Production of biogas from fruit waste

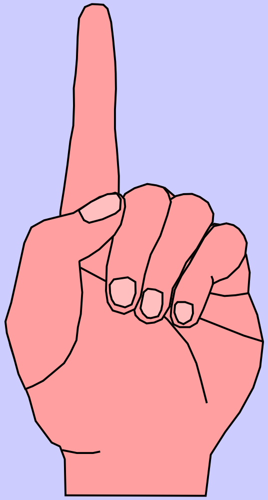
Overview of the experiment

1. Fermentation

2. Quantitative determination of biogas

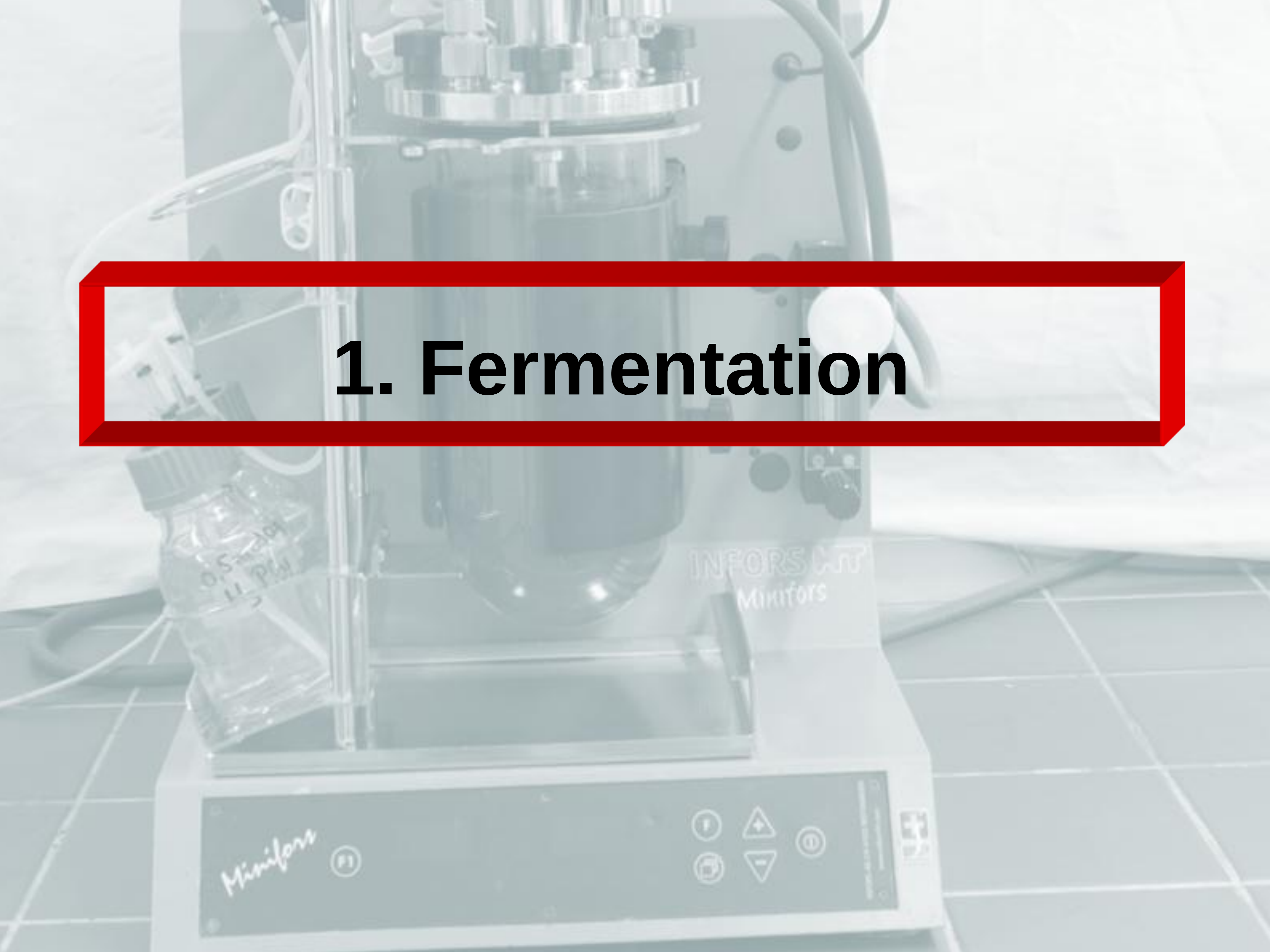
3. Qualitative determination of biogas

Safety note



- In this experiment you work with live cultures and combustible gases
    - **Be sure to wear protective goggles and always disinfect your hands after completing the experiment!**

1. Fermentation



1. Fermentation

1.1 Fill 90% of the available volume in the fermenter with inoculum (liquid substrate) and close the fermenter gas-tight.

- The inoculum consists of fruit waste with living microorganisms.

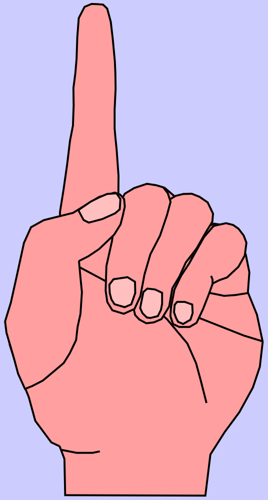
1. Fermentation

1.2. Adjust the temperature of the fermenter to 37°C. Set the agitator at 200 revolutions per minute.

1. Fermentation

1.3 Add glucose so that its concentration at the beginning of the fermentation is 10 g/l.

Note



ATTENTION!

The biogas production works only under anaerobic conditions, that is the fermenter must be closed gas-tight!

Task 1

Measure the concentration of glucose at the beginning and during the fermentation every 30 minutes.

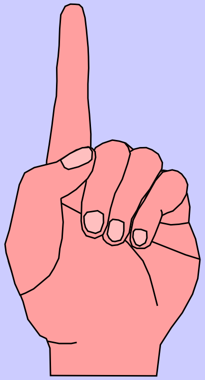
2. Quantitative determination of biogas by gas syringe

2. Quantitative determination of biogas

2.1 Connect a gas syringe gas-tight to the fermenter.

2. Quantitative determination of biogas

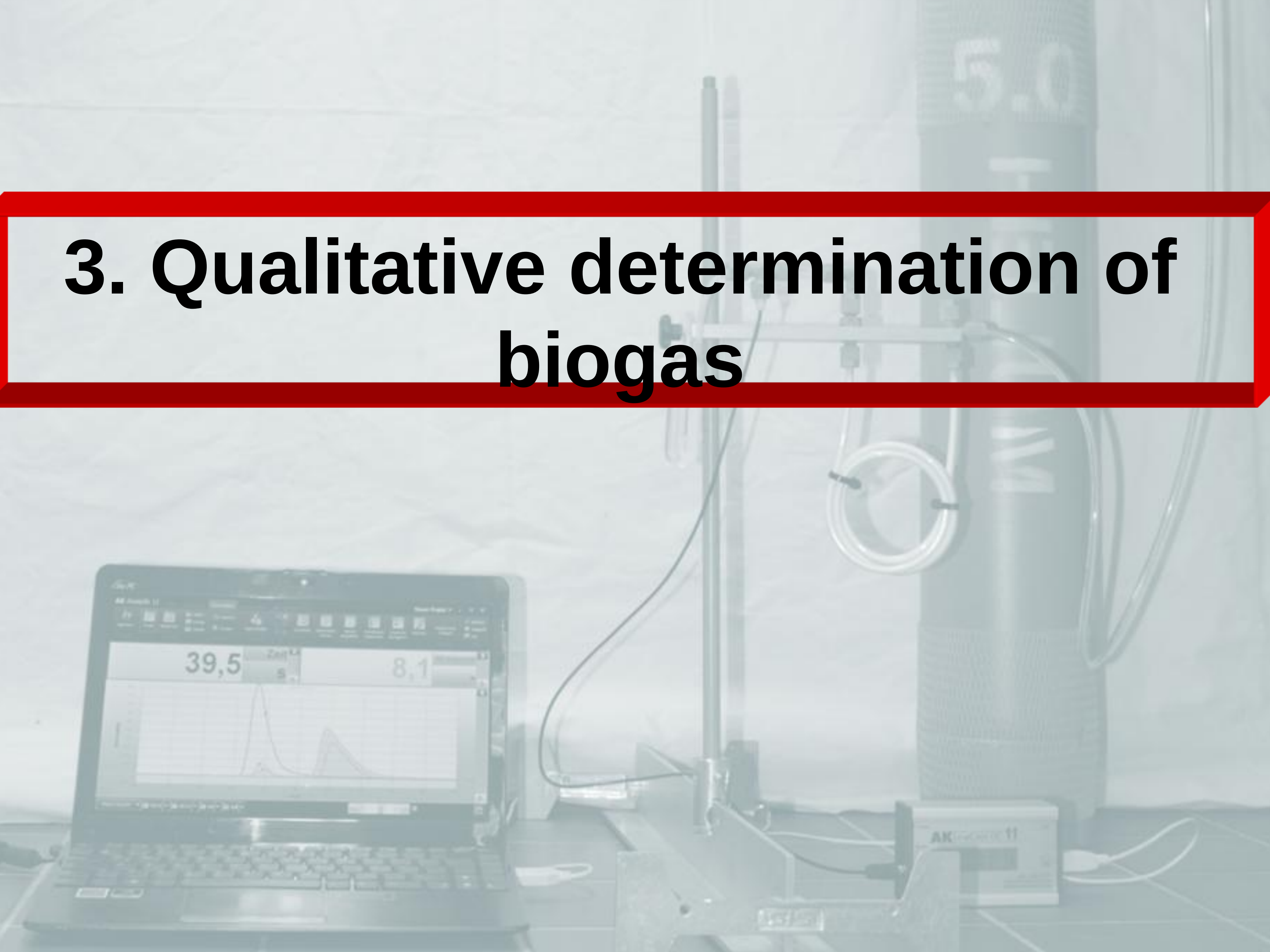
Check the gas-tightness by pulling on the plunger of the gas syringe.



Task 2

On the gas syringe, read the increased volume of biogas every 30 minutes and put the data on the graph.

3. Qualitative determination of biogas



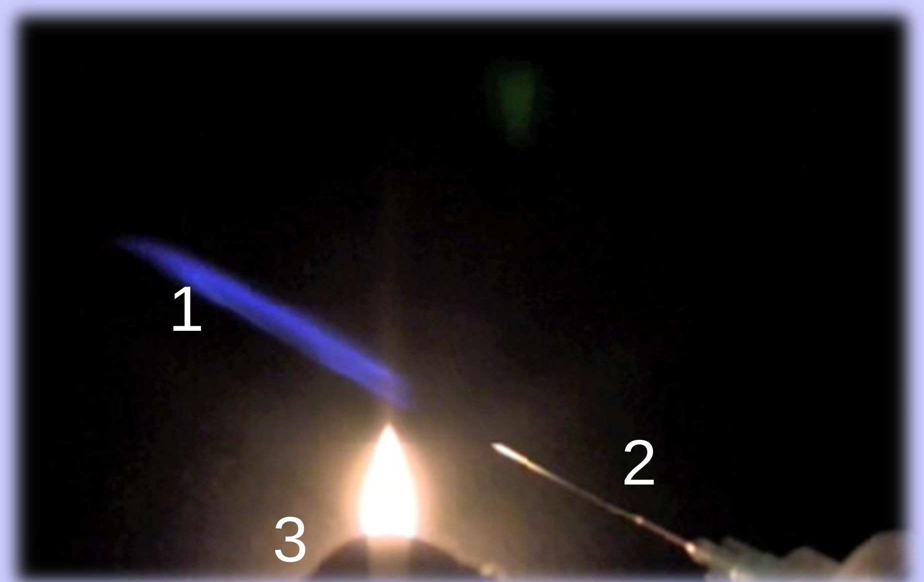
Task 3

Test the produced biogas on flammability by blowing a small amount of biogas from the syringe into the flame of the burner.

3. Qualitative determination of biogas

3.1 Quick flammability test

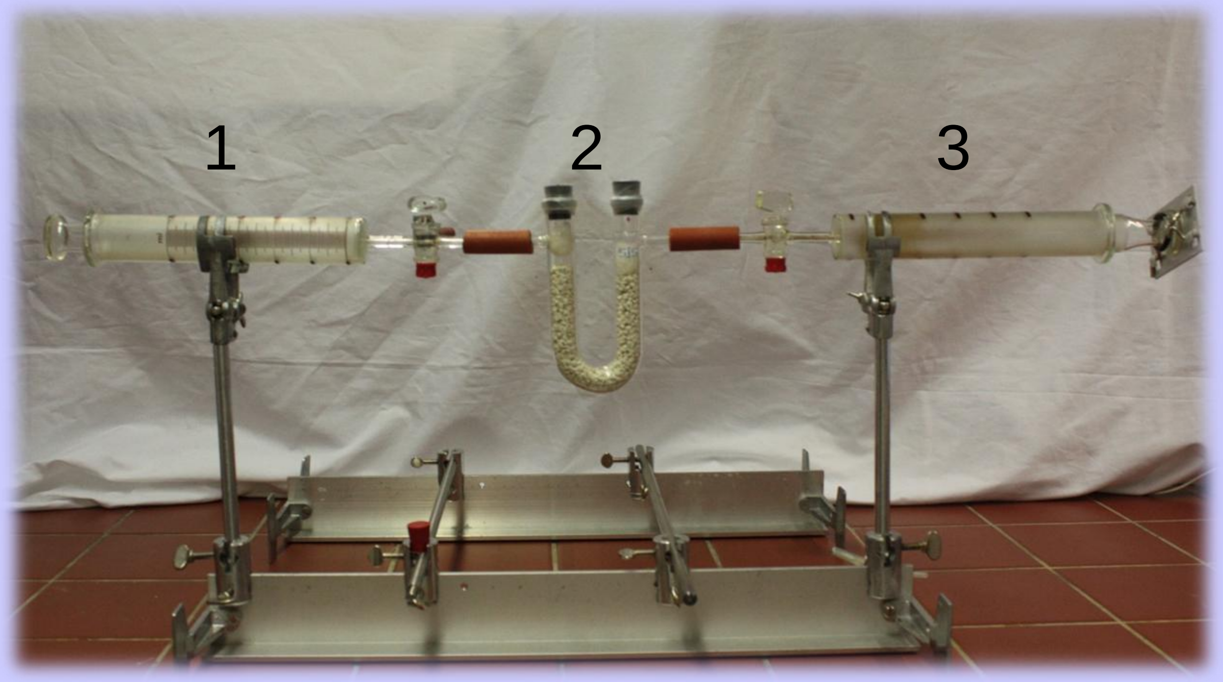
- Check the produced gas on flammability



1. Biogas flame
2. Tip of the syringe
3. Flame

3. Qualitative determination of biogas

3.2 Chemical reaction of CO_2 with soda lime



1. Gas syringe I
2. Soda lime
3. Gas syringe II

3. Qualitative determination of biogas

Rinse the biogas purification apparatus with helium.

Take 100 ml sample of biogas from the gas syringe on the fermenter.

Task 4

- Transport 100 ml of biogas 5 times slowly through the U-tube until the volume stays constant.

40% loss

- Read off the volume of CO_2 which was bound from the gas syringe scale.

Task 5

- Complete the following reaction equations:

$NaOH + CO_2 \rightarrow$

$Ca(OH)_2 + CO_2 \rightarrow$

3. Qualitative determination of biogas

3.3 Gas chromatography

Task 6

- Inject 0.5 ml of the produced biogas mixture into the gas chromatograph and evaluate the gas chromatogram.

3. Qualitative determination of biogas

3.3 **Gas chromatography**

3.3.1 Separation conditions

- CO_2 and CH_4 flow with helium as mobile phase (carrier gas) through the column.
- The column contains as stationary phase silicone oil and is therefore non-polar.
- CH_4 is more polar than CO_2 and remains therefore shorter in the column.

Animation

3. Qualitative determination of biogas

3.3.2 Start the computer programme AK Analysis.

3. Qualitative determination of biogas

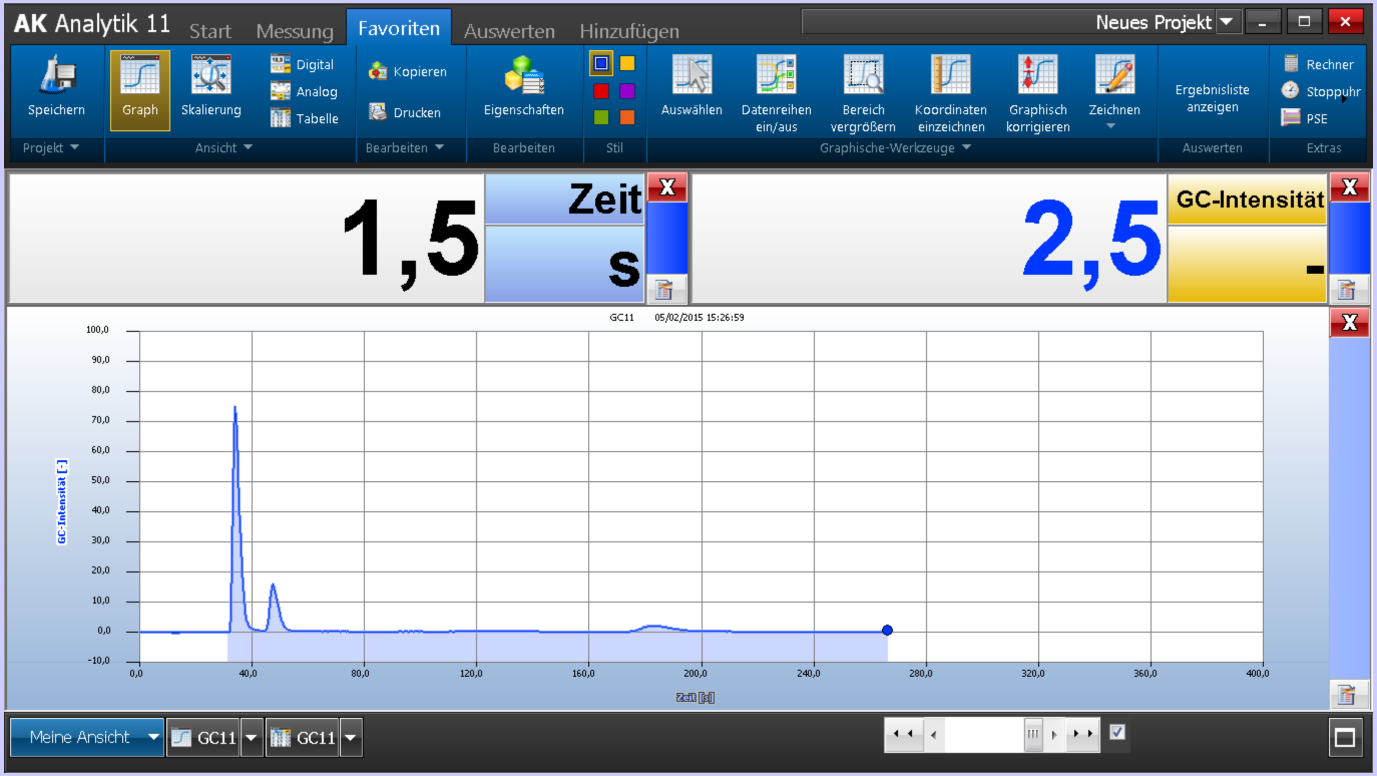
3.3.3 Detection

Animation

- Gases have different thermal conductivity.
- The detector filament changes its temperature because of the gases which are passing across it and their different thermal conductivity.
- The conductivity of metal is dependent on the temperature, the warmer the metal, the less conductive it becomes.
- This voltage change is recorded and displayed as a peak.

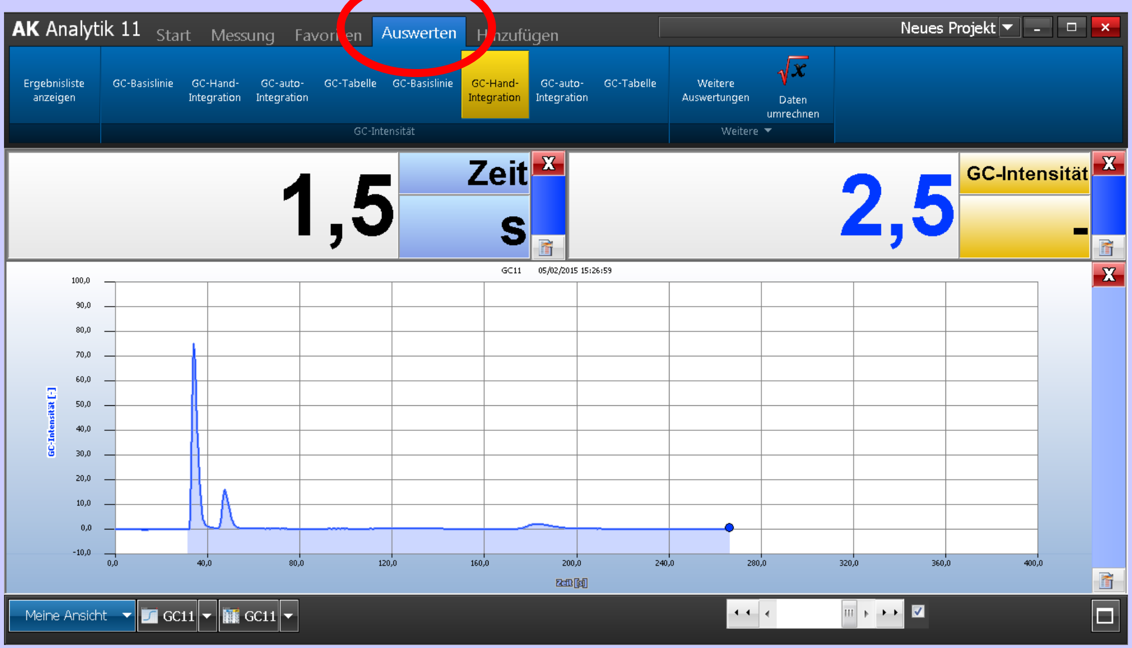
3. Qualitative determination of biogas

3.3.4 Evaluate your results using the programme.



3. Qualitative determination of biogas

3.3.4 Evaluate your results using the programme.



1. Evaluation
2. GC manual intergration

3. Qualitative determination of biogas

3.3.4 Evaluate your results using the programme.

3. Peaks evaluation

3. Qualitative determination of biogas

3.3.4 Evaluate your results using the programme.