
Experimental study of Kłodnica river water purity
based on its diversity

# What is a Group 4 project?

A Group 4 project is an interdisciplinary collaboration between memebers of various teams of group 4 subjects: physics, biology and chemistry.

| | | |
|---|---|---|
| **Initial session: REFLECTION** | About 2 hours | All students meet together.<br><br>Choice of theme.<br><br>Problem determined.<br><br>Establishment of specific investigations in subject groups.<br><br>Note: Students doing 2 or 3 sciences will be involved in projects in each subject. |
| **Second phase: ACTION** | 6 to 7 hours of class time (+ out of class research) | Carry out projects. |
| **Final session: EVALUATION** | 2 hours | Presentation of project in the form of a poster or web site.<br><br>Assessment by teachers and by yourselves of yourselves. |

## BIOLOGY:

### During the project:

- a sample of silt along with present there animals was taken
- plants growing on the river bank were taken so as to identify them
- photos of birds were taken
- an experiment with cress was carried out
- an experiment will be completed by information from various sources: (eg. Water Supply System's Information and a Regional Disease Control Centre, etc.)

# IDENTIFIED PLANTS:

| BOTANICAL NAME | COMMON NAME |
|---|---|
| *Philadelphus coronarius* | Sweet Mock-orange, English Dogwood |
| *Rumex obtusifolius* | Broad-leaved Dock, Bitter Dock, Bluntleaf Dock, Dock Leaf or Butter Dock |
| *Taraxacum officinale* | Common Dandelion (often simply called "dandelion") |
| *Acer platanoides* | Norway Maple |
| *Urtica dioica* | Stinging nettle or common nettle |
| *Plantago major* | Greater Plantain, Common Plantain |
| *Aesculus hippocastanum* | Horse-chestnut or Conker tree |
| *Rubus idaeus* | Red Raspberry; occasionally as European Raspberry, Framboise, or simply Raspberry |
| *Sambucus nigra* | Elder, Elderberry, Black Elder, European Elder, European Elderberry, European Black Elderberry,Common Elder, or Elder Bush |

| | |
|---|---|
| *Tilia platyphyllos* | Large-leaved Linden |
| *Dactylis glomerata* | Cock's-foot and orchard grass |
| *Convolvulus arvensis* | Field Bindweed |
| *Ranunculus repens* | Creeping Buttercup |
| *Galium mollugo* | Upright bedstraw, Upright hedge bedstraw and White bedstraw |
| *Triticum* sp. | Wheat |
| *Viola* sp. | Viola and violetta |
| *Allium sativum* | Garlic |
| *Arctium lappa* | Greater burdock, Edible burdock, or Lappa Burdock |
| *Chenopodium album* | lamb's quarters, goosefoot and fat-hen, pigweed |
| *Festuca arundinacea* | Tall fescue |
| *Euphorbia lathyris* | Caper Spurge, Paper Spurge, Gopher Spurge, Gopher Plant or Mole Plant |
| *Aegopodium podagr aria* | ground-elder, herb gerard, bishop's weed, goutweed, and snow-in-the-mountain |
| *Chelidonium majus* | greater celandine; in Europe tetterwort |

| | |
|---|---|
| *Lamium album* | White Deadnettle |
| *Quercus petraea* | Sessile Oak, Sessile or Durmast Oak |
| *Parthenocissus inserata* | Virginia creeper, five-leaved ivy, or five-finger |
| *Artemisia vulgaris* | mugwort or common wormwood |
| *Solidago gigantea* | giant goldenrod |
| *Trisetum flavescens* | golden oat grass, yellow oat grass |
| *Solidago canadensis* | Canada golden-rod, Canada goldenrod |
| *Crataegus* sp. | hawthorn or thornapple |
| *Juglans regia* | Persian walnut, English walnut, Common walnut |
| *Galinsoga parviflora* | Guasca |
| *Geum riale* | Water Avens |
| *Salix* sp. | Willow, sallow and osier |
| *Polygonum aviculare* | Common Knotgrass, birdweed, pigweed and lowgrass |

## IDENTIFIED ANIMALS:

Gammarus tigrinus (At the thought to be Gammarus pulex)
Anisus spirorbis (an empty shell, which seems to be doubtful evidence).

## CATEGORY OF WATER'S CLEANNESS:

marked with the use of instruction presented on the work record: 5 (the worst)

## AN EXPERIMENT:

Three small scale pans were filled with 100 seeds of cress each. Each sample was watered with different solution so as to observe its effects on germination. Solutions used were: tap water, water from Kłodnica and synthetic sewage prepared by students (50 ml of distilled water, 10 drops of petrol, 10 drops of NaOH, 10 drops of $H_2SO_4$ and a little bit of carbolic acid).

| | Germinated: | Other observed features: |
|---|---|---|
| Tap water | 96/100 | Tall germinated seeds |
| Synthetic sewage | 0/100 | Seeds started to swell |
| Water from Kłodnica | 85/100 | Plants only a little bit smaller than those which were watered with tap water. |

## CHEMISTRY:

**Aim**: Examine water from river Kłodnica and determine its class via a series of tests

**Hypothesis:** Considering industrial character of some city areas and nearness of the Technical University's Chemistry Section water may be a third class or lower.

**Substances**: Water from river Kłodnica, distilled water, 1cm3 K2Cr 10 %, 100 cm3 of 0.1 mole/dm3 solution of AgNO3

**Equipment**: Conical flask, burette+/- 0.5 cm3, 4 tubes, balance +/- 0.01 g , stand, ring stand, 2 watch glasses, spoon, set for determining the presence of NO3-, NO2-,PO4 3- NH4+, acidity probe, litmus paper, papers indicating the hardness of water, pipette +/- 0.5 cm3, 2 bakers, evaporating dish, stirring rod

## CALCULATIONS:

10 g – 10 % - K2Cr
Cp = ms/mr * 100 %
Ms = Cp * mr / 100 %
Ms = 10 % * 10 g / 100 %
Ms = 1g

V=100 cm3
0.1 M - AgNO3
Cm = 0.1 M
n = 100 cm3 * 01 M / 1000 cm3 = 0.01 mole
m = M * n = 0.01 mole * (107 + 14 + 48) = 1.69 g

# METHODS:

**1. Determine the presence of $NO_3^-$, $NO_2^-$, $PO_4^{3-}$ $NH_4^+$ in water**

A. Prepare 4 tubes and add 10 cm3 of water from Kłodnica to each one
B. Add indicators in a proper order according to the instruction
C. Wait 15 minutes to let sample change color
D. Note the change in a color in each tube and using added annex determine the amount of each of a given substances in a water samples
E. Record the data and repeat points A-D at least one more time

**2. Determine the acidity of the water**

A. Take two 20 cm3 water samples and but each into a separate baker
B. Use litmus paper to determine acidity of the water in both samples
C. Use acidity probe to determine acidity of the water in both samples
D. Compare results from both samples
E. Record data

**3. Determine a hardness of the water**

A. Take two 20 cm3 water samples and but each into a separate baker
B. Use papers indicating the hardness on the water in both samples
D. Compare results from both samples
E. Record data

**4.Determine the presence of Cl- in water**

A. Using pipette put 50 cm3 of destilled water and the same about of tested water into a conical flask.
B. Add 1 cm3 of K2Cr
C. Put 50 cm3 AgNO3 into burette and titrate until the color change from yellow-brown to yellow-green.
D. Repeat at least one more time

**5. Calculate the amount of dry residue**

A. Weigh evaporating dish
B. Take 10 cm3 of the water and put it into evaporating dish
C. Reweigh evaporating dish
D. Put dish on sing stand and put burner under it.
E. Turn on the burner, keep a medium flame and let it burn until there is nothing of water left inside
F. Reweigh evaporating dish and calculate a weight of dry residue

# RAW DATA:

| Tube | Color |
|---|---|
| First tube | Glimpses of yellow |
| Second tube | Strong pink |
| Third tube | Bluish |
| Fourth tube | Greenish |

| | |
|---|---|
| pH | 7.7 |

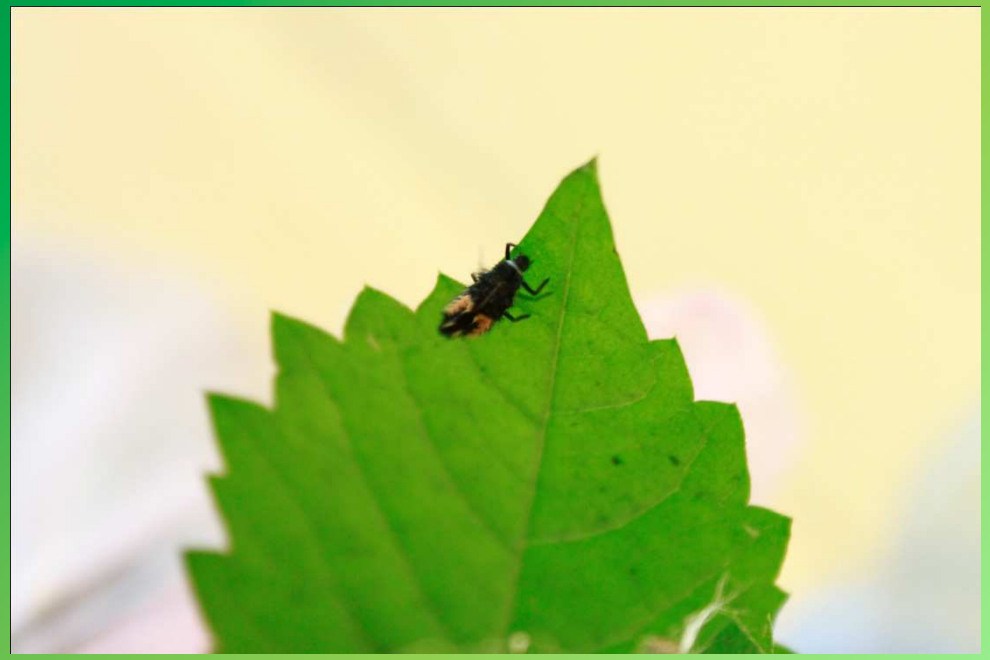
| | |
|---|---|
| Hardness | Maximum |

| | |
|---|---|
| Evaporating dish (first) | 60,41 g |
| Evaporating dish + water | 83,23 g |
| Evaporating dish (second) | 63,52 g |

## PROCEEDING DATA:

Weight of dry matter
61,52 g  - 60,41 g = 1.11g

Concentration of Cl-
X= 1000 * a(V1-V2)/Vw
X= 1000 * 0.1(48.6-1)/50
X= 1000 * 0.1*47.6/50
X= 1000 * 4.76/50
X= 1000 * 95.2



| Tube | Amount of substance [mg/l] |
|---|---|
| First tube | <0.05 |
| Second tube | 0.5 |
| Third tube | 1.2 |
| Fourth tube | 10 |

| Indicator | Class |
|---|---|
| Amount of PO4 | IV |
| Amount of NH4+ | I |
| Amount of Cl- | I |
| Amount of NO2 | II |
| Amount of NO3 | III |
| Weight of dry matter | III |
| pH | III |
| Hardness | IV |

Source: http://www.wodip.opole.pl/eko/eko_biala/s3a.htm

## CONCLUSION:

Most of the indicators imply the third and forth class of water cleanliness. Only 3 from 8 suggest otherwise. Because the lowest indicator is one determining the class we can say that river Kłodnica has fourth class of cleanliness. Considering industrial character of some city areas and nearness of the Technical University's Chemistry Section it is not surprising.

## EVALUATION:

Some test like acidity test or of $NO_3^-$, $NO_2^-$, $PO_4^{3-}$ $NH_4^+$ presence should be repeated not 2, but at least 3 times. Also some other method may be used to ensure the credibility of the results.

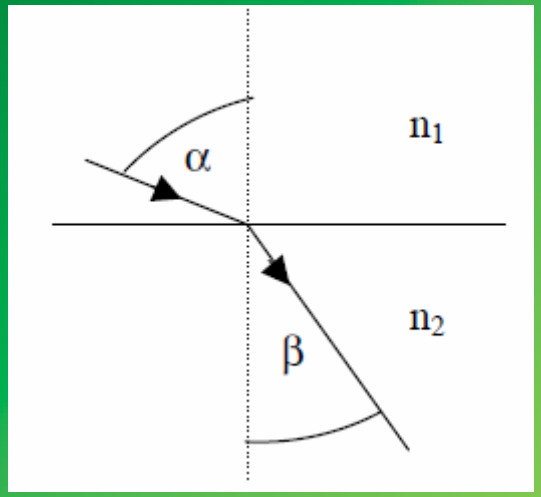
## PHYSICS:

**Determination of refractive index in a sample of water taken from Kłodnica river, using Abbe refractometer**

## RESEARCH:

Aim of the experiment is to understand the optical phenomena occurring on the border of two transparent mediums and experimental determination of the refractive index by total internal reflection method using Abbe refractometer.
The basis of all refractometer measurements is the law of refraction (Snell's law) which says that the ratio of the sine of the angle of incidence to the sine of the angle of refraction is for the two mediums a constant value equal to the ratio of the absolute refractive index n2 to n1, so the relative coefficient of refraction of the second medium relative to the first . It is also equal to the ratio of the speed of light in the medium, from which it comes out (v1) to the speed of light in the medium which it enters (v2).

$$\frac{sin\alpha}{sin\beta} = \frac{n_2}{n_1} = n_{2,1} = \frac{v_1}{v_2}$$



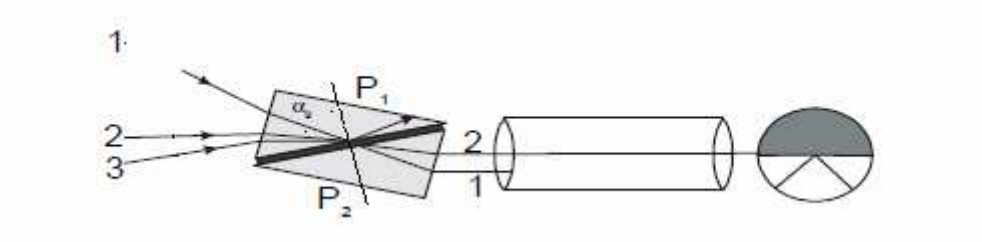

*The radius of the incident, normal at the point of incidence and the broken radius lie in the one dimension.*

A simplified method of determining the refractive index is based on obtaining the phenomenon of total internal reflection. It takes place when a light ray goes from the environment optically denser to rarer, for example, from water to air, and falls on the boundary surface at an angle greater than the so-called critical angle. It's the angle of incidence in the optically denser environment, for which the angle of refraction in the less dense environment is 90 °. Due to the principle of course reversibility of the light ray we write:

$n_{2,1} = \sin 90° / \sin \alpha_c = 1 / \sin \alpha_c$

$\alpha_c$ is the critical angle

This phenomenon is called total reflection, because in the reflected light the total energy of the incident ray is contained. Relying on equation (I) we can easily find the refractive index n, experimentally determining the critical angle αc. The construction of refractometers is based on this principle. They are used primarily to determine the refractive indices of liquids. Also the refractive indices of solids can be measured.




*Abbe refractometer diagram.*

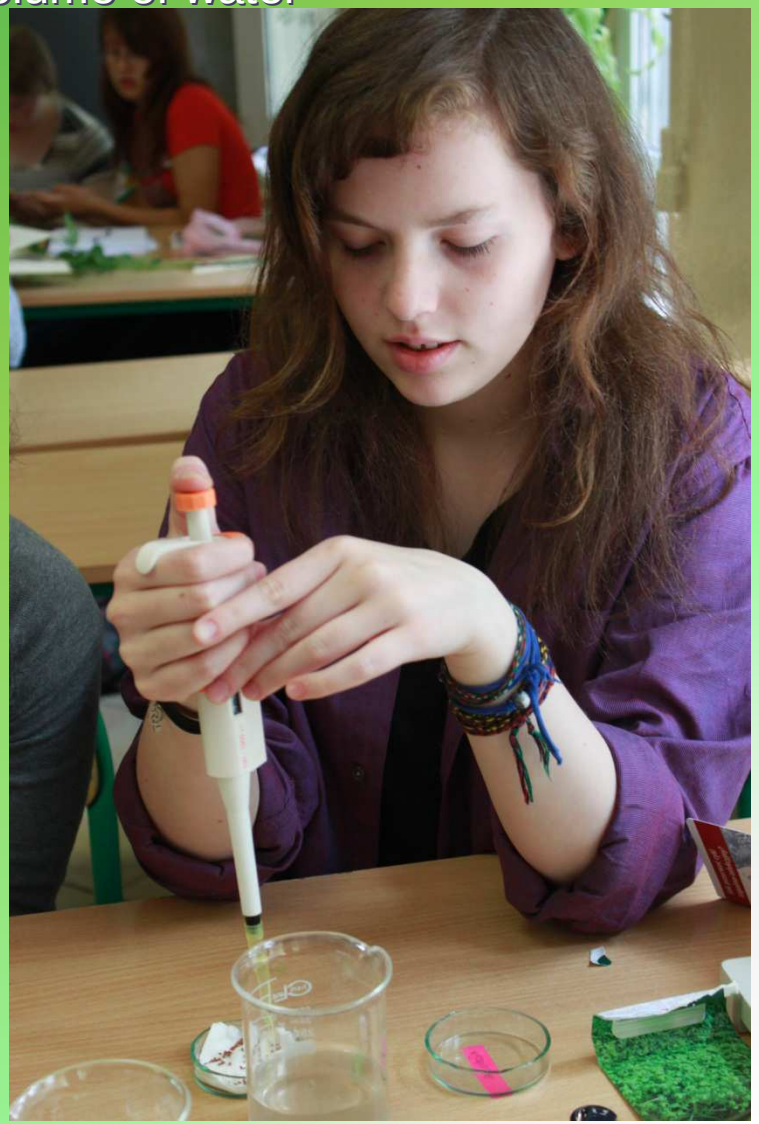
To determine the refractive index, Abbe refractometer is used. It is constructed of two rectangular prism with a refractive index greater than the coefficient of the tested liquid, which is placed between prisms 1 and 2 . It creates a thin, plane-parallel layer to which from different angles fall rays from the prism P1. Some radiation is totally internally reflected, and some of them after the collapse leaves the second prism. Rays incident at an critical angle run along the border surface and are absorbed by the blackened walls of the prism casing. Thanks to such course of rays, vision in telescope is divided into two parts: a dark and bright. By turning the knob we set the appropriate boundary line of both parts on intersection of the cross lines and then read on the scale of the refractometer the refractive index of the liquid.

## VARIABLES:

- The dependant variable is refractive index of liquid and indicator Z
- The controlled variables are corrections A, B and б
- The independent variables are temperature and volume of water

## APPARATUS:

- Abbe refractometer
- Bottle of water
- Pipette
- Paper towels



## METHODS:

1. Halogen lamp was enabled to electricity and was set to illuminate the upper surface of the prism.
2. Upper prism was deflected, prisms were purified with distilled water and gently wiped with a paper towel.
3. Preparation of the refractometer to measurements:
• on the lower prism a thin layer of water was applied by pipette to completely cover its surface. After moving down the upper prism, an excess of flowing water was removed.
• the light intensity and sharpness of vision was adjusted in order to see a sharp image of the crossing lines and scale.
4. Measurement of the refractive index n:
• image in the ocular area of view was observed. The area should be divided into a light and dark part. If it were not so, then the knob was turned to the right side of the casing, thereby moving the boundary line between light and dark parts, exactly in the middle of the cross lines.
• the value of the index Z and the refractive index was read on the scale in ocular area of view.
• measuring knob was rotated to any angle and measurements were taken again. measurement was repeated 6 times.
• the average value of the refractive index n was determined, basing on previous measurements.

## Collecting data

The following tables shows the data of experiment.

## Distilled water

| Refractive index $n_D$ | Indicator Z | Corrections | | |
|---|---|---|---|---|
| | | A | B | б |
| 1.330 | 42.0 | 0.025 | 0.031 | 0.588 |
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## Water from Kłodnica River

| Refractive index $n_D$ | Indicator Z | Corrections | | |
|---|---|---|---|---|
| | | A | B | б |
| 1.331 | 42.0 | 0.025 | 0.031 | 0.588 |
| 1.331 | 42.0 | 0.025 | 0.031 | 0.588 |
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Uncertainty of refractive index is $\pm 0.001$ and uncertainty of indicator Z is $\pm 0.1$.

## MEASUREMENTS:

We shall create chart to see the percentage concentration of water from Kłodnica River. We assume that the percentage concentration of distilled water is constant. However as we can see from the tables both samples of water have the same indicator Z and the Refractive index is almost the same. It means that the percentage concentration is the same.  There is no point in making any chart.

## CONCLUSION:

The experiment showed that the percentage concentration of distilled water and water from Kłodnica River are the same. It is impossible because there can be seen by one's eyes that water from river is contaminated. It means that the experiment failed and cannot be seen as an appropriate example of finding the percentage concentration.

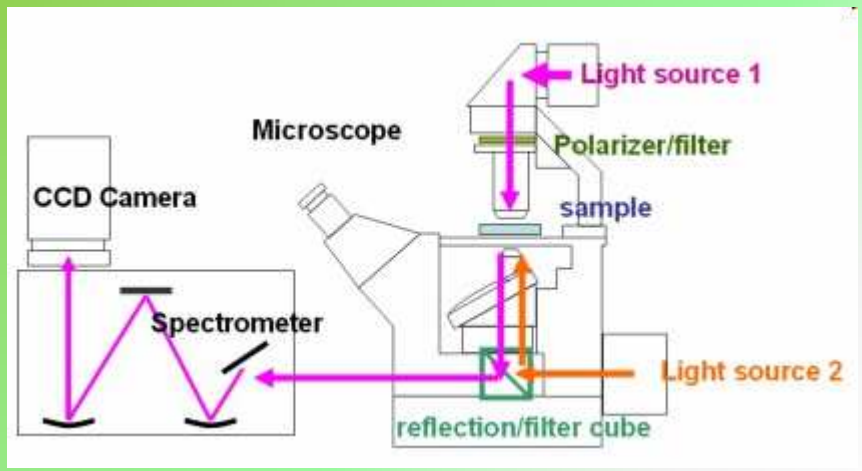
## ERRORS:

Certain failure of this experiment shows that there was a big error in this experiment. Probably the equipment used was broken. Also the water was “shallow water” which means that it was not taken from the depth of the river.

## IMPROVEMENTS:

The experiment can be repeated by the way described above. Second attempt to the experiment with brand new equipment should make this experiment effective. Also the important thing is to take water from depth of the river.

# DETERMINATION OF THE PERCENTAGE DIFFERENCE OF PERMEABILITY OF THE KŁODNICA WATER AND DISTILLED WATER USING SPECTROPHOTOMETER

# Density measurement of solids and liquids with the use of pycnometer.

## INTRODUCTION:

Int his investigation I am going to derive the density of the water taken from Gliwice's Canal called Kłodnica. After that I am going to compare the result with the density of distilled water.
My variables are:
-Masses of:
-pycnometer
-distilled water
-water taken from Kłodnica
-Temperature

The independent value in this experiment is for sure the temperature and mass. The dependent value – the one I am trying to calculate is the density of water taken from Kłodnica because it depends on the mass of water and the temperature measured.
The thing I am going to do is to measure masses both of the distilled water – which density is known from the tables of relationship between the temperature and the density.

## DESIGN:

The method of achieving the density of a liquid is not complicated. The stuff we are going to need is a very accurate weight, pycnometer, some water from Klodnica and the distilled one.
The thing that had to be done first was to measure the temperature and the mass of an empty pycnometer. After that we had to measure in the same way – using a weight with very big accuracy which was ±0,0001g – the mass of the pycnometer with both the water from Klodnica and distilled one.

| Temperature in room, °C | 25,3 | Density of water in the temperature of room $\rho_w, \frac{kg}{m^3}$ | | 997,04 |
|---|---|---|---|---|
| | Mass of the weights, g | The indication of the pointer, mg | Location on the scale, mg | Total weight, g |
| $m_1$-mass of an empty pycnometer | 10 | 210 | 7,7 | 10,2177 |
| $m_2$-mass of the pycnometer with distilled water | 19 | 980 | 5,7 | 19,9857 |
| $m_3$-mass of the pycnometer with water from Klodnica | 20 | 100 | -1,2 | 20,0088 |

To calculate the value of density, we have to use this equation:

$$\rho_s = \rho_w \cdot \frac{m_3 - m_1}{m_2 - m_1}$$

We know all the variables and it is now only about the calculation:

$$\rho_3 = 997{,}04 \cdot \frac{20{,}0088 - 10{,}2177}{19{,}9857 - 10{,}2177}$$

$$\rho_3 = 997{,}04 \cdot \frac{9{,}7911}{9{,}768}$$

$$\rho_3 = 999{,}3979$$

The value obtained is satisfying our measurements

## PROBLEMS WITH ANALYSIS AND COLLECTING DATA:

We came to a conclusion that this experiment could have been done much better because there were some things that could influence our results, such as that the temperature – important when it comes to density – probably was not the same in both cases – distilled water and Kłodnica water. This could have affected the result in some way. We cannot be also sure if in the pycnometer was no air. Air would change the mass, and automatically the density too. Another thing is that after filling the pycnometer with distilled water it could not have been cleaned perfectly, so we can suppose that there was some water left when we put there water from Kłodnica.

## EVALUATION:

To improve this experiment we could have used a water kept in the same temperatures, the pycnometer was not probably completely clean so we could have used another one and wait for it to dry fully.


## CONCLUSION:

From that experiment we observed that the density of these kinds of water differ, but the difference is not big. Despite the rubbish and dirtiness which is given to the canal, the density(~999,4) is only a little higher when comparing it with distilled water(~997,04). We know that the results are not fully accurate but they show what is the difference.

## SUMMARIZING:

We have collected data from three subject groups, which took part into this project (Biology, Physics, and Chemistry) All of the experiments showed different information related to the topic of our GROUP 4 PROJECT which was: Experimental study of Kłodnica river water purity based on its diversity. Chemistry group find out that Kłodnica river has fourth class of cleanliness, by water contamination (considering also the industrial character of some city areas and nearness of the Technical University's Chemistry Section). Physics group have focused on the comprehension between distilled water and the water took from Kłodnica river. Despite the wastes and dirtiness of the canal, the density is only a bit higher when we compared it with distilled water. The experiment unfortunately failed partly because even the eyes could see the contamination differences. Finally, when it comes to Biology group they were measuring also the cleanliness of the river and the diversity of plants occurring around.

Summarizing, our investigation has showed us the water purity of Kłodnica river based on the diversity. The methods and data were collected as accurately as it is possible, however summing up there were also many mistakes made which caused for example the failure in the comprehension of cleanliness of Kłodnica river and distilled water. Apart of those mistakes our investigation supported our assumptions of huge contamination of the water instead of high biodiversity occurred around.

# SOURCES:


- http://www.sci-support.com/images/300/1331.jpg
- http://en.wikipedia.org/wiki/IB_Group_4_subjects
- http://www.saburchill.com/IBbiology/group4/001.html
- http://www.lbb.ethz.ch/Equipment/spectrophotometer/schem?hires
- http://wapedia.mobi/thumb/25d7510/pl/fixed/470/352/K%25C5%2582odnica.JPG?format=jpg