

12. Geyser

The Problem

Support a long, vertical tube containing water. Heat the tube directly from the bottom and you will observe that the water erupts. Arrange for the water to drain back into the tube to allow repeated eruptions.

Investigate the parameters that affect the time dependence of the process.

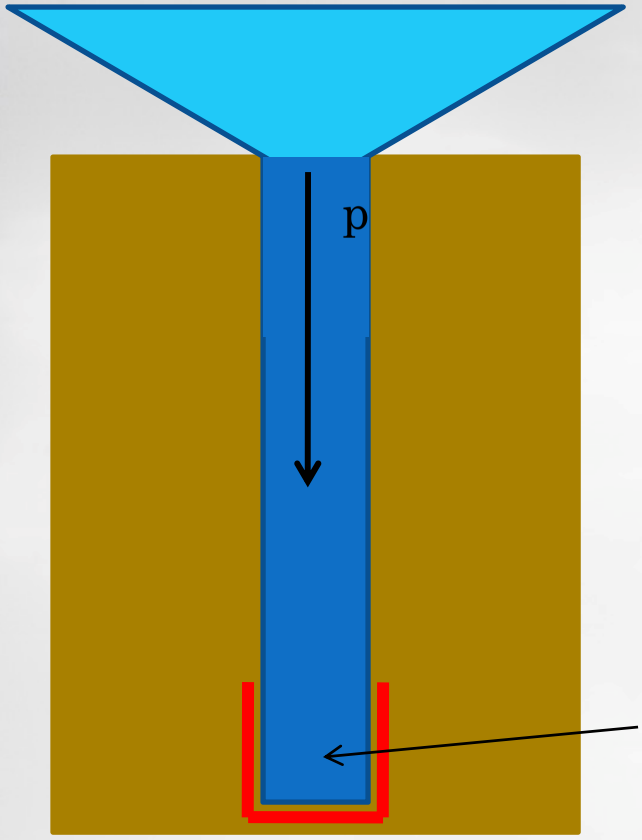
Outline

- Basic explanation
- Experimental setup
  - Copper tube
  - Glass model
- Experimental results and interpretation
- Conclusion

Achieving the effect



Basic explanation–I



Water is heated from below

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Reaches boiling temperature

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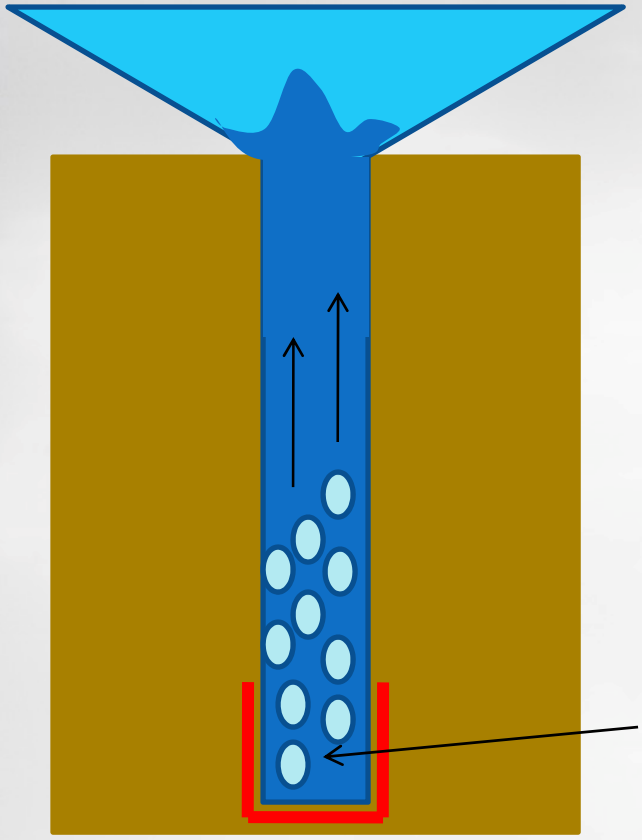
Pressure from above prevents boiling

↓

Water is overheated

Basic explanation–II



Overheated water

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Boils- air bubbles surge upwards

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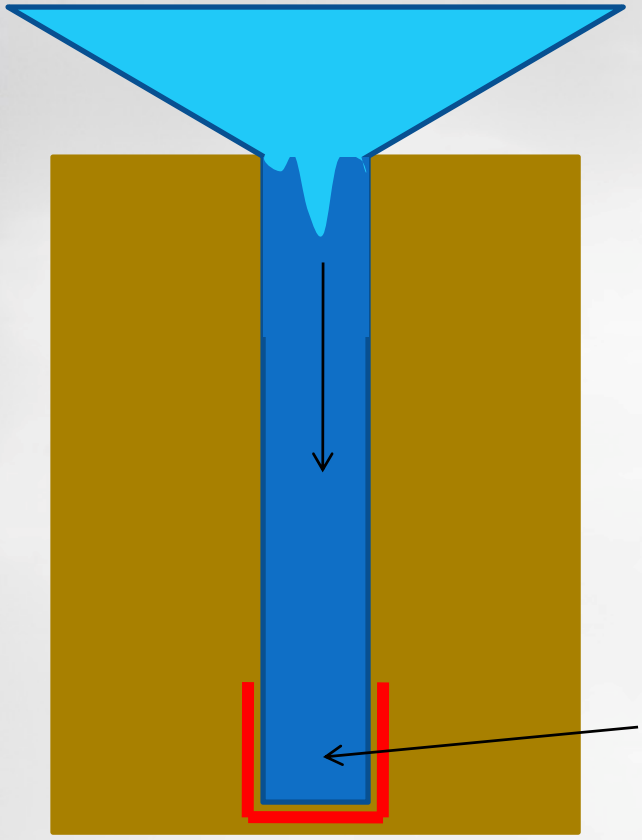
Causes water level to rise

Basic explanation–III



Overheated water

Air bubbles- condensate on their way up

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Loose volume- pressure drop

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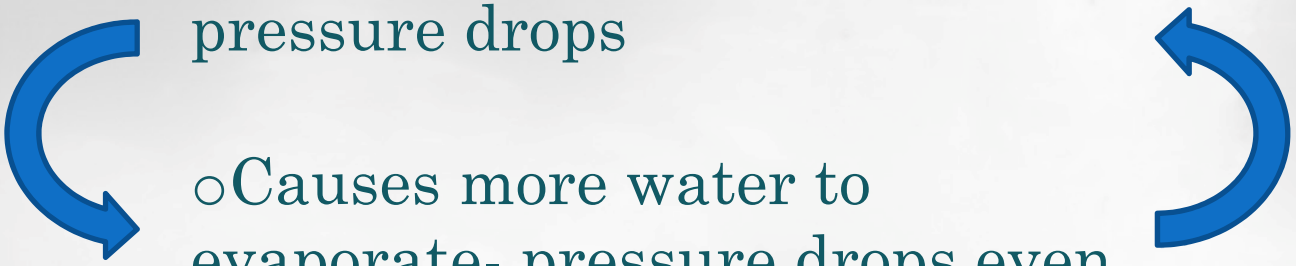
Sucks water back in

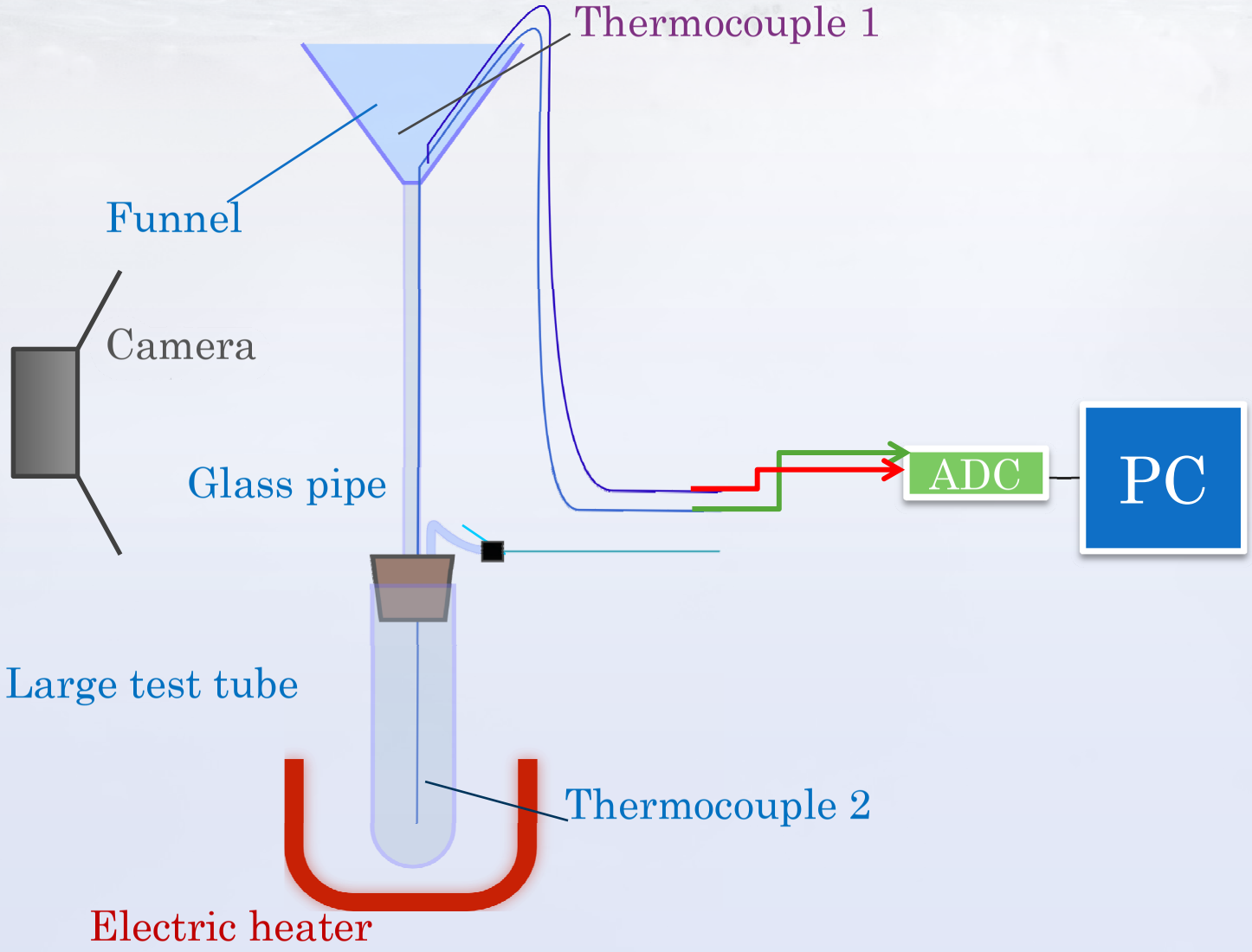
Basic explanation- feedback effect

- Small amount of water exits- pressure drops
- Causes more water to evaporate- pressure drops even more

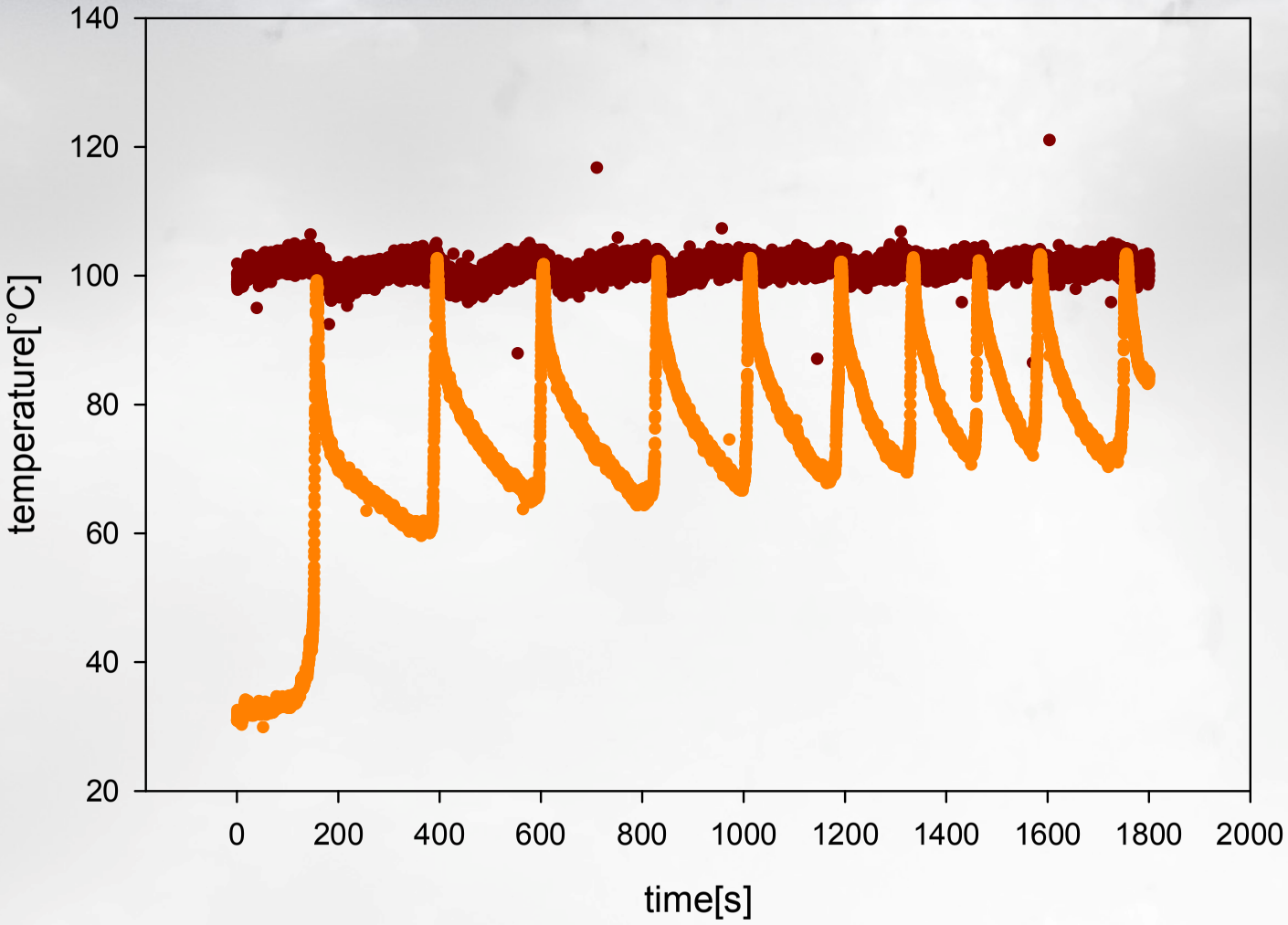


- **Sudden eruption**

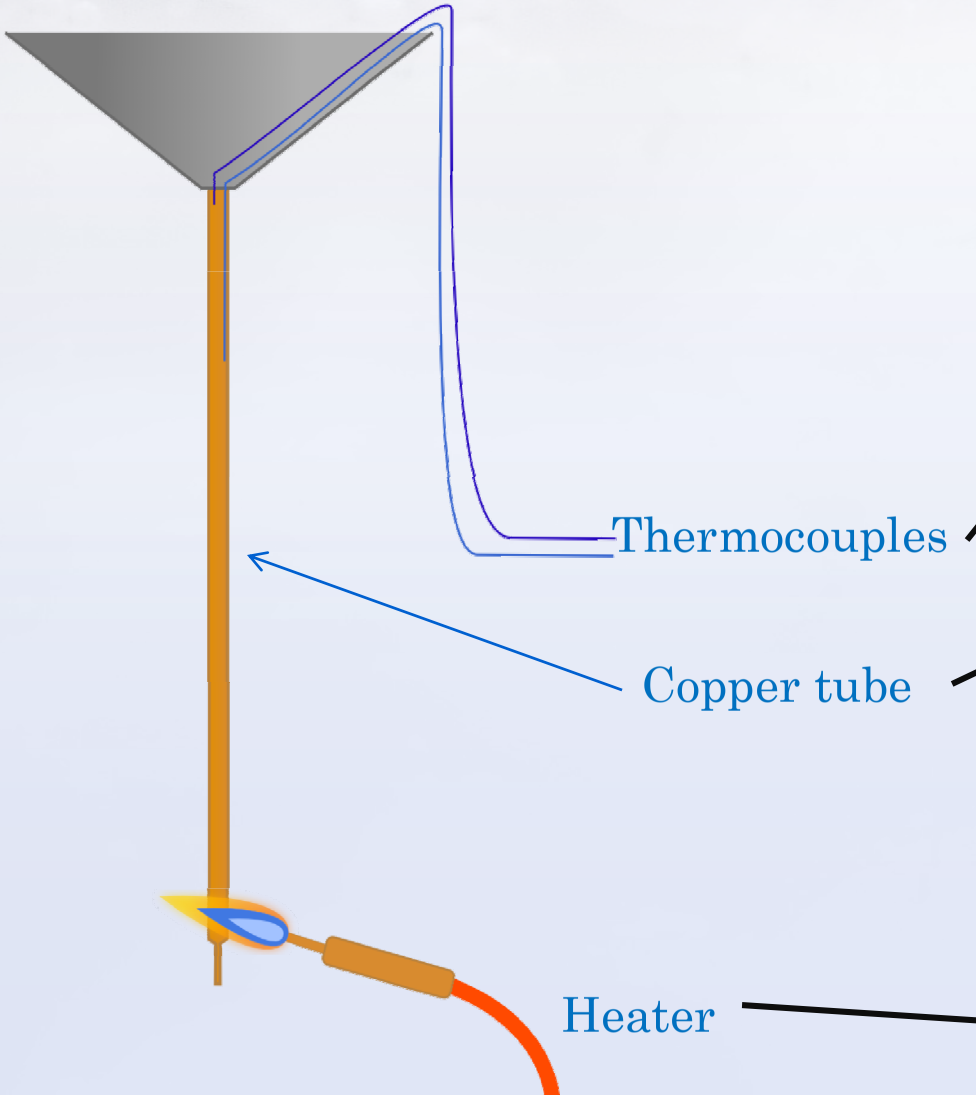
Experimetal setup- glass



Temperature- time depenance

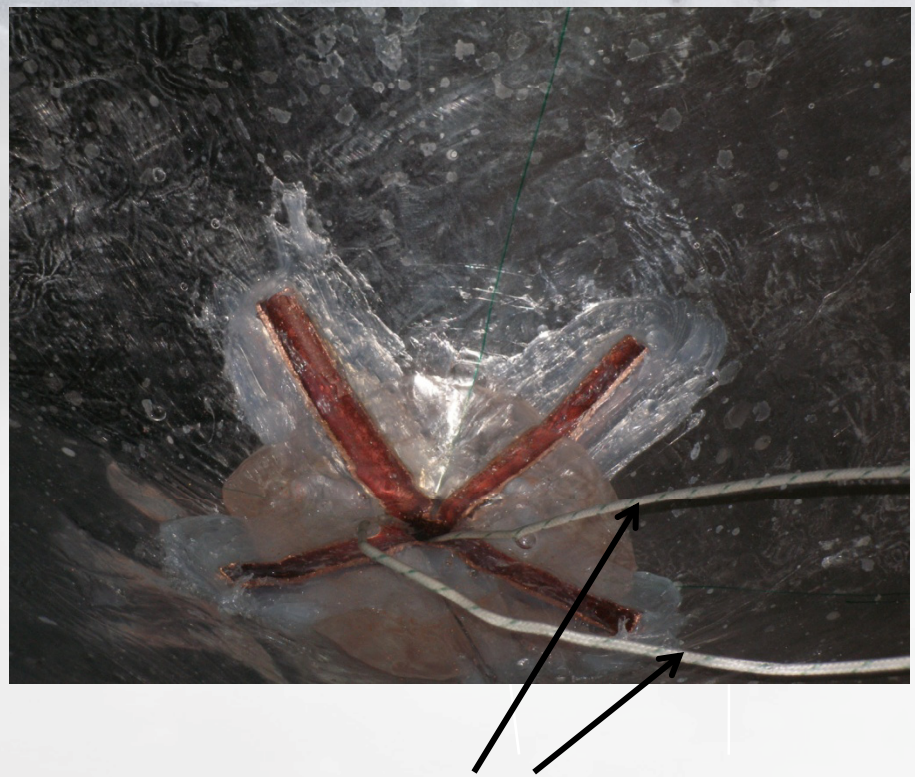


Experimetal setup- copper tube





Experimental setup- copper



Thermocouples

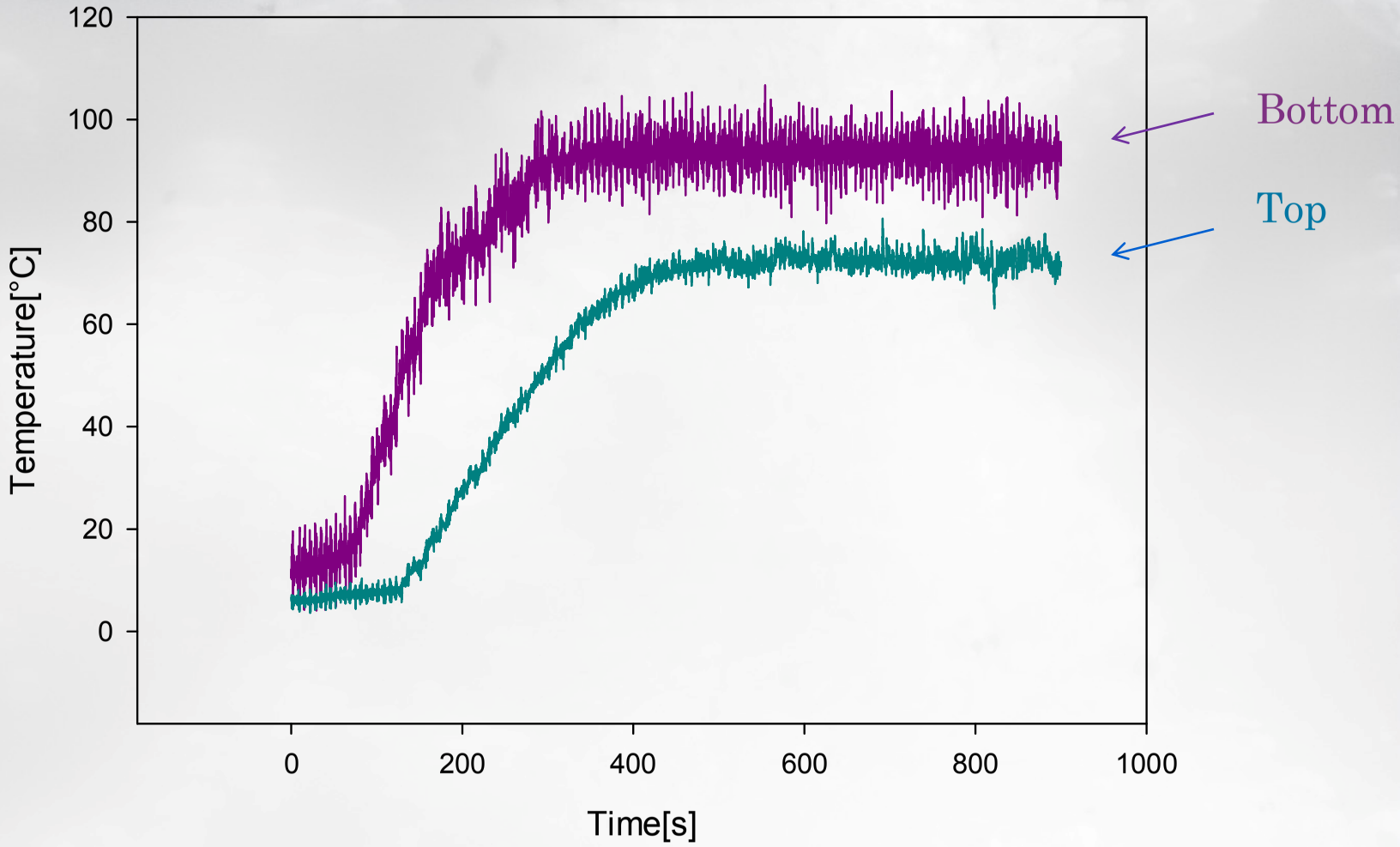
Long copper tube used

- 1 cm diameter
- 3 m long

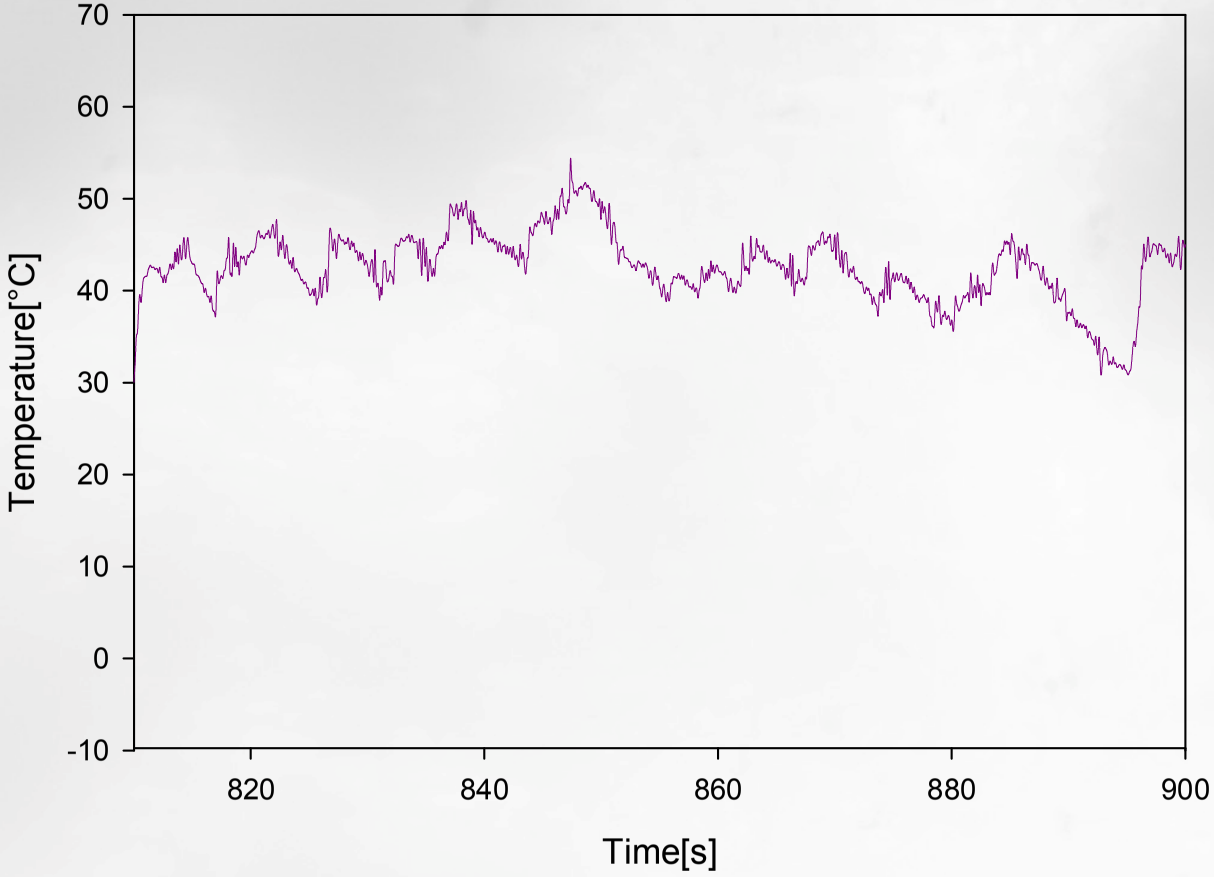


Heated from directly from belo

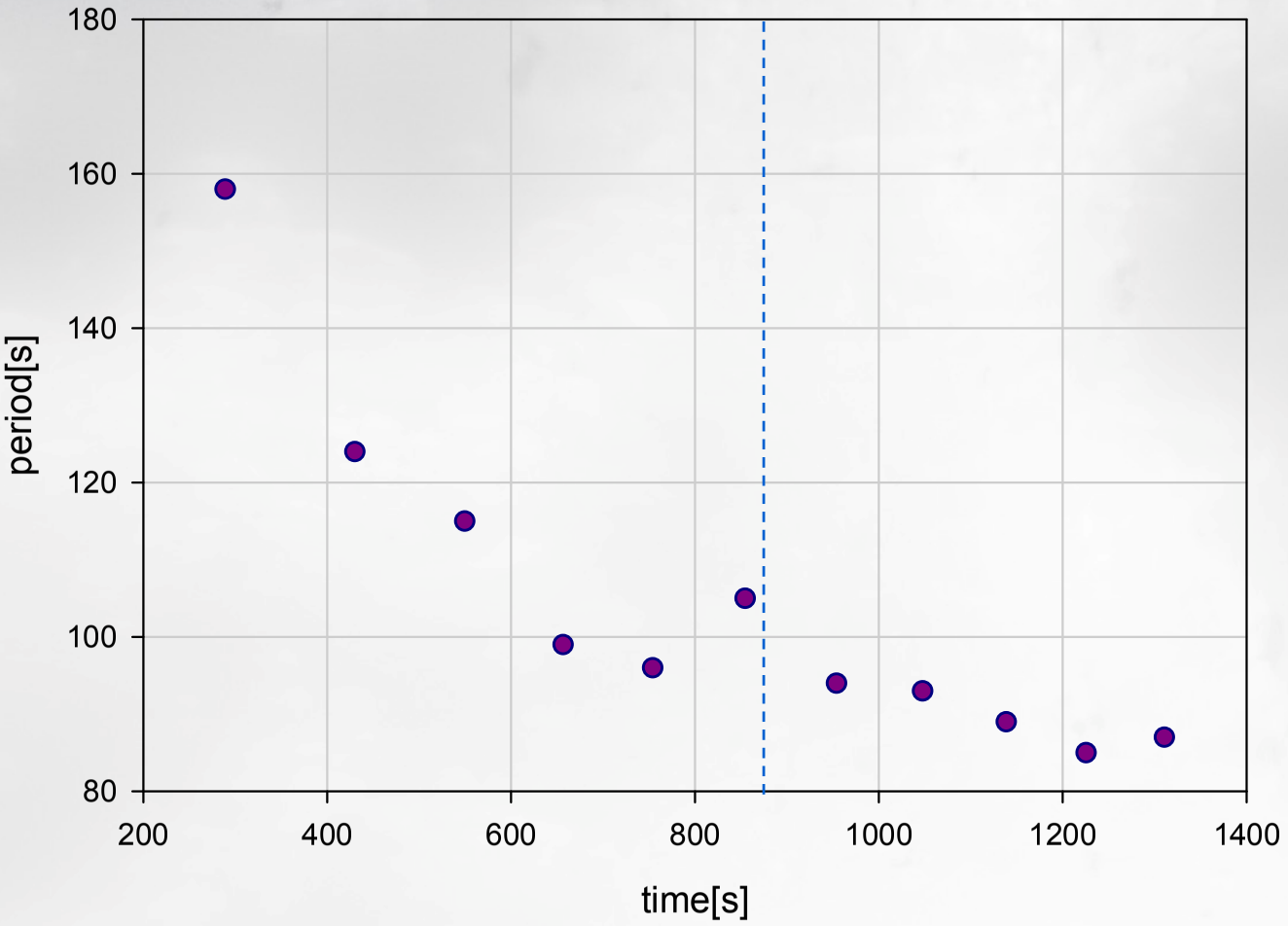
Experimental setup- copper



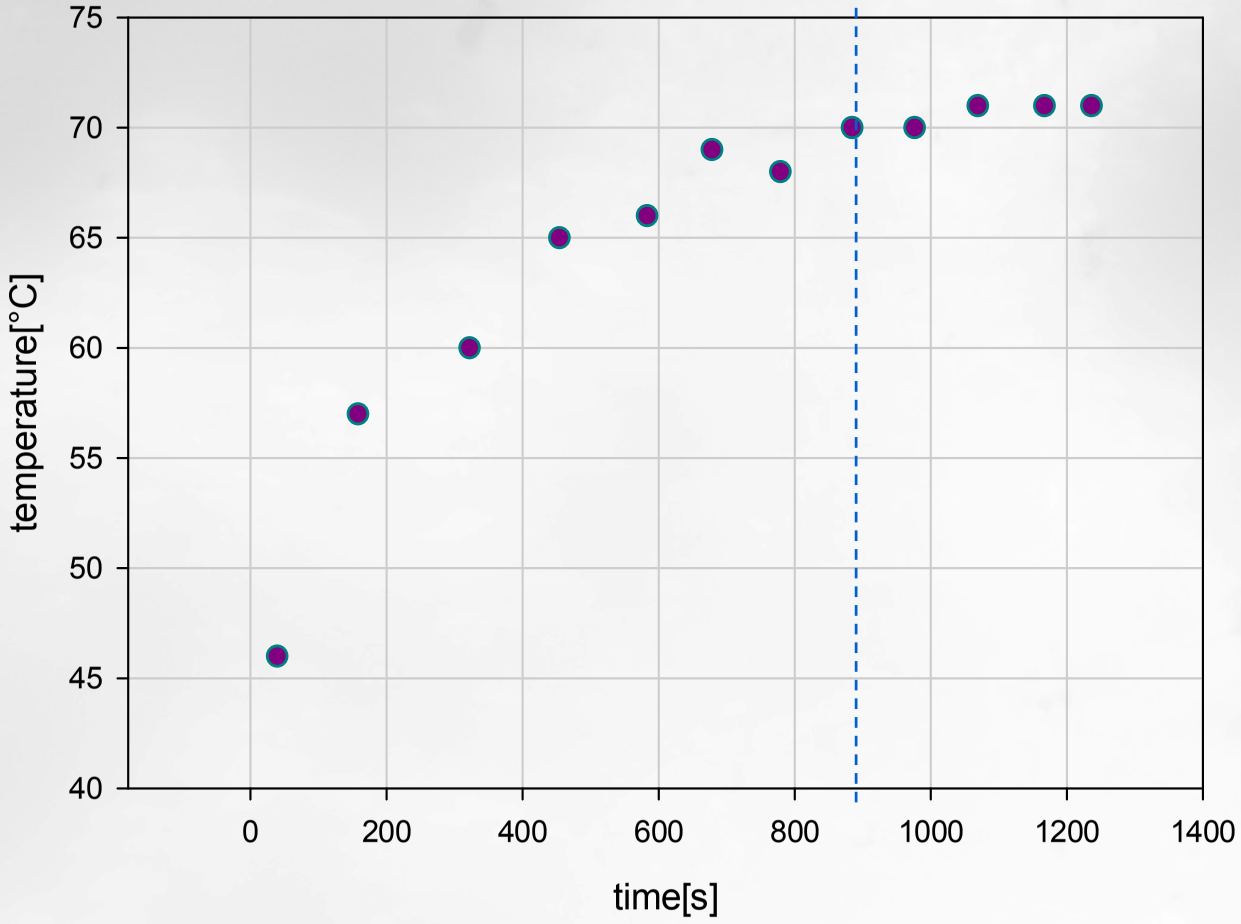
Experimental setup- copper



Results- time dependence

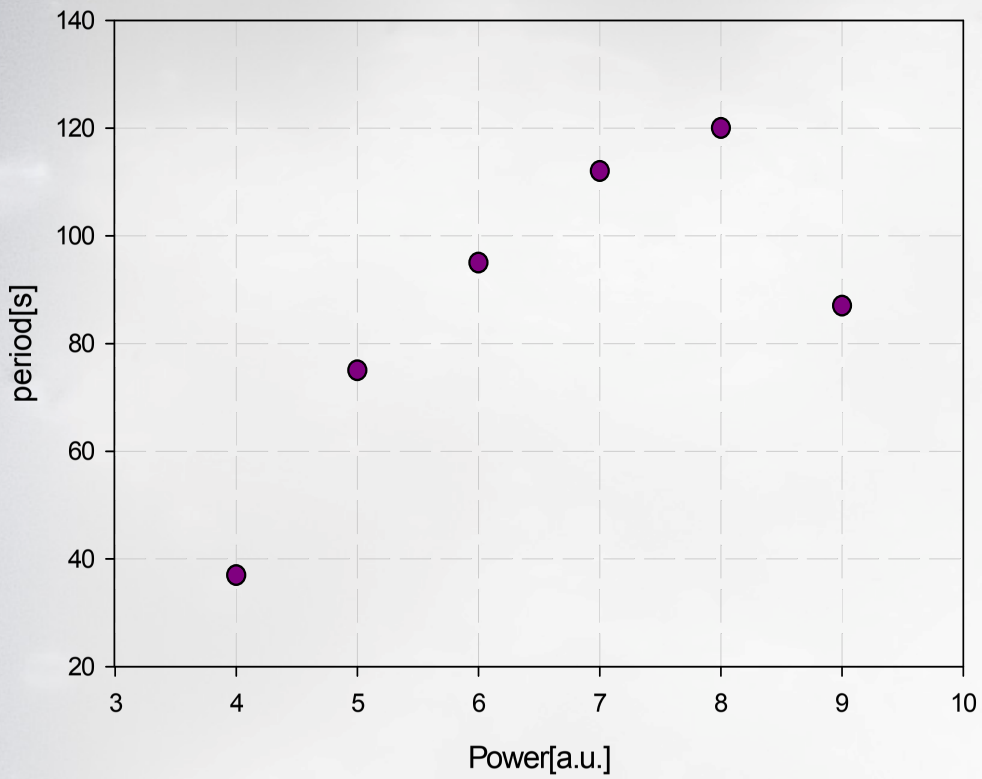


Results- time dependence



Results- heating power

- **Two impacts:**
  - Heating speed
  - Time spent in funnel

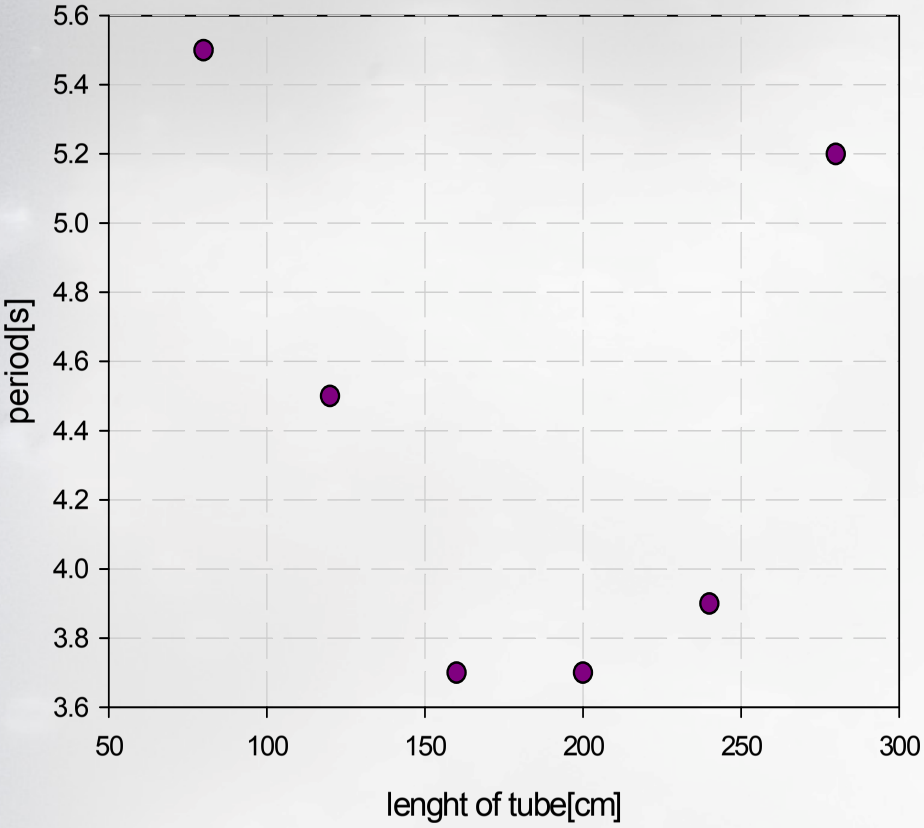


- **Strong heating-**
  - Faster heating
  - whole tube hotter
  - Air bubbles can't condensate in hot tube
  - water stays in funnel longer- **cools**

- **Weak heating-**
  - Slower heating
  - Shorter time in funnel
    - **Warmer water**

Results- tube length

- **Two impacts:**
  - Pressure of water
  - Time spent in funnel

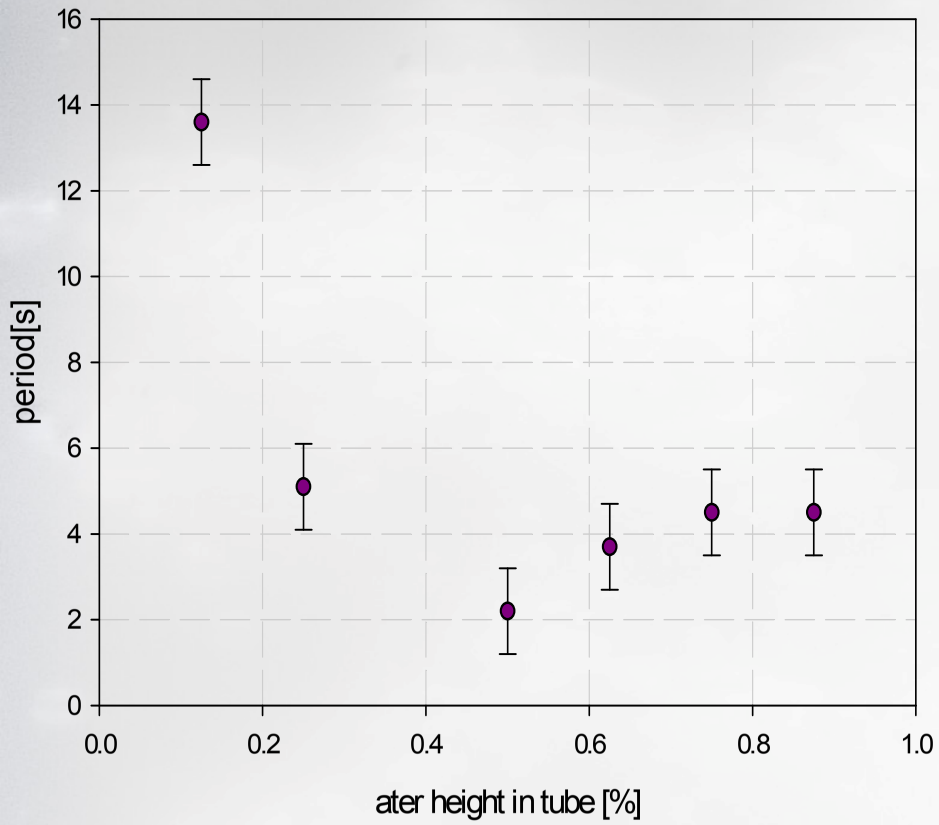


- **Short tube**
  - Smaller pressure
  - smaller gradient
    - Slower condenation
  - Longer time in funnel

- **Long tube-**
  - Larger pressure- higher boiling temperature
  - Longer time needed to heat to boiling point
  - Large temperature gradient
    - Fast condensation
  - Shorter time in funnel

Results-water level

- **Two impacts:**
  - Height to climb
  - Pressure impact

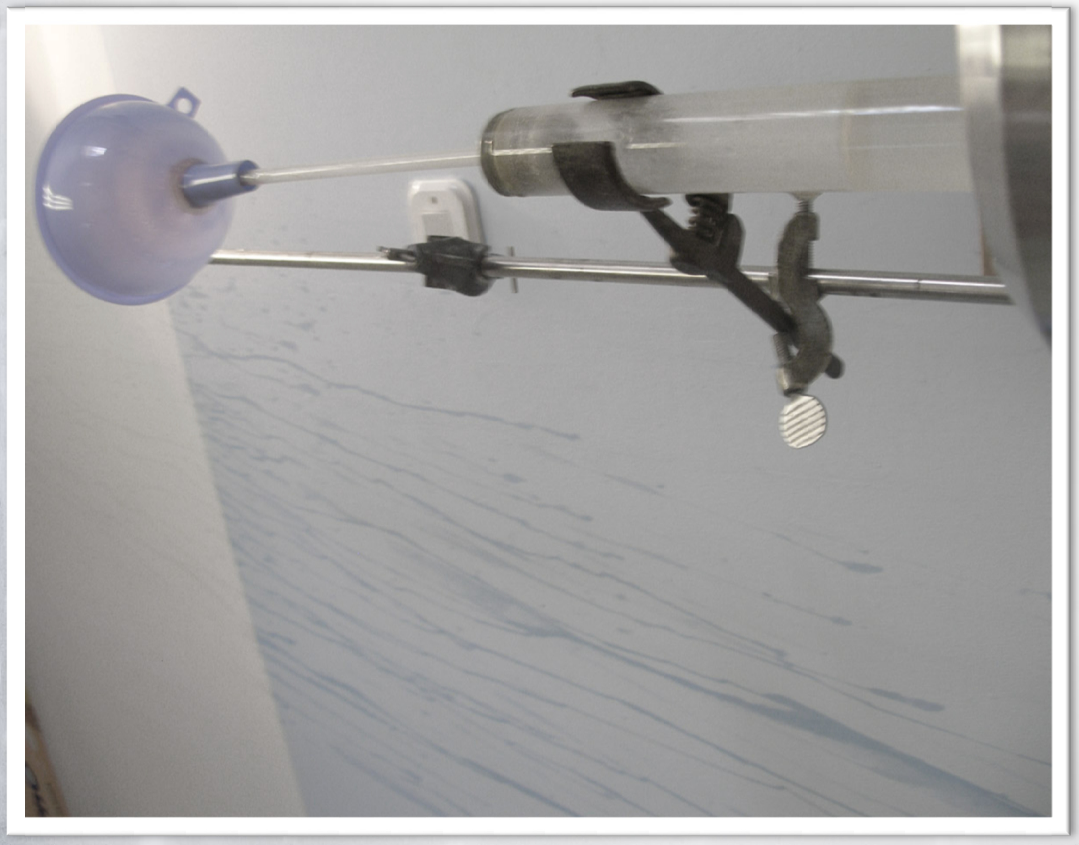


- **small water column-**
  - Greater volume needed to evaporate in order for eruption to occur
  - smaller pressure

- **high water column-**
  - smaller volume needs to evaporate
  - Larger pressure

Conclusion

- Complex behaviour
  - I. Heating
  - II. Eruption
  - III. Return into the tube
- Time dependence investigated
  - Period reaches constant value
- Parameters investigated
  - Column height
  - Tube length
  - Heating power
- Parameter affect:
  - Pressure of water column
  - Speed of heating
  - Temperature gradient




Thank you for your attention!