TESS expert PHYWE

Demo expert PHYWE

Eng

Geo

JAN. 2013

Engineering/Geo Science

University Experiments

PHYWE excellence in science

Materials Science and Engineering: Curricula Compliant Experiments –

for your educational needs

PHYWE™ experiments have been matched to the curricula of more than 30 selected universities worldwide. The interaction between PHYWE's experiments and the supporting content of experimental lectures and lab courses has led to the creation of a teaching package that is highly relevant to the curriculum worldwide.

Materials Science and Engineering

Bachelor of Science Course – Reference Curriculum

Content	1. Sem.	2. Sem.	3. Sem.	4. Sem.	5. Sem.	6. Sem.
Laboratory Experiments	General Physics*		Electrical Engineering (Chapter 5)		Material Analysis and Testing (e.g. NDT) (Chapter 4)	
	General and Inorganic Chemistry**		Physical Chemistry**	Crystallography (Chapter 3)	Thermo-chemistry**	
		Materials Science 1 (Chapter 3)	Materials Science 2 (Chapter 3)			
Lecture, Tutorial, Experiments	General Physics*		Electrical Engineering (Chapter 5)		Solid State Physics*	
	Materials Science 1 (Chapter 3)		Materials Science 2 (Chapter 3)		Material Analysis and Testing (e.g. NDT) (Chapter 4)	
	General and Inorganic Chemistry**		Physical Chemistry**	Organic Chemistry**	Electrochemistry**	
			Crystallography (Chapter 3)		Thermo-chemistry**	
Elective Subject			e.g. Metals, Polymers, Ceramics, Biomaterials		e.g. Nanotech., Renew. Energy, Electr. Devices, Photonics (Chap. 5,6,7)	
Theoretical Courses	Mathematics		Computer Sciences and Engineering		Measurement Technology	
			Technical Mechanics		Design and Construction	Business Administration and Industrial Management
Interships			Industrial Intership		Research Intership	
Bachelor Thesis						Bachelor Thesis

More than 80% of the experimental courses are covered by PHYWE experiments!

PHYWE Experiments available in this catalogue

* Please refer to TESS expert Physics catalogue

** Please refer to TESS expert Chemistry catalogue

Geo Science: Curricula Compliant Experiments –

multidisciplinary education with PHYWE

Geo science is one of the most multidisciplinary subjects taught in natural sciences. The first semesters or introductory courses cover general topics in physics, chemistry and biology followed by classical topics of geo science such as: geology, petrology, palaeontology, mineralogy, environment (climate, soil, water), spectroscopy, or X-ray analyses. Find corresponding experiments in this catalogue or refer to our TESS expert and Demo expert cataloques Physics, Chemistry or Biology.

Geo Science

Bachelor of Science Course – Reference Curriculum

Content	1. Sem.	2. Sem.	3. Sem.	4. Sem.	5. Sem.	6. Sem.
Laboratory Experiments	General Chemistry**		Optics and Microscopy***	Water: Cycle and Quality (Chapter 8.1)	General Biology***	Ore Microscopy, Nanoimaging (Chapter 3)
	General Physics*		Geochemistry	Soil Science (Chapter 8.3)	Mineralogy and Crystallography (Chapter 4.1)	Elementary Analysis/ Spectroscopy (e.g. XRF) (Chapter 4.1, 8.4)
Lecture, Tutorial, Experiments		Introductory Geology	Mineralogy and Petrology	Geophysics	Geoecology (Chapter 8)	Petrology / Petro-chemistry**
Elective Subject		Metallurgy**	Atmosphere: Science, Climate, and Change (Chapter 8.2)	Meteorology	Water: Hydrogeology, Hydrochemistry**	X-ray Powder Diffraction Laboratory (Chapter 8.9)
Theoretical Courses	Mathematics		Palaeontology	Sedimentation	Digital Mapping	
	Geology	Mineralogy	Sedimentary / Igneous	Petrology	Geomorphology	Meteorology, Climatology
Field Studies	e.g. Field Mapping		e.g. Landscape Evolution and Analysis		e.g. Environmental Geology	
Bachelor Thesis						Bachelor Thesis

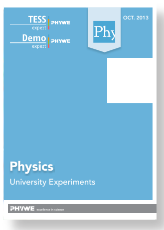
More than 60% of the experimental courses are covered by PHYWE experiments!

PHYWE Experiments available in this catalogue.

* Please refer to TESS expert Physics catalogue

** Please refer to TESS expert Chemistry catalogue

*** Please refer to TESS expert Biology catalogue



TESS expert and Demo expert Physics

TESS expert and Demo expert Chemistry / Pharmacy

TESS expert and Demo expert Biology

TESS expert Engineering and Geo Science

How to use
the table of contents

Use the curricula-based content on the next pages to find your topics and our corresponding experiments. The TESS expert catalogue is adapted to international university curricula making it easy for you to find experiments corresponding to your desired topic. On each page you find the detailed description of one of our university level experiments. More information including the complete experiment description is available on our website **www.phywe.com.**

Overview TESS expert

2 Applied Mechanics — Curricular topic = main chapter of the catalogue

2.1 Statics — Curricular subtopic = sub-chapter of the catalogue

P2120200	Modulus of elasticity	14
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P2131500	Moment and angular momentum	20
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P2131301	Moment of inertia and angular acceleration and with an air bearing	21
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Curricular fitting PHYWE experiments

Find the overview of all experiments fitting to the international reference curriculum on our hompage!

Click www.phywe.com

2 Applied Mechanics

3 Materials Science

4 Non-destructive Testing (NDT)

5.3 Properties of Electrical Circuits

6 Renewable Energy

6.1 Preparatory Courses

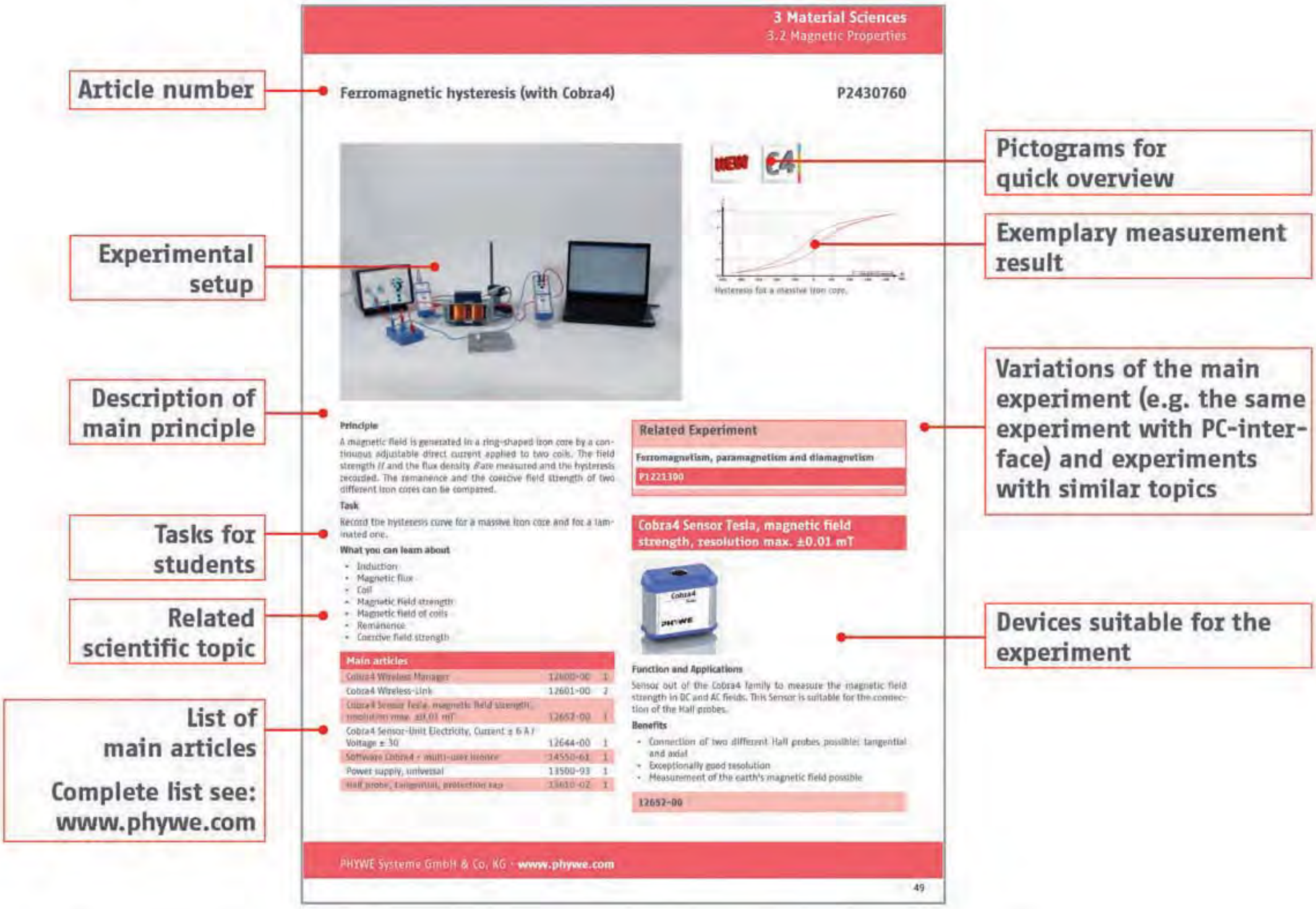
6.2 Basic Principles

7 Photonics

How to use

Facts about the TESS expert catalogue

The TESS expert catalogue is adapted to the PHYWE reference curriculum. PHYWE's experiments fit to the content of experimental lectures and lab courses of schools, colleges and universities. The description of each experiment offers you a lot of information:



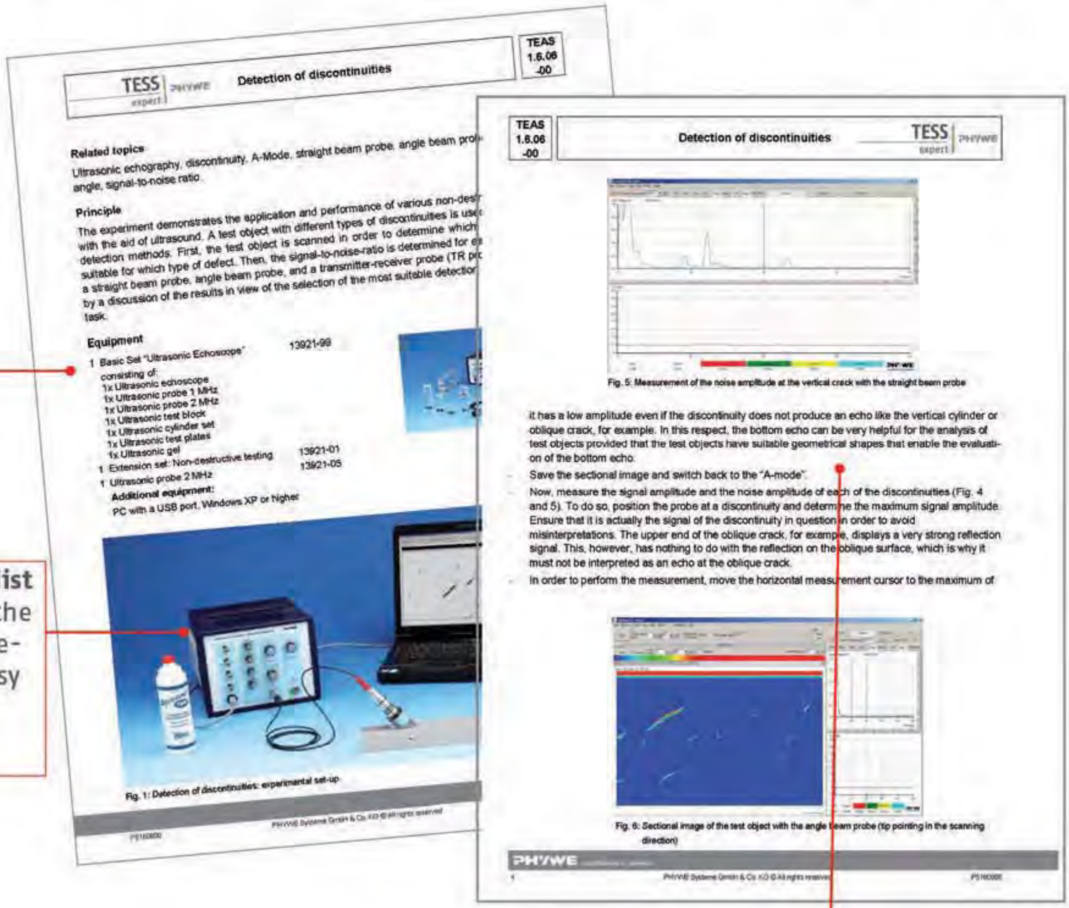
Pictograms for a quick overview of categories, related films or information:

- Experiments with the Computer based measuring system Cobra4
- Demonstration experiments
- Experiments with laser
- Experiments which have received a Nobel Prize
- Computer based measuring
- Experiments with radioactivity
- Product movie available - click at www.phywe.com
- New and completely revised experiments
- Training recommended

Didactic literature –
comprehensive guide for every experiment

Extensive experimental literature is available for all our university level experiments.
Rely on the advantages of our TESS expert experiment descriptions:

- All experiments are uniformly built up
- Experiments cover the entire range of classical and modern chemistry
- Didactically adapted descriptions – enables direct preparation by the student
- Developed and proven by practitioners – comfortable and reliable performance
- Excellent measurement accuracy – results agree with theory
- Computer-assisted experiments – easy, rapid assessment of results
- Modular experimental set-up – multiple use of individual devices, cost effective and flexible



Picture, Equipment list and Instruction for the execution of the experiment guarantee easy conduction of the experiment.

Theory and evaluation includes full theory of the experiment and shows graphical and numerical experimental results.

Your solution
with just one click!

Our comprehensive Internet site **www.phywe.com** provides you with all the information you need covering the full spectrum of solutions and products from PHYWE – in five languages! Whether your specific needs involve physics, chemistry, biology or applied sciences, and whether you are looking for information relating to school or university-level materials, you can always find just the right products there quickly and easily.

Further highlights on our website include:

- More than 50 product videos
- Complete assembly instructions in video form
- Up-to-date software downloads
- Free-of-charge descriptions of the experiments
- Operating manuals and instruction sheets to download

1. Language
2. Subject area = Physics, Chemistry, Biology, Applied Sciences
3. Education level = School, University
4. Media e. g. product videos
5. Downloads e. g. experimental literature

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There's a way to do
it better – find it.

Thomas Edison

The share of ideas and transfer of knowledge between academia and PHYWE is one of our major attempts in R&D. Our network is spread out worldwide and comprises cooperation projects, research assignments, and the education of expert staff.

GEORG-AUGUST-UNIVERSITÄT GÖTTINGEN

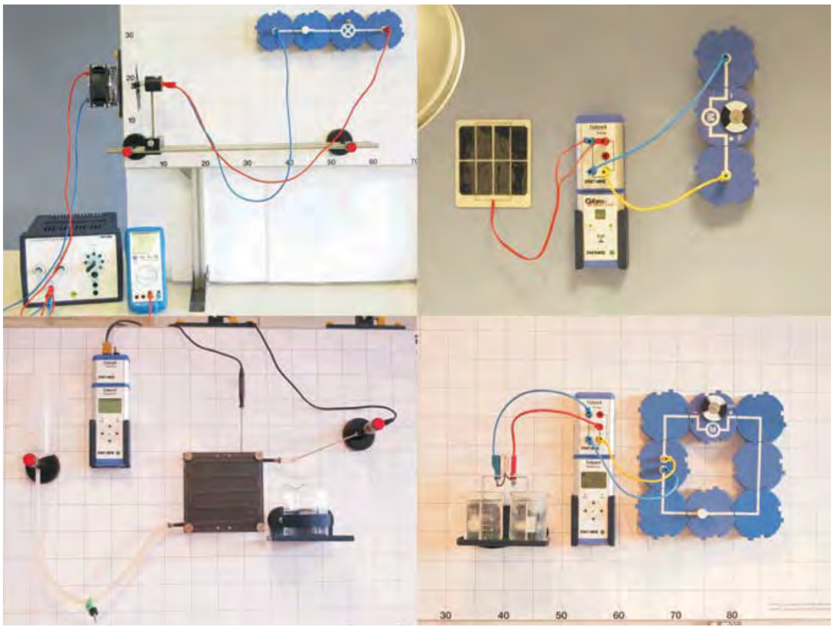
HOCHSCHULE FÜR ANGEWANDTE WISSENSCHAFT UND KUNST HILDESHEIM/HOLZMINDEN/GÖTTINGEN FACULTY OF NATURAL SCIENCES AND TECHNOLOGY HAWK

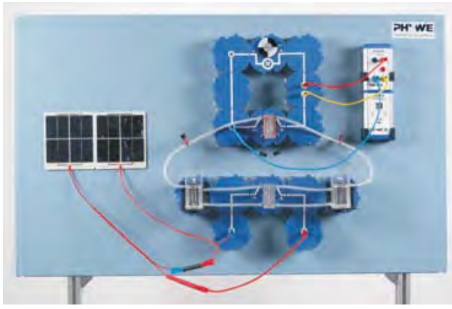
Some breathtaking novelties of our new XR 4.0 plattform are one by one the result of fruitful cooperation in this regard - thank you!

XLAB Göttinger Experimentallabor für junge Leute e.V.

Renewable Energy

09492-88 Demo Applied Sciences Set Renewable Energy ENT1





Function and Applications

Set 1 of 2 to perform more than 30 demo board experiments in the field of energy and sustainable energy sources:

conversion, storage, solar (voltaic, thermal), wind, water, geothermal energy, topics as the greenhouse effect and thermal insulation, hydrogen and fuel cell technology, concentrated solar power technology (CSP).

Benefits

- In combination with set 2 more than 30 experiments can be performed
- Complete set: easy set-up of the experiments to all relevant topics in the field of renewable energy
- Corresponding students kits available (13287-88, 13288-88): for flexible and competence-oriented science classes
- More than 90% of the experiments with computer based part: for modern and up-to-date sciences classes
- Matched to international curriculum: all subjects are covered
- High quality detailed descriptions with quick orientation guide, reference to everyday live and to corresponding student experiments
- Safe storage: durable, easy to store (stackable), quick control of completeness (foam insert)

Equipment and technical data

Selected parts:

- Solar Cells / Batteries
- Thermogenerator
- Electric Building Blocks
- Wind Generator / Turbine
- Solar Collector

Including storage boxes with insert foam, (mm): 130 × 410 × 545

Supplementary Set

Demo Applied Sciences Set Renewable Energy ENT2

09493-88

Literature

Demo advanced Applied Sciences manual Renewable Energy on the magnetic board

01157-02

Cobra4 extension Set

Cobra4 wireless, extension set for renewable energy: electric parameters, temperature

12608-88

Thermal and electrical conductivity of metals — P2350200

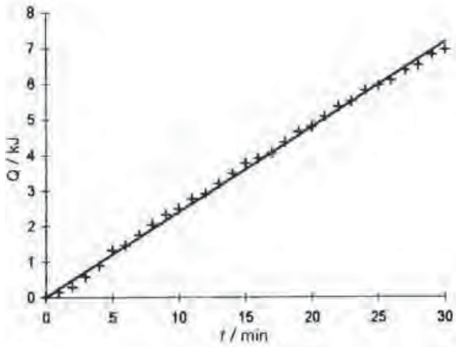


Diagram: Heat of surroundings over time.

Principle

The thermal conductivity of copper and aluminium is determined in a constant temperature gradient from the calorimetrically measured heat flow.

The electrical conductivity of copper and aluminium is determined, and the Wiedmann-Franz law is tested.

Tasks

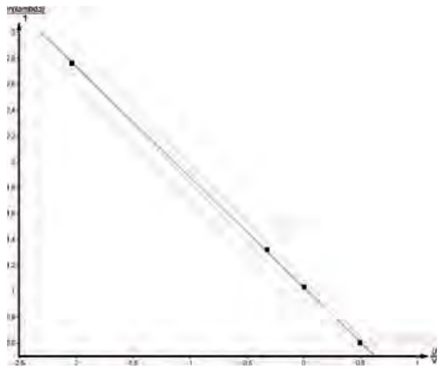
1. Determine the heat capacity of the calorimeter in a mixture experiment as a preliminary test.
2. Measure the calefaction of water at a temperature of 0 °C in a calorimeter due to the action of the ambient temperature as a function of time.
3. To begin with, establish a constant temperature gradient in a metal rod with the use of two heat reservoirs (boiling water and ice water). After removing the pieces of ice, measure the calefaction of the cold water as a function of time and determine the thermal conductivity of the metal rod.
4. Determine the electrical conductivity of copper and aluminium by recording a current-voltage characteristic line.
5. Test of the Wiedmann-Franz law.

What you can learn about

- Electrical conductivity
- Wiedmann-Franz law
- Lorenz number
- Diffusion
- Temperature gradient
- Heat transport
- Specific heat
- Four-point measurement

Main articles		
Temperature meter digital, 4-2	13617-93	1
Universal measuring amplifier	13626-93	1
Multitap transformer, 14 VAC/ 12 VDC, 5 A	13533-93	1
Rheostat, 10 Ohm , 5.7A	06110-02	1
Heat conductivity rod, Cu	04518-11	1
Magnetic stirrer Mini / MST	47334-93	1
Temp. probe, immersion type, Pt100, stainless steel, -20...+300°C	11759-01	1

P3010701 Thermal conductivity of gases



Calibration curve fot the determination of coefficients of thermal conductivity.

Principle

The thermal conductivity of different gases are measured with a gas-chromatographic thermal conductivity detector under stationary conditions. The electrical measurement parameter, which is obtained as a voltage signal in the experimental setup, is proportional to the logarithm of the coefficent of thermal conductivity.

Tasks

1. Measure the thermal conductivity of different gases.
2. Prepare a calibration curve by making a semi-logarithmic plot of the tabulated thermal-conductivity values against the measurement signals.

What you can learn about:

- Thermal conductivity
- Coefficient of thermal conductivity
- Thermal-conductivity detector
- Gas chromatography

Main articles		
Control unit gas chromatograph	36670-99	1
Multirange meter with amplifier	07042-00	1
Steel cylinder helium, 2 l, filled	41776-00	1
Mesure probe for gas chromatograph, BNC contact	36670-10	1
Reducing valve for C02 / He	33481-00	1
Table stand for 2 l steel cylinders	41774-00	1
Silicone oil 500 ml	31849-50	1

Control unit gas chromatograph

Function and Applications

For voltage supply and for equalisation of the measure probe for gas chromatograph.

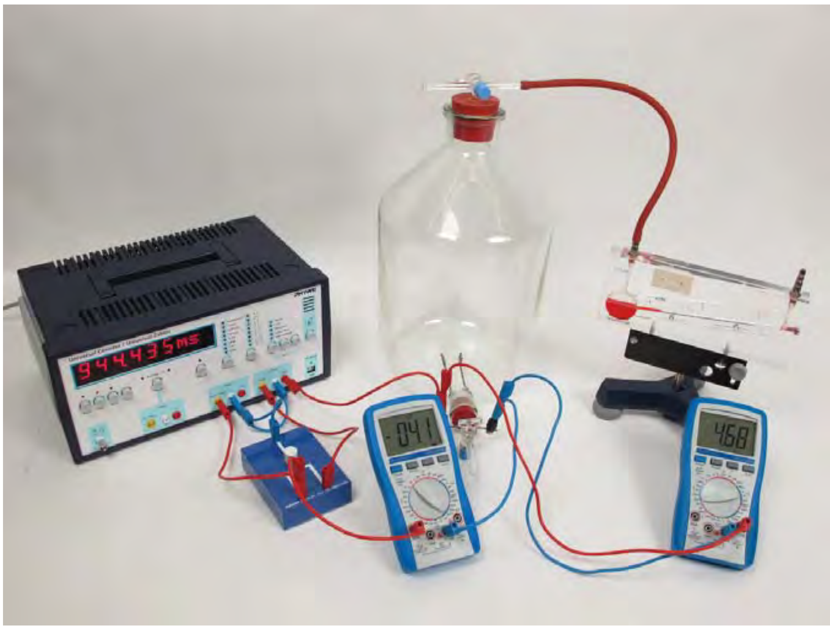
Eqipment and technical data

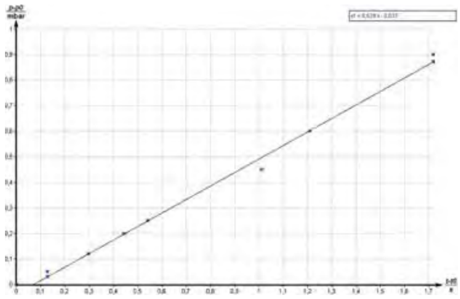
- Zero balance: Push button for rough balance, potentiometer for fine balance
- Input: BNC sockets for probe
- Output: 4-mm sockets for display device (e.g. interface)
- Dimensions (mm): 225 × 113 × 125
- Voltage supply: 110...230 V AC

36670-99

Heat capacity of gases

P2320201





Pressure change p as a function of the heat-up time t. U = 4.59 V, I = 0.43 A.

Principle

Heat is added to a gas in a glass vessel by an electric heater which is switched on briefly. The temperature increase results in a pressure increase, which is measured with a manometer. Under isobaric conditions a temperature increase results in a volume dilatation, which can be read from a gas syringe. The molar heat capacities C_V and C_p are calculated from the pressure or volume change.

Task

Determine the molar heat capacities of air at constant volume C_V and at constant pressure C_p.

What you can learn about

- Equation of state for ideal gases
- First law of thermodynamics
- Universal gas constant
- Degree of freedom
- Mole volumes
- Isobars
- Isotherms
- Isochors and adiabatic changes of state

Main articles		
Universal Counter	13601-99	1
Precision manometer	03091-00	1
Weather station, wireless	04854-00	1
Mariotte flask, 10 l	02629-00	1
Tripod base PHYWE	02002-55	1
Digital multimeter 2010	07128-00	2
Two-way switch, single pole	06030-00	1

Related Experiment

Specific heat capacity of water (with Cobra4)

P1043960

Cobra4 Experiments - available 2013

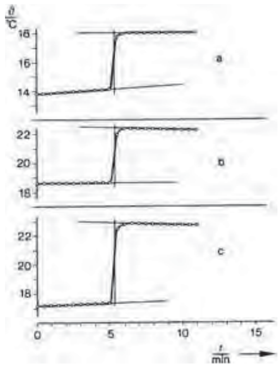
Heat capacity of metals (with Cobra4)

P2330160

Heat capacity of gases (with Cobra4)

P2320260

P2330101 Heat capacity of metals



Temperature as a function of time in the method of mixtures experiment a) steel, b) brass, c) aluminium.

Principle

Heated specimens are placed in a calorimeter filled with water at low temperature. The heat capacity of the specimen is determined from the rise in the temperature of the water.

Tasks

1. To determine the specific heat capacity of aluminium, iron and brass.
2. To verify Dulong Petit's law with the results of these experiments.

What you can learn about

- Mixture temperature
- Boiling point
- Dulong Petit's law
- Lattice vibration
- Internal energy
- Debye temperature

Main articles		
Calorimeter, 500 ml	04401-00	1
Aneroid barometer	03097-00	1
Butane burner, Labogaz 206 type	32178-00	1
Thermometer -10...+50 °C	38034-00	1
Stopwatch, digital, 1/100 s	03071-01	1
Metal bodies, set of 3	04406-00	4
Set of Precision Balance Sartorius TE 601 and measure software balances,230V	48837-88	1

Cobra4 Experiment - available 2013

Heat capacity of metals (with Cobra4)

P2330160

Calorimeter, 500 ml

Function and Applications

For determination of the specific heat capacities of solid state bodies and liquids.

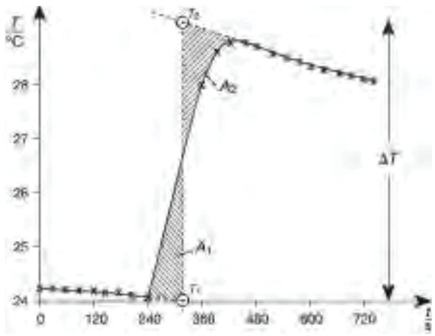
Equipment and technical data

- Calorimeter, 500 ml.
- Aluminium vessel in container with heat insulation.
- Cover with stirrer. 4 mm sockets for power supply.
- Spiral heating resistance: approx. 2.4 Ohm.
- Diameter: 134 mm. Height: 160 mm.

04401-00

Mechanical equivalent of heat

P2330200



Temperature-time diagram for a measurement example.

Principle

In this experiment, a metal test body is rotated and heated by the friction due to a tensed band of synthetic material.The mechanical equivalent of heat for problem 1 is determined from the defined mechanical work and from the thermal energy increase deduced from the increase of temperature. Assuming the equivalence of mechanical work and heat, the specific thermal capacity of aluminium and brass is determined.

Tasks

1. Determination of the mechanical equivalent of heat.
2. Determination of the specific thermal capacity of aluminum and brass.

What you can learn about

- Mechanical equivalent of heat
- Mechanical work
- Thermal energy
- Thermal capacity
- First law of thermodynamics
- Specific thermal capacity

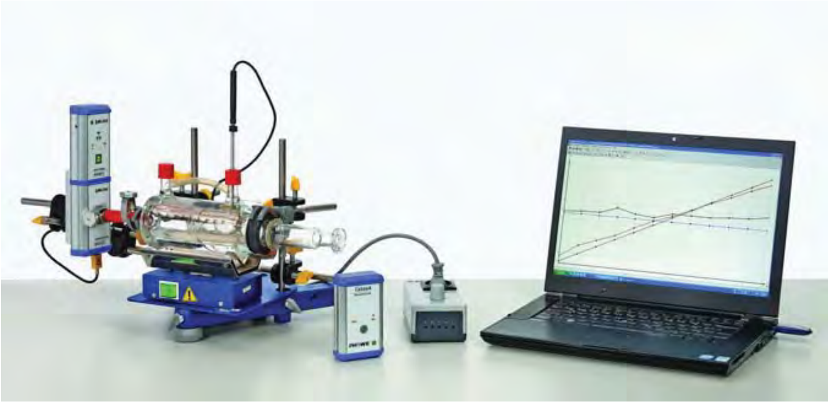
Main articles		
Mechanical equiv.of heat app.	04440-00	1
Friction cylinder CuZn, m 1.28 kg	04441-02	1
Spring balance 100 N	03060-04	1
Friction cylinder Al, m 0.39 kg	04441-03	1
Spring balance 10 N	03060-03	1
Bench clamp PHYWE	02010-00	1
Commercial weight, 2000 g	44096-78	1

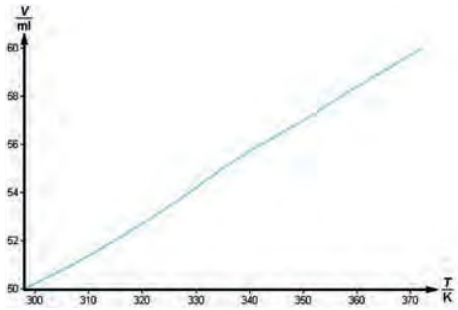
Cobra4 Experiment - available 2013

Mechanical equivalent of heat (with Cobra4)

P2330260

P3011160 Gay-Lussac's law (with Cobra4)





Dependence of the volume on the temperature under isobaric conditions.

Principle

The state of a gas is determined by temperature, pressure and amount of substance. For the limiting case of ideal gases, these state variables are linked via the ideal gas law. For a change of state under isobaric conditions this equation converts Gay-Lussac's first law.

Tasks

1. Experimentally investigate the validity of Gay-Lussac's law for a constant amount of gas (air).
2. Calculate the universal gas constant and the thermal coefficient of expansion from the relationship obtained.

What you can learn about

- Pressure; Temperature; Volume
- Coefficient of thermal expansion
- Ideal gas law; Universal gas constant
- Gay-Lussac's law

Main articles		
Set Gas laws with glass jacket system and Cobra4	43020-00	1
Cobra4 Remote-Link	12602-00	1

Related Experiments

Amontons' law (with Cobra4)

P3011260

Boyle's law (with Cobra4)

P3011360

Set Gas laws with glass jacket system and Cobra4

Function and Applications

Complete device compilation for a comfortable way to derive the ideal gas laws experimentally with help of the Cobra4 Senor-Unit Thermodynamics and the glass jacket system.

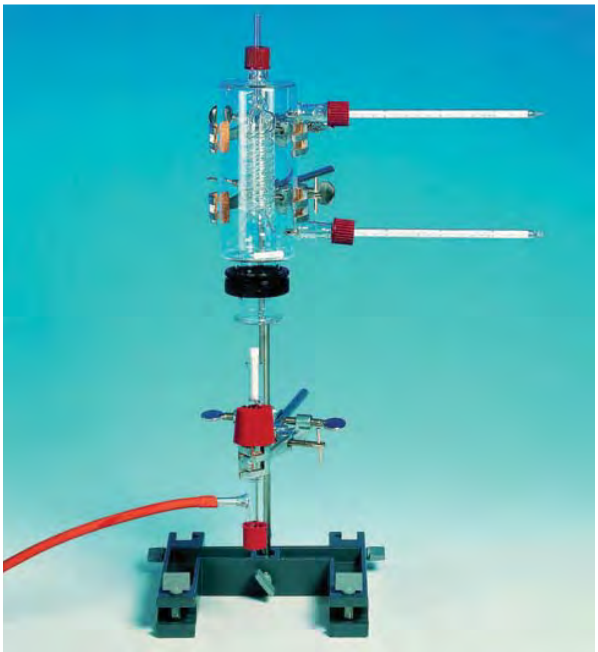
Equipment and technical data

The set consists of:

- 1 Cobra4 Wireless Manager. 1 Cobra4 Wireless-Link
- 1 Cobra4 Sensor-Unit Thermodynamics, pressure absolute 2 bar and 2 x temperature
- 1 Software measure Cobra4, single user and school licence
- 1 Glass jacket; 1 Gas syringe 100 ml
- 1 Heater for Glass jacket
- 1 Immersion probe NiCr-Ni, -50...1000 °C

43020-00

Determination of the heating value of fuel oil and of the calorific value of olive oil — P3021701



$$H = \frac{(m_W \cdot c_W + C_{cal}) \cdot \Delta T}{m}$$

Equation to calculate the calorific value (of fuels) and the gross calorific value (of foodstuffs).

Principle

The heat of reaction generated during the complete combustion of 1000 g of solid or liquid fuel is known as the calorific value *H*. In the case of complete combustion of nutritional fats, the gross calorific value can also be determined. In order to ensure complete combustion, the reaction takes place under oxygen. The heat generated during the combustion of a specific amount of fuel is absorbed by a glass jacket calorimeter of known heat capacity. The calorific value of the test substance can be calculated from the temperature increase in the calorimeter.

Task

Determine the calorific value of heating oil and the gross calorific value of olive oil.

What you can learn about

- Heat of reaction
- Heat of combustion
- Enthalpy of combustion
- First law of thermodynamics

Main articles		
Glass jacket	02615-00	1
Steel cylinder oxygen, 2 l, filled	41778-00	1
Calorimeter insert for glass jacket	02615-01	1
Reducing valve for oxygen	33482-00	1
Table stand for 2 l steel cylinders	41774-00	1
Set of Precision Balance Sartorius CPA 623S and measure software, 230 V	49224-88	1

Calorimeter insert for glass jacket

Function and Applications

Calorimeter insert for glass jacket.

Benefits

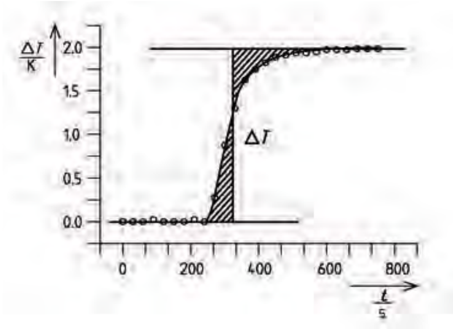
- It can determine calorific values, heat of combustion and enthalpies of gaseous, liquid and solid substances.
- Combustion chamber with a circular cross section, rotating double helix as a heat exchanger

Equipment and technical data

- Total length: 280 mm
- Combustion chamber length: 90 mm
- Outer combustion chamber: 36 mm
- Length of the approach pipe: 70 mm
- OD approach pipe: 8 mm

02615-01

P3021401 Determination of the enthalpy of combustion with a calorimetric bomb



Determining the corrected temperature difference.

Principle

The bomb calorimeter is used to completely burn substances in an excess of oxygen. The heat of combustion released is absorbed by the calorimetric vessel in which the bomb is immersed, and results in a temperature increase ΔT. The heat capacity of the system is first determined by adding a defined amount of heat from the combustion of benzoic acid. The combustion of the naphthalene is subsequently performed under the same conditions.

Tasks

1. Determine the enthalpy of combustion of naphtalene using a bomb calorimeter.
2. Calculate the enthalpy of formation of naphthalene from the enthalpy of combusting unsing Hess' law.

What you can learn about

- First law of thermodynamics
- Hess' law of constant heat summation
- Enthalpy of combustion
- Enthalpy of formation
- Heat capacity

Main articles		
Calorimetric bomb	04403-00	1
Temperature meter digital, 4-2	13617-93	1
Power supply, universal	13500-93	1
Magnetic stirrer MR Hei-Standard	35750-93	1
Calorimeter, transparent, volume appr. 1200 ml	04402-00	1
Set of Precision Balance Sartorius CPA 6202S and measure software, 230 V	49226-88	1
Set of Precision Balance Sartorius CPA 623S and measure software, 230 V	49224-88	1

Calorimetric bomb

Function and Applications

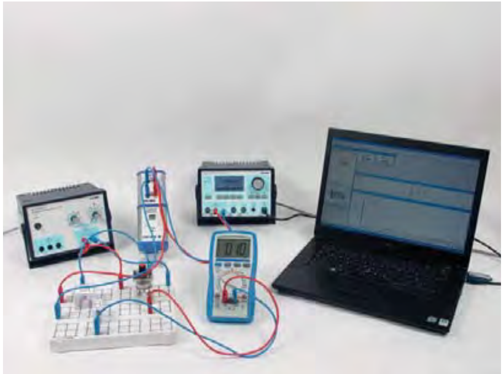
Calorimetric bomb for the quantitative determination of combustion heat of liquid and solid organic substances under high oxygen pressure.

Equipment and technical data

- Stainless steel body
- Contents approx. 120 ml
- Stainless steel lid with valve
- Oxygen filling connection
- Max. oxygen pressure 25 bar
- Ignition wire

04403-00

Characteristic curves of semiconductors (with Cobra4) P2410960



Principle

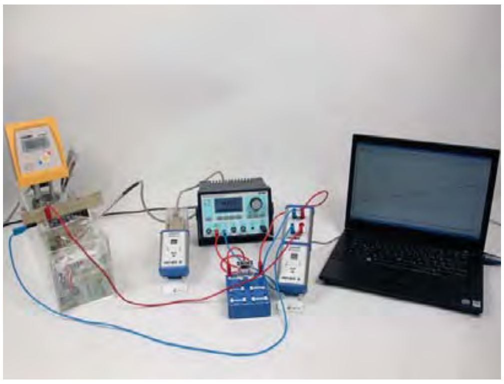
Determine the current strength flowing through a semi-conducting diode. Determine the collector current with the collector voltage for various values of the base current intensity.

Tasks

1. To investigate the dependence of the current strength flowing through a semi-conducting diode.
2. To determine the variations of the collector current with the collector voltage for varios values of the base current intensity.

For more details refer to page 111.

Temperature dependance of different resistors and diodes (with Cobra4) P2410460



Principle

The temperature dependence of an electrical parameter (e.g. resistance, conducting-state voltage, blocking voltage) of different components is determined. To do this, the immersion probe set is immersed in a water bath and the resistance is measured at regular temperature intervals.

Tasks

1. Measurement of the temperature dependence of the resistance of different electrical components.
2. Measurement of the temperature dependence of the conducting state voltage of semiconducting diodes.

For more details refer to pages 53, 112.

Hall effect in p-germanium (with Cobra3) P2530111

Principle

The resistivity and Hall voltage of a rectangular germanium sample are measured as a function of temperature and magnetic field. The band spacing, the specific conductivity, the type of charge carrier and the mobility of the charge carriers are determined from the measurements.

Task

The Hall voltage is measured at room temperature and constant magnetic field as a function of the control current and plotted on a graph (measurement without compensation for defect voltage).

For more details refer to www.phywe.com

Transformer

P2440100

Principle

An alternating voltage is applied to one of two coils (primary coil) which are located on a common iron core. The voltage induced in the second coil (secondary coil) and the current flowing in it are investigated as functions of the number of turns in the coils and of the current flowing in the primary coil.

Tasks

The secondary voltage on the open circuited transformer is determined as a function

1. Of the number of turns in the primary coil.
2. Of the number of turns in the secondary coil.
3. Of the primary voltage.

For more details refer to page 123.

Charging curve of a capacitor / charging and discharging of a capacitor

P2420201

Principle

A capacitor is charged by way of a resistor. The current is measured as a function of time and the effects of capacitance, resistance and the voltage applied are determined.

Tasks

To measure the charging current over time:

1. using different capacitance values C, with constant voltage U and constant resistance R
2. using different resistance values (C and U constant)
3. using different voltages (R and C constant).

For more details refer to page 114.

Switch-on behaviour of a capacitor and an inductance with the FG module (with Cobra3)

P2420715

Principle

To measure the course of current strength and voltage in a capacitance/inductivity in the instant of switching on. The capacitance/inductivity is determined from the measurement curve.

Tasks

1. To measure the course of current strength and voltage in a capacitance in the instant of switching on. The capacitance is determined from the measurement curve.
2. To measure the course of current strength and voltage in inductivity in the instant of switching on. The inductivity is determined from the measurement curve.

For more details refer to page 115.

Dielectric constant of different materials — P2420600

Principle

The electric constant is determined by measuring the charge of a plate capacitor to which a voltage is applied. The dielectric constant is determined in the same way, with plastic or glass filling the space between the plates.

Tasks

1. The relation between charge Q and voltage U is to be measured using a plate capacitor.
2. The electric constant is to be determined from the relation measured under point 1.

For more details refer to pages 57, 113.

Electric fields and potentials in the plate capacitor — P2420100

Principle

A uniform electric field E is produced between the charged plates of a plate capacitor. The strength of the field is determined with the electric field strength meter, as a function of the plate spacing d and the voltage U. The potential φ within the field is measured with a potential measuring probe.

Tasks

1. The relationship between voltage and electric field strength is investigated, with constant plate spacing.
2. The relationship between electric field strength and plate spacing is investigated, with constant voltage.

For more details refer to www.phywe.com

Nernst equation (with Cobra4) — P3060962

NEW

C4

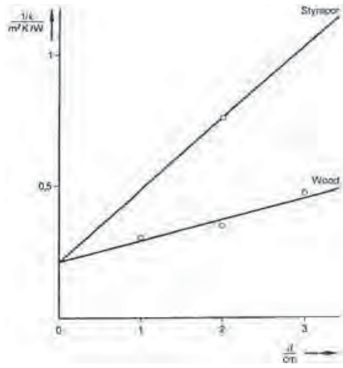
Principle

The Nernst equation expresses how the electrical potential of an electrode in contact with a solution of ions depends upon the concentrations (more accurately, activities) of those ions. The equation may be experimentally verified using an electrochemical cell formed from an inert indictator electrode coupled with a convenient reference electrode. The potential of the indicator electrode, and hence the e.m.f. of the cell, is monitored as the ionic composition of the electrolyte solution is changed.

For more details refer to page 127.

P2360360 Heat insulation / heat conduction

C4



Heat transition resistance 1/*k* as a function of the wall thickness *d*.

Principle

A model house with replaceable side walls is used for determining the heat transition coefficients (*k* values) of various walls and windows and for establishing the heat conductivities of different materials. For this purpose the temperatures on the inside and outside of the walls are measured at a constant interior and outer air temperature (in the steady state).

With a multilayer wall structure the temperature difference over a layer is proportional to the particular thermal transmission resistance. The thermal capacity of the wall material affects the wall temperatures during heating up and temporary exposure to solar radiation.

Tasks

1. Measurement and interpretation of water temperatures during the heating up and during temporary external illumination of the walls.
2. Determination of the heat conductivities of wood and polystyrene.
3. Determination of the *k* values of ordinary glass and insulating glass windows and of wooden walls of different thicknesses, and of walls with wood, polystyrene or cavity layers.

What you can learn about

- Heat transition; Heat transfer; Heat conductivity
- Thermal radiation
- Hothouse effect
- Thermal capacity
- Temperature amplitude attenuation

Main articles		
High insulation house	04507-93	1
Thermal regulation for high insulation house	04506-93	1
Cobra4 Mobile-Link set, incl. rechargeable batteries, SD memory card, USB cable and software "measure"	12620-55	2
Cobra4 Sensor-Unit 2 x Temperature, NiCr-Ni	12641-00	2
Thermocouple NiCr-Ni, -50...500°C	13615-02	4

High insulation house

Function and Applications

Device for quantitative experiments with thermal insulation.

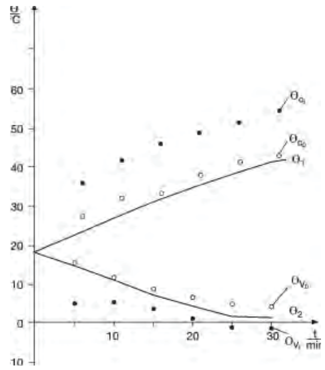
Equipment and technical data

- The high insulation house consists of a thermally insulated base rack with removable lid, measuring walls, exterior insulation and heating.
- Basic rack: ground insulated through a 5 cm thick Styrofoam plate.
- Side walls with square apertures (210 mm × 210 mm).
- The measuring walls are set in from the inside and pressed by two screws against the aperture gasket.
- Each of the exterior walls carry a profile and a small eccentric plate to hold supplementary insulating material.
- Every angle pillar has a hole to introduce temperature probes.
- The hole is sealed off with foam material.
- Lid insulated by a 5 cm thick Styrofoam plate, fixed to the angle pillars of the base rack with 4 knurled screws which cannot be lost.
- Casing dimensions (mm): 400 × 400 × 400 .

04507-93

Electric compression heat pump

P2360200



Temperatures at the inlet and outlet of the vaporiser Vi, Vo and condenser Ci, Co as a function of the operating time; continuous curves: temperature in water reservoirs.

Principle

Pressures and temperatures in the circulation of the heat electrical compression heat pump are measured as a function of time when it is operated as a water-water heat pump.

The energy taken up and released is calculated from the heating and cooling of the two water baths.

When it is operated as an air-water heat pump, the coefficient of performance at different vaporiser temperatures is determined.

Tasks

1. Water heat pump: To measure pressure and temperature in the circuit and in the water reservoirs on the condenser side and the vaporiser side alternately. To calculate energy taken up and released, also the volume concentration in the circuit and the volumetric efficiency of the compressor.
2. Air-water heat pump: To measure vaporiser temperature and water bath temperature on the condenser side under different operating conditions on the vaporiser side,

- with stream of cold air
- with stream of hot air
- without blower.

If a power meter is available, the electric power consumed by the compressor can be determined with it and the coefficient of performance calculated.

What you can learn about

- Refrigerator; Compressor
- Restrictor valve; Cycle
- Vaporization; Condensation
- Vapour pressure; Vaporisation enthalpy

Main articles

Heat pump, compressor principle	04370-88	1
Work and power meter	13715-93	1
Tripod base PHYWE	02002-55	1
Hot/cold air blower, 1800 W	04030-93	1

Work and power meter

Function and Applications

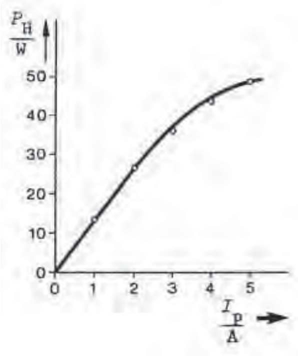
For AC and DC circuits.

Equipment and technical data

- Two 4-digit, 20 mm LED-displays
- Display 1 for real and apparent power, current, voltage, phase difference and freqency
- Display 2 for energy and time; Selector for serial display of all units
- LED-Status-display and automactic range selection
- Power: max. 2400 W; Resolution: max. 0.001 W
- Voltage: 0-30V AC/DC, 0-240; Veff- Current: 0...10A AC/DC
- Phasen difference: 0...+/- 90 degree; Frequency: 0...10000 Hz
- Energy: max. 9999 Wh or Ws; Resolution: max. 0.001 Ws
- Analog output for all units of disp. 1; Mains: 110/230V, 50/60Hz
- Shock-resistant plastic housing with carry handle and base

13715-93

P2410800 Peltier heat pump



Pump cooling capacity as a function of the operating current.

Principle

The (cooling capacity) heating capacity and efficiency rating of a Peltier heat pump are determined under different operating conditions.

Tasks

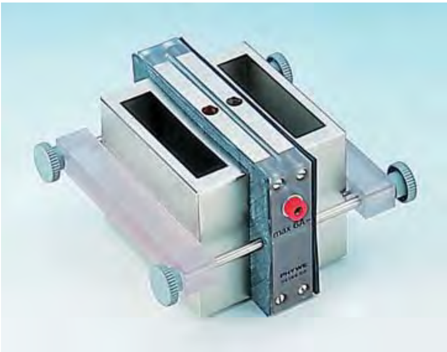
1. To determine the cooling capacity Pc the pump as a function of the current and to calculate the efficiency rating hc at maximum output.
2. To determine the heating capacity Pw of the pump and its efficiency rating hw at constant current and constant temperature on the cold side.
3. To determine Pw, η w and Pc , ηc from the relationship between temperature and time on the hot and cold sides.
4. To investigate the temperature behaviour when the pump is used for cooling, with the hot side air-cooled.

What you can learn about

- Peltier effect; Heat pipe; Thermoelectric e. m. f.
- Peltier coefficient; Cooling capacity; Heating capacity
- Efficiency rating; Thomson coefficient; Seebeck coefficient
- Thomson equations; Heat conduction; Convection
- Forced cooling; Joule effect

Main articles		
Thermogenerator with 2 water baths	04366-00	1
Power supply, universal	13500-93	1
Rheostat, 33 Ohm , 3.1A	06112-02	1
Flow-through heat exchanger	04366-01	1
Air cooler	04366-02	1

Thermogenerator with 2 water baths



Function and Applications

To commute thermal energy into electrical energy directly and for operation as heat pump. Also been used to demonstrate the Seebeck effect and the Peltier effect.

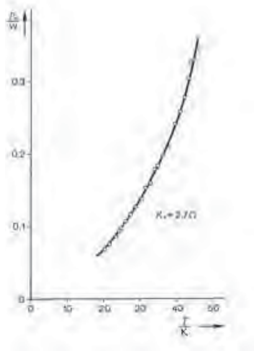
Equipment and technical data

- Generator block consisting of two nickel coated copper plates with hole for thermometer, between these, p- and n-conducting silicon thermocouples, connected thermally parallel and electrically in series.
- Two water containers with open sides, which are used as heat reservoirs, are screwed to the generator block. They can be exchanged for flowthrough heat exchanger or air cooler.
- Standard accessories: 2 open water containers (brass, nickel coated); 2 rubber gaskets; 2 clamping jaws and 4 knurled screws.

04366-00

Semiconductor thermogenerator – Seebeck effect

P2410700



Electrical power generated as a function of the temperature difference.

Principle

In a semi-conductor thermogenerator, the no-load voltage and the short-circuit current are measured as a function of the temperature difference. The internal resistance, the Seebeck coefficient and the efficiency are determined.

Tasks

1. To measure no-load voltage Uo and short-circuit current Is at different temperature differences and to determine the Seebeck coefficient.
2. To measure current and voltage at a constant temperature difference but with different load resistors, and to determine the internal resistance R_i from the measured values.
3. To determine the efficiency of energy conversion, from the quantity of heat consumed and the electrical energy produced per unit time.

What you can learn about

- Seebeck effect (thermoelectric effect)
- Thermoelectric e.m.f.
- Efficiency
- Peltier coefficient
- Thomson coefficient
- Seebeck coefficient
- Direct energy conversion
- Thomson equations

Main articles

Thermogenerator with 2 water baths	04366-00	1
Immersion thermostat Alpha A, 230 V	08493-93	1
Rheostat, 33 Ohm , 3.1A	06112-02	1
Voltmeter,0.3-300VDC,10-300VAC /	07035-00	1
Bath for thermostat, Makrolon	08487-02	1
Ammeter 1/5 A DC	07038-00	1
Flow-through heat exchanger	04366-01	2

Flow-through heat exchanger

Function and Applications

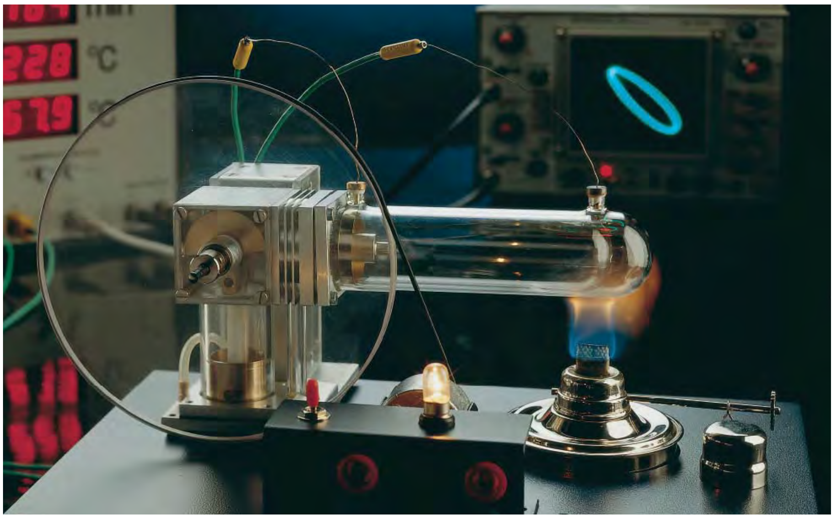
To generate a constant temperature with running water.

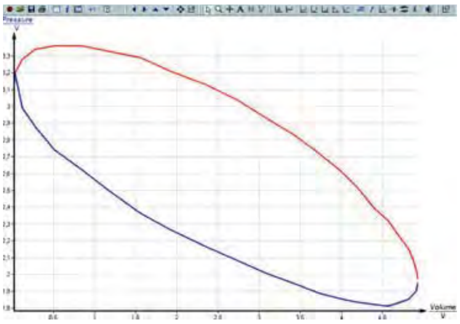
Equipment and technical data

- Nickel coated brass with tubing olives; is fastened to the generator block of the thermo generator in place of a water container.
- When using the thermo generator as a Peltier heat pump to generate low temperatures (about -15 °C), the warm side is cooled.
- Dimensions (mm): 28 × 70 × 94.

04366-01

P2360401 Stirling engine with an oscilloscope





Pressure as a function of volume for the Stirling process.

Principle

The Stirling engine is submitted to a load by means of an adjustable torquemeter, or by a coupled generator. Rotation frequency and temperature changes of the Stirling engine are observed. Effective mechanical energy and power, as well as effective electrical power, are assessed as a function of rotation frequency. The amount of energy converted to work per cycle can be determined with the assistance of the pV diagram. The efficiency of the Stirling engine can be estimated.

Tasks

1. Determination of the burner's thermal efficiency.
2. Calibration of the sensor unit.
3. Calculation of the total energy produced by the engine through determination of the cycle area on the oscilloscope screen, using transparent paper and coordinate paper.
4. Assessment of the mechanical work per revolution, and calculation of the mechanical power output as a function of the rotation frequency, with the assistance of the torque meter.
5. Assessment of the electric power output as a function of the rotation frequency.
6. Efficiency assessment.

What you can learn about

- First and second law of thermodynamics; Reversible cycles; Isochoric and isothermal changes
- Gas laws; Efficiency; Stirling engine; Conversion of heat; Thermal pump

Main articles		
Meter for Stirling engine, pVnT	04371-97	1
Stirling engine transparent	04372-00	1
30 MHz digital storage oscilloscope with colour display, 2 x BNC cables l =75 cm incl.	11462-99	1
Sensor unit pVn for Stirling engine	04371-00	1
Torque meter	04372-02	1
Motor/ generator unit	04372-01	1
Rheostat, 330 Ohm , 1.0A	06116-02	1

Cobra4 Experiment - available 2013

Stirling engine (with Cobra4)

P2360460

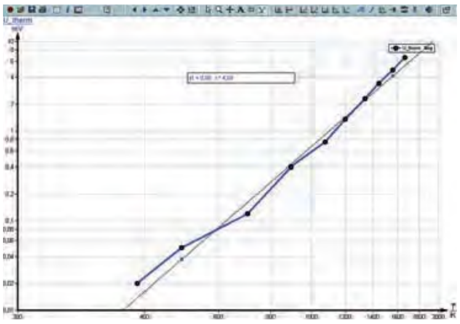
Meter for Stirling engine, pVnT

Function and Applications

To display temperature and number of revolutions per minute and for the output of analogue voltages for Stirling motor pressure and volume.

04371-97

Stefan-Boltzmann's law of radiation with an amplifier P2350101



Thermoelectric e. m. f. of thermopile as a function of the filament's absolute temperature.

Principle

According of Stefan-Boltzmann's law, the energy emitted by a black body per unit area and unit time is proportional to the power "four" of the absolute temperature of the body. Stefan-Boltzmann's law is also valid for a so-called "grey" body whose surface shows a wavelength independent absorption-coefficient of less than one. In the experiment, the "grey" body is represented by the filament of an incandescent lamp whose energy emission is investigated as a function of the temperature.

Tasks

1. To measure the resistance of the filament of the incandescent lamp at room temperature and to ascertain the filament's resistance R_0 at zero degrees centrigrade.
2. To measure the energy flux density of the lamp at different heating voltages. The corresponding heating currents read off for each heating voltage and the corresponding filament resistance calculated. Anticipating a temperature-dependency of the second order of the filament-resistance, the temperature can be calculated from the measured resistances.

What you can learn about

- Black body radiation
- Thermoelectric e. m. f.
- Temperature dependence of resistances

Main articles		
Universal measuring amplifier	13626-93	1
Thermopile, Moll type	08479-00	1
Power supply variable 15 VAC/ 12 VDC/ 5 A	13530-93	1
Optical profile bench l = 60 cm	08283-00	1
Digital multimeter 2010	07128-00	3
Slide mount for optical bench, h = 30 mm	08286-01	2
Lamp holder E 14,on stem	06175-00	1

Cobra4 Experiment - available 2013

Stefan-Boltzmann's law of radiation (with Cobra4)

P2350160

Universal measuring amplifier

Function and Applications

Universal measuring amplifier for amplification of AC and DC voltages. Suitable for practical exercises.

13626-93

P2360100 Solar ray collector

No.	Glass plate	Light	Cold air	$\frac{\vartheta_{in}}{°C}$	$\frac{\vartheta_{out}-\vartheta_{in}}{K}$	$\frac{\eta}{\%}$
1.1	+*	–	–	≈ 5	2.5	15
1.2	–*	–	–	≈ 5	5.0	29
2.1	+	+	–	≈ 20	11.0	64
2.2	–	+	–	≈ 20	12.5	73
3.1	+	+	–	≈ 50	8.0	47
3.2	–	+	+	≈ 50	8.0	47
3.3	+	+	–	≈ 50	6.0	35
3.4	–	+	+	≈ 50	3.0	17

Water temperatures and collector efficiency under various experimental conditions, m = 100 cm^3/min, qi = 1 kW/m^2, A = 0 • 12 m^2.

Principle

The solar ray collector is illuminated with a halogen lamp of known light intensity. The heat energy absorbed by the collector can be calculated from the volume flow and the difference in the water temperatures at the inlet and outlet of the absorber, if the inlet temperature stays almost constant by releasing energy to a reservoir. The efficiency of the collector is determined from this. The measurement is made with various collector arrangements and at various absorber temperatures.

Tasks

To determine the efficiency of the solar ray collector under various experimental conditions.

- Absorption of energy from the environment (20 °C) without illumination by sun or halogen lamp, water temperature at the absorber inlet Te ; 5 °C.

1. Absorber with insulation and glassplate (complete collector).
2. Absorber alone (energy ceiling).

- Illumination with halogen lamp. Water temperature Te; 20 °C.

1. Complete collector.
2. Collector without glass plate.

- Illumination with halogen lamp. Water temperature Te; 50 °C.

1. Complete collector.
2. Complete collector, cold jet of air impinges.
3. Collector without glass plate.
4. Collector without glass plate, cold jet of air impinges.

What you can learn about

- Absorption; Heat radiation; Greenhouse effect
- Convection; Conduction of heat
- Collector equations; Efficiency; Energy ceiling

Main articles

Solar ray collector	06753-00	1
Circulating pump w. flowmeter	06754-01	1
Halogen lamp 1000 W	08125-93	1
Power supply 0...12 V DC/ 6 V, 12 V AC, 230 V	13505-93	1
Heat exchanger	06755-00	1
Solar collector stand, teaching aid	06757-00	1

Solar ray collector

Function and Applications

Compact unit for study of all collector functions.

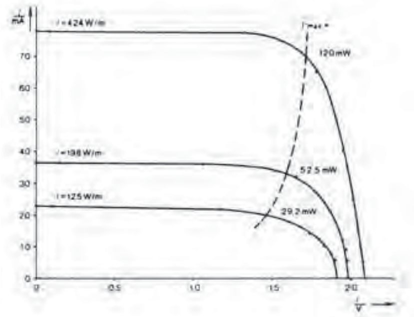
Equipment and technical data

- Flat collector to heat water through absorption of radiation energy or thermal energy from environment.
- Black stainless steel absorbers with 2 temperature measurement points at inlet and outlet.

06753-00

Characteristic curves of a solar cell

P2410901



Current-voltage characteristic at different light intensities J.

Principle

The current-voltage characteristics of a solar cell are measured at different light intensities, the distance between the light source and the solar cell being varied. The dependence of no-load voltage and short-circuit current on temperature is determined.

Tasks

1. To determine the light intensity with the thermopile at various distances from the light source.
2. To measure the short-circuit current and no-load voltage at various distances from the light source.
3. To estimate the dependence of no-load voltage, and short-circuit current on temperature.
4. To plot the current-voltage characteristic at different light intensities.
5. To plot the current-votlage characteristic under different operating conditions: cooling the equipment with a blower, no cooling, shining the light through a glass plate.
6. To determine the characteristic curve when illuminated by sunlight.

What you can learn about

- Semiconductor; p-n junction; Energy-band diagram
- Fermi characteristic energy level; Diffusion potential
- Internal resistance; Efficiency; Photo-conductive effect
- Acceptors; Donors; Valence band; Conduction band

Main articles		
Universal measuring amplifier	13626-93	1
Thermopile, Moll type	08479-00	1
Rheostat, 330 Ohm , 1.0A	06116-02	1
Ceramic lamp socket E27 with reflector, switch, safety plug	06751-01	1
Solar battery, 4 cells, 2.5 x 5 cm	06752-04	1
Tripod base PHYWE	02002-55	2
Digital multimeter 2010	07128-00	2

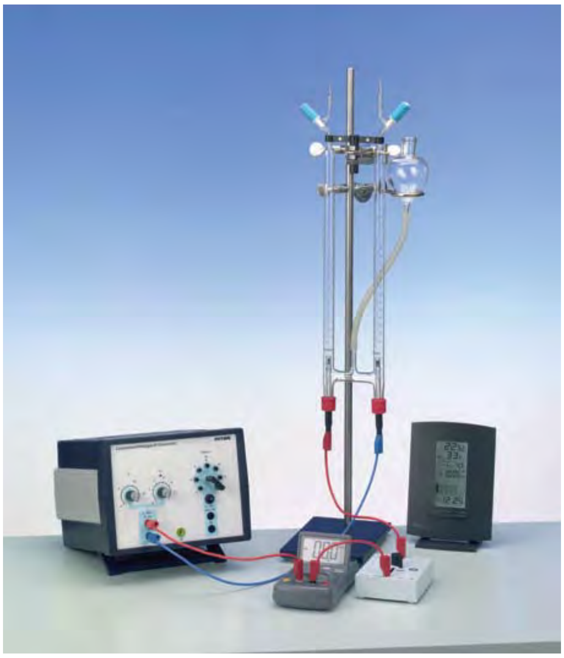
Universal measuring amplifier

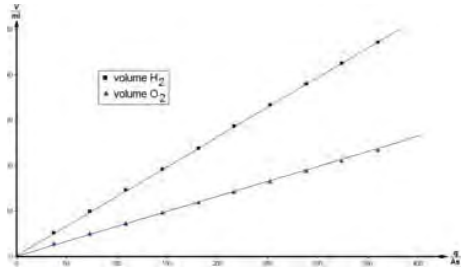
Function and Applications

Universal measuring amplifier for amplification of AC and DC voltages. Suitable for practical exercises.

13626-93

P2411200 Faraday's law





Correlations between the transferred charge and the evolved volumes of hydrogen and oxygen in the electrolysis of diluted sulphuric acid (T = 296.05 K and p = 100.4 kPa).

Principle

The correlation between the amounts of substances transformed in the electrode reaction and the applied charge (amount of electricity) is described by Faraday's law. Faraday ´s constant, which appears as a proportionality factor, can be determined experimentally from this dependence.

Task

Determine Faraday's constant from the dependence of the volumes of hydrogen and oxygen evolved on the applied charge in the hydrolysis of diluted sulphuric acid.

What you can learn about

- Electrolysis
- Coulometry
- Charge
- Amount of substance
- Faraday's law
- Faraday's constant
- Avogadro's number
- General equation of state for ideal gases

Main articles		
Power supply, universal	13500-93	1
Electrolysis apparatus-Hofmann	44518-00	1
Weather monitor, 6 lines LCD	87997-10	1
Digital multimeter 2010	07128-00	1
On/off switch	06034-01	1
Retort stand, h = 750 mm	37694-00	1
Set of Precision Balance Sartorius TE 612 and measure software balances,230V	48836-88	1

Power supply, universal

Function and Applications

Versatile heavy duty power supply which can also be used as a constant current supply in schools, laboratories or workshops.

Equipment and technical data

- Direct current source: Stabilised, regulated output direct voltage, continuously adjustable from 0...18 V
- Adjustable current limit between 0...5 A
- LED display for constant current operation
- Permantely short-circuit proof & protected against exterior voltages
- Alternative voltage output:
- Multitap transformer 2...15 V, outputs galvanically separated from main grid
- Full load capacity (5 A), even if direct current is supplied simultaneously
- Short-circuit protection through overcurrent circuit breaker
- All output voltages available at 4 mm safety plug sockets.

13500-93

Determination of the heat of formation of water

P3021501

$$\Delta n\,(H_2) = \frac{pV}{RT}$$

General equation of state for ideal gases.

Principle

Standard molar enthalpies of formation $\Delta_B H^{\Phi}$ are important compiled thermodynamics tabulation quantities for calculating standard enthalpies of reaction for any arbitrary reaction.

They are defined as the heat of reaction occurring in the direct formation of one mole of the pertinent pure substance from the stable pure elements at constant pressure. For spontaneous and quantitative formation reactions, e.g. the conversion of hydrogen and oxygen to water, standard enthalpies of formation can be measured directly using calorimetry.

Task

Determine the enthalpy of formation of water by burning 100 ml H_2 in a closed glass jacket calorimeter.

What you can learn about

- First law of thermodynamics
- Thermochemistry
- Calorimetry
- Enthalpy of formation
- Enthalpy of reaction

Main articles		
High voltage supply unit, 0-10 kV	13670-93	1
Glass jacket	02615-00	1
Steel cylinder hydrogen, 2 l, full	41775-00	1
Lid for calorimeter insert	02615-02	1
Steel cylinder oxygen, 2 l, filled	41778-00	1
Calorimeter insert for glass jacket	02615-01	1
Set of Precision Balance Sartorius CPA 623S and measure software, 230 V	49224-88	1

Glass jacket

Function and Applications

Glass jacket, used as cooling or heating mantle.

Benefits

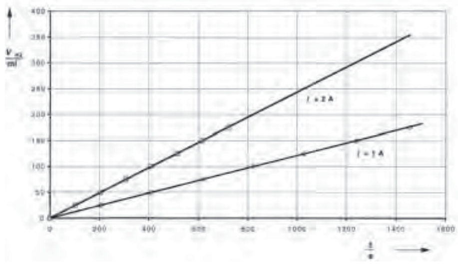
The cylinder is made of DURAN 50 ®, which gave him an extreme heat resistance, high thermal shock resistance, mechanical strength and excellent chemical resistance.

Equipment and technical data

- Cylindrical glasstube with screw closures for different inserts
- Length: 205 mm
- Outer diameter: 75 mm
- Connecting nut and gasket for flanging cylindrical inserts with an outer diameter of 36 mm watertight and airtight
- 1 Flange with ring nut

02615-00

P2411100 Characteristic curve and efficiency of a PEM fuel cell and a PEM electrolyser



Volume of the hydrogen generated by the PEM electrolyser as a function of time at different current I.

Principle

In a PEM electrolyser, the electrolyte consists of a proton-conducting membrane and water (PEM = Proton- Exchange-Membrane). When an electric voltage is applied, hydrogen and oxygen are formed. The PEM fuel cell generates electrical energy from hydrogen and oxygen. The electrical properties of the electrolyser and the fuel cell are investigated by recording a current-voltage characteristic line. To determine the efficiency, the gases are stored in small gasometers in order to be able to measure the quantities of the gases generated or consumed.

Tasks

1. Recording the characteristic line of the PEM electrolyser.
2. Recording the characteristic line of the PEM fuel cell.
3. Determination of the efficiency of the PEM electrolysis unit.
4. Determination of the efficiency of the PEM fuel cell.

What you can learn about

- Electrolysis; Electrode polarisation
- Decomposition voltage; Galvanic elements
- Faraday's law

Main articles

Power supply, universal	13500-93	1
PEM electrolyser	06748-00	1
Cobra4 Mobile-Link set, incl. rechargeable batteries, SD memory card, USB cable and software "measure"	12620-55	1
PEM fuel cell	06747-00	1
Cobra4 Sensor-Unit Weather: Humidity, Air pressure,Temperature, Light intensity, Altitude	12670-00	1
Gas bar	40466-00	1
Digital multimeter 2010	07128-00	2

PEM electrolyser

Function and Applications

For the production of hydrogen and oxygen through electrolysis.

Equipment and technical data

- Electrolyser and storage container for distilled water mounted on a stable baseplate.
- Without use of caustic lyes or acids.
- Only distilled water is used for operating it.
- Voltage input protected against polarity reversal.
- Operating instructions with detailed description of experiment.
- Electrode surface: 16 cm^2. Output: 4 W. Voltage required: 1.7...2 V.

06748-00

About PHYWE

Traditional yet modern
100 years of quality

Those who know nothing must believe everything.

Marie von Ebner-Eschenbach

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The product range comprises scientific equipment, experiments and solution systems along with modern blended learning systems, literature and software for the areas of physics, chemistry, biology, medicine, material science and earth science. A broad spectrum of services such as training programmes, installation and comprehensive consulting services completes the portfolio.

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PHYWE supplies more than
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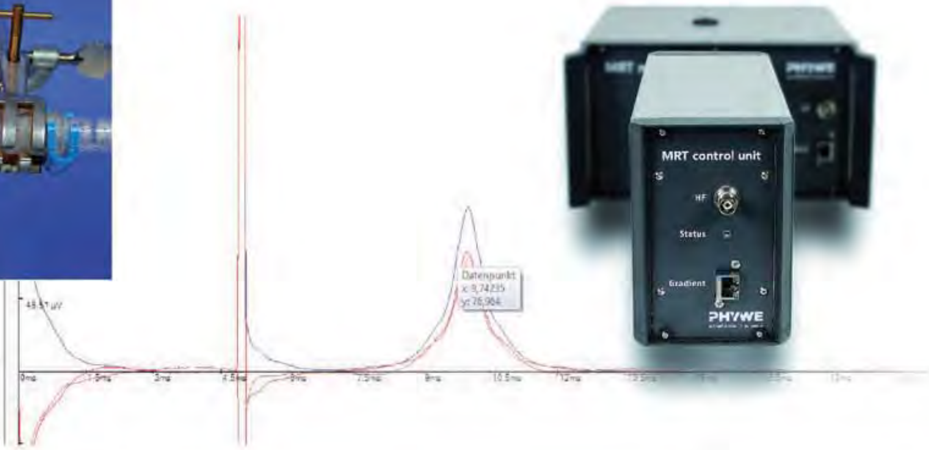
The Nobel Prize is awarded annually in the disciplines of physics, chemistry, physiology or medicine, literature and peace. For scientists and researchers, it is the highest award.

PHYWE supplies more than 50 Nobel Prize awarded experiments. From Conrad Röntgen to Max Planck or Albert Einstein. Experiments in the footsteps of Nobel Prize winners. PHYWE made Nobel Prize experiments understandable.



Nobel Prize awarded experiments (Selection)

1900 ...

1901 – Wilhelm Conrad Röntgen

1901 – Jacobus Henricus van 't Hoff

1902 – Hendrik A. Lorentz, Pieter Zeeman

1903 – Henri Becquerel, Pierre Curie, Marie Curie

1908 – Ernest Rutherford

1909 – Wilhelm Ostwald

1910 ...

1910 – Johannes Diderik van der Wals

1914 – Max von Laue

1915 – Sir William Henry Bragg, Sir William Lawrence Bragg

1912 – F. A. Victor Grignard

1918 – Fritz Haber

1920 ...

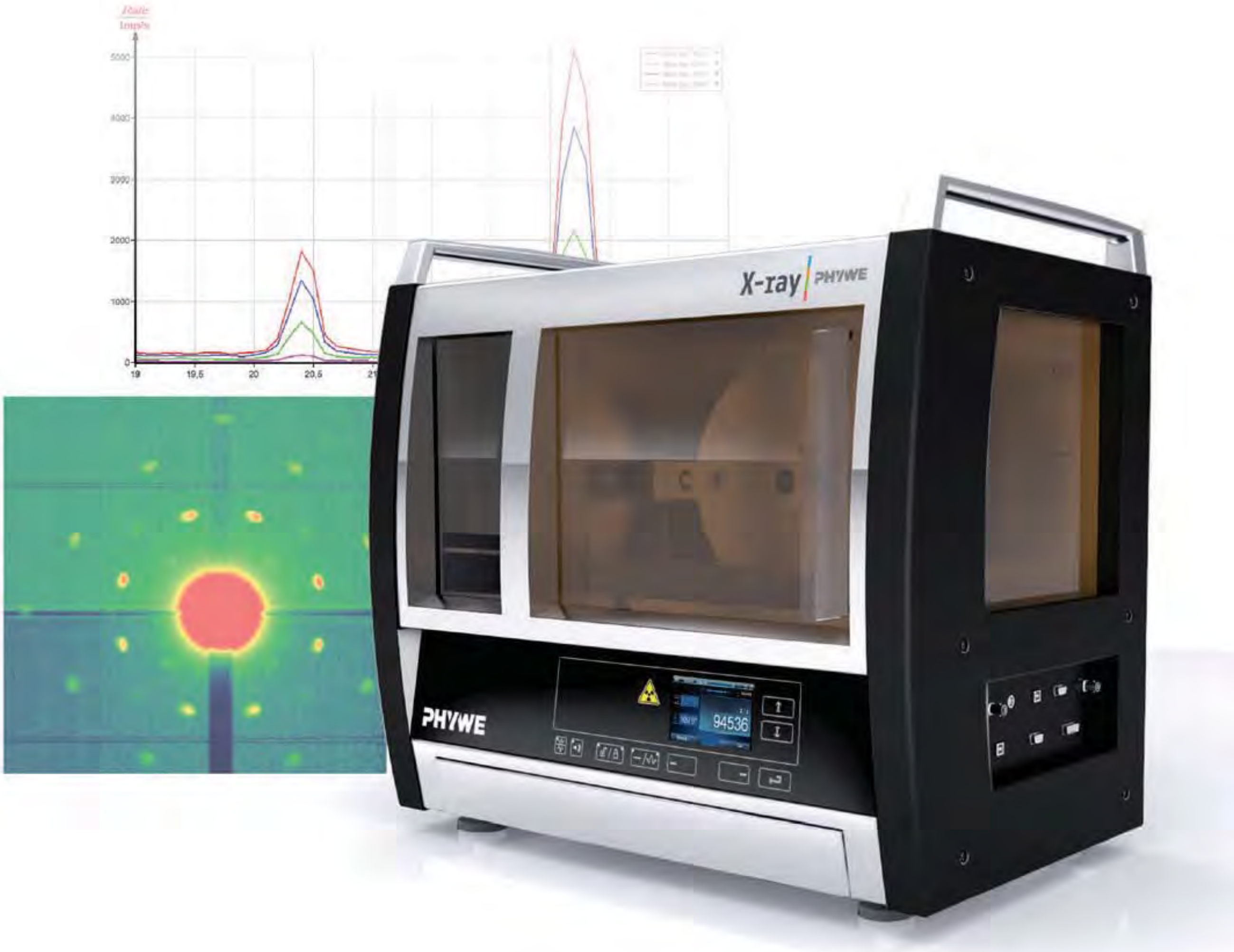
1921 – Albert Einstein

1922 – Niels Bohr, Henrik David

1924 – Manne Siegbahn

1924 – Willem Einthoven

1925 – James Franck, Gustav Hertz



1930 ...

1931 – Carl Bosch, Friedrich Bergius

1932 – Irving Langmuir

1936 – Victor Franz Hess, Carl David Anderson

1936 – Peter Josephus W. Debye

1940 ...

1943 – Otto Stern

1952 – Felix Bloch, Edward M. Purcell

1952 – Archer John P. Martin, Richard Laurence M. Synge

1954 – Max Born, Walther Bothe

1970 until today

1971 – Dennis Gabor

1979 – Allan M. Cormack, Godfrey N. Hounsfield

1986 – Heinrich Rohrer, Gerd Binnig

2003 – Paul C. Lauterbur, Sir Peter Mansfield

Computer assisted measurement – for your science experiments

Cobra4 | PHYWE

With computer-assisted experiments from PHYWE you rely on a system that perfectly matches the demands of modern scientific education. Approximately 50% of the total number of TESS expert university experiments are computer-based. PHYWE offers the unique Cobra4 system with completely new experimentation possibilities. Be inspired by more than 200 described experiments with Cobra4.

The corresponding software measure stands for simple and reliable data recording, analysis and further processing – and it is available in 24 languages. Get more information about our Cobra4 program in the brochure "Experiments with Cobra4"

Benefits

- wireless measurements – comfortable and modern
- more than 30 sensors for more than 50 measurands
- time-saving: settings can be saved
- fully automatic sensor identification
- up to 99 sensors can be addressed simultaneously
- can be used as a hand-held measuring instrument

Cobra4 Interface System

The Cobra4 interfaces

Wireless measurement with Wireless-Link + Wireless Manager + Remote-Link

For high data rates with the USB-Link

Mobile-Link – even more functions included as of 2013 – no computer necessary

The Cobra4 sensor family

Cobra4 PHYWE

Our roadmap for future products –
Coming up 2013

Cobra4 | PHYWE

Cobra4 Sensors

Sound level (12669-00)	Skin resistance (12677-00)	Oxygen (12676-00)	Forceplate (12661-00)	Colorimeter (12634-00)

Cobra4 Signal-Link –
The integrated and high accuracy interface for high speed experiments

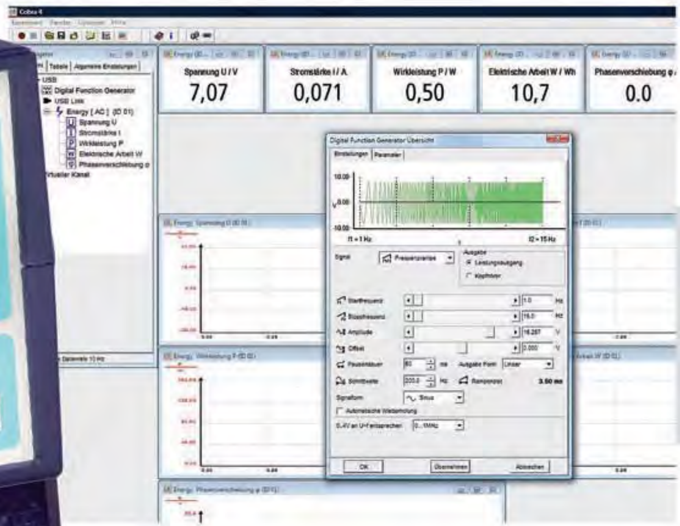
Features

- Integrated unit of voltage & current sensors + USB interface
- 4 channels (2x current, 2x voltage), electrically isolated
- True RMS converter for all channels
- High resolution: up to 5 microvolts, up to 1 microampere
- Sampling rate: > 1 MHz for current channels and >5 MHz for voltage channels
- Compatible to all Cobra4 equipment

Digital function generator – universal and intuitive

Cobra4 compatible

NEW



Features

- Universal, programmable voltage source with a bandwidth of 1 MHz and an output current of 1 A
- Can be used with Cobra4 or as a stand-alone device
- Intuitive operation via function keys and a rotary control knob
- Illuminated display for optimum visibility
- Low distortion factor and high signal-to-noise ratio for brilliant signals (acoustics/hearing)
- U = U(f) output for a particularly easy pick-up of the frequency – ideal for analysing circuits with frequency ramps
- Part of more than 25 TESS experiments

Faraday effect (P2260106)

Chladni's figures (P2150702)