
LABORATORY WORK NO. 2

MEASURING OF VOLUME AND DENSITY

■ PRINCIPLE :

Measuring the volume by the volumetric dishes :

The main volume unit according to the SI system is m^3 , which is divided according to the needs into the sub-units as dm^3 , cm^3 , mm^3 . In a laboratory, the most commonly used unit is $1\text{ ml} = 1\text{ cm}^3$.

The volume of substances varies depending on temperature (due to thermal expansion), so it is always necessary to measure the volume at a constant temperature of 20°C .

The volumetric dishes are calibrated to this temperature.

Volumetric dishes are divided into:

- dishes for topping : graduated cylinder , volumetric flask
- the outpouring dishes : pipette , burette .

For topping vessels, we measure the volume using the lower meniscus of a liquid , only for coloured liquids we use the upper meniscus.

We have our eye at the level of a scale line, the vessel stands on a horizontal surface.

For outpouring vessels we count with the rest of the liquid in the tip of vessel - that is not included in the measured volume, liquid is allowed to flow out freely.

Density measurement :

To measure the density of substances in a laboratory, we use two methods - gravimetric or so called pycnometric method and buoyancy method , ie a method using a hydrometer/densimeter.

Gravimetric method is based on the weight of water of precisely defined volume in the vessel (pycnometer) at a constant temperature of 20°C .

To calculate the density ρ , we apply the following equation:

$$\rho = \frac{m}{V} \quad \text{where } \mathbf{m} \text{ is the mass of the object in kg}$$

\mathbf{V} is the volume of the object in m^3 .

The main unit of density is $kg\ m^{-3}$, sub-unit is $g.cm^{-3}$.

TASK 1. MEASURING THE VOLUME BY THE VOLUMETRIC DISHES

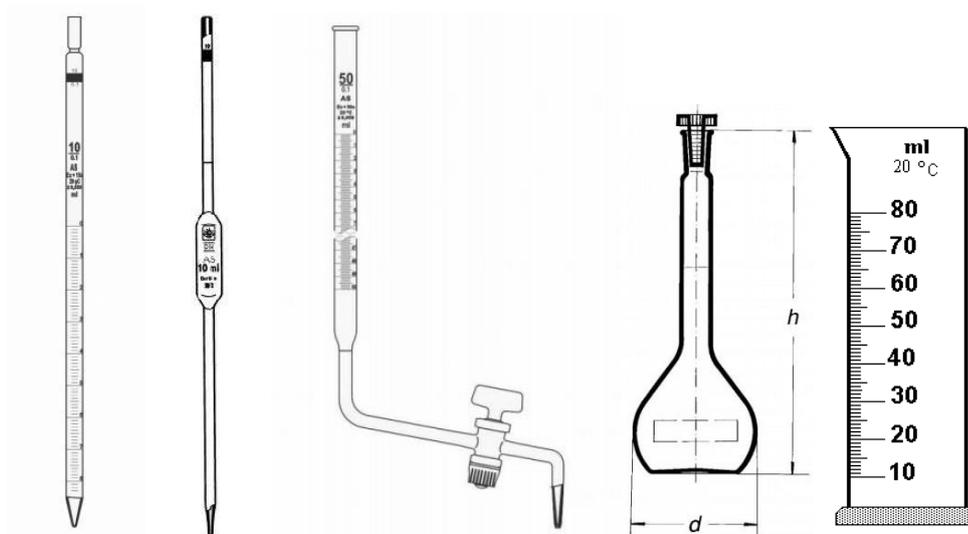
- #### ■ **CHEMICALS:** distilled water

INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ

- **AIDS:** graduated cylinders (10 ml, 25 ml, 50 ml, 100 ml), volumetric flask 250 ml, undivided pipette 20 ml, graduated pipette 10 ml or 5 ml, burette 25 ml or 50 ml, 2 beakers 150 ml
- **PROCEDURE:**
 1. Measure out 8 ml, 22 ml, 45 ml and 92 ml of water with the graduated cylinder.
 2. Using an undivided pipette, pipette 20 ml of water into a graduated cylinder. Find out the difference in the measured volumes.
 3. With a graduated pipette, pipette 4 ml and 6 ml of water.
 4. Fill in the burette with water, check the leakage. Then set the level to zero and measure out 7.5 ml and 10 ml of water into the graduated cylinder. Repeat 3 times.
 5. Using a burette, determine how many drops are contained in one ml of water. Perform this measurement 3 times, write down into the table and calculate the average.

Amount of H ₂ O (ml)	Number of drops
V ₁ =	
V ₂ =	
V ₃ =	
Average V =	Average number of drops n =

6. Picture of the volumetric glassware – name these items:

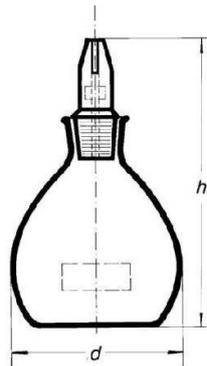


- CONCLUSION:** Write down the conclusions of measurement. Compare the measured volume of water in the cylinder and in the pipette. Calculate the average number of drops of water in 1 ml of water.

Task No. 2 MEASUREMENT OF DENSITY BY USING PYCNOMETER

- CHEMICALS:** distilled H₂O
- AIDS:** scales, pycnometer
- PROCEDURE:** Weigh an empty pycnometer (m_1) on analytical scales. Then fill it with distilled water and weigh again (m_2).
Every pycnometer has its exactly stated volume V (cm³).

Picture of the pycnometer



- CALCULATIONS:**

$$\text{density } \rho = \frac{m_2 - m_1}{V} \left[\frac{\text{g}}{\text{cm}^3} \right]$$

m_2 weight of the pycnometer with water [g]

m_1 weight of the empty pycnometer [g]

- CONCLUSION:** Calculate the density of distilled water according to the equation .

TASK No. 3 MEASUREMENT OF DENSITY BY HYDROMETER

- **CHEMICALS:** 5% sugar solution, 15% NaCl solution (or choose one solution according to time possibilities)
- **AIDS:** graduated cylinder, densitometer, scales, pycnometer
- **PROCEDURE:** Prepare 100 ml of 5% solution of sugar (weigh off 5 g of sugar, pour it into the 250 ml beaker and dissolve in 95 ml of distilled water). Pour the sugar solution into the volumetric cylinder and dip a hydrometer into it, take a reading – value ρ_1 . Measure the density of this solution also using a pycnometer – value ρ_2 . The procedure is the same as in task No. 2.

Prepare (in similar way) 100 ml of 15% NaCl solution and determine its density by hydrometer (ρ_1) and pycnometrically (ρ_2).

- **CALCULATIONS:** $\rho = \frac{m_2 - m_1}{V} \left[\frac{\text{g}}{\text{cm}^3} \right]$ density determined by using pycnometer

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the sample [g]

m_2 weight of pycnometer with

pycnometer [g]

m_1 weight of the empty

- **CONCLUSION:** Compare the density ρ_1 (density determined by using hydrometer) and ρ_2 (density determined by using pycnometer) of measured samples.



STUDENT'S SHEET No.2 MEASURING OF VOLUME AND DENSITY

1. Vocabulary: Match the Czech words with their English equivalents:

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|---------------------------|---------------------|
| 1. pycnometer | a) vzorky |
| 2. scales | b) váhy |
| 3. weigh | c) přesný objem |
| 4. density | d) nádobí na vylití |
| 5. exact volume | e) nádobí na dolití |
| 6. hydrometer | f) hustoměr |
| 7. samples | g) hustota |
| 8. graduated cylinder | h) vážit |
| 9. dishes for topping | i) odměrný válec |
| 10. dishes for outpouring | j) pyknometr |

2. Translate:

- Odměrné nádobí se dělí na nádobí na dolití a nádobí na vylití.
- Připrav 100 ml 15% roztoku cukru.
- K měření hustoty používáme dvě metody – pyknometrickou a za použití hustoměru.
- Porovnej hustotu 1 a hustotu 2 u měřených vzorků.
- Vypočítej hodnotu hustoty podle následujícího vzorce.
- Objem měříme za použití dolního menisku kapaliny.

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3. Choose the write spelling of following words:

- | | | | |
|-------------------|----------------|----------------|----------------|
| 1. a) denzity | b) densiti | c) density | d) denzyti |
| 2. a) skale | b) scale | c) skales | d) scales |
| 3. a) burette | b) byrette | c) burret | d) byrret |
| 4. a) measerement | b) measurement | c) mezurement | d) measuremnt |
| 5. a) gravimeric | b) gravinetric | c) gravimetric | d) gravimetrik |



4. Describe by your own words the method of measuring density pycnometrically:

5. a) Give some examples of volumetric glassware for topping:

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b) Give some examples of volumetric glassware for outpouring:

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**6. Give step by step instructions how to prepare 100 ml of 15% solution of NaCl.
Which glassware do you need? Which laboratory equipment?**