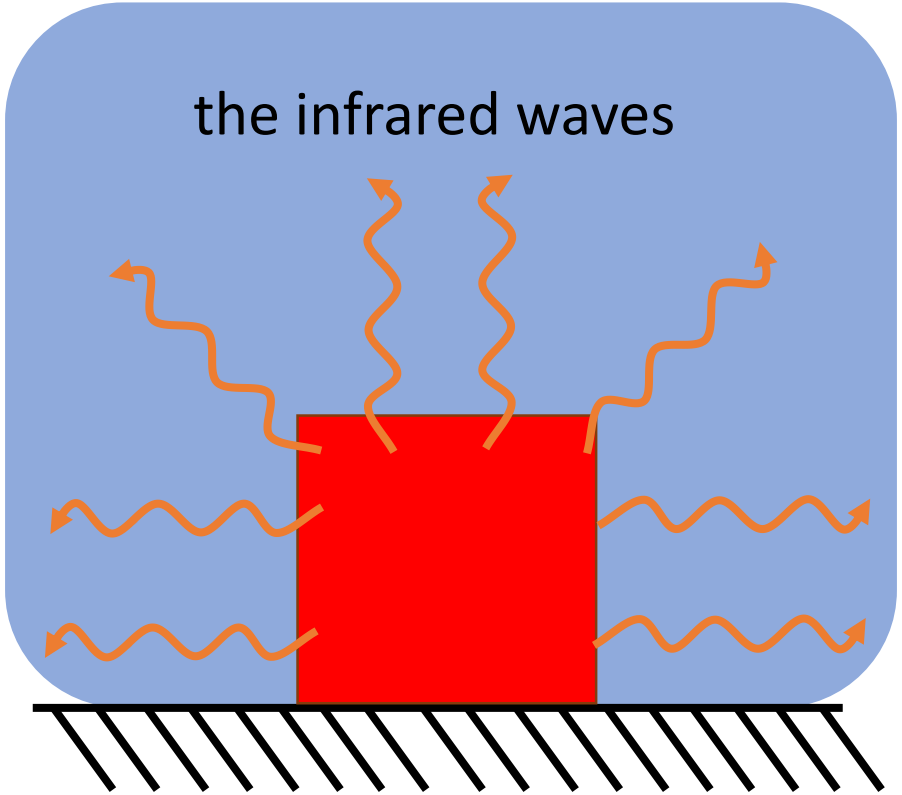
With greenhouse



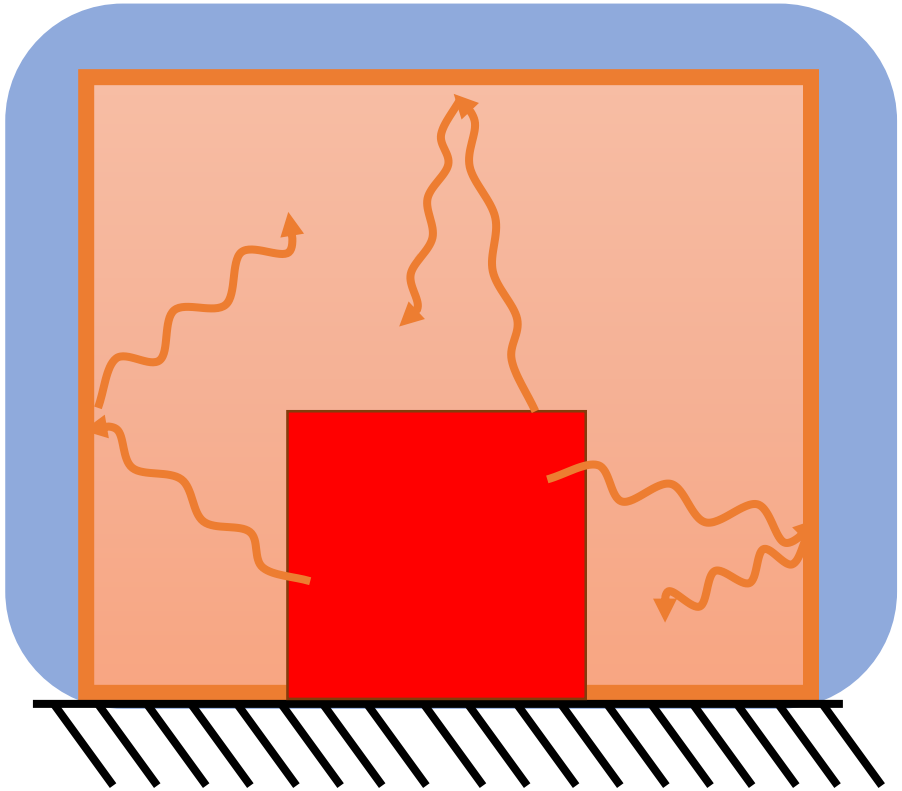
The rate of heat loss due to convection decreases, because structure is not open to the atmosphere, so the warmed air cannot escape

Radiation

Without greenhouse



With greenhouse



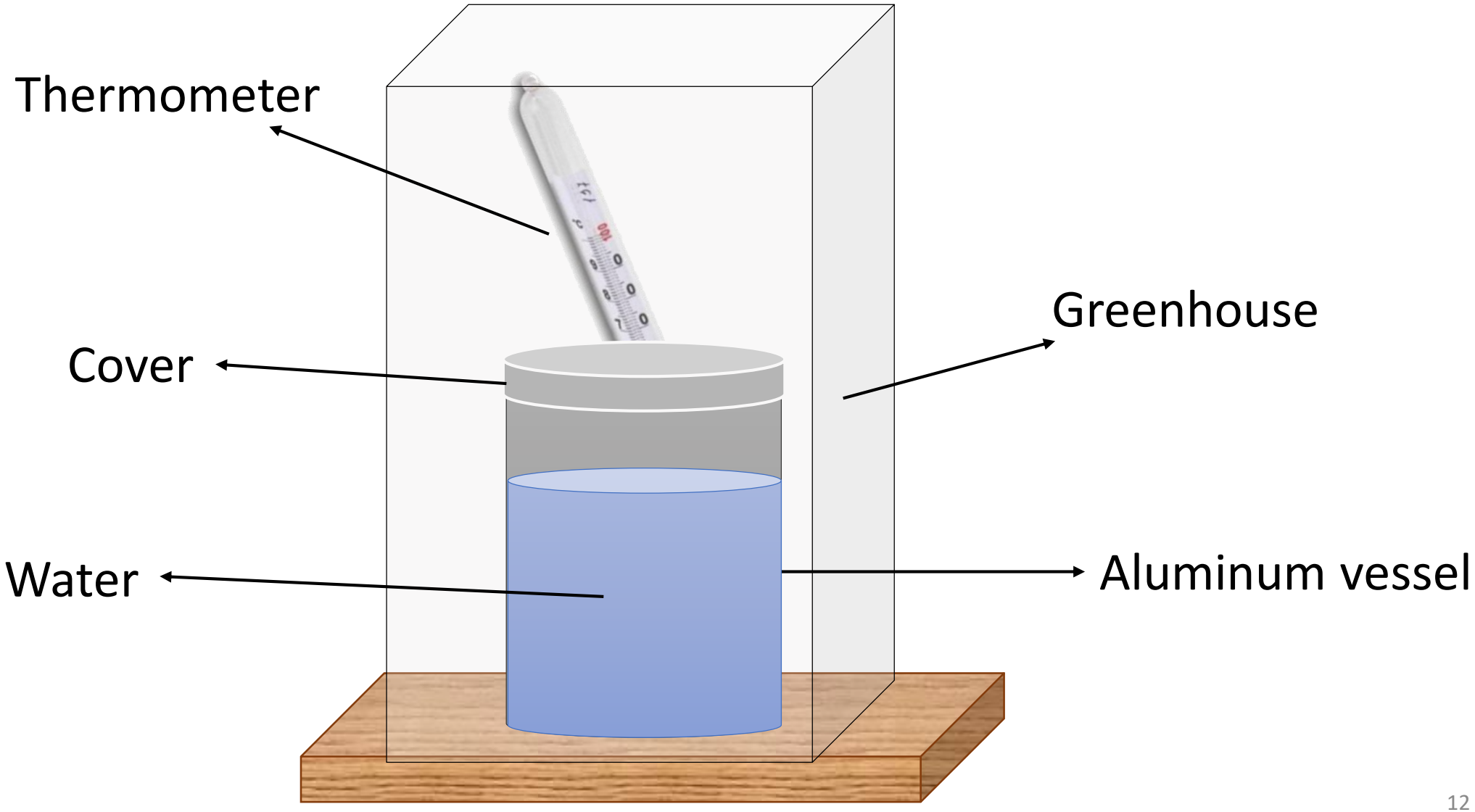
The rate of heat loss due to radiation decreases, because infrared radiation reflects from the plastic-glass walls

Experimental part

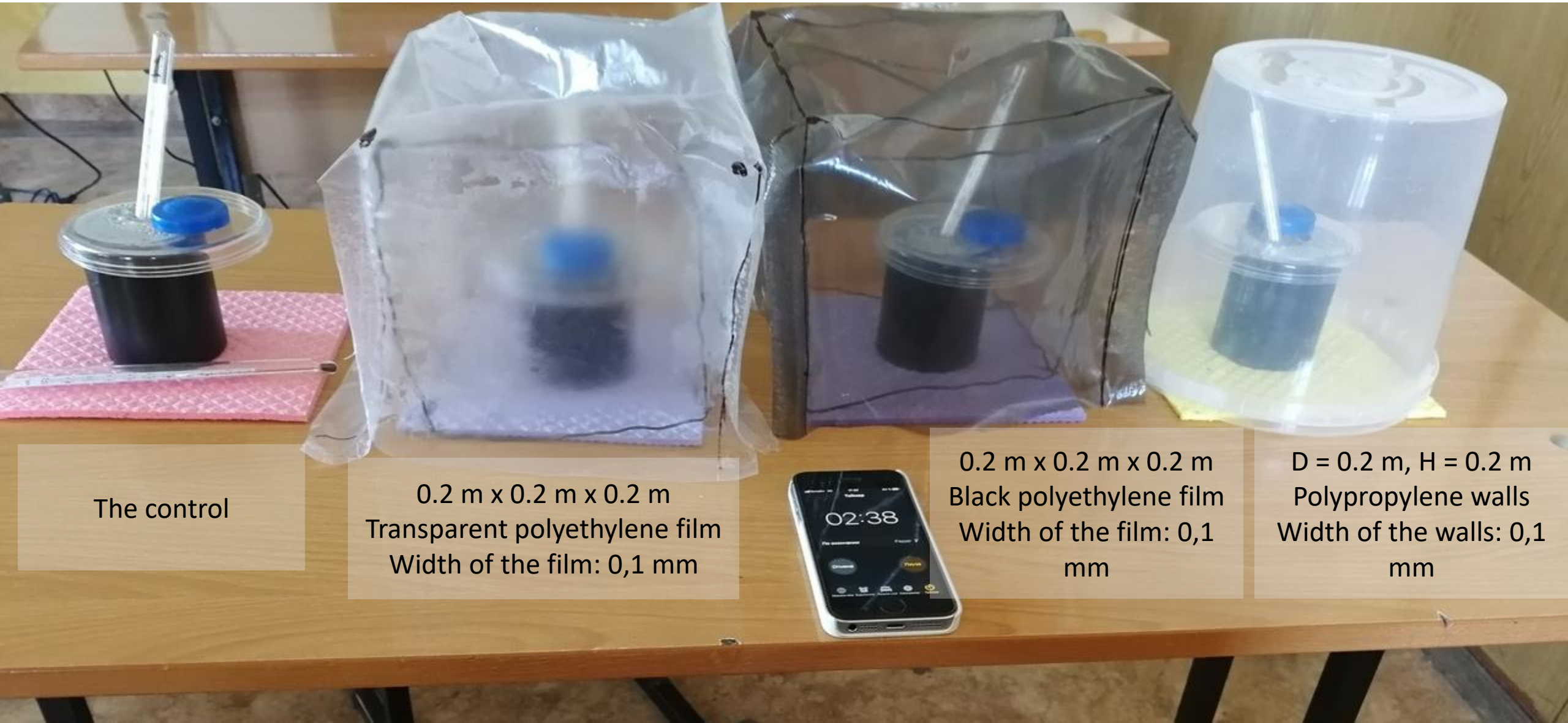
Equipment

- 4 vessels with covers
- Hot water: m = 300 g, T_{water} = 80°C
- Greenhouses
- Black dye
- Thermometer

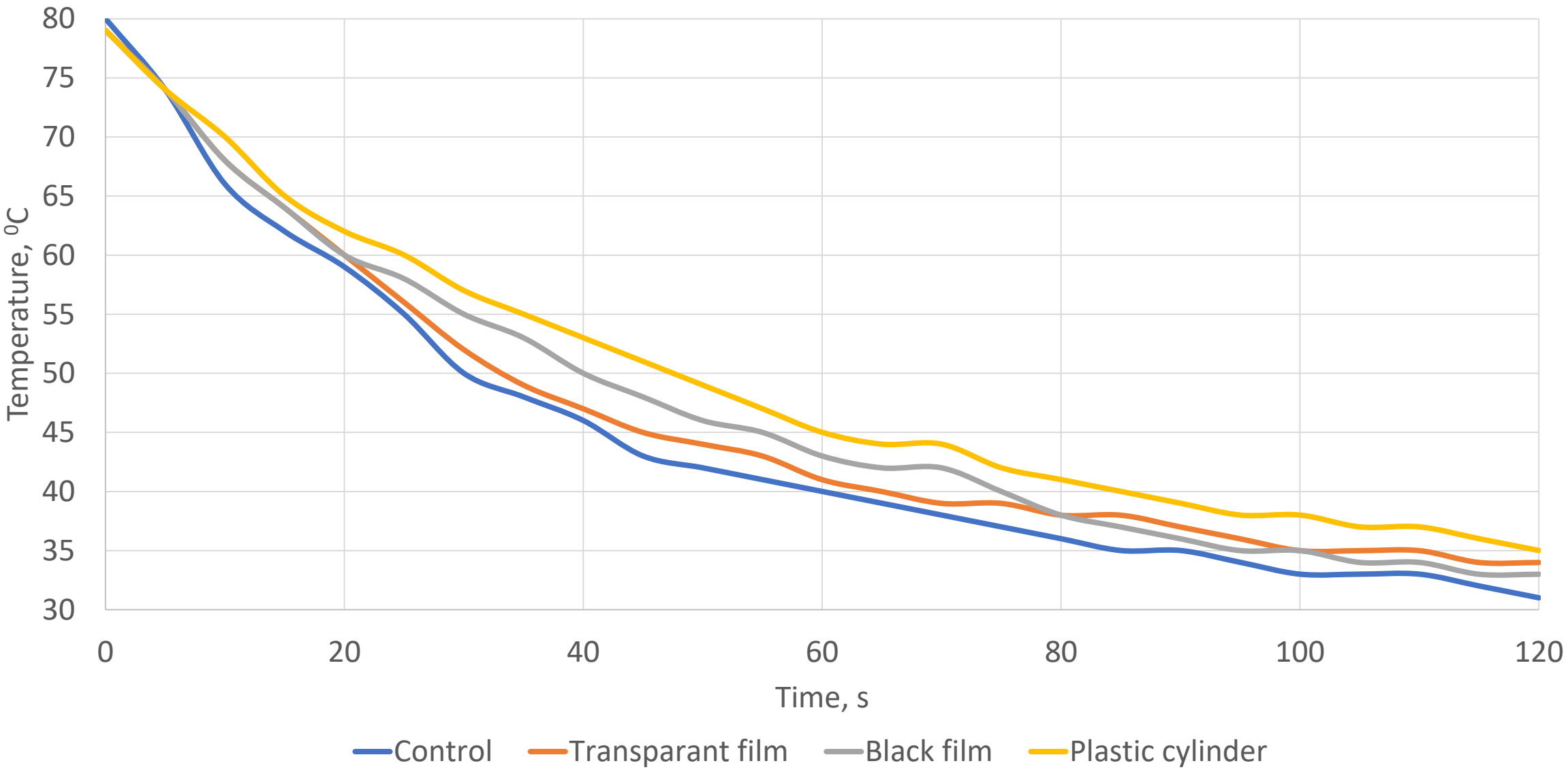
Laboratory experiment



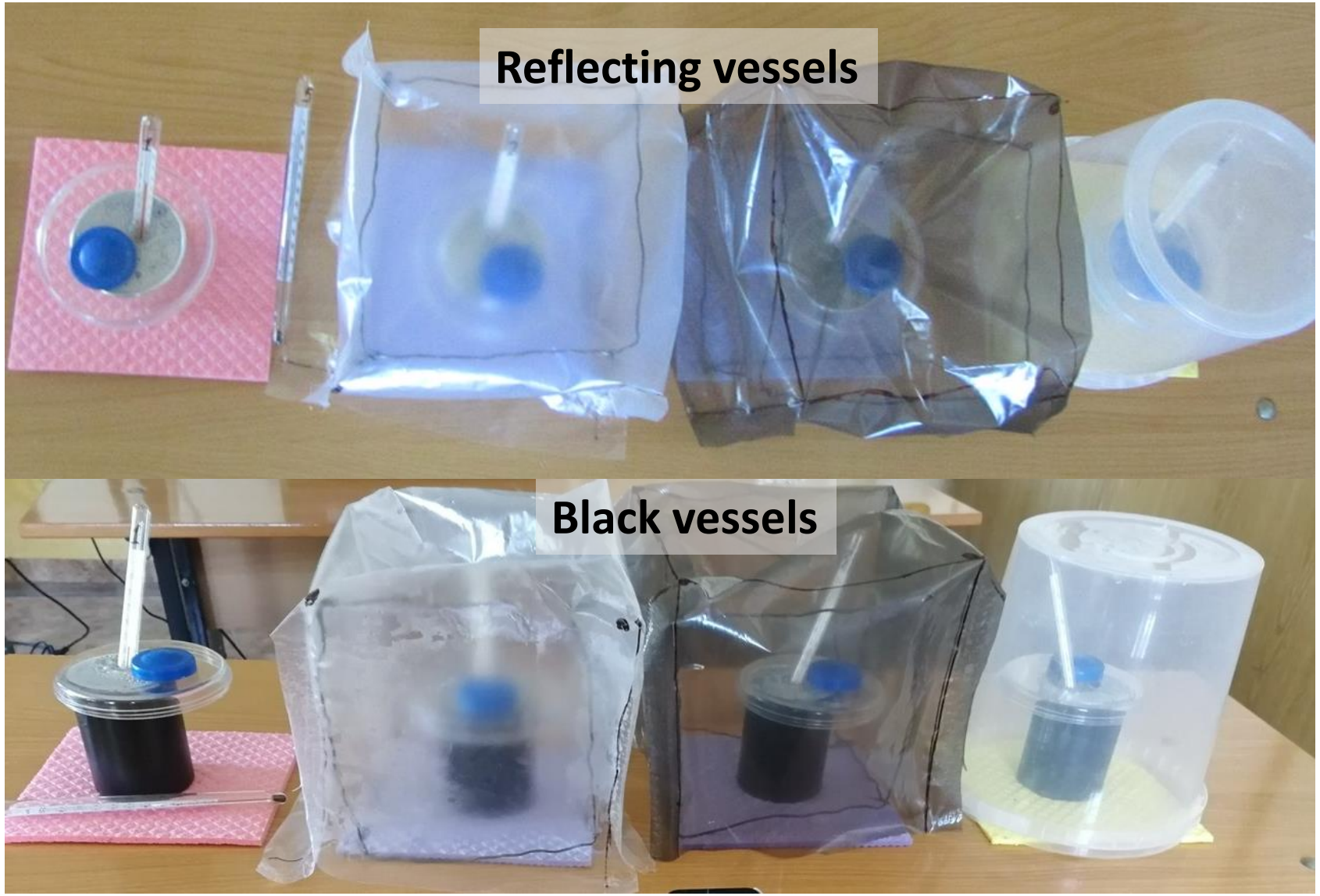
The greenhouses



The temperature VS time

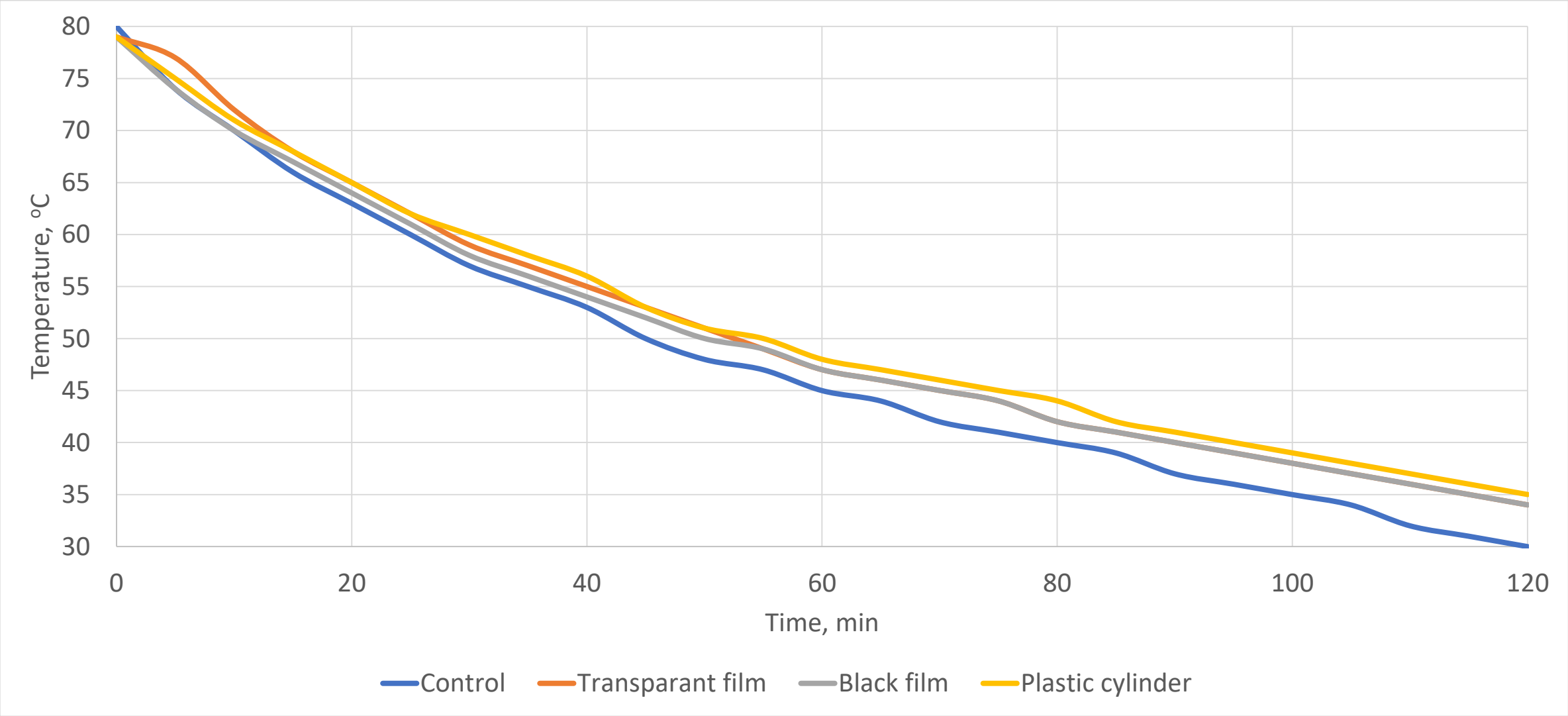


Black vessels VS reflecting vessels

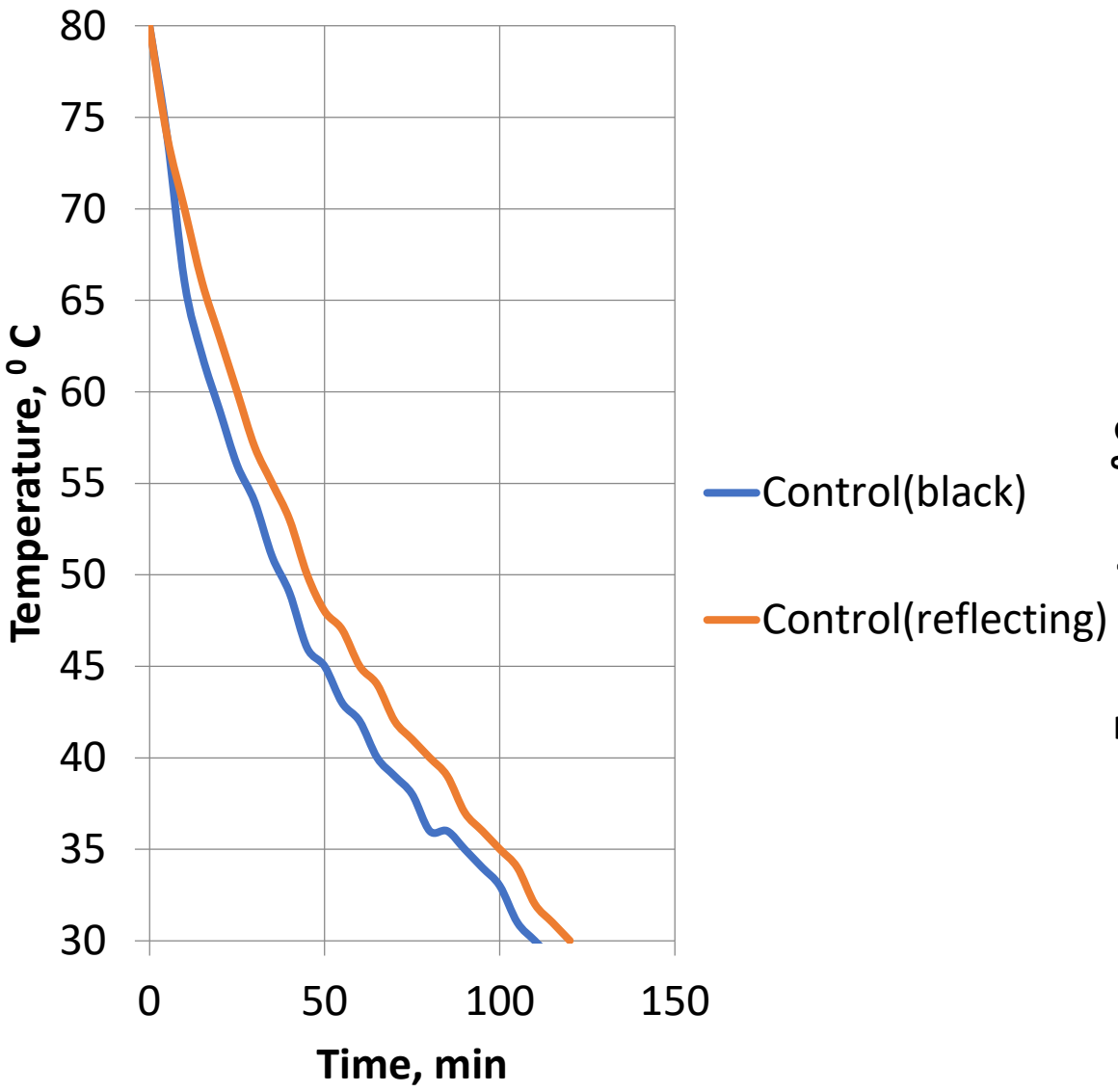


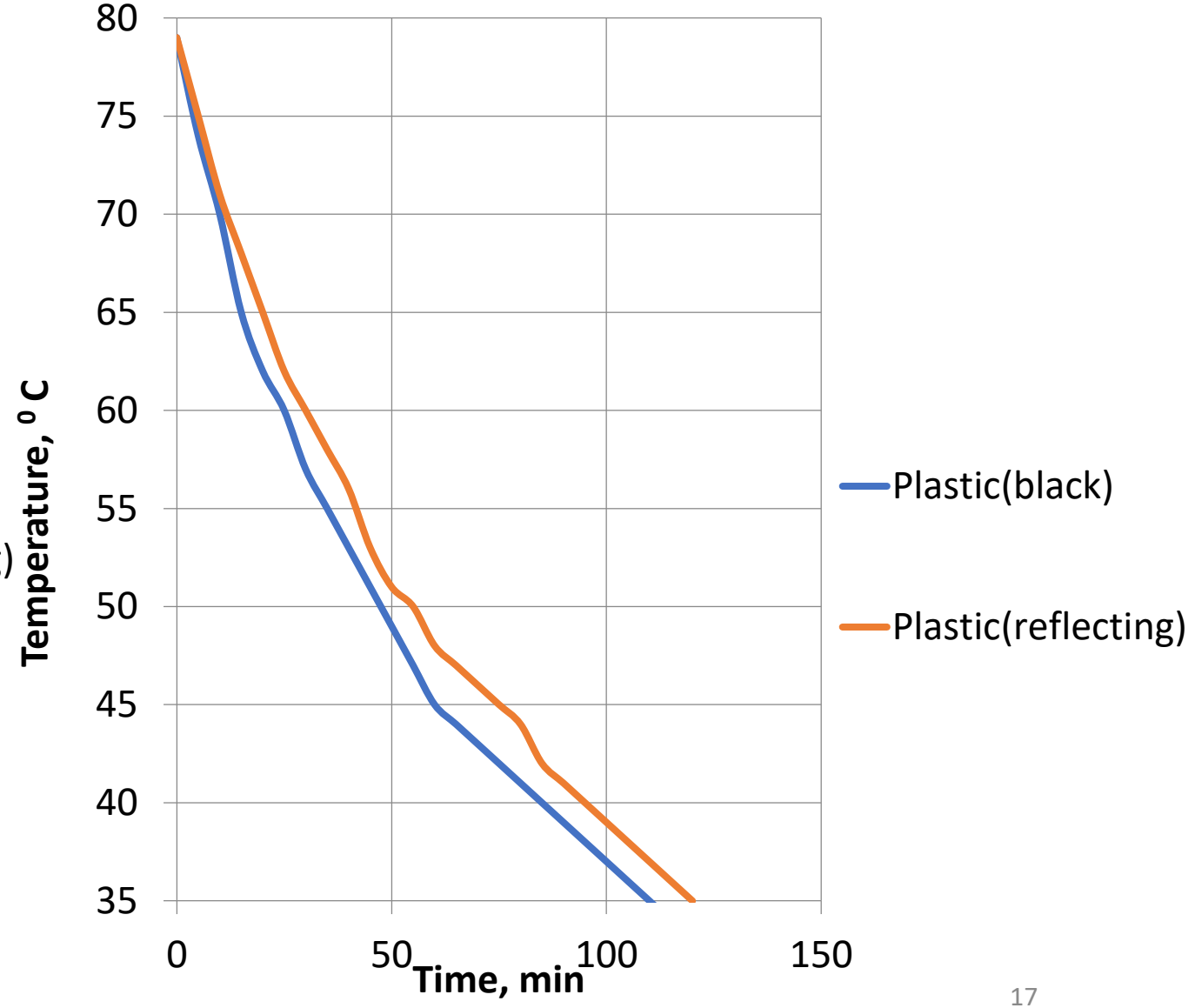
Black vessel: heat loss due to radiation increases

The temperature VS time



Black VS Reflecting





Real-life experiment

Camera records the thermometer reading

Calorimeter in the greenhouse

Calorimeter in the outer space

The equipment

- Hot water,

  m = 300 g, T_{water} = 80°C
- 2 calorimeters
- greenhouse:

  Length=1,5 m

  Height=0,85 m

  Width=1m

  material
- Thermometer
- Camera

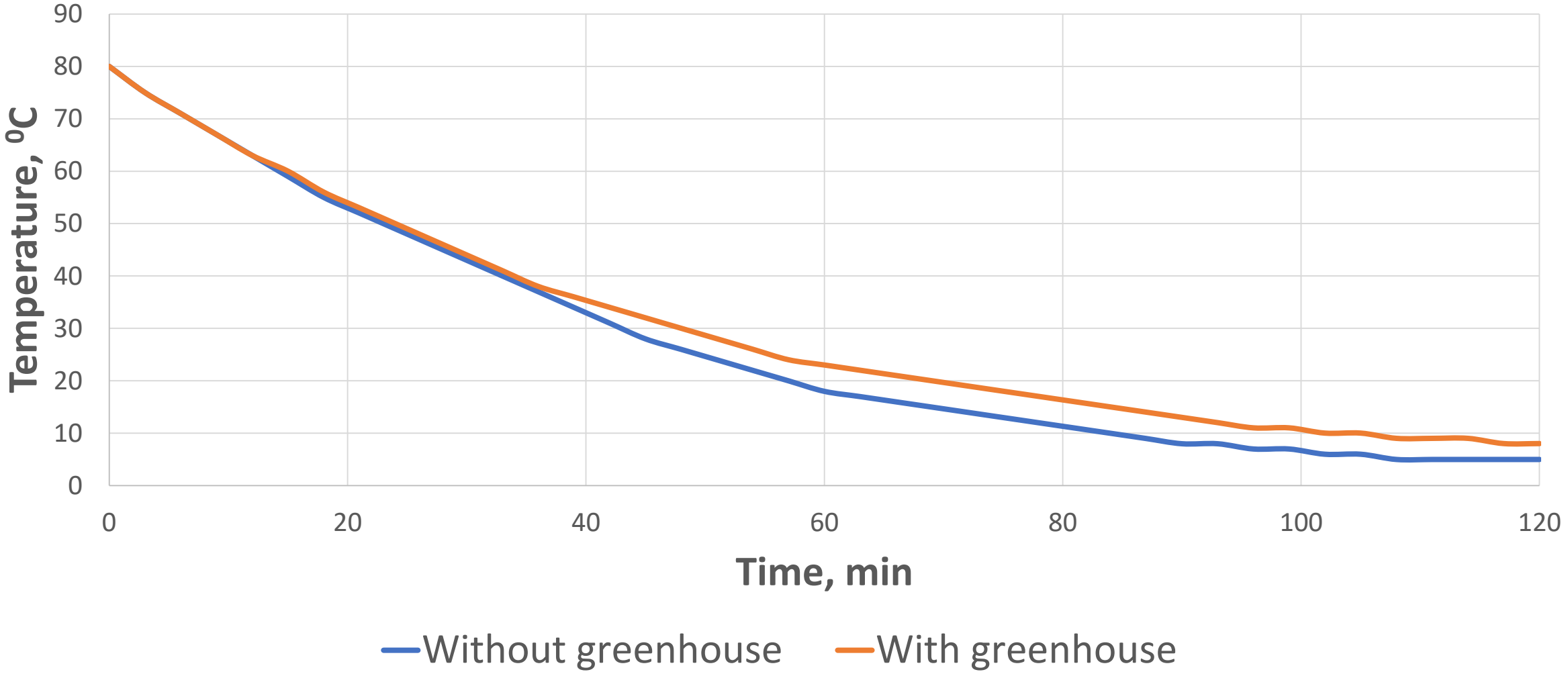
Experimental process

- 2 calorimeters with hot water are placed:
  - One in the greenhouse
  - Other near the greenhouse
- The temperature of water is recorded on camera.
- The temperature dependence over time is investigated.

$T_0 = +4^0C$

Experiment lasted for 120 min

The experimental results



Conclusion

- We explained how the greenhouse slows down the cooling of heated object by the mechanisms of:
  - Convection
  - Conduction
  - Radiation

- We experimentally investigated the change of temperature over time in greenhouses with different parameters


Thank you for your attention!

Наша команда

Наша команда

Руководители команды

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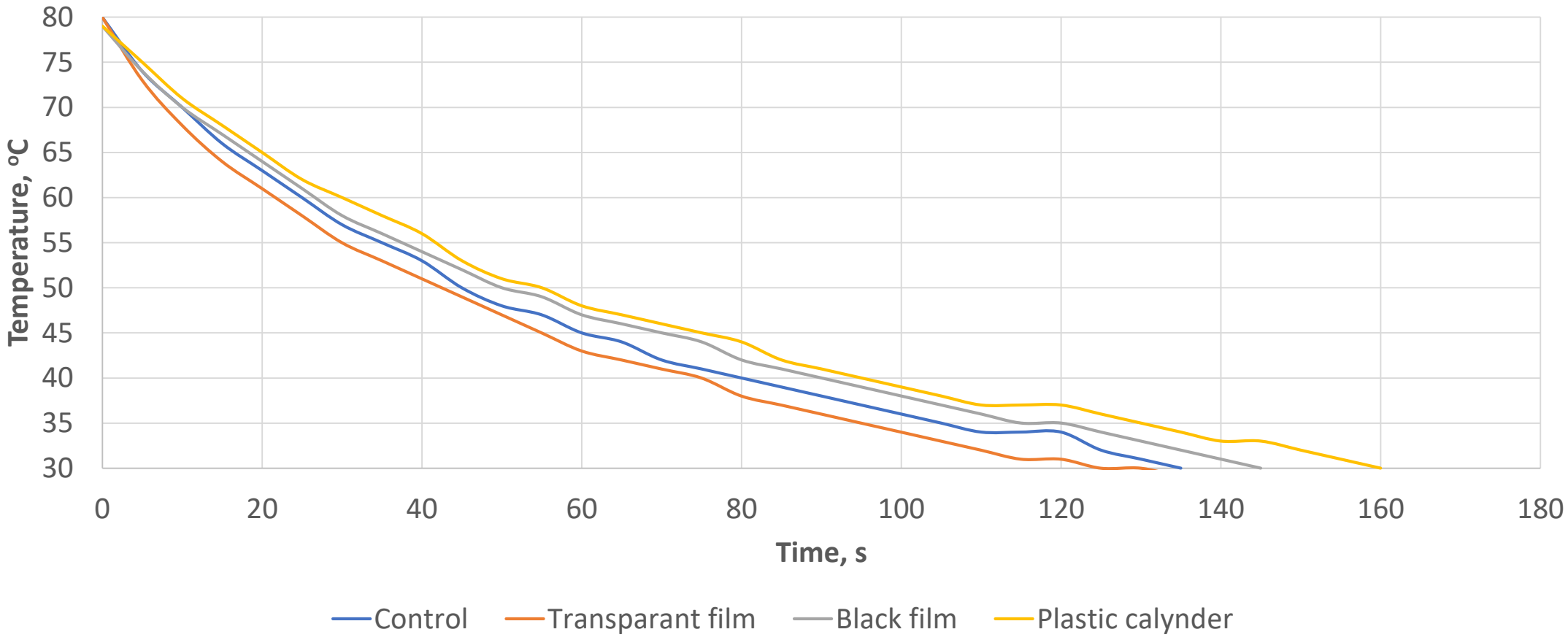
The temperature VS time



Conduction

1.