Team Awkward Turtles

Bulgaria

10. Greenhouse

IYNT Tbilisi 2018

Summary

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2. Introduction
3. Materials and methods
4. Experiment
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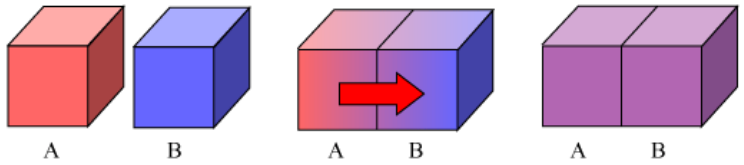
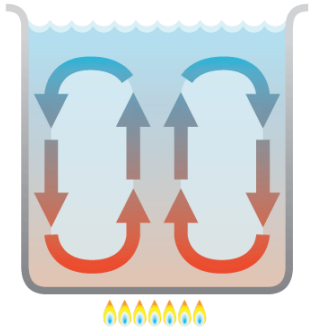
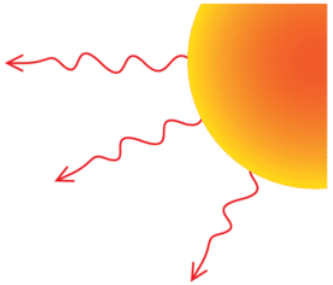
1. Problem statement

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.

2. Introduction

heat loss = heat transfer = transfer of heat from a hotter area to a colder area until both have the same temperature (equilibrium)

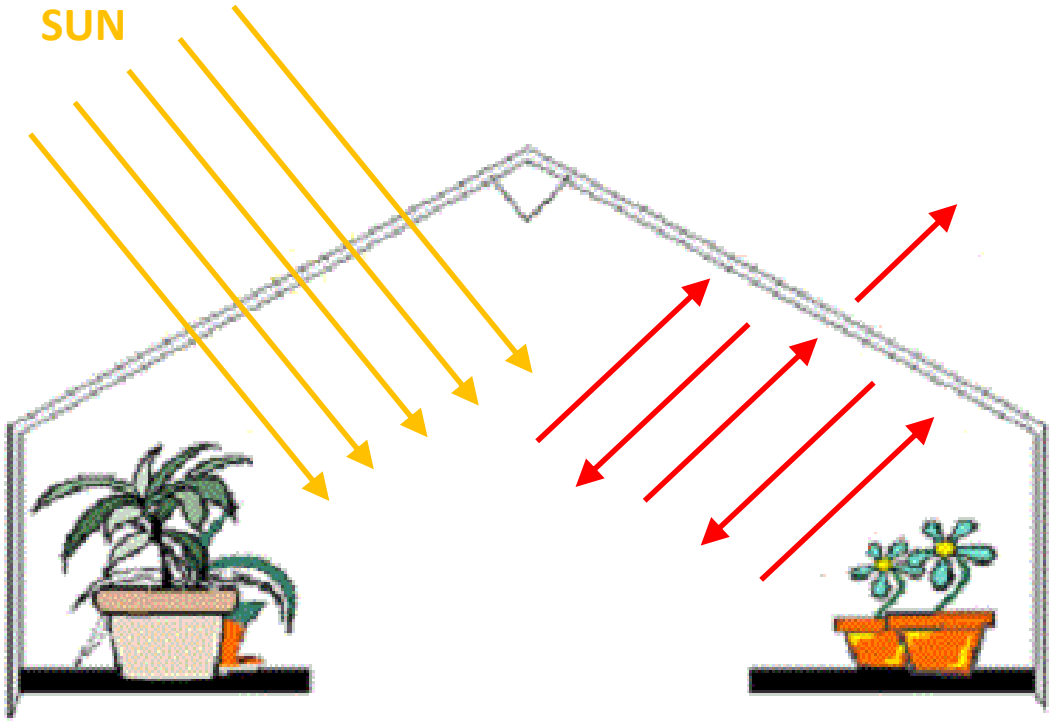
Mechanisms of heat transfer

Conduction	Convection	Radiation
heat transfer via direct flow of heat trough a material due to physical contact 	natural or forced heat transfer via direct movement of a fluid (air or water) 	heat transfer via electromagnetic waves (does not necessary require a medium to carry the heat) 

2. Introduction

What is a greenhouse and how it works?

A greenhouse is made of glass which let's the visible light (radiated heat) from the sun through. The heat is absorbed by plants and soil which then give out the heat. Some of the heat passes through the glass, but most is trapped inside and keeps the greenhouse warm. Glass is not a good heat conductor – it acts as an insulator.



Earth's atmosphere as a greenhouse

Gases like CO_2 act like the glass of a greenhouse and block the heat from escaping the Earth. Human activities such as burning fossil fuels increase the amount of greenhouse gases released into the atmosphere. Trapping this heat results in rising temperatures on Earth and climate change in recent history.

3. Materials and methods

Follow the time that is needed for a heated copper object to give away its temperature to the environment (from 100 °C to 40 °C) via the following mechanisms:

1) natural convection in open air – metal object, thermometer, stopwatch

2) natural convection in closed vessel – glass vessel with lid

3) forced convection in closed vessel – fan

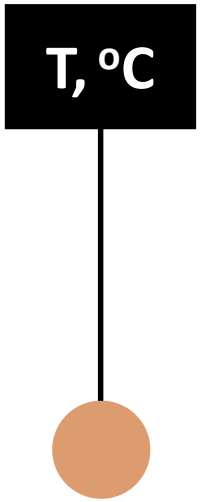
4) natural convection in closed vessel in the presence of only CO_2 gas

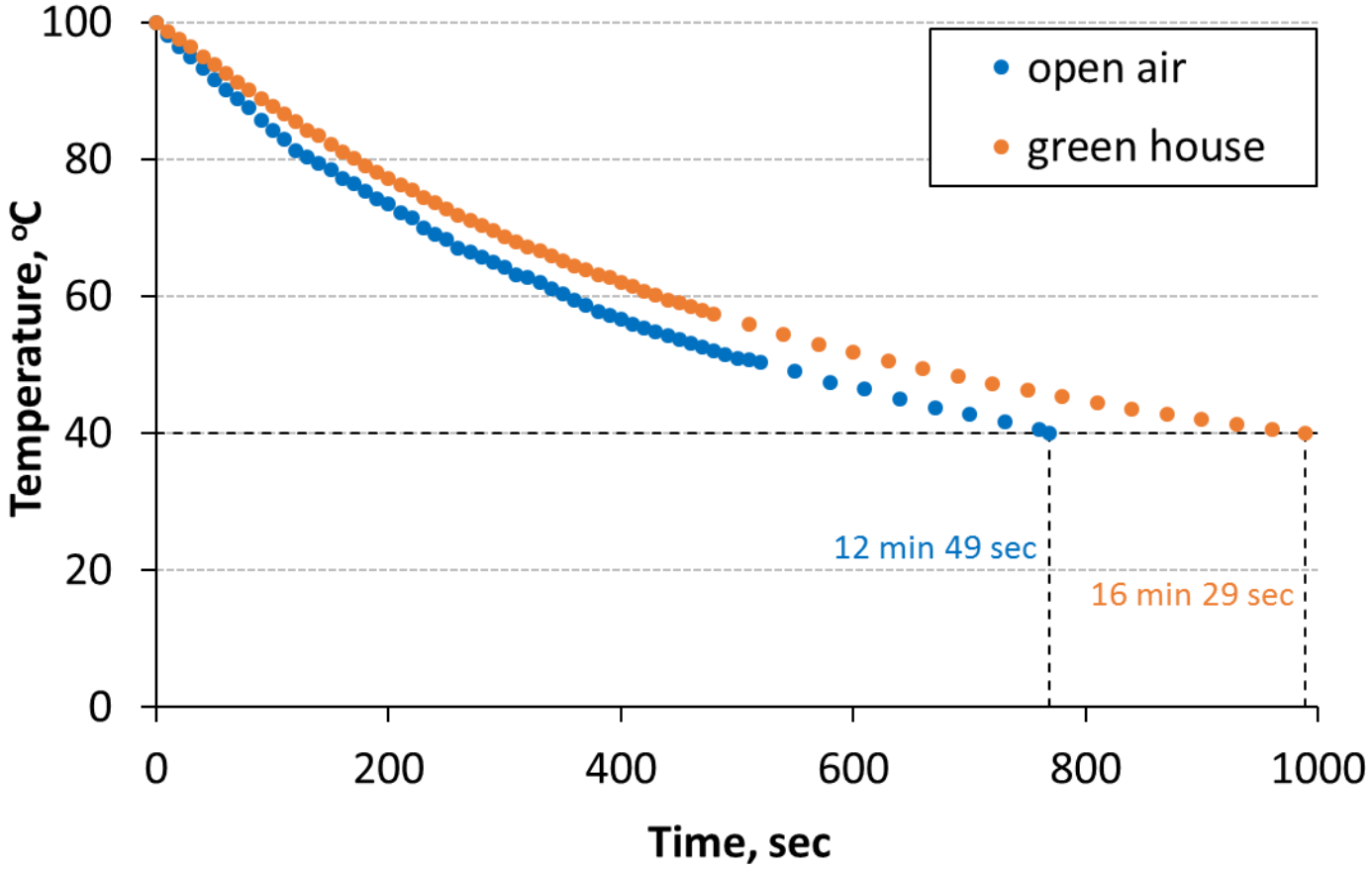
CO_2 produced following this reaction:

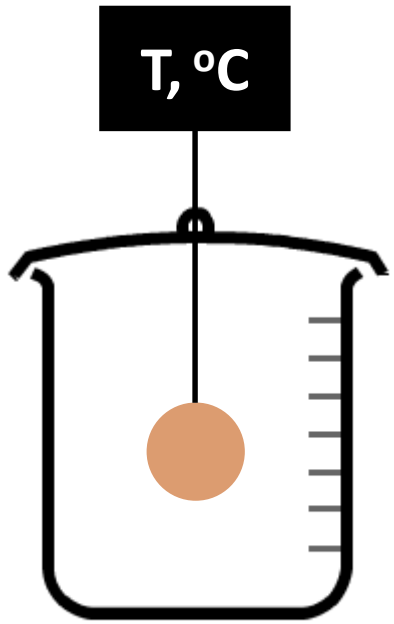
$Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$

4. Experiment

Natural convection in **open air** vs Natural convection in **closed vessel**



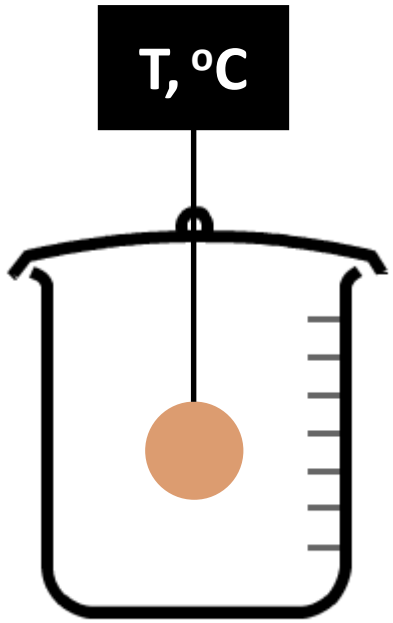


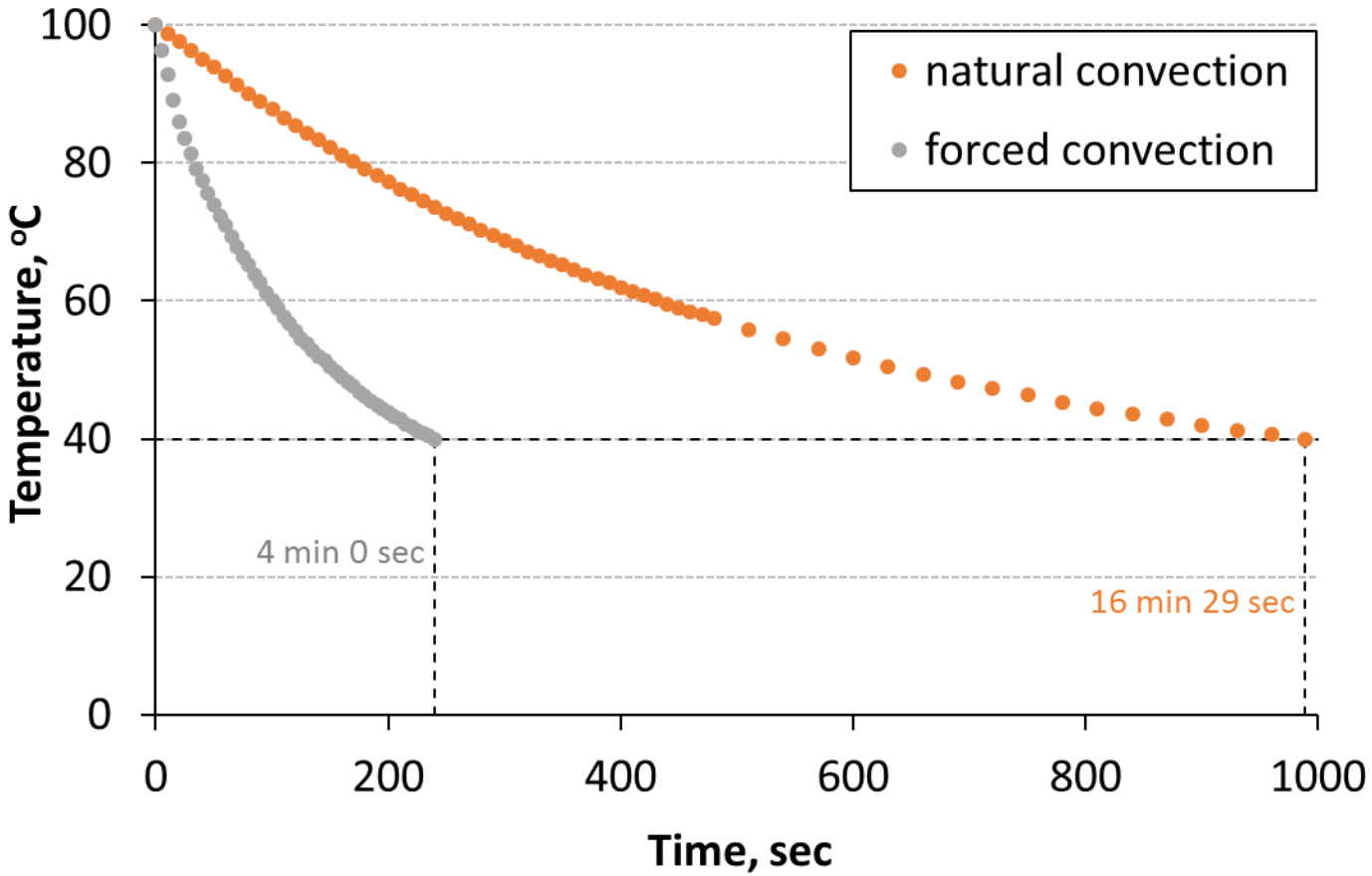


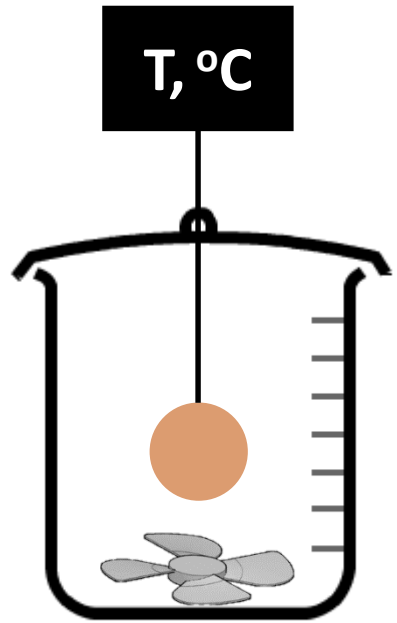
Containing a metal object in a green house leads to longer time for heat transfer as compared to cooling in open air (**3 min 40 sec**).

4. Experiment

Natural convection in closed vessel vs **Forced convection** in closed vessel



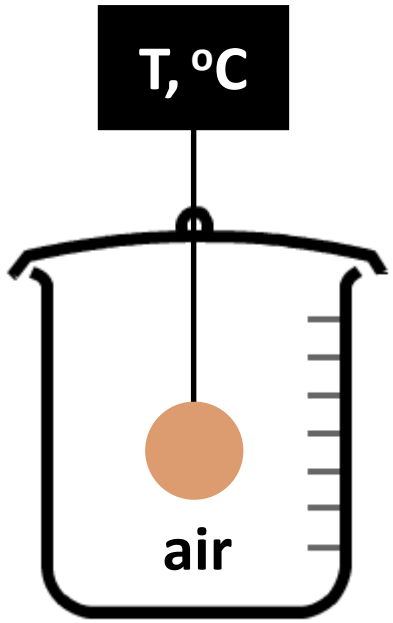


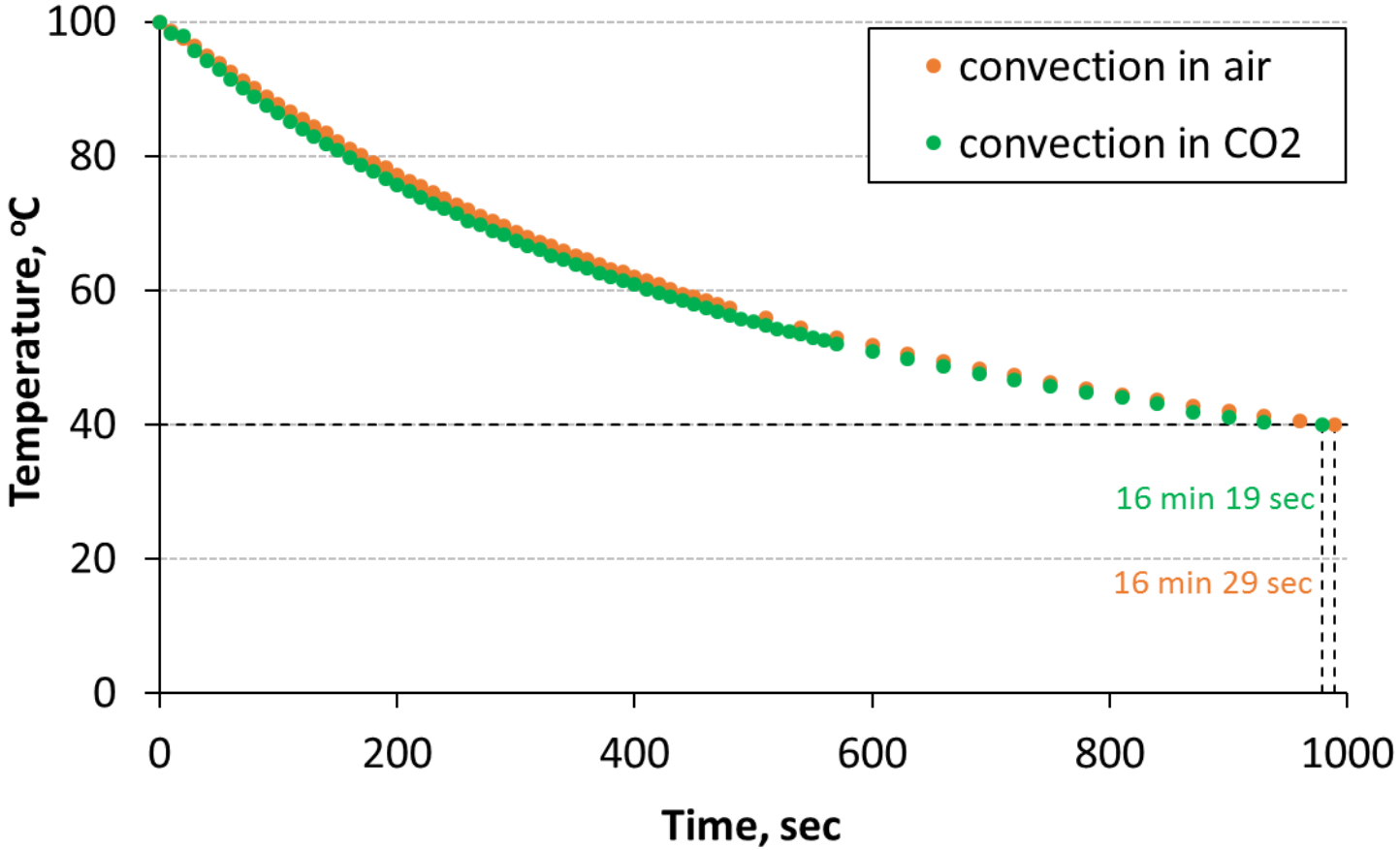


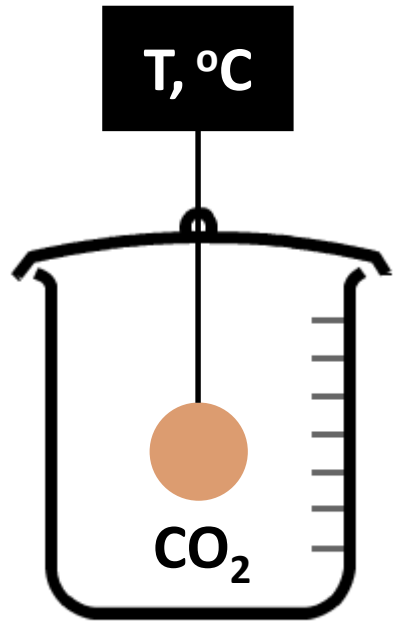
Forced convection leads to faster heat transfer than natural convection (**12 min 29 sec**).

4. Experiment

Natural convection in closed vessel in **air** vs Natural convection in closed vessel in **CO_2**







Heat transfer due to natural convection in carbon dioxide environment showed no difference as compared to air environment.

5. Results

Velocity of heat loss:

- natural convection in open air – **0.08 °C/min**
- natural convection in greenhouse – **0.06 °C/min**
- forced convection in greenhouse – **0.25 °C/min**
- natural convection in CO_2 medium – **0.06 °C/min**

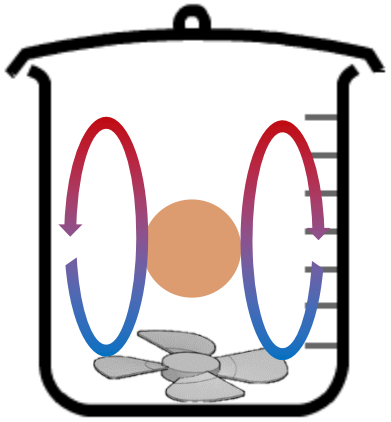
Natural convection in air and CO_2 medium had the same velocity of heat loss, although we expected that CO_2 will slow down the heat loss. This could be due to the fact that we used both CO_2 and greenhouse. If the object was left to cool down in CO_2 atmosphere, it should loose the heat slower than in air because the air will let heat through and CO_2 won't.

6. Conclusions

We observed 3 heat transfer phenomena – natural convection, forced convection and the greenhouse effect.

Velocity of heat loss was in the following order:

Heat transfer via forced convection is the fastest because the fan creates the motion of the air (not dependent on density) and cools the air.



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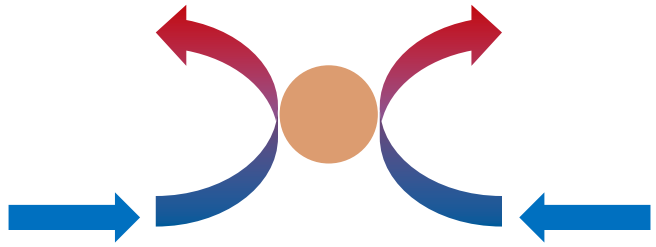
Heat transfer via natural convection in open air is slower because it is dependent on differences in air density.



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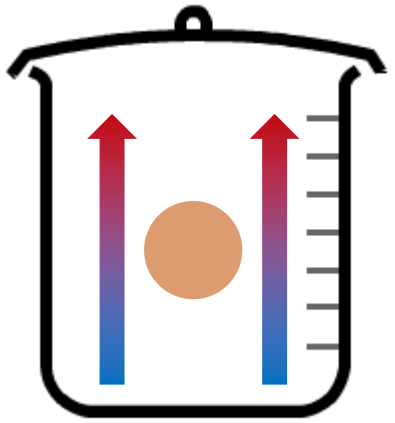
Heat transfer via natural convection in a closed vessel is the slowest because there is limited amount of cold air available.



THANK YOU FOR YOUR ATTENTION!

Used literature

[1] http://hyperphysics.phy-astr.gsu.edu/hbase/thermo/heatra.html
[2] http://www.physicsclassroom.com/class/thermalP/Lesson-1/Methods-of-Heat-Transfer
[3] https://www.nationalgeographic.org/encyclopedia/greenhouse-effect/
[4] http://www.environment.gov.au/climate-change/climate-science-data/climate-science/greenhouse-effect

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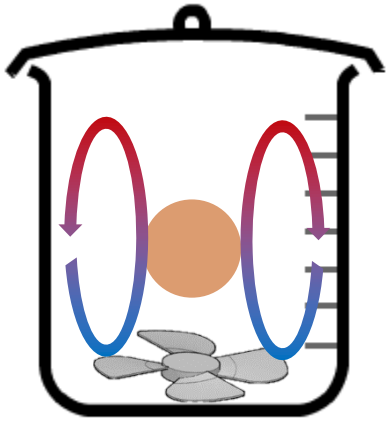

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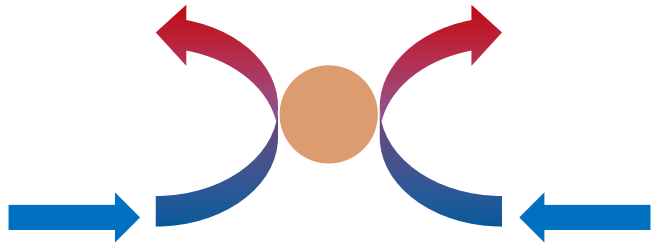

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