

## Experimental Techniques

### Today

- > syllabus
- > What are experiments?
- > How to write a lab report
- > Intro to Error Analysis

# What is an experiment?

## **experiment:**

a procedure carried out to support or refute a hypothesis, or determine the efficacy or likelihood of something previously untried

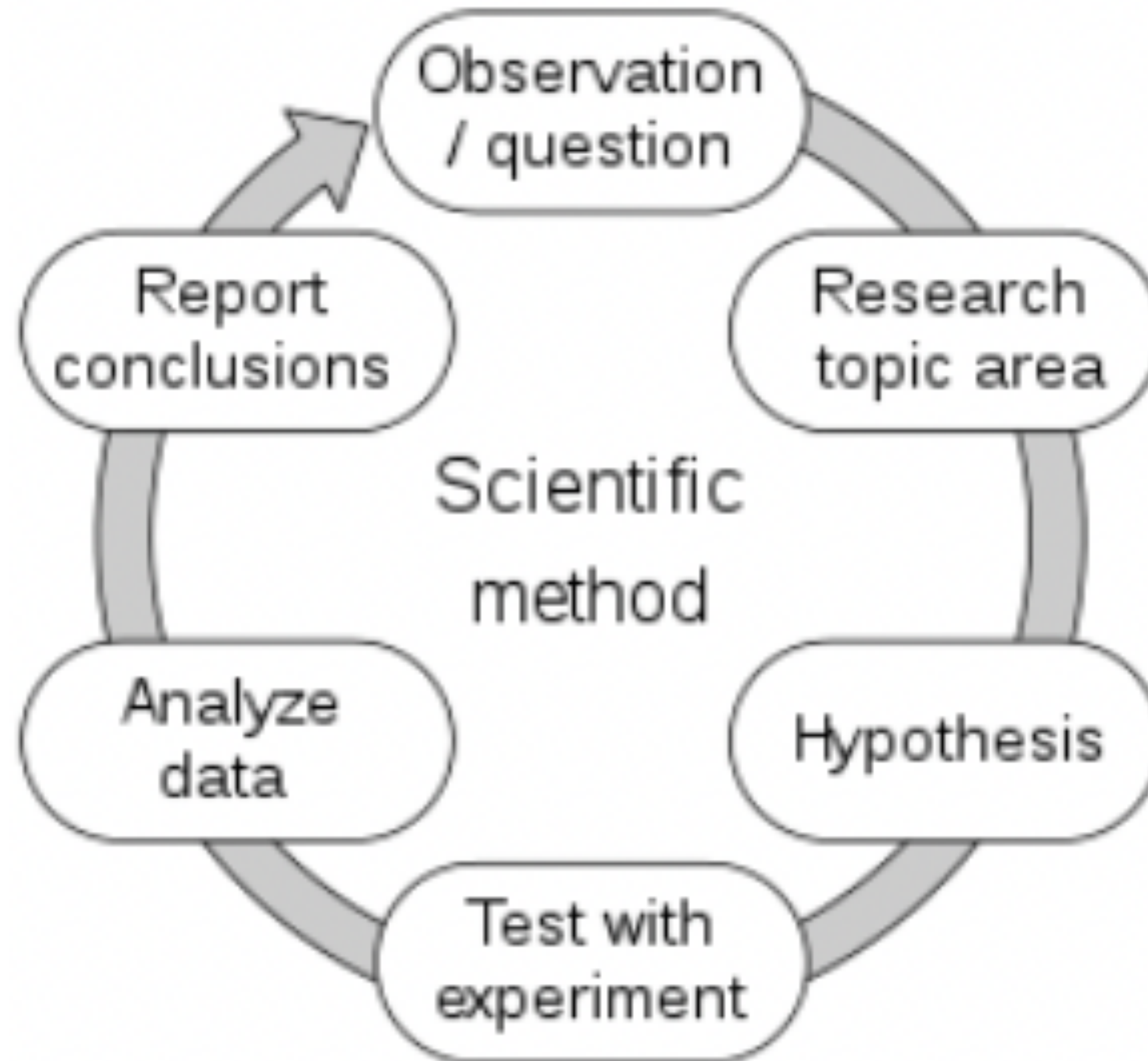
## **hypothesis:**

a proposed explanation for a phenomenon

## **scientific hypothesis:**

a testable hypothesis, that can be confirmed or refuted through the scientific method

# The scientific method?



# Suggestions for your lab experiments: use the scientific method

1. What is the question you're trying to answer?
  - a. observation you're trying to explain, etc.
2. Research the background
3. Generate testable hypotheses
4. Design the experiment
5. Collect data
6. Analyze data
7. Refute or confirm your hypotheses

Example: people that are right handed have better handwriting

Can we design an experiment to test this?

Example: Archimedes and the gold crown problem

Find whether a golden crown is made of 18-carat gold, as claimed, or a cheaper alloy

# How to write a lab report?

Please use Times New Roman, 10-11pt font, single space

## **Abstract:**

summary of the experiment as a whole and should familiarize the reader with the purpose of the research. Typically < 300 words! (1 paragraph)

Should address the following questions:

- > Why was the research/experiment done?
- > What problem is being addressed?
- > What are the results?
- > What do the results mean?
- > How is the problem better understood?

# How to write a lab report?

## **Introduction:**

provides all the requisite information for the reader to understand the experiment and results

Should address the following:

- > what is the problem being studied?
- > what is the motivation?
- > state the hypotheses
- > don't copy from the lab write-up, use your own words



# How to write a lab report?

## **Methods:**

provide an overview of any equipment, apparatus, or other materials used in the experiment, as well as the steps taken during the experiment (protocol).

Should address the following:

- > what is the experimental setup?
- > detail step-by-step experimental protocol
- > step-by-step description of data analysis
- > another person should be able to replicate the experiment just by reading your methods

# How to write a lab report?

## **Results:**

show using figures, graphs, plots, the data (in raw and analyzed form) from the experiment. Explain in words the data and reference the figures/graphs/plots

Should address the following:

- > label figures (Fig.1, Fig.2, etc) and references in text (“The results can be seen in Fig.1”)
- > provide calculations (if not described in Methods)

# How to write a lab report?

## **Discussion:**

most important part, provide analysis and interpretation of the results.

Should address the following:

- > if results are unexpected, why?
- > must address uncertainty, where does it come from, how it was managed
- > What do the result mean?
- > What is the significance?
- > Are there any gaps in knowledge?
- > What are the new questioned raised by the results?

# How to write a lab report?

## **Conclusion:**

a summary of the entire report. summarize the problem studied, the methods used, the result found, and clearly and concisely state what was learned and it's importance

What will we do in lecture?

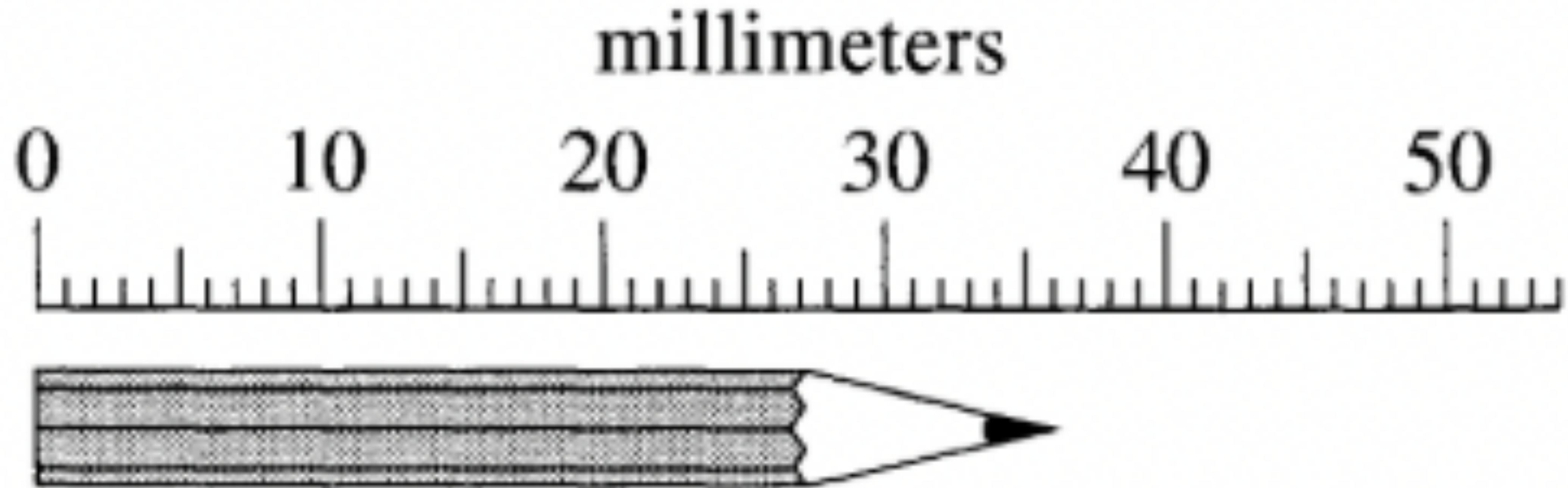
**Error Analysis:**

the study and evaluation of uncertainty in a measurement

No measurement can be complete free of uncertainties

How should we deal with uncertainties?

# How to estimate uncertainties?



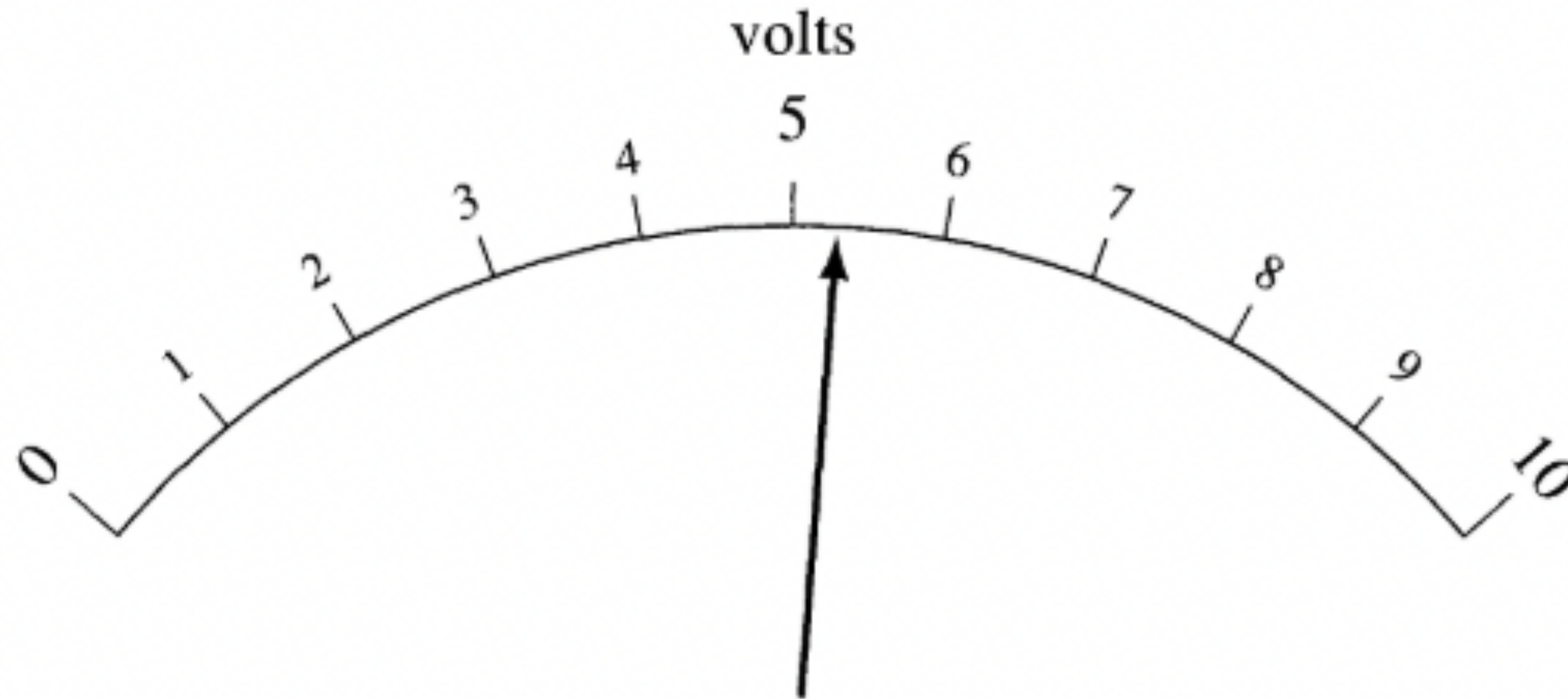
How long is the pencil?

probable range: 35.5 - 36.5 mm

36mm?

probable range: 36 +/- 0.5 mm

# How to estimate uncertainties?



What are the Volts?

$> 5V$  and  $< 5.5V$

probable range: 5.2 - 5.4 V

probable range:  $5.3 \pm 0.1 V$