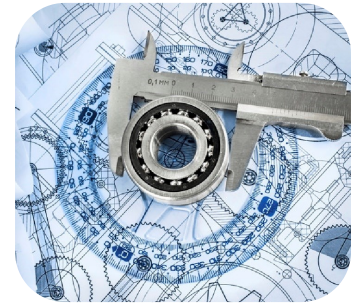


ENG 200

SCIENCE AND ENGINEERING MEASUREMENTS



This laboratory introduces the student to basic engineering and scientific technical measurements and methods to two categories of measurements:

- A. Electronics and Electrical Engineering
- B. Scientific

The lab contains all the necessary components needed for performing hands-on experiments. In both sectors mentioned above all measurements are taken by digital means i.e. using data acquisition systems with high resolution data logging and sensor components.

The concept of the lab is mainly to train the student in grasping the units, the relationships and the interpolation of physical and engineering measurement, while also practicing the theory related to those elements.

The Laboratory comes with complete documentation and a virtual application – simulation software FP200 to allow students to experiment on a virtual apparatus prior to the hands-on experience with the real lab equipment. The didactic application is built-on an interactive platform and allows the interface between the student and the instructor via the Wi-Fi network. All trainers are connected a PC (PCs are not supplied - Min. requirement for MS Windows 7 or higher).

The application also includes many other tools to assist the teacher and/or the student to perform a step by step experiment, to take digital measurements and analyze the results and correlate measurements according to theory.

The Didactic Application also comes with new add-on modules such as:

1. Classroom management system.
2. Student response system which supports Android Pad and Smartphone user interface.
3. Classroom Performance Evaluation and Statistics.
4. Teacher add-on content Link Interface.
5. Voice file add-on Annotation utility.

ENG 201MB

Basic Measurements

MB1
Basic Measurements tool set

DL1
Digital Measurement tool set

DL1P *add-on set to DL1*
Digital Measurement tool set -
Physics

DL2
Digital Measurement tool set -
Chemistry

DL3
Digital Measurement tool set -
Biology

FP201
Electronics and Electrical
Engineering Measurements

STEM BT11A
Scientific Measurements

FLM 213
Surface tension

FLM 214
Viscosity measurements

FLM 215
Polarimetry

ENG 201MB Basic Measurements

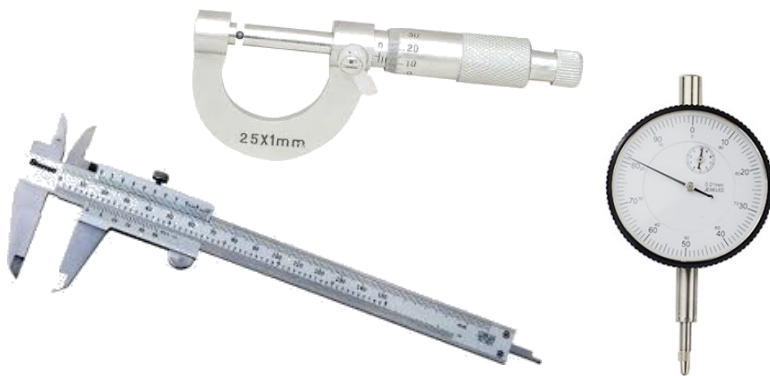
The concept of the ENG 201MB metrology experiment sets is mainly to train the student in grasping the measurement units, the relationships and the interpolation of physical and engineering measurement, while also practicing the theory related to those elements. For the broader and extended training of the students, measurements are implemented by using wherever applicable:

- Conventional – Basic means using the **MB1** set
- Digital measurement means using the **DL1** set

MB1 Basic Measurements tool set

Caliper gauges, micrometers and spherometers are used for the accurate measurement of lengths, thicknesses, diameters and curvatures. Measuring procedures, accuracy of measurement and reading accuracy are demonstrated.

The set is provided with the MB1 set of equipment along with some auxiliaries, to assist the students in principle measuring tasks as listed below, but not limited to them only.



- **Volume measurements of geometrical shapes: Tubes, Cylinders, Pipes, cubes and parallelepipeds.**
- **Thickness measurements of Wires, pipe walls, Φ Internal - external pipe diameter, bolts and screws ,metal sheets and glass plates (acrylic).**
- **Curvature measurements of different watch glasses using the spherometer and many more...**



Metrology is the **science** of **measurement**.

It establishes a common understanding of physical and engineering unit standards in our everyday activities. This standardization has evolved into the establishment of the **SI International System of Units**.

MB1 equipment set

- **Vernier caliper**
- **Micrometer screw gauge**
- **Spherometer Gauge**
- **Set of cubes & parallelepipeds**
- **Iron wires, M6/M4 screw& bolts**
- **Aluminum and iron thin sheets**
- **Pipe, 10 cm long**
- **Wood and Teflon solid cylinder**
- **3 x Glass test tubes**
- **3 X Curved watch glasses**



DL1 Digital Measurement tool set

Modern technology measurement methods are providing a variety of sensor and transducers for measurements of all kinds of physical quantities. Furthermore, in combination with data loggers and modern data acquisition software applications, all measurement data collection, analysis, interpolation etc became so easy and useful in the progress of technology.

Force sensor and Photogates are used in mechanics to measure accurately, speed, acceleration, kinetic and dynamic energy, period and time, angular speed and acceleration. Temperature sensors are used to monitor time on line of every experiment with temperature variation.

The aim of this basic set is to train students in the modern data acquisition methods in combination with basic physical experiments. Measuring procedures with Data collection, data analysis and graphs of data, formula interpolation and all the features of a modern data acquisition application in the laboratory.

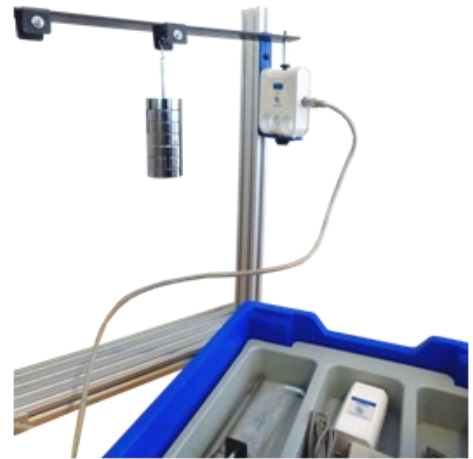
The set is provided with the DL1 basic equipment along with some auxiliaries, to assist the students in principle measuring tasks as listed below, but not limited to them only. The ENG DLx series includes kits with many more sensors. Please see the complete list of provided sensors.

DAQ-DATA ACQUISITION system

One set for many experiments.

The DL series of Data acquisition kits offer a variety of sensors and are used across a vast number of experiments, in Physics, Chemistry, Biology and Engineering laboratory works. We support cross usage of the DL sets so they can be used in a vast variety of experimental sets with no need for purchase repetition.

The DAQ - iLab application requires a PC Win 10.



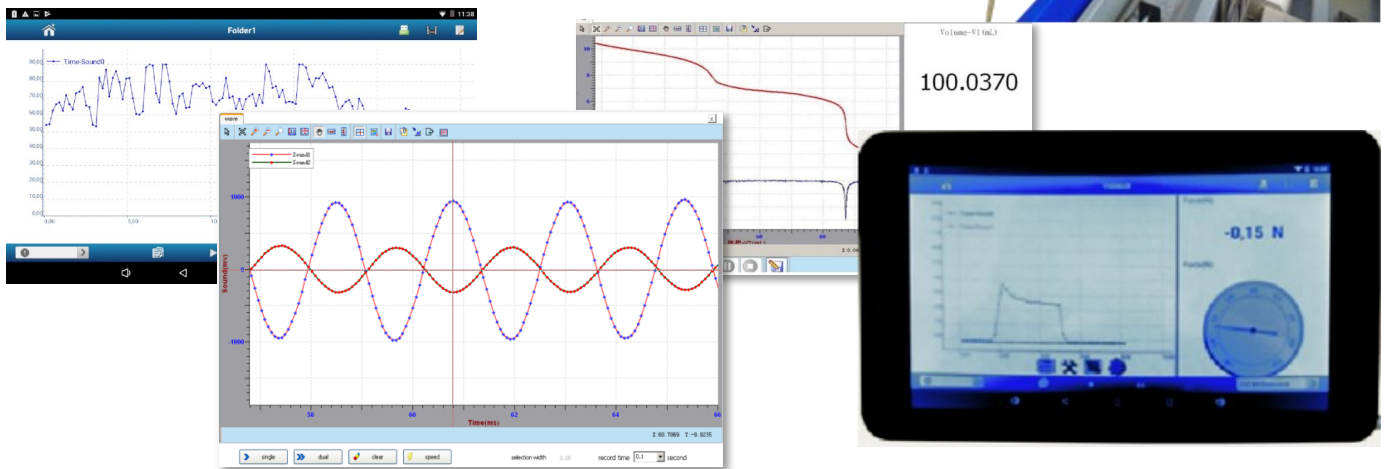
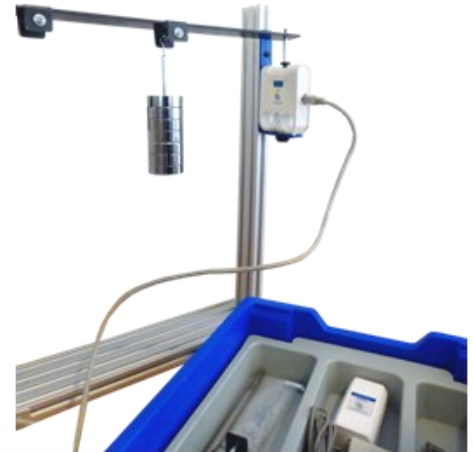
DL1 equipment set

- **Data Logger DL 100**
- **Force sensor**
- **2 x Photogates**
- **Temperature sensor**
- **Retord stand apparatus**
- **Spring set**
- **Pendulum**
- **Beaker 500 ml**
- **iLab SW DAQ applications**



iLab Software DAQ application

It is the software application used for the Data Logger. Supported by OS Microsoft Windows 7 or later version and the most recent Android versions for tablets. It includes user manual and program installation and is available either on CD or USB. The software ensures the recording, transmission, processing and storage of data received from the sensors. The data can be displayed in numeric or graphic form. It provides the ability to export results into MS Excel and the mathematical processing and analysis, as well as printing them out. In addition, it enables to record data in real-time measurements with the function of the snapshot.



The **iLab** DAQ application offers to the PC user easy creation of a new experiment.

A complete control GUI environment with all the devices and their setting available to the user to have a full control of the data acquisition process.

iLab features facilities as:

- ◆ Quick experiment mode
- ◆ Create, rename delete a experiment file or folders folder
- ◆ Scientific Formula implementation for derivative results and to create multiple graphics results or data from primary data
- ◆ Graph Axis line creation with values and characteristics
- ◆ Scientific Variable editing
- ◆ Start button
- ◆ Manual collection button
- ◆ Pause button
- ◆ Stop Button
- ◆ Save an experiment button
- ◆ Generate an experiment report in table, graphic, custom template or XL format
- ◆ Replay experiment mode button
- ◆ Setting up values for data collection as resolution and frequency
- ◆ Template Creation utility allowing the user to create or edit custom made graphics outputs

iLab Tool kit additionally offers:

- ◆ Coordinate zone, panning, zoom in and out, screen color and graph color
- ◆ Offers built in parameters for experiments and graphics tools as
 - Straight-line fitting
 - Polynomial fitting
 - Hyperbola fitting
- ◆ Definition and adaption of variables
- ◆ Statistical functions and graphics functions
- ◆ Tools for calculation
- ◆ Hardware settings allowing
- ◆ Trigger Setting for data collection
- ◆ Sensor calibration
- ◆ Dedicated software for certain typical sensor applications as heart rate, harmonic sound waves, force analysis etc.
- ◆ Set up for language, type of communication with PC and other driver utilities in a very user friendly GUI.

DL1P Digital Measurement tool set - Physics (add-on set to DL1)

A tool set of dataloggers and sensors used for the digital measurements in Physics experiments.



DL1P equipment set

- Data Logger DL 100
- Data Logger DL 120RS (optional)
- Voltage sensor
- Current sensor
- Pressure sensor
- Motion sensor
- Acceleration sensor
- Magnetic field sensor

DL2 Digital Measurement tool set - Chemistry

A tool set of dataloggers and sensors used for the digital measurements in Chemistry experiments.



DL2 equipment set

- Data Logger DL 100
- Data Logger DL 120RS (optional)
- Voltage sensor
- Current sensor
- Temperature sensor
- Pressure sensor
- pH sensor
- O₂ sensor
- CO₂ sensor

DL3 Digital Measurement tool set - Biology

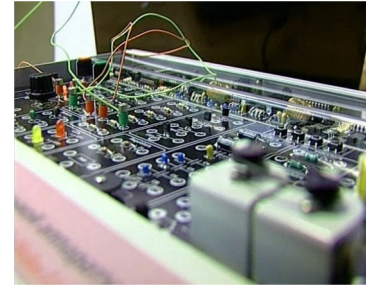
A tool set of dataloggers and sensors used for the digital measurements in Biology experiments.



DL3 equipment set

- Data Logger DL 100
- Data Logger DL 120RS (optional)
- Temperature sensor
- pH sensor
- O₂ sensor
- CO₂ sensor
- E.C.G. sensor
- Respiration sensor

FP 201 Electronics & Electrical Engineering Measurements Trainer



The trainer is enclosed in a metal case, which has a wide experiment platform printed circuit board (24cm x 12cm) to insert the FP 201 printed circuit board. This ensures easy handling and good visibility of the components.

The components are located on the board which has a silkscreen print of the analytical circuit and component symbols. The central part of the experiment board includes all the circuit block drawings and all the hands-on components and test points.

The protected components are located on the circuit board, clearly visible to the student and protected by a sturdy transparent cover. The system includes a built-in power supply with +12V, +5V, variable DC voltage and AC voltage outlets. An included low voltage external AC power adapter feeds the system. The Trainer PCB board includes the following components:

- Diodes (Silicon, Germanium and Zener)
- Resistors, Potentiometer, Rheostat
- Thermistors (NTC & PTC), LDR, phototransistor
- Inductors, capacitors and variable capacitors
- Transistors (NPN, PNP, JFET, MOSFET)
- SCR, TRIAC, DIAC, UJT
- Transformer, Regulator
- AC Motor and DC Motor

The **FP200 application** also includes a:

1. PTF 200V - Virtual Oscilloscope
2. PTF 200S - Virtual Signal Generator

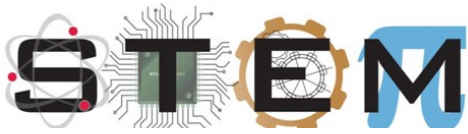
The fault insertion on the trainer PCB board can be introduced by the instructor by simply using software parameters and various fault scenarios, via the FP200 application, for each trainer or all of them.

EXPERIMENTS

This system enables the student to perform several experiments covering the following topics:

- Voltmeter, Ohmmeter and Ampere meter.
- Resistor measurements.
- Ohms Law.
- Series and parallel resistor circuits.
- Kirchhoff's laws.
- Thevenin, Norton's, superposition theorems.
- Electric and magnetic fields.
- Mutual and self induction.
- Transformers types and properties.
- Capacitance and capacitors.
- RLC series and parallel circuits.
- Voltage and current phase angle relations.
- Frequency and phase measurements.
- Three phase measurements.
- Power supplies characteristics.
- Square waves characteristics.
- Square waves in RLC circuits.
- Analog and digital signals.
- Flat noise and Signal to Noise measurement.
- Amplifier characteristics methods of measurements.
- Signal and power consumption methods of measurements.

BT 11A Scientific Measurements



A **universal testing platform** for Digital experiments and Digital measurements used in science and engineering.

BT 11A is a small size integrated apparatus **combining a data acquisition system and devices** which students can use to perform various experiments applied in all sciences. The system allows the performance of experimental measurements using at least **15 different types of sensors**. The sensors are provided separately and must be ordered by the client according to subject. BT11A top surface is build from the chemically resistant, non-porous, hygienic, non toxic and non destructive DuPont™ Corian® material. The basic frame under the surface is made out of aluminum.

Corian is a modern building material highly recommended for sanitary, non toxic and clean surface applications.

BT11A is compact, modular, light and versatile apparatus useful to any science classroom and in any level of education from elementary school to high school.

It introduces the students to measurement techniques using the most modern methods provided today by sensors, data loggers and computer Data analysis software. BT11A includes a build-in wireless data logger to connect to a PC system, a power supply of 6V DC and a set of equipment to contact the experiments. BT11A comes in an aluminum frame briefcase, with all devices and a sensors stored in it and with a complete pedagogical software application.

- BT11A is **MODULAR...** Meaning that the same platform can be used for a variety of

experiments by adding the different experimental modules, boards, sensors etc.

- BT11A is **VERSATILE...** Meaning that the modules can be used in various ways to implement experiments in various areas. They are designed not of a single use but for various uses within the content of the curriculum of activities. BT11A due to the above features is the most **COMPACT** digital lab offered in the market by which the student can process more than **100 science experiments**.

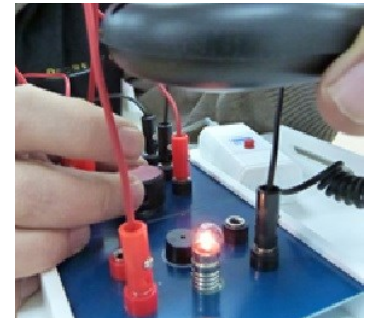
BT11A Didactic application

The BT11A interconnects the Teacher with the Students in a uniform platform.

- Theory Introduction per science Topic with interfaces to any Student Response System or Interactive board
- Theory quizzes
- Lab Simulation for the Topic, Virtual measurement Simulations
- Data acquisition applications
- a Step-by-Step procedure for Student experiments activities and student quizzes jointly in BT11A provide the most modern platform in Science teaching.

The BT11A application includes also various utilities as Inventory, directing the students what equipment to use, Instructions for different devices in the kit, instructions for the software applications which are used during the teaching process.

All instructions and Documentation is included in the BT11A application making BT11A one complete **CAI** - Computer Assisted Instruction - environment for the student, having all the required information available Online.



SENSORS FOR BT11A

RS 101 Voltage

RS 102 Current

RS 104 Temperature

RS 105 Pressure

RS 106 Force

RS 107 Motion

RS 108 Photogate

RS 111 Magnetic Field

RS 112 Sound

RS 202 pH

RS 204 O₂

RS 206 CO₂

RS 207 Relative Humidity

RS 210 ECG

RS 211 Respiration (Spiro)



Based on each Subject, the BT11A laboratory activities are the following:

PHYSICS



- Weight and mass
- Volume and Density
- Forces
- Boyant force
- Archimedes Principle
- Gravity
- Free fall
- Balance and moments
- 3rd Newton's law
- Impulse of force
- Hooke's Law
- Spring system
- Pendulum
- Types of oscillation
- Mechanical energy
- Light intensity
- Sound level
- Water-Oil thermometer
- Heat conductivity of materials
- Gay Lussac's Law
- Boyle's law
- Relative humidity 1
- Relative humidity 2
- Barometer
- Conductors Insulators
- Measuring voltage
- Measuring Current
- Calculating resistance
- Diode
- Serial circuit (1)
- Serial circuit (2)
- Parallel circuit (1)
- Parallel circuit (2)
- Capacitor performance
- Magnetic field
- Electromagnetic field
- Electromagnetic induction

CHEMISTRY

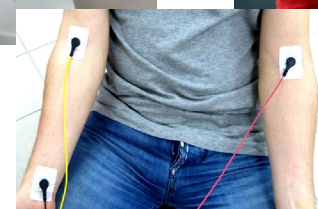
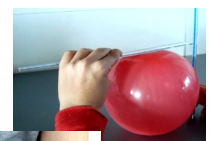
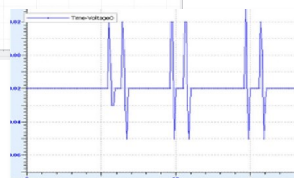
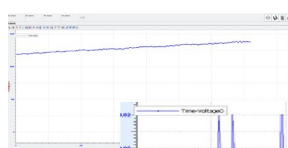


- Dilution and pH measurement of Acids and Alkalis
- Conductance of solution samples
- Catalytic decomposition and O₂ gas release
- Electrolysis of salt water
- Ionic Decay Of Salt Water
- Enthalpy changes in a series of reactions
- Exothermic and Endothermic reaction
- Heat of neutralization
- CO₂ Gas Production In Double Replacement Reaction
- Neutralization reaction and moisture changes
- Osmosis and pressure changes
- pH change is neutralization reactions
- Pressure changes in catalytic decomposition reactions
- Pressure changes in Chemical reactions
- Redox states of transition electron
- Temperature changes associated to phase change
- Humidity changes associated to phase change
- The PH measurement
- Hess's Law Demonstration
- Stoichiometric Analysis Of Catalytic Decomposition Reaction

BIOLOGY



- Measuring the rate of photosynthesis on day time
- Measuring CO₂ level / photosynthesis at night
- Transpiration in a plant
- Respiration process during germination
- Measuring the pH of soil
- Relative Humidity of Soil
- Membrane permeability
- PH and organisms
- Decomposition reaction by enzymatic catalysis
- Sugar Fermentation
- Acidification of Milk
- Measuring CO₂ production during fermentation
- Muscle fatigue
- Body temperature regulation
- Determining your vital air capacity
- Breathing air O₂ content
- Breathing air CO₂ content
- Humidity of breathing air
- Measuring heart rate with ECG
- Exercise and heart rate



FLM 213 Surface tension

Du Noüy ring method

With this apparatus, the **du Noüy ring method** can be used to **determine the surface tension of various liquids in different temperature conditions.**

This is a technique for measuring the **surface tension** of a liquid with a ring that is attached to the force sensor with a silk thread and it is dipped into the liquid. The liquid level is lowered and the force that acts on the ring just before the liquid film tears is measured. The surface tension and the tear-off force is automatically recorded from the force sensor. Using diameter rings and liquids in different temperatures and variable **surface tension coefficient γ** , theoretical calculations can be verified with measurements.

Aim

1. Determine the surface tension of food oils as olive, corn and oil mixtures even etc. as a function of diameter of the ring and temperature state.
2. Determine the surface tension of water/ ethanol mixtures as a function of their mixing ratio and temperature state.

* DAQ-DATA ACQUISITION

One set for many experiments.

The DL1 kit is used across a vast number of experiments in Physics, Chemistry, Biology and Engineering laboratory works. We support cross usage of the DL sets so they can be used in a vast variety of experimental sets with no need for purchase repetition.

The DAQ - iLab application requires a PC Windows 10.

Magnetic stirrer with heater

Technical Specifications

Automation Grade
 Electronic Speed Regulation
 Stirring Volume
 Temperature

Semi-Automatic
 up to 1500 rpm
 up to 15 Lt
 up to 550° Celsius



Equipment

Magnetic stirrer with heater
 Force sensor*
 Temperature sensor*
 Surface tension measuring ring (a and b)
 Retort stand set
 Glass beaker 500ml
 Glass beaker 250ml
 Silk thread, l = 200 m
 Glass tubes, straight
 Glass tubes, straight with stopcock
 Silicone tubing
 Volumetric pipette, 10 ml
 Volumetric pipette, 20 ml
 temperature sensor
 Graduated cylinder 100 ml

Chemicals (purchased locally)

Ethyl alcohol, absolute 500 ml
 Olive oil, pure 100 ml
 Water, distilled 5 lt



FLM 214 Viscosity measurements

Falling ball viscometer

The falling ball viscometer typically measures the viscosity of Newtonian liquids. The method applies Newton's law of motion under force balance on a falling sphere ball when it reaches a terminal velocity. In Newton's law of motion for a falling ball, there exist buoyancy force, weight force and drag force, and these three forces reach a net force of zero.

Measuring Viscosity

Liquids, due to internal friction among their particles, have different viscosities. The viscosity factor μ of a substance is a parameter of the substance's structure, i.e. density, and temperature and can be experimentally determined by measuring the rate of fall of a various size balls in a tube filled with the liquid to be investigated.

Aim

Measure the viscosity of:

- water and salt mixtures;
- various type of food oils;
- methanol-water mixture in constant temperature;
- water as a function of the temperature;
- methanol as a function of temperature.

The apparatus provides an automated testing system consisting of:

- A Viscosity test tube (1), where the tested liquid is placed, positioned inside the center of a larger transparent cylindrical tank, the water tube (2), where ionized water circulates to control the temperature of the liquid in the viscosity tube.
- The larger tube is connected to water conditioner (5) with a small pump. It also allows the insertion of a temperature sensor probe (4) to monitor the water temperature circulating in it.
- The travel period of the ball is done automatically by the provided sensors (3) and the controller (5). Height of falling ball travel can be adjusted at any distance up to 25 cm. The standard is to use 100mm distance measurement.
- The provided water conditioner (5) is controllable and can supply water at temperature ranging for 16 degrees to 45 degrees temperature. For higher temperatures the conditioner can be altered according to customers specifications.
- Temperature, falling distance start and end times are monitored by the provided DL 101 controller (6) and the Data Acquisition Application provided. The application offers facilities for automatic calculation of the tested liquid's Viscosity μ , given some parameters as distance, ball diameter and fluid densities.

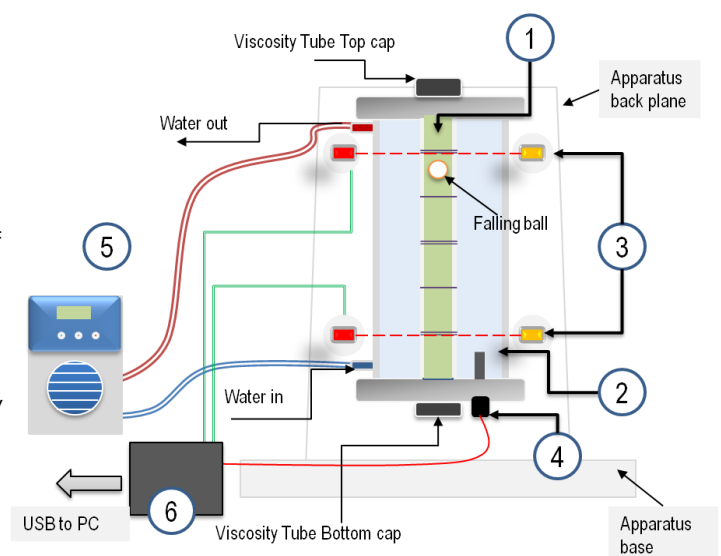


Equipment

- Falling ball viscometer
- Temperature sensor
- Precision balance
- Water chiller - Conditioner with pump
- Stopwatch, digital, 1/100 s
- Set of Rubber tubing
- Wash bottle, plastic, 500 ml
- Plastic Cylinder 100ml
- Erlenmeyer flask 50 ml
- Glass Beaker 400ml
- Glass beaker 250ml
- DL 101 Controller - with USB
- LDR – Interrupt switches - (ball travel timing)
- Requires PC Win 10 (provided by the Client)

Chemicals

- Water, distilled 5lt (locally purchased)



FLM 215 Polarization

Some chemical substances are optically active and polarized single-direction light will rotate either to the left (counter-clockwise) or right (clockwise) when passed through these substances. The angle of rotation of the light is known as observed angle of polarization of the substance.



Principle of Experiment

The rotation of the plane of polarization through a sugar solution measured with a half-shade penumbra polarimeter and the reaction rate constant for the inversion of cane sugar determined.

Aim

1. To determine the specific angle of rotation of cane sugar (sucrose) and lactose by measuring the rotation of various solutions of known concentration.
2. To determine the reaction rate constant when cane sugar is transformed into invert sugar.

Lab Polarimeter

- A half shade polarizer, analyzer, 100mm.
- The instrument is equipped with a 589nm sodium lamp.
- When switch on the power, the polarized light beam immediately radiates to polarizer filter and someone can observe the distinct visual fields through eyepiece which is magnified by 3 times.
- The sample tube auxiliary provided with the instrument is 100 mm long. The test tube must be filled with the solution.
- Then the sample tube is inserted into the measuring field chamber.
- To rotate the sample tube, rotate the Vernier knob till an equal brightness is found. The reading of the Vernier scale gives the angle of polarization of the specific tested solution.

Equipment

Polarimeter
 Stopwatch, digital, 1/100 s
 Crucible tongs
 Pipette with rubber bulb, long
 Graduated cylinder 100 ml
 Graduated vessel, 1 l, with handle
 Spoon, with spatula end, 18 cm, plastic
 Beaker, 250 ml, low form, plastic
 Funnel, plastic, diam. 100 mm
 Tubing connector, ID 6-10mm
 Glass rod

Chemicals (purchased locally)

Hydrochloric acid 37 %, 1000 ml
 Water, distilled, 5 lt
 D (+)-Sucrose, 100 gr
 D(+)-Lactose, powder 100 gr



Non Polarized view



Polarized view

Measuring Range	-180°~180°
Scale Value	1°
Vernier	0.05°
Magnifier	3X
Light Source	Sodium Lamp
Wavelength	589.44nm
Test Tube	<input type="checkbox"/> 100/200mm
Power Requirements	220V/50Hz