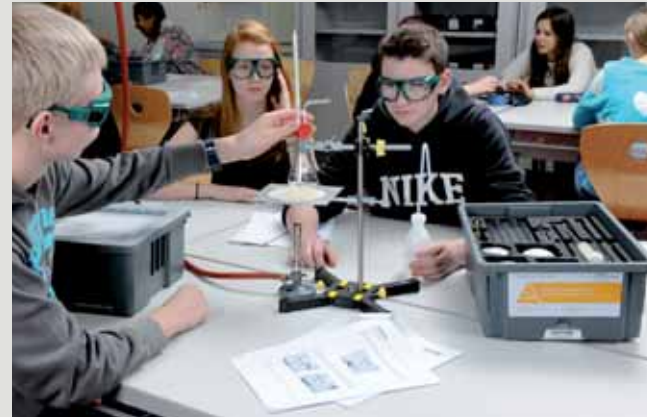


Valid from  
07/2014

# PHYWE

excellence in science



## Natural Sciences Experiments for Schools

Student experiments | Teacher experiments | Datalogging | Literature

Physics **Phy**

Chemistry **Che**

Biology **Bio**

Applied Sciences **Sci**

**PHYWE** excellence in science

### Teaching with PHYWE

science knowledge plus methodological skills

Science experiments with PHYWE are best suitable for all modern and integrated teaching concepts such as STEM, ICT.

Based on the experiments that they perform themselves, students can identify and gather answers to science-related questions and problems. Apart from the fact that they acquire specialised skills, they also learn the associated and necessary methodology.

Prepare your students for shaping the world of tomorrow by teaching these subjects interactively and in a mutual context. How does it work? It's easy – experiments from PHYWE are the ideal basis for familiarising the students with the classical topics in technology and science and for making them eager to know more. Try it.

#### Methodological skills at a glance

- Communication skills
- Critical thinking
- Autonomous learning
- Teamwork and sense of collaboration
- Problem identification and hypothesis proposal
- Learn to collect data, analyse situations and get results



made  
in  
Germany

**PHYWE** excellence in science

## Quick overview – Find the perfect experiments for your individual needs

The layout of our pages ensures that you can find your topic particularly quickly – student or teacher experiments, with or without computer assistance, for all science fields and class levels.

The screenshot shows a webpage layout for '2 Physics 2.6 Electricity'. It features a main header, a list of 24 experiments, a 'Necessary equipment' section, and 'Experiment descriptions'. Red lines connect callout boxes to specific elements on the page.

Pictograms indicate special features and important prerequisites (see below).

This list shows everything that you need for the experiments.

Different logos for quick distinction:

**TESS** | PHYWE stands for student experiments. One topic – one set, including the student worksheets.

**Demo** | PHYWE stands for teacher experiments. Their concept is in line with the student experiments in the TESS system.

**Cobra4** | PHYWE stands for the recording of measurement data during science classes.

All of the experiments shown here can be performed in a computer-assisted manner with Cobra4.

Overview of all of the topics of the set – for quick matching with your curriculum!

Here, you can find the associated literature: printed as manuals or in the form of interactive learning software.

**Pictograms for a quick overview:**

- Cobra4**: Set with measurement data acquisition with Cobra4
- +**: Extension set for another set
- NEW**: New and completely revised sets or experiments
- e**: Experiments available in the interactive learning software
- Open Book**: Printed manual with experiments

## Our student and teacher experiments – the perfect solution for every class level

At PHYWE, the experiment is at the centre of attention. With more than 2,600 student (TESS) and demonstration experiments (Demo), science topics can be treated in a particularly easy and comprehensible way at schools and universities.

Depending on the age group and level of knowledge, TESS and Demo are divided into three performance classes:

University	<p>&gt;700 experiments</p>	<p><b>TESS</b>   PHYWE expert</p> <p><b>Demo</b>   PHYWE expert</p>
	<p>Laboratory courses for advanced students</p> <p>Laboratory courses for beginners</p>	<p>Experiments for continuing education in advanced courses.</p>
School	<p>&gt;1,800 experiments</p>	<p><b>TESS</b>   PHYWE advanced</p> <p><b>Demo</b>   PHYWE advanced</p>
	<p>Advanced course</p> <p>Class 11 - 13</p> <p>Class 7 - 10</p>	<p>The sets cover all of the curriculum-relevant topics.</p>
School	<p>&gt;100 experiments</p>	<p><b>TESS</b>   PHYWE beginner</p> <p><b>Demo</b>   PHYWE beginner</p>
	<p>Class 4 - 6</p>	<p>Perfectly adapted to the science subject.</p>

# Experiments for schools

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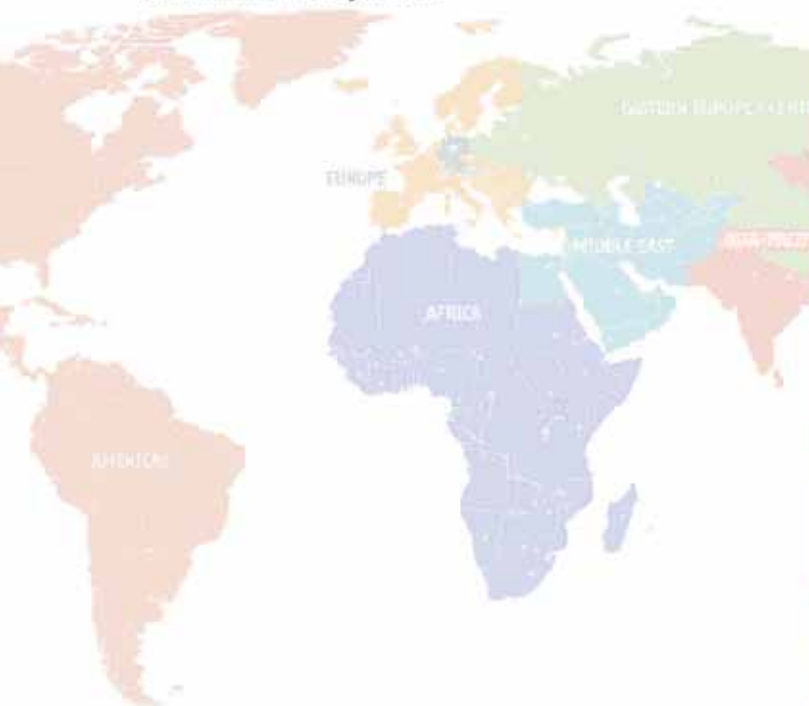
## Your curriculum – Our solution for you

For more than 100 years PHYWE stands for high quality. Directly from the development of our products and solution systems, we work together with teachers and we orient ourselves closely to the different curricula. PHYWE has for every curriculum subject, the matching experiments and equipment.

- For all curricula worldwide
- For all **science subjects**
- Available as **Student and Teacher experiment**
- Many experiments **with or without computer based datalogging** with Cobra4
- Always suitable **experiment description** available



Inspire your students for natural sciences -  
curriculum compliant!







International Reference Curriculum (School)

Sets or experimental collection	Mechanics 1-2	Thermal physics	Physics book	Acoustics 1-2	Heat 1-2	Thermodynamics 1-2	Electricity & Magnetism 1-2	Optics 1-2	Modern physics	Electronics	Physics 1-2	Optics 1-2	Thermal physics	Radioactivity	Modern physics
Theme	100% Score	100% Score	100% Score	100% Score	100% Score	100% Score	100% Score	100% Score	100% Score	100% Score	100% Score	100% Score	100% Score	100% Score	100% Score
<b>PHYSICS BOOKS (100%)</b>															
Phenomena of nature															
Heat															
Green physics															
Energy (mechanics, acoustics, work, heat)															
<b>EXPERIMENTAL COLLECTIONS</b>															
Heat, acoustics and radiation															
Heat															
Reflection, refraction															
Diffraction, interference, polarization															
Light and color															
Heat															
<b>EXPERIMENTAL COLLECTIONS</b>															
Heat, acoustics															
Thermodynamics															
Thermal expansion of materials															
Heat energy															
<b>EXPERIMENTAL COLLECTIONS</b>															
Phenomena of radiation															
Thermal energy, heat transfer															
Current, primary, secondary															
Electrical circuits															
Electrical energy															
Electrical energy - work and heat															
Electromagnetism															
Electrical work															
<b>EXPERIMENTAL COLLECTIONS</b>															
Radioactivity, ionization and absorption															
Classical particles															
Quantum physics															

Phy

The matrices can be found at the beginning of each chapter.

**Interdisciplinary teaching:**

Let yourself be inspired by our chapter "Interdisciplinary teaching". Find there curriculum compliant solutions that cover special topics and provide exciting, modern education.

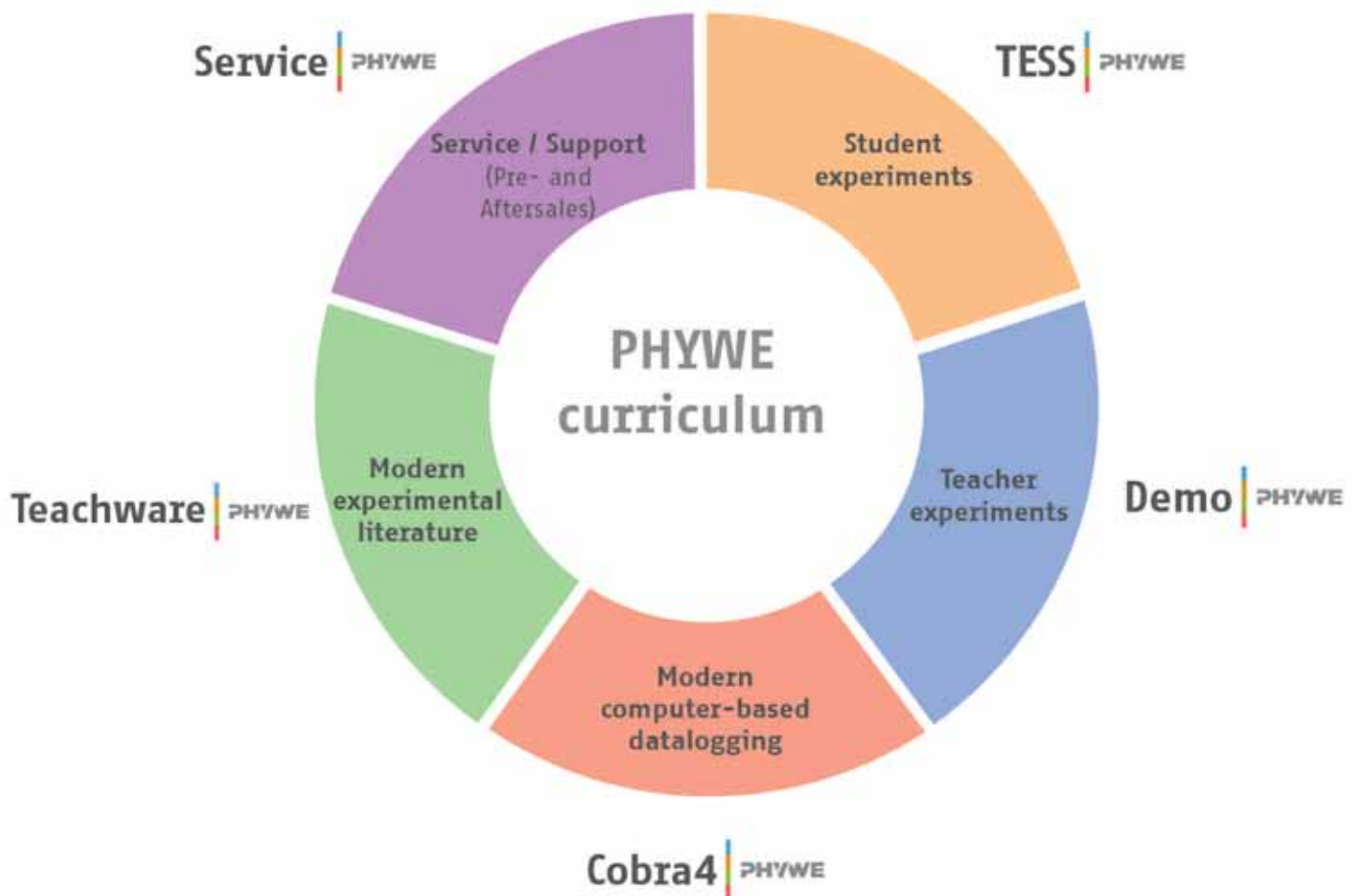


## The elements for your success – PHYWE solutions for a modern education

PHYWE is one of the leading international suppliers of solutions for the education in science. Either for Physics, Chemistry, Biology or interdisciplinary topics – we have guaranteed the suitable curriculum compliant solution for you, in many cases even with modern computer-based datalogging.

Of course, all PHYWE solutions are matched perfectly with each other and will be completed by an excellent service in advance, during and also long time after the sales.

**This is what PHYWE stands for – a consistent and complete solution for you.**





## Datalogging



### Datalogging for science experiments – according to your curriculum

Cobra4 is the computer interface system that offers new experimentation possibilities. It combines classic experiments with modern datalogging. More than 300 detailed experiments are adapted to the international curricula for schools and integrate the sensors into the various subjects.


Physics	
General Physics / Mechanics:	<ul style="list-style-type: none"><li>• Forces</li><li>• Linear motion</li><li>• Energy: Conversion, conservation, work, power</li></ul>
Oscillations and Waves:	<ul style="list-style-type: none"><li>• Sound</li></ul>
Thermal Physics:	<ul style="list-style-type: none"><li>• States of matter</li><li>• Temperature</li><li>• Thermal properties of materials</li><li>• Heat energy</li></ul>
Modern Physics:	<ul style="list-style-type: none"><li>• Radioactivity: detection and characteristics</li></ul>
Electricity and Magnetism:	<ul style="list-style-type: none"><li>• Current, voltage, resistance</li><li>• Electrical circuits</li><li>• Electrical energy, power and work</li><li>• Electromagnetism</li></ul>
Chemistry	
Physical Chemistry, Electrochemistry and Reaction Kinetics, Energetics:	<ul style="list-style-type: none"><li>• Chemical energetics</li><li>• Redox</li><li>• Electrochemistry</li><li>• Equilibria, Reversible reactions</li><li>• Reaction kinetics, Rate (speed) of reaction</li></ul>
Inorganic Chemistry:	<ul style="list-style-type: none"><li>• Acids, bases and salts (preparation, oxides)</li></ul>
Application of Chemistry:	<ul style="list-style-type: none"><li>• Applications of analytical chemistry</li></ul>
Biology	
Metabolism: Nutrition, Nutrients, Excretion, Respiration:	<ul style="list-style-type: none"><li>• Plants: Photosynthesis, Leaf structure, mineral requirements</li><li>• Enzymes</li><li>• Respiration (cells): aerobic and anaerobic as an energy transfer process</li></ul>
Transportation and gas exchange:	<ul style="list-style-type: none"><li>• Transport in mammals: heart and blood system</li><li>• Gas exchange: lungs etc. and smoking</li></ul>
Coordination and response:	<ul style="list-style-type: none"><li>• Senses</li></ul>
Ecology:	<ul style="list-style-type: none"><li>• Energy flow and Nutrient cycles</li><li>• Human influences on ecosystem: Agriculture, Pollution, Conservation</li></ul>
Biochemistry and enzymes:	<ul style="list-style-type: none"><li>• Enzymes: Mode of action of enzymes, Immobilisation of enzymes</li></ul>

Please find in the curricula at the beginning of each chapter and on the pages related to our experiments the detailed information about the applications of the different sensors.

What do you want to measure? - The right sensor for your experiment


Phy

Physic Sensors

 12651-00	 12649-00	 12650-00	 12644-00	 12656-00	 12665-00	 12669-00	 12652-00
<b>Timer-Counter</b> Motion with light barriers	<b>Motion</b> Motion	<b>Acceleration</b> 3D acceleration	<b>Electricity</b> Current, voltage	<b>Energy</b> Current, voltage, work, power	<b>Radioactivity</b> Radioactivity	<b>Sound level</b> Sound, dBA, dBC <b>NEW!</b>	<b>Tesla</b> Magnetic field
 12661-00	 12643-00	 12642-00	 12640-00	 12641-00	 12647-00	 12638-00	
<b>Forceplate</b> Force, weight (500 kg) <b>NEW!</b>	<b>Force 40 N</b> Force 40 N	<b>Force 4 N</b> Force 4 N	<b>Temperature</b> Temperature (semi-conductor)	<b>Temperature</b> Temperature (2 x NiCr-Ni)	<b>Pressure</b> Pressure, (7 bar)	<b>Thermodynamics</b> Pressure, temperature	



Che

Chemistry Sensors

 12631-00	 12630-00	 12636-00	 12676-00	 12671-00	 12638-00	 12633-00	 12632-00	 12634-00
<b>pH</b> pH value	<b>Chemistry</b> pH, temperature	<b>Drop counter</b> Titration	<b>Oxygen</b> Dissolved and gaseous oxygen <b>NEW!</b>	<b>CO<sub>2</sub></b> CO <sub>2</sub> content in air	<b>Thermodynamics</b> Pressure, temperature	<b>Conductivity</b> Conductivity, temperature	<b>Conductivity+</b> Conductivity, temperature (Pt1000)	<b>Colorimeter</b> Photometry <b>NEW!</b>

Bio

Biology Sensors

 12676-00	 12671-00	 12633-00	 12670-00
<b>Oxygen</b> Dissolved and gaseous oxygen <b>NEW!</b>	<b>CO<sub>2</sub></b> CO <sub>2</sub> content in air	<b>Conductivity</b> Conductivity, temperature	<b>Weather</b> Air pressure, humidity, altitude, temperature, light intensity

Sci

Sensors for Human Physiology & Medicine

 12673-00	 12677-00	 12675-00	 12672-00
<b>Electrophysiology</b> EKG, EMG, EOG	<b>Skin resistance</b> Conductance <b>NEW!</b>	<b>Spirometry</b> Respiratory volume, wind speed	<b>Pulse</b> Pulse

### Modern Teaching with datalogging – wireless, modular, and intuitive

#### The principle



**What do you want to measure?**  
More than 30 different sensors

**How do you want to measure?**  
4 different interfaces

*"We have been using the Cobra4 system and the "Environment and outdoors" case intensively for 3 years with the children and teenagers who come to us. We still think it is fantastic!"*

D. Schwerdtfeger,  
Internationaler Schulbauernhof  
Hardegsen gGmbH

#### How do you want to measure? – The matching interface for your specific needs.

##### Mobile-Link 2 \*



NEW 2014

##### Mobile datalogging

Capture measurement values without a PC and save them on a SD card.

- direct display of measurement graphs on the colour display
- live measurement on a computer via a USB cable

\* utility model



Measurement datalogging without a PC with a clearly visible demonstration display

##### Wireless-Link 2



NEW 2014

##### Wireless measurements

The Wireless-Link 2 enables easy and quick communication with all types of mobile devices (regardless of the operating system), without annoying cables, simply via wireless LAN.

- automatic set-up of the wireless network



Wireless-Link 2

##### USB-Link



1.7610-00

##### Easy and cost-effective

Transfer of sensor data to the PC via a USB port.

##### Xpert-Link



NEW 2014

##### Precise and quick

For high-frequency current and voltage measurements



Cobra 4 can make numerous experiments clearer or even possible. Combine our datalogging system Cobra4 with our student and teacher experiments TESS and Demo and benefit from the wide range of possible applications.

### Quick measurement



Precise recording of rapid events and processes (e.g. activation processes, collisions).

### Long-time measurements



Uninterrupted observation of processes with a long duration (e.g. weather observation, photosynthesis).

### Mobile classroom



Location-independent execution of experiments (e.g. environment experiments).

### New experimentation methods



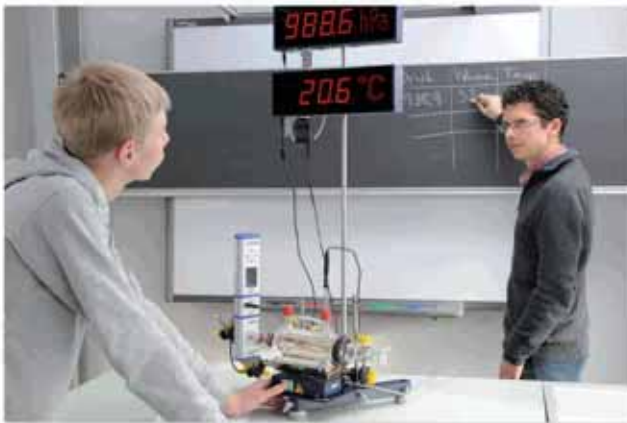
Wireless motion measurements (e.g. friction, free fall).

# 1 Datalogging

## Datalogging with Cobra4



More than 300 detailed student and teacher experiments from all science fields integrate the sensors into the relevant curriculum topics.



### Your advantages

- more than 300 detailed experiments with Cobra4, in compliance with the curricula
- plug & measure: simply connect the device and start the measurement
- wireless measurements – comfortable and modern
- Mobile-Link with a particularly large display for demonstration experiments

### Datalogging with tablet computers and smartphones

Discover the new dimensions of wireless datalogging with our new Wireless-Link (available as of September 2014). Communicate directly with notebooks, tablet computers, or smartphones via wireless LAN. With the new measureAPP, your students can perform, evaluate, and share their measurements.



measureAPP | PHYWE



Can be used on all types of devices, regardless of the operating system.



iOS





## Basic natural sciences

2.1	<b>Overview</b>	<b>12</b>
2.2	<b>Light, Air and Earth</b>	<b>14</b>
2.3	<b>Optics</b>	<b>15</b>
2.4	<b>Senses</b>	<b>16</b>
2.5	<b>Current and Magnets</b>	<b>17</b>
2.6	<b>Motion</b>	<b>18</b>
2.7	<b>Water</b>	<b>19</b>
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## TESS beginner

### Easy access into the natural sciences

The TESS beginner sets are specially adapted to interdisciplinary science classes (as of elementary school or secondary level I). The sets cover the following topics:

- heat
- water
- senses
- motion
- light, air, and earth
- current and magnets
- optics – light in the spotlight

The sets include all of the required materials and instructions. More than 100 age-appropriate experiment descriptions help students to perform the experiments independently on their own and to document and evaluate their results. In doing so, they also learn how to handle the experiment equipment, such as the support material, laboratory glassware, dynamometers, stopwatches, etc.



TESS beginner set "Light, air, and earth" (15243-88). All of the required materials are stored in a sturdy and well-structured storage tray.

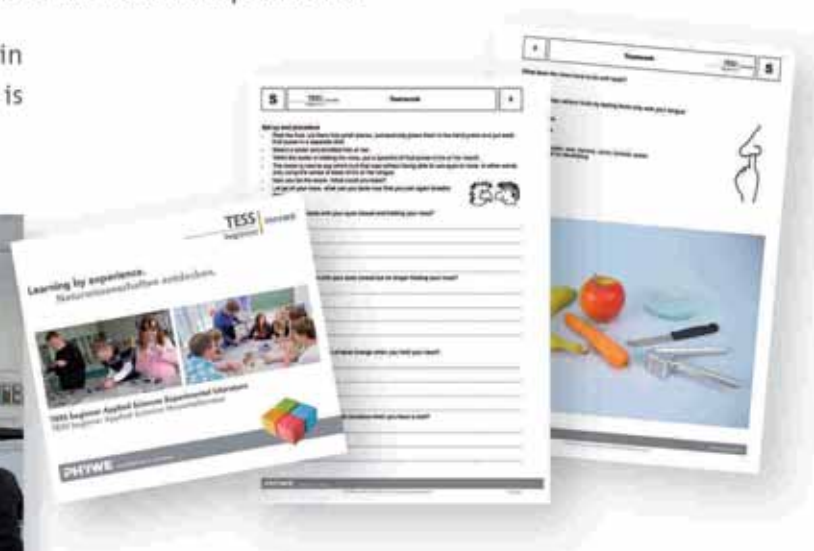
## Demo beginner

### Teacher experiments



In addition, sets for teacher experiments and the accompanying literature for teachers are also available. The teacher booklet includes notes on the preparation and execution of the experiments as well as the typical measurement results and the solutions of the student experiments.

All of the experiments are included on the DVD in PDF format and as editable Word files! The DVD is included in every TESS beginner set.



Matching Demo beginner set "Light, air, and earth" (13244-88). As far as possible, the materials are stored in storage trays.

# Light, Air, Soil

## Student experiments



### 17 Experiments

1. Light and shade
2. Mirrored shadow
3. Mirror games
4. The spoon mirror
5. The bent coin
6. A magnifying glass made of water
7. The magic wand
8. Balloon in the beaker
9. The trick with the postcard
10. Warm and cold air
11. Fresh and used air
12. The thirsty candle
13. A little bit of gardening
14. Just dirt?
15. Air in soil
16. Fast forward
17. Underground forces

### Necessary equipment

TESS beginner Applied Sciences set Light, Air, Soil  
15243-88

### Experiment descriptions

The experiment descriptions are available on a DVD that comes with each set, both as PDF as well as editable Word™ files.

### Corresponding demonstration experiments



### 6 Experiments

- Day and night
- Light and shade
- Things to do with a magnifying glass
- Air is not nothing
- Air pollution
- Determination of soil horizons

The experiment descriptions are available on a DVD that comes with each set, both as PDF as well as editable Word™ files.

DEMO beginner Applied Sciences set Light, Air, Earth  
13244-88

TESS beginner Applied Sciences manual Light, Air, Earth, student and demonstration experiments  
13244-02



# Optics

## Student experiments

TESS  
beginner | PHYWE



### 6 Experiments

1. The book of mirrors
2. The bent mirror
3. The look into infinity
4. The labyrinth of light
5. The rainbow CD
6. Numerous suggestions for free experimentation

### Necessary equipment

TESS beginner Applied Sciences set Optics - Look at Light  
15237-88

### Experiment descriptions

The experiment descriptions are available on a DVD that comes with each set, both as PDF as well as editable Word™ files.

#### Advantages of the set:

- ✓ Numerous colour photos serving as motivation for free experimentation
- ✓ Additional questions for internal differentiation
- ✓ The students can experience light phenomena in a playful way



# Senses

## Student experiments

TESS  
beginner | PHYWE



### 15 Experiments

1. The tongue in the mirror
2. Teamwork: how nose and tongue provide for taste
3. A matter of taste: where does one taste what?
4. Investigating skin
5. Sense of touch
6. Warm and cold
7. Sound waves
8. Music
9. Orientation in space
10. A view at the eye
11. Close and far
12. Candle on its head
13. The blind spot
14. Two eyes see more than one
15. Optical illusions

### Necessary equipment

TESS beginner Applied Sciences set Senses  
15241-88

### Experiment descriptions

The experiment descriptions are available on a DVD that comes with each set, both as PDF as well as editable Word™ files.

### Corresponding demonstration experiments



Demo  
beginner | PHYWE

#### 5 Experiments:

- Circulation of smell
- Touch sensitivity
- Vibrations in the air
- Lense shape
- Vision of shape and colour

The experiment descriptions are available on a DVD that comes with each set, both as PDF as well as editable Word™ files.

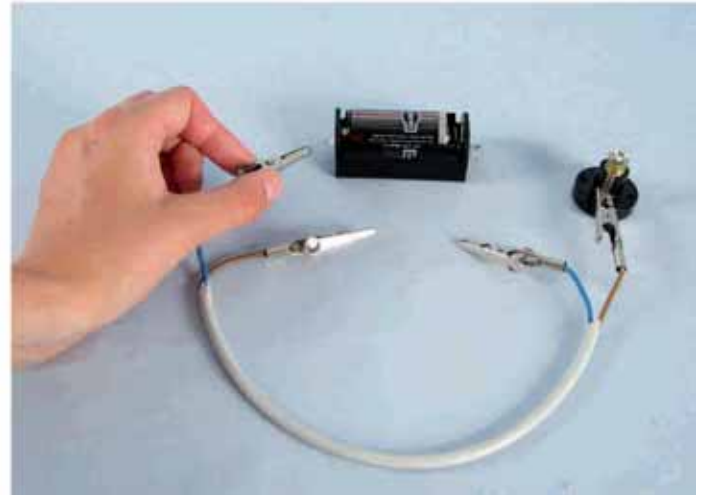
Demo beginner Applied Sciences set Senses  
13242-88

TESS beginner Natural sciences manual Senses, Student  
and demonstration experiments  
13242-02

# Current and Magnets

## Student experiments

TESS  
beginner | PHYWE



### 15 Experiments

1. Getting illuminated
2. The perfect electric circuit
3. On and off
4. Take one, make two
5. A battery-powered heater
6. The path of current
7. More lamps - more light?
8. The magnet testing apparatus
9. The power of magnets
10. Long-distance effect
11. Magnetic patterns
12. An invisible force
13. For scouts and seafarers
14. Opposites attract
15. Abracadabra - be a magnet

### Necessary equipment

TESS beginner Applied Sciences set Current and Magnets  
15245-88

### Experiment descriptions

The experiment descriptions are available on a DVD that comes with each set, both as PDF as well as editable Word™ files.

### Corresponding demonstration experiments



Demo  
beginner | PHYWE

#### 4 Experiments:

- Burning iron
- Short circuit
- One magnet and five metals
- The divided magnet

The experiment descriptions are available on a DVD that comes with each set, both as PDF as well as editable Word™ files.

DEMO beginner Applied Sciences set Current and Magnets  
13246-88

TESS beginner Applied Sciences manual Current and Magnets, student and demonstration experiments  
13246-02



# Motion

## Student experiments



### 14 Experiments

1. Measuring the class room (dimensions)
2. Measuring time (fast and slow pendulum)
3. A fast sprinter (measuring speed)
4. Breathing lessons (breathing rate)
5. Measuring pulse
6. Muscular strength
7. The force meter
8. The force of chocolate
9. The pulley
10. Leverage
11. Keeping in shape (the shape of the backbone)
12. Back-breaking work
13. Really quite agile
14. A chemical substance migrates

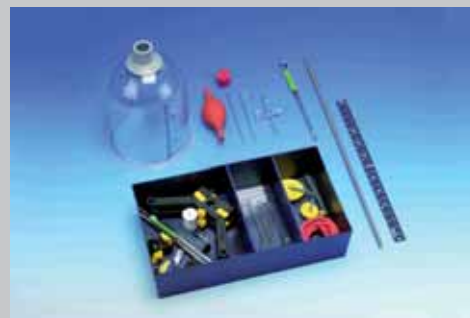
### Necessary equipment

TESS beginner Applied Sciences set Motion  
15231-88

### Experiment descriptions

The experiment descriptions are available on a DVD that comes with each set, both as PDF as well as editable Word™ files.

### Corresponding demonstration experiments



#### 4 Experiments

- Measurement of respiratory volume
- Calibration of a force meter
- Have more pull
- Save forces with curling

The experiment descriptions are available on a DVD that comes with each set, both as PDF as well as editable Word™ files.

DEMO beginner Naturwissenschaften Set Bewegung  
13232-88

TESS beginner Natural sciences manual Motion, student  
and demonstration experiments  
13232-02

# Water

## Student experiments

TESS  
beginner | PHYWE



### 14 Experiments

1. Water and ice
2. Sweet and salty solutions
3. The egg in water
4. The refrigerator in the beaker
5. Colder than ice
6. Soft and hard water
7. Soapsuds
8. Water and oil
9. The water mountain
10. The sinking paper clip
11. The soap vessels
12. The crack in the water surface
13. Water droplets
14. Cleaning water

### Necessary equipments

**TESS beginner Applied Sciences set Water**  
15233-88

### Experiment descriptions

The experiment descriptions are available on a DVD that comes with each set, both as PDF as well as editable Word™ files.

### DEMO beginner Applied Sciences set Water



Demo  
beginner | PHYWE

### 5 Experiments

- The state of aggregation of water
- Water hardness
- Bank filtration
- Distillation
- The conductivity of water

The experiment descriptions are available on a DVD that comes with each set, both as PDF as well as editable Word™ files.

**DEMO beginner Applied Sciences set Water**  
13234-88

**TESS beginner Natural sciences manual Water, student and demonstration experiments**  
13234-02

# Heat

## Student experiments

TESS  
beginner | PHYWE



### 13 Experiments

1. Temperature sense of the skin
2. Thermal expansion of air and water
3. Thermal expansion of air and spirit
4. Calibration of a thermometer
5. Temperature measurement
6. Temperature of mixtures
7. Heat insulation by wool
8. Heat insulation by air (feather)
9. Heat insulation by styrofoam
10. Heat of evaporation of water
11. Evaporation of spirit
12. Depression of melting point by salt
13. Ice floats, maximum of density of water at 4°C

### Necessary equipment

**TESS beginner Applied Sciences set Heat**  
15235-88

### Experiment descriptions

The experiment descriptions are available on a DVD that comes with each set, both as PDF as well as editable Word™ files.

### Corresponding demonstration experiments



Demo  
beginner | PHYWE

### 5 Experiments

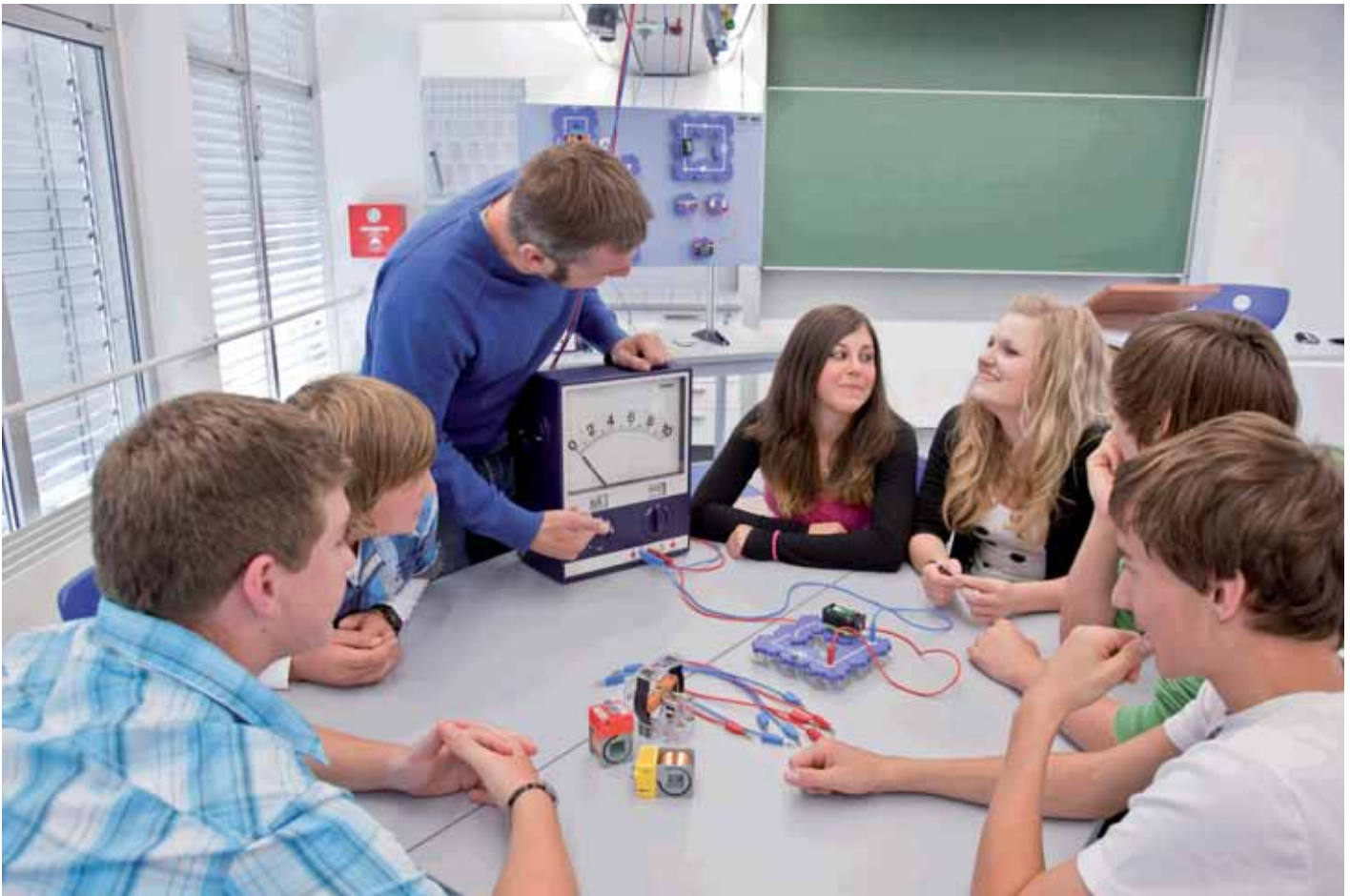
- Absorption of heat radiation
- Flow of water due to heat
- Heat transport in glass and metal
- Temperatures in different waterdepths
- Ice floats, maximum of density of water at 4°C

The experiment descriptions are available on a DVD that comes with each set, both as PDF as well as editable Word™ files.

**DEMO beginner Applied Sciences set Heat, 230 V**  
13236-88

**TESS beginner Natural sciences manual Heat, student and demonstration experiments**  
01160-52










## Physics

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3.5	<b>Renewable Energy</b>	49
3.6	<b>Electricity</b>	56
3.7	<b>Optics</b>	72
3.8	<b>Radioactivity</b>	80
3.9	<b>Modern Physics</b>	83

# 3 Physics

## 3.1 Curriculum and Overview

PHYWE covers the requirements of the educational plans for the

International Reference Curriculum (School)						
Sets or experimental collection  Theme	Mechanics 1-3	Circular motion	Ripple tank	Acoustics 1-2	Heat 1-2	Renewable Energy 1-3
	TESS / Demo	Demo	Demo	TESS	TESS / Demo	TESS / Demo
						
<b>GENERAL PHYSICS / MECHANICS</b>						
Properties of matter	✓					
Forces	✓					
Linear motion	✓					
Circular motion		✓				
Energy: Conversion, conservation, work, power	✓				✓	✓
<b>OSCILLATIONS AND WAVES</b>						
Wave properties and oscillations			✓			
Lenses						
Reflection, Refraction						
Diffraction, Interference, Polarisation						
Light and Colour						
Sound				✓		
<b>THERMAL PHYSICS</b>						
States of matter					✓	
Temperature					✓	
Thermal properties of materials					✓	
Heat energy					✓	✓
<b>ELECTRICITY AND MAGNETISM</b>						
Phenomena of magnetism						
Electric charge, Electrostatics						
Current, voltage, resistance						
Electrical circuits						
Electrical safety						
Electrical energy, power and work						
Electromagnetism						
Electric fields						
<b>MODERN PHYSICS</b>						
Radioactivity: detection and characteristics						
Charged particles						
Quantum physics						
Nuclear physics						
Production and use of X-rays						





### Student experiments for physics classes – extensive and comfortable



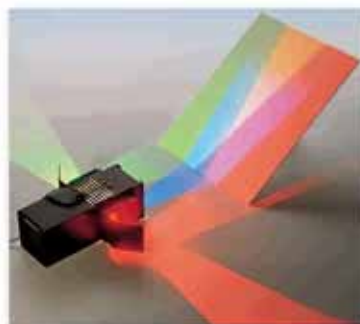
The TESS system for student experiments includes 3 components that are optimally adapted to one another in order to make your daily teaching work easier for you:

- student-adapted equipment for safe experimentation
- experiment descriptions specifically written for students, including useful information for the teacher
- space-saving and clear storage for easy handling



#### Student-adapted equipment

The equipment is highly versatile, e.g. the optical lamp: it can be used as a light box, a light for colour mixing, or as a lamp for the optical bench.



Robust and safe, e.g. the student power supply unit: stabilised, short-circuit-proof, highly robust housing, with current and voltage control.





## Teacher experiments for physics – time-saving and well-structured

The Demo system – our unique, multifunctional solution for teacher experiments that assists you optimally during your daily teaching work:



- vertical, well-structured set-up, clearly visible even from the last row
- quick positioning and modification of the experiment set-ups by way of magnetic holders
- double-sided board: one side with a one-colour coating and the other side for optics experiments with a white, reflective film and grid pattern for quick evaluation
- quick and secure fastening of measuring instruments
- complete experiment sets in convenient storage cases for all standard topics in the field of physics
- more than 250 physics experiments described in well-structured instructions
- mobile thanks to the mobile experimentation stand with a storage rack for the experiment sets

### Magnetic board – demonstrative and well-structured



# Mechanics 1

## Student experiments



### 32 Experiments

#### Physical quantities and characteristics

1. Measurement of length
2. Measurement of time
3. Determination of the mass of solid and liquid bodies
4. Determination of the density of solid bodies
5. Determination of the density of liquids

#### Forces

6. Measurement of forces
7. Force and reaction
8. Weight
9. Hooke's law
10. Force aligned in the same and opposite direction
11. Combination of forces; parallelogram of forces
12. Force on a pulley mounting
13. Finding the center of gravity
14. Reaction forces for an unloaded beam
15. Reaction forces for a loaded beam

#### Simple machines

16. Beam balance
17. Double-sided lever
18. One-sided lever
19. Force and displacement on a fixed pulley

20. Force and displacement on a free pulley
21. Block and tackle formed from a free and a fixed pulley
22. Block and tackle with four pulleys
23. Potential energy and tension energy
24. Power

#### Liquids and gases

25. Finding the density of solid bodies by measuring the buoyancy
26. Finding the density of liquids using a densimeter

#### Oscillations

27. Helical spring pendulum
28. Thread pendulum (mathematical pendulum)
29. Damping
30. Forced oscillation and resonance
31. Reversible pendulum (physical pendulum)
32. Coupled pendulum systems





## Necessary equipment

TESS advanced Physics Basic Set Mechanics 1  
15271-88

TESS advanced Mechanics ME 1 consumables for 10  
groups  
13450-88

## Experiment descriptions



Software interTESS Physics, Mechanics, DVD  
01051-00

TESS advanced Physics manual Mechanics 1 to 5  
01158-02

## 2 Experiments with Cobra4



The following experiments of the set Mechanics 1 can be performed alternatively with the Cobra4 extension set Mechanics:

1. Weight
2. Helical spring pendulum

TESS advanced Physics set Cobra4, extension set for  
Mechanics  
15273-88

# Mechanics 2

## Student experiments



### 19 Experiments

#### Physical quantities and characteristics

1. Determination of the volume of regular and irregular bodies

#### Forces

2. Bending of a leaf spring
3. Calibration of a dynamometer
4. Stability
5. Restoring force on a displaced pendulum
6. Friction
7. Coefficient of friction

#### Simple machines

8. Force and displacement on a step wheel
9. Gear mechanisms and belt drives

#### Liquids and gases

10. Joined vessels
11. Hydrostatic pressure
12. Buoyancy and floating
13. Archimedes' principle
14. Finding the density of immiscible liquids
15. Capillary action
16. Boyle-Mariotte law
17. Pumps and siphons

#### Oscillations

18. Oscillations of a leaf spring
19. Displacement-time recording

### Necessary equipment

TESS advanced Physics supplementary set Mechanics 2  
15272-88

TESS advanced Mechanics 2 consumables for 10 groups  
13451-88

TESS advanced Physics Basic Set Mechanics 1  
15271-88

TESS advanced Mechanics 1 consumables for 10 groups  
13450-88



### Experiment descriptions



Software interTESS Physics, Mechanics, DVD  
01051-00

TESS advanced Physics manual Mechanics 1 to 5  
01158-02

### 2 Experiments with Cobra4



The following experiments of the set Mechanics 1 can be performed alternatively with the Cobra4 extension set Mechanics:

1. Bending of a leaf spring
2. Friction

TESS advanced Physics set Cobra4, extension set for  
Mechanics  
15273-88



# Linear motion

## Student experiments

TESS advanced PHYWE

4 Cobra NEW



### 6 Experiments

1. Instantaneous and average speed
2. Laws of motion with uniform acceleration
3. Potential and kinetic energy
4. Free fall
5. Newton's law: acceleration as a function of force
6. Newton's law: acceleration as a function of mass

### Necessary equipment

All experiments can be performed either with the classical timer or with the Cobra4 Mobile-Link.

**TESS advanced Physics Set Linear Motion with Timer 2-1 (Dynamics)**  
15283-88

**TESS advanced Physics Set Linear Motion with Cobra4 Mobile-Link (Dynamics)**  
15284-88

### Optional extension set



With the optional extension set Car, motor driven the following 3 experiments can be performed:

1. Uniform linear motion
2. Comparison of uniform and non-uniform motion
3. Laws of uniform linear motion

**TESS advanced Mechanics linear motion optional accessories for 1 group**  
13453-88



### Experiment descriptions



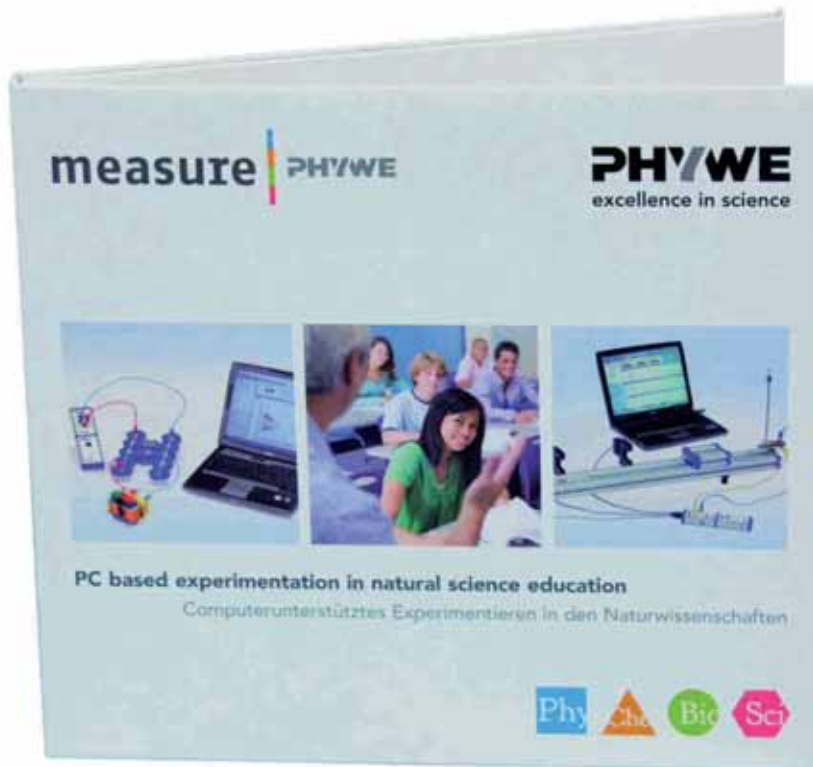
Software interTESS Physics, Mechanics, DVD  
01051-00

*"Prime quality materials  
with great ease of use."*

Mr. Adem Soylamis,  
Istanbul university,  
Alkev school, schools adviser,  
Istanbul

# Linear motion

## Video analysis



### 23 Experiments

The software measure Dynamics includes example videos and analysis of the following topics:

#### Mechanics

1. Thread pendulum
2. Spring pendulum
3. Coupled pendulums
4. Rod pendulum
5. Interrupted pendulum
6. Forced oscillation: Pohl's pendulum
7. Uniform linear motion
8. Uniformly decelerated linear motion
9. Newton's second law
10. Free fall
11. Projectile motion
12. Vertical throw
13. Inclined plane
14. Elastic collision (momentum conservation)
15. Inelastic collision (momentum conservation)
16. Maxwell's wheel (mechanical conservation of energy)

#### Physics and sports

17. Discus throw
18. Football
19. Hammer throw

20. Jugglery
21. Sling ball
22. Pole vault
23. Long jump

### Necessary equipment



For the performance of the experiments additional equipment is necessary which you take from your collection or we can make an offer for you.

**Software "Measure Dynamics", school licence  
14440-62**





The video analysis software "measure Dynamics" provides a demonstrative possibility to analyze movements and display them in the shape of diagrams. All you need is a digital video camera, whereby modern webcams, camcorders or common digital cameras with film mode function are completely sufficient.

Four easy steps to a positive result:

- Tape a video
- Capture a phenomenon
- Build a model
- Analyze

#### Advantages of the set:

- ✓ Integrated opening, playing, editing, and exporting of videos
- ✓ Automatic object detection and tracking (also several objects simultaneously)
- ✓ Numerous demonstrative inserts possible (arrows, lines, points of time)
- ✓ Extensive export options (video with opening and end titles, stroboscopic image)

# Mechanics 1

## Teacher experiments

Demo  
advanced PHYWE

NEW



### 23 Experiments

#### Forces

1. Mass and weight
2. Extension of a rubber band and helical spring
3. Hooke's law
4. Force and counterforce
5. Composition of non-parallel forces
6. Resolution of a force into two non-parallel forces
7. Resolution of forces on an inclined plane
8. Resolution of forces on a crane
9. Determination of the centre of gravity of an irregular plate

#### Simple machines

10. Double-sided lever
11. One-sided lever
12. Double-sided lever and more than two forces
13. Reaction forces
14. Torque
15. Beam balance
16. Fixed pulley
17. Free pulley
18. Block and tackle

#### Oscillation

19. Thread pendulum
20. Spring pendulum
21. Physical pendulum (reversible pendulum)

#### Mechanical forms of energy

22. Restraint energy

#### Mechanics of liquids and gases

23. Density determination by measuring buoyancy

### Necessary equipment

**DEMO advanced Physics Set Mechanics 1**  
15510-88

**DEMO advanced Mechanics 1 necessary accessories**  
15510-01

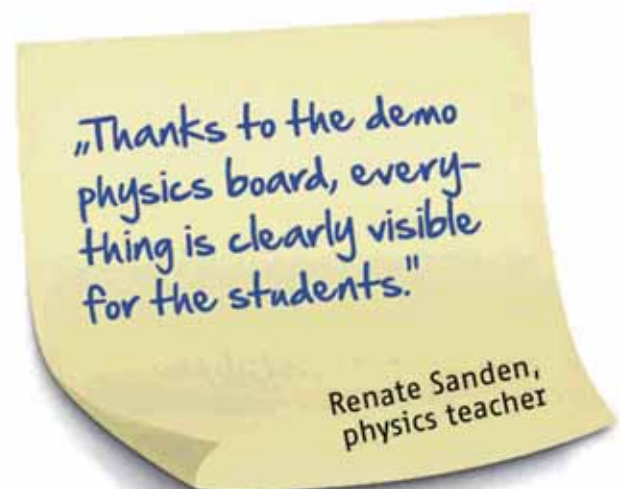
**Demo Physics board with stand**  
02150-00



### Experiment descriptions



Physics, Manual Magnet Board Mechanics, 1  
01152-02





# Mechanics 2

## Teacher experiments

Demo  
advanced PHYWE



### 19 Experiments

#### Forces

1. Making and calibrating a dynamometer
2. Banding of a leaf spring
3. Restoring force on a displaced pendulum
4. Frictional force
5. Determination of the coefficient of friction of an inclined plane

#### Simple machines

6. Sliding weight balance
7. Wheel and axle
8. Toothed gearing
9. Driving belts

#### Mechanical forms of energy

10. Energy conversion of a roller coaster

#### Mechanics of liquids and gases

11. U-tube manometer
12. Hydrostatic pressure
13. Communicating vessel
14. Hydraulic press
15. Artesian well

16. Archimedes' principle
17. Discharge velocity of a vessel
18. Pressure in gases
19. Boyle-Mariotte law

### Necessary equipment

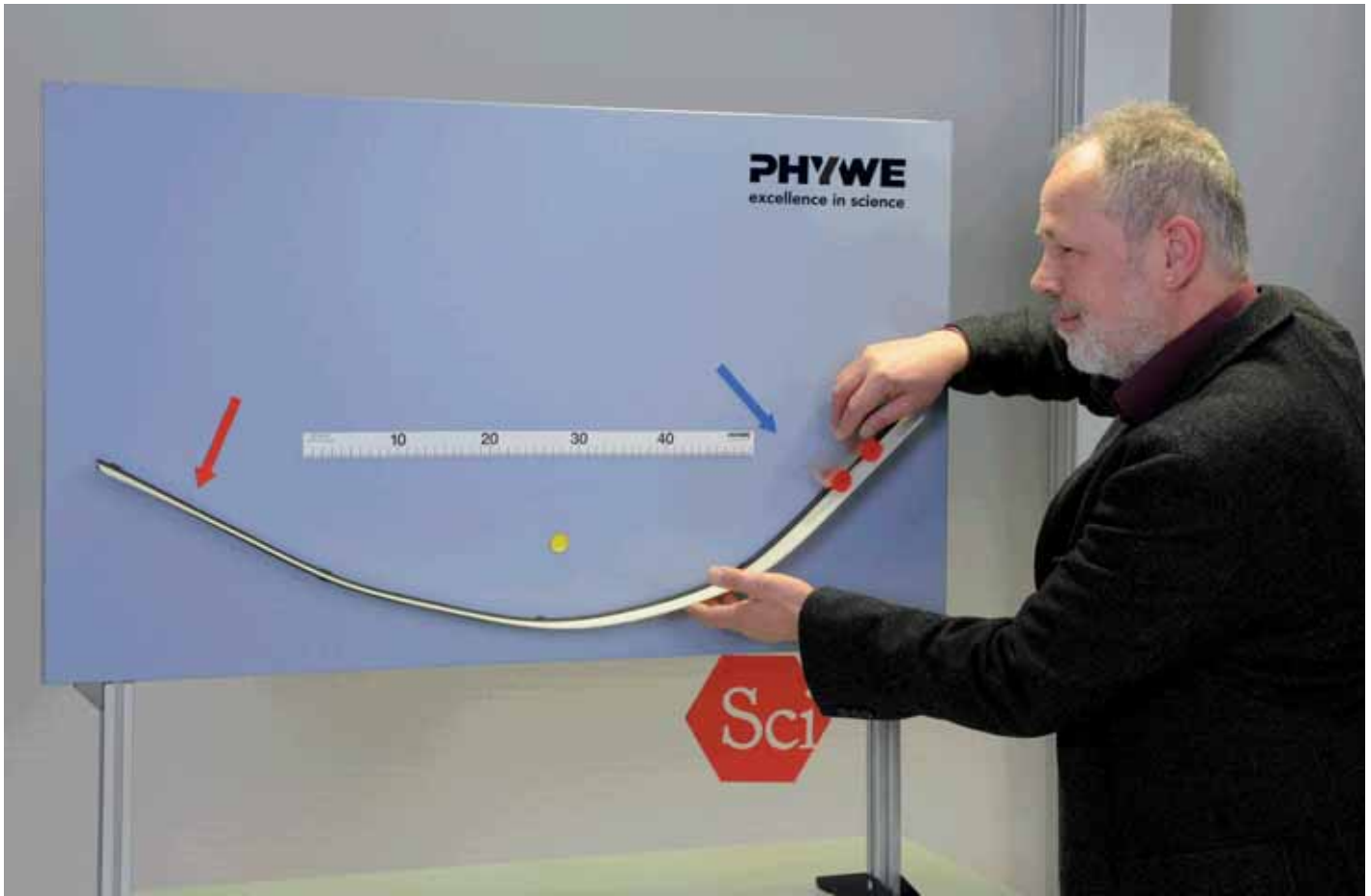
DEMO advanced Physics Supplementary Set Mechanics 2  
15511-88

DEMO advanced Mechanics 2 necessary accessories  
15511-01

DEMO advanced Physics Set Mechanics 1  
15510-88

DEMO advanced Mechanics 1 necessary accessories  
15510-01

Demo Physics board with stand  
02150-00



### Experiment descriptions



Physics, Manual Magnet Board Mechanics, 2  
01153-02



"PHYWE's concept of high quality, flexibility, professionalism and their uniqueness are the important factors that increase the interest in natural sciences in general and make them simple and easy to understand!"

DR. S.A. Lovjagin, Honour teacher,  
Russian Federation

# Linear motion

## Teacher experiments

Demo | PHYWE  
advanced

NEW



### 13 Experiments

1. Linear uniform motion
2. Uniformly accelerated motion with an accelerating mass
3. Uniformly accelerated motion with an inclined track
4. Uniformly decelerated motion
5. Law of inertia (Newton's first law)
6. Fundamental law of dynamics (Newton's second law)
7. Law of reciprocal actions (actio= reactio, Newton's third law)
8. Equivalence of inertial mass and gravitational mass
9. Impulse and momentum
10. Conservation of momentum in elastic collisions
11. Conservation of momentum in inelastic collisions
12. Conservation of momentum in multiple elastic collisions
13. Conservation of momentum in multiple inelastic collisions

### Necessary equipment

DEMO advanced Physics Set Linear Motion (Dynamics)  
15512-88

### Experiment descriptions



Demo advanced Physics Manual Linear Motion (LMT)  
16001-02

"I can definitely recommend the demonstration track with the compact light barrier and time measuring device. It is a brilliant combination, saves a lot of time in terms of the experiment set-up, and offers a well-thought-out didactic concept."

Hermann Stübler,  
teacher from Stuttgart



# Acceleration with Cobra4 Teacher experiments

Demo  
advanced PHYWE



## 5 Experiments

1. Frequency of a spring pendulum
2. Sliding friction
3. Rolling friction
4. Free fall with air friction
5. Zero gravity during free fall

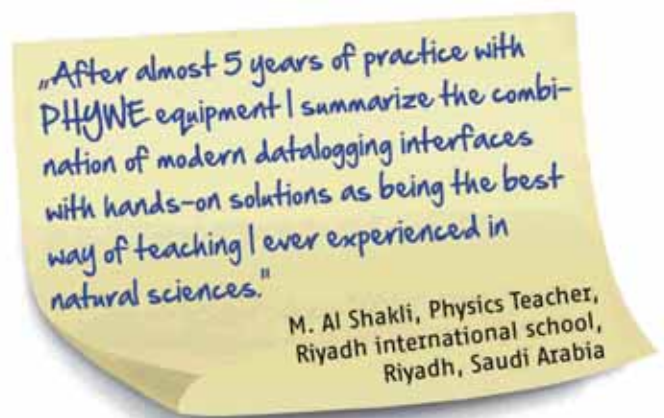
## Necessary equipment

DEMO advanced Physics set Mechanics: Acceleration with Cobra  
15513-88

## Experiment descriptions



Demo advanced Physics Manual Cobra4 Acceleration  
01333-02



# Circular motion

## Teacher experiments



### 3 Experiments

1. Dependency of the centripetal force on angular velocity
2. Dependency of the centripetal force on radius
3. Dependency of the centripetal force on mass

### Necessary equipment

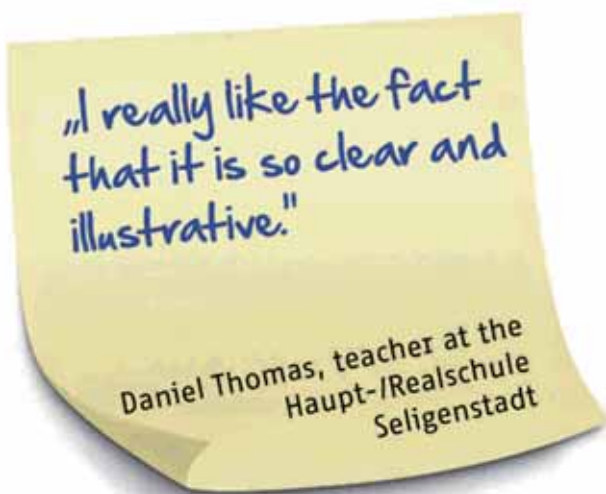
Centripetal force with Cobra4  
P6000660

### Optional extension set



With the Sensor-Unit 3D-Acceleration, you can directly measure the centripetal acceleration as additional parameter.

Cobra4 Sensor-Unit 3D-Acceleration,  $\pm 2 \text{ g}$ ,  $\pm 6 \text{ g}$   
12650-00



# Wave phenomena

## Teacher experiments



### 10 Experiments

1. Generation of waves
2. Reflection by various obstacles
3. Connection between the frequency and wavelength
4. Dependence of the velocity of propagation on the depth of water
5. Refraction at a planoparallel plate / on a prism
6. Refraction at a convergent lens / at a divergent lens
7. Interference of water waves travelling in opposite directions
8. Interference pattern of several point exciters (Huygens)
9. Diffraction at obstacles and slits
10. Diffraction and interference at a double slit

### Optional extension set

With the external vibration generator, 2 additional experiments can be performed:

1. Doppler effect
2. Influence of the phase difference on the interference patterns of two exciters

**External vibration generator for ripple tank**  
11260-10

### Necessary equipment

**Ripple Tank with LED-light source, complete**  
11260-99

**Demo set with mirror for Ripple Tank**  
11260-30

### Experiment descriptions



**Handbook Physics, Experiments with the Ripple Tank**  
16040-02



# Generation, propagation and perception of sound

## Student experiments



### 14 Experiments

#### Generation, propagation and perception of sound

1. Generation of sound waves
2. Propagation of sound in air
3. Propagation of sound in solid bodies
4. Propagation of sound in water
5. Sound as a sine wave
6. Sound and noise
7. Lower and upper hearing threshold
8. Directional hearing

#### Physical properties: oscillations and waves

9. Beat frequency
10. Measurement of sound velocity

#### Applications in the field of medicine, music, and everyday life

11. Bone conduction
12. Noise level traffic lights
13. Scales and intervals
14. Fundamental, overtone and tone colour

### Experiment descriptions



TESS advanced Applied Sciences manual Acoustics  
13289-02

### Necessary equipment

TESS advanced Physics set Acoustics 1  
15289-88

TESS Acoustics 1 necessary accessories for 1 group  
15289-77

# Oscillations and waves

## Student experiments

TESS  
advanced PHYWE



### 8 Experiments

#### Physical properties: oscillations and waves

1. Harmonic Oscillation
2. Visualization of the vibrations of a tuning fork
3. Reflection and echo
4. Standing waves
5. Resonance

#### Applications in the field of medicine, music, and everyday life

6. Determination of an unknown frequency (beats)
7. Reflection and absorption of sound
8. Acoustic Doppler-effect

### Necessary equipment

TESS advanced Physics set Acoustics 2  
15321-88

TESS advanced Physics set Acoustics 1  
15289-88

TESS Acoustics 1 necessary accessories for 1 group  
15289-77

### Experiment descriptions



TESS advanced Applied Sciences manual Acoustics  
13289-02

### Measuring sound level with Cobra4



4  
Cobra

How loud is a conversation, the main road, a silent nature path, the classroom? The sensor enables especially in combination with the Cobra4 Mobile-Link the simple and fast measurement of sound sources.

Cobra4 Sensor-Unit Sound level  
12669-00

Cobra4 Mobile-Link 2 incl. accessories: battery, USB cable, charger and SD memory card  
12620-10

# Heat 1

## Student experiments



### 21 Experiments

#### Thermal equilibrium and temperature measurement

1. Heat sensitivity of the skin
2. Thermal equilibrium
3. Calibration of a thermometer (thermometer model)

#### Thermal expansion

4. Expansion of liquids and gases
5. Expansion coefficient of liquids
6. Expansion of air at constant pressure
7. Expansion of air at constant volume

#### Heat transfer

8. Thermal convection in liquids and gases
9. Thermal insulation

#### Thermal energy

10. Heating different quantities of water
11. Heating various liquids
12. Temperature of mixed liquids
13. Heat capacity of the calorimeter

#### Change of state

14. Volume change during the melting of ice
15. Latent heat of fusion of ice

16. Heat of evaporation of water
17. Heat of condensation of water
18. Evaporation

#### Solutions

19. Heat of solution
20. Freezing point depression (freezing mixture)
21. Boiling point elevation

### Necessary equipment

**TESS advanced Physics Basic Set Heat 1**  
15274-88

**TESS advanced Heat 1 necessary accessories for 1 group**  
13455-88

**TESS advanced Heat 1 consumables for 10 groups**  
13456-88





### Experiment descriptions



Software interTESS Physics, Heat, DVD  
01052-00

TESS advanced Physics manual Heat  
01160-02

The following experiments of the set Heat 1 can be performed alternatively with the Cobra4 extension set Heat.

1. Thermal equilibrium
2. Thermal insulation
3. Heating different quantities of water
4. Heating various liquids
5. Heat capacity of the calorimeter
6. Evaporation
7. Heat of solution
8. Freezing point depression (freezing mixture)

**Cobra4 extension set for TESS advanced Heat**  
15285-88

### 8 Experiments with Cobra4



# Heat 2

## Student experiments



### 13 Experiments

**Thermal equilibrium and temperature measurement**

1. Temperature measurement with a thermocouple

**Thermal expansion**

2. Linear expansion of metals  
3. Bimetallic principle

**Heat transfer**

4. Thermal conduction of solid bodies  
5. Thermal conduction coefficient of metals  
6. Thermal conduction in liquids  
7. Absorption of thermal radiation

**Thermal energy**

8. Specific heat capacity of water  
9. Specific heat capacity of solid bodies  
10. Calorimetric temperature measurement  
11. Conversion of mechanical energy into internal energy

**Change of state**

12. Melting and freezing curve of sodium thiosulphate  
13. Distillation

### Necessary equipment

TESS advanced Physics supplementary set Heat 2  
15275-88

TESS advanced Heat 2 necessary accessories for 1 group  
13457-88

TESS advanced Heat 2 consumables for 10 groups  
13458-88

TESS advanced Physics Basic Set Heat 1  
15274-88

TESS advanced Heat 1 necessary accessories for 1 group  
13455-88

TESS advanced Heat 1 consumables for 10 groups  
13456-88



## Experiment descriptions



Software interTESS Physics, Heat, DVD  
01052-00

TESS advanced Physics manual Heat  
01160-02

## 5 Experiments with Cobra4



The following experiments of the set Heat 2 can be performed alternatively with the Cobra4 extension set Heat.

1. Specific heat capacity of water
2. Specific heat capacity of solid bodies
3. Calorimetric temperature measurement
4. Conversion of mechanical energy into internal energy
5. Melting and freezing curve of sodium thiosulphate

**Cobra4 extension set for TESS advanced Heat**  
**15285-88**



# Heat

## Teacher experiments

Demo | PHYWE  
advanced

4  
Cobra NEW



### 17 Experiments

#### Thermal expansion

1. Volume expansion of liquids
2. Preparing a thermometer scale
3. Anomaly of the water
4. Linear expansion of solid bodies
5. Volume expansion of gases at constant pressure
6. Pressure increase during the heating of gases with constant volume

#### Heat transfer

7. Heat convection in liquids and gases
8. Heat conduction in solid bodies
9. Heat conduction in water
10. Heat absorption as a function of surface colour

#### Thermal Energy

11. Thermal energy and heated mass
12. Measurement of the mixing temperature
13. Specific heat capacity of solid bodies

#### States of Matter

14. Melting of ice
15. Specific evaporation heat of water
16. Specific condensation heat of water
17. Distillation

### Necessary equipment

DEMO advanced Physics Set Heat  
15530-88

DEMO advanced Heat necessary accessories  
15530-01

Demo Physics board with stand  
02150-00

### Experiment descriptions



Phys.Exp.Magnet Board Heat  
01154-02

# Energy conversion, thermal energy

## Student experiments

TESS  
advanced PHYWE



### 17 Experiments

#### Energy conversion

1. Conversion of light into motion with a solar cell
2. Conversion of mechanical energy into electrical energy
3. Conversion of thermal energy into electrical energy
4. Conversion of thermal energy into motion
5. Driving a water wheel

#### Thermal energy from solar energy

6. Thermal conduction
7. Influence of surface on the absorption of solar energy
8. Influence of insulation on the absorption of solar energy
9. Using the greenhouse effect with a solar collector
10. Heating water in a solar collector
11. Thermal insulation of houses and thermal imaging
12. Thermal radiation and greenhouse effect

#### Energy from ambient heat

13. Generation of electrical energy using a thermogenerator (thermoelectric power)
14. Thermal voltage and temperature
15. Peltier effect: cooling engine
16. Peltier effect: heat pump
17. Using ambient heat with the aid of a Peltier heat pump

### Optional extension set

The optional extension set (lamp with reflector, 120W) serves as stronger light source.

**TESS advanced Renewable Energy Basic Set optional accessories for 1 group**  
13481-88

### Experiment descriptions



**Software interTESS Applied Science, Renewable Energy, DVD**  
01081-00

### Necessary equipment

**TESS advanced Applied Sciences Basic Set Renewable Energy basics and thermal energy**  
15287-88

**TESS advanced Renewable Energy Basic Set necessary accessories for 1 group**  
13480-88

# Solar energy, wind energy, hydropower

## Student experiments



### 26 Experiments

#### Electrical energy from solar energy

1. Influence of illumination level on voltage and current of a solar cell
2. Influence of surface area of solar cell on voltage and current
3. Voltage and current in a series connection of solar cells
4. Voltage and current in a parallel connection of solar cells
5. The solar cell as a power source for LED
6. The solar cell as a diode
7. Voltage and current of a solar cell as a function of light intensity
8. Storage of electrical energy of a solar cell with the aid of a rechargeable battery
9. Solar-dark characteristic curve
10. The characteristic current-voltage curves of solar cells
11. Storage of the electric energy from a solar cell in a capacitor

#### Wind energy

12. Electrical energy from wind energy
13. Influence of wind speed

14. Influence of wind direction
15. Wind energy under load
16. Influence of number of rotor blades
17. Storage of electrical energy from wind energy with the aid of a rechargeable battery
18. Storage of the electric energy won from wind energy in a capacitor
19. Current-voltage characteristic of the wind wheel

#### Hydropower

20. Pumping water using solar energy
21. Pumping water using wind energy
22. Efficiency of the pump in the conversion of electric energy to potential energy

23. Running water drives a generator

#### Parabolic trough power plant

24. Heating water using a parabolic trough
25. How heating is influenced by the position of the absorber in the parabolic trough
26. Model of a parabolic trough field

"TESS makes the experiments easier to understand, more informative and also more interesting for a young generation of modern students, a fact that is particularly important to me."

Filippova Ilze Yanovna, Physics teacher  
St. Petersburg, Russia

## Necessary equipment

TESS advanced Applied Sciences supplementary set  
Renewable Energy Solar / Water / Wind  
15288-88

TESS advanced Applied Sciences Basic Set Renewable  
Energy basics and thermal energy  
15287-88

TESS advanced Renewable Energy Basic Set necessary  
accessories f for 1 group  
13480-88

## Experiment descriptions



Software interTESS Applied Science, Renewable Energy,  
DVD  
01081-00



## Measuring current, voltage work and power with Cobra4



The Cobra4 Sensor-Unit Energy is used for the measurement and direct indication of measurement variables of the electrical power and energy in direct current and alternating current circuits (current, voltage, effective and apparent power, angular phase shift, frequency, electric work).

This sensor measures directly the values for alternating current and direct current. This allows numerous basic as well as application-oriented experiments, e.g. the determination of the characteristics of alternating current resistances or the investigation of the energy demand of consumers.

**Cobra4 Sensor-Unit Energy: Current, voltage, work, power**  
12656-00

**Cobra4 Mobile-Link 2 incl. accessories: battery, USB cable, charger and SD memory card**  
12620-10



# Fuel cells

## Student experiments



### 10 Experiments

#### Hydrogen technology

1. Generation of hydrogen and oxygen using a PEM electrolyser
2. Generation of electric energy using a PEM fuel cell
3. Solar-hydrogen system
4. Wind-hydrogen system
5. Characteristic curve of a PEM electrolyser
6. Faraday efficiency and energetic efficiency of a PEM electrolyser
7. Current-voltage characteristic of a PEM fuel cell
8. Faradic and energetic efficiencies of a PEM fuel cell
9. The efficiency of a electrolyser-fuel cell system
10. Current-voltage characteristic of an air breathing fuel cell

### Necessary equipment

**TESS advanced Applied Sciences supplementary set  
Renewable Energy Fuel Cells  
15286-88**

**TESS advanced Applied Sciences Basic Set Renewable  
Energy basics and thermal energy  
15287-88**

**TESS advanced Renewable Energy Basic Set necessary  
accessories f for 1 group  
13480-88**

### Experiment descriptions



**Software interTESS Applied Science, Renewable Energy,  
DVD  
01081-00**

# Energy conversion, thermal energy

## Teacher experiments

Demo **PHYWE**  
advanced



### 10 Experiments

#### Energy conversion

1. Conversion of light into motion with a solar cell
2. Conversion of thermal energy into electrical energy and into motion
3. Conversion of electrical energy into thermal energy
4. Conversion of electrical energy into mechanical energy and vice versa

#### Heat energy from solar energy

5. Influence of the surface on the absorption of solar energy
6. The greenhouse effect
7. Heating water in a solar collector

#### Energy from ambient heat

8. Peltier effect
9. Peltier effect: Heat pump
10. Pilot experiment for the use of ambient heat with the help of the peltier heat pump



### Experiment descriptions



Demo advanced Applied Sciences Manual Renewable Energy on the magnetic board, incl CD ROM  
01157-02

### Necessary equipment

DEMO advanced Applied Sciences Basic Set Renewable Energy basics and thermal energy  
15580-88

DEMO advanced Renewable Energy Basic Set , necessary accessories  
15580-01

Cobra4 wireless, extension set for renewable energy: electric parameters, temperature case  
12608-88

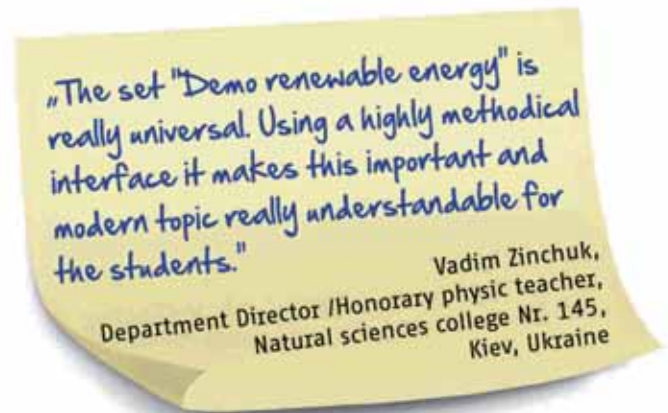
Demo Physics board with stand  
02150-00

#### Advantages of the set:

- ✓ Sturdy magnetic components
- ✓ Realistic component design
- ✓ Perfectly adapted to the student experiments

# Solar and wind energy, hydropower

## Teacher experiments



### 17 Experiments

#### Electrical energy from solar energy

1. Voltage and current of a solar cell - Influence of surface area and lighting
2. Voltage and current in a series and parallel connection of solar cells
3. Operating a LED with solar energy
4. The solar cell as a diode
5. Storage of electrical energy of a solar cell with the aid of an accumulator
6. Storage of electrical energy of a solar cell with the aid of an capacitor
7. The characteristic current-voltage curves of a solar cell

#### Wind energy

8. Electrical energy from wind energy - Influence of wind speed and load
9. Influence of number of rotor blades
10. Storage of electric energy from wind energy with an accumulator
11. Storage of electric energy from wind energy with an capacitor
12. Current-voltage characteristic of a wind wheel

#### Hydropower

13. Pumping water using solar energy
14. Pumping of water using wind energy
15. Running water driving a generator - determination of the power

#### Parabolic trough

16. Heating water using a parabolic trough
17. Model of a field of a parabolic troughs

### Experiment descriptions



**Demo advanced Applied Sciences Manual Renewable Energy on the magnetic board, incl CD ROM**  
01157-02

### Necessary equipment

**DEMO advanced Applied Sciences Renewable Energy supplementary set Solar cells, Wind energy, Hydropower**  
15581-88

**DEMO advanced Applied Sciences Basic Set Renewable Energy basics and thermal energy**  
15580-88

**DEMO advanced Renewable Energy Basic Set , necessary accessories**  
15580-01

**Cobra4 wireless, extension set for renewable energy: electric parameters, temperature case**  
12608-88

**Demo Physics board with stand**  
02150-00

# Fuel cells

## Teacher experiments

**Demo** PHYWE  
advanced



### 7 Experiments

#### Fuel cells

1. Generation of hydrogen and oxygen and the characteristic curve of a PEM electrolyser
2. Faraday efficiency and energetic efficiency of a PEM electrolyser
3. Generation of electric energy with a PEM fuel cell / Solar hydrogen system
4. Wind-hydrogen system
5. Current-voltage characteristic and power of a PEM fuel cell
6. Faraday efficiency and energetic efficiency of a PEM fuel cell
7. The efficiency of a electrolyser-fuel cell system

#### Advantages of the set:

- ✓ Fuel cells: the central components of hydrogen technology
- ✓ The electrolyser and fuel cell supply enough energy for driving a small motor
- ✓ Enables the model set-up of a complete solar-hydrogen or wind-hydrogen system (model of a power plant)

### Necessary equipment

**DEMO advanced Applied Sciences Renewable Energy supplementary set Fuel Cells**  
15582-88

**DEMO advanced Set Fuel Cells, necessary accessories**  
15582-01

**DEMO advanced Applied Sciences Basic Set Renewable Energy basics and thermal energy**  
15580-88

**DEMO advanced Renewable Energy Basic Set , necessary accessories**  
15580-01

**Cobra4 wireless, extension set for renewable energy: electric parameters, temperature case**  
12608-88

**Demo Physics board with stand**  
02150-00

### Experiment descriptions



**Demo advanced Applied Sciences Manual Renewable Energy on the magnetic board, incl CD ROM**  
01157-02



# Basic electrics

## Student experiments



### 29 Experiments

#### Electric circuits

1. The simple electrical circuit
2. Measurement of voltage
3. Measurement of current
4. Conductors and non-conductors
5. Changeover switches and alternating switches
6. Parallel and series connection of voltage sources
7. The safety fuse
8. The bimetallic switch

#### Electrical resistance

9. Ohm's law
10. The resistance of wires - dependence on the length and cross-section
11. The resistivity of wires
12. Current and resistance in a parallel connection
13. Current and resistance in a series connection
14. Voltage in a series connection
15. The potentiometer

16. The internal resistance of a voltage source

#### Power and work

17. Electrical power and work

#### Conversion of energy

18. Conversion of electrical energy into thermal energy

#### Electrochemistry

19. Conductivity of aqueous solutions of electrolytes
20. Connection between voltage and current in conductive processes in liquids
21. Electrolysis
22. Galvanisation
23. Galvanic cells
24. The lead accumulator

#### Working safely with electricity

25. Earthing of the power supply line
26. The protective conductor system

#### Sensors

27. The NTC resistor
28. The PTC resistor
29. The light dependent resistor

## Experiment descriptions



Software interTESS Physics, Electrics / Electronics, DVD  
01054-00

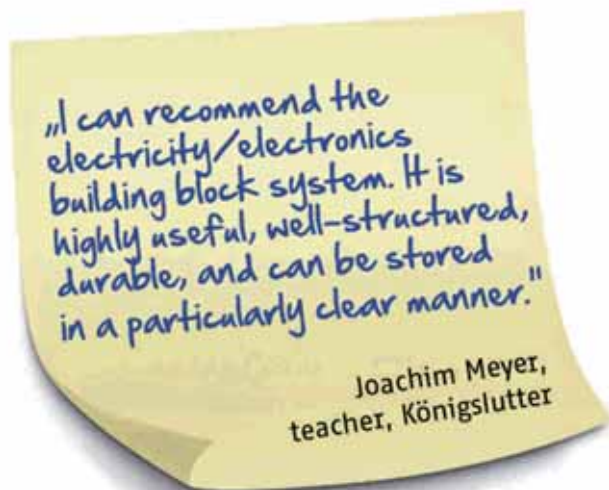
TESS Physics Electric/Electronic Building Block System  
01006-02

## Necessary equipment

TESS advanced Physics Electricity/Electronics Building  
Block System, Basic Set electricity  
15265-88

TESS advanced Electronics Basic Set necessary  
accessories for 1 group  
13470-88

TESS advanced Electronics Basic Set consumables for 10  
groups  
13471-88



## 6 Experiments with Cobra4



The following experiments of the set Electrics can be performed alternatively with the Cobra4 extension set Electrics.

1. The resistance of wires - dependence on the length and cross-section
2. Current and resistance in a parallel connection
3. Current and resistance in a series connection
4. The potentiometer
5. Electrical power and work
6. Electrolysis

Cobra4 extension set for TESS advanced Electrics  
15268-88

# Electromagnetism and Induction

## Student experiments



### 19 Experiments

#### Electromagnetism

1. The magnetic effect of a current-carrying conductor
2. A current-carrying conductor in a magnetic field
3. The electric bell
4. The electromagnetic relay
5. Controlling with a relay
6. The light-sensitive switch
7. The galvanometer

#### Electric motors

8. The permanent magnet DC motor
9. The series motor
10. The shunt motor

#### Electromagnetic induction

11. Generation of an induced voltage with permanent magnets
12. Generation of an induced voltage with electromagnets
13. The alternating current generator

#### Transformers

14. Voltage transformation
15. Current transformation

#### Self-Induction

16. Self-induction when switching a circuit on
17. Self-induction when switching a circuit off
18. Coils in alternating current circuits

#### Safe Working with Electrical Energy

19. The protective isolation transformer

### Necessary equipment

TESS advanced Physics Electricity/Electronics Building Block System, supplementary set Electromagnetism and Induction  
15266-88

TESS advanced Physics Electricity/Electronics Building Block System, Basic Set electricity  
15265-88

TESS advanced Electronics Basic Set necessary accessories for 1 group  
13470-88

TESS advanced Electronics EB 1 consumables for 10 groups  
13471-88



### Experiment descriptions



Software interTESS Physics, Electrics / Electronics, DVD  
01054-00

TESS Physics Electric/Electronic Building Block System  
01006-02

### 2 Experiments with Cobra4



The following experiments of the set Electrics can be performed alternatively with the Cobra4 extension set Electrics:

1. The permanent magnet DC motor
2. The series motor

**Cobra4 extension set for TESS advanced Electrics  
15268-88**



# Electronics

## Student experiments



### 24 Experiments

#### Capacitor

1. Capacitors in direct current circuits
2. Charging and discharging a capacitor
3. Capacitors in alternating current circuits

#### Diode, part 1

4. Diodes as electrical valves
5. Diodes as rectifiers
6. The characteristic curve of a silicon diode
7. Properties of solar cells
8. Current-voltage characteristic of a solar cell

#### Transistor, part 1

9. The NPN transistor
10. The transistor as a direct current amplifier
11. The current-voltage characteristic of an NPN transistor
12. The transistor as a switch
13. The transistor time-delay switch

#### Diode, part 2

14. Characteristic curve of a Zener diode
15. The Zener diode as voltage stabiliser
16. Light-emitting diodes
17. Photo diodes

18. Bridge rectifiers

19. Filter networks

#### Transistor, part 2

20. The transistor as a voltage amplifier
21. Stabilisation of the operating point
22. Controlling a transistor with a photoresistor
23. Temperature control of a transistor
24. Undamped electromagnetic oscillations

### Experiment descriptions



Software interTESS Physics, Electrics / Electronics, DVD  
01054-00

TESS Physics Electric/Electronic Building Block System  
01006-02



### Necessary equipment

TESS advanced Physics Electricity/Electronics Building Block System, supplementary set Electronics 15267-88

TESS advanced Electronics consumables for 10 groups 13473-88

TESS advanced Physics Electricity/Electronics Building Block System, Basic Set electricity 15265-88

TESS advanced Electronics Basic Set necessary accessories for 1 group 13470-88

TESS advanced Electronics Basic Set consumables for 10 groups 13471-88

### 4 Experiments with Cobra4



The following experiments of the set Electrics can be performed alternatively with the Cobra4 extension set Electrics.

1. Charging and discharging a capacitor
2. Diodes as electrical valves
3. The diode as a rectifier
4. Bridge rectifiers

**Cobra4 extension set for TESS advanced Electrics 15268-88**

# Magnetism

## Student experiments



### Measuring magnetic field strength with Cobra4



Sensor-Unit out of the Cobra4 family to measure the magnetic field strength in DC and AC fields. This Sensor is suitable for the connection of the- Hall probe, axial or- Hall probe, tangential.

### 11 Experiments

#### Magnetic interaction

1. Magnetic and non-magnetic substances
2. Magnetic poles and polarity
3. Magnetic attraction (distant effect)

#### Magnetic induction

4. Magnetisation and de-magnetisation
5. Breaking down magnets (elementary magnets)
6. Combining magnets

#### Magnetic Fields

7. Representation of the field lines of a bar magnet
8. Direction of the field lines of a bar magnet
9. Pattern produced by the field lines of two like poles
10. Pattern produced by the field lines of two unlike poles
11. The earth's magnetic field

### Necessary equipment

TESS advanced Physics Set Magnetism  
15230-88

TESS advanced Magnetism consumables for 10 groups  
13409-88

Cobra4 Sensor Tesla, Set with 2 hall probes  
12652-88

Cobra4 Mobile-Link 2 incl. accessories: battery, USB cable, charger and SD memory card  
12620-10

### Experiment descriptions



Software interTESS Physics, Electrostatics / Magnetism, Equipotential lines, DVD  
01055-00

TESS advanced Physics manual Magnetism  
01162-02

# Electrostatics

## Student experiments



### 16 Experiments

#### Contact electricity

1. Demonstration of the type of charge on rubbed rods
2. Demonstration of the type of charge on films and plates

#### Electrostatic force

3. Forces between charged bodies
4. A model of an electroscope
5. The mode of operation of an electroscope

#### Electrostatic induction

6. Electrostatic induction with conductors and non-conductors
7. The effect of a force of electrostatic induction (imagecharge)
8. Electrostatic induction with an electroscope

#### Storing charge

9. A conductor as a capacitor
10. Charge distribution in a Faraday cup
11. Storing of positive and negative charges
12. Charge transport with a pendulum

#### Insulators and conductors

13. The mobility of charges in insulators and conductors
14. Testing conductivity with an electroscope
15. Discharging by ionisation
16. Discharging at points

### Necessary equipment

TESS advanced Physics set Electrostatics  
15240-88

TESS advanced Electrostatics consumables for 10 groups  
13410-88

### Experiment descriptions



Software interTESS Physics, Electrostatics /  
Magnetism, Equipotential lines, DVD  
01055-00

TESS advanced Physics manual Electrostatics  
01163-02





# Electric motor / generator

## Student experiments



### 10 Experiments

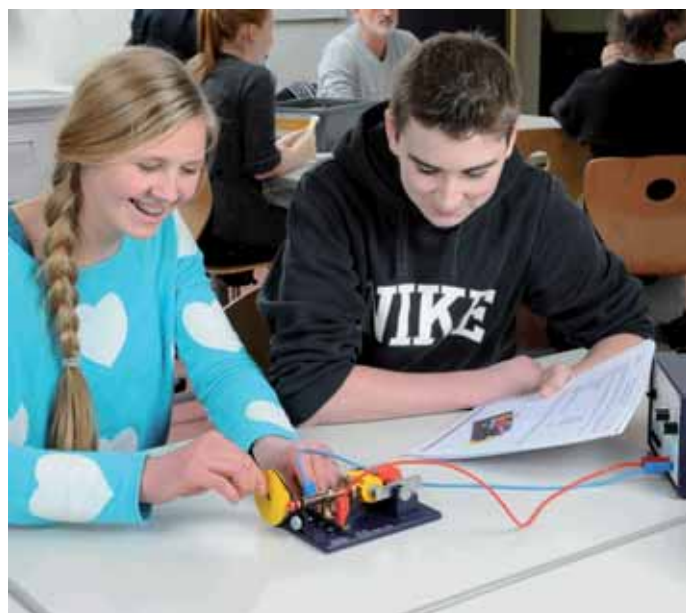
1. Magnetic field of a coil
2. Conversion of electrical energy into kinetic energy
3. Commutator
4. Direct current motor
5. Synchronous motor
6. Series and shunt-wound motor
7. Electromagnetic induction
8. The electrical generator
9. Engine-generator
10. Transformer

### Necessary equipment

TESS advanced Physics set Electric motor/ Generator  
15221-88

TESS advanced Electric Motor / Generator necessary  
accessories for 1 group  
13412-88

TESS advanced Electric Motor / Generator consumables  
for 10 groups  
13413-88



### Experiment descriptions



TESS advanced Physics Handbook Electric Motor /  
Generator (English)  
07880-02

# Electric fields

## Student experiments



### 5 Experiments

1. Electric fields
2. Electric field strength
3. Inhomogeneous electric fields (dipole fields)
4. The electric conductor as an equipotential surface
5. Electrostatic tip-shape effect

### Necessary equipment

TESS advanced Physics set Equipotential lines and electric fields  
15250-88

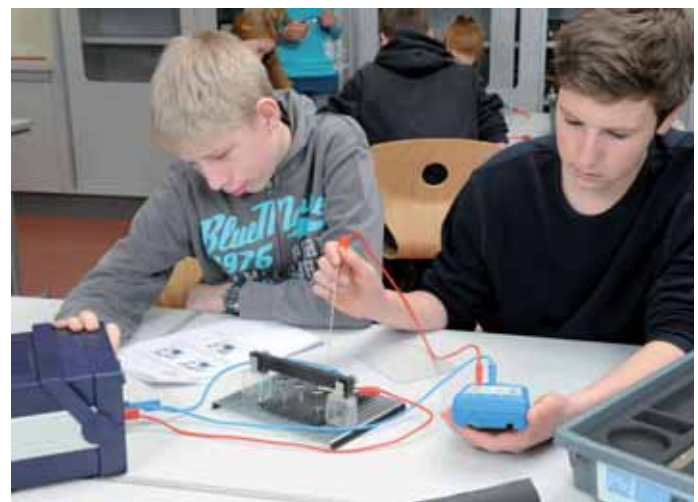
TESS advanced Equipotential lines necessary accessories for 1 group  
13411-88

### Experiment descriptions



Software interTESS Physics, Electrostatics / Magnetism, Equipotential lines, DVD  
01055-00

TESS advanced Physics manual Equipotential lines and Electric field  
13029-02



### Advantages of the set:

- ✓ No electrolyte required
- ✓ Direct measurement of the potentials with a high-resistance voltmeter
- ✓ Direct transfer of the measuring points on a white sheet of paper during the measurement

# Basic electrics

## Teacher experiments

NEW



### 31 Experiments

#### Electric circuits

1. The simple circuit
2. Voltage measurement
3. Current measurement
4. Conductors and non-conductors
5. Changeover switches and alternating switches
6. Series and parallel connection of sources of voltage
7. The safety fuse
8. The bimetallic switch
9. And- and Or circuit

#### Electrical resistance

10. Ohm's law
11. The resistance of wires - dependence on the length and cross-section
12. The resistance of wires- dependence on the material and temperature
13. The resistivity of wires
14. Current and resistance in a parallel connection
15. Current and resistance in a series connection
16. Voltage in a series connection
17. The potentiometer
18. The internal resistance of a voltage source

#### Electric power and work

19. The power and work of the electric current

#### Transformation of Energy

20. Conversion of electrical energy into thermal energy

#### Electrochemistry

Conversion of electrical energy into mechanical energy and vice versa

21. Conductivity of aqueous solutions of electrolytes
22. The connection between current and voltage in conductive processes in liquids
23. Electrolysis
24. Galvanisation
25. Galvanic cells
26. The lead accumulator

#### Safe working with electricity

27. Earthing of the power supply line
28. The protective conductor system

#### Sensors

- The protective isolation transformer
29. The NTC resistor
  30. The PTC resistor
  31. The light dependent resistor



### Necessary equipment

DEMO advanced Physics Electricity/Electronics Building Block System, electricity  
15570-88

DEMO advanced Electricity necessary accessories  
15570-01

Demo Physics board with stand  
02150-00

### Experiment descriptions



Electricity/Electronics on the Magnetic Board,  
Handbook  
01005-02



# Electromagnetism and Induction

## Teacher experiments



### 27 Experiments

#### Transformation of energy

1. Conversion of electrical energy into mechanical energy and vice versa

#### Electromagnetism

2. The magnetic effect of a current-carrying conductor
3. The Lorentz force: current-carrying conductors in a magnetic field
4. The electric bell
5. The electromagnetic relay
6. Controlling with a relay
7. The light-sensitive switch
8. The galvanometer

#### Electric motors

9. The permanent magnet motor
10. The series motor
11. The shunt motor
12. The synchronous motor

#### Induction

13. Generation of induced voltages with a permanent magnet
14. Generation of induced voltages with an electromagnet
15. The alternating current generator

16. The direct current generator

17. Lenz's law

18. The behaviour of a direct current generator under load

#### Transformers

19. Voltage transformation

20. Current transformation

21. The forces between the primary and secondary coils of a transformer

22. The high-current transformer

#### Self-induction

23. Self-induction when switching a circuit on

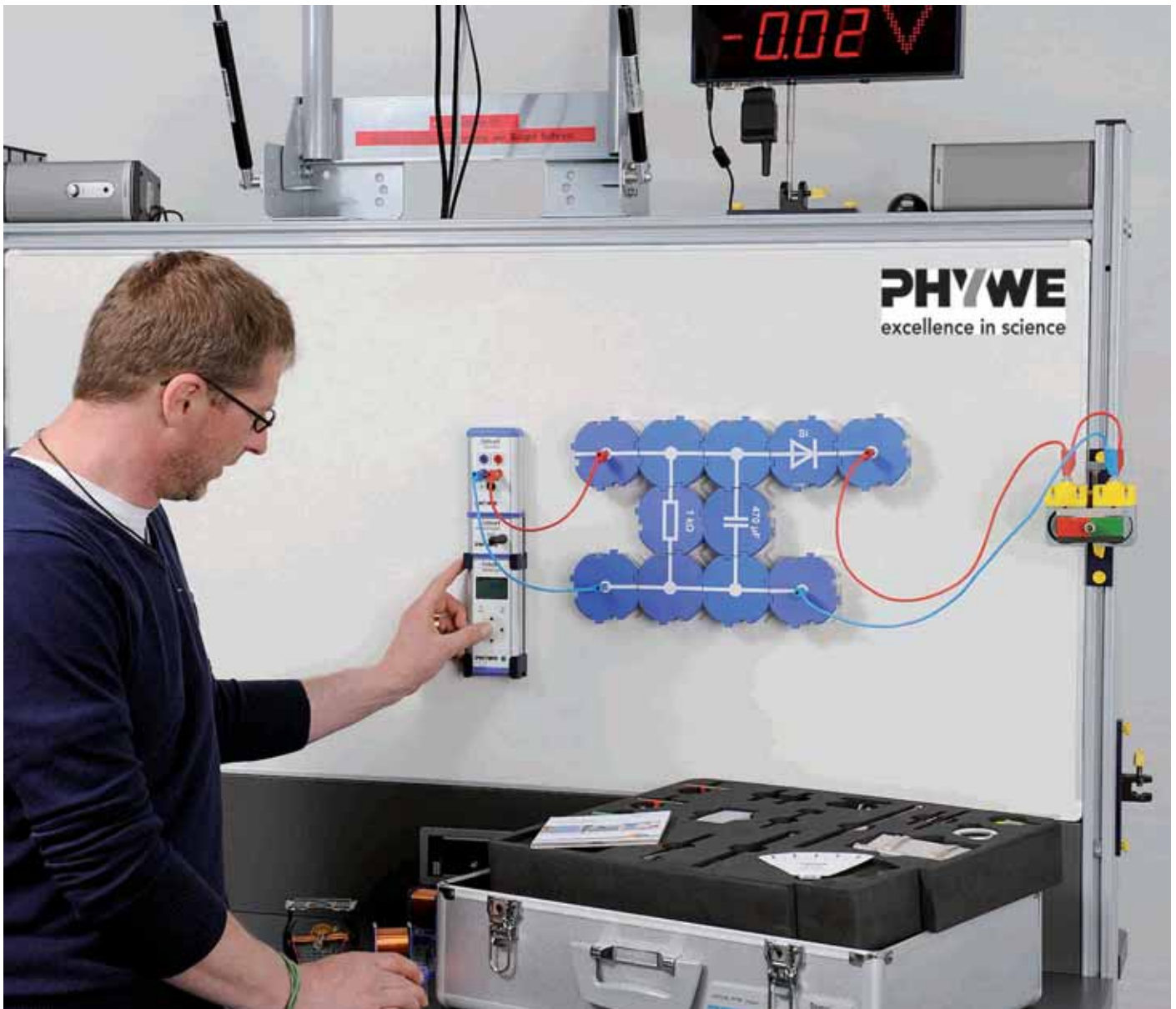
24. Self-induction when switching a circuit off

25. The coil in the alternating current circuit

26. Behaviour of a coil when a circuit is switched on - current and voltage over time

#### Safe working with electricity

27. The protective isolation transformer



### Necessary equipment

DEMO advanced Physics Electricity/Electronics Building Block System, supplementary set Electromagnetism and Induction  
15571-88

DEMO advanced Electromagnetism and induction necessary accessories  
15571-01

Demo Physics board with stand  
02150-00

DEMO advanced Physics Electricity/Electronics Building Block System, electricity  
15570-88

DEMO advanced Electricity necessary accessories  
15570-01

### Experiment descriptions



Electricity/Electronics on the Magnetic Board, Handbook  
01005-02

# Electronics

## Teacher experiments



### 31 Experiments

#### Capacitor

1. Capacitors in direct current circuits
2. Charging and discharging a capacitor
3. Capacitors in alternating current circuits

#### Diode, part 1

4. Diodes as electrical valves
5. Diodes as rectifiers
6. Characteristics of a silicon diode
7. Properties of solar cells - dependence on the illuminance
8. The current-voltage characteristic of a solar cell
9. Series and parallel connection of solar cells - open-circuit voltage and short-circuit current
10. Series and parallel connection of solar cells - current-voltage characteristics and power

#### Diode, part 2

11. Characteristic curve of a Zener diode
12. The Zener diode as voltage stabiliser
13. Light-emitting diodes
14. Photo diodes

15. Bridge rectifiers
16. Filter networks

#### Transistor, part 1

17. The NPN transistor
18. The transistor as a direct current amplifier
19. The current-voltage characteristic of a transistor
20. The transistor as a switch
21. The transistor time-delay switch
22. The PNP transistor

#### Transistor, part 2

23. Alternating voltage amplification with a transistor
24. Stabilisation of the operating point of a transistor amplifier stage
25. Controlling a transistor with light
26. Temperature control of a transistor
27. Undamped electromagnetic oscillations
28. The Darlington circuit
29. The two-stage transistor amplifier
30. The mode of operation of phototransistors
31. Optical fibre communication

## Necessary equipment

DEMO advanced Physics Electricity/Electronics Building Block System, supplementary set Electronics  
15572-88

DEMO advanced Electronics necessary accessories  
15572-01

Demo Physics board with stand  
02150-00

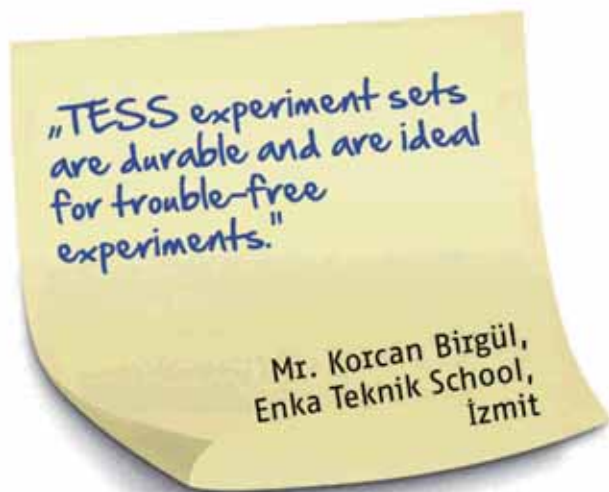
DEMO advanced Physics Electricity/Electronics Building Block System, electricity  
15570-88

DEMO advanced Electricity necessary accessories  
15570-01

## Experiment descriptions



Electricity/Electronics on the Magnetic Board,  
Handbook  
01005-02



## Measuring current and voltage with Cobra4



The Cobra4 Sensor-Unit Electricity is a secured measuring sensor, which can be connected to the Cobra4 Wireless-Link, the Cobra4 Mobile-Link, the Cobra4 Junior-Link or the Cobra4 USB-Link using a secure and reliable plug-in / lockable connection. The sensor has a voltage difference input. Simultaneous measurement of current and voltage is possible

**Cobra4 Sensor-Unit Electricity**  
12644-00

**Cobra4 Mobile-Link 2 incl. accessories: battery, USB cable, charger and SD memory card**  
12620-10



# Optics 1

## Student experiments



### 36 Experiments

#### Propagation of light

1. Rectilinear propagation of light
2. Transparent and opaque objects  
Shadows (umbra and penumbra)
3. Solar and lunar eclipses (with the light box)

#### Mirrors

4. Reflection of light
5. Reflection by a plane mirror
6. Images in a plane mirror
7. Reflection by a concave mirror
8. Image construction for a concave mirror
9. Reflection by a convex mirror
10. Image construction for a convex mirror

#### Refraction

11. Refraction at the air-glass boundary
12. Determining the refractive index of glass
13. Refraction at the air-water boundary
14. Refraction at the boundary between two liquids
15. Refraction at the glass-air boundary
16. Total reflection and the critical angle
17. Passage of light through a planoparallel plate
18. Refraction at a prism

19. Deviating prisms
20. Reversing prisms

#### Lenses

21. Light path and focal length of a convex lens
22. Image construction for a convex lens
23. Light path and focal length of a concave lens
24. Image construction for a concave lens
25. Light path of lens combinations
26. Focal length of lens combinations
27. Spherical aberration
28. Chromatic aberration

#### Colours

29. Colour dispersion with a prism
30. Reunification of spectral colours
31. Complementary colours

#### The human eye

32. Mode of operation of the human eye (normal vision)
33. Short-sightedness and its correction
34. Long-sightedness and its correction
35. Defective accommodation in old age and its correction
36. Optical illusions

## Necessary equipment

TESS advanced Physics Basic Set Optics 1  
15276-88

TESS advanced Optics 1 necessary accessories for 1  
group  
13460-88

TESS advanced Optics 1 consumables for 10 groups  
13461-88

## Experiment descriptions



Software interTESS Physics, Optics & Wave Optics, DVD  
01053-00

TESS Physics manual Optics  
01164-02



## Optional extension set



The following 4 Experiments are possible with 13250-77:

1. Shadows (umbra and penumbra)
2. Additive colour mixing
3. Subtractive color mixing
4. Colours of objects

TESS advanced Physics supplementary Set Colour mixing  
13250-77



# Optics 2

## Student Experiments



### 30 Experiments

#### Propagation of light

1. Day and night
2. The seasons
3. The phases of the moon
4. Solar and lunar eclipses (with the earth-moon model)
5. The pinhole camera
6. Luminous intensity (photometer)
7. Illuminance (inverse square law)

#### Mirrors

8. Projected image with a concave mirror
9. Law of imagery for a concave mirror
10. Determining the magnification of a concave mirror
11. Images in a convex mirror

#### Lenses

12. Image obtained with a convex lens
13. Determining the focal length of a convex lens
14. Law of imagery for a convex lens

15. Determining the magnification of a concave lens
16. Image obtained with a concave lens
17. Pincushion and barrel distortion

#### Optical equipment

18. The magnifying glass
19. The structure of a microscope
20. Determining the magnification of a microscope
21. The astronomical telescope
22. The Galilean telescope
23. Determining the magnification of a telescope
24. The camera

25. The depth of focus of a camera

26. The slide projector

#### Wave optics

27. Diffraction at a grid
28. Determination of the wavelength by grid diffraction
29. Polarisation with filters
30. Rotation of the polarisation plane with a sugar solution



## Necessary equipment

TESS advanced Physics supplementary set Optics 2  
15277-88

TESS advanced Optics 2 consumables for 10 groups  
13462-88

TESS advanced Physics supplementary Set Colour mixing  
13250-77

TESS advanced Physics Basic Set Optics 1  
15276-88

TESS advanced Optics 1 necessary accessories for 1  
group  
13460-88

TESS advanced Optics 1 consumables for 10 groups  
13461-88

TESS Physics manual Optics  
01164-02

TESS Physics manual Wave Optics  
01167-02

*"The TESS optics equipment is sturdy, basically indestructible, and the entire product range is well-structured and very extensive."*

Mr. Becker  
Friedrich-Ebert-Schule

## Experiment descriptions



Software interTESS Physics, Optics & Wave Optics, DVD  
01053-00



# Wave Optics

## Student experiments



### Necessary equipment

TESS advanced Physics supplementary set Optics 3  
15280-88

TESS advanced Optics 3 consumables for 10 groups  
13463-88

TESS advanced Physics supplementary set Optics 2  
15277-88

TESS advanced Optics 2 consumables for 10 groups  
13462-88

TESS advanced Physics supplementary Set Colour mixing  
13250-77

TESS advanced Physics Basic Set Optics 1  
15276-88

TESS advanced Optics 1 necessary accessories for 1  
group  
13460-88

TESS advanced Optics 1 consumables for 10 groups  
13461-88

### Experiment descriptions



Software interTESS Physics, Optics & Wave Optics, DVD  
01053-00

TESS Physics manual Optics  
01164-02

TESS Physics manual Wave Optics  
01167-02

### 23 Experiments

#### Interference

1. Young's double slit experiment

#### Diffraction from unidimensional objects

Newton's rings

2. Diffraction at an edge

3. Diffraction at a slit

4. Diffraction at a narrow obstacle (line) - Babinet's principle

5. Diffraction at a double slit

6. Diffraction at multiple slits

7. Diffraction at a grating

8. Determination of the wavelength by grid diffraction

9. Coherence condition

#### Diffraction from two-dimensional objects

10. Diffraction at a crossed grating

11. Diffraction at circular apertures

12. Diffraction at a system of circular apertures of equal size

#### Resolving power

13. Resolving power of optical devices

14. Resolving power of the microscope

15. Spectral resolving power of a grating

#### Qualitative experiments on polarisation

16. Polarisation by filters

17. Polarisation by strain double refraction (birefringence)

18. Chromatic polarisation

19. Polarisation by reflection

20. Polarisation by refraction

21. Polarisation by dispersion

#### Quantitative experiments on polarisation

22. Brewster's law

23. Rotation of the polarisation plane in a sugar solution

### Optional extension set



The following 6 experiments are possible with the extension set:

1. Fresnel's double mirror experiment

2. Fresnel's biprism experiment

3. Newton's rings

4. Malus' law

5. Birefringence in calcite

6. Elliptic and circular polarisation

TESS advanced Optics OE 3 optional accessories for 1  
group  
13464-88

# Optics / Atomic physics

## Student experiments



### 17 Experiments

#### Spectroscopic analysis

1. Why is the sky blue?
2. What does the spectrum of a light-emitting diode (LED) looklike?

#### Diffraction on a grating

3. What does the LED spectrum look like with a transmissiongrating?

#### Diffraction on everyday life's objects

4. What is the groove spacing on a CD?
5. What can one learn from diffraction patterns?

#### Absorption and fluorescence

6. How is light attenuated when it passes through matter?
7. When does a substance fluoresce?
8. How is light attenuated by liquids?

#### h-Determination with light emitting diodes

9. How are the energy and the colour of light connected?

#### Bandgap of semiconductors

10. When is a light-emitting diode a receiver?

#### Investigation of solar cells and fotodiodes

11. How does the intensity of light decrease a function of thedistance?
12. What does the photoelectric current of a solar cell dependon?

#### Electric and optical properties of LED

13. At which wavelength does an LED emit light?
14. What does the UI characteristic of an LED look like?

#### Polarisation of light

15. How does light oscillate?
16. How can light be "distorted"?
17. Stress pattern made visible

### Necessary equipment

TESS advanced Physics set Optics / Atomic physics  
15350-88

TESS advanced Optics / Atomphysics necessary  
accessories for 1 group  
13466-88

### Experiment descriptions



Software interTESS Physics, Optics / Atomic Physics, DVD  
01056-00

# Optics

## Teacher experiments

NEW



### Necessary equipment

DEMO advanced Physics Set Optics  
15550-88

DEMO advanced Optics necessary accessories  
15550-01

Demo Physics board with stand  
02150-00

### Experiment descriptions



Phys. Exp. Magnet Board Optics, Manual  
01151-02

"I can recommend the physics/optics equipment for the magnetic and demonstration board. The major aspects of light refraction and reflection can be demonstrated in a particularly quick and memorable way."

Dr. M. Furtkamp  
teacher, Realschule1, Stolberg



## 60 Experiments

### Propagation of light

1. Rectilinear propagation of light
2. Shadow formation by a point light source
3. Umbra and penumbra with two point light sources
4. Umbra and penumbra with an extensive light source
5. Length of shadows
6. Solar and lunar eclipses with a point light source
7. Solar and lunar eclipses with an extensive light source

### Mirrors

8. Reflection of light
9. The law of reflection
10. Formation of an image point by a plane mirror
11. Image formation by a plane mirror
12. Applications of reflection by plane mirrors
13. Reflection of light by a concave mirror
14. Properties of a concave mirror
15. Real images with a concave mirror
16. Law of imagery and magnification of a concave mirror
17. Virtual images with a concave mirror
18. Aberrations with a concave mirror (catacaustics)
19. Reflection of light by a convex mirror
20. Properties of a convex mirror
21. Image formation by a convex mirror
22. Law of imagery and magnification of a convex mirror
23. Reflection of light by a parabolic mirror

### Refraction

24. Refraction of light at the air-glass boundary
25. Refraction of light at the air-water boundary
26. The law of refraction (quantitative)
27. Total reflection of light at the glass-air boundary
28. Total reflection of light at the water-air boundary
29. Passage of light through a planoparallel glass plate
30. Refraction by a prism

31. Light path through a reversing prism
32. Light path of through a deviating prism
33. Light transmission by total reflection

### Lenses

34. Refraction of light by a convergent lens
35. Properties of a convergent lens
36. Real images with a convergent lens
37. Law of imagery and magnification of a convergent lens
38. Virtual images with a convergent lens
39. Refraction of light at a divergent lens
40. Properties of a divergent lens. OT 4.7
41. Image formation by a divergent lens
42. Law of imagery and magnification of a divergent lens
43. Lens combination consisting of two convergent lenses
44. Lens combination consisting of a convergent and a divergent lens
45. Spherical aberration
46. Chromatic aberration

### Colours

47. Colour dispersion with a prism
48. Non-dispersivity of spectral colours
49. Reunification of spectral colours
50. Complementary colours
51. Additive colour mixing
52. Subtractive colour mixing

### The human eye

53. Structure and function of the human eye
54. Short-sightedness and its correction (myopia)
55. Long-sightedness and its correction (hyperopia)

### Optical equipment

56. The magnifying glass
57. The camera
58. The astronomical telescope
59. The Newtonian reflecting telescope
60. Herschel's reflecting telescope



# Radioactivity

## Student experiments

TESS  
advanced | PHYWE



### 14 Experiments

#### Examination of naturally occurring radioactive substances

1. The background effect
2. Statistical fluctuations in the count rates
3. Examination of rock samples
4. Examination of salts
5. Radioactive minerals as sources of different types of radiation

#### Types of radiation and their characteristics

6. The influence of distance on the intensity of radiation
7. Range and shielding of alpha radiation
8. Shielding of beta radiation
9. The inverse-square law for beta and gamma radiation
10. The deflection of beta radiation in a magnetic field
11. The behaviour of gamma radiation in a magnetic field
12. The back-scattering of beta radiation

#### Technical applications of nuclear radiation

13. Level control
14. Layer thickness determination

### Necessary equipment

TESS advanced Physics set Radioactivity  
15261-88

TESS Radioactivity consumables for 10 groups  
13468-88

### Experiment descriptions



Software interTESS Physics, Radioactivity, DVD  
01057-00

TESS advanced Physics manual Radioactivity  
01155-02



### Measuring count rates with Cobra4



The Cobra4 Sensor-Unit Radioactivity allows the measurement of radioactive radiation (alpha, beta and gamma) with the aid of a Geiger-Mueller counter tube. In combination with the highly sensitive counting tube even natural radioactive radiation can be measured. An integrated speaker makes the counted pulses audible.

**Cobra4 Mobile-Link 2 incl. accessories: battery, USB cable, charger and SD memory card**  
12620-10

**Cobra4 Sensor-Unit Radioactivity**  
12665-00

**Geiger-Mueller Counter tube, 45 mm**  
09007-00

**Screened cable, BNC, l 750 mm**  
07542-11



# Radioactivity

## Teacher experiments



NEW

### 16 Experiments

#### Detection of radioactive radiation

1. Determination of counting rates with the Geiger-Müller counter

2. Background effect

#### Statistics of radioactive Processes

3. Statistical fluctuations and frequency distribution of counting rates

#### Natural radioactivity

4. Radioactivity of minerals

5. Radioactivity of potassium

6. Detection of radioactivity in the air

#### Characteristic properties of radioactive radiation

7. Range of alpha particles

8. Attenuation of beta rays

9. Deflection of beta- particles (electrons) in a magnetic field

10. Deflection of beta+ particles (positrons) in a magnetic field

11. Attenuation of gamma rays

12. The behaviour of gamma rays in a magnetic field

13. The inverse-square law for gamma rays

14. Determination of the radioactive half-life

#### Application of radioactive substances

15. Level control

16. Layer thickness determination



### Experiment descriptions



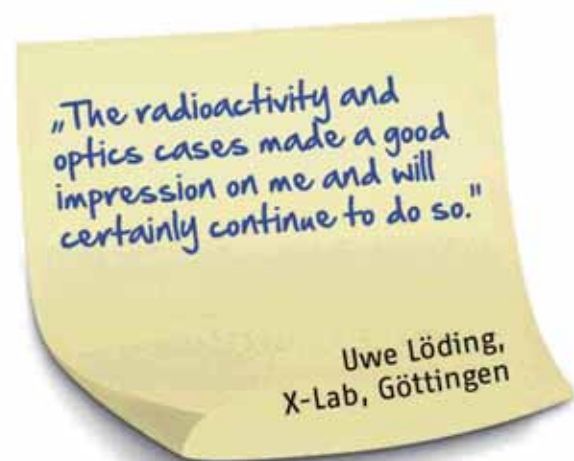
Phys.-Exp., Magnet Board, Radioact.  
01156-02

### Necessary equipment

DEMO advanced Physics set Radioactivity  
15590-88

DEMO advanced Radioactivity necessary accessories  
15590-01

Demo Physics board with stand  
02150-00



# X-ray physics

## Teacher experiments



### 7 Experiments

1. Radiographic examination of objects
2. Qualitative examination of the absorption of X-rays
3. Characteristic X-rays of tungsten
4. Counter tube characteristics
5. Duane-Hunt displacement law and Planck's quantum of action
6. The intensity of characteristic X-rays as a function of anode current and anode voltage
7. Absorption of X-rays

### Necessary equipment

XRE 4.0 X-ray expert set  
09110-88

XRP 4.0 X-ray Solid state physics upgrade set  
09120-88

### Experiment descriptions



TESS expert Physics Handbook X-Ray Experiments  
01200-02

"In a research laboratory students might see a research XRD machine, but with the XR 4.0 they really operate the X-ray machine: load crystal samples, set scan parameters, record patterns, and analyse their own data"

Pat McMillan, University of New South Wales, School of Physics, Australia



### XRE 4.0 expert set – Details at a glance

Experience the perfect synthesis of innovative technology, highest level of safety, well-proven PHYWE quality and modern design. Extensive performance characteristics and ideas make working with the PHYWE XR 4.0 a special experience.

We have presented some device highlights for you here.

#### Tube XChange Technology

- Self-adjusting X-ray tubes with quick-change technology
- Contact protection against hot parts
- 4 anode materials for specific experiments (W, Mo, Cu, Fe)



#### Touch Panel

- Simultaneous control, manually and by computer
- Interactive, intuitive handling
- Self-explanatory icons for fast operation

#### 3View – Insight provides a transparent view

- Exceptional observability of the experimentation space
- Extra-large window front on 3 sides (Diagonals: : 18"/18"/14", 46cm/46cm/36cm)



#### XXL Chamber

- Large space for large experiments
- Temperature-controlled, internally-ventilated experimentation space



**X-ray** | PHYWE  
XR 4.0

**Optical bench with riders**

- Radiography experiments
- simple, precise positioning of optical components



**S-Lock – new PHYWE Safety interlock**

- Electrical and mechanical safety lock
- Prevents door opening with switched on X-radiation
- thus offers the highest possible safety
- patent pending

**Goniometer (not pictured)**

- Self-calibrating
- Collision protected
- Easy, safe handling

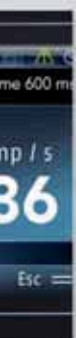


**MultiLINK**

- Connection field internal and external
- USB 2.0, N<sub>2</sub>, BNC, XRED, Aux, etc.
- No annoying „cable-laying“
- In addition, extra-large cable conduit

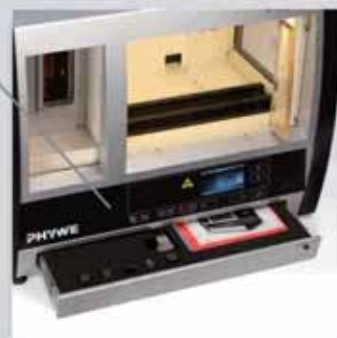
**High-resolution TFT backlit display**

- diagonal 4,3"
- 480 x 272 Pixel
- 16 Bit, 65.536 colors
- with LED lighting
- Optimal, dynamic representation of all important device parameters and measured values



**Safekeeping drawer**

- All accessories are kept safely and always ready at hand
- Lockable



# Quantum physics

## Teacher experiments

### Specific charge of the electron $e/m$



#### Principle

Electrons are accelerated in an electric field and enter a magnetic field at right angles to the direction of motion. The specific charge of the electron is determined from the accelerating voltage, the magnetic field strength and the radius of the electron orbit.

#### Task

Determination of the specific charge of the electron ( $e/m_0$ ) from the path of an electron beam in crossed electric and magnetic fields of variable strength.

#### What you can learn about

- Cathode rays
- Lorentz force
- Electron in crossed fields
- Electron mass
- Electron charge

### Specific charge of the electron $e/m$ P2510200

### Franck-Hertz experiment with a Hg-tube



#### Principle

Electrons are accelerated in a tube filled with mercury vapour. The excitation energy of mercury is determined from the dis-

tance between the equidistant minima of the electron current in a variable opposing electric field.

#### Tasks

1. To record the countercurrent strength  $I$  in a Franck-Hertz tube as a function of the anode voltage  $U$ .
2. To determine the excitation energy  $\mathcal{E}$  from the positions of the current strength minima or maxima by difference formation.

#### What you can learn about

- Energy quantum
- Electron collision
- Excitation energy

### Franck-Hertz experiment with a Hg-tube P2510311

### Elementary charge and Millikan experiment



#### Principle

Charged oil droplets subjected to an electric field and to gravity between the plates of a capacitor are accelerated by application of a voltage. The elementary charge is determined from the velocities in the direction of gravity and in the opposite direction.

#### Tasks

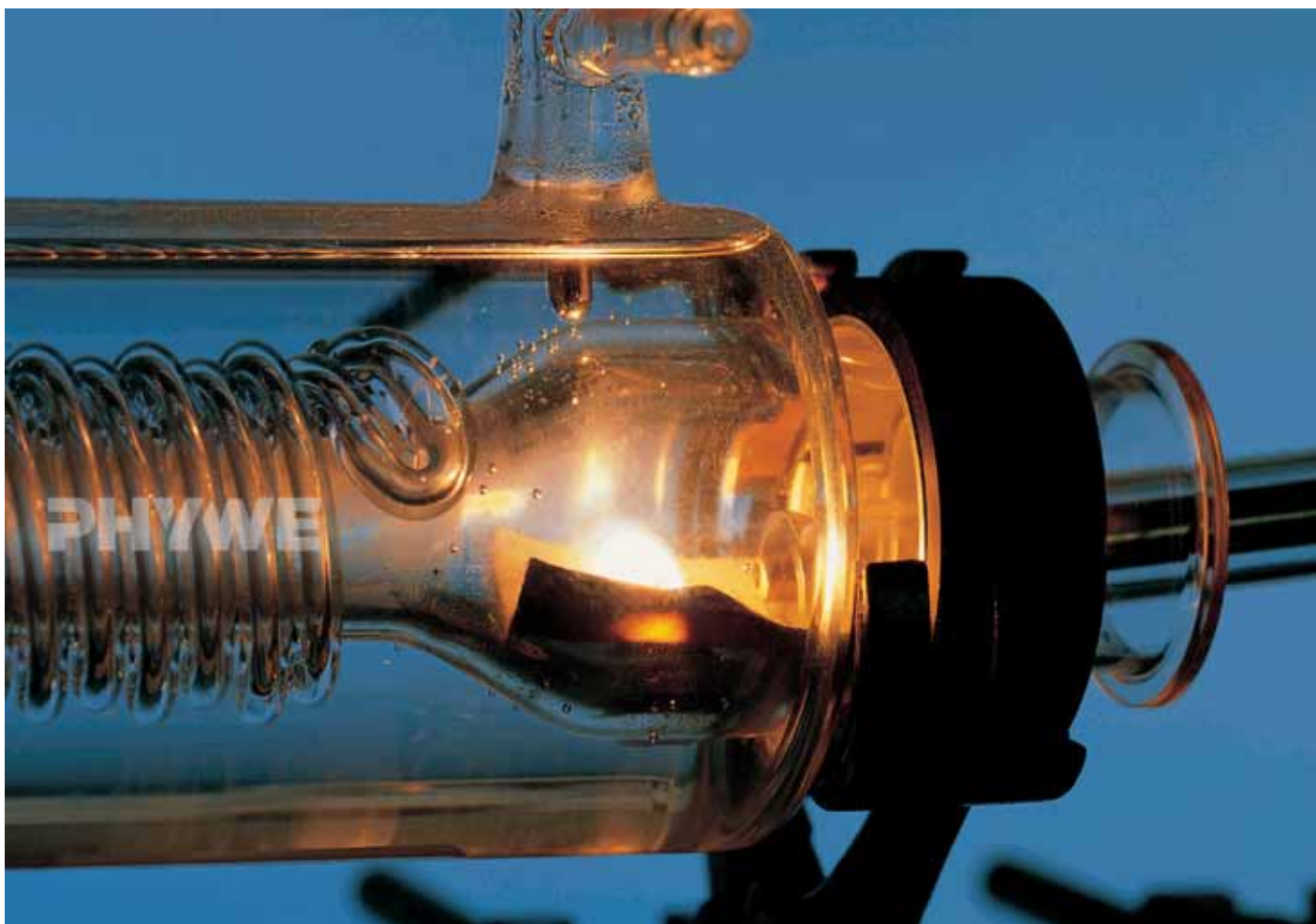
1. Measurement of the rise and fall times of oil droplets with various charges at different voltages.
2. Determination of the radii and the charge of the droplets.

#### What you can learn about

- Electric field
- Viscosity
- Stokes' law
- Droplet method
- Electron charge

### Elementary charge and Millikan experiment P2510100





## Chemistry

<b>4.1</b>	<b>Curriculum and Overview</b>	<b>88</b>
<b>4.2</b>	<b>General Chemistry</b>	<b>92</b>
<b>4.3</b>	<b>Inorganic Chemistry</b>	<b>96</b>
<b>4.4</b>	<b>Environmental Chemistry</b>	<b>105</b>
<b>4.5</b>	<b>Organic Chemistry</b>	<b>106</b>
<b>4.6</b>	<b>Physical Chemistry</b>	<b>114</b>
<b>4.7</b>	<b>Molecular Models</b>	<b>120</b>



PHYWE covers the requirements of the educational plans for the

International Reference Curriculum (School)					
Theme	Sets or experimental collection	General Chemistry	Environment and Outdoor	Inorganic Chemistry	Acids, Bases, Alkalis
		TESS / Demo	TESS	TESS / Demo	TESS / Demo
<b>GENERAL CHEMISTRY</b>					
States of matter, diffusion (kinetic particle theory)		✓		✓	
Criteria of purity and Methods of purification		✓			
Chemical bonding		✓			✓
Stoichiometry and The mole concept		✓		✓	
<b>PHYSICAL CHEMISTRY, ELECTROCHEMISTRY AND REACTION KINETICS, ENERGETICS</b>					
Chemical energetics					
Redox		✓		✓	
Electrochemistry					
Equilibria, Reversible reactions		✓			
Reaction kinetics, Rate (speed) of reaction					
<b>INORGANIC CHEMISTRY</b>					
Acids, bases and salts (preparation, oxides)				✓	✓
Identification of ions and gases		✓		✓	
The periodic table: chemical periodicity		✓		✓	
Metals (properties, reactivity, extraction, use)				✓	✓
Air and Water		✓	✓	✓	
Group II				✓	✓
Group IV, Carbonates				✓	✓
Group VII				✓	✓
An introduction to the chemistry of transition elements (colour, complexes)				✓	
Nitrogen and sulfur		✓		✓	
<b>ORGANIC CHEMISTRY</b>					
Introductory topics					
Fuels					
Hydrocarbons					
Hydroxy compounds					
Carbonyl compounds					
Carboxylic acids and derivatives					
Nitrogen compounds					
Macromolecules; Polymerisation					
<b>APPLICATION OF CHEMISTRY</b>					
The chemistry of life (proteins, enzymes, DNA)					
Applications of analytical chemistry			✓		

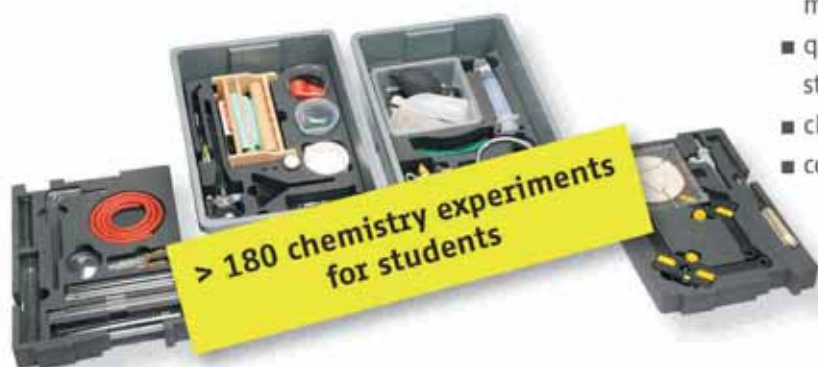
### natural sciences teaching (chemistry)

Titration	Organic Chemistry	Polymer Chemistry	Food Chemistry	Gas Laws Thermochemistry, Kinetics	Electrochemistry	Colorimetry
Demo	TESS / Demo	TESS	TESS / Demo	Demo	TESS / Demo	TESS
				✓		
					✓	
				✓	✓	
				✓		
✓						
	✓					
	✓					
	✓					
	✓					
	✓					
	✓					
	✓					
			✓			
		✓				
			✓			
✓						✓

# Student experiments for chemistry classes – experimentation made easy



## Storage in sets (single-user sets)



- the entire material for a topic in one set – minimum preparation time
- quick check for completeness (well-structured storage)
- chemical-resistant foam inlays
- convenient storage in a matching mobile cabinet



## Storage in trays (class sets)

The sets can also be stored block-wise for several student groups. Equipment parts of one kind are stored together in a tray. The trays are clearly marked, have several compartments, and, where required, also foam inlays.



- customisable to your individual needs
- well-structured storage: inventory lists
- clear and descriptive labelling
- material for several groups in one storage system
- low space requirement



## Teacher experiments for chemistry – quick set-up, safe experimentation

Demo | PHYWE

### Demonstration experiments with support material

With PHYWE's firm support base, complete experiment set-ups, even big or compact ones, can be transported in a particularly easy and safe manner. In order to perform the experiment, simply fetch the ready-to-use set-up, position it in the classroom, connect it, and get started.

Our extensive literature covers all of the topics of your curriculum.



> 270 chemistry experiments  
for demonstration purposes

### Demonstration experiments on the board

Selected standard experiments from various chemistry topics are also available as ready-to-use set-ups on a plate.

- clear and well-structured experiment set-up
- excellent visibility of glassware
- minimum preparation time
- complete experiment set-ups can be quickly hooked into the board and changed as desired





# General chemistry

## Student experiments



### 25 Experiments

#### Properties of matter

1. Hardness, colour, magnetisability, water solubility
2. Combustibility, melting point
3. Density determination

#### Mixtures and mixture separation

4. Properties of mixtures of substances
5. Liquid mixture
6. Evaporation
7. Filtration, magnetic separation
8. Extraction
9. Chromatography

#### Chemical reactions, stoichiometry

10. Comparison of a physical process and a chemical reaction
11. Reaction of copper and sulphur

#### Test reactions

12. Test for oxygen
13. Test for hydrogen
14. Test for nitrogen

#### States of matter, dissolution (kinetic particle theory)

15. Boiling temperature

16. Sublimation

17. Volume contraction of liquids

18. Dissolution processes in liquids

19. Dissolution of salts

20. Crystallisation

21. Melting-point lowering and boiling-point elevation

#### Chemical bonding

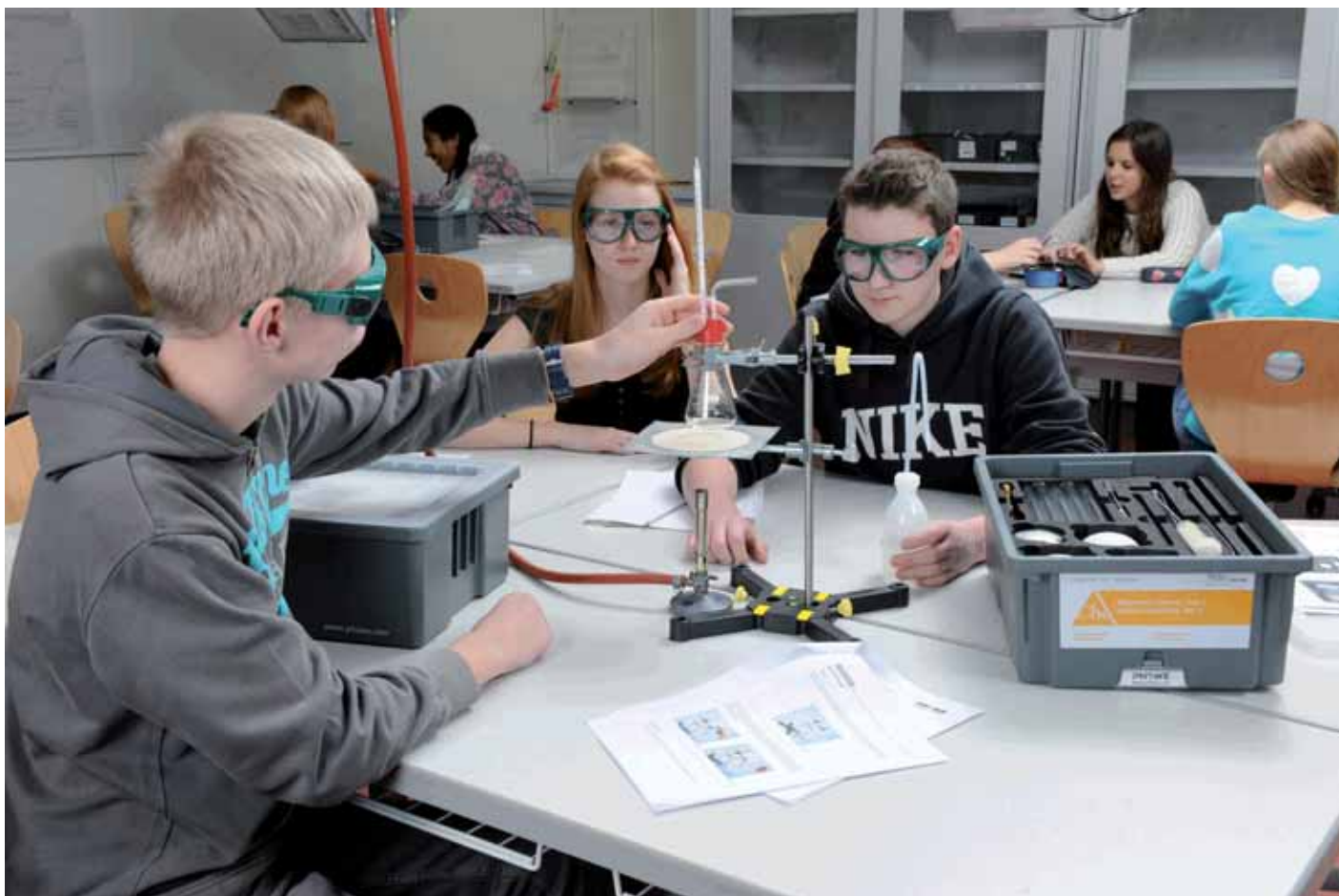
22. Test confirming the migration of ions by means of indicator

23. Dipole properties

24. Behaviour of salts with regard to solvents of different polarities

#### The periodic table

25. Periodic system



### Necessary equipment

TESS advanced Chemistry set General Chemistry  
15300-88

TESS advanced General Chemistry, necessary accessories  
for 1 group  
13431-88

TESS advanced General Chemistry, consumables and  
chemicals for 10 groups  
13300-10

### Experiment descriptions

Software interTESS Chemistry, General Chemistry, DVD  
01061-00

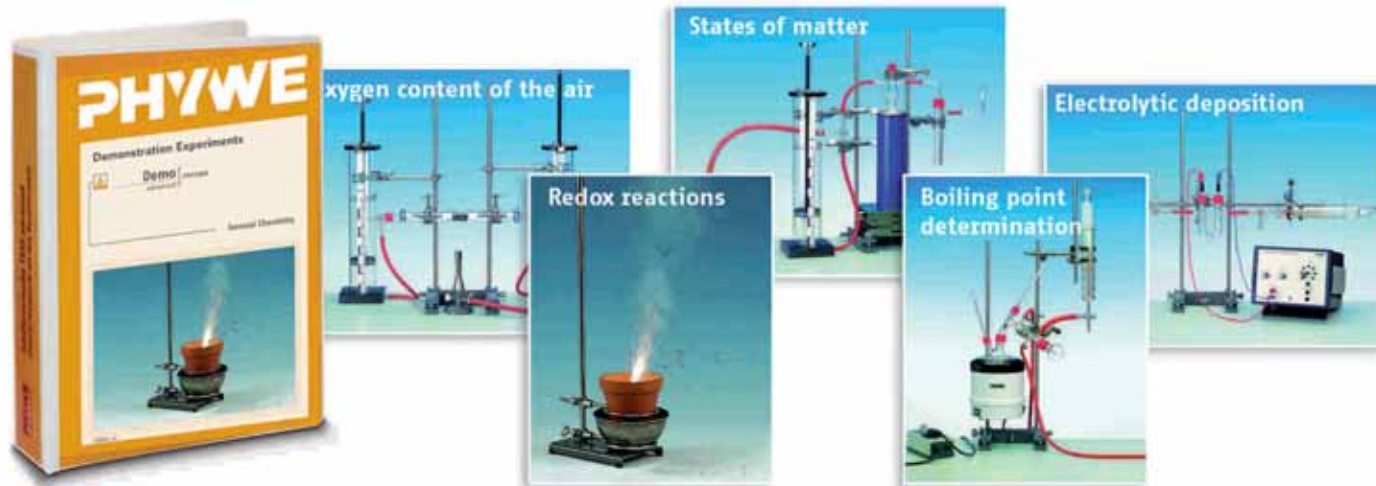
TESS advanced Chemistry manual General Chemistry  
English  
01835-12

#### Advantages of the set:

- ✓ Basic laboratory equipment set
- ✓ All of the chemistry topics included in one set
- ✓ High-quality support material included

# General chemistry

## Teacher experiments



Select your desired experiments and order them by way of the number that starts with P (order numbers for experiments). Every experiment includes all of the necessary equipment.

### 36 Experiments

#### Properties of matter

- P1130100 How does one recognise a substance?
- P1130200 Test methods for identifying substance properties
- P1130400 Melting point determination
- P1130500 Boiling point determination
- P1272660 Boiling point determination of ethanol
- P1138900 Sublimation und Löslichkeit von Iod
- P1130600 Determination of the densities of liquids and solids
- P1130800 Substances differ in terms of their resistance against air, water, and acids

#### Mixtures and mixture separation

- P1131900 Mixture types 1: solid/solid and solid/liquid
- P1132000 Mixture types 2: liquid/liquid
- P1132200 Separation of mixtures of solid substances
- P1132300 Separation methods for suspensions and solutions
- P1132500 Separation of a mixture of liquids by distillation
- P1132600 Separation of mixtures of liquids by extraction and centrifugation
- P1132800 Separation of solutions of gases
- P1133000 Chromatographic separation processes: TLC

#### Particle models

- P1131100 Condensation of gases
- P1131200 Particle motion (diffusion, thermal agitation)
- P1131300 Spatial expansion of particles of matter
- P1136000 Ebullioscopy
- P1136100 Cryoscopy
- P1135300 Water as a solvent

#### Chemical reactions, stoichiometry, the mole concept

- P1131400 Chemical process: change of properties by heating
- P1131500 Chemical process: internal transformation and combustion
- P1131600 Chemical process: a reaction of two substances
- P1131700 Chemical process: synthesis and analysis
- P1133900 Reduction - reducing agents - redox process
- P1134300 The law of conservation of mass
- P1134400 The law of definite proportions
- P1134500 The law of multiple proportions
- P1134600 Equivalent masses

#### Test reactions

- P1137300 Properties of lithium, sodium and potassium

#### Chemical bonding

- P1135700 Osmosis
- P1146300 Water molecules - dipoles
- P1146800 Chemical garden

#### Chemistry and environment

- P1139800 Solubility of sulphur dioxide in water - acid rain

### Experiment descriptions



**Demo advanced Chemistry Manual General Chemistry**  
**English**  
**01850-12**

# General chemistry

## Experiments on the board

Demo PHYWE  
advanced

### Boiling point elevation



#### Principle

On adding urea to water, this first dissolves. Subsequent to this, a new boiling point equilibrium, at a temperature that is changed by some hundreds of a degree, is attained. The elevation of the boiling point is proportional to the concentration of the solution. One mole of dissolved particles increases the boiling point temperature by 0.515 K. This enables the molar mass of the added substance to be calculated from the elevation of the boiling point and the mass of added substance (ebullioscopy). The boiling point is higher, the higher the concentration of the solution.

**Boiling point elevation**  
P1310200

### Steam distillation



#### Principle

Many high boiling liquids that are not miscible, or are hardly miscible, with water can be distilled at a temperature as low as about 100 °C, when they are heated together with water, or when hot steam flows across them during distillation. This technique is still used nowadays to win ethereal oils and essences

#### Literature for this experiment as follows:

Complete Experiments Chemistry/Biotechnology  
01855-02 English

P1311500

### Measuring pressure and temperature with Cobra4



4  
Cobra

#### Function and Applications

The Cobra4 Sensor-Unit Thermodynamics is a measuring recorder for pressure and temperature measurements, which is controlled by micro-controller.

#### Benefits

- It can be fitted with two NiCr-Ni thermoelements (type K), in order to measure up to two temperatures and one absolute pressure value simultaneously.
- High resolution of the pressure sensor enables precise measurements.

**Cobra4 Sensor-Unit Thermodynamics, pressure abs. 2 bar and 2 temperature NiCr-Ni**  
12638-00

**Cobra4 Mobile-Link 2 incl. accessories: battery, USB cable, charger and SD memory card**  
12620-10

**Immersion probe NiCr-Ni, teflon, 300 °C**  
13615-05



# Inorganic chemistry

## Student experiments



### 34 Experiments

#### Air and combustions

1. The importance of air for combustion processes
2. Air, a mixture of substances
3. Structure and mode of operation of a Bunsen burner
4. The candle flame

#### Water

5. Water content of natural substances
6. Dissolved components in different waters
7. Solubility of gases in water
8. Solutions, colloids, suspensions
9. Solubility of salts in water
10. Water hardness
11. Test for water
12. Water, an oxide
13. Degradation of water by reducing agents
14. Synthesis of water

#### Metals and alloys

15. Oxidation of metals
16. Factors determining the reaction behaviour of metals
17. Rusting- "slow combustion"

#### Nonmetals, gases and metalloids

18. Oxygen, cause of oxidation
19. Reactions in pure oxygen

20. Reactions in pure oxygen
21. Nitrogen, preparation and properties
22. Carbon dioxide, preparation and properties
23. Soda-lime glass beads

#### Redox reactions, electron migration

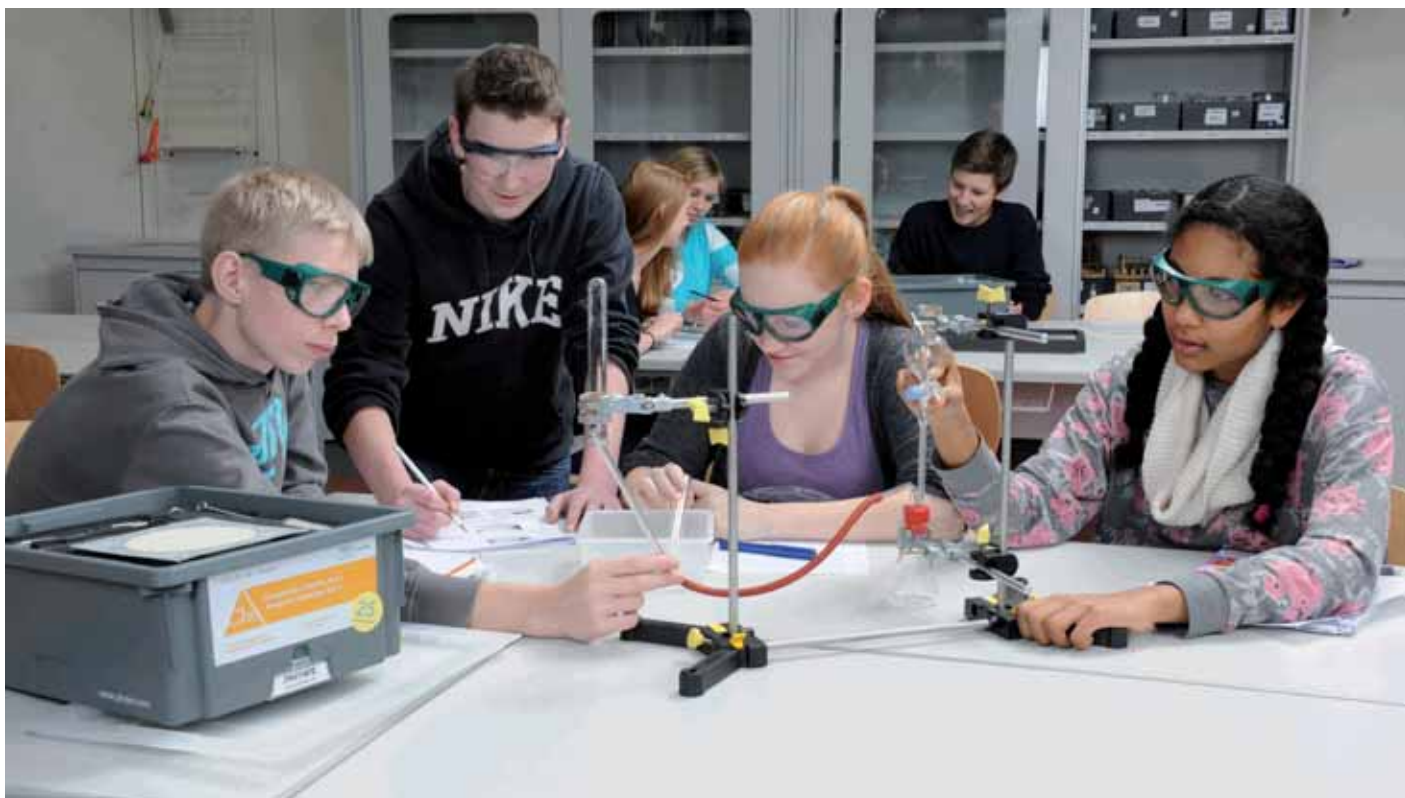
24. Reduction of copper oxide
25. Quantitative analysis of oxides

#### Special topics: fire fighting, construction materials and fertilizer

26. Model of a fire extinguisher
27. Production of gypsum plaster
28. Processing of gypsum
29. Plaster moulds
30. Mineral constituents of plants
31. Absorption of minerals by plants
32. Ammonia fertilizer
33. Burnt lime

#### Chemistry and environment

33. Mode of operation of an aeration tank
34. Water treatment in sewage treatment plants



### Necessary equipment

TESS advanced Chemistry Set Inorganic Chemistry  
15301-88

TESS advanced Inorganic Chemistry, consumables and  
chemicals for 10 groups  
13301-10

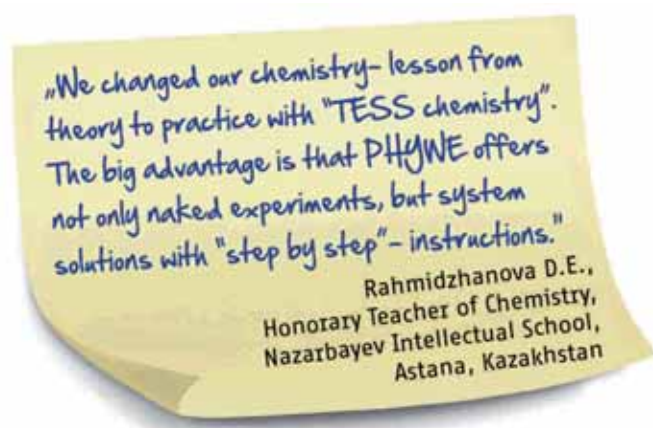
TESS advanced Inorganic Chemistry, necessary  
Accessories for 1 group  
13433-88

### Experiment descriptions



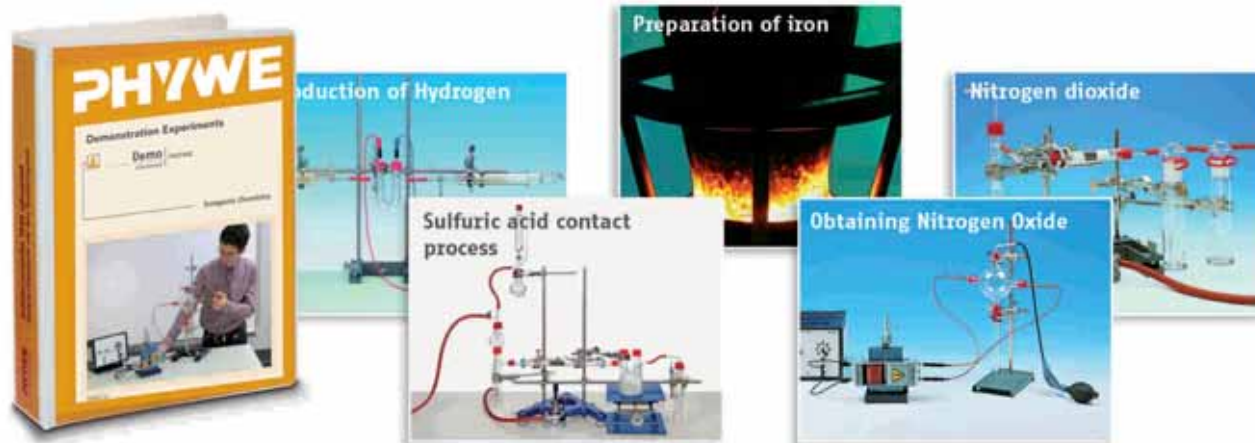
Software interTESS Chemistry, Inorganic Chemistry, DVD  
01062-00

TESS advanced Chemistry manual Inorganic Chemistry  
English  
01836-12



# Inorganic Chemistry

## Teacher experiments



Select your desired experiments and order them by way of the number that starts with P (order numbers for experiments). Every experiment includes all of the necessary equipment.

### 45 Experiments

#### Air and combustion

- P1133400 Air- a mixture of the gases oxygen and nitrogen
- P1133200 Ignition - ignition temperature
- P1133300 The air requirement of a combustion process
- P1133600 Combustion in pure oxygen

#### Water

- P1135000 Drinking water
- P1135100 Hard water - soft water
- P1135400 The composition of water

#### Metals and Alloys

- P1143400 Properties of aluminium
- P1143500 Chemical properties of copper
- P1143600 Chemical properties of zinc
- P1143900 Production of metal alloys
- P1137300 Properties of Li, Na and K
- P1137400 Reactions of Li, Na and K with water
- P1137900 Reactions of Li, Na, K, Mg and Ca with air and CO<sub>2</sub>
- P1138000 Reaction of Mg and Ca with water - hydroxide formation

#### Non-metals, gases and metalloids

- P1135500 Preparation of hydrogen
- P1135600 Properties of hydrogen
- P1138300 Preparation of chlorine
- P1138700 Reaction of bromine with metals
- P1139000 Reaction of iodine with metals and with hydrogen
- P1139300 Halogen - displacement reaction
- P1133500 Preparation of oxygen
- P1139600 Properties of sulphur
- P1140500 Binding of nitrogen by base metals

- P1140900 Quantitative analysis of ammonia
- P1141400 Nitrates, their properties, detection
- P1141500 Red and white phosphorus
- P1142000 Detection of phosphate ions
- P1142200 Graphite and diamond
- P1142500 Carbon dioxide
- P1142900 Preparation of silicon from quartz
- P1143200 Glass

#### Redox reactions, electron migration

- P1133800 Slow oxidation (rusting, operating metabolism)
- P1143300 Preparation of iron from oxidic ores
- P1134000 Redox reactions between metals and metal oxides
- P1133900 Reduction - reducing agents - redox process

#### Special topics: fire fighting, explosions and construction materials

- P1133700 Rapid combustion - explosions
- P1134100 Extinguishing fires
- P1134200 Functional models of hand-held fire extinguishers
- P1138200 The occurrence of calcium carbonate in nature
- P1140200 Salts of sulphuric acid - sulphates

#### Special topics: commercial processes

- P1139500 Obtaining sulphur
- P1140600 Obtaining nitrogen oxides by burning air
- P1140700 Ammonia preparation (Haber-Bosch process)
- P1139900 The sulphuric acid contact process

### Experiment descriptions



**Demo advanced Chemistry Manual Inorganic Chemistry**  
**English**  
**01851-12**

# Inorganic Chemistry

## Experiments on the board

Demo  
advanced PHYWE

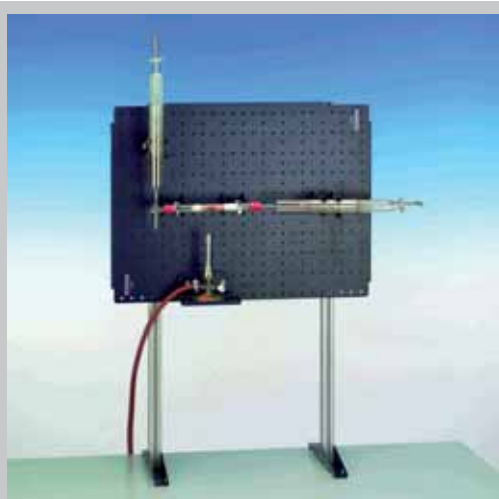
### The contact process



When sulphur burns, sulphur dioxide is formed. In the presence of oxygen, the sulphur dioxide so formed is oxidised on the surface of the platinum to sulphur trioxide. In contrast to  $\text{SO}_2$ ,  $\text{SO}_3$  is solid at below  $16.9^\circ\text{C}$ , and is so deposited in this experiment in the cooled U-tube. Excess  $\text{SO}_2$  dissolves well in water to form sulphurous acid, which is neutralised by the caustic soda.

The contact process  
P1310400

### Air analysis (nitrogen in air)

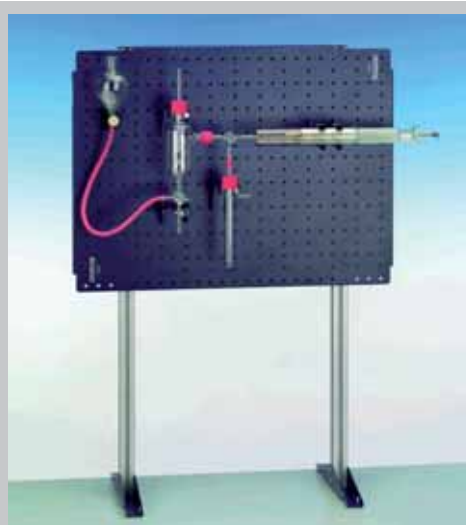


Copper is heated with a burner in air. The copper turns black. The 100 ml initial volume of air is decreased by the reaction to approximately 80 ml of remaining gas. Only about one fifth of the gas mixture air reacts with the copper. This part of air is

oxygen. The remaining gas does not react with copper. It consists almost exclusively of nitrogen.

Air analysis (nitrogen in air)  
P1309700

### Determination of the molar masses of metals



A piece of metal is weighed and placed in the insert of the reaction cylinder, whereafter an acid is added to the cylinder to the three-way valve until it is about half full. The metal is made to react with the acid by lowering the insert. The gas syringe connected to the reaction cylinder is used to collect the hydrogen which is generated. The mass of the metal and the volume of the hydrogen generated are used to calculate the desired molar mass. The reaction can also be used to determine the valency of the metal.

Determination of the molar masses of metals  
P1309462



# Acids, Bases, Salts

## Student experiments



### 31 Experiments

#### Acids

1. General safety precautions to be taken when handling acids
2. Hazardousness of concentrated sulphuric acid
3. Plant pigments as indicators
4. The effects of acids on indicators
5. The effects of acids and lyes on natural and commercial
6. The effects of acids on metals
7. Acid strength
8. Preparation and properties of hydrochloric acid
9. Preparation and properties of sulphurous acid
10. PVC- a potential hydrochloric acid former
11. Sulphurous acid - environmental hazards
12. Oxidation of sulphurous acid
13. Preparation and properties of sulphuric acid
14. Preparation and properties of carbonic acid
15. Brönsted acids: conductivity of molten and dissolved oxalic acid
16. Acidity comparison of aqueous and acetic citric acid solutions

#### Bases

17. Safety precautions to be taken when handling lyes
18. Alkalis - constituents of household detergents
19. Aqueous solubility of ammonia
20. Preparation and properties of sodium hydroxide solution
21. Preparation and properties of sodium hydroxide solution
22. Alkali formation due to a reaction of base metals with water
23. Alkali formation reaction of metal oxides with water
24. Reaction of alkalis with aluminium

#### Salts

25. Salt formation due to a reaction of acids with alkalis
26. Salt formation due to a reaction of acids with metal oxides
27. Salt formation from chemical elements

28. Salt formation by precipitation reaction
29. Hydrolysis of salts
30. Thermal decomposition of salts
31. Osmosis: a "chemical garden"

### Experiment descriptions



Software interTESS Chemistry, Acids, Bases, Salts, DVD  
01063-00

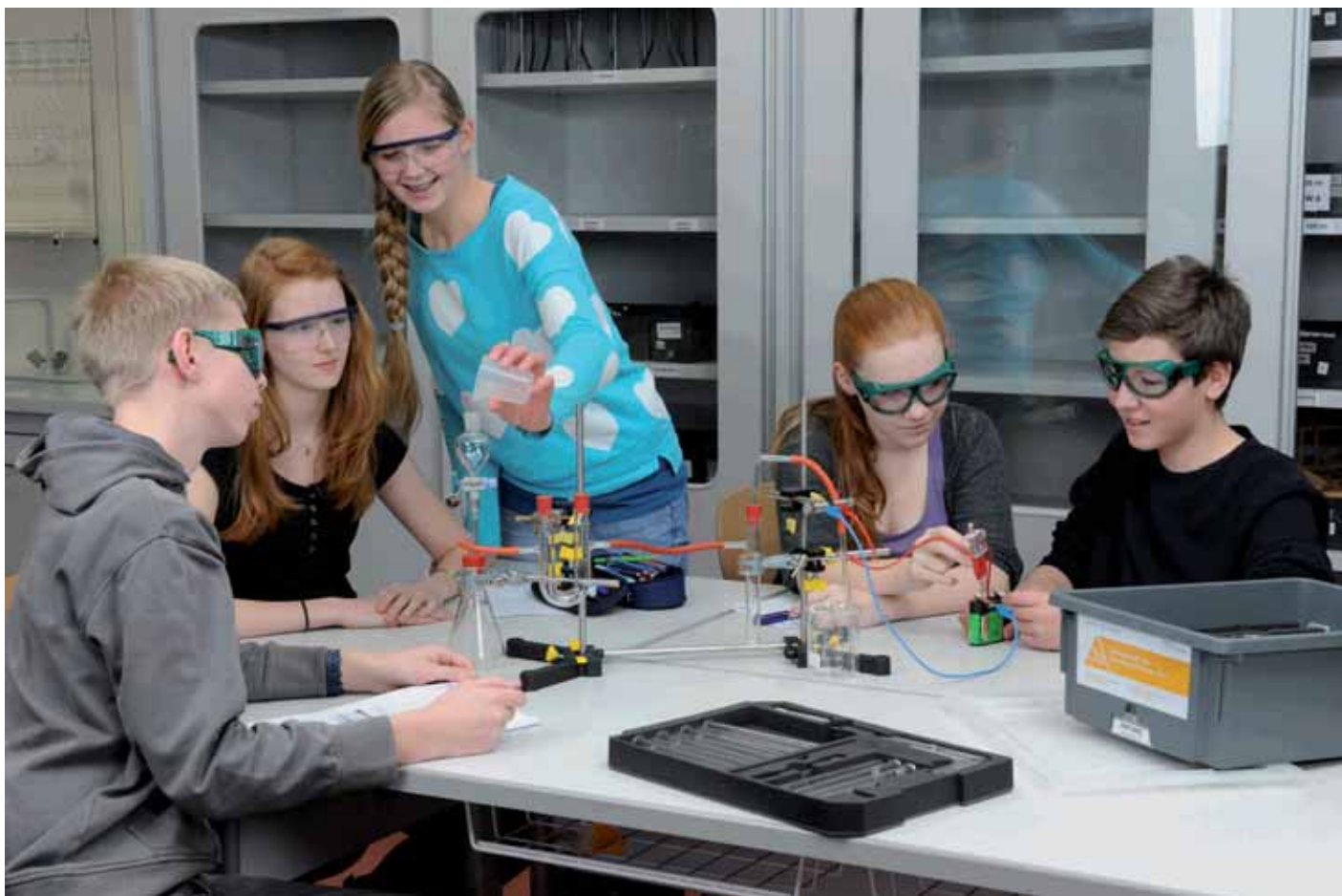
TESS advanced Chemistry manual acids, bases, and salts  
English  
01842-02

### Necessary equipment

TESS advanced Chemistry Set Acids, Bases, Salts  
15302-88

TESS advanced Chemistry Acids, Bases, Salts, necessary  
Accessories for 1 group  
13435-88

TESS advanced Chemistry Acids, Bases, Salts,  
consumables and chemicals for 10 groups  
13436-88



### Measuring pH-value with Cobra4



Cobra4 Sensor-Unit pH, BNC connector  
12631-00

Cobra4 Mobile-Link 2 incl. accessories: battery, USB  
cable, charger and SD memory card  
12620-10

pH-electrode, plastic body, gel, BNC  
46265-15

#### Advantages of the set:

- ✓ Safe experimentation with acids and lyes
- ✓ Includes qualitative electrochemical experiments
- ✓ Detection of anions based on sulphates and chlorides

# Acids, Bases, Salts

## Teacher experiments



Select your desired experiments and order them by way of the number that starts with P (order numbers for experiments). Every experiment includes all of the necessary equipment.

P1145400 Formation of salts by precipitation  
 P1145500 Complex salts  
 P1145600 Acidic and alkaline reactions of solutions of salts  
 P1145900 The boiling point elevation  
 P1146200 Heat of solution - enthalpy  
 P1146300 Water molecules - dipoles

### 29 Experiments

#### Acids

P1144000 Hydrogen chloride I  
 P1144100 Hydrogen chloride II  
 P1144200 Hydrogen chloride from hydrochloric acid  
 P1144400 Chemical properties of hydrochloric acid  
 P1140000 Sulphuric acid (density, hygroscopicity)  
 P1140100 Sulphuric acid (decomposition of organic substances, reactions)  
 P1141200 Preparation of nitric acid  
 P1141300 Properties of nitric acid  
 P1141900 Phosphoric acid and its salts  
 P1144600 Detection of acidic reaction with various indicators  
 P1144800 Reaction velocity of strong and weak acids  
 P1146400 Acid-base theory according to Brønsted  
 P1146500 Water as an ampholyte  
 P1270060 Basic principles of pH measurement

#### Bases

P1138000 Reaction of magnesium and calcium with water  
 P1137400 Reactions of Li, Na and K with water  
 P1137700 Properties of alkali hydroxides  
 P1144500 Neutralisation of hydrochloric acid  
 P1145300 Neutralisation - neutralisation enthalpy  
 P1142700 Salts of carbonic acid  
 P1142800 Temporary hardness and acid binding capacity

#### Salts

P1145000 Formation of salts by reaction of metals with acids  
 P1145200 Formation of salts by reaction of lyes and acids

### Experiment descriptions



**Demo advanced Chemistry Manual Acids, Bases, Salts**  
**English**  
**01854-02**

# Acids, Bases, Salts

## Experiments on the board

Demo PHYWE  
advanced

### Chemical fountain



#### Principle

Some gases such as hydrogen chloride dissolve readily in water. For example, 1 litre of water at 20 °C can dissolve approximately 443 litres of hydrogen chloride. For example, vacuum builds up quickly in a closed flask when the gas comes in contact with water, because the gas dissolves in the water and additional water is drawn into the flask. This is the basis of how the chemical fountain works - an exciting way to demonstrate the solubility of gases in water.

**Chemical fountain**  
P1310100

### Boiling point elevation



#### Principle

This educationally vivid complete experimental set-up of a gas chromatograph makes it possible to separate substances which are highly volatile at up to 100°C. A butane mixture is a suitable choice here, for example.

System components include such elements as the carrier gas supply, flow measurement, separation column with stationary phase, temperature control system, thermal conductivity detector and recorder. All of the components of this open system are easily recognised, enabling a clear explanation of the operating principle.

**Boiling point elevation**  
P1310200

### Mesuring pH-value or potential and 2x temperature at the same time with Cobra4



4  
Cobra

The Cobra4 Sensor-Unit pH and 2 x temperature NiCr-Ni is a measuring recorder for pH, potential and temperature measurements, which is controlled by micro-controller.

**Cobra4 Sensor-Unit Chemistry**  
12630-00

**Cobra4 Mobile-Link 2 incl. accessories: battery, USB cable, charger and SD memory card**  
12620-10

**pH-electrode, plastic body, gel, BNC**  
46265-15

**Immersion probe NiCr-Ni, steel, -50...400 °C**  
13615-03



# Titration

## Teacher experiments

Demo | PHYWE  
advanced



### 8 Experiments

1. Determination of pH values and calibration of pH-electrodes  
Basic principles of pH measurement
2. Manual pH titration with Cobra4
3. Titration curves and buffering capacity with Cobra4
4. Potentiometric pH titration (phosphoric acid in soft drinks) with Cobra4
5. Titration of a polyvalent acid with a strong base
6. Titration of a weak organic acid with sodium hydroxide
7. Titration of a weak base (ammonia) with a strong acid
8. Titration of a weak base (ammonia) with a weak acid

### Necessary equipment

Demo advanced Basic Set pH Titration Cobra4  
12627-88

Chemical set for Basic Set pH Titration Cobra4  
12627-10

Standard Labware for Set pH-Titration Cobra4  
12627-01



# Environment and outdoors

## Student experiments

TESS  
advanced | PHYWE

4  
Cobra



### 16 Experiments

#### Introduction

1. Learning stations using the experimentation case

#### Water

2. We examine our drinking water
3. Acidity changes of a watercourse
4. Salinity changes of a watercourse
5. Water quality - contamination with heavy metals
6. We visit a wastewater treatment plant

#### Soil

7. Salinity of soils and plant substrates
8. The pH value of various soils
9. Raised bog and fen

#### Weather and climate,

10. Comparison of soil and air temperatures in the course of a day
11. Meteorological observations
12. Changes of the light conditions in a deciduous forest

#### Terrain

13. Altitude measurement on a trail
14. Measuring the height of a tower
15. Terrain mapping
16. Air pressure and relative humidity in an aircraft

### Necessary equipment

TESS Applied Sciences Cobra4 environment and outdoors, for 4 work groups inclusive aluminum case 12626-88

### Optional extension set

TESS Environment and Outdoors optional accessories for 10 groups 13445-88

### Experiment descriptions



TESS advanced Applied Sciences manual Cobra4 environment and outdoors 12622-02

# Organic chemistry

## Student experiments

TESS  
advanced | PHYWE

NEW



### 36 Experiments

#### Preliminary tests

1. The decomposition of organic substances
2. The detection of carbon with lime-water
3. The detection of carbon by oxidation
4. The detection of oxygen
5. The detection of nitrogen
6. The detection of sulphur
7. The Beilstein test

#### Hydrocarbons

8. The characterisation of methane
9. The homologous series of the alkanes
10. The reactivity of the alkanes
11. The characterisation of ethylene
12. The characterisation of ethine (acetylene)

#### Petroleums

13. Oil fields
14. The cracking of petroleum
15. Removal of paraffins by extraction
16. Removal of paraffins by urea

#### Alcohols

17. Alcoholic fermentation
18. Production of methanol "wood spirit"
19. Alco test-tubes
20. The borax test
21. The iodoform test
22. The properties of homologous series
23. Polyhydric alcohols

#### Carbonyl compounds

24. The oxidation of alkanols
25. Schiff's test and Fehling's test
26. The characterisation of acetone

#### Carboxylic (alkane) acids

27. The use of formic acid
28. The characterisation of acetic acid "wood vinegar"
29. The acidic character of carboxylic (alkane) acids
30. Iron chloride test / Formation of verdigris

#### Esters

31. Esters of acetic acid
32. Esters of various alkane acids
33. The splitting of esters

#### Soaps

34. Production of soap
35. The properties of soap
36. The action of soap

### Necessary equipment

TESS advanced Chemistry Set Organic Chemistry  
15304-88

TESS advanced Organic Chemistry, necessary Accessories  
for 1 group  
13437-88

TESS advanced Organic Chemistry, consumables and  
chemicals for 10 groups  
13438-88





### Experiment descriptions



Software interTESS Chemistry, Organic Chemistry, DVD  
01066-00

TESS advanced Chemistry manual Organic Chemistry  
English  
01837-12

*"The easy and intuitive usage of the Phywe items in chemistry brought values to my students that they did not experience before. it's one thing to understand daily phenomena in natural sciences, it's another thing to keep and develop this knowledge on a long range."*

Hussein M. Ahmed,  
Governmental school,  
Cairo, Egypt



# Organic chemistry

## Teacher experiments



Select your desired experiments and order them by way of the number that starts with P (order numbers for experiments). Every experiment includes all of the necessary equipment.

### 35 Experiments

#### Preliminary tests

- P1149600 Thermal decomposition of wood
- P1149700 Qualitative detection of elements
- P1149800 Temperature behaviour of organic compounds

#### Hydrocarbons

- P1150200 Flash point and burning point
- P1150500 Preparation of methane
- P3110900 Methane, ethane and propane
- P1151000 Preparation of ethylene (ethene)
- P1151200 Preparation of acetylene (ethyne)

#### Alcohols

- P1152100 Producing ethanol by fermentation
- P1152300 Properties of ethanol
- P1152400 Detection of alcohol
- P1152600 Properties of alcohols (II)
- P1152700 Isomeric alcohols
- P1152800 Polyhydric alcohols

#### Carbonyl compounds

- P1152900 Alkanals - oxidation products of primary alcohols
- P1153100 Condensation reactions of alkanals
- P1153300 Preparation of propanone (acetone)
- P1153400 Reactions with acetone (propanone)
- P3101400 Aldehydes - reactions with ammonia

#### Carboxylic (alkane) acids

- P1153500 Methanoic acid (formic acid)
- P1153600 Formic acid and oxalic acid
- P1153700 Acetic acid (ethanoic acid)

#### Esters

- P1153800 Preparation of ethyl acetate and butyl acetate
- P1153900 Ester saponification
- P1154000 Keto-enol tautomerism of ethyl acetoacetate

#### Aromatics and organic halogen compounds

- P3101000 Haloalkanes: Grignard reagent
- P3101100 Haloalkanes: Wurtz reaction
- P3101300 Toluene: Bromination in the nucleus

### Manual



**Demo advanced Chemistry Manual Organic Chemistry**  
**English**  
**01853-12**

# Organic Chemistry

## Experiments on the board

Demo  
advanced PHYWE

### Synthesis of ethyl acetate



#### Principle

Carboxylic acids and alcohols can react with esters under suitable conditions. Water forms as a by-product and, under the properly selected reaction conditions, it can be continuously separated by means of a distilling trap (Dean-Stark apparatus). The progress of the reaction can be followed very clearly based on the quantity of water separated. The set-up depicted here with components from the comprehensive chemistry/biotechnology experiment set enables optimum visibility of the glass equipment and can be set up rapidly.

### Synthesis of ethyl acetate and butyl acetate

P1309100

### Distillation - determination of the alcohol content of wine



#### Principle

If the alcohol content of a wine is determined directly with an alcohol meter (hydrometer), the resulting alcohol content reading is approximately 0% by volume. This is due to the composition of the wine. The effect of the alcohol on the density is cancelled out by other components such as sugars, acids, essential oils, etc.. For this reason, in order to determine alcohol content by density, the alcohol must be separated out by means of distillation prior to the determination.

### Distillation - determination of the alcohol content of wine with Cobra4

P1308962

### Measuring temperature with Cobra4



### Cobra4 Sensor-Unit 2 x Temperature, NiCr-Ni

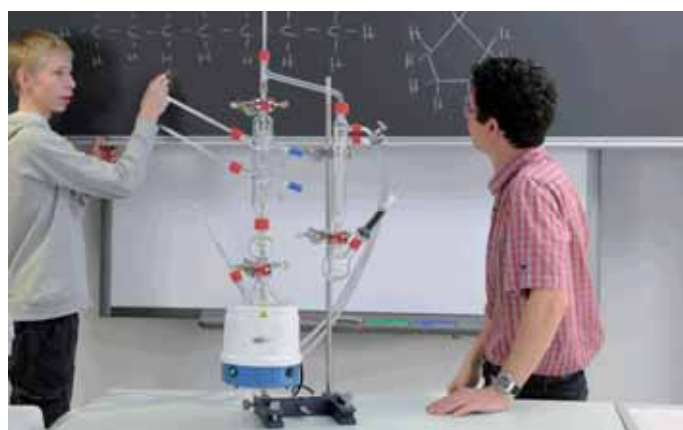
12641-00

### Cobra4 Mobile-Link 2 incl. accessories: battery, USB cable, charger and SD memory card

12620-10

### Immersion probe NiCr-Ni, teflon, 300 °C

13615-05



# Food Chemistry

## Student experiments

NEW



### 40 Experiments

#### Proteins

1. The structure and composition of proteins
2. The coagulation of egg white changes its composition
3. Procedure for producing Quark

#### Fat

4. The solubility of fats
5. Winning oils
6. Production of soap
7. The composition of fats
8. The water content of fatty products
9. The production of margarine
10. Detection of fats with dyes
11. Removal of grease stains
12. Fresh and spent deep-fry fat

#### Beverage

13. Detection of methanol
14. Tanning matter in tea
15. Coffee in beverages

#### Spices

16. Active agents in pepper

#### Carbohydrate

17. The term carbohydrate
18. The solubility of carbohydrates
19. The detection of glucose with Fehling's solution
20. Reducing properties of glucose
21. Fructose
22. Lactose
23. Detection of starch
24. Potatoe starch and paste
25. Composition of starch

26. Wheat gluten
27. Pectins
28. Cleavage of starch during digestion

#### Vitamines and minerals

29. Detection of vitamin C

#### Water

30. Drinking water treatment
31. Compounds containing nitrogen
32. Carbon dioxide

#### Additives

33. Ammonia in liquorice
34. Phosphate in meat products
35. Detection of nitrite in meat products
36. Enzymatic browning
37. Baking powder
38. Emulsifying agents
39. Enzymatic cleavage of proteins
40. Catalases



### Necessary equipment

TESS advanced Chemistry Set Food Chemistry  
15306-88

TESS advanced Food Chemistry, necessary Accessories  
for 1 group  
13484-88

TESS advanced Food Chemistry, consumables and  
chemicals for 10 groups  
13485-88

### Advantages of the set:

- ✓ Ideal for cross-discipline teaching
- ✓ Context closely related to life

### Experiment descriptions



Software interTESS Chemistry, Food Chemistry, DVD  
01065-00

TESS advanced Chemistry manual Food Chemistry  
English  
01839-12



# Food Chemistry

## Teacher experiments

Demo | PHYWE  
advanced



Select your desired experiments and order them by way of the number that starts with P (order numbers for experiments). Every experiment includes all of the necessary equipment.

### 28 Experiments

#### Proteins

- P1255900 Albumins and globulins in egg white
- P1256100 Protein content of foodstuffs - Kjeldahl method
- P1256300 Precipitation of casein at the isoelectric point
- P1265100 Titration curve and buffering capacity

#### Fat

- P1257200 Quantitative fat determination in foodstuffs
- P1257500 Determination of the acid value of vegetable oils
- P1257700 The saponification value of fats
- P1258200 The non-saponifiable components in butter fat
- P1258800 Congealing, melting and boiling point of fats
- P1265300 Obtaining vegetable oils by extraction
- P1265400 Detection of unsaturated fatty acids

#### Beverage

- P1259100 Determination of the alcohol content of wine
- P1265500 The pH value and degree of acidity of coffee

#### Spices

- P1255700 Production of soup seasoning
- P1260000 Constituents of pepper
- P1260100 Spice essence from cloves powder - steam distillation

#### Carbohydrate

- P1260700 Molecular form of glucose
- P1261100 Polarimetric determination of sugar
- P1261300 Table sugar made from sugar beets
- P1261400 Conversion of fructose into glucose
- P1262300 Dietary fibres

#### Vitamines and minerals

- P1262800 Molecular structure and reactivity of vitamin C
- P1265600 Absorption spectrum of  $\beta$ -carotene

#### Water

- P1259700 Fruit acids in fruit juices
- P1259800 Detection of quinine in tonic water
- P1259900 Extraction of citric acid from fruit juices

#### Additives

- P1256000 Production and properties of gelatine
- P1262400 Obtaining pectin and properties of pectin

### Experiment descriptions



Demo advanced Manual Food Chemistry English  
01840-12

# Polymer chemistry

## Student experiments

TESS  
advanced PHYWE

NEW



### 26 Experiments

#### Characteristics of plastics

1. The thermal decomposition/oxidation of polymers
2. The detection of polymer constituents/the Beilstein test
3. The decomposition of naturally occurring polymers
4. Production of a plastic material from a protein
5. The mechanical properties of plastics
6. Determination of the densities of plastics
7. Flammability
8. Deformability on warming
9. Determination of the melting range

#### Synthesis of plastics

10. Properties of monomers
11. Formation of polystyrene
12. Formation of polymethylacrylate
13. The formation of polyamide
14. The formation of polyamide
15. Base-catalysed formation of phenol resins
16. Acid-catalysed formation of phenol resins
17. Aldol addition
18. Polyurethane formation

#### Modification of plastics

19. Production of phenol resin foam
20. Production of urea resin foam
21. Production of polystyrene foam
22. Production of plexiglas plates

#### Identifying plastics

23. Thermoplastics and thermosetting plastics
24. Identification scheme for thermoplastics

#### Re-cycling

25. Re-melting
26. Pyrolysis

### Experiment descriptions



Software interTESS Chemistry, PolymerChemistry, DVD  
01064-00

TESS advanced Chemistry manual Chemistry of Polymers  
English  
01838-12

### Necessary equipment

TESS advanced Chemistry Set Chemistry of Polymers  
15305-88

TESS advanced Chemistry of polymers, necessary  
Accessories for 1 group  
13482-88

TESS advanced Chemistry of polymers, consumables and  
chemicals for 10 groups  
13483-88

# Electrochemistry

## Student experiments



### 23 Experiments

#### Preliminary tests

1. A remarkable source of electric current
2. Electric voltage from a salt solution
3. Solution pressure

#### Electrochemical cell and electrode potentials

4. The copper/zinc cell (Daniell cell)
5. Daniell cells connected in series and parallel
6. The voltaic cell
7. Nonmetal galvanic cells
8. The standard hydrogen electrode
9. The silver/silver chloride as reference electrode
10. Silver/silver chloride electrodes used for reference
11. The standard potential of the redox couple  $\text{Fe}^{3+}/\text{Fe}^{2+}$
12. Galvanic cells from a series of concentrations
13. Setting up a concentration series
14. Galvanic cells with different redox couples
15. Potentials using the Nernst equation
16. Changes in the voltage of a concentration series due to precipitation or binding of effective metal ions in complexes
17. Determination of the solubility products of silver halides

#### Protection against corrosion and energy storage

18. Corrosion of metals, local cells
19. Why is the base metal aluminium so non-corrosive?
20. Protecting against corrosion by passivation
21. Galvanic zincing
22. Storing energy in reversible galvanic cells
23. The zinc/oxygen cell

### Necessary equipment

TESS Electrochemical measurement set  
30505-88

TESS advanced Chemistry Electrochemical measurement set necessary accessories for 1 group  
13422-88

TESS advanced Electrochemical measurement set, consumables and chemicals for 10 groups  
30505-10

### Experiment descriptions

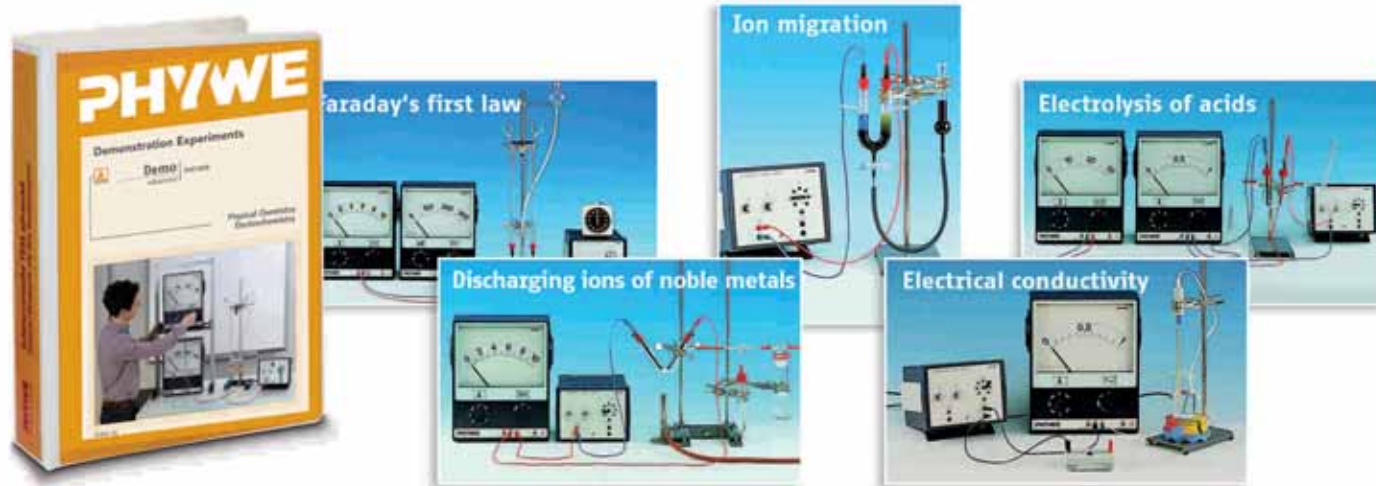


Handbook electrochemical measurement set  
01194-02

# Electrochemistry

## Teacher experiments

Demo | PHYWE  
advanced



Select your desired experiments and order them by way of the number that starts with P (order numbers for experiments). Every experiment includes all of the necessary equipment.

### 33 Experiments

#### Preliminary tests

- P1146000 Ionic migration
- P1146100 Water in the formation of freely mobile ions

#### Electrolysis

- P1144300 Electrolysis of hydrochloric acid
- P1147200 Electrolysis of solutions of bromides and iodide
- P1147300 Electrolysis of aqueous solutions of sulphates
- P1147400 Electrolysis of acids
- P1147500 Faraday's first law
- P1147600 Faraday's second law
- P1147700 Preparation of caustic soda solution
- P1147800 Nickel and copper plating of metallic objects
- P1147900 Zink and tin plating of metallic objects
- P1148100 Molten-salt electrolysis of lead chloride
- P7105160 Electrolysis with Cobra4

#### Conductivity

- P1144700 Electrical conductivity of acids
- P1145700 Electrical conductivity of solutions of salts
- P1145800 Electrical conductivity of aqueous solutions
- P1282560 Conductivity of crystalline and molten salts
- P1510160 Temperature dependence of conductivity
- P1271160 Connection between conductivity and electrode surface
- P1271260 Conductivity and kind of ion
- P1271360 Change in conductivity diluting different salt solutions
- P1271560 Specific conductivity of acetic acid

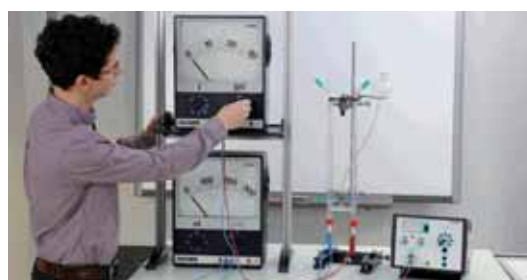
#### Potentials

- P1148200 Discharging ions of noble metals with base metals
- P1148300 Potential differences between various metals
- P1148400 Normal hydrogen electrode
- P1148600 Galvanic cells
- P1148700 Secondary cells - the lead accumulator
- P1148800 Fuel cells
- P1148900 Concentration cells (Nernst equation)
- P1149000 Corrosion of iron - protection against corrosion
- P1268360 Voltage of a concentration cell with Cobra4
- P1268460 The solubility product of silver chloride
- P1282360 Electrochemical series of metals with Cobra4

### Experiment descriptions



Demo advanced Chemistry Manual Electrochemistry  
English  
01856-02





# Electrochemistry

## Experiments on the board

### Molten-salt electrolysis



#### Principle

The electrolysis of molten sodium chloride to obtain chlorine and sodium, which can be further processed to produce sodium hydroxide, is an important industrial-scale process. The experiment depicted here can be used for a simple demonstration of the important steps in this process. Due to the high melting point of sodium chloride, however, lower-melting lead chloride is used as the raw material in the model experiment.

#### Literature for this experiment as follows:

Complete Experiments Chemistry/Biotechnology  
01855-02 English

P1310500

### Faraday's laws



#### Principle

Passing an electric current through a solution can cause chemical reactions. Here the current is the driving force of the redox reactions that occur.

If ions are added to water to make it conductive and that water is then electrolysed, hydrogen collects at the cathode and oxy-

gen collects at the anode. If these two gases are collected separately, such as with a Hofmann voltameter, the reaction can be followed quantitatively, making it possible to derive two laws ascribed to Faraday.

Faraday's first law states that the mass of a material separated by electrolysis is proportional to the quantity of electricity which flowed through the solution.

The second law states that the electrochemical equivalents are proportional to their equivalent masses (molar mass divided by valency).

The experimental setup depicted here can be used to clearly derive the two laws experimentally.

#### Literature for this experiment as follows:

Complete Experiments Chemistry/Biotechnology  
01855-02 English

P1309500

### Conductivity / temperature with Cobra4



#### Function and Applications

The Cobra4 Sensor Unit Conductivity / Temperature (Pt1000) is a microcontroller-based measuring recorder with a 5-pin diode socket for connecting conductance measuring sensors with a cell constant of  $K = 1.00/\text{cm}$  or Pt1000 thermocouples.

**Cobra4 Sensor-Unit Conductivity+**  
12632-00

**Cobra4 Mobile-Link 2 incl. accessories: battery, USB cable, charger and SD memory card**  
12620-10

**Conductivity temperature probe Pt1000**  
13701-01

# Colorimetry with Cobra4 Sensor-Unit Colorimetry



## Colorimetry with Cobra4



### Function and Application

The Sensor-Unit Colorimeter is used for the photometric measurement of concentrations in liquids, e.g. iron or nitrate in aqueous solutions (environment analytics). It can also be used for measurement of reaction kinetics (time dependence of concentrations).

- Suitable for student experiments indoors and outdoors.

### Equipment and Technical Data

- The sensor includes five standard cuvettes.
- Range: 4 wavelengths (LEDs), red/orange/green/blue
- Transmission 0... 100 %
- Resolution: 0,01 %T
- Max. data rate: 10 Hz

### Cobra4 Sensor-Unit Colorimetry 12634-00

**Cobra4 Mobile-Link 2 incl. accessories: battery, USB cable, charger and SD memory card  
12620-10**

## Lambert Beers law, photometry

### Principle

This experiment is used to introduce the Lambert-Beer law. It demonstrates the relationships between absorption and concentration. Quantitative analyses by photometry can also be performed for other coloured solutions based on the same principle.

**P7110160**

# Gas Laws, Thermochemistry and Kinetics

## Teacher experiments

Demo | PHYWE  
advanced



Select your desired experiments and order them by way of the number that starts with P (order numbers for experiments). Every experiment includes all of the necessary equipment.

### 27 Experiments

#### Thermochemistry

- P1136300 Enthalpy and entropy in chemical reactions
- P1136400 Energy of activation
- P1136500 Catalysts
- P1136700 Endothermic processes - electrolysis of water
- P1223751 Methane, ethane and propane
- P1223800 Determination of the heat of formation of water
- P1223900 'Hess' law'
- P1224051 Determination of the heating values fuels
- P1224300 Determination of the heating value of fuel oil
- P1273460 Heat of fusion of sodium thiosulphate with Cobra4
- P1282060 Melting and crystallization diagram
- P7200460 Model experiments of hand warmers
- P7200560 Temperature change when a gas is liquefied by compression

#### Kinetics

- Dependence of the reaction velocity
- P1149100 ... on the type of substance I
- P1149200 ... on the type of substance II
- P1149300 ... on the concentration (Landolt reaction)
- P1149400 ... on the temperature
- P3050860 The saponification of esters with Cobra4
- P3070601 Reaction kinetics with measureSpec

#### Ideal gas law

- P1222900 Gay-Lussac's law

- P1223000 Charles's (Amontons') law
- P1223100 The Boyle-Mariotte law
- P1223200 The gas laws
- P1223301 Determination of molar masses with the vapour density method
- P1223400 The law of integral volumes
- P1223551 Gay-Lussac's law of volumes
- P1223651 Avogadro's law

### Manual

Demo advanced Chemistry Manual Gas Laws, Thermochemistry, and kinetics English  
01857-02

### Set Gas laws with glass jacket & Cobra4



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

Set Gas laws w. glass jacket & Cobra4  
43020-00

# Glass Jacket System

## Teacher experiments

Demo  
advanced PHYWE

UNIQUE

The glass jacket system was developed primarily for experimenting with gases and can be used across disciplines in chemistry, physics and biology classes. In chemistry, it is used to develop the gas laws, to determine molar masses, to measure combustion enthalpies, and many other applications.

### The advantages at a glance

- Demonstrative and transparent
- Versatile modular system, easy to assemble
- Ideal for working with gases
- Manual with detailed instructions of experiments
- Uncomplicated, fast experiments
- Excellent results
- Can be stored completely assembled

Gas Laws (e.g. P3011360)

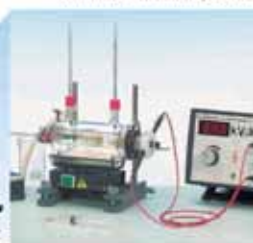


Determination of molar masses (P3010501)



Gas reactions (e.g. The law of Avogadro, P3111000)

Gas reactions (e.g. Empirical molecular formula of methane, P3111000)



Gas syringe



Plunger eudiometer



Slow eudiometer



Steam distillation (P3031251)



Distillation insert



Glass jacket



Gas separation column



Gas chromatography (P3031760)

Calorimeter insert



Lid for the calorimeter insert



Calorimetry (e.g. Hess' law, P3021601)



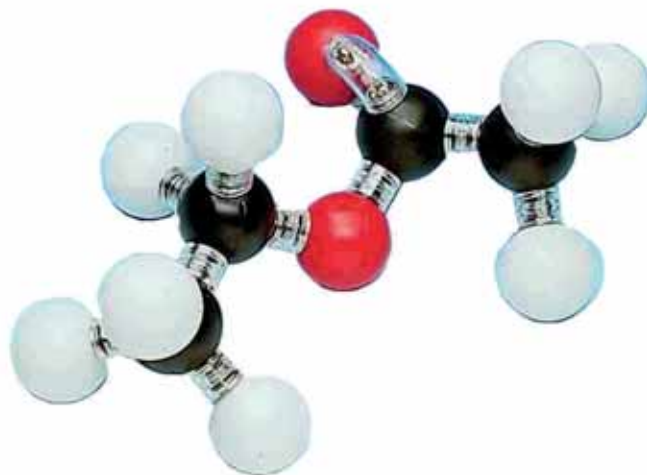
Energy balances at gas reactions (P3021501)



# Molecular model construction kits

## For demonstration

Demo  
advanced | PHYWE



### Molecular models by PHYWE

#### Function and Application

With these big elements (Atoms) for molecular models structures of chemical compounds can be presented especially vividly also to a greater number of observers

#### Benefits

- structural elements of shockproof plastic
- diameter of the elements: 38 mm
- angularity of the connections by precisely rivetted push-buttons according to the valences of the elements
- push-buttons for a secure connection of the elements even after years of use

### Molecular model construction kit, organic chemistry



39821-88

### Molecular model construction kit, basic set



39820-88

### Molecular model construction kit, polymer chemistry



39818-88



## Biology

5.1	Curriculum and Overview	122
5.2	Microscopy	126
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5.5	Human Physiology	138
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5.9	Biotechnology	144

PHYWE covers the requirements of the educational plans for the

International Reference Curriculum (School)					
Theme	Sets or experimental collection	Microscopy	General Biology	Plant physiology and Biochemistry	Environment and outdoors
		TESS	TESS / Demo	Demo 	TESS 
<b>CELLS</b>					
The microscope in cell studies, magnification		✓			
Cell structure and organisation		✓			
Detailed structure of typical animal and plant cells, cell organelles		✓			
Levels of organisation - cell-tissue-organ		✓			
Characteristics of prokaryotic and eukaryotic cells		✓			
Movement in and out of cells: Diffusion, Active Transport, Osmosis		✓			
Zellorganellen - elektronenmikroskopisch, erkennbare Strukturen		✓			
Cell and nuclear division, mitosis		✓			
<b>METABOLISM: NUTRITION, NUTRIENTS, EXCRETION, RESPIRATION</b>					
Plants: Photosynthesis, Leaf structure, mineral requirements			✓	✓	
Animals: alimentary canal, digestion (mechanical, physical, chemical)			✓		
Absorption, assimilation			✓		
Excretion in humans			✓		
Enzymes				✓	
Respiration (cells): aerobic and anaerobic as an energy transfer process				✓	
<b>PLANTS</b>					
Regulation of the internal environment		✓	✓		
Communication and control in flowering plants			✓		
Plant growth regulators			✓		
Crop plant reproduction and adaptations			✓		
<b>TRANSPORTATION AND GAS EXCHANGE</b>					
Transport system in plants: Water uptake and translocation		✓	✓		
Transport in mammals: heart and blood system					
Gas exchange: lungs etc. and smoking					
<b>COORDINATION AND RESPONSE</b>					
Nervous control in humans, neurobiology					
Senses			✓		
<b>REPRODUCTION, GROWTH AND DEVELOPMENT</b>					
Asexual and sexual Reproduction in Plants		✓	✓		
Growth and development; Gametogenesis			✓		
<b>INHERITANCE AND GENETICS</b>					
Inheritance			✓		
Chromosomes, Mitosis and Meiosis		✓			
Role of DNA in protein synthesis, gene technology					
<b>ECOLOGY</b>					
Levels of ecological organisation					✓
Energy flow and Nutrient cycles				✓	✓
Human influences on the ecosystem: Agriculture, Pollution, Conservation					✓
<b>BIOCHEMISTRY AND ENZYMES</b>					
Biological molecules: carbohydrates, lipids and proteins			✓		
Enzymes: Mode of action of enzymes, Immobilisation of enzymes				✓	







### Teaching biology with TESS sets – outdoor and indoor experimentation

Biology is the science of life. It centres on living organisms, i.e. plants, animals, and humans, of course. PHYWE offers perfectly matching sets for all the various fields in biology.

#### TESS General Biology

TESS General Biology – a set with experiments covering nearly all of the curriculum topics:

- cytology
- reproduction and development
- animals
- plants
- respiration
- bones
- senses
- behaviour
- nutrition and digestion
- ecology



#### TESS Electrophysiology

TESS Electrophysiology: dull theory in the past – now with the active involvement of the students!



### Cobra4 Environment and Outdoors Case

Station-based learning with the Cobra 4 Environment and Outdoors Case. Teach ecology where it takes place: **outdoors!**

#### Advantages at a glance

- designed for 5 groups working in parallel
- datalogging with Cobra4
- handbook included
- robust storage case



# Microscopy

## Student experiments



### 50 Experiments

#### Basics of microscopy

1. The components of a microscope MI 1.1
2. Working with the microscope
3. Microscopic magnification

#### Work techniques

4. Preparation of temporary microscopic slides
5. Manual section technique
6. Staining of living organisms
7. Rapid staining technique
8. Fixation and staining
9. Embedding in Canada balsam

#### Preparation of reagents

10. Preparation of reagents

#### Cell components

11. The cell wall of the onion
12. The cellular membrane of animal cells
13. Chloroplasts in moss leaves
14. Chromoplasts
15. Nucleus and chromosomes
16. Vacuole
17. Plasmolysis and deplasmolysis
18. Protoplasma streaming

#### Seed plants

19. Upper epidermis of a deciduous leaf
20. Lower epidermis with guard cells
21. Cross-section of a deciduous leaf
22. Cross-section of a conifer (gymnosperm) leaf
23. The stem of a dicotyledonous plant
24. The stem of a monocotyledonous plant
25. Root with root-hair cells

26. Cross-section of a plant ovary
27. Starch as a nutritional reserve substance in plants

#### Vertibrates

28. Wing feathers of birds
29. Comparison of raw milk and homogenised milk
30. Fish scales in comparison
31. Skeletal muscle
32. Blood cells
33. Kidney
34. Liver cells (hepatocytes)
35. Fish gills

#### Invertebrates

36. Insect wings
37. The mouth parts of insects
38. Planaria
39. Nematoda
40. Brine shrimp (*Artemisia salina*)
41. Water flea (*Daphnia*)
42. The ciliated epithelium of mussels

#### Other plants

43. The spore capsules of ferns

#### Fungi

44. Mould fungi growing on food

#### Protists

45. Ciliates in a hay infusion
46. Colony-forming ciliates in an aquarium
47. Volvox
48. Diatoms in moor water
49. Radiolaria

#### Prokaryotes

50. Bacteria





### Necessary equipment

TESS advanced Biology set Microscopy  
15290-88

TESS advanced Microscopy necessary accessories for 1  
group  
13443-88

TESS advanced Microscopy consumables for 10 groups  
13444-88

### Experiment descriptions



TESS advanced Biology manual Microscopy  
13290-02

### Advantages of the set:

- ✓ Extensive descriptions of the fundamental working techniques and methods included
- ✓ Handbook including a CD-ROM with numerous pictures
- ✓ Templates for student worksheets



## TESS microscopy – complete solution for 50 microscopy applications

**TESS** | PHYWE  
advanced

TESS microscopy uses numerous field-proven methods that are explained in 50 experiment descriptions on the CD-ROM. Among others, the following biological topics are covered

- fundamental principles of microscopy
- microscopy working methods
- cell components
- spermatophytes and ferns
- vertebrates and lower animals
- fungi
- protists
- prokaryotes

Together with the SWIFT M3-M, it is ideally suitable for your biology classes!

### Features

- 50 documented experiments with a microscope
- TESS set specifically adapted to the experiment didactics, including the microscopy accessories
- adapted to the curricula of secondary school levels I and II
- topics covering all fields of biology
- self-explaining drawings for the independent execution of the experiments by the students
- accompanying teacher handbook with tips and assistance



Set including TESS microscopy, a SWIFT M3-M microscope and a CD-ROM (G/E) (15290-33)

### Material included and technical data

- TESS advanced biology set microscopy, MIC (15290-88)
- SWIFT macro microscope M3-M (63001-99)
- CD-ROM for TESS microscopy (13290-12)

### Necessary accessories and consumables

- TESS advanced microscopy MIC, necessary accessories for 1 group (13443-88)
- TESS advanced microscopy MIC, consumables for 10 groups (13444-88)

15%  
saving

# Microscopy

## Teacher microscope

Demo | PHYWE  
advanced

### SWIFT teacher microscope M10T-S



#### Function and application

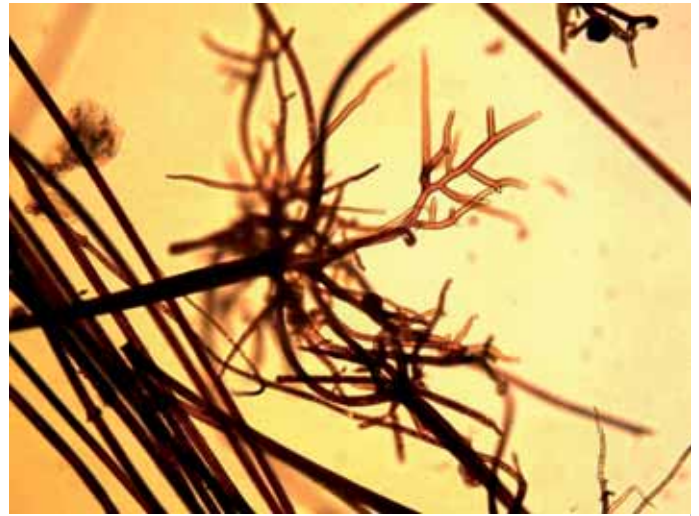
Trinocular microscope ideal for high school, advanced studies and professional applications. Supplied with trinocular head and semi-plan lenses.

#### Benefits

- Integrated carry handle
- easy to move Quad objective turret is ball-bearing mounted for smooth, precise positioning of objectives.
- Mounted in reverse position to facilitate ease in changing slides.
- Variable, corded, energy-efficient LED illumination - up to 50000 hours lifetime

#### Technical data

- Ergonomic Siedentopf head
- Coaxial focusing: Coaxial coarse and fine focusing controls, coarse has tension adjustment, fine is graduated.
- Widefield 10x /20mm eyepieces.
- Trinocular viewing head with 30° inclined eyepieces, with diopter and interpupillary adjustment 54mm to 76mm.
- DIN standard 4x (0.10 N.A.), 10x (0.25 N.A.), 40xR (0.65 N.A.) and 100xR oil immersion (1.25 N.A.) objectives.
- semi-plan lenses. All are parfocalled, parcentered and color-coded.
- Variable, 3 watt LED provides bright, white illumination.
- 110V - 220V switching power supply, unit shipped with American plug.
- Large 5-3/4 in. x 5-1/2 in. (142mm x 140mm) stage; built-in, low profile, ball-bearing mounted mechanical specimen holder with low-position coaxial controls.
- 1.25 N.A. Abbe condenser has rack & pinion focusing and iris diaphragm.
- Base dimensions: 10-1/4 in. x 6-3/4 in. (261mm x 172mm)



- Height: 14-1/2 in. (369mm).
- Net wt. 30.9 lbs (14.0 kgs).

63024-99

### Experiment descriptions



TESS advanced Biology manual Microscopy  
13290-02



# General biology

## Student experiments



### 41 Experiments

#### The human being : bones, body heat and breathing

1. Structure and strength of bones
2. Body heat
3. Do we also eliminate something from our bodies when we breathe?

#### Plants

4. We study a flower
5. Hermaphrodite flowers
6. Monoecious and dioecious flowers
7. From seed to plant
8. Conditions necessary for germination of seeds
9. Swelling
10. Germination and oxygen
11. Sowing time
12. Germination and light
13. Why don't seeds germinate while still inside the fruit?
14. What are seed leaves for?
15. What is a plant's seed made of?
16. Why do cut flowers wilt without water?
17. Evaporation protection
18. Importance of roots
19. Water supply in plants
20. What does a plant need to produce starch?
21. What is the significance of the green leaf pigment?

#### Reproduction

22. Seed dispersal

#### Ground survey

23. The size of soil particles
24. Lime content of soil

#### Nutrients and digestion

25. Foodstuffs and nutrient substances
26. Which foods contain starch?
27. Which foods contain sugar?
28. Which foods contain fat?
29. Proteins
30. Digestion in the mouth
31. Digestion in the stomach
32. Digestible and indigestible proteins
33. What does bile do?
34. Digestion in the intestines
35. Digestible and indigestible fats

#### Senses

36. Our sense of smell
37. The combination of the senses of the taste and smell
38. Our sense of taste
39. The blind spot
40. Optical illusions
41. Response of algae to light





### Necessary equipment

TESS advanced Biology basic set General Biology  
15296-88

TESS advanced Biology necessary accessories for 1  
group  
13486-88

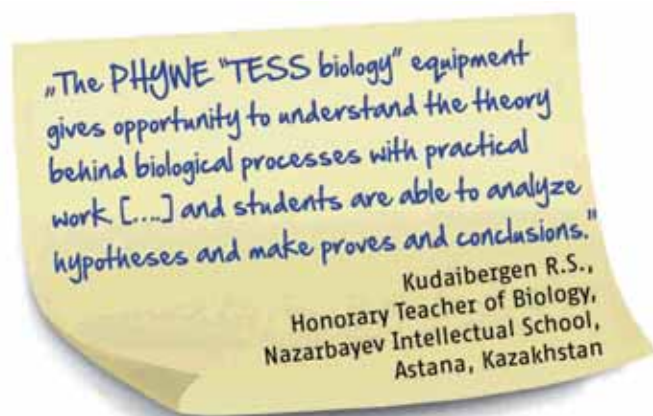
TESS advanced Biology consumables for 10 groups  
13487-88

### Experiment descriptions



Software interTESS Biology, DVD  
01070-00

TESS advanced Biology manual Students experiments  
01845-02





# General Biology

## Teacher experiments



### Vision defects (model experiment)



#### Function and Applications

This experiment allows a vivid demonstration of short-sightedness and long-sightedness compared to the normal vision of the human eye and of how such defects can be corrected

#### Benefits

- The back part of which is formed as a projection surface and is removable
- various eyeball lengths can be attained by inserting spacer rings
- correction of sight defects is achieved with lenses placed in front of the model
- it allows a vivid demonstration of short-sightedness and long-sightedness compared to the normal vision of the human eye and of how such defects can be corrected
- the image on the "retina" (projection surface) is not turned rightside up, as it is by brain activity and is so seen upside down.

### Vision defects (model experiment) P1054300

### Subjective colour mixing with the colour wheel



#### Principle

If a circular disc separated into various differently coloured sectors is rotated by a motor so fast that the eye can no longer distinguish the colours, a mixed colour is then perceived. By varying the composition and size of the sectors, it is possible to give the impression of any colour at all. The colour triangle can be used to predict what the perceived colour will be.

### Subjective colour mixing with the colour wheel P0872500

### Mechanism of diaphragmatic respiration



#### Principle

Mechanical model for the demonstration of how the human lung functions work. The model shows the expansion of the lungs (rubber balloons) when the breast area (polystyrene jar) is expanded by sinking the diaphragm (rubber cloth). Air flows into the lungs through the windpipe and bronchi (glass Y-tube).

### Mechanism of diaphragmatic respiration P1049300

Find more interesting  
biology experiments on our webpage -  
[www.phywe.com](http://www.phywe.com)

WEB @ PHYWE



### Time resolving capability of the human eye



As excitation of the light-perceptive cells of the retina always takes a little longer than the light stimulus, only a limited number of stimuli per unit of time can be processed (time-related resolving power of the eye). If a light source is switched on and off periodically in increasingly rapid sequence the eye at first perceives the individual flashes, then the appearance of flicker occurs and finally the impression of a continuous light (fusion of the flicker).

**Time resolving capability of the human eye**  
P4070300

### Osmosis



Osmosis describes the phenomenon that solvent molecules move through a partially permeable membrane into a region of higher solute concentration. Thus, the concentration of solute is equalized on both sides. The experimental set-up consists of two chambers that are separated by a semi-permeable membrane. One of them is filled with a solution of sugar and the other with pure water. The liquid column in the capillaries is determined and the dependence of the osmotic pressure on the concentration can easily be shown.

**Osmosis**  
P1047300

### Learned behaviour in fish

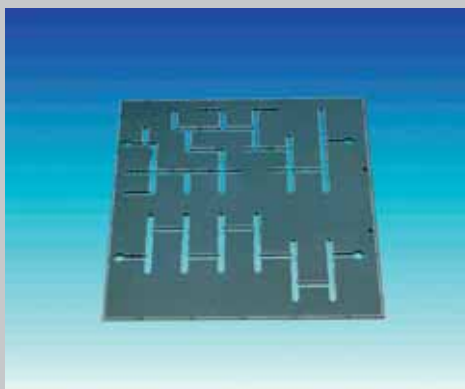


#### Principle

Fish are able to learn that certain colours are connected to food. A fish is fed as follows: Choose one plate (e.g. the red one) and clamp a living worm (Tubifex spec.) to the plate. Offer all of the three plates to the fish. It is going to detect the worm and eat it. Change the positions of the plates so that only the colour leads to the worm. After a few days the fish is going to swim to the red plate immediately after entering the aquarium.

**Learned behaviour in fish**  
P1056600

### Learning performance of humans



#### Principle

The blindfolded test subject has to find the way to the finish with a felt-tip pen in the slits of a finger labyrinth. Success and error are checked by placing a sheet of paper underneath.

**Learning performance of humans**  
P4080300

# Environment and Outdoors

## Student experiments



### 16 Experiments

#### Introduction

1. Learning stations using the experimentation case

#### Water

2. We examine our drinking water
3. Acidity changes of a watercourse
4. Salinity changes of a watercourse
5. Water quality - contamination with heavy metals
6. We visit a wastewater treatment plant

#### Soil

7. Salinity of soils and plant substrates
8. The pH value of various soils
9. Raised bog and fen

#### Weather and climate,

10. Comparison of soil and air temperatures in the course of a day
11. Meteorological observations
12. Changes of the light conditions in a deciduous forest

#### Terrain

13. Altitude measurement on a trail
14. Measuring the height of a tower
15. Terrain mapping
16. Air pressure and relative humidity in an aircraft

*"We have been using the Cobra4 system and the environment and outdoors case intensively for three years with the children and teenagers who come to us. We still think it is fantastic!"*

D. Schwerdtfeger,  
Internationaler Schulbauernhof  
Hardegsen gGmbH



### Necessary equipment

TESS Applied Sciences Cobra4 environment and outdoors, for 4 work groups inclusive aluminum case 12626-88

### Optional extension set

TESS Environment and Outdoors optional accessories for 10 groups 13445-88

### Experiment descriptions



One manual is already included in the set.

TESS advanced Applied Sciences manual Cobra4 environment and outdoors 12622-02

### Determine oxygen concentration with Cobra4



#### Function and Applications

- Measure the oxygen content in air or in liquids and the temperature

Cobra4 Sensor-Unit Oxygen 12676-00

Cobra4 Mobile-Link 2 incl. accessories: battery, USB cable, charger and SD memory card 12620-10

Electrode Oxygen 12676-11



# Soil examination

## Student experiments



### 19 Experiments

#### Soil profile

1. Identification of the soil horizons
2. Determination of the soil type

#### Mineral matter

3. Estimation of the stone content
4. Determination of the fine earth content
5. Determination of the soil texture

#### Body of humus

6. Estimation of the humus content
7. Analysis of the type of humus

#### Water/air

8. Estimation of soil moisture
9. Examination of the water capacity
10. Examination of the water permeability rate
11. Determination of the utilizable water capacity

#### Soil structure

12. Measurement of soil compaction
13. Measurement of the aggregate stability/tilth

#### Acidity

14. Measurement of the pH value
15. Determination of the lime content

#### Nutrients

16. Measurement of the nitrate content of soil
17. Measurement of the nitrate content of fruit and vegetables

#### Life in the soil

18. Registration of soil animals

#### Taking soil samples

19. Taking soil sample

### Necessary equipment

**TESS Applied Sciences set examination of soil**  
30836-77

**TESS Examination of soil consumables for 10 groups**  
30836-10

### Experiment descriptions



One manual is already included in the set

**TESS Applied Sciences manual examination of soil**  
30836-02

### Optional extension set

**Soil auger**  
64221-01

# Water analysis

## Student experiments



### Chemo-physical water analysis list of topics

The following parameters are measured:

- temperature
- oxygen content
- pH-value
- conductivity
- nitrate, nitrit, phosphate and ammonium content
- alkalinity (total hardness)

### Necessary equipment

**TESS Biology set chemo-physical water testing**  
30837-77

### Experiment descriptions



One manual is already included in the set.

**TESS Biology manual chemo-physical water testing**  
30837-22

### Biological water analysis 10 Experiments

1. Fresh water as a habitat
2. Trophic states and the saprobic system
3. Documentation of anthropogenic stress based on bioindicators
4. Methods for the biological analysis of running waters
5. Methods of analysis of bodies of standing waters
6. Macroscopic-biological analysis
7. Presentation of animals as indicators
8. Identification key in accordance with Xylander-Nagelschmid
9. Identification key in accordance with Wassmann / Xylander
10. Method of analysis in accordance with D. Meyer

### Necessary equipment

**Ecology case, biological water analysis**  
30834-77

### Experiment descriptions



One manual is already included in the set.

**TESS Biology manual biological water quality testing**  
30834-02

# Electrophysiology

## Student experiments




### 6 Experiments

- Heart**
1. We investigate our heartbeat - electrocardiography
  2. We determine our heart frequency
  3. We investigate our physical fitness - the heart under stress with Cobra4
- Muscle**
4. We investigate our muscular power - electromyography
- Eye**
5. We measure our eye movements - electrooculography
  6. Measuring reading skills with Cobra4

### Necessary equipment

TESS advanced Applied Sciences set Electrophysiology  
15673-88

### Experiment descriptions



One manual is already included in the set.

**TESS advanced Biology manual Cobra4**  
**Electrophysiology: ECG, EMG, EOG**  
**12673-12**

*"I use "TESS Electrophysiology" Set in Biology classes in our 8th form course "Human physiology". The sensor is easy-to-use and it is wirelessly connected to a PC that is a big advantage in movable biological experiments."*

Alla Bulyuk, Biology Teacher of  
Secondary School No. 138,  
St.Petersburg, Russia

# Human physiology

## Student experiments

TESS  
advanced | PHYWE

4  
Cobra NEW



### 8 Experiments

#### Conductivity and temperature of the skin

1. Changes in the blood flow during smoking with Cobra4
2. Stroop Effect

#### Circulatory System

3. Pulse at rest and during exercise
4. Blood pressure measurement

#### Breathing

5. How much air can our lungs contain with Cobra4?
6. Direct determination of lung volume from a spirogram
7. Does the lung volume depend on how tall you are?
8. Diagnosis of lung disease (FEV) with Cobra4

### Necessary equipment

TESS advanced Applied Sciences Set Human Physiology  
15675-88

### Experiment descriptions



One manual is already included in the set.

TESS advanced Applied Sciences Manual Human  
Physiology  
01846-02

#### Advantages of the set:

- ✓ Measurements are possible with or without a computer
- ✓ Including the SU Skin Resistance - „lie detector“ (polygraph) - motivating and relating to our everyday life



### Plant physiology and Biochemistry Teacher experiments



#### 9 Experiments

##### Cell membrane

1. Ionic permeability of the cell membrane with the Basic-Unit

##### Fotosynthese

2. Fotosynthese (O<sub>2</sub> pressure measurement)

3. Fotosynthese (Bläschen-Zähl-Methode)

##### Glycolysis

4. Glycolysis (temperature measurement)

5. Glycolysis (pressure measurement)

##### Enzyme kinetics

6. The enzymatic activity of catalase (with the Cobra3 Basic-Unit)

7. Determination of the Michaelis constant with the Basic-Unit

8. Substrate inhibition of enzymes with the Basic-Unit

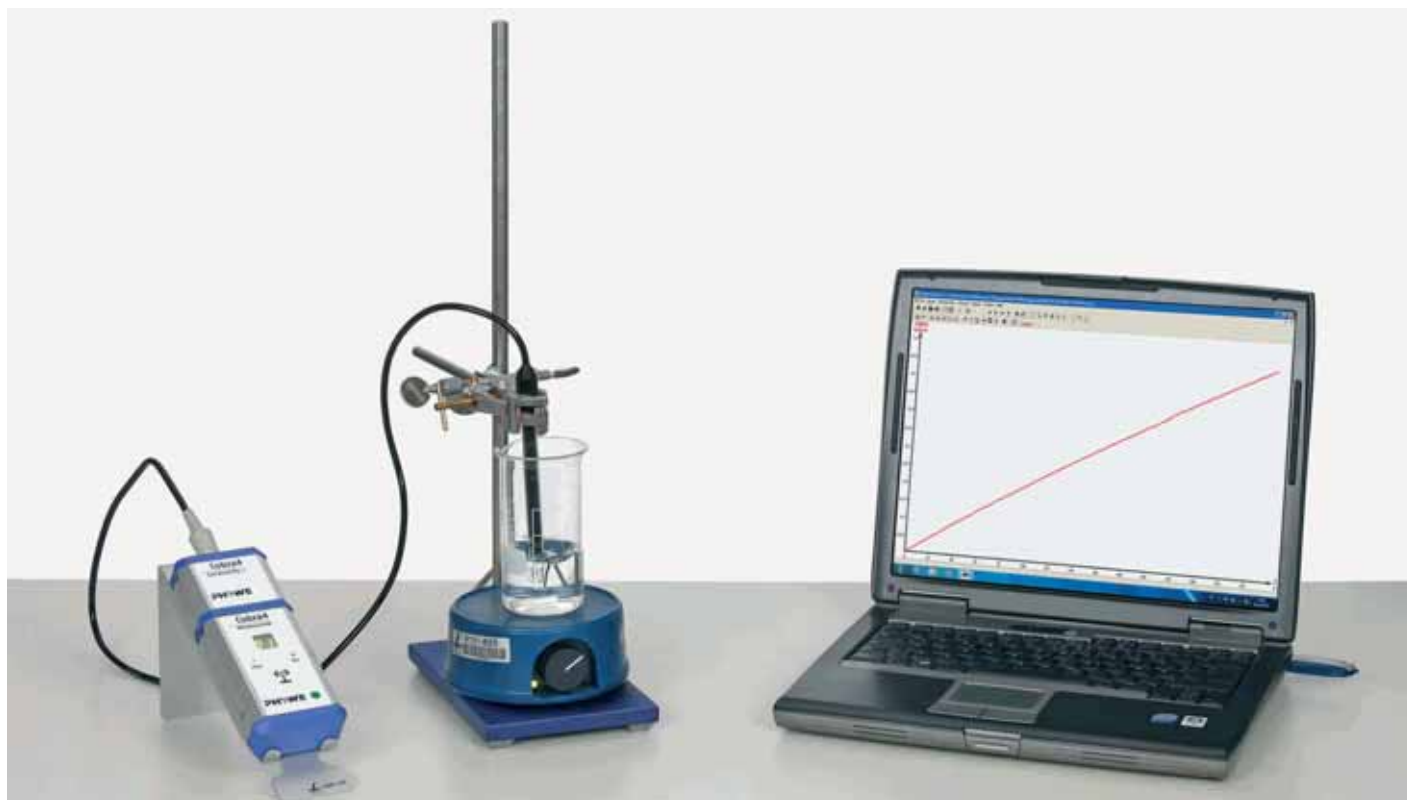
9. Enzyme inhibition (poisoning of enzymes) with the Basic-Unit

#### Necessary equipment

Basic set Cobra4 Biochemistry and plant physiology  
65982-88

Standard labware set for Biochemistry & plant  
physiology  
65980-77

Chemicals set Biochemistry & plant physiology  
65980-10



## Experiment descriptions



Demo advanced Biology Manual Cobra4 Biochemistry & plant physiology  
01331-02

*"Cobra4 is [...] unique with its mobility, user friendliness and protection against outer surroundings."*

Kudaibergen R.S.,  
Honorary Teacher of Biology,  
Nazarbayev Intellectual School,  
Astana, Kazakhstan

## Measuring conductivity / temperature with Cobra4



Cobra4 Sensor-Unit Conductivity+  
12632-00

Conductivity temperature probe Pt1000  
13701-01

Cobra4 Mobile-Link 2 incl. accessories: battery, USB cable, charger and SD memory card  
12620-10

# DNA-Electrophoresis

## Student experiments

NEW



### Available test kits



**Kit: Electrophoresis Plasmide DNA**  
35023-05

**Kit: Electrophoresis Lambda DNA**  
35023-06

**Forensic DNA fingerprinting kit**  
35023-07

**Kit: Paternity Test with DNA Electrophoresis**  
35023-08

### Necessary equipment

**TESS advanced Biology set Molecular Biology**  
15310-88

**TESS advanced Biology Set Molecular Biology, necessary accessories for 1 group**  
13446-88

**TESS advanced Biology Set Molecular Biology, necessary accessories for 5 groups**  
13448-88

**TESS advanced Biology Set Molecular Biology, consumables and chemicals for 10 groups**  
13447-88

# Nervous system

## Teacher experiments

Demo advanced PHYWE



### 16 Experiments

1. Membrane time constant and low-pass filtering
2. Mode of operation of excitatory synapses
- 3-15. Nerve cells (13 experiments)
16. Interaction of nerve cells

### Experiment descriptions



One manual is already included in the set.

### Neurobiology Lab, 230 V

65963-11

Interface zum Messen, Steuern und Regeln	12150-50	1
Neurosimulator	65963-00	1
Neurosimulator, Betriebsgerät	65963-93	1
Software für Interface	14504-61	1
Netzgerät 12 VDC/2 A	12151-99	1
Demo expert Biologie Handbuch Neurosimulator (NST)	01191-01	1
Demo expert Biology Manual Neurosimulator (NST)	01191-02	1

### Neurosimulator Handbook

01191-02

### Necessary equipment

Neurobiology Lab, 230 V  
65963-11





# Biotechnology

## Teacher experiments on board

### Production of amino acids by fermentation of *Corynebacterium glutamicum* with Cobra4



#### Principle

A bacteria culture of *Corynebacterium glutamicum* is used in a bioreactor at a constant temperature of 30 °C to produce amino acids. Under these conditions the fermentation of *Corynebacterium glutamicum* takes place in a so-called batch process for 7 to 10 days.

P1313862

### Bacteria and mining - microbial extraction of ore by *Thiobacillus ferrooxidans* and thiooxidans with Cobra4



#### Principle

Scientists first recognised importance of certain bacteria for the extraction of metals from ore in the 1950s. Nowadays the microbial ore leaching with so-called 'lean ores' represents more than 10% of the total production of copper in the USA alone. The bioreactor shown here can be used to clearly demonstrate

to the students this method of extraction (e.g. copper from copper ore) using such bacteria (*Thiobacillus ferrooxidans*).

P1313962

### Fermentation of molasse to ethanol with yeast



#### Principle

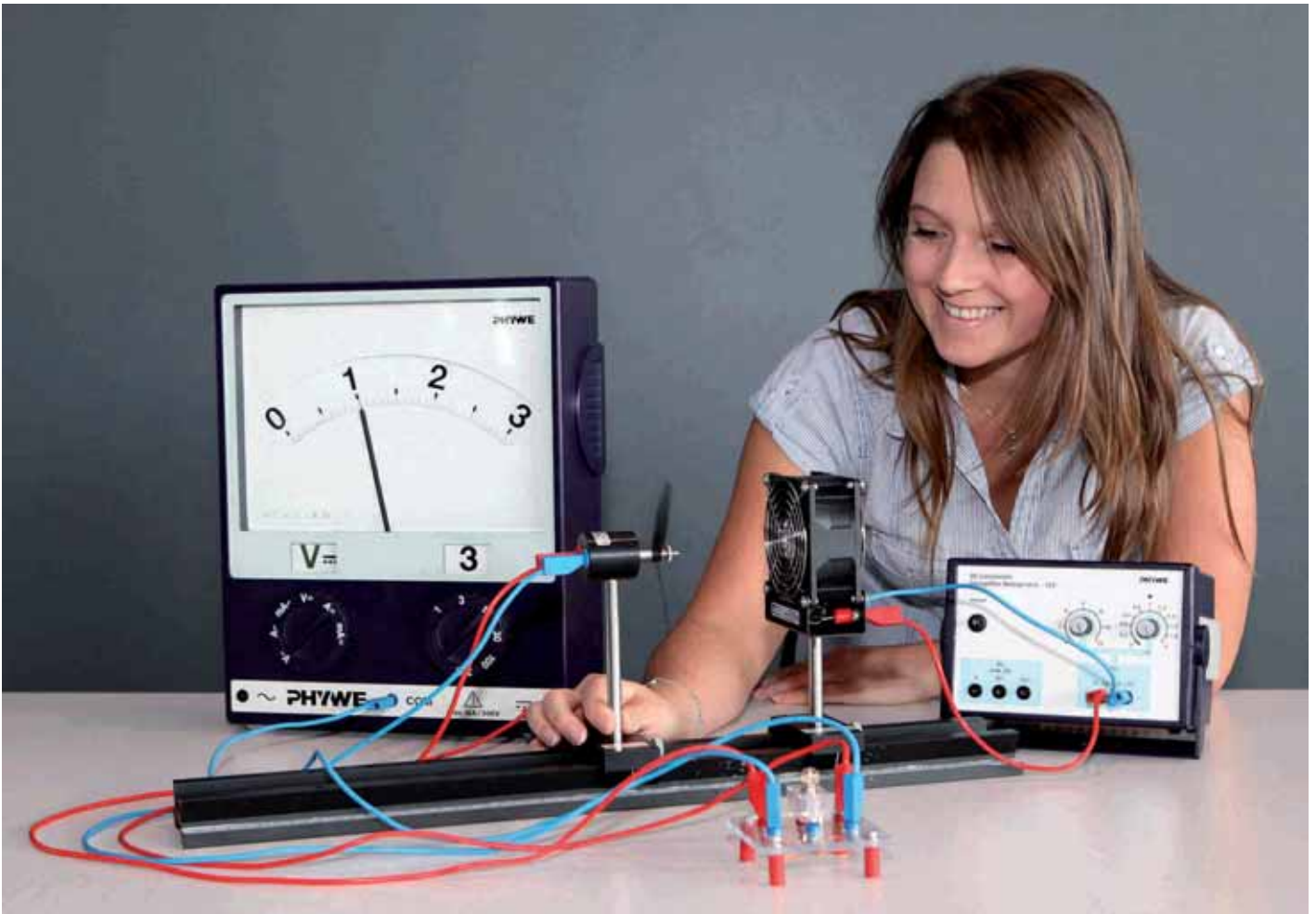
As a result of the need to save energy and the increased consciousness of environmental problems, biotechnological production methods are on the advance. Fermenters are used for the biotechnological production of enzymes and other products using bacteria, yeast and cell cultures. For educational purposes a bubble bioreactor used in this experiment is a more convenient and economical alternative to commercial fermenters. To demonstrate how fermenters work, in this experiment molasse which is a waste product of sugar production is fermented in the so-called batch process.

Fermentation of molasse to ethanol with yeast  
P1313600

### Literature



Complete Experiments Chemistry/Biotechnology  
01855-02



## Interdisciplinary teaching

### 6.1 Interdisciplinary student and teacher experiments

146

## 6 Interdisciplinary teaching

### 6.1 Interdisciplinary student and teacher experiments

## Interdisciplinary teaching – with applied sciences

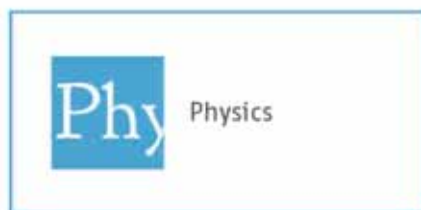


Applied sciences have long been part of the repertoire of physicists, chemists, and biologists. The cross-linking of science disciplines is a common factor for success in this context. The separation into the classic fields of physics, chemistry, and biology becomes increasingly obsolete and there is a strong trend towards interdisciplinary and application-oriented teaching and learning.

Let us inspire you with our applied sciences topics!



### Quick overview of the subjects





# Renewable energy – the future of energy production



TESS Basic Set Renewable energy	15287-88	TESS Supplementary set Renewable Energy Solar, Water, Wind	15288-88	TESS Supplementary set Fuel Cells	15286-88
Demo set (not shown)	15580-88	Demo set (not shown)	15581-88	Demo set (not shown)	15582-88

## Curricular topics

**Phy**

- Combustion engine
- Electric motor
- Energy and power
- Conservation of energy
- Characteristic curve
- Insulation

**Eng**

- Generator
- Wind energy
- Solar cells
- Energy from water
- Power plant technology
- Solar hydrogen plant
- Fuel cell

### Corresponding experiments of the sets

<b>Energy:</b>
▪ Energy conversion
▪ Heating water in a solar collector
▪ Conversion of thermal energy into electrical energy
▪ Electric energy from solar cells
▪ Wind energy
▪ Water power
▪ Parabolic trough power plant
▪ Hydrogen technology
<b>Heat:</b>
▪ Thermal insulation
▪ Heat conduction
▪ Absorption of thermal radiation
▪ ...





# 6 Interdisciplinary teaching

## 6.1 Interdisciplinary student and teacher experiments



### Biophysics – Eye and ear



Tess advanced Physics set Optics 15276-88



TESS advanced Biology Basis set General Biology 15296-88

#### Curricular topics

##### Optics

- Lens equation
- Diffraction and interference
- Refraction of light



##### Eye

- The human eye
- Function of the pupil
- Adaption of the eye
- Functionality of the retina, rods, and cones
- Limits of our visual performance



#### Corresponding experiments of the sets

- Law of lenses
- Functioning of the human eye
- Refraction at the air-water boundary
- Light path of lens combinations
- Short- and long-sightedness and its correction
- Optical illusions
- The blind spot
- ...



Tess advanced Applied Sciences set Acoustics 1

15289-88



Tess advanced Applied Sciences set Acoustics 2

15321-88

### Curricular topics

Phy

#### Acoustics

- Basics of acoustics
- Wave character of sound
- Acoustic pressure
- Noise pressure level
- Frequency and tone pitch

Bio Med

#### Ear

- The human ear
- Sound propagation in the inner ear
- Generation of neural impulse

### Corresponding experiments of the sets

- Generation and propagation of sound waves
- Reflection and echo
- Sound and noise
- Sound as a sine wave
- Standing waves
- Determination of an unknown frequency (beats)
- Sound insulation and sound attenuation
- Lower and upper hearing threshold
- Directional hearing
- Bone conduction
- ...



### Biophysics – Electric fields in diagnosis and therapy



Tess advanced Physics set Electrical fields

15250-88



Tess advanced Applied Sciences set Electrophysiology

15673-88

#### Curricular topics

Phy

- Electrical fields

Bio

- Physics of the heart
- Muscles
- Senses

Med

- Examination of the heart: electrocardiography
- Examination of the eye: electronystagmography and electrooculography

#### Corresponding experiments of the sets

- Physics of electrical fields
- Electronystagmography
- Heart beat – electrocardiography
- Muscle- electromyography
- Eye movements - electrooculography
- Heart frequency
- Physical fitness - the heart under stress
- Electromyography (EMG)
- Electrooculography (EOG)
- ...



# Radiation biophysics –

## Imaging methods: X-rays and ultrasound



XR 4.0 expert unit 09110-88

XRCT 4.0 X-ray Computer Tomography Supplementary set 09180-88

### Curricular topics

**Phy**

**X-rays**

- Generation of x-rays
- Properties of x-rays
- Radon transform

**Ultra sound**

- Generation and properties of ultra sound

**Bio Med**

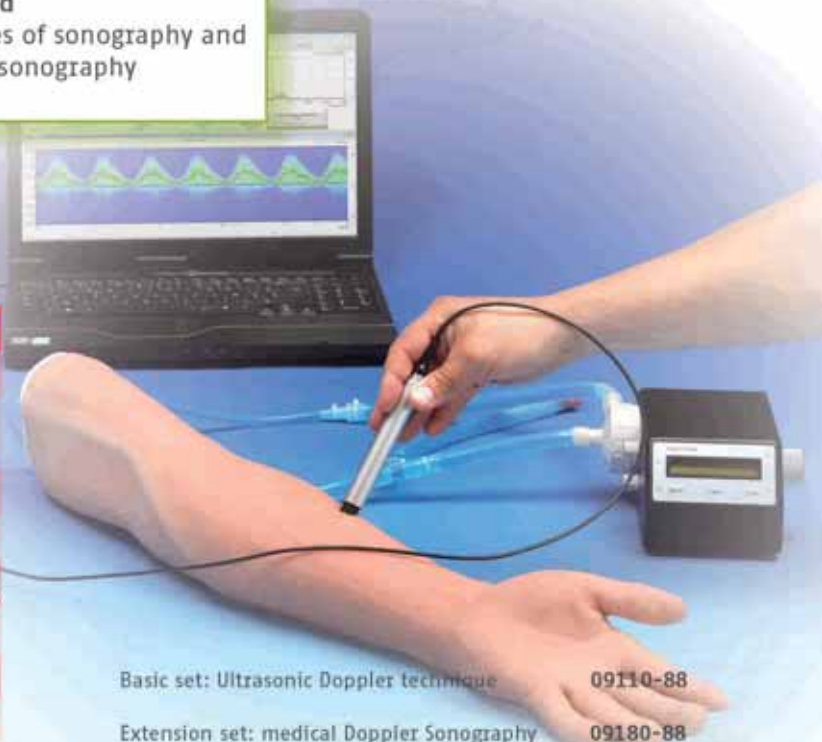
**X-rays**

- X-ray tube in medicine
- Biological effects of x-rays
- Ionizing radiation in diagnosis
- Computed tomography

**Ultra sound**

- Principles of sonography and Doppler sonography

- Corresponding experiments of the sets**
- Characteristics of x-rays (P2540101)
  - Principles of X-ray attenuation and contrast (P2550200)
  - Principles of beam intensity (P2550300)
  - Basics of computed tomography (P2550500)
  - Beam hardening and metal artefacts (P2550800)
  - Hounsfield units (P2550900)
  - Doppler sonography (P5950100)
  - ...



Basic set: Ultrasonic Doppler technique 09110-88

Extension set: medical Doppler Sonography 09180-88



### Material sciences – X-ray fluorescence analysis

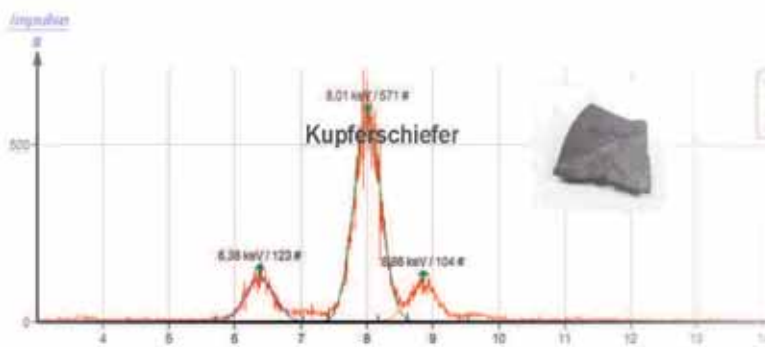


XR 4.0 expert unit 09110-88

XRM 4.0 X-ray Material analysis  
Supplementary set 09160-88

#### Curricular topics

<div style="text-align: right; font-size: 2em; color: orange;">Che</div> <ul style="list-style-type: none"> <li>▪ Periodic system</li> <li>▪ X-ray fluorescence analysis</li> <li>▪ Ores</li> <li>▪ Compounds of non-metals</li> </ul>	<div style="text-align: right; font-size: 2em; color: blue;">Phy</div> <ul style="list-style-type: none"> <li>▪ Atoms</li> <li>▪ Interaction of x-rays with matter</li> </ul>	<div style="text-align: right; font-size: 2em; color: red;">Geo</div> <ul style="list-style-type: none"> <li>▪ Geology</li> <li>▪ Minerals</li> </ul>
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#### Corresponding experiments of the sets

- Qualitative X-ray fluorescence spectroscopy of metals - Moseley's law (P2544501)
- Qualitative X-ray fluorescence analysis of ore samples (P2544901)
- Quantitative X-ray fluorescence analysis of alloyed materials (P2545001)
- ...

## Life sciences –

Soil, environment, climate, ecology



TESS Applied Sciences Cobra4  
Environment and Outdoors,  
set for 4 groups

12626-88

### Curricular topics

Bio

- Ecology
- Botany
- Marine sciences
- Pollution of the environment

Geo

- Climatology
- Soil science
- Meteorology
- Geomorphology

Chem

- Geochemistry
- Chemistry of the atmosphere
- Environmental chemistry

### Corresponding experiments of the sets

- Water quality - contamination with heavy metals
- Acidity changes of a watercourse
- Salinity changes of a watercourse
- Altitude measurement on a trail
- Terrain mapping
- Weather observation with the Cobra4 Mobile-Link
- Changes of the light conditions in a deciduous forest
- Comparison of soil and air temperatures in the course of a day
- The pH value of various soils
- Salinity of soils and plant substrates
- We visit a wastewater treatment plant
- ...



# 6 Interdisciplinary teaching

## 6.1 Interdisciplinary student and teacher experiments

### Biomechanics – Biostatics, running, jumping

**TESS** | PHYWE  
**measure** | PHYWE  
dynamics



TESS beginner set Motion

15231-88



TESS advanced Physics set Mechanics

15271-88



Software measure dynamics, school licence

14440-62

### Curricular topics

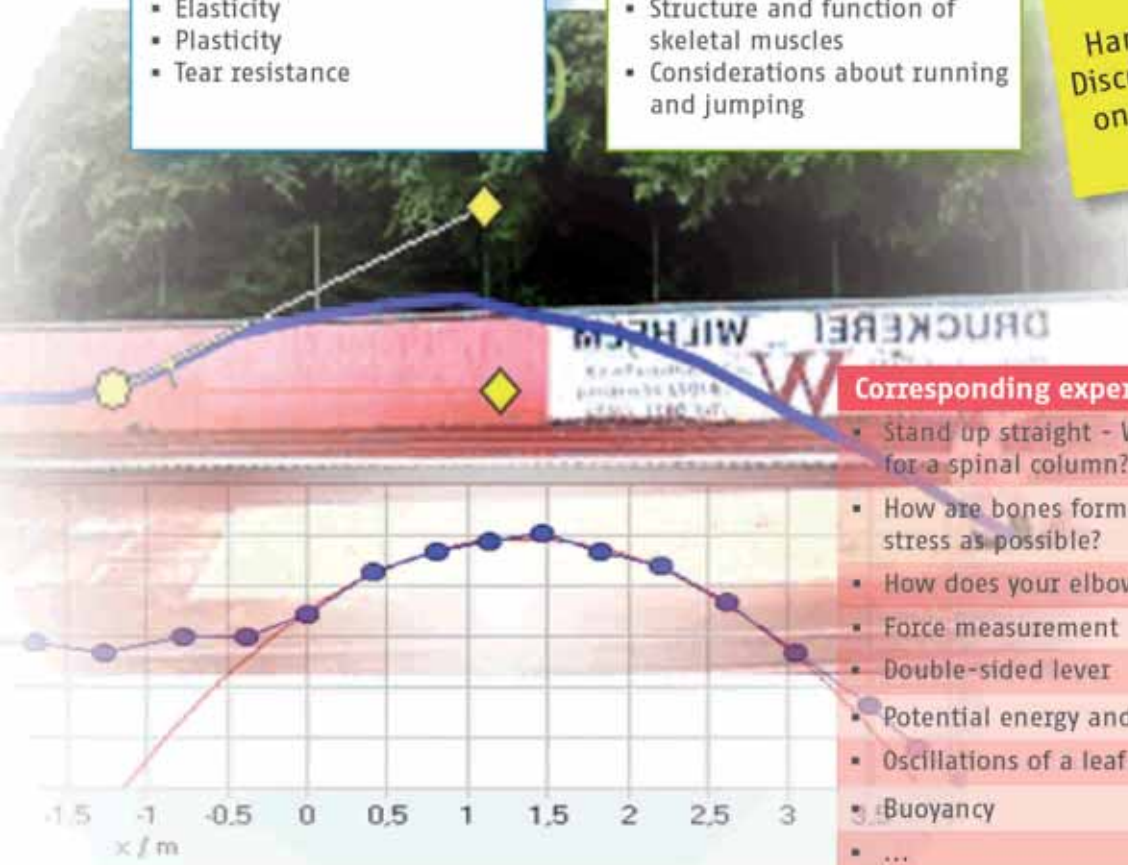
Phy

- Lever and torque
- Expansion behavior
- Elasticity
- Plasticity
- Tear resistance

Bio Med

- Stability of plants and bones
- The human backbone
- Structure and function of skeletal muscles
- Considerations about running and jumping

**measure dynamics projects:**  
Hammer throw, Pole vault, Discus, Centripetal acceleration, Long jump, Football, ...



### Corresponding experiments of the sets

- Stand up straight - Which is the ideal shape for a spinal column?
- How are bones formed to hold up to as much stress as possible?
- How does your elbow joint function?
- Force measurement
- Double-sided lever
- Potential energy and tension energy
- Oscillations of a leaf spring
- Buoyancy
- ...





## PHYWE Service and solution systems



### Service at PHYWE – individual and reliable

By choosing a PHYWE product you decide for a comprehensive service at the same time. We support you with our multi-level service concept. From planning through to installation and up to our extensive after sales service. Rely on our strengths: rugged and long-lasting products made in Germany, customized for your needs.



From your vision in mind, we advise you competently locally in your project:

- Proposals for new acquisition, expansion or Modernization of your teaching materials collection

Complete project definition according to your curriculum topics, including:

- Solution for science experiments
- Solution for infrastructure & furniture
- Additional services, e.g. assistance in tendering

Save time by:

- Fast, on-time delivery
- Service for Unpacking or Granting
- Check for completeness
- Installing of Hardware and Software



■ made  
■ in  
■ Germany



### Training

### Hotline & Maintenance

For successful use:

- Training of operation, Explanation of device-specific specials
- Training for maintenance and handling

We are also available after the purchase:

- Hotline service – call our experts or write an E-mail:  
Monday to Friday from 8 am to 4 pm (german local time).  
Phone: +49 (0) 551 604-196  
Fax: +49 (0) 551 604-106  
E-mail: [service@phywe.de](mailto:service@phywe.de)
- Repair Service / Spare Parts

### Services

**On-site installation, per day:**

We install your equipment and do a function test at your site.

**On-site installation**

Article No.

03333-06

**On-site training, per day**

We train the handling of equipment and experiments at your site.

**On-site training**

03333-02

**Training & Presentation, per day at Phywe site:**

We train the handling of equipment and experiments at PHYWE site.

**Training & Presentation**

03333-03

### TESS: student experiments from PHYWE – easy, safe, and time-saving experimentation

#### Easy

Space-saving and well-structured storage:

- robust and safe
- space-saving, stackable
- clear and quick check for completeness

#### Safe

Student-adapted equipment for safe experimentation:

- proven and reliable
- robust and versatile equipment
- quality made in Germany

#### Versatile

One system for all science subjects and interdisciplinary classes:



#### Uniform

There is a matching Demo set for teacher experiments for every TESS student set:







### The advantages of the PHYWE experiment descriptions at a glance

#### Student version with:

- precise formulation of the tasks
- complete lists of materials
- step-by-step set-up instructions
- ready-to-use tables for the experiment results
- questions and drawing templates for the evaluation
- notes on hazards and disposal

#### Teacher version additionally with:

- information concerning the learning goals and theoretical background
- measurement results and diagrams
- answers to the questions on the student sheets

#### Printed or in digital format:

- various topic-based handbooks
- in digital format on a CD in the interactive learning software interTESS or on the learning platform CurricuLAB.

### Time-saving

Detailed, curriculum-compliant experiment descriptions for students and teachers (including solutions and additional information).

### Modern

In numerous cases, the TESS experiments can also be performed with a datalogging system (Cobra4).





### Space-saving and clearly arranged the TESS advanced storage system

The TESS system enables experience-oriented classes - the students can perform the experiments independently, on their own. All the necessary equipment is included in the TESS sets. Only consumables must be restocked at regular intervals. Optional equipment, e.g. Bunsen burners or power supply units, are not included in the sets, but available separately from PHYWE.

The sets consist of sturdy boxes with a foam inlay in which the equipment fits perfectly. This enables you to perform quick checks for completeness.

#### Storage system at a glance

- Robust and safe
- Versatile
- Fits into any type of cabinet
- Space-saving
- Clear colour marking indicating the different science disciplines
- Easily stackable
- Perfectly fitting, chemical-resistant foam inlay for the equipment
- Clearly arranged, quick check for completeness
- stable lid for protection and transport





The boxes can be stacked and clearly assigned to the various science disciplines thanks to a colour system. An optional, robust cover for even better protection is also available.



### Storage and Transportation

The sets can simply and lucidly be kept in fitting rolling containers available from PHYWE. These can effortlessly be rolled from one room into the other to provide the experimenting sets for the pupils. This reduces the preparation time enormously and makes the work easier for the teacher.

#### Storage containers at a glance

- Clear storage
- Clear and descriptive labelling
- All needed material in one box
- Easy and flexible distribution



Storage Container with rollers for TESS sets, for 8 trays with 15 cm height	15210-00
Storage Container with rollers for TESS sets, for 18 trays with 15 cm height	15211-00

### Experiment descriptions from PHYWE – questions and tasks for the students, answers and solutions for the teachers

We offer matching experiment descriptions for all of our PHYWE experiments. These detailed, modern instructions can be used by you to assist you during your lessons or as a collection of ideas. The students will be accompanied step by step through the set-up, execution, and evaluation of the experiments. If you wish, you can even use the documents as worksheets. The instructions for teachers include all of the solutions for the questions and tasks of the student worksheets.

#### Instructions for the students



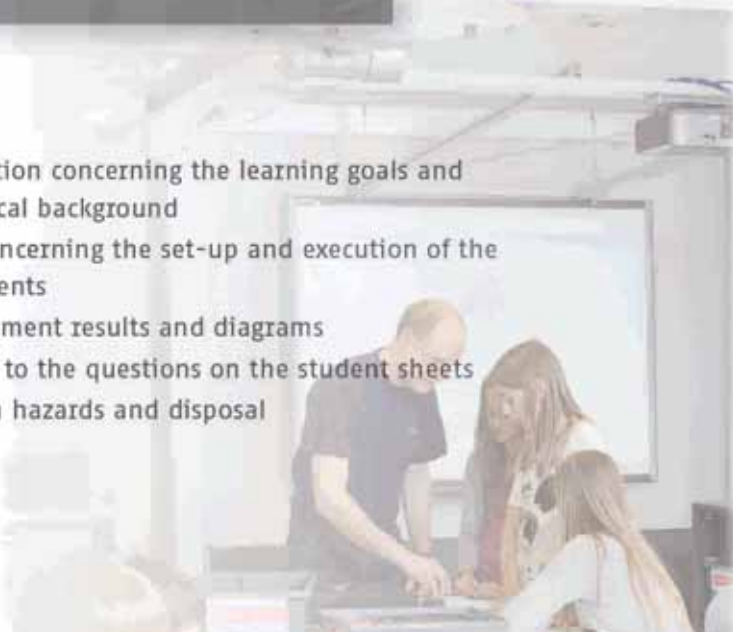
- precise formulation of the tasks
- complete lists of materials
- set-up instructions
- instructions for executing the experiments
- prepared tables for the experiment report
- questions and drawing templates for the evaluation
- notes on hazards and disposal



#### Solutions for the teachers



- information concerning the learning goals and theoretical background
- notes concerning the set-up and execution of the experiments
- measurement results and diagrams
- answers to the questions on the student sheets
- notes on hazards and disposal






## Interactive learning platform – effective teaching worldwide


interTESS | PHYWE

Attractive Experimentation – The computer-based implementation of the experiments is appealing for the students and at the same time it is promoting media literacy.


**Interactive**




**1** Select the desired experiment from a total of more than 400 experiments.




**2** The software shows the required material.




**3** The experiment set-up is illustrated in numerous pictures.



**4** Detailed guidance through the experiment, Automatic diagram creation via interactive tables.



**5** Questions to ensure comprehension are answered in the form of free texts, drawings, and multiple-choice questions.



**6** The results can be printed or saved individually for every student.

More than 16 languages  
available.





### Demo: teacher experiments from PHYWE— quick, clearly visible, and reliable

The curriculum-compliant teacher experiments have been created in line with the student experiments. They can be performed with or without computer assistance (datalogging with Cobra4).



#### Your advantages

##### Minimum preparation time

- complete sets and experiment set-ups
- matching experiment descriptions concerning the set-up, execution, and evaluation of the experiments

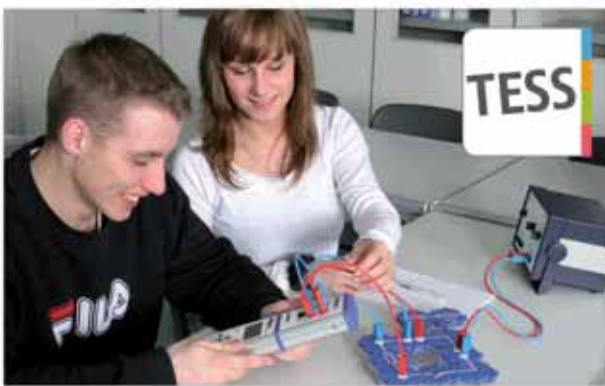
##### Clearly visible

- optimised for demonstration: shifted from the horizontal to the vertical, uniform background, demonstration measuring instruments and display units

##### Reliable

- developed in cooperation with teachers and in compliance with the curricula
- extensively tested, robust, and durable

**Corresponding concept:** the same topics as in the student experiments, but with bigger set-ups



Small, horizontal set-up on the desk



Big, vertical set-up on the board



**Expanding:** the same topic, but with deeper context



**Qualitative experiment:** Melting point depression/boiling point elevation (P7152400)



**Quantitative experiment:** Determination of molar masses via a measurement of the boiling point elevation (ebullioscopy) (P1136000)

**Progressive:** topics that are only possible as teacher experiments



**Preparation of iron from oxidic ores**  
(blast furnace process) (P1143300)



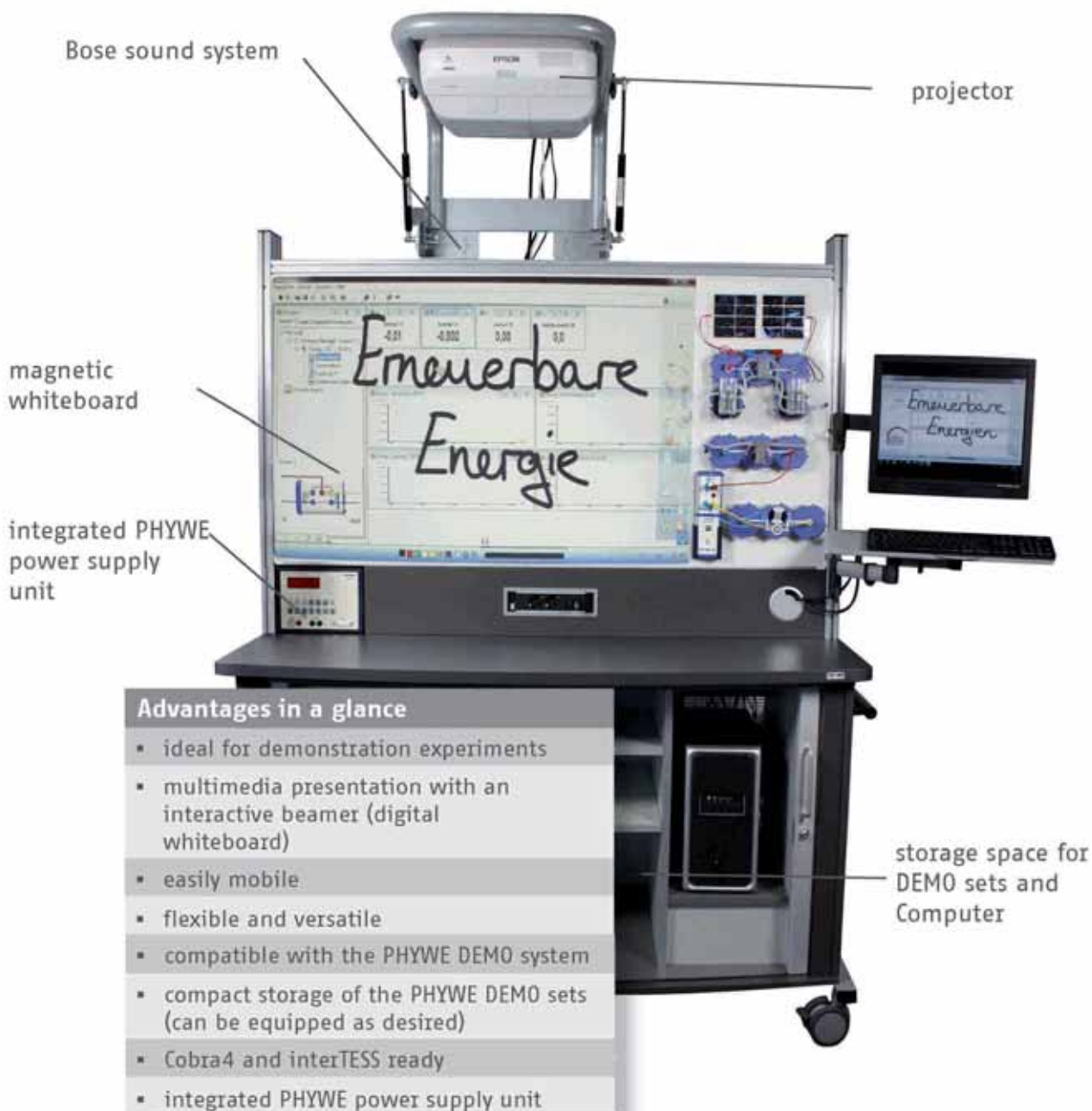
**Characteristic X-rays of copper**  
(P2540101)

**Time-saving:** matching descriptions for every experiment

Detailed, curriculum-compliant experiment descriptions, including notes and instructions for the set-up, execution, and evaluation, are available for every experiment.

## Multimedia Demo Lab – Teacher experiments in every classroom

With the Mobile Demo Lab any classroom can immediately be converted into a science teaching laboratory. The Mobile Demo Lab is a movable table to perform teacher experiments in natural science classes supported by an integrated power supply, datalogging and processing (via Computer) and modern multimedia presentation with a projector on an interactive board.



Mobile Demo Lab for teacher experiments with magnetic board

02190-93



## Ordering overview



## Ordering overview

### Important note

All electric devices and power supply units in this catalogue are presented in the version for 220V/50 Hz electrical network. For 110V/60 Hz please ask your sales agent.

For transport and importation of chemical substances please mind and follow the local laws and regulations. Note that special charges and fees may apply or permissions may be required.

For literature in your local language please contact your sales agent.

### TESS beginner

### TESS beginner 15243-88 Applied Sciences set Light, Air, Soil

Erlenmeyerkolben 100 ml, SB 19	36418-00	1
Aufstelldecke	02066-00	1
Spiegel 80 x 50 mm	08209-01	2
Digitale Stoppuhr, 24 h, 1/100 s & 1 s	24025-00	1
Schere, l = 125 mm, spitz-stumpf	46970-00	1
Seidenfaden, Nähseide, l = 200 m	02412-00	1
Messzylinder 50 ml, PP transparent	36628-01	1
Kunststofflupe, 5x, d = 30 mm	88002-01	1
Löffelspatel, Stahl, l = 150 mm	33398-00	1
Rundfilter, qual., d = 90 mm, 100 St.	32977-03	1
Gummiblasen, 10 Stück	02620-03	1
Weißer Schirm, 12 x 12 cm	13243-04	1
Laborbeker, Polypropylen, 250 ml	36013-01	2
Büroklammer, 25 mm, 100 Stück	13231-30	1
Kressesamen	13243-03	1
Lineal, l = 200 mm, Kunststoff	09937-01	1
Becher, PP, niedrige Form, 100 ml	36011-01	1
Gummistopfen 26/32, ohne Bohrung	39258-00	1
Petrischalen, Kunststoff, d = 60, 1 St.	64710-01	3
Schlauch, di = 7 mm, l = 1 m	03985-00	1
Glasrührstab, Boro 3.3, l = 200 mm, d = 5 mm	40485-03	1
Trichter, Oben-d = 50 mm, PP	36890-00	1
Gummistopfen 17/22, 1 Bohrung 7 mm	39255-01	1
Teelicht, d = 3,6cm, 1 Stück	13241-31	2
Glasröhrchen, l = 80 mm, 10 St.	36701-65	0.1
Plastilina, 10 Stangen	03935-03	0.1
Tesa-Film, 19 mm, matt		1
Digitales Handbuch auf DVD		1

### DEMO beginner 13244-88 Applied Sciences set Light, Air, Earth

Light box, halogen 12 W/20 W with 2.1 mm socket for smallpower supplies	09801-01	1
Power supply 12V / 2A	12151-99	1
Support base, variable	02001-00	1
Protective desk plate 40 x 40 cm	39180-10	1

Magnifier w.handle, 6x, d=30mm	87004-06	1
Model earth/moon	09825-00	1
Erlenmeyer flask, narrow neck, 500 ml, PN 29	36421-00	1
Bottom with stem for light box	09802-10	1
Screen, white, 150x150mm	09826-00	1
Glass tube, right-angled, 10 pcs.	36701-52	1
Slide mount for optical bench	09822-00	1
Support rod, stainless steel, l = 600 mm, d = 10 mm	02037-00	2
Storage tray 413x240x100mm	47325-02	2
PVC-plates, pack.5 pcs.	31751-02	1
Scissors, straight, 180 mm	64798-00	1
Litmus paper, blue, 1 box	30678-01	1
Porcelain dish 140ml, d 100mm	32518-00	2
Crucible tongs, w.bow, stainl.steel	46964-00	1
Protecting glasses, clear glass	39316-00	1
Garden trowel, steel	40484-02	1
Glass beaker DURAN®, short, 400 ml	36014-00	1
Pipette with rubber bulb, long	64821-00	1
Measuring tape, l = 2 m	09936-00	1
Cardboards 200x300mm, black, 10 pcs	06306-01	1
Glass beaker DURAN®, short, 250 ml	36013-00	1
Diaphragm with hole, d=20mm	09816-01	1
Funnel, glass, top dia. 80 mm	34459-00	1
Partition for storage tray, 230 x 95 mm	47326-02	2
Rubber stopper 26/32, 2 holes 7 mm	39258-02	1
Rubber stopper 26/32, 1 hole 7 mm	39258-01	1
PVC tubing, i.d. 7mm	03985-00	1

### TESS beginner 15237-88 Applied Sciences set Optics - Look at Light

Spielwürfel, transparent, rot		1
Spielwürfel, transparent, grün		1
Spielwürfel, transparent, lila		1
Taschenlampe mit Batterien		1
Kaleidoskop, l=150 mm, d=45 mm		1
Esslöffel		1
CD-Rohling CD-R 80, 700 MB		2
Papier, DIN A4, weiß, 250 g/m²		2
Klebeband, Textil, ws, B = 19 mm		1
Spiegelfliese, 150 x 150 mm, Polyacryl		3
Spiegelfliese, 150 x 150 mm, mit Loch d=10 mm		1
Spiegelfacetten-Matte, 320 x 320 mm		1
Spiegelfolie, 250 x 200 mm		1
Planspiegel auf Träger, 50 mm x 20 mm		5
Digitales Handbuch auf DVD		1

### TESS beginner 15241-88 Applied Sciences set Senses

Handpresse	64154-00	1
Aufstelldecke	02066-00	1
Stimmgabel 440 Hz	03424-00	1
Spiegel 80 x 50 mm	08209-01	1
Schere, l = 125 mm, spitz-stumpf	46970-00	1
Seidenfaden, Nähseide, l = 200 m	02412-00	1
Kunststofflupe, 5x, d = 30 mm	88002-01	1
Kartensatz, Physiologisches Sehen (Blinder Fleck etc.)	13241-20	1
Tastborste	64928-00	1
Wattestäbchen, 100 Stück	13241-10	1
Uhrschale, d = 100 mm	34574-00	5
Becher, PP, niedrige Form, 100 ml	36011-01	1
Lineal, l = 200 mm, Kunststoff	09937-01	1
Stricknadel, d = 2 mm, l = 200 mm / 2 Stück	13241-40	1
Schlauch, Innen-d = 6 mm, lfd. m	47527-00	1

Messer	33476-00	1
Teelicht, d = 3,6cm, 1 Stück	13241-31	1
Filzschreiber, wasserlösl., 3 St., schwarz, blau, rot	38710-03	1
Digitales Handbuch auf DVD		1

### DEMO beginner 13242-88 Applied Sciences set Senses

Light box, halogen 12 W/20 W with 2.1 mm socket for smallpower supplies	09801-01	1
Butane burner f. cartridge 270+470	47536-00	1
Figures / types and colours	64923-00	1
Retort stand, h = 750 mm	37694-00	1
Power supply 12V / 2A	12151-99	1
Piston	03474-02	1
Tuning fork, 1700 Hz	03423-00	1
Ring with boss head, i. d. = 10 cm	37701-01	1
Charging strip	03474-01	1
Universal clamp	37715-00	1
Storage tray 413x240x100mm	47325-02	1
Dividers, nickel-plated, 14 cm	64857-00	1
Glass tube, e.d. 38mm, l 640 mm	03918-00	1
Block, semicircular	09810-01	1
Lab thermometer, -10...+100 °C	38056-00	1
Dropping pipette with bulb, 10pcs	47131-01	1
Striking hammer	03429-01	1
Block, planoconvex lens, fl-100mm	09810-05	1
Block, planoconvex lens, fl+100mm	09810-04	1
Cork dust, 3 g	03477-00	1
Right angle clamp	37697-00	1
Butane cartridge CV 300 Plus, 240 g	47538-01	1
Wire gauze with ceramic, 160 x 160 mm	33287-01	1
Spoon + spatula, steel, l=120mm	46949-00	1
Beaker, low, BORO 3.3, 400 ml	46055-00	1
Beaker, low, BORO 3.3, 50 ml	46052-00	5
Partition for storage tray, 230 x 95 mm	47326-02	2
Rubber stopper, d=38/31mm, w/o hole	39260-00	1
Ruler, plastic, 200 mm	09937-01	1
Glass rod, boro 3.3, l=200mm, d=5mm	40485-03	5

### TESS beginner 15245-88 Applied Sciences set Current and Magnets

Wagen, 72 x 20 x 25 mm, Kunststoff	11059-00	1
Konstantendraht, 15,6 Ohm/m, d = 0,2 mm, l = 100 m	06100-00	1
Glühlampen 1,5 W/0,15 A, E10, 10 Stück	06150-03	1
Lampenfassung E 10, 2 Stück	06170-02	1
Magnet, l = 50 mm, stabförmig	07819-00	2
Krokodilklemme, mit Klemmschraube, 10 Stück	07274-10	1
Schülerthermometer, -10...+110°C, l = 180 mm	38005-02	1
Streuer mit Eisenpulver, 20 ml	06305-10	1
Schaublock für TESS beginner Strom	04411-00	1
Zeichenkompass, 1 Stück	06350-03	1
Schraubendreher	01612-00	1
Schere, l = 125 mm, spitz-stumpf	46970-00	1
Seidenfaden, Nähseide, l = 200 m	02412-00	1
Laborschreiber, wasserfest	38711-00	1
Moosgummi, 20 x 15 cm, 2 mm stark	13231-11	1
Eisennägel, d = 1,6 mm, l = 30 mm, 125 Stück	05505-10	1
Markierungspunkt, rot, 416 Stück	06305-04	1
Markierungspunkt, grün, 416 Stück	06305-05	1
Büroklammer, 25 mm, 100 Stück	13231-30	1

Babyzelle 1,5 V, R14/UM-2 DIN 40866, Typ C	07922-01	1
Lineal, l = 200 mm, Kunststoff	09937-01	1
Versandtaschenklammern, Eisen vermessingt, 10 Stück	13231-41	1
Messer	33476-00	1
Glasrührstab, Boro 3.3, l = 200 mm, d = 5 mm	40485-03	1
Petrischale, d = 94 mm, 1 Stück	64709-05	1
Schaltzdraht, 0,5 sw, 1 m		1
Tesa-Film, 19 mm, matt		1
Batteriehalter, Babyzelle		1
Schlauchleitung 2 x 0,75, gr., 1 m		1
Digitales Handbuch auf DVD		1

## DEMO beginner 13246-88 Applied Sciences set Current and Magnets

Protective desk plate 40 x 40 cm	39180-10	1
Knife switch, transparent	06034-06	1
Lamp holder E10, transparent	06170-01	2
Battery case, transparent	06030-22	2
Storage tray 413x240x100mm	47325-02	1
Bar magnet, l 150mm	06310-00	1
Constantan wire, 15.6 Ohm/m, d = 0.2 mm, l = 100 m	06100-00	1
Pocket compass	06350-00	1
Nickel electrode 76x40 mm	45218-00	1
Connecting plug, 2 pcs.	07278-05	2
Iron wool 200 g	31999-20	1
Lab thermometer, -10...+100 °C	38056-00	1
Filament lamps 3.5V/0.2A, E10, 10	06152-03	1
Iron wire, d = 0.2 mm, l = 100 m	06104-00	1
Crucible tongs, w. bow, stainl. steel	46964-00	1
Sprinkler w. iron powder, 25ml	06305-10	1
Scissors, straight, pointed, l 140mm	64623-01	1
Connecting cord, 32 A, 250 mm, black	07360-05	6
Screwdriver, width 3mm	01612-00	1
Copper electrode, 76 mm x 40 mm	45212-00	1
Iron electrode, 76 x 40 mm	45216-00	1
Aluminium electrode, 76x40 mm	45217-00	1
Zinc electrode, 76 mm x 40 mm	45214-00	1
Parchment disks, 10 pieces	02672-00	1
Partition for storage tray, 230 x 95 mm	47326-02	1
Flat battery, 4.5 V	07496-01	2
Knife, stainless	33476-00	1

## TESS beginner 15231-88 Applied Sciences set Motion

Kraftmesser, transparent, 2 N	03065-03	1
Eisendraht, d = 0,5 mm, l = 50 m	06105-00	1
Stahlkugel mit Öse, d = 12,7 mm	02464-01	1
Sandsack, Luftballon mit Sand gefüllt	13231-20	1
Stativstange Edelstahl 18/8, l = 250 mm, d = 10 mm	02031-00	2
Maßband, l = 2 m	09936-00	1
Digitale Stoppuhr, 24 h, 1/100 s & 1 s	24025-00	1
Labor-Marker, abwaschbar, schwarz	46402-01	1
Schaumblock für TESS beginner Strom	04411-00	1
Schere, l = 125 mm, spitz-stumpf	46970-00	1
Seidenfaden, Nähseide, l = 200 m	02412-00	1
Moosgummi, 20 x 15 cm, 2 mm stark	13231-11	1
Gummischlauch, d = 7 mm, 1 m	47526-00	1
Büroklammern, 25 mm, 100 Stück	13231-30	1
Versandtaschenklammern, Eisen vermessingt, 10 Stück	13231-41	1
Uhrglasschale, d = 60 mm	34570-00	1
Schraubzwinge mit Stativstange, l = 100 mm	02016-00	1
Tesa-Film, 19 mm, matt		1
Digitales Handbuch auf DVD		1

## DEMO beginner 13232-88 Applied Sciences set Motion

Bell jar, 5 l	64156-00	1
Support base, variable	02001-00	1
Glass tube, hooked, 160x30, 10p	36701-54	1
Lever	03960-00	1
Rubber bulb, with glass tube	64170-00	1
Spring balance, transparent, 2 N	03065-03	1
Spring balance, transp., 2N, non-adj	03065-09	1
Stopcock, 1-way, r.-angled, glass	36705-01	1
Rod for pulley	02263-00	1
Support rod, stainless steel, l = 600 mm, d = 10 mm	02037-00	1
Storage tray 413x240x100mm	47325-02	1
Boss head	02043-00	1
Weight holder for slotted weights	02204-00	1
Pulley, movable, dia. 65mm, w. hook	02262-00	1
Holding pin	03949-00	1
Pulley, movable, dia. 40mm, w. hook	03970-00	1
Support rod with hole, stainless steel, 10 cm	02036-01	1
Slotted weight, black, 10 g	02205-01	4
Slotted weight, black, 50 g	02206-01	3
Spring balance holder	03065-20	1
Fishing line, l. 20m	02089-00	1
Measuring tape, l = 2 m	09936-00	1
Support rod, stainless steel, l = 250 mm, d = 10 mm	02031-00	1
Glass tube, straight, l=80 mm, 10/pkg.	36701-65	1
Partition for storage tray, 230 x 95 mm	47326-02	2
Rubber stopper, d=35/29mm, 1 hole	39259-01	1
Rubber tubing, i.d. 6 mm	39282-00	1

## TESS beginner 15233-88 Applied Sciences set Water

Erlenmeyerkolben 100 ml, SB 29	36428-00	1
Schülthermometer, -10...+110°C, l = 180 mm	38005-02	2
Korkmehl 20 ml, in Schraubglas, klar, 57 x 27,5 mm	46217-01	1
Waschpulver 20 ml, in Schraubglas, klar, 57 x 27,5 mm	46217-02	1
Spülmittel 10 ml, in Pipettenflasche DIN 18, rund, klar	64785-01	1
Öl 10 ml, in Pipettenflasche DIN 18, rund, klar	64785-02	1
Messzylinder 50 ml, PP transparent	36628-01	1
Laborschreiber, wasserfest	38711-00	1
Rundfilter, qualitativ, d = 90 mm, 100 Stück	32977-03	1
Löffelpatel, Stahl, l = 120 mm	46949-00	1
Doppelpatel, Stahl, l = 150 mm	33460-00	1
Schraubglas, klar, 30 ml, 72 x 27,5 mm	46216-00	3
Laborbecher, Polypropylen, 250 ml	36013-01	1
Gummistopfen 26/32, 1 Bohrung 7 mm, 1 Bohrung 12 mm	39258-19	1
Becher, PP, niedrige Form, 100 ml	36011-01	2
Trichter, oben-d = 50 mm, PP	36890-00	1
Glasrührstab, Boro 3.3, l = 200 mm, d = 5 mm	40485-03	2
Pipette mit Gummikappe, 10 St.	47131-01	0.1
Schale 200 x 150 mm, Kunstst., weiß	85110-00	1
Schraubkappe, Gl 25, für Gewindeflasche		3
Digitales Handbuch auf DVD		1

## DEMO beginner 13234-88 Applied Sciences set Water

Butane burner f. cartridge 270+470	47536-00	1
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Retort stand, 210mm x 130mm, 500mm	37692-00	1
Distilling bridge GL18/8	35902-15	1
Knife switch, transparent	06034-06	1
Flask, round, 1-neck, 250ml, GL25/13	35812-15	1
Holder for two electrodes	45284-01	1
Lamp holder E10, transparent	06170-01	1
AQUADUR-Test sticks Water hardne.	47020-01	1
Battery case, transparent	06030-22	1
Glass wool 100 g	48154-10	1
Ring with boss head, i. d. = 10 cm	37701-01	1
Universal clamp	37715-00	2
Storage tray 413x240x100mm	47325-02	2
Lab thermometer, -10...+100 °C	38056-00	1
Pipettor, bulb, 3 valves, 10ml max.	47127-01	1
Dropping pipette with bulb, 10pcs	47131-01	1
Filament lamps 1.5V/0.15A, E10, 10 pieces	06150-03	1
Glass tube, d 38/35mm, l 300mm	64940-00	1
Storage tray, 413 x 120 x 100 mm	47325-01	1
Evapor. dish, boro 3.3, spout, 15ml	46250-00	3
Right angle clamp	37697-00	2
Butane cartridge CV 300 Plus, 240 g	47538-01	1
Crucible tongs, 200mm, stainl. steel	33600-00	1
Iron electrode, d 8mm	45204-00	2
Connecting cord, 32 A, 500 mm, black	07361-05	4
Glass tube, straight, l=80 mm, 10/pkg.	36701-65	1
Funnel, glass, top dia. 80 mm	34459-00	1
Spoon, special steel	33398-00	1
Wire gauze with ceramic, 160 x 160 mm	33287-01	1
Erlenmeyer wide neck, boro., 100ml	46151-00	1
Beaker, low, BORO 3.3, 400 ml	46055-00	2
Graduated pipette, 5 ml	36599-00	1
Beaker, low, BORO 3.3, 100 ml	46053-00	3
Partition for storage tray, 230 x 95 mm	47326-02	4
Flat battery, 4.5 V	07496-01	1
Rubber stopper 26/32, 1 hole 7 mm	39258-01	1
Glass rod, boro 3.3, l=200mm, d=5mm	40485-03	1

## TESS beginner 15235-88 Applied Sciences set Heat

Laborthermometer, -10...+100°C	38056-00	2
Isolierschaum für Schraubglas 40 ml	04410-00	1
Rührthermometer, ungraduiert	38003-00	1
Kapillarrohr, di = 1,7 mm, l = 250 mm	36709-00	2
Filzplatte, 100 x 100 mm	04404-20	3
Gummiringe, 50 Stück	03920-00	1
Becher, PP, niedrige Form, 100 ml	36011-01	1
Trichter, oben-d = 50 mm, PP	36890-00	1
Schraubglas, 40 ml		2
Verbindungskappe, Gl 25		2
Dichtung, Gl 25/8		2
Tesa-Film, 19 mm, matt		1
Tesa-Handabroller		1
Digitales Handbuch auf DVD		1

## DEMO beginner 13236-88 Applied Sciences set Heat, 230 V

Ceramic lamp socket E27	06751-01	1
Retort stand, 210mm x 130mm, 500mm	37692-00	1
Heating + cooking hotplate, 230V	04025-93	1
Stainless Steel pot 3, 2 l	05934-00	1
Convection of liquids tube, small	04510-01	1
Filament lamp, 220V/120W, w.refl.	06759-93	1
Test tube, d = 30 mm, l = 200 mm, white	36294-05	1
Test tube, d 30mm, l 200mm, black	36294-06	1
Test tube rack, wood, for 6 tubes d= 30 mm	40569-10	1
Universal clamp	37715-00	1

# 8 Ordering overview

Scope of delivery of all sets

Storage tray 413x240x100mm	47325-02	1
Heat sensitive paper	04260-00	2
Aluminium rod,U-shaped	05910-00	1
Copper rod, U-shaped	05910-01	1
Lab thermometer,-10..+100 °C	38056-00	2
Storage tray, 413 × 120 × 100 mm	47325-01	1
Glass beaker DURAN®, tall, 600 ml	36006-00	1
Right angle clamp	37697-00	2
Glass tube holder with tape measure clamp	05961-00	1
Support rod, stainless steel, l = 250 mm, d = 10 mm	02031-00	1
Glass rod,U-shaped	05911-00	1
Graduated vessel, 1 l, with handle	36640-00	1
Circular filter,d 70 mm,100 pcs	32977-02	1
Partition for storage tray, 230 x 95 mm	47326-02	2
Partition 115x95 mm	47326-01	1
Rubber stopper 26/32, 1 hole 7 mm	39258-01	2

## Mechanics

### TESS advanced 15271-88 Physics Basic Set Mechanics 1

Support base, variable	02001-00	1
Lever	03960-00	1
Set of precision weights,1g-50g	44017-00	1
TESS box, plastics, high, 305 x 425 x 150 mm	15200-00	1
Support rod, l = 600 mm, d = 10 mm, split in 2 rods with screw threads	02035-00	3
Spring balance,transparent, 1 N	03065-02	1
Spring balance,transparent, 2 N	03065-03	1
Rod for pulley	02263-00	1
Steel pellets, d = 2 mm, 120 g	03990-00	1
Pulleys, double in line	02266-00	2
Lid for TESS box, plastic	15205-00	1
Plate with scale	03962-00	1
Balance pan, plastic	03951-00	2
Boss head	02043-00	2
Weight holder for slotted weights	02204-00	2
Pulley,movable,dia.65mm,w.hook	02262-00	1
Vernier calliper, plastic	03011-00	1
Holding pin	03949-00	1
Glass tubes,l.250 mm, pkg.of 10	36701-68	0.2
Helical spring, 3 N/m	02220-00	1
Pulley,movable,dia.40mm,w.hook	03970-00	1
Support rod with hole, stainless steel, 10 cm	02036-01	2
Slotted weight, black, 10 g	02205-01	4
Slotted weight, black, 50 g	02206-01	3
Spring balance holder	03065-20	2
Aluminium column	03903-00	1
Steel Column nickel-plated	03913-00	1
Fishing line, l. 20m	02089-00	1
Glass tube holder with tape measure clamp	05961-00	1
Measuring tape, l = 2 m	09936-00	1
Support rod, stainless steel, l = 250 mm, d = 10 mm	02031-00	1
Digital stop watch, 24 h, 1/100 s & 1 s	24025-00	1
Helical spring, 20 N/m	02222-00	1
Test tube 160x16 mm, 10 pcs	37656-03	0.1
Wood column	05938-00	1
Pointer for lever	03961-00	1
Pipette with rubber bulb	64701-00	1
Graduated cylinder, 50 ml, plastic	36628-01	1
Beaker, 250 ml, low form, plastic	36013-01	1
Beaker, low form, plastic, 100 ml	36011-01	1

### TESS advanced 13450-88 Mechanics ME 1 consumables for 10 groups

Petroleum ether, 50-75 C 500 ml	31711-50	1
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Sodium chloride, 500 g	30155-50	1
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### TESS advanced 15272-88 Physics supplementary set Mechanics 2

Glass tube,hooked, 160x30, 10p	36701-54	0.1
TESS box, plastics, high, 305 x 425 x 150 mm	15200-00	1
Wheel and axle	02360-00	1
Probes for hydrostatic pressure	02634-00	1
Leaf spring attachment	02228-05	1
Spring balance,transp.,2N,non-adj	03065-09	1
Friction block	02240-01	1
Overflow vessel 250 ml	02212-00	1
Lid for TESS box, plastic	15205-00	1
Glass bell with tube	03917-00	2
Capillary tube, 4, 0.5 to 1.2mm	40581-00	1
Gear wheel, 20 teeth	02350-13	1
Gear wheel, 40 teeth	02351-03	1
Leaf spring	02228-00	1
Syringe 20ml, Luer, 10 pcs	02591-03	0.1
Glass tubes,l.250 mm, pkg.of 10	36701-68	0.2
Glass beaker DURAN®, short form, 600 ml	36015-00	1
Rubber caps, pack of 20	02615-03	0.25
Shaft, dia.12mm, l.45mm	02353-00	2
Plasticine, 10 sticks	03935-03	0.2
Glass tube, straight, l=80 mm, 10/ pkg.	36701-65	0.1
Rubber ball,diam.15 mm	03921-00	2
Silicone tubing i.d. 7mm	39296-00	3
Rubber stopper 26/32, 2 holes 7 mm	39258-02	1
Rubber stopper 26/32, 1 hole 7 mm	39258-01	2
Rubber tubing, i.d. 3 mm	39279-00	1
Tubing connect.,T-shape,ID 8-9 mm	47519-03	1
Rubber stopper, d=9/5mm, w/o hole	39250-00	1

### TESS advanced 13451-88 Mechanics ME 2 consumables for 10 groups

Glycerol, 250 ml	30084-25	1
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### TESS advanced 15283-88 Physics Set Linear Motion with Timer 2-1 (Dynamics)

Timer 2-1	13607-99	1
Light barrier, compact	11207-20	2
Track, l 900 mm	11606-00	1
Cart for measurements and experiments	11060-00	1
Support base, variable	02001-00	1
Adapter plate for Light barrier compact	11207-22	2
TESS box, plastics, high, 305 x 425 x 150 mm	15200-00	1
Support rod, l = 600 mm, d = 10 mm, split in 2 rods with screw threads	02035-00	1
Ball release unit	02505-00	1
Rod for pulley	02263-00	1
Weight holder, silver bronze, 1 g	02407-00	1
Shutter plate for cart	11060-10	1
Lid for TESS box, plastic	15205-00	1
Boss head	02043-00	2
Pulley,movable,dia.65mm,w.hook	02262-00	1
Holding pin	03949-00	1
Pulley,movable,dia.40mm,w.hook	03970-00	1
Support rod with hole, stainless steel, 10 cm	02036-01	1

Slotted weight, black, 10 g	02205-01	4
Slotted weight, black, 50 g	02206-01	3
Connecting cord, 32 A, 1000 mm, red	07363-01	2
Connecting cord, 32 A, 1000 mm, yellow	07363-02	2
Connecting cord, 32 A, 1000 mm, blue	07363-04	2
Measuring tape, l = 2 m	09936-00	1
Support rod, stainless steel, l = 250 mm, d = 10 mm	02031-00	1
Slotted weight, blank, 1 g	03916-00	4
Silk thread, l = 200 m	02412-00	1
Steel ball, d = 19 mm	02502-01	1

### TESS advanced 15284-88 Physics Set Linear Motion with Cobra4 Mobile-Link (Dynamics)

Cobra4 Mobile-Link 2 incl. accessories: battery, USB cable, charger and SD memory card	12620-10	1
Cobra4 Sensor-Unit Timer/Counter	12651-00	1
Light barrier, compact	11207-20	2
Track, l 900 mm	11606-00	1
Cobra4 adapter for Sensor-Unit Timer/Counter to connect one light barrier	12651-01	1
Cart for measurements and experiments	11060-00	1
Support base, variable	02001-00	1
Adapter plate for Light barrier compact	11207-22	2
TESS box, plastics, high, 305 x 425 x 150 mm	15200-00	1
Support rod, l = 600 mm, d = 10 mm, split in 2 rods with screw threads	02035-00	1
Ball release unit	02505-00	1
Rod for pulley	02263-00	1
Weight holder, silver bronze, 1 g	02407-00	1
Shutter plate for cart	11060-10	1
Lid for TESS box, plastic	15205-00	1
Boss head	02043-00	2
Pulley,movable,dia.65mm,w.hook	02262-00	1
Holding pin	03949-00	1
Pulley,movable,dia.40mm,w.hook	03970-00	1
Support rod with hole, stainless steel, 10 cm	02036-01	1
Slotted weight, black, 10 g	02205-01	4
Slotted weight, black, 50 g	02206-01	3
Measuring tape, l = 2 m	09936-00	1
Support rod, stainless steel, l = 250 mm, d = 10 mm	02031-00	1
Slotted weight, blank, 1 g	03916-00	4
Silk thread, l = 200 m	02412-00	1
Steel ball, d = 19 mm	02502-01	1

### TESS advanced 15273-88 Physics set Cobra4, extension set for Mechanics

Cobra4 Mobile-Link 2 incl. accessories: battery, USB cable, charger and SD memory card	12620-10	1
Cobra4 Sensor-Unit Force ± 4 N	12642-00	1
TESS advanced Physik Handbuch Cobra4	01332-01	1
Mechanik, Wärme, Elektrik / Elektronik	01332-01	1

### TESS advanced 13453-88 Mechanics ME-DYN optional accessories for 1group

Car, motor driven	11061-00	1
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Shutter plate for car, motor driven	11061-03	1
Battery cell, 1.5 V, baby size, type C	07922-01	1

## DEMO advanced 15510-88 Physics Set Mechanics 1

Torsion dynamometer	03069-03	2
Roller for inclined plane	11301-01	1
Inclined plane f.demonstr.board	02152-00	1
Optical disk, magnet held	08270-09	1
Block and tackle, with 4 pulleys	02265-00	1
Sinker, aluminum	03903-01	1
Lever	03960-00	1
Support plate on fixing magnet	02155-00	1
Clamp on fixing magnet	02151-01	1
Rod on fixing magnet	02151-02	1
Hook on fixing magnet	02151-03	1
Fish line, l. 100m	02090-00	1
Center-of-gravity plate	02300-01	1
Rod for pulley	02263-00	1
Pointers f. Demonstr.Board, 4 pcs	02154-01	1
Pointer for demonstration lever	03963-00	1
Scale for demonstration board	02153-00	1
Balance pan, plastic	03951-00	2
Weight holder for slotted weights	02204-00	2
Pulley, movable, dia. 65mm, w.hook	02262-00	1
Holding pin	03949-00	1
Helical spring, 3 N/m	02220-00	1
Pulley, movable, dia. 40mm, w.hook	03970-00	1
Slotted weight, black, 10 g	02205-01	4
Slotted weight, silver bronze, 10 g	02205-02	4
Slotted weight, black, 50 g	02206-01	2
Slotted weight, silver bronze, 50 g	02206-02	2
Glass beaker DURAN®, tall, 600 ml	36006-00	1
Marker, black	46402-01	1
Helical spring, 20 N/m	02222-00	1
Rubber bands, 50 pieces	03920-00	1

## DEMO advanced 15510-01 Mechanics 1 necessary accessories

Stop watch, interruption type	03076-01	1
Set of precision weights, 1g-50g	44017-00	1
Glycerol, 250 ml	30084-25	1
Denaturated alcohol (spirit for burning), 1000 ml	31150-70	1
Copper wire, d = 0.2 mm, l = 100 m	06106-00	1

## DEMO advanced 15511-88 Physics Supplementary Set Mechanics 2

Rollercoaster track, fix.magnet	02159-00	1
Hollow and solid cylinder	02636-00	1
Syringe holder on fixing magnet	02156-00	2
Gas syringe, 100 ml	02614-00	1
Clamping holder, 0-13 mm, fixing magnet	02151-07	1
Overflow vessel on fixing magnet	02158-00	1
Plunger plate for gas syringes	02618-00	2
Gas syringe, 50 ml	02610-00	1
Axle on fixing magnet	02151-04	2
Wheel and axle	02360-00	1
Commercial weight, 500 g	44096-50	1
Commercial weight, 200 g	44096-20	2
Weight, 150 g, for 11060.00	11060-01	1
Friction block	02240-01	1
Scale for demonstration board	02153-00	1
Marker points for demonstration board, 24 pcs	02154-02	1

Immersion probe	02632-00	1
Gear wheel, 20 teeth	02350-13	1
Gear wheel, 40 teeth	02351-03	1
Leaf spring	02228-00	1
Glass tubes, straight, 400 mm, 10	36701-67	0.2
Storage tray, 413 x 120 x 100 mm	47325-01	1
Rubber caps, pack of 20	02615-03	1
Glass tube holder with tape measure clamp	05961-00	2
Support rod, stainl.steel, 100mm	02030-00	1
Hose clamp for 5-12 mm diameter	40997-00	2
Silicone tubing, ID 6 mm	47530-00	2
Beaker, low form, plastic, 100 ml	36011-01	1
Funnel, plastic, dia. 50mm	36890-00	1

## DEMO advanced 15511-01 Mechanics 2 necessary accessories

Patent Blue V (sodium salt), 25 g	48376-04	1
Spirit level	02124-00	1
Microspoon, steel	33393-00	1
Ruler, l = 50 cm	09851-04	1

## DEMO advanced 15512-88 Physics Set Linear Motion (Dynamics)

Timer 4-4	13604-99	1
Starter system for demonstration track	11309-00	1
Demonstration track, aluminium, 1.5 m	11305-00	1
Cart, low friction sapphire bearings	11306-00	2
Light barrier, compact	11207-20	4
Equiforce launcher	11311-00	1
Portable Balance, OHAUS CS2000E	48911-00	1
Friction accessory for low friction cart	11310-00	1
End holder for demonstration track	11305-12	2
Weight for low friction cart, 400 g	11306-10	2
Magnet w.plug f.starter system	11202-14	1
Holder for pulley	11305-11	1
Support clamp for small case	02043-10	1
Pulley for demonstration track	11305-10	1
Shutter plate for low friction cart, width: 100 mm	11308-00	2
Needle with plug	11202-06	2
Weight holder, silver bronze, 1 g	02407-00	1
Plate with plug	11202-10	1
Tube with plug	11202-05	2
Fork with plug	11202-08	1
Weight holder for slotted weights	02204-00	1
Pulley, movable, dia. 40mm, w.hook	03970-00	1
Slotted weight, black, 10 g	02205-01	4
Slotted weight, silver bronze, 10 g	02205-02	4
Slotted weight, black, 50 g	02206-01	3
Slotted weight, silver bronze, 50 g	02206-02	3
Holder for light barrier	11307-00	4
Connecting cord, 32 A, 1000 mm, red	07363-01	4
Connecting cord, 32 A, 1000 mm, yellow	07363-02	6
Connecting cord, 32 A, 1000 mm, blue	07363-04	4
Measuring tape, l = 2 m	09936-00	1
Plasticine, 10 sticks	03935-03	0.1
Slotted weight, blank, 1 g	03916-00	20
Silk thread, l = 200 m	02412-00	1
Rubber bands for fork with plug, 10 pcs	11202-09	1

## DEMO advanced 15513-88 Physics set Mechanics: Acceleration with Cobra

Software Cobra4 - multi-user licence	14550-61	1
Cobra4 Wireless-Link	12601-00	1
Cobra4 Sensor-Unit 3D-Acceleration, ± 2 g, ± 6 g	12650-00	1
Cobra4 Wireless Manager	12600-00	1
Cart for measurements and experiments	11060-00	1
Fish line, l. 100m	02090-00	1
Touch fastener, selfadhesive, 100 cm	12680-01	1
Weight holder for slotted weights	02204-00	1
Helical spring, 3 N/m	02220-00	2
Slotted weight, black, 50 g	02206-01	2
Measuring tape, l = 2 m	09936-00	1
Rubber rings, 5 pieces	02673-00	2

## Centripetal force with Cobra4 P6000660

Laboratory motor, 220 V AC	11030-93	1
Software Cobra4 - multi-user licence	14550-61	1
Gearing 30/1, for 11030.93	11029-00	1
Cobra4 Wireless-Link	12601-00	1
Cobra4 Sensor-Unit Force ± 4 N	12642-00	1
Centrifugal force apparatus	11008-00	1
Bearing unit	02845-00	1
Cobra4 Wireless Manager	12600-00	1
Support base DEMO	02007-55	1
Tripod base PHYWE	02002-52	1
Cart for measurements and experiments	11060-00	1
Fish line, l. 100m	02090-00	1
Right angle clamp PHYWE	02040-55	1
Weight, 150 g, for 11060.00	11060-01	2
Boss head	02043-00	1
Holding pin	03949-00	1
Slotted weight, black, 50 g	02206-01	2
Driving belt	03981-00	1
Support rod, stainless steel, l = 250 mm, d = 10 mm	02031-00	1

## Acoustics

## TESS advanced 15289-88 Physics set Acoustics 1

Software "Measure Acoustics", single user license	14441-61	1
TESS box, plastics, high, 305 x 425 x 150 mm	15200-00	1
Tuning fork 880 Hz	03421-00	1
Frame drum, d = 20 cm	13289-11	1
Lid for TESS box, plastic	15205-00	1
Styrofoam sphere with hook	13289-13	1
Striking hammer	03429-00	1
Tuning fork 440 Hz	03424-00	2
Measuring tape, l = 2 m	09936-00	1
Silk thread, l = 200 m	02412-00	1
Silicone tubing, inner diameter 3 mm	39292-00	0.5
Ruler, plastic, 200 mm	09937-01	1
Beaker, low form, plastic, 100 ml	36011-01	1
PVC tubing, i.d. 7mm	03985-00	1
Filter funnel, d = 75 mm, PP	46895-00	2



# 8 Ordering overview

Scope of delivery of all sets

## TESS advanced 15321-88 Physics set Acoustics 2

Doppler source for TESS Acoustics	13289-30	1
Tuning fork with pen	13289-00	1
Metal angle bracket for glass tube o.d. = 44 mm	13289-16	2
Lid for TESS box, plastic	15205-00	1
Glass tube, d(outside) = 44 mm, l = 340 mm	13289-20	1
Weight holder for slotted weights	02204-00	1
Helical spring, 3 N/m	02220-00	1
Slotted weight, black, 50 g	02206-01	2
Digital stop watch, 24 h, 1/100 s & 1 s	24025-00	1
Felt sheet, 100 x 100 mm	04404-20	1

## Heat

## TESS advanced 15274-88 Physics Basic Set Heat 1

Support base, variable	02001-00	1
Heating coil with sockets	04450-00	1
TESS box, plastics, high, 305 x 425 x 150 mm	15200-00	1
Support rod, l = 600 mm, d = 10 mm, split in 2 rods with screw threads	02035-00	2
Ring with boss head, i. d. = 10 cm	37701-01	1
Erlenmeyer flask 100 ml, wide-neck SB 29	36428-00	1
Lid for TESS box, plastic	15205-00	1
Universal clamp	37715-00	1
Boss head	02043-00	2
Thermometer, non-graduated	04256-00	1
Lid for student calorimeter	04404-01	1
Glass tubes, l. 250 mm, pkg. of 10	36701-68	0.2
Students thermometer, -10...+110°C, l = 230 mm	38005-10	1
Students thermometer, -10...+110°C, l = 180 mm	38005-02	1
Agitator rod	04404-10	1
Fishing line, l. 20m	02089-00	1
Glass tube holder with tape measure clamp	05961-00	1
Measuring tape, l = 2 m	09936-00	1
Glass beaker DURAN®, short, 400 ml	36014-00	1
Support rod, stainless steel, l = 250 mm, d = 10 mm	02031-00	1
Digital stop watch, 24 h, 1/100 s & 1 s	24025-00	1
Erlenmeyer flask, wide neck, 250ml	36134-00	1
Connecting cord, 32 A, 500 mm, blue	07361-04	2
Glass beaker DURAN®, short, 250 ml	36013-00	1
Graduated cylinder 100 ml, PP transparent	36629-01	1
Glass tube, straight, l=80 mm, 10/pkg.	36701-65	0.1
Pipette with rubber bulb	64701-00	1
Wire gauze with ceramic, 160 x 160 mm	33287-01	1
Silicone tubing i.d. 7mm	39296-00	2
Spoon, w. spatula end, 18 cm, plastic	38833-00	1
Felt sheet, 100 x 100 mm	04404-20	2
Rubber stopper 26/32, 2 holes 7 mm	39258-02	1
Rubber stopper 26/32, 1 hole 7 mm	39258-01	1
Beaker, low form, plastic, 100 ml	36011-01	1

## TESS advanced 13455-88 Heat 1 necessary accessories for 1 group

Power supply 0-12 V DC/ 6 V, 12 V AC, 230 V	13505-93	1
Butane burner f. cartridge 270+470	47536-00	1
Butane cartridge CV 300 Plus, 240 g	47538-01	1

## TESS advanced 13456-88 Heat 1 consumables for 10 groups

Glycerol, 250 ml	30084-25	1
Patent Blue V (sodium salt), 25 g	48376-04	1
Sodium thiosulphate pentahydrate, 500 g	30169-50	1
Boiling beads, 200 g	36937-20	1
Sodium chloride, 500 g	30155-50	1

## Cobra4 extension 15285-88 set for TESS advanced Heat

Cobra4 Mobile-Link 2 incl. accessories: battery, USB cable, charger and SD memory card	12620-10	1
Cobra4 Sensor-Unit Temperature	12640-00	2
TESS advanced Physik Handbuch Cobra4 Mechanik, Wärme, Elektrik / Elektronik	01332-01	1
Rubber stopper 26/32, 2 holes 7 mm + 6 mm	39258-16	1
Rubber stopper 26/32, 1 hole 6 mm	39258-06	1

## TESS advanced 15275-88 Physics supplementary set Heat 2

Iron tube	04234-12	1
TESS box, plastics, high, 305 x 425 x 150 mm	15200-00	1
Metal bodies, set of 3	04406-00	1
Brass tube	04234-11	1
Lab thermometer, w. stem, +15...+40C	38057-00	1
Collar for linear expansion	04231-55	1
Rotating shaft with pointer	04236-01	1
Tube, plastic, d. 30mm, l. 500mm	04446-00	1
Aluminium tube	04234-13	1
Steel pellets, d = 2 mm, 120 g	03990-00	1
Constantan wire, 4 Ohm/m, d = 0.4 mm, l = 50 m	06102-00	1
Lid for TESS box, plastic	15205-00	1
Heat sensitive paper	04260-00	1
Boss head	02043-00	1
Aluminium rod, U-shaped	05910-00	1
Iron wire, d = 0.5 mm, l = 50 m	06105-00	1
Copper rod, U-shaped	05910-01	1
Copper rod, U-shaped, d 3mm, w. 175mm	05910-03	1
Copper rod, U-shape, d. 5mm, w. 120mm	05910-04	1
Beaker, black	05904-00	1
Bimetal strip	05913-00	1
Alligator clips, bare, 10 pcs	07274-03	0.2
Connecting cord, 32 A, 500 mm, red	07361-01	1
Test tube, 200x30 mm, DURAN	36304-01	1
Beaker, aluminum, polished	05903-00	1
Rubber stopper 26/32, 1 hole 7 mm	39258-01	1
Rubber stopper 26/32, without hole	39258-00	1

## TESS advanced 13457-88 Heat WE 2 necessary accessories for 1 group

Multi-range meter, analogue	07028-01	1
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## TESS advanced 13458-88 Heat WE 2 consumables for 10 groups

Constantan wire, 4 Ohm/m, d = 0.4 mm, l = 50 m	06102-00	1
Iron wire, d = 0.5 mm, l = 50 m	06105-00	1

## DEMO advanced 15530-88 Physics Set Heat

Convection of liquids tube	04510-00	1
Burner-holder on fixing magnet	02162-00	1
Wire gauze holder on fix. magnet	02163-00	1
Clamping holder, 0-13 mm, fixing magnet	02151-07	2
Clamp on holder	02164-00	1
Support plate on fixing magnet	02155-00	1
Clamp holder d=28-36mm fix. magn.	02151-06	2
Holder for Cobra4, magn.	02161-10	1
Iron tube	04234-12	1
Rod on fixing magnet	02151-02	1
Metal bodies, set of 3	04406-00	2
Brass tube	04234-11	1
Brass rod, U-shaped	05910-02	1
Collar for linear expansion	04231-55	1
Rotating shaft with pointer	04236-01	1
Aluminium tube	04234-13	1
Test tube, d 30mm, l 200mm, black	36294-06	1
Test tube, d = 30 mm, l = 200 mm, white	36294-05	1
Erlenmeyer flask 100 ml, wide-neck SB 29	36428-00	2
Pointers f. Demonstr. Board, 4 pcs	02154-01	1
Scale for demonstration board	02153-00	1
Heat sensitive paper	04260-00	2
Marker points for demonstration board, 24 pcs	02154-02	1
Aluminium rod, U-shaped	05910-00	1
Thermometer, non-graduated	04256-00	1
Copper rod, U-shaped	05910-01	1
Glass tubes, straight, 400 mm, 10	36701-67	0.2
Glass tubes, straight, 200 mm, 10	36701-66	0.1
Graduated cylinder 250 ml, PP transparent	36630-01	1
Glass beaker DURAN®, short, 400 ml	36014-00	1
Fishing line, l. 20m	02089-00	1
Marker, black	46402-01	1
Glass beaker DURAN®, short, 250 ml	36013-00	1
Graduated cylinder 100 ml, PP transparent	36629-01	1
Glass rod, U-shaped	05911-00	1
Glass tube, straight, l=80 mm, 10/pkg.	36701-65	0.2
Pipette with rubber bulb	64701-00	1
Microspoon, steel	33393-00	1
Wire gauze with ceramic, 160 x 160 mm	33287-01	1
Silicone tubing, ID 6 mm	47530-00	2
Beaker, aluminum, polished	05903-00	2
Rubber stopper 26/32, 2 holes 7 mm + 2,5 mm	39258-13	2
Felt sheet, 100 x 100 mm	04404-20	2
Rubber stopper 26/32, 1 hole 7 mm	39258-01	1
Beaker, low form, plastic, 100 ml	36011-01	1
Glass rod, boro 3.3, l=200mm, d=5mm	40485-03	1
Funnel, plastic, dia. 50mm	36890-00	1

## DEMO advanced 15530-01 Heat necessary accessories

Large-scale display, digital, RS-232 port	07157-93	1
Cobra4 Display-Connect	12623-88	1
Cobra4 Mobile-Link 2 incl. accessories: battery, USB cable, charger and SD memory card	12620-10	1

Cobra4 Sensor-Unit 2 x Temperature, NiCr-Ni	12641-00	1
Ceramic lamp socket E27	06751-01	1
Butane burner f. cartridge 270+470	47536-00	1
Immersion probe NiCr-Ni, steel, -50...400 °C	13615-03	2
Water boiler cordless, 1.7 l, 230 V	04027-93	1
Filament lamp, 220V/120W, w.refl.	06759-93	1
Patent Blue V (sodium salt), 25 g	48376-04	1
Glycerol, 250 ml	30084-25	1
Boiling beads, 200 g	36937-20	1
Support rod, stainless steel, 500 mm	02032-00	1
Denaturated alcohol (spirit for burning), 1000 ml	31150-70	1
Butane cartridge CV 300 Plus, 240 g	47538-01	1

## Renewable Energies

### TESS advanced 15287-88 Applied Sciences Basic Set Renewable Energy basics and thermal energy

Thermal generator for student experiments	05770-00	1
Solar collector for student experiments	05760-00	1
Mount for halogen lamp with reflector	05781-00	1
Generator with metrical thread axis and nut	05751-01	1
Support base, variable	02001-00	1
Motor with indicating disc, SB	05660-00	1
Socket module for incandescent lamp E10, SB	05604-00	1
TESS box, plastics, high, 305 x 425 x 150 mm	15200-00	1
Support rod, l = 600 mm, d = 10 mm, split in 2 rods with screw threads	02035-00	2
Interrupted connector module, SB	05601-04	1
Junction module, SB	05601-10	4
Solar cell 2.5 x5 cm, with plugs	06752-11	1
Angled connector module, SB	05601-02	4
Flow indicator for liquids	46434-00	1
Slide mount for optical bench	09822-00	1
Holder for solar cell 2.5 x5 cm, with plugs	06752-12	1
Lid for TESS box, plastic	15205-00	1
Filament lamp 6 V/3 W, E10, 10 pcs.	35673-03	0.1
Lab thermometer, -10...+100 °C	38056-00	2
Filament lamps 1.5V/0.15A, E10, 10 pieces	06150-03	0.1
Beaker, black	05904-00	1
Fishing line, l. 20m	02089-00	1
Measuring tape, l = 2 m	09936-00	1
Glass beaker DURAN®, short, 400 ml	36014-00	1
Digital stop watch, 24 h, 1/100 s & 1 s	24025-00	1
Connecting cord, 32 A, 500 mm, red	07361-01	2
Connecting cord, 32 A, 500 mm, blue	07361-04	1
Connecting cord, 32 A, 250 mm, red	07360-01	2
Connecting cord, 32 A, 250 mm, blue	07360-04	2
Double sockets, 1 pair, red a. black	07264-00	1
Silicone tubing i.d. 7mm	39296-00	1
Lamp 4 V/0,04 A, E 10	06154-00	1
Halogen lamp with reflector, 12V / 20W	05780-00	1
Beaker, aluminum, polished	05903-00	1
Felt sheet, 100 x 100 mm	04404-20	1
Beaker, low form, plastic, 100 ml	36011-01	1
Filter funnel, d = 75 mm, PP	46895-00	1

### TESS advanced 13480-88 Renewable Energy EN-BS necessary accessories f for 1 group

Power supply 0-12 V DC/ 6 V, 12 V AC, 230 V	13505-93	1
DMM with NiCr-Ni thermo couple	07122-00	2

### TESS advanced 13481-88 Renewable Energy EN-BS optional accessories for 1 group

Ceramic lamp socket E27	06751-01	1
Filament lamp, 220V/120W, w.refl.	06759-93	1

### TESS advanced 15288-88 Applied Sciences supplementary set Renewable Energy Solar / Water / Wind

Water pump/ water turbine/ generator	05753-00	1
Blower, 12V	05750-00	1
Solar battery, 4 cells, with cable and connectors	06752-20	1
Concentrated solar power unit	05765-00	1
Potentiometer module 250 Ohm, SB	05623-25	1
Capacitor (gold cap), 1F, SB	05650-10	1
On-off switch module, SB	05602-01	1
TESS box, plastics, high, 305 x 425 x 150 mm	15200-00	1
Interrupted connector module, SB	05601-04	2
Light emitting diode module red, SB	05654-00	1
Battery holder module (AA type), SB	05606-00	1
Solar cell 2.5 x5 cm, with plugs	06752-11	1
clamp, d = 16 mm, with mounting rod	05764-00	1
Straight connector module, SB	05601-01	2
Holder for solar cell 2.5 x5 cm, with plugs	06752-12	1
Lid for TESS box, plastic	15205-00	1
Rotor, 2 pieces	05752-01	1
Boss head	02043-00	1
Syringe 20ml, Luer, 10 pcs	02591-03	0.1
Ni-MH accu, size AA, 1.3 Ah / 1.2V, 1 pair	07922-03	1
Support rod, stainless steel, l = 250 mm, d = 10 mm	02031-00	1
Cardboards 200x300mm, black, 10 pcs	06306-01	0.1
Dish, plastic, 150x150x65 mm	33928-00	1
Connecting cord, 32 A, 500 mm, blue	07361-04	1
Connecting cord, 32 A, 500 mm, red	07361-01	1
Double sockets, 1 pair, red a. black	07264-00	1

### TESS advanced 13480-88 Renewable Energy EN-BS necessary accessories f for 1 group

Power supply 0-12 V DC/ 6 V, 12 V AC, 230 V	13505-93	1
DMM with NiCr-Ni thermo couple	07122-00	2

### TESS advanced 15286-88 Applied Sciences supplementary set Renewable Energy Fuel Cells

PEM electrolyser, SB	05662-00	1
Solar battery, 4 cells, with cable and connectors	06752-20	1
PEM fuel cell for hydrogen/ oxygen operation and hydrogen/ air operation, SB	05661-00	1
Gas storage, SB, incl. tubes and plugs	05663-00	2
TESS box, plastics, high, 305 x 425 x 150 mm	15200-00	1
Lid for TESS box, plastic	15205-00	1
Boss head	02043-00	1
Support rod, stainless steel, l = 250 mm, d = 10 mm	02031-00	1

### DEMO advanced 15580-88 Applied Sciences Basic Set Renewable Energy basics and thermal energy

Solar ray collector, magnetic	02165-00	1
Thermogenerator, Peltie element	04374-00	1
Motor with indicating disc, 5 V, module DB	09469-00	1
Clamping holder with 2 clamping possibilities, 0-13 mm, fixing magnet	02151-08	1
Motor 12 V, module DB	09475-01	1
Solar battery, 4 cells, with cable, connectors, and magnetpads	06752-21	1
Switch on/off, module DB	09402-01	1
Switch, change-over, module DB	09402-02	1
Apparatus carrier w. fix. magnet	45525-00	1
Clamp on holder	02164-00	1
Socket for incandescent lamp E10, module DB	09404-00	1
Connector interrupted, module DB	09401-04	2
Junction, module DB	09401-10	2
Heating coil with sockets	04450-00	1
Connector, straight, module DB	09401-01	1
Connector, angled, module DB	09401-02	4
Connector, T-shaped, module DB	09401-03	2
Connector, angled with socket, module DB	09401-12	1
Scale for demonstration board	02153-00	1
Weight holder for slotted weights	02204-00	1
Lid for student calorimeter	04404-01	1
Filament lamps 1.5V/0.15A, E10, 10 pieces	06150-03	1
Slotted weight, black, 10 g	02205-01	4
Slotted weight, black, 50 g	02206-01	1
Agitator rod	04404-10	1
Funnel, plastic, cylindrical, 300ml	36889-00	1
Heat insulating sheet, felt, 100 mm x 135 mm	04375-00	1
Glass beaker DURAN®, short, 400 ml	36014-00	2
Fishing line, l. 20m	02089-00	1
Connecting cord, 32 A, 500 mm, yellow	07361-02	1
Connecting cord, 32 A, 500 mm, blue	07361-04	2
Connecting cord, 32 A, 500 mm, red	07361-01	2
Glass beaker DURAN®, short, 250 ml	36013-00	2
Connecting cord, 32 A, 250 mm, yellow	07360-02	1
Connecting cord, 32 A, 250 mm, blue	07360-04	2
Connecting cord, 32 A, 250 mm, red	07360-01	2
Pinchcock, width 15 mm	43631-15	1
Silicone tubing, ID 6 mm	47530-00	1
Felt sheet, 100 x 100 mm	04404-20	2
Glass rod, boro 3.3, l=200mm, d=5mm	40485-03	1

# 8 Ordering overview

Scope of delivery of all sets

## DEMO advanced 15580-01 Renewable Energy Basic Set , necessary accessories

Power supply, universal	13500-93	1
Ceramic lamp socket E27	06751-01	1
Hot/cold air blower, 1800 W	04030-93	1
Filament lamp, 220V/120W, w.refl.	06759-93	1
Support rod PHYWE, square, l 630mm	02027-55	1
Water, distilled 5 l	31246-81	1
Connecting cord, 32 A, 750 mm, red	07362-01	1
Connecting cord, 32 A, 750 mm, blue	07362-04	1

## DEMO advanced 15581-88 Applied Sciences Renewable Energy supplementary set Solar cells, Wind energy, Hydropower

Pelton wheel, model	02521-00	1
Concentrated solar power unit, 180 mm	02168-00	1
Resistance decade, module DB	09420-00	1
Water pump/ water turbine/ generator	05753-00	1
Clamping holder with 2 clamping possibilities, 0-13 mm, fixing magnet	02151-08	1
Blower, 12V	05750-00	2
Solar battery, 4 cells, with cable, connectors, and magnetpads	06752-21	1
Solar cell (2.5x5)cm, module DB	09470-00	2
Generator with metrical thread axis and nut	05751-01	2
Capacitor (gold cap), 1F, DB	09450-10	1
Connector interrupted, module DB	09401-04	1
Light emitt. diode, red, module DB	09454-00	1
Sliding mount for optical bench	02151-09	1
Connector, straight, module DB	09401-01	1
Battery holder module (AA type), SB	05606-00	1
clamp, d = 16 mm, with mounting rod	05764-00	2
Rotor, 2 pieces	05752-01	2
Boss head	02043-00	1
Filament lamps 4V/0.04A, E10, 10	06154-03	1
Support rod, stainless steel, 500 mm	02032-00	2
Filament lamps 3.5V/0.2A, E10, 10	06152-03	1
Syringe 20ml, Luer, 10 pcs	02591-03	0.1
Ni-MH accus, size AA, 1.3 Ah / 1.2V, 1 pair	07922-03	1
Driving belt	03981-00	1
Connecting cord, 32 A, 750 mm, red	07362-01	1
Connecting cord, 32 A, 750 mm, blue	07362-04	1
Cardboards 200x300mm, black, 10 pcs	06306-01	0.1
Dish, plastic, 150x150x65 mm	33928-00	1
Double sockets, 1 pair, red a. black	07264-00	1
Hose clamp for 10-17 mm diameter	40998-00	1
Rubber tubing, i.d. 8 mm	39283-00	2

## DEMO advanced 15582-88 Applied Sciences Renewable Energy supplementary set Fuel Cells

Double PEM fuel cell for hydrogen/ oxygen operation and hydrogen/ air operation, DB	09486-00	1
Double PEM electrolyser, DB	09488-00	1
Resistance decade, module DB	09420-00	1
Clamping holder with 2 clamping possibilities, 0-13 mm, fixing magnet	02151-08	1
Blower, 12V	05750-00	2

Solar battery, 4 cells, with cable, connectors, and magnetpads	06752-21	1
Generator with metrical thread axis and nut	05751-01	2
Clamp on holder	02164-00	1
Gas storage with magnetic pad, incl. tube and plugs	09489-00	2
Connector, straight, module DB	09401-01	1
Building Block with magnetic pad, DB	09490-00	2
Connector, angled with socket, module DB	09401-12	1
Metal angle for building block with magnetic pad	09491-00	2
Rotor, 2 pieces	05752-01	2
Connecting cord, 32 A, 750 mm, red	07362-01	1
Connecting cord, 32 A, 750 mm, blue	07362-04	1
Double sockets, 1 pair, red a. black	07264-00	1

## DEMO advanced Set 15582-01 Fuel Cells, necessary accessories

Lab protecting glasses with UV filter	39315-00	1
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## Cobra4 wireless, 12608-88 extension set for renewable energy: electric parameters, temperature case

Software Cobra4 - multi-user licence	14550-61	1
Cobra4 Sensor-Unit Energy: Current, voltage, work, power	12656-00	1
Cobra4 Wireless-Link	12601-00	2
Cobra4 Sensor-Unit 2 x Temperature, NiCr-Ni	12641-00	1
Cobra4 Wireless Manager	12600-00	1
Immersion probe NiCr-Ni, steel, -50...400 °C	13615-03	2
Fast Charging System for up to 4 MeH Accumulators	07930-99	1
Holder for Cobra4, magn.	02161-10	2
Ni-MH accu, Mignon, 1.2 V, 2000 mAh, Eneloop Type, 4 pcs.	07930-03	1

## Demo Physics 02150-00 board with stand

## Electricity

## TESS advanced 15265-88 Physics Electricity/Electronics Building Block System, Basic Set electricity

Model person for electrical safety, SB	05680-00	1
Potentiometer module 250 Ohm, SB	05623-25	1
On-off switch module, SB	05602-01	1
Change-over switch module, SB	05602-02	2
Socket module for incandescent lamp E10, SB	05604-00	2
TESS box, plastics, high, 305 x 425 x 150 mm	15200-00	1
Interrupted connector module, SB	05601-04	2

Conductors/non-conductors, l = 150 mm	06107-50	1
Junction module, SB	05601-10	2
PTC-resistor module, SB	05631-00	1
Bell gong on 4-mm-plug	05673-02	1
Angled connector module with socket, SB	05601-12	2
NTC-resistor module, SB	05630-01	1
Photo-resistor module LDR 03, SB	05632-00	1
Straight connector module, SB	05601-01	4
Angled connector module, SB	05601-02	4
T-shaped connector module, SB	05601-03	2
Straight connector module with socket, SB	05601-11	2
Battery holder module (C type), SB	05605-00	2
Resistor module 100 Ohm, SB	05613-10	1
Resistor module 10 kOhm, SB	05615-10	1
Resistor module 47 kOhm, SB	05615-47	1
Resistor module 50 Ohm, SB	05612-50	1
Lid for TESS box, plastic	15205-00	1
Connecting plug, 2 pcs.	07278-05	1
Trough, grooved, w/o lid	34568-01	1
Bimetal strip	05913-00	1
Alligator clips, bare, 10 pcs	07274-03	1
Connecting cord, 32 A, 500 mm, red	07361-01	2
Connecting cord, 32 A, 500 mm, blue	07361-04	2
Connecting cord, 32 A, 250 mm, red	07360-01	2
Connecting cord, 32 A, 250 mm, blue	07360-04	2
Copper electrode, 76 mm x 40 mm	45212-00	2
Iron electrode, 76 x 40 mm	45216-00	2
Lead electrode, 76 mm x 40 mm	45215-00	2
Zinc electrode, 76 mm x 40 mm	45214-00	1

## TESS advanced 13470-88 Electronics Basic Set necessary accessories for 1 group

Power supply 0-12 V DC/ 6 V, 12 V AC, 230 V	13505-93	1
DMM with NiCr-Ni thermo couple	07122-00	2
Battery cell, 1.5 V, baby size, type C	07922-01	2

## TESS advanced 13471-88 Electronics EB 1 consumables for 10 groups

Constantan wire, 6.9 Ohm/m, d = 0.3 mm, l = 100 m	06101-00	1
Constantan wire, 4 Ohm/m, d = 0.4 mm, l = 50 m	06102-00	1
Filament lamps 12V/0.1A, E10, 10	07505-03	1
Filament lamp 6 V/3 W, E10, 10 pcs.	35673-03	1
Filament lamps 4V/0.04A, E10, 10	06154-03	1
Constantan wire, 15.6 Ohm/m, d = 0.2 mm, l = 100 m	06100-00	1
Iron wire, d = 0.2 mm, l = 100 m	06104-00	1
Filament lamps 1.5V/0.15A, E10, 10 pieces	06150-03	1
Copper wire, d = 0.2 mm, l = 100 m	06106-00	1

## Cobra4 extension 15268-88 set for TESS advanced Electrics

Cobra4 Mobile-Link 2 incl. accessories: battery, USB cable, charger and SD memory card	12620-10	1
Cobra4 Sensor-Unit Electricity	12644-00	1
TESS advanced Physik Handbuch Cobra4 Mechanik, Wärme, Elektrik / Elektronik	01332-01	1
Connecting cord, 32 A, 250 mm, blue	07360-04	1
Connecting cord, 32 A, 250 mm, red	07360-01	1

## TESS advanced 15266-88 Physics Electricity/Electronics Building Block System, supplementary set Electromagnetism and Induction

Relais module 6 V, SB	05674-00	1
Motor model for student experiments	07850-10	1
U-core	07832-00	1
Coil, 400 turns	07829-01	2
Coil, 1600 turns	07830-01	1
Galvanometer movement	07875-00	1
Universal holder module, SB	05603-00	1
Contact spring with armature	05673-00	1
Yoke	07833-00	1
TESS box, plastics, high, 305 x 425 x 150 mm	15200-00	1
Bar magnet, l = 72mm	07823-00	1
Coil holder module, SB	05672-00	1
Galvanometer scale	07876-00	1
Contact element on 4-mm-plug	05673-01	1
Notch bearing with plug	07877-00	1
Rotating stem	07836-00	1
Lid for TESS box, plastic	15205-00	1
Tightening screw	07834-00	1
Neon lamp 110 V AC, E10	07506-90	1
Drawing compass, 1 units	06350-03	1

## TESS advanced 15267-88 Physics Electricity/Electronics Building Block System, supplementary set Electronics

U-core	07832-00	1
Potentiometer module 10 kOhm, SB	05625-10	1
Coil, 400 turns	07829-01	1
Coil, 1600 turns	07830-01	1
On-off switch module, SB	05602-01	1
Earphones, 2kOhm, with 4mm-plugs	06811-00	1
Bridge rectifier module, SB	05655-00	1
Yoke	07833-00	1
TESS box, plastics, high, 305 x 425 x 150 mm	15200-00	1
Light emitting diode module red, SB	05654-00	1
NPN transistor module BC337, SB	05656-00	1
Silicon-diode module 1N4007, SB	05651-00	1
Z-diode module ZF4.7, SB	05652-00	1
Solar cell 2.5 x5 cm, with plugs	06752-11	1
Photodiode module, SB	05653-00	1
T-shaped connector module, SB	05601-03	2
Resistor module 100 Ohm, SB	05613-10	1
Resistor module 500 Ohm, SB	05613-50	1
Resistor module 1 kOhm, SB	05614-10	1
Capacitor module 47 nF, SB	05642-47	1
Capacitor module 47 µF non-polar electrolytic, SB	05645-47	1
Capacitor module 100 µF non-polar electrolytic, SB	05646-10	1
Capacitor module 470 µF non-polar electrolytic, SB	05646-47	1
Holder for solar cell 2.5 x5 cm, with plugs	06752-12	1
Lid for TESS box, plastic	15205-00	1
Tightening screw	07834-00	1

## TESS advanced 15230-88 Physics set Magnetism

Iron wire, notched, d = 1,2 mm, 2 kg	06343-03	1
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Magnetic field sensor	06309-00	1
Earth globe model f.magnet 8x60mm	06308-00	1
Lid for TESS box, plastic	15205-00	1
Pocket compass	06350-00	1
Bar magnet l 50 mm	07819-00	2
Conductors/non-conductors, l=50 mm	06107-01	1
Sprinkler w. iron powder, 25ml	06305-10	1
Polycarbonate plate, 136x112x1 mm	13027-05	1
Magnet, d 8mm, l 60mm	06317-00	1

## TESS advanced 13409-88 Magnetism MAG consumables for 10 groups

Iron wire, notched, d = 1,2 mm, 2 kg	06343-03	1
Iron powder, techn. 500 g	30067-50	1

## TESS advanced 15240-88 Physics set Electrostatics

Electroscope w. metal pointer	13027-01	1
Electrostatic ind.plate, 30mmx60mm	13027-12	1
Pendulums, pair, f.electrostatics	13027-15	1
Lid for TESS box, plastic	15205-00	1
Faraday pail, d. 40mm, h. 75mm	13027-03	1
Acrylic resin rod, d.8mm, l.175mm	13027-08	1
Support rod, stainless steel, d = 8 mm, l = 175 mm	02038-00	1
Neon tube	06656-00	1
Clip for rods, with cord	13027-16	1
Polycarbonate plate, 136x112x1 mm	13027-05	1
Polypropylene rod, d. 8mm, l.175mm	13027-07	2
Rubber stopper, d=49/41mm, 1 hole	39263-01	1

## TESS advanced 13410-88 Electrostatics EST consumables for 10 groups

Film, transparent, DIN A4, 100 sheets	08186-10	1
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## TESS advanced 13411-88 Equipotential lines ÄQU necessary accessories for 1 group

Power supply 0-12 V DC/ 6 V, 12 V AC, 230 V	13505-93	1
DMM with NiCr-Ni thermo couple	07122-00	1
Connecting cord, 32 A, 250 mm, blue	07360-04	2
Connecting cord, 32 A, 250 mm, red	07360-01	2

## TESS advanced 15221-88 Physics set Electric motor/ Generator

Electric motor/ Generator, EMG	15221-00	1
TESS box, plastics, high, 305 x 425 x 150 mm	15200-00	1
Lid for TESS box, plastic	15205-00	1
Connecting cord, 2 mm-plug, 5A, 250 mm, red	07355-01	2

Connecting cord, 2 mm-plug, 5A, 250 mm, blue	07355-04	2
Adaptor 4 mm plug / 2 mm socket	39161-02	2

## TESS advanced 13412-88 Electric Motor / Generator EMG necessary accessories for 1 group

Power supply 0-12 V DC/ 6 V, 12 V AC, 230 V	13505-93	1
DMM with NiCr-Ni thermo couple	07122-00	1
Socket module for incandescent lamp E10, SB	05604-00	1
Junction module, SB	05601-10	2
Pocket compass	06350-00	1
Connecting cord, 19A, 50cm, red	07314-01	1
Connecting cord, 19A, 50cm, blue	07314-04	1

## TESS advanced 13413-88 Electric Motor / Generator EMG consumables for 10 groups

Filament lamps 1.5V/0.15A, E10, 10 pieces	06150-03	1
Silicone tubing i.d. 2mm	39298-00	1

## TESS advanced 15250-88 Physics set Equipotential lines and electric fields

Set of electrodes with holder for set equipotential lines	13027-24	1
Mounting plate r, 16cmx21cm	13002-00	1
Universal holder, block R	13024-13	2
Carbon paper f.Equipot. 30 sheets	13027-29	1
Lid for TESS box, plastic	15205-00	1
Polycarbonate plate, 136x112x1 mm	13027-05	1

## TESS advanced 13473-88 Electronics EB 2 consumables for 10 groups

Sodium hydroxide sol., 10%, 1000ml	31630-70	1
Copper-II sulphate, cryst. 250 g	30126-25	1
Sulphuric acid, 10%, tech.gr., 1000 ml	31828-70	1
Water, distilled 5 l	31246-81	1
Emery paper, medium, 5 sheets	01605-02	1
Sodium sulphate dried 250 g	48344-25	1
Denaturated alcohol (spirit for burning), 1000 ml	31150-70	1

## TESS advanced 13410-88 Electrostatics EST consumables for 10 groups

Film, transparent, DIN A4, 100 sheets	08186-10	1
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# 8 Ordering overview

Scope of delivery of all sets

## TESS advanced 13409-88 Magnetism MAG consumables for 10 groups

Iron wire, notched, d = 1,2 mm, 2 kg	06343-03	1
Iron powder, techn. 500 g	30067-50	1

## DEMO advanced 15570-88 Physics Electricity/Electronics Building Block System, electricity

Human model f.electric. safety,DB	09480-00	1
Motor, 2 V DC	11031-00	1
Switch on/off, module DB	09402-01	2
Switch, change-over, module DB	09402-02	2
Potentiometer 250 Ohm, module DB	09423-25	1
Socket for incandescent lamp E10, module DB	09404-00	2
Connector interrupted, module DB	09401-04	4
Junction, module DB	09401-10	2
Resistor 1 Ohm, module DB	09411-10	1
Resistor 10 Ohm, module DB	09412-10	1
Resistor 50 Ohm, module DB	09412-50	1
Resistor 100 Ohm, module DB	09413-10	2
Resistor 10 kOhm, module DB	09415-10	1
Resistor 47 kOhm, module DB	09415-47	1
NTC-resistor, module DB	09430-00	1
PTC-resistor, module DB	09431-00	1
Photoresistor LDR 03, module DB	09432-00	1
Support plate w. holder, module DB	09471-00	1
Glass tank, 100x50x120 mm	06620-10	1
Electr.symbols f.demo-board,12pcs	02154-03	1
Clamp on fixing magnet	02151-01	1
Connector, straight, module DB	09401-01	6
Conductors/non-conductors, l = 150 mm	06107-50	1
Connector, angled, module DB	09401-02	6
Connector, T-shaped, module DB	09401-03	4
Connect.straight w.socket,mod. DB	09401-11	2
Connector, angled with socket, module DB	09401-12	2
Bell gong on 4-mm-plug	05673-02	1
Plate electrode holder	06618-00	2
Battery holder module (C type), SB	05605-00	2
Disc for 11031-00	11031-01	1
Filament lamps 12V/0.1A, E10, 10	07505-03	1
Scale for demonstration board	02153-00	1
Filament lamp 6 V/3 W, E10, 10 pcs.	35673-03	1
Filament lamps 4V/0.04A, E10, 10	06154-03	1
Connecting plug, 2 pcs.	07278-05	1
Filament lamps 1.5V/0.15A,E10,10 pieces	06150-03	1
Bimetal strip	05913-00	1
Alligator clips, bare, 10 pcs	07274-03	1
Connecting cord, 32 A, 500 mm, blue	07361-04	2
Connecting cord, 32 A, 500 mm, red	07361-01	2
Connecting cord, 32 A, 250 mm, blue	07360-04	2
Connecting cord, 32 A, 250 mm, red	07360-01	2
Connecting cord, 100 mm, red	07359-01	1
Connecting cord, 32 A, 100 mm, blue	07359-04	1
Copper electrode, 76 mm x 40 mm	45212-00	2
Iron electrode, 76 x 40 mm	45216-00	1
Lead electrode, 76 mm x 40 mm	45215-00	2
Zinc electrode, 76 mm x 40 mm	45214-00	1

## DEMO advanced 15570-01 Electricity necessary accessories

Multimeter ADM2, demo., analogue	13820-01	2
Power supply, universal	13500-93	1

Stop clock, demo.; diam. 13 cm	03075-00	1
Hot/cold air blower, 1800 W	04030-93	1
Lab thermometer,w.stem,+15..+40C	38057-00	1
Constantan wire, 6.9 Ohm/m, d = 0.3 mm, l = 100 m	06101-00	1
Sodium hydroxide sol.,10%, 1000ml	31630-70	1
Sodium sulphate 500 g	30166-50	1
Constantan wire, 4 Ohm/m, d = 0.4 mm, l = 50 m	06102-00	1
Sodium chloride 1000 g	30155-70	1
Copper-II sulphate,cryst. 250 g	30126-25	1
Sulphuric acid, 10%, tech.gr., 1000 ml	31828-70	1
Water, distilled 5 l	31246-81	1
Constantan wire, 15.6 Ohm/m, d = 0.2 mm, l = 100 m	06100-00	1
Iron wire, d = 0.2 mm, l = 100 m	06104-00	1
Emery paper, medium, 5 sheets	01605-02	1
Denaturated alcohol (spirit for burning), 1000 ml	31150-70	1
Flashlight, w/o battery,medium	08164-00	1
Copper wire, d = 0.2 mm, l = 100 m	06106-00	1
Connecting cord, 32 A, 1000 mm, red	07363-01	3
Connecting cord, 32 A, 1000 mm, blue	07363-04	3
Spoon,w.spatula end,18 cm,plastic	38833-00	1
Battery cell, 1.5 V, baby size, type C	07922-01	2

## DEMO advanced 15571-88 Physics Electricity/Electronics Building Block System, supplementary set Electromagnetism and Induction

Motor model f. magnet board	07850-20	1
Relay 6 V, module DB	09474-00	1
Coil f.galvanomtr.model,module DB	09477-00	1
Coil 400 turns, module DB	09472-01	2
Coil 1600 turns, module DB	09472-02	1
Motor 12 V, module DB	09475-01	1
Holder for U-magnet, module DB	09476-00	1
U-core	07832-00	1
Magn.rotor f.generator model	07850-22	1
Insulating support, l = 235 mm	07924-00	1
Magn.rotor f.electr.motor model	07850-21	1
Conductor swing	06412-00	1
Clamp on holder	02164-00	1
Junction, module DB	09401-10	2
Universal holder,module DB	09403-00	1
Contact spring w. armature,mod.DB	09473-00	1
Wire crossing, insulated, module DB	09401-05	1
Magnet holder,d=18mm	09476-10	1
Yoke	07833-00	1
Holder f.electr.motor,magn.board	07849-00	1
Magnet, bar-shaped, d = 18 mm, l = 70mm	06318-00	1
Contact element,module DB	09473-01	1
Scale f.galvanomtr.model,mod. DB	09477-01	1
Pole shoes,1 pair (18x4x70)mm	09476-11	1
Rod for pulley	02263-00	1
Circular trough	07835-00	1
Weight holder for slotted weights	02204-00	1
Tightening screw	07834-00	1
Pulley,movable,dia.40mm,w.hook	03970-00	1
Slotted weight, black, 10 g	02205-01	2
Slotted weight, silver bronze, 10 g	02205-02	2
Slotted weight, black, 50 g	02206-01	1
Neon lamp 110 V AC, E10	07506-90	1
Fishing line, l. 20m	02089-00	1

## DEMO 15571-01 advanced Electromagnetism and induction necessary accessories

Multimeter ADM2, demo., analogue	13820-01	1
Power supply variable 15 VAC/ 12 VDC/ 5 A	13530-93	1

## DEMO advanced 15572-88 Physics Electricity/Electronics Building Block System, supplementary set Electronics

Coil 400 turns, module DB	09472-01	1
Coil 1600 turns, module DB	09472-02	1
Solar cell (2.5x5)cm,module DB	09470-00	2
Potentiometer 10 kOhm,module DB	09425-10	1
Bridge rectifier w. LED,module DB	09455-01	1
U-core	07832-00	1
Bridge rectifier,module DB	09455-00	1
Transistor BC337,module DB	09456-00	2
Transistor BC327,module DB	09457-00	1
Clamp on holder	02164-00	1
Junction, module DB	09401-10	2
Wire crossing,connected,module DB	09401-06	1
Resistor 500 Ohm,module DB	09413-50	1
Resistor 1 kOhm,module DB	09414-10	1
Capacitor 10 nF,module DB	09442-10	1
Capacitor 47 nF,module DB	09442-47	1
Capacitor(ELKO)0.047 mF,module DB	09445-47	1
Capacitor(ELKO)0.1 mF,module DB	09446-10	1
Capacitor(ELKO)0.47 mF,module DB	09446-47	1
Silicon diode 1N4007,module DB	09451-00	1
Z-diode ZF 4.7,module DB	09452-00	1
Photodiode,module DB	09453-00	1
Light emitt. diode,red,module DB	09454-00	1
Phototransistor, module DB	09458-00	1
Transmitter f. opt. fiber,mod. DB	09461-00	1
Wire crossing, insulated, module DB	09401-05	1
Yoke	07833-00	1
Magnet, bar-shaped, d = 18 mm, l = 70mm	06318-00	1
Optical fiber, 2m	09461-02	1
Tightening screw	07834-00	1

## DEMO advanced 15572-01 Electronics necessary accessories

Digital Function Generator, USB	13654-99	1
30 MHz digital storage oscilloscope with colour display,2 x BNC cables l =75 cm incl.	11462-99	1
Loudspeaker,8 Ohm/5 kOhm	13765-00	1
Ceramic lamp socket E27	06751-01	1
Filament lamp,220V/120W,w.refl.	06759-93	1
Adapter, BNC-plug/socket 4 mm.	07542-26	2
Universal clamp	37715-00	1
Boss head	02043-00	1
Support rod, stainless steel, 500 mm	02032-00	1

**Optics**

**TESS advanced 15276-88**  
**Physics Basic Set Optics 1**

Light box, halogen 12V/20 W	09801-00	1
TESS box, plastics, high, 305 x 425 x 150 mm	15200-00	1
Mirror, concave-convex	09812-00	1
Lid for TESS box, plastic	15205-00	1
Optical disk	09811-00	1
Block, semicircular	09810-01	1
Block, trapezoidal	09810-02	1
Block, rectangular triangle	09810-03	1
Mirror on block, 50 mm x 20 mm	08318-00	1
Block, planoconvex lens, fl+100mm	09810-04	2
Block, planoconcave lens, fl-100mm	09810-05	1
Cuvette, double semicircular	09810-06	1

**TESS advanced 13250-77**  
**Physics supplementary Set**  
**Colour mixing**

Light box accessories for colour mixing	09806-00	1
Color filter set, add. color mixt.	09807-00	1
Color filter set, subtr. col. mixt.	09808-00	1

**TESS advanced 13460-88**  
**Optics OE 1 necessary**  
**accessories for 1 group**

Power supply 0-12 V DC/ 6 V, 12 V AC, 230 V	13505-93	1
Halogen lamp, 12V/20W	08129-09	1

**TESS advanced 13461-88**  
**Optics OE 1 consumables for**  
**10 groups**

Glycerol, 250 ml	30084-25	1
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**TESS advanced 15277-88**  
**Physics supplementary set**  
**Optics 2**

Optical profile-bench for student experiments, l = 600 mm	08376-00	1
Grating, 80 lines/mm	09827-00	1
TESS box, plastics, high, 305 x 425 x 150 mm	15200-00	1
Concave/convex mirror with rod	09821-00	1
Lens on slide mount, f=+50mm	09820-01	1
Lens on slide mount, f=+100mm	09820-02	1
Lens on slide mount, f= -50mm	09820-06	1
Model earth/moon	09825-00	1
Mount with scale on slide mount	09823-00	1
Table with stem	09824-00	1
Screen, white, 150x150mm	09826-00	1
Bottom with stem for light box	09802-20	1
Slide mount for optical bench	09822-00	2
Lid for TESS box, plastic	15205-00	1
Diaphragms, d 1, 2, 3, 5 mm	09815-00	1
Polarising filter, 50 mm x 50mm	08613-00	2

Diaphragm holder, attachable	11604-09	2
Ground glass screen, 50x50x2 mm	08136-01	1
Object -L-, glass bead	11609-00	1
Slide -Emperor Maximilian-	82140-00	1
Diaphragm with hole, d=20mm	09816-01	1
Diaphragm with slit	09816-02	1
Diaphragm with square	09816-03	1

**TESS advanced 13462-88**  
**Optics OE 2 consumables for**  
**10 groups**

Stearin candles, d 13mm, 20 pcs	09901-02	1
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**TESS advanced 15280-88**  
**Physics supplementary set**  
**Optics 3**

Slit, adjustable, up to 1 mm	11604-07	1
Measuring magnifier	09831-00	1
Plate mount f.3 objects	09830-00	2
TESS box, plastics, high, 305 x 425 x 150 mm	15200-00	1
Lens on slide mount, f=+300mm	09820-04	2
Mount with scale on slide mount	09823-00	1
Diaphragm, single slit, edge	08521-00	1
Diaphragm, 3 single slits	08522-00	1
Diaphragm, 4 double slits	08523-00	1
Diffraction grating, 4 lines/mm	08532-00	1
Diffraction grating, 8 lines/mm	08534-00	1
Diffraction grating, 10 lines/mm	08540-00	1
Diaphragm, 4 multiple slits	08526-00	1
Lid for TESS box, plastic	15205-00	1
Aperture, d 0.4mm	08206-04	1
Photoelastic model	09829-00	1
Measuring tape, l = 2 m	09936-00	1
Glass beaker DURAN®, short, 250 ml	36013-00	1
Microscopic slides, 50 pcs	64691-00	1

**TESS advanced 13463-88**  
**Optics OE 3 consumables for**  
**10 groups**

Cardboards 200x300mm, black, 10 pcs	06306-01	1
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**TESS advanced 13464-88**  
**Optics OE 3 optional**  
**accessories for 1 group**

Polarization specimen, mica	08664-00	1
Fresnel biprism	08556-00	1
Multi-range meter, analogue	07028-01	1
Fresnel mirror on plate	08561-00	2
Plate and lens f. Newton rings	08551-00	1
Insulating pin	07807-00	1
Light dep.resistor, LDR3, case G1	39119-06	1
Connecting cord, 32 A, 500 mm, red	07361-01	1
Connecting cord, 32 A, 500 mm, blue	07361-04	2

**TESS advanced 15350-88**  
**Physics set Optics / Atomic**  
**physics, OA**

Optical profile-bench for student experiments, l = 600 mm	08376-00	1
Light sensor with amplifier, adjustable	09852-70	1
Screen, semitransparent, 150x150mm <sup>2</sup>	09851-03	1
LED - UV, with series resistor and 4 mm plugs	09852-50	1
Halogen lamp, 12 V/10 W, mounted with 4 mm plugs	09852-00	1
LED - green, with series resistor and 4 mm plugs	09852-30	1
LED - IR, with series resistor and 4 mm plugs	09852-10	1
LED - blue, with series resistor and 4 mm plugs	09852-40	1
TESS box, plastics, high, 305 x 425 x 150 mm	15200-00	1
Lens on slide mount, f=+50mm	09820-01	1
Lens on slide mount, f=+100mm	09820-02	1
LED - red, with series resistor and 4 mm plugs	09852-20	1
LED - white, with series resistor and 4 mm plugs	09852-60	1
Power supply, 5 V DC	09852-99	1
Stray light tube	09852-71	1
Solar cell 2.5 x5 cm, with plugs	06752-11	1
Mount with scale on slide mount	09823-00	2
Universal bench	09840-10	1
Cuvette holder for universal bench	09840-11	1
Lambda/4 film, in slide frame, glassless	09851-13	1
Diffraction objects acc.Koppelman, in slide frame, glassless	09851-15	1
Stray light tube for LED, Di = 8 mm, l = 40 mm	09852-01	1
Lid for TESS box, plastic	15205-00	1
Macro-cuvettes, PS, 4ml, 100 pcs	35663-10	0.04
Slide mount without angle scale	09851-02	2
Polarisation filter, in slide frame, glassless	09851-14	2
Foil filter grey 50% in slide frame glassless	09851-11	5
Grating, 500 lines/mm, in slide frame, glassless	09851-16	1
Diaphragm holder, attachable	11604-09	4
CD-ROM in Slimcase, 10 pcs	09851-24	0.1
Plate, fluorescent, red	09851-19	1
Plate, fluorescent, yellow	09851-20	1
Plate, fluorescent, green	09851-21	1
Plate, fluorescent, blue	09851-22	1
Angular scale, laminated	09851-01	1
Measuring tape, l = 2 m	09936-00	1
Illumination slit, 0.5 mm, hardpaper	09851-12	1
Cuvette, plastic, W x D x H: 99 x 59 x 42 mm	09851-05	1
Ruler, l = 30 cm	09851-40	1

**TESS advanced 13466-88**  
**Optics / Atomphysics OA**  
**necessary accessories for 1**  
**group**

Power supply 0-12 V DC/ 6 V, 12 V AC, 230 V	13505-93	1
DMM with NiCr-Ni thermo couple	07122-00	2
Connecting cord, 32 A, 750 mm, red	07362-01	3
Connecting cord, 32 A, 750 mm, blue	07362-04	2

# 8 Ordering overview

Scope of delivery of all sets

## DEMO advanced 15550-88 Physics Set Optics

Lamp,halogen,mag.held,12V/50W	08270-20	1
Cuvette, magnet held, 230x75 mm	08270-08	1
Opt. block,semicirc.,magnet held	08270-01	1
Opt. block,triangular,magnet held	08270-06	1
Light box, halogen 12V/20 W	09801-00	1
Opt. block,planoconvex, magn.held	08270-02	2
Opt. block,planoconcave,magn.held	08270-03	1
Opt. block,trapeze, magnet held	08270-05	1
Model earth/moon, magnet held	08270-07	1
Light guide model, magnet held	08270-11	1
Plane mirror, magnet held	08270-13	2
Optical disk, magnet held	08270-09	1
Light box accessories for colour mixing	09806-00	1
Concave/convex mirror,magnet held	08270-12	1
Diaphragm w. holder, magnet held	08270-10	2
Magnetic bottom for light box	09804-10	1
Color filter set,add.color mixt.	09807-00	1
Color filter set,subtr.col.mixt.	09808-00	1
Scale for demonstration board	02153-00	1

## DEMO advanced 15550-01 Optics necessary accessories

Power supply, universal	13500-93	1
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## Radioactivity

## TESS advanced 15261-88 Physics set Radioactivity

Geiger-Mueller Counter tube, 45 mm	09007-00	1
Cobra4 Mobile-Link 2	12620-09	1
Cobra4 Sensor-Unit Radioactivity	12665-00	1
Base plate for radioactivity	09200-00	1
Absorption material f.student exp	09014-03	1
Holder for counter tube large	09206-00	1
Plate holder on fixing magnet	09203-00	1
TESS box, plastics, high, 305 x 425 x 150 mm	15200-00	1
Defl.magnets f. plate holder,2pcs	09203-02	1
Columbite, natural mineral	08464-01	1
Screened cable, BNC, l 750 mm	07542-11	1
USB power supply for Cobra4 Mobile-Link 2.0	07932-99	1
Lid for TESS box, plastic	15205-00	1
SD memory card for Cobra4-Mobile-Link, 2 GB, 20MB/sec	12620-01	1
Crystallizing dish,boro3.3, 60ml	46241-00	1
Spoon + spatula, steel, l=120mm	46949-00	1
Bottle,wide neck,plastic,100ml	33913-00	1

## TESS Radioaktivität 13468-88 RE Verbrauchsmaterial für 10 Gruppen

Präparat Ra-226, max. 4,0 kBq	09041-00	1
Kupfer(II)-sulfat-5-Hydrat, 250 g	30126-25	1
Kaliumchlorid, reinst, 250 g	30098-25	1
Calciumchlorid Hexahydrat 250 g	48020-25	1

## DEMO advanced 15590-88 Physics set Radioactivity

Geiger-Mueller counter tube, type B	09005-00	1
Absorption plates f. beta-rays	09024-00	1
Plate holder on fix. magnet	09204-00	1
Absorption material f.student exp	09014-03	1
Clamp on holder	02164-00	1
Plate holder on fixing magnet	09203-00	1
Optical disk, magnet held	08270-09	1
Counter tube holder on fix.magn.	09201-00	1
Support plate on fixing magnet	02155-00	1
Source holder on fixing magnet	09202-00	1
Defl.magnets f. plate holder,2pcs	09203-02	1
Support clamp for small case	02043-10	1
Columbite, natural mineral	08464-01	1
Specimen tube with holder	09203-01	1
Steel pellets, d = 2 mm, 120 g	03990-00	1
Scale for demonstration board	02153-00	1
Support rod,stainl.steel, 100mm	02030-00	1
Petri dish, d 40 mm	64704-00	2

## DEMO advanced 15590-01 Radioactivity necessary accessories

Radioactive sources, set	09047-50	1
Isotope generator Cs-137, 370 kBq	09047-60	1
High voltage supply unit, 0-10 kV, less than 2 mA	13673-93	1
Geiger-Müller-Counter	13606-99	1
High-value resistor, 50 megOhms	07159-00	1
Conductor ball, d 40mm	06237-00	1
Insulating support, l = 235 mm	07924-00	2
Barrel base PHYWE	02006-55	3
Insulating stem	06021-00	1
Danger sign - high-voltage - Vernier calliper stainless steel 0-160 mm, 1/10	03010-00	1
Connecting cord, 30 kV, 1000 mm	07367-00	1
Potassium chloride 250 g	30098-25	1
Copper-II sulphate,cryst. 250 g	30126-25	1
Copper wire, d = 0.5 mm, l = 50 m	06106-03	1
Connecting cord, 32 A, 500 mm, red	07361-01	2
Connecting cord, 32 A, 250 mm, red	07360-01	1
Connecting cord, 32 A, 250 mm, blue	07360-04	1

## Modern Physics

## XRE 4.0 X-ray 09110-88 expert set

XR 4.0 expert unitX-ray unit, 35 kV	09057-99	1
XR 4.0 X-ray plug-in unit W tube	09057-80	1
XR 4.0 Software measure X-ray	14414-61	1
XR 4.0 X-ray fluorescent screen	09057-26	1
XR 4.0 X-ray optical bench	09057-18	1
TESS expert Physik Handbuch		
Experimentemit Röntgenstrahlung (XT)	01200-01	1
TESS expert Physics Handbook X-Ray Experiments	01200-02	1
Slide mount for optical bench, h = 30 mm	08286-01	2
Slide mount f.opt.profile-bench	08286-00	1
Adapter for mains cable	07349-00	1
Table with stems	09824-01	1
Data cable USB, plug type A/B, 1.8 m	14608-00	1

## XRP 4.0 X-ray Solid 09120-88 state physics upgrade set

XR 4.0 X-ray goniometer	09057-10	1
Geiger-Mueller counter tube, type B	09005-00	1
XR 4.0 X-ray LiF crystal, mounted	09056-05	1
XR 4.0 X-ray Absorption set for X-rays	09056-02	1
XR 4.0 potassium bromide (KBr) crystal	09056-01	1
XR 4.0 X-ray Diaphragm tube d = 1 mm	09057-01	1
XR 4.0 X-ray Diaphragm tube d = 2 mm	09057-02	1
XR 4.0 X-ray Diaphragm tube d = 5 mm	09057-03	1

## General Chemistry

## TESS advanced 15300-88 Chemistry set General Chemistry

Support base, variable	02001-00	1
Stop watch 4	03078-00	1
Cubes, set of 8	02214-00	1
TESS box, plastics, high, 305 x 425 x 150 mm	15200-00	2
Bar magnet, l = 72mm	07823-00	1
Ring with boss head, i. d. = 10 cm	37701-01	1
Erlenmeyer flask 100 ml, wide-neck SB 29	36428-00	1
Lid for TESS box, plastic	15205-00	2
Universal clamp	37715-00	1
Boss head	02043-00	1
Mortar w. pestle, 70ml, porcelain	32603-00	1
Indicator paper, pH1-14, roll	47004-02	1
Combustion spoon, l=300 mm	33346-00	1
Lab thermometer,-10..+150C	38058-00	1
Cannula 0.9x70mm, Luer, 20 pcs	02597-04	0.05
Trough, grooved, w/o lid	34568-01	1
Syringe 20ml, Luer, 10 pcs	02591-03	0.1
Circular filter,d 150 mm,100 pcs	32977-06	1
Test tube rack f. 6 tubes, wood	37685-10	1
Support rod, stainless steel, l=370 mm, d=10 mm	02059-00	1
Protecting glasses, clear glass	39316-00	1
Stopcock, 1-way, Luer-Lock	02594-00	1
Porcelain dish, 75ml, d = 80 mm	32516-00	3
Crucible tongs,200mm,stainl.steel	33600-00	1
Pipette with rubber bulb, long	64821-00	2
Pipette, w. rubber bulb, long tip	64838-00	2
Test tube, 18x188 mm, 10 pcs	37658-03	0.5
Rubber gloves, size S (7)	39325-00	1
Dish, plastic, 150x150x65 mm	33928-00	1
Scissors, l = 110 mm, straight, point blunt	64616-00	1
Glass beaker DURAN®, short, 150 ml	36012-00	1
Connecting cord,19A,50cm, red	07314-01	1
Connecting cord,19A,50cm, blue	07314-04	1
Copper electrode, 76 mm x 40 mm	45212-00	2
Polypropylene rod, d. 8mm,l.175mm	13027-07	1
Spatula, powder, steel, l=150mm	47560-00	1
Grad.cylinder,high,PP,50ml	46287-01	1
Labor pencil, waterproof	38711-00	1
Wire gauze with ceramic, 160 x 160 mm	33287-01	2
Graduated cylinder, 25 ml, transparent, PP	36635-00	1
Tweezers, l = 130 mm, straight, blunt	64610-00	1
Triangle w.pipeclay, l 50mm	33277-00	1
Wash bottle, 250 ml, plastic	33930-00	1
Beaker, 100 ml, low form, stackable, plastic	36081-00	4
Rubber stopper 26/32, 2 holes 7 mm	39258-02	1
Flat battery, 4.5 V	07496-01	1
Beaker, 50 ml, low form, stackable, plastic	36080-00	2
Rubber stopper 26/32, without hole	39258-00	1
Test tube brush w. wool tip,d25mm	38762-00	1
Filter funnel, PP, d=60 mm	47318-00	1
Watch glass, dia.60 mm	34570-00	2

Glass rod, boro 3.3, l=200mm, d=5mm	40485-03	2
Test tube holder, up to d 22mm	38823-00	1
Rubber stopper, d=22/17 mm, without hole	39255-00	5

## TESS advanced 13431-88 General Chemistry CH 1, necessary accessories for 1 group

Butane burner f. cartridge 270+470	47536-00	1
Butane cartridge CV 300 Plus, 240 g	47538-01	1

## TESS advanced 13300-10 General Chemistry CH 1, consumables and chemicals for 10 groups

Stand. petrol b.p.65-95 C 1000 ml	31311-70	1
Magnesium, ribbon, roll, 25 g	30132-00	1
Quartz glass wool 10 g	31773-03	1
Calcium, granular 50 g	30049-05	1
Standard sand, coarse 2500 g	31826-79	1
Copper foil, 0.1 mm, 100 g	30117-10	1
Potassium sodium tartrate 250 g	30105-25	1
Glycerol, 250 ml	30084-25	1
Naphthalene white 250 g	48299-25	1
Iron powder, techn. 500 g	30067-50	1
Gelatin powder 250 g	30083-25	1
Sulphur, pieces, 500 g	30277-50	1
Rock salt, granular, 1 kg	31851-70	1
Benzoic acid 100 g	30251-10	1
Boiling beads, 200 g	36937-20	1
Potassium permanganate, chem. pur., 250 g	30108-25	1
Petroleum ether, 100-140 C, 500 ml	30037-50	1
Potassium nitrate 250 g	30106-25	1
Sodium hydroxide, flakes, 500 g	30157-50	1
Zinc, sheet 250x125x0.5 mm, 200 g	30245-20	1
Hydrochloric acid 37 %, 1000 ml	30214-70	1
Copper-II sulphate, cryst. 250 g	30126-25	1
Acetone, gr 1 l	30004-70	1
Ammonium chloride 250 g	30024-25	1
Potassium aluminium sulphate 250g	30018-25	1
Phenolphthalein, 0,5% solution in ethanol, 100 ml	31715-10	1
Denaturated alcohol (spirit for burning), 1000 ml	31150-70	1
Sodium chloride 250 g	30155-25	1
Olive oil, pure 100 ml	30177-10	1
Wood splints, l=35cm, d=3mm, 200pcs	39126-20	1

## Inorganic Chemistry

## TESS advanced 15301-88 Chemistry Set Inorganic Chemistry

Support base, variable	02001-00	1
Dropping funnel with drip nozzle, 50ml	36912-00	1
Rubber bulb, double	39287-00	1
TESS box, plastics, high, 305 x 425 x 150 mm	15200-00	2
Glass tubes, right-angled, 10	36701-57	0.1
Glass tubes, right-angled, 10	36701-59	0.1
Glass tube, right-angled, 10 pcs.	36701-52	0.1

Ring with boss head, i. d. = 10 cm	37701-01	1
Erlenmeyer flask 100 ml, wide-neck SB 29	36428-00	1
Magnesia rods, 25 pcs	38718-04	1
Lid for TESS box, plastic	15205-00	2
Test tube, 180x20 mm, side arm, PN19	36330-00	1
Glass tubes, straight with tip, 10	36701-63	0.1
Universal clamp	37715-00	3
Boss head	02043-00	3
Glass tubes, straight with tip, 10	36701-62	0.1
Combustion tube, l 120mm, DURAN	37029-01	1
Litmus paper, red, 1 box	30678-02	1
Mortar w. pestle, 70ml, porcelain	32603-00	1
Combustion spoon, l=300 mm	33346-00	1
Test tube rack f. 6 tubes, wood	37685-10	1
Support rod, stainless steel, l=370 mm, d=10 mm	02059-00	3
Litmus paper, red, 1 booklet	30207-00	1
Porcelain crucible, dia.34mm, 25 ml	32683-00	1
Circular filter, d 125 mm, 100 pcs	32977-05	1
Glass tubes, straight, 200 mm, 10	36701-66	0.1
Protecting glasses, clear glass	39316-00	1
Test tube, 180x20 mm, DURAN, PN19	36293-00	2
Students thermometer, -10...+110°C, l = 180 mm	38005-02	1
Stopcock, 1-way, Luer-Lock	02594-00	1
Porcelain dish, 75ml, d = 80 mm	32516-00	1
Crucible tongs, 200mm, stain. steel	33600-00	1
Glass beaker DURAN®, tall, 250 ml	36004-00	1
Test tube, 18x188 mm, 10 pcs	37658-03	0.6
Rubber gloves, size S (7)	39325-00	1
Dish, plastic, 150x150x65 mm	33928-00	1
Scissors, l = 110 mm, straight, point blunt	64616-00	1
Glass beaker DURAN®, tall, 50 ml	36001-00	1
Glass beaker DURAN®, short, 250 ml	36013-00	1
Glass tube, straight, l=80 mm, 10/ pkg.	36701-65	0.2
Syringe 50 ml, Luer-lock	02592-00	1
Cannula 0.6x60 mm, Luer, 20 pcs	02599-04	0.05
Funnel, glass, top dia. 80 mm	34459-00	1
Pipette with rubber bulb	64701-00	2
Labor pencil, waterproof	38711-00	1
Grad. cylinder, high, PP, 50ml	46287-01	1
Spatula, powder, steel, l=150mm	47560-00	1
Wire gauze with ceramic, 160 x 160 mm	33287-01	1
Triangle w. pipeclay, l 60mm	33278-00	1
Wash bottle, 250 ml, plastic	33930-00	1
Test tube, 200x30 mm	37660-01	2
Beaker, 250 ml, low form, plastic	36013-01	1
Rubber stopper 26/32, 2 holes 7 mm	39258-02	1
Powder funnel, upper dia. 65mm	34472-00	1
Rubber tubing, i.d. 6 mm	39282-00	1
Test tube brush w. wool tip, d25mm	38762-00	1
Rubber stopper 26/32, without hole	39258-00	2
Knife, stainless	33476-00	1
Watch glass, dia.60 mm	34570-00	3
Glass rod, boro 3.3, l=200mm, d=5mm	40485-03	1
Test tube holder, up to d 22mm	38823-00	1
Rubber stopper, d = 22/17 mm, 1 hole	39255-01	2
Rubber stopper, d=22/17 mm, without hole	39255-00	3

## TESS advanced 13433-88 Inorganic Chemistry CH 2, necessary Accessorie for 1 group

Butane burner f. cartridge 270+470	47536-00	1
Water jet pump, plastic	02728-00	1
Portable Balance, OHAUS YA302	49213-00	1
Rubber tubing, vacuum, i.d.6mm	39286-00	1
Butane cartridge CV 300 Plus, 240 g	47538-01	1

## TESS advanced 13301-10 Inorganic Chemistry, consumables and chemicals for 10 groups

Stand. petrol b.p.65-95 C 1000 ml	31311-70	1
Copper turnings 250 g	30263-25	1
Platinum wire, d 0.3 mm, 100 mm	31739-03	1
Calcium, granular 50 g	30049-05	1
Quartz flour, 0-3 micro-m, 1000 g	31774-70	1
Manganese-IV oxide, powder 500 g	30138-50	1
Standard sand, fine 2500 g	31825-79	1
Standard sand, coarse 2500 g	31826-79	1
Gypsum, crude pieces, 250 g	48273-25	1
Copper foil, 0.1 mm, 100 g	30117-10	1
Glycerol, 250 ml	30084-25	1
Lithium chloride 100 g	31526-10	1
Iron powder, techn. 500 g	30067-50	1
Charcoal powder 250 g	30087-25	1
Hydrogen peroxide, 30%, tech. gr., 1l	31942-70	1
Sodium thiosulphate pentahydrate, 500 g	30169-50	1
Paraffin, 45-50 gr 500 g	30179-50	1
Calcium hydroxide solution 1000ml	31458-70	1
Copper-II oxide, powder 100 g	30125-10	1
Sulphuric acid, 95-98% 500 ml	30219-50	1
Ammonia solution, 25% 1000 ml	30933-70	1
Methylene blue sol., alkal. 250 ml	31568-25	1
Activated carbon, granular 250 g	30011-25	1
Methyl orange soln., 0.1% 250 ml	31573-25	1
Calcium oxide, powder, 500 g	30055-50	1
Iron-II sulphate 500 g	30072-50	1
Soap solu.(Boutron-Boudet) 250 ml	30221-25	1
Boiling beads, 200 g	36937-20	1
Aluminium sheet, 0.2mm 50 g	30017-05	1
Ammonium sulphate 250 g	30027-25	1
Potassium nitrate 250 g	30106-25	1
Zinc, sheet 250x125x0.5 mm, 200 g	30245-20	1
Liquid paraffin 250 ml	30180-25	1
Hydrochloric acid 37 %, 1000 ml	30214-70	1
Copper-II sulphate, cryst. 250 g	30126-25	1
Zinc, powder 100 g	31978-10	1
Potassium aluminium sulphate 250g	30018-25	1
Charcoal, small pieces 300 g	30088-30	1
Marble, pieces 1000 g	30140-70	1
Sodium carbonate, anhyd. 250 g	30154-25	1
Calcium carbonate 500 g	30052-50	1
Iron wool 200 g	31999-20	1
Denaturated alcohol (spirit for burning), 1000 ml	31150-70	1
Sodium chloride 250 g	30155-25	1
Wood splints, l=35cm, d=3mm, 200pcs	39126-20	1
Cotton wool, white 200 g	31944-10	1
Ceramic fibres, 50g	38754-05	1

## Acids, Bases, Salts

## TESS advanced 15302-88 Chemistry Set Acids, Bases, Salts

Support base, variable	02001-00	1
Stop watch 4	03078-00	1
Holder for two electrodes	45284-01	1
Dropping funnel with drip nozzle, 50ml	36912-00	1
TESS box, plastics, high, 305 x 425 x 150 mm	15200-00	2
Lampholder E10, case G1	17049-00	1
U-tube w. 2 lat tubulure PN19	36966-00	1
Erlenmeyer flask, narrow neck, PN 29	36424-00	2
Glass tubes, right-angled, 10	36701-59	0.1
Glass tube, right-angled, 10 pcs.	36701-52	0.2
Ring with boss head, i. d. = 10 cm	37701-01	1
Test tube, 180x18 mm, 100pcs	37658-10	0.12
Graphite electrode, d=7, l=150,6pc	44512-00	0.33



# 8 Ordering overview

Scope of delivery of all sets

Lid for TESS box, plastic	15205-00	2
Test tube rack for 12 tubes, holes d=22 mm, wood	37686-10	1
Test tube,180x20 mm,side arm,PN19	36330-00	1
Glass tubes,straight with tip, 10	36701-63	0.1
Universal clamp	37715-00	3
Boss head	02043-00	4
Glass tubes,straight with tip, 10	36701-62	0.1
Mortar w. pestle, 70ml, porcelain	32603-00	1
Magnifier, 3x and 6x	64601-00	1
Combustion spoon, l=300 mm	33346-00	1
Support rod, stainless steel, l=370 mm, d=10 mm	02059-00	3
Porcelain boats, 10 pcs	32471-03	0.1
Protecting glasses, clear glass	39316-00	1
Test tube,180x20 mm,DURAN, PN19	36293-00	2
Students thermometer,-10...+110°C, l = 180 mm	38005-02	1
Porcelain dish, 75ml, d = 80 mm	32516-00	3
Crucible tongs,200mm,stainl.steel	33600-00	1
Pipette with rubber bulb, long	64821-00	1
Alligator clips, bare, 10 pcs	07274-03	0.2
Circular filter,d 110 mm,100 pcs	32977-04	1
Rubber gloves, size S (7)	39325-00	1
Dish, plastic, 150x150x65 mm	33928-00	1
Scissors, l = 110 mm, straight, point blunt	64616-00	1
Glass beaker DURAN®, tall, 50 ml	36001-00	1
Glass beaker DURAN®, short, 250 ml	36013-00	1
Connecting cord,19A,50cm, red	07314-01	2
Connecting cord,19A,50cm, blue	07314-04	1
Tweezers, straight,blunt, 160 mm	64610-02	1
Pipette with rubber bulb	64701-00	6
Spatula, powder, steel, l=150mm	47560-00	1
Grad.cylinder,high,PP,50ml	46287-01	2
Labor pencil, waterproof	38711-00	1
Wire gauze with ceramic, 160 x 160 mm	33287-01	1
Iron rods, flexible, 5 off	45127-00	0.4
Lamp 4 V/0,04 A/E 10	06154-00	1
Wash bottle, 250 ml, plastic	33930-00	1
Beaker, 100 ml, low form, stackable, plastic	36081-00	2
Rubber stopper 26/32, 2 holes 7 mm	39258-02	1
Petri dish, d 100 mm	64705-00	2
Flat battery, 4.5 V	07496-01	1
Rubber tubing, i.d. 6 mm	39282-00	1
Rubber stopper 26/32, without hole	39258-00	2
Test tube brush w. wool tip,d25mm	38762-00	1
Knife, stainless	33476-00	1
Filter funnel, PP, d=60 mm	47318-00	1
Watch glass, dia.60 mm	34570-00	6
Glass rod,boro 3.3,l=200mm, d=5mm	40485-03	1
Test tube holder, up to d 22mm	38823-00	1
Rubber stopper, d = 22/17 mm, 1 hole	39255-01	2
Rubber stopper, d=22/17 mm, without hole	39255-00	2

## TESS advanced 13435-88 Chemistry Acids, Bases, Salts, necessary Accessories for 1 group

Butane burner f.cartridge 270+470	47536-00	1
Portable Balance, OHAUS CS200E	48910-00	1
Butane cartridge CV 300 Plus, 240 g	47538-01	1

## TESS advanced 13436-88 Chemistry Acids, Bases, Salts, consumables and chemicals for 10 groups

Magnesium, ribbon, roll, 25 g	30132-00	2
Lithium metal, bottle w.can, 25 g	31523-03	1
Copper-II sulphate, anhydr. 250 g	31495-25	1
Sulphurous acid,5-6%,g.r. 1000 ml	31832-70	1
Calcium, granular 50 g	30049-05	1
Liquid Indicator pH1-13 UNISOL113	47014-02	1
Crude oil (petroleum),synthetic, 500 ml	31808-50	1
Manganese-IV oxide,powder 500 g	30138-50	1
Standard sand, fine 2500 g	31825-79	1
Iron-III oxide, red 500 g	48114-50	1
Manganese-II chloride,crys. 250 g	31556-25	1
Polyvinyl chloride,powder 250 g	31745-25	1
Glycerol, 250 ml	30084-25	1
Silver nitrate solution 5% 100 ml	30223-10	1
Hydrogen peroxide,30%,tech.gr.1l	31942-70	1
Sulphur, pieces, 500 g	30277-50	1
Calcium hydroxide solution 1000ml	31458-70	1
Iodine resublimed 25 g	30093-04	1
Copper-II oxide,powder 100 g	30125-10	1
Sodium hydrogen sulphate 250 g	30265-25	1
Sulphuric acid, 95-98% 500 ml	30219-50	1
Ammonia solution, 25% 1000 ml	30933-70	1
Magnesium, powder 100 g	30133-10	1
Methyl orange soln., 0.1% 250 ml	31573-25	1
Acetone, chem.pure 250 ml	30004-25	1
Iron powder xtra pure 500 g	30068-25	1
Iron-II sulphate 500 g	30072-50	1
Copper-II chloride 100 g	30121-10	1
Sodium hydrogen carbonate 500 g	30151-50	1
Sodium sulphate 500 g	30166-50	1
Iron-III chloride, 250 g	30069-25	1
Barium hydroxide 250 g	30034-25	1
Magnesium oxide 100 g	31546-10	1
Potassium permanganate, chem. pur., 250 g	30108-25	1
Aluminium chloride 250 g	31017-25	1
Aluminium sheet, 0.2mm 50 g	30017-05	2
Citric acid 250 g	30063-25	1
Potassium chloride 250 g	30098-25	1
Potassium hydroxide pellets,500 g	30103-50	1
Potassium nitrate 250 g	30106-25	1
Sodium hydroxide, flakes, 500 g	30157-50	1
Zinc, sheet 250x125x0.5 mm, 200 g	30245-20	1
Acetic acid 99...100%, 500 ml	31301-50	1
Litmus solution 100 ml	30127-10	1
Barium chloride 250 g	30033-25	1
Ortho-phosphoric acid 85% 250 ml	30190-25	1
Hydrochloric acid 37 %, 1000 ml	30214-70	1
Copper-II sulphate,cryst. 250 g	30126-25	1
Zinc, powder 100 g	31978-10	1
Ammonium chloride 250 g	30024-25	1
L /+ tartaric acid 100 g	30240-10	1
Water, distilled 5 l	31246-81	2
Sodium silicate solution 500 ml	31653-50	1
Potassium carbonate,98-100% 250 g	30096-25	1
Litmus paper, blue, 1 box	30678-01	4
Litmus paper, red, 1 box	30678-02	4
Magnesium chloride 500 g	31540-50	1
Indicator paper, pH1-14, roll	47004-02	4
Marble, pieces 1000 g	30140-70	1
D (+)-Sucrose 100 g	30210-10	1
Oxalic acid cryst. 100 g	30268-10	1
Sodium acetate trihydrate, 250 g	30149-25	1
Potass.iodide/starch paper,1 book	30202-00	4
Phenolphthalein, 0,5% solution in ethanol, 100 ml	31715-10	1
Denaturated alcohol (spirit for burning), 1000 ml	31150-70	1
Bromothymol blue, 0.1% sol. 5 g	48004-05	1
Sodium chloride 250 g	30155-25	1
Wood splints,l=35cm,d=3mm,200pcs	39126-20	1
Cotton wool, white 200 g	31944-10	1

## Titration

### Demo advanced 12627-88 Basic Set pH Titration Cobra4

Software Cobra4 - multi-user licence	14550-61	1
Cobra4 Wireless-Link	12601-00	2
Cobra4 Sensor-Unit Chemistry	12630-00	1
Cobra4 Sensor-Unit Drop Counter	12636-00	1
pH-electrode, glass, refill., BNC	46268-10	1
Cobra4 Wireless Manager	12600-00	1
Immersion probe NiCr-Ni, teflon, 300 °C	13615-05	1
Holder for Cobra4 with support rod	12680-00	2
Storage flask for pH electrodes, filled with 250 ml 3.0 M KCl solution	18481-20	1

### Standard Labware 12627-01 for Set pH-Titration Cobra4

Precision Balance, Sartorius		
QUINTIX513-1S, 510 g / 0,001 g	49282-99	1
Magnetic stirrer MR Hei-Standard	35750-93	1
Burette, lateral stopcock, Schellbach, 50 ml, graduations 0, 1 ml	36513-01	2
Retort stand, 210mm x 130mm, 500mm	37692-00	1
Retort stand, h = 750 mm	37694-00	1
Burette, lateral stopcock, Schellbach, 25 ml	36506-01	1
Burette clamp, roller mount., 2 pl.	37720-00	1
Volumetric flask 1000ml, IGJ24/29	36552-00	4
Pipette dish	36589-00	1
Volumetric flask 500 ml, IGJ19/26	36551-00	1
Electrode holder, slewable	18461-88	1
Pipettor	36592-00	1
Universal clamp	37715-00	1
Lab protecting glasses with UV filter	39315-00	1
Volumetric flask 250 ml, IGJ14/23	36550-00	7
Pasteur pipettes, 250 pcs	36590-00	1
Volumetric flask 100 ml, IGJ12/21	36548-00	1
Right angle clamp	37697-00	3
Volumetric pipette, 50 ml	36581-00	1
Volumetric pipette, 25 ml	36580-00	1
Glass beaker DURAN®, tall, 150 ml	36003-00	16
Rubber caps, 10 pcs	39275-03	1
Glass beaker DURAN®, short, 150 ml	36012-00	3
Glass beaker DURAN®, tall, 100 ml	36002-00	1
Glass beaker DURAN®, tall, 50 ml	36001-00	1
Glass beaker DURAN®, short, 250 ml	36013-00	1
Funnel, glass, top dia. 80 mm	34459-00	1
Volumetric pipette, 10 ml	36578-00	1
Spoon, special steel	33398-00	1
Funnel, glass, top dia. 55 mm	34457-00	1
Volumetric pipette, 2 ml	36576-00	1
Magnetic stirring bar 30 mm, cylindrical	46299-02	1
Volumetric pipette, 1 ml	36575-00	1
Wash bottle, plastic, 500 ml	33931-00	1
Magn.stirring bar 15mm, cyl.	46299-01	1
Graduated pipette 10 ml	36600-00	1
Graduated pipette, 1 ml	36595-00	1
Funnel, d.40 mm, f.burettes	36888-00	1

### Chemical set for 12627-10 Basic Set pH Titration Cobra4

Buffer solution, pH 4.62 1000 ml	30280-70	1
Buffer solution, pH 9 1000 ml	30289-70	1
Sodium acetate, anhydr. 250 g	31612-25	1
Caustic soda sol.,0.1M 1000 ml	48328-70	1
Hydrochloric acid, 1.0 mol/l, 1000 ml	48454-70	1
Acetic acid, 0.1 M sol., 1000 ml	48126-70	1
Buffer solution, pH 7.01, 1000 ml	46271-12	1
Hydrochloric acid,0.1M 1000 ml	48452-70	1

Acetic acid, 1 M sol., 1000 ml	48127-70	1
Caustic soda solution, 1.0 M, 1000 ml	48329-70	1
Ammonia solution, 25% 1000 ml	30933-70	1
Glycocol /glycine/ 100 g	31341-10	1
Ortho-phosphoric acid 85% 250 ml	30190-25	1
Water, distilled 5 l	31246-81	1
Weighing dishes, square shape, 84 x 84 x 24 mm, 25 pcs.	45019-25	1
Gloves, Neoprene, medium	46347-00	1

## Environment and Outdoors

### TESS Applied 12626-88 Sciences Cobra4 environment and outdoors, for 4 work groups inclusive aluminum case

Cobra4 Mobile-Link 2	12620-09	4
Cobra4 Sensor-Unit Weather	12670-00	1
Cobra4 Sensor-Unit Conductivity, with stainless steel electrodes	12633-00	1
Cobra4 Sensor-Unit pH, BNC connector	12631-00	1
Cobra4 Sensor-Unit Temperature	12640-00	1
pH-electrode, plastic body, gel, BNC	46265-15	1
TESS advanced Applied Sciences Handbuch Cobra4 Umwelt und Freiland	12622-01	1
TESS advanced Applied Sciences manual Cobra4 environment and outdoors	12622-02	1
Foam insert for Cobra4 Environmental Experimentation case	12622-25	1
Buffer solution tablets pH4, 100	30281-10	1
Buffer solution tablets pH10, 100	30283-10	1
Protection sleeve for electrode with a diameter of 12 mm	37651-15	1
Stand.solu.1413±5/cm(25°C), 460ml	47070-02	1
USB power supply for Cobra4 Mobile-Link 2.0	07932-99	4
SD memory card for Cobra4-Mobile-Link, 2 GB, 20MB/sec	12620-01	4
Labels for microscopic slides, 120/pkg	64703-00	1
Wash bottle, plastic, 500 ml	33931-00	1
Beaker, 250 ml, low form, plastic	36013-01	2
Bottle,square,HDPE,100ml	47417-00	4
DVD measure current version, incl. measure Dynamics	14501-00	1

### TESS Environment 13445-88 and Outdoors optional accessories for 10 groups

Urease, lyophilized 5 g	31923-02	1
Telescopic rod for sample nets	64581-00	1
Portable Balance, OHAUS CS200E	48910-00	1
Stop watch, interruption type	03076-01	1
Beaker, plastic, for water sample	64581-12	1
Stand for Cobra4	12681-00	1
Copper-II sulphate,cryst. 250 g	30126-25	1
Urea, 250 g	30086-25	1
Graduated cylinder 100 ml	36629-00	1
Graduated cylinder 10 ml	36625-00	1
Grad.cylinder,high,boro3.3,25ml	47328-00	1
Glass beaker DURAN®, tall, 50 ml	36001-00	1
Glass beaker DURAN®, tall, 100 ml	36002-00	1
Glass beaker DURAN®, short, 250 ml	36013-00	1
Magnetic stirring bar 8mm, cylindrical	46299-00	1
Graduated pipette, 1 ml	36595-00	1
Petri dish, d 100 mm	64705-00	4
Glass rod,boro 3.3,l=200mm,d=5mm	40485-03	2

## Organic Chemistry

### TESS advanced 15304-88 Chemistry Set Organic Chemistry

Support base, variable	02001-00	1
Stop watch 4	03078-00	1
Dropping funnel with drip nozzle, 50ml	36912-00	1
Rubber bulb, double	39287-00	1
TESS box, plastics, high, 305 x 425 x 150 mm	15200-00	2
Reaction flask, 100ml, PN19	34885-00	1
Glass tube,right-angled w.tip,10	36701-53	0.1
Glass tubes,right-angled, 10	36701-59	0.2
Erlenmeyer flask 100 ml, narrow neck, PN 19	36418-00	2
Glass tube,right-angled, 10 pcs.	36701-52	0.1
Ring with boss head, i. d. = 10 cm	37701-01	1
Test tube, 180x18 mm,100pcs	37658-10	0.08
Lid for TESS box, plastic	15205-00	2
Test tube,180x20 mm,side arm,PN19	36330-00	2
Test tube rack for 12 tubes, holes d=22 mm, wood	37686-10	1
Glass tubes,straight with tip, 10	36701-63	0.1
Universal clamp	37715-00	3
Boss head	02043-00	3
Combustion spoon, l=300 mm	33346-00	1
Safety tube,-fermentation tube-Lab thermometer,-10..+150C	36935-00	2
Support rod, stainless steel, l=370 mm, d=10 mm	02059-00	3
Protecting glasses, clear glass	39316-00	1
Test tube,180x20 mm,DURAN, PN19	36293-00	1
Porcelain dish, 75ml, d = 80 mm	32516-00	4
Crucible tongs,200mm,stainl.steel	33600-00	1
Rubber gloves, size S (7)	39325-00	1
Dish, plastic, 150x150x65 mm	33928-00	1
Scissors, l = 110 mm, straight, point blunt	64616-00	1
Glass beaker DURAN®, short, 150 ml	36012-00	2
Glass beaker DURAN®, short, 250 ml	36013-00	1
Pipette with rubber bulb	64701-00	4
Graduated cylinder, 50 ml, plastic	36628-01	1
Grad.cylinder,high,PP,50ml	46287-01	1
Labor pencil, waterproof	38711-00	1
Wire gauze with ceramic, 160 x 160 mm	33287-01	2
Spoon, special steel	33398-00	1
Tweezers, l = 130 mm, straight, blunt	64610-00	1
Pipette bottle 10 ml, clear, screw	64785-00	1
Glass tube,straight,400 mm,8 mm	64132-00	1
Wash bottle, 250 ml, plastic	33930-00	1
Test tube,200x30 mm	37660-01	1
Glass tube 200 mm ext. d=8 mm	64807-00	1
Rubber tubing, i.d. 6 mm	39282-00	1
Test tube brush w. wool tip,d25mm	38762-00	1
Watch glass, dia.60 mm	34570-00	2
Funnel, plastic, dia.50mm	36890-00	1
Glass rod, boro 3.3, l=200mm, d=6mm	40485-04	1
Test tube holder, up to d 22mm	38823-00	1
Rubber stopper, d = 22/17 mm, 1 hole	39255-01	3
Rubber stopper, d=22/17 mm, without hole	39255-00	6

### TESS advanced 13437-88 Organic Chemistry, necessary Accessories for 1 group

Butane burner f.cartridge 270+470	47536-00	1
Portable Balance, OHAUS CS200E	48910-00	1
Butane catridge CV 300 Plus, 240 g	47538-01	1

### TESS advanced 13438-88 Organic Chemistry, consumables and chemicals for 10 groups

Ethanol extra pure ab.95% 1000 ml	30008-70	1
Aluminium carbide 25 g	31016-04	1
Silver foil, 150 x150 x 0.1 mm, 25 g	31839-04	1
Stand.petrol b.p.65-95 C 1000 ml	31311-70	1
Magnesium, ribbon, roll, 25 g	30132-00	1
Aluminium sulphate 500 g	31022-50	1
Bromine 100 ml	30046-10	1
Copper-II sulphate, anhydr. 250 g	31495-25	1
N-amyil alcohol 500 ml	31051-50	1
Crude oil (petroleum),synthetic, 500 ml	31808-50	1
Aluminium oxide 250 g	30020-25	1
Soda lime, gran. a.r. 250 g	30170-25	1
Polyvinyl chloride,powder 250 g	31745-25	1
Copper foil, 0.1 mm, 100 g	30117-10	1
Glycerol, 250 ml	30084-25	1
Casein, alkali-soluble 100 g	31188-10	1
n-hexane 250 ml	31369-25	1
Silver nitrate solution 5% 100 ml	30223-10	1
Naphthalene white 250 g	48299-25	1
Sodium tetraborate,tech.gr.,250 g	31615-25	1
Acetaldehyde, 98-100% 250 ml	30001-25	1
Schiff's reagent 250 ml	31827-25	1
N-butyric acid 100 ml	30047-10	1
Isopropyl alcohol, 1000 ml	30092-70	1
Charcoal powder 250 g	30087-25	1
Calcium hydroxide solution 1000ml	31458-70	1
Paraffin, 45-50 gr 500 g	30179-50	1
Propionic acid, 500 ml	31753-50	1
Sulphur, pieces, 500 g	30277-50	1
Sodium hydroxide, flakes, 1000 g	30157-70	1
Methanol 500 ml	30142-50	1
Stearic acid 250 g	30228-25	1
Copper-II oxide,powder 100 g	30125-10	1
Starch,soluble 100 g	30227-10	1
Sulphuric acid, 95-98% 500 ml	30219-50	1
Nitric acid 1,40 g/ml, 65%, 500 ml	30213-50	1
Activated carbon, granular 250 g	30011-25	1
N-butanol 250 ml	31142-25	1
Sudan-III solution,alcohol 250 ml	31861-25	1
Isobutyl alcohol 250 ml	31393-25	1
Soap solu.(Boutron-Boudet) 250 ml	30221-25	1
Fehling's solution II 250 ml	30080-25	1
Iron-III chloride, 250 g	30069-25	1
Formic acid 98-100% 250 ml	30021-25	1
D(+)-glucose 1-hydr. 250 g	30237-25	1
Potassium permanganate, chem. pur., 250 g	30108-25	1
Ethyl acetate 250 ml	30075-25	1
Citric acid 250 g	30063-25	1
Acetic acid 99...100%, 500 ml	31301-50	1
Liquid paraffin 250 ml	30180-25	1
Litmus solution 100 ml	30127-10	1
Hydrochloric acid 37 %, 1000 ml	30214-70	1
Copper-II sulphate,cryst. 250 g	30126-25	1
Calcium acetate 100 g	30050-10	1
Acetone, gr 1 l	30004-70	1
Ethylene glycol 250 ml	30085-25	1
Water, distilled 5 l	31246-81	2
Propyl alcohol,normal 250 ml	31754-25	1
Urea, 250 g	30086-25	1
Potassium carbonate,98-100% 250 g	30096-25	1
Magnesium chloride 500 g	31540-50	1
Fehling's solution I 250 ml	30079-25	1
Sodium carbonate, anhydr. 250 g	30154-25	1
Indicator paper, pH1-11, book	47006-01	1
Calcium carbide,granul. 250 g	48018-25	1
Iron wool 200 g	31999-20	1
Iodine potassium iodide solution	30094-10	1
Phenolphthalein, 0,5% soution in ethanol, 100 ml	31715-10	1
Denaturated alcohol (spirit for burning), 1000 ml	31150-70	1
Sodium chloride 250 g	30155-25	1
Litmus paper, red, 1 booklet	30207-00	1
Olive oil,pure 100 ml	30177-10	1
Wood splints,l=35cm,d=3mm,200pcs	39126-20	1
Cotton wool, white 200 g	31944-10	1

# 8 Ordering overview

Scope of delivery of all sets

Ceramic fibres, 50g 38754-05 1

## Food Chemistry

### TESS advanced 15306-88 Chemistry Set Food Chemistry

Support base, variable	02001-00	1
TESS box, plastics, high, 305 x 425 x 150 mm	15200-00	2
Ring with boss head, i. d. = 10 cm	37701-01	1
Test tube, 180x18 mm, 100pcs	37658-10	0.1
Lid for TESS box, plastic	15205-00	2
Test tube rack for 12 tubes, holes d=22 mm, wood	37686-10	1
Universal clamp	37715-00	1
Boss head	02043-00	1
Mortar w. pestle, 70ml, porcelain	32603-00	1
Magnifier, 3x and 6x	64601-00	1
Support rod, stainless steel, l=370 mm, d=10 mm	02059-00	1
Protecting glasses, clear glass	39316-00	1
Test tube, 180x20 mm, DURAN, PN19	36293-00	1
Students thermometer, -10...+110°C, l = 180 mm	38005-02	1
Porcelain dish, 75ml, d = 80 mm	32516-00	1
Crucible tongs, 200mm, stainl. steel	33600-00	1
Glass beaker DURAN®, short, 400 ml	36014-00	1
Erlenmeyer flask, narrow n., 100 ml	36118-00	1
Rubber gloves, size S (7)	39325-00	1
Dish, plastic, 150x150x65 mm	33928-00	1
Glass beaker DURAN®, short, 250 ml	36013-00	1
Graduated cylinder 100 ml, PP transparent	36629-01	1
Pipette with rubber bulb	64701-00	10
Labor pencil, waterproof	38711-00	1
Wire gauze with ceramic, 160 x 160 mm	33287-01	1
Spoon, special steel	33398-00	1
Tweezers, l = 130 mm, straight, blunt	64610-00	1
Wash bottle, 250 ml, plastic	33930-00	1
Beaker, 100 ml, low form, stackable, plastic	36081-00	3
Watch glass, dia. 100 mm	34574-00	3
Beaker, 100 ml, low form, stackable, plastic	36082-00	1
Test tube brush w. wool tip, d25mm	38762-00	1
Knife, stainless	33476-00	1
Filter funnel, d = 75 mm, PP	46895-00	2
Glass rod, boro 3.3, l=200mm, d=6mm	40485-04	3
Test tube holder, up to d 22mm	38823-00	1
Rubber stopper, d=22/17 mm, without hole	39255-00	3

### TESS advanced 13484-88 Food Chemistry, necessary Accessories for 1 group

Compact Balance, OHAUS TA 302, 300 g / 0.01 g	49241-93	1
Butane burner f. cartridge 270+470	47536-00	1
Butane cartridge CV 300 Plus, 240 g	47538-01	1

### TESS advanced 13485-88 Food Chemistry, consumables and chemicals for 10 groups

Ethanol extra pure ab.95% 1000 ml	30008-70	1
2,6-Dichlorophenol indophenol, 5 g	31277-02	1

Pepsin powder, soluble 100 g	30181-10	1
Indicator paper f. water roll 5m	47015-00	5
Petroleum ether, 40-60 gr 1000 ml	30184-70	1
D(+)-glucose 1000 g	30237-70	1
Nitrate, nitrite, tester, 100pcs	30346-07	1
Ninhydrin 10 g	31666-03	1
Liquid Indicator pH1-13 UNISOL113	47014-02	1
Ammonium molybdate 50 g	30025-05	1
Activated carbon, granular 500 g	30011-50	1
Potass. hydrogen sulphate 250 g	31439-25	1
Starch, soluble 250 g	30227-25	1
Nessler's reagent 100 ml	30171-10	1
Silver nitrate solution 5% 100 ml	30223-10	1
Resorcin, recryst. 50 g	30209-05	1
Gelatin powder 250 g	30083-25	1
Schiff's reagent 250 ml	31827-25	1
folded filter, qual., 150 mm, 100pcs	47580-04	2
Fehling's solution II 500 ml	30080-50	1
Caustic soda sol. 32% 1000 ml	30266-70	1
Calcium hydroxide solution 1000ml	31458-70	1
Sodium hydroxide, flakes, 1000 g	30157-70	1
Methanol 500 ml	30142-50	1
Stearic acid 250 g	30228-25	1
Fehling's solution I 1000 ml	30079-70	1
Ammonia solution, 25% 1000 ml	30933-70	1
Nitric acid 1,40 g/ml, 65%, 500 ml	30213-50	1
Sulphuric acid, 95-98% 500 ml	30219-50	1
Methylene blue sol., alkal. 250 ml	31568-25	1
Iron-III chloride 6-hydr. 500 g	30069-50	1
Sudan-III solution, alcohol 250 ml	31861-25	1
Boiling beads, 200 g	36937-20	2
Acetic acid 99...100%, pure 1 l	31301-70	1
Trisodium phosphate 12-hydr. 250 g	30164-25	1
Magnesium oxide 100 g	31546-10	2
Potassium permanganate, chem. pur., 250 g	30108-25	1
Hydrogen peroxide, 30%, 250 ml	31710-25	1
Citric acid 250 g	30063-25	1
Methyl red solution (alc.) 50 ml	30145-05	1
Ortho-phosphoric acid 85% 250 ml	30190-25	1
Hydrochloric acid 25% 1000 ml	31822-70	1
Acetone, gr 1 l	30004-70	1
Ammonium chloride 250 g	30024-25	1
Iodine potass. iodide sol., 250 ml	30094-25	1
D (+)-Sucrose 250 g	30210-25	1
Water, distilled 5 l	31246-81	2
Indicator paper, pH1-14, roll	47004-02	5
Marble, pieces 1000 g	30140-70	1
D-fructose -laevulose- 25 g	30128-04	1
L(+) ascorbic acid, cryst. 100 g	31067-10	1
Oxalic acid cryst. 100 g	30268-10	1
Sodium chloride, 500 g	30155-50	1
Denaturated alcohol (spirit for burning), 1000 ml	31150-70	1
Circular filter, d 125 mm, 100 pcs	32977-05	1

## Polymer Chemistry

### TESS advanced 15305-88 Chemistry Set Chemistry of Polymers

Support base, variable	02001-00	1
Mold, spherical, diameter 40mm	35033-00	1
TESS box, plastics, high, 305 x 425 x 150 mm	15200-00	2
Erlenmeyer flask 100 ml, narrow neck, PN 19	36418-00	1
Glass tube, right-angled, 10 pcs.	36701-52	0.1
Ring with boss head, i. d. = 10 cm	37701-01	1
Test tube, 180x18 mm, 100pcs	37658-10	0.12
Lid for TESS box, plastic	15205-00	2
Test tube, 180x20 mm, side arm, PN19	36330-00	1
Test tube rack for 12 tubes, holes d=22 mm, wood	37686-10	1
Universal clamp	37715-00	1
Boss head	02043-00	1
Lab thermometer, -10...+250C	38065-00	1
Pipettor, bulb, 3 valves, 10ml max.	47127-01	1

Support rod, stainless steel, l=370 mm, d=10 mm	02059-00	1
Protecting glasses, clear glass	39316-00	1
Test tube, 180x20 mm, DURAN, PN19	36293-00	3
Students thermometer, -10...+110°C, l = 180 mm	38005-02	1
Porcelain dish, 75ml, d = 80 mm	32516-00	1
Crucible tongs, 200mm, stainl. steel	33600-00	2
Iron basin, d 100 mm	33201-00	1
Glass beaker DURAN®, short, 400 ml	36014-00	1
Rubber gloves, size S (7)	39325-00	1
Dish, plastic, 150x150x65 mm	33928-00	1
Scissors, l = 110 mm, straight, point blunt	64616-00	1
Glass beaker DURAN®, short, 150 ml	36012-00	1
Pipette with rubber bulb	64701-00	2
Grad. cylinder, high, PP, 50ml	46287-01	1
Wire gauze with ceramic, 160 x 160 mm	33287-01	1
Spoon, special steel	33398-00	1
Tweezers, l = 130 mm, straight, blunt	64610-00	1
Sieve, fine mesh, d=60 mm	40968-00	1
Graduated pipette, 5 ml	36598-00	1
Triangle w. pipeclay, l 50mm	33277-00	1
Wash bottle, 250 ml, plastic	33930-00	1
Graduated pipette, 1 ml	36595-00	1
Beaker, 100 ml, low form, stackable, plastic	36081-00	1
Petri dish, d 40 mm	64704-00	2
Beaker, 100 ml, low form, stackable, plastic	36082-00	2
Glass tube, right-angled	36701-07	3
Test tube brush w. wool tip, d25mm	38762-00	1
Knife, stainless	33476-00	1
Glass rod, boro 3.3, l=200mm, d=6mm	40485-04	2
Test tube holder, up to d 22mm	38823-00	1
Rubber stopper, d = 22/17 mm, 1 hole	39255-01	3
Rubber stopper, d=22/17 mm, without hole	39255-00	2

### TESS advanced 13482-88 Chemistry of polymers, necessary Accessories for 1 group

Butane burner f. cartridge 270+470	47536-00	1
Portable Balance, OHAUS CS200E	48910-00	1
Protective desk plate 40 x 40 cm	39180-10	1
Butane cartridge CV 300 Plus, 240 g	47538-01	1

### TESS advanced 13483-88 Chemistry of polymers, consumables and chemicals for 10 groups

Sample set for study of plastics, 60 pcs. of each species	31730-00	2
Dyestuffs, set of 9	31329-00	1
Acrifix 190, 1000 g	31003-70	1
Sebacoyl dichloride f. synth. 25 ml	31833-04	1
Bromine 100 ml	30046-10	1
Moltoprene A+B, 500 ml each	48294-70	2
Copper-II sulphate, anhydr. 250 g	31495-25	1
Silicone oil 500 ml	31849-50	1
Standard sand, fine 2500 g	31825-79	1
Copper foil, 0.1 mm, 100 g	30117-10	1
Polyvinyl chloride, powder 250 g	31745-25	1
Glycerol, 250 ml	30084-25	1
Casein, alkali-soluble 100 g	31188-10	1
Catalyst 20, 80 g	31471-06	2
Resorcin, recryst. 50 g	30209-05	1

Acetaldehyde, 98-100% 250 ml	30001-25	1
Phenol, liquefied 250 ml	31713-25	1
Calcium hydroxide solution 1000ml	31458-70	1
Copper-II oxide, powder 100 g	30125-10	1
Styropor P, 250 g	48492-25	2
Sulphuric acid, 95-98% 500 ml	30219-50	1
Starch, soluble 100 g	30227-10	1
Styrene 250 ml	31858-25	1
Test tube, 180x18 mm, 100pcs	37658-10	2
Benzoyl peroxide/25% H2O 25 g (restricted export!)	30977-04	1
Hexamethylene diamine 25 g	31367-04	1
Boiling beads, 200 g	36937-20	1
Fehling's solution II 250 ml	30080-25	1
Benzine, tech.gr., 100-140C, 1000ml	30037-70	1
Potassium permanganate, chem. pur., 250 g	30108-25	1
D(+)-glucose 1-hydr. 250 g	30237-25	1
Sodium hydroxide, flakes, 500 g	30157-50	1
Zinc, sheet 250x125x0.5 mm, 200 g	30245-20	10
Acetic acid 99...100%, 500 ml	31301-50	1
Hydrochloric acid 37 %, 1000 ml	30214-70	1
Formaldehyde sol. ca.35% 500 ml	48146-50	1
AH-salt 100 g	30910-10	1
PVC-plates, pack.5 pcs.	31751-02	2
Water, distilled 5 l	31246-81	2
Urea, 250 g	30086-25	1
Indicator paper, pH1-14, roll	47004-02	5
Fehling's solution I 250 ml	30079-25	1
Sodium carbonate, anhyd. 250 g	30154-25	1
Oxalic acid cryst. 100 g	30268-10	1
Sodium chloride, 500 g	30155-50	1
Iodine potassium iodide solution	30094-10	1
Phenolphthalein, 0,5% solution in ethanol, 100 ml	31715-10	1
Denaturated alcohol (spirit for burning), 1000 ml	31150-70	1
PVC tubing, i.d.19mm	39293-00	2
Cardboard beakers, 580 ml, 5 pcs	32991-00	8

## Electrochemistry

### TESS 30505-88 Electrochemical measurement set

Motor, 2 V DC	11031-00	1
Digital-Multimeter compact, NiCr-Ni, Autorange Cat 3	07126-01	1
Storage tray for electro-chemist.	11935-00	1
Electrode platinum, short	45207-00	1
Coverage f. cell-meas. bloc, 8 piec.	37683-00	1
Block with 8 holes, d = 40 mm	37682-00	1
Alligator clip, insulated, 2 mm socket, 2 pcs.	07275-00	3
Scissors, l = 110 mm, straight, point blunt	64616-00	1
Glass beaker DURAN®, tall, 50 ml	36001-00	6
Connecting cord, 2 mm-plug, 5A, 500 mm, red	07356-01	1
Connecting cord, 2 mm-plug, 5A, 500 mm, blue	07356-04	1
Connecting cord, 2 mm-plug, 5A, 250 mm, red	07355-01	1
Connecting cord, 2 mm-plug, 5A, 250 mm, blue	07355-04	1
Reducing plug 4mm/2mm socket, 2	11620-27	2
Pipette with rubber bulb	64701-00	1
Bottle, wide neck, plastic, 50ml	33912-00	1
Dropping bottle, plastic, 50ml	33920-00	1

### TESS advanced 13422-88 Chemistry Electrochemical measurement set EC necessary accessories for 1 group

Power supply 0-12 V DC/ 6 V, 12 V AC, 230 V	13505-93	1
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### TESS advanced 30505-10 Electrochemical measurement set EC, consumable and chemicals for 10 groups

Silver nitrate, cryst. 25 g	30222-04	1
Silver foil, 150 x150 x 0.1 mm, 25 g	31839-04	1
Copper foil, 0.1 mm, 100 g	30117-10	1
Hydrochloric acid, 1.0 mol/l, 1000 ml	48454-70	1
Sulphuric acid, 0.5M 1000 ml	48462-70	1
Hydrochloric acid, 0.1M 1000 ml	48452-70	1
Sodium thiosulphate pentahydrate, 500 g	30169-50	1
Zinc chloride, dry, 250 g	31983-25	1
Potassium iodide 50 g	30104-05	1
Ammonia solution, 25% 1000 ml	30933-70	1
Nitric acid 1,40 g/ml, 65%, 500 ml	30213-50	1
Potassium thiocyanate 100 g	30110-10	1
Iron-II sulphate 500 g	30072-50	1
Sodium sulphate 500 g	30166-50	1
Iron-III chloride, 250 g	30069-25	1
Zinc oxide 250 g	30248-25	1
Potassium nitrate 250 g	30106-25	1
Potassium chloride 250 g	30098-25	1
Zinc sulphate 7-hydr. 250 g	30249-25	1
Sodium hydroxide, flakes, 500 g	30157-50	1
Zinc, sheet 250x125x0.5 mm, 200 g	30245-20	1
Graphite electrode, d=5, l=150, 6pc	44510-00	2
Sheet metal strips, 20 pcs	06532-00	1
Aluminium, sheet, 1x20x200mm, 5 pcs	31074-00	1
Copper-II sulphate, cryst. 250 g	30126-25	1
Potassium bromide 100 g	30258-10	1
Water, distilled 5 l	31246-81	1
Emery cloth, 158x224mm, 2 pieces	01606-00	5
Filter paper, 580x580 mm, 10 sheets	32976-03	1

## Microscopy

### TESS advanced 15290-88 Biology set Microscopy

TESS box, plastics, high, 305 x 425 x 150 mm	15200-00	1
Microscopic slides, in box	13290-11	1
Lid for TESS box, plastic	15205-00	1
Blood lancets, sterile, 200/pkg	64217-00	1
Dropping pipette with bulb, 10pcs	47131-01	1
Pipettor, bulb, 3 valves, 10ml max.	47127-01	1
Scissors, straight, pointed, l 110mm	64623-00	1
Scalpel holder	64615-00	1
Scalpel blades, rounded tip, 10 off	64615-02	1
Graduated cylinder 100 ml, PP transparent	36629-01	1
Petri dishes, plast., d94mm, 20 off	64709-04	1
Magnifier, plastic, 5x, d=30mm	88002-01	1
Tweezers, straight, pointed, 120mm	64607-00	1
Beaker, high, PP, 1000ml	46275-01	1
Spatula, powder, steel, l=150mm	47560-00	1
Labels for microscopic slides, 120/pkg	64703-00	1
Microscopic slides, 50 pcs	64691-00	1
Dissecting needle, lancet-shaped	64621-00	1

Graduated pipette 10 ml	36600-00	1
Beaker, 100 ml, low form, stackable, plastic	36081-00	3
Cover glasses 18x18 mm, 50 pcs.	64685-00	2
Beaded rim glass, 30 x 50 mm	33624-01	12
Dissecting needle, pointed	64620-00	1
Beaker, 100 ml, low form, stackable, plastic	36082-00	3
Reagent bottle, scr. cap, cl., 50ml	46191-00	10
Glass rod, boro 3.3, l=200mm, d=5mm	40485-03	2
Funnel, plastic, dia.50mm	36890-00	1
Test tube holder, up to d 22mm	38823-00	1

### TESS advanced 13443-88 Microscopy MIC necessary accessories for 1 group

SWIFT micro/macro microscope M3-M, monocular	63001-99	1
Portable Balance, OHAUS JE120	48895-00	1
Knife, stainless	33476-00	1

### TESS advanced 13444-88 Microscopy MIC consumables for 10 groups

Chemicals set for TESS Microscopy (for up to 10 workgroups)	13290-10	1
Weighing dishes, square shape, 84 x 84 x 24 mm, 500 pcs.	45019-50	1
Entellan, quick-embedding, 100 ml	31294-10	1
Elder pith, 10 sticks	31372-00	1
Chromatographic paper 100 stripes	32972-00	1

### Set of TESS 15290-33 Microscopy MIC, with CD-ROM and Microscope SWIFTM3-M

SWIFT micro/macro microscope M3-M, monocular	63001-99	1
TESS advanced Biology set Microscopy	15290-88	1
CD-ROM for TESS Microscopy	13290-12	1

## General Biology

### TESS advanced 15296-88 Biology basic set General Biology

Support base, variable	02001-00	1
TESS box, plastics, high, 305 x 425 x 150 mm	15200-00	2
Support rod, l = 600 mm, d = 10 mm, split in 2 rods with screw threads	02035-00	1
Rubber bulb, with glass tube	64170-00	1
Support ring, i.d. 130mm, w. boss	37722-03	1
Clinical thermometer, digital	04166-00	1
Lid for TESS box, plastic	15205-00	2
Mortar w. pestle, 70ml, porcelain	32603-00	1
Snap-cap		
vials, d=30mm, h=100mm, 10p	33623-03	0.1
Pipettor, bulb, 3 valves, 10ml max.	47127-01	1
Physiological vision figures	64949-00	1
Test tube rack f. 6 tubes, wood	37685-10	1
Protecting glasses, clear glass	39316-00	1



# 8 Ordering overview

Scope of delivery of all sets

Students thermometer, -10...+110°C, l = 180 mm	38005-02	1
Glass beaker DURAN®, tall, 600 ml	36006-00	1
Scissors, straight, pointed, l 110mm	64623-00	1
Glass beaker DURAN®, tall, 100 ml	36002-00	1
Test tube 160x16 mm, 10 pcs	37656-03	0.8
Graduated cylinder 100 ml, PP transparent	36629-01	1
Circular filter, d 90 mm, 100 pcs	32977-03	1
Glass tube, straight, l=80 mm, 10/pkg.	36701-65	0.2
Magnifier, plastic, 5x, d=30mm	88002-01	1
Optical illusion figures	64948-00	1
Pipette with rubber bulb	64701-00	2
Tweezers, straight, pointed, 120mm	64607-00	1
Labor pencil, waterproof	38711-00	1
Wire gauze with ceramic, 160 x 160 mm	33287-01	1
Bottle, nar. mouth, 100ml, clear, p.st	41101-01	4
Rubber bands, 50 pieces	03920-00	1
Spoon, w. spatula end, 18 cm, plastic	38833-00	1
Graduated pipette 10 ml	36600-00	3
Graduated pipette, 1 ml	36595-00	1
Petri dish, d 100 mm	64705-00	6
Beaker, 100 ml, low form, stackable, plastic	36082-00	3
Dissecting needle, pointed	64620-00	1
Rubber tubing, i.d. 6 mm	39282-00	1
Watch glass, dia.60 mm	34570-00	3
Knife, stainless	33476-00	1
Filter funnel, PP, d=60 mm	47318-00	1
Glass rod, boro 3.3, l=200mm, d=5mm	40485-03	1
Test tube holder, up to d 22mm	38823-00	2
Rubber stopper, d = 22/17 mm, 1 hole	39255-01	1

## TESS advanced 13486-88 Biology BS1 necessary accessories for 1 group

Portable Balance, OHAUS JE120	48895-00	1
Butane burner, Labogaz 206 type	32178-00	1
Butane cartridge C206, without valve	47535-00	1

## TESS advanced 13487-88 Biology BS 1 consumables for 10 groups

Pepsin powder, soluble 100 g	30181-10	1
Fuchsin acid -rubin s-, 25 g	31813-04	1
Indicator paper f. water roll 5m	47015-00	1
Ox gall, desiccated 100 g	31310-10	1
Peptone, dry, from meat 50 g	31708-05	1
Quinine hydrochloride 10 g	31196-03	1
Glycerol, 250 ml	30084-25	1
Calcium hydroxide solution 1000ml	31458-70	1
Starch, soluble 100 g	30227-10	1
Sudan-III solution, alcohol 250 ml	31861-25	1
Fehling's solution II 250 ml	30080-25	1
D(+)-glucose 1-hydr. 250 g	30237-25	1
Sodium hydroxide, flakes, 500 g	30157-50	1
Liquid paraffin 250 ml	30180-25	1
Pancreatin 25 g	31699-04	1
Copper-II sulphate, cryst. 250 g	30126-25	1
Iodine potass. iodide sol., 250 ml	30094-25	1
Water, distilled 5 l	31246-81	1
Litmus paper, red, 1 box	30678-02	2
Wire gauze squ., copper, 150x150 mm	33290-00	1
Fehling's solution I 250 ml	30079-25	1
D-fructose -laevulose- 25 g	30128-04	1
D (+)-Sucrose 100 g	30210-10	1
Sodium chloride, 500 g	30155-50	1
Hydrochloric acid, approx. 5% 250ml	30315-25	1
Denaturated alcohol (spirit for burning), 1000 ml	31150-70	1
Olive oil, pure 100 ml	30177-10	1
D(+)-Lactose, powder 100 g	31577-10	1

Filter paper, 580x580 mm, 10 sheets	32976-03	1
Cotton wool, white 200 g	31944-10	1

## Environment and Outdoors

### TESS Applied 12626-88 Sciences Cobra4 environment and outdoors, for 4 work groups inclusive aluminum case

Cobra4 Mobile-Link 2	12620-09	4
Cobra4 Sensor-Unit Weather	12670-00	1
Cobra4 Sensor-Unit Conductivity, with stainless steel electrodes	12633-00	1
Cobra4 Sensor-Unit pH, BNC connector	12631-00	1
Cobra4 Sensor-Unit Temperature	12640-00	1
pH-electrode, plastic body, gel, BNC	46265-15	1
TESS advanced Applied Sciences Handbuch Cobra4 Umwelt und Freiland	12622-01	1
TESS advanced Applied Sciences manual Cobra4 environment and outdoors	12622-02	1
Foam insert for Cobra4 Environmental Experimentation case	12622-25	1
Buffer solution tablets pH4, 100	30281-10	1
Buffer solution tablets pH10, 100	30283-10	1
Protection sleeve for electrode with a diameter of 12 mm	37651-15	1
Stand.solu.1413æS/cm(25°C), 460ml	47070-02	1
USB power supply for Cobra4 Mobile-Link 2.0	07932-99	4
SD memory card for Cobra4-Mobile-Link, 2 GB, 20MB/sec	12620-01	4
Labels for microscopic slides, 120/pkg	64703-00	1
Wash bottle, plastic, 500 ml	33931-00	1
Beaker, 250 ml, low form, plastic	36013-01	2
Bottle, square, HDPE, 100ml	47417-00	4
DVD measure current version, incl. measure Dynamics	14501-00	1

### TESS Environment 13445-88 and Outdoors optional accessories for 10 groups

Urease, lyophilized 5 g	31923-02	1
Telescopic rod for sample nets	64581-00	1
Portable Balance, OHAUS CS200E	48910-00	1
Stop watch, interruption type	03076-01	1
Beaker, plastic, for water sample	64581-12	1
Stand for Cobra4	12681-00	1
Copper-II sulphate, cryst. 250 g	30126-25	1
Urea, 250 g	30086-25	1
Graduated cylinder 100 ml	36629-00	1
Graduated cylinder 10 ml	36625-00	1
Grad. cylinder, high, boro 3.3, 25ml	47328-00	1
Glass beaker DURAN®, tall, 50 ml	36001-00	1
Glass beaker DURAN®, tall, 100 ml	36002-00	1
Glass beaker DURAN®, short, 250 ml	36013-00	1
Magnetic stirring bar 8mm, cylindrical	46299-00	1
Graduated pipette, 1 ml	36595-00	1
Petri dish, d 100 mm	64705-00	4
Glass rod, boro 3.3, l=200mm, d=5mm	40485-03	2

## Soil Examination

### TESS Applied 30836-77 Sciences set examination of soil

Portable Balance, OHAUS YA501	49214-00	1
Nitrate, nitrite, tester, 100pcs	30346-07	1
pH test sticks 2.0-9.0, 100 sticks	30301-06	1
TESS Applied Sciences manual examination of soil	30836-02	1
Soil density probe, l=58 cm	64244-00	1
Spring balance, transparent, 100 N	03065-07	1
Snap-cap vials, d=30mm, h=100mm, 10p	33623-03	1
Circular filter, d 150 mm, 100 pcs	32977-06	1
Nature viewer 5x, lens d=42mm	64600-00	6
Garden trowel, steel	40484-02	6
Plastic sack, flat, DIN A5, 100pc	46444-01	1
Measuring tape, l = 2 m	09936-00	1
Dish, plastic, 150x150x65 mm	33928-00	6
Petri dishes, plast., d94mm, 20 off	64709-03	1
Wire gauze square 150MMx150mm	33284-00	6
Graduated cylinder 100 ml, PP transparent	36629-01	1
Foam insert for soil examination set	30836-25	1
Glass tube, straight, l=80 mm, 10/pkg.	36701-65	2
Brush, fine	64702-00	6
Beaker, 250 ml, low form, plastic	36013-01	6
Bottle, square, LDPE, 500ml, GL65	47400-00	1
Rubber stopper, d=27/21mm, 2 holes	39257-02	6
Bottle, square, LDPE, 500ml, GL32	47396-00	1
PVC tubing, i.d. 7mm	03985-00	6
Dropping bottle, plastic, 50ml	33920-00	6
Measuring scoop, PP, white, 10 ml	47457-00	6

### TESS Examination 30836-10 of soil consumables for 10 groups

Hydrochloric acid, 10%, tech. gr., 1l	31821-70	1
Calcium chloride 6-hydr. 250 g	48020-25	1
Ammonia solution, 25%, 250 ml	30933-25	1

## Chemo-physical Water Analysis

### TESS Biology set 30837-77 chemo-physical water testing

Conductivity tester, digital	18482-00	1
Oxygen ECO-Test 1-10 mg/l	30837-09	1
Ammonium ECO-Test 0.2-3 mg/l	30837-01	1
Nitrate ECO-Test 0-120 mg/l	30837-03	1
Nitrite ECO-Test 0.02-5 mg/l	30837-02	1
pH ECO-Test, calorimetr., 4-9 pH	30837-06	1
Phosphate ECO-Test 0.2-5 mg/l	30837-04	1
Total hardness ECO-Test 1-20 d	30837-07	1
TESS Biology manual chemo-physical water testing	30837-22	1
Lab thermom. -10...+50°C, w/o Hg	47039-00	1
Stopper, IGJ 14.5/23, glass, obliq.	41251-11	1
Bottle, nar. mouth, 50ml, clear, p.st.	41100-01	1
Bottle, square, LDPE, 500ml, GL65	47400-00	2

**Biological Water Analysis**

**Ecology case, 30834-77  
biological water analysis**

TESS Biology manual biological water quality testing	30834-02	1
Vernier calliper, plastic	03011-00	1
Snap-cap		
vials, d=30mm, h=100mm, 10p	33623-03	1
Dropping pipette with bulb, 10pcs	47131-01	1
Nature viewer 5x, lens d=42mm	64600-00	6
Sieve, narrow mesh, 160mm dia	65854-00	6
Snap-cap vials, d=24mm, h=52mm, 10p.	33621-03	1
Painters brush, hard	40979-00	2
Dish, plastic, 150x150x65 mm	33928-00	6
Tweezers, curved, pointed, 100 mm	64608-00	6
Petri dishes, plast., d94mm, 20 off	64709-04	1
Fishing net f.aquatic insects	64576-30	1
Brush, fine	64702-00	4
Nature viewer 3x, lens d=22 mm	64599-00	6
Ruler, plastic, 200 mm	09937-01	2

**Electrophysiology**

**TESS advanced 15673-88  
Applied Sciences set  
Electrophysiology**

Software Cobra4 - multi-user licence	14550-61	1
Cobra4 Sensor-Unit Electrophysiology:		
ECG, EMG, EOG	12673-00	1
Cobra4 Wireless-Link	12601-00	1
Cobra4 Wireless Manager	12600-00	1
EMG electrodes, 3 off	65981-02	1
ECG electrodes, 3/pkg	65981-01	1
Shielded leads for electrophysiology, color-coded, 3/pkg	12673-01	1
TESS advanced Biologie Handbuch		
Cobra4 Elektrophysiologie: EKG, EMG, EOG	12673-11	1
TESS advanced Biology manual Cobra4		
Electrophysiology: ECG, EMG, EOG	12673-12	1
Electrodes for ECG Sensor, 100 pcs.	12559-01	1
Electrode Gel, tube	65981-06	1
Lid for TESS box, plastic	15205-00	1
Crocodile clips for disposable electrodes, 3/pkg	12673-02	1

**Human Physiology**

**TESS advanced 15675-88  
Applied Sciences Set Human  
Physiology**

Software Cobra4 - multi-user licence	14550-61	1
Cobra4 Mobile-Link 2 incl. accessories: battery, USB cable, charger and SD memory card	12620-10	1
Cobra4 Sensor-Unit Spirometry, Pulmonary volume and wind speed	12675-00	1
Cobra4 Sensor-Unit Pulse, Heart rate, incl. ear clip	12672-00	1
Cobra4 Sensor-Unit Skin Resistance	12677-00	1
Cobra4 Sensor-Unit Temperature	12640-00	1
Disposable turbine with cardboard-mouthpiece, set of 50 (for Cobra4 Sensor-Unit Spirometry)	12675-11	1
Blood pressure measuring unit	64234-00	1

TESS box, plastics, high, 305 x 425 x 150 mm	15200-00	1
Lid for TESS box, plastic	15205-00	1
Rubber bands, 50 pieces	03920-00	1

**Photosynthesis, Glycolysis  
and Enzymes**

**Basic set Cobra4 65982-88  
Biochemistry and plant  
physiology with handbook**

Software Cobra4 - multi-user licence	14550-61	1
Cobra4 Sensor-Unit Thermodynamics, pressure abs. 2 bar and 2 temperature NiCr-Ni	12638-00	1
Cobra4 Wireless-Link	12601-00	1
Cobra4 Sensor-Unit Weather	12670-00	1
Cobra4 Sensor-Unit Conductivity+	12632-00	1
Conductivity temperature probe Pt1000	13701-01	1
Cobra4 Wireless Manager	12600-00	1
Cobra4 Sensor-Unit pH, BNC connector	12631-00	1
Ceramic lamp socket E27	06751-01	1
pH-electrode, plastic body, gel, BNC hot/cold air blower, 1800 W	04030-93	1
Immersion probe NiCr-Ni, steel, -50...400 °C	13615-03	2
Holder for Cobra4 with support rod	12680-00	1
Support base, variable	02001-00	2
Demo advanced Biologie Handbuch		
Cobra4 Biochemie & Pflanzenphysiologie	01331-01	1
Demo advanced Biology Manual Cobra4		
Biochemistry & plant physiology	01331-02	1
Dialysis clips, 2	64209-00	2
Universal clamp with joint	37716-00	1
Filament lamp, 220V/120W, w.refl.	06759-93	1
Test tube, 200x30 mm, side arm, PN29	36331-00	1
Thermos flask	64841-00	2
Universal clamp	37715-00	2
Boss head	02043-00	2
Dialysis tubing 24A, diam.44mm, 1m	64208-00	1
Test tube, 200x30 mm, DURAN, PN29	36294-00	1
Support rod, stainless steel, 500 mm	02032-00	3
Support rod, stainless steel, l = 250 mm, d = 10 mm	02031-00	1
Rubber stopper, d=41/34mm, 2 holes	39261-02	2
Rubber stopper 26/32, 1 hole 1,5 mm	39258-09	1
Rubber stopper 26/32, 1 hole 7 mm	39258-01	1

**Standard labware 65980-77  
set for Biochemistry & plant  
physiology**

Precision Balance, OHAUS AdventurerPro AV212, 210 g /0,01 g	49273-93	1
Magnetic stirrer Mini / MST	47334-93	1
Lab jack, 160 x 130 mm	02074-00	1
Micro-l syringe, 100 micro-l	02606-00	1
Retort stand, h = 750 mm	37694-00	1
Bunsen burner DIN, natural gas	32165-05	1
Test tubes 100x12 mm, FIOLEX, 100pc	36307-10	1
Separator for magnetic bars	35680-03	1
Erlenmeyer flask, narrow neck, PN 29	36424-00	1
Erlenmeyer flask 100 ml, narrow neck, PN 19	36418-00	7
Mortar with pestle, 150 ml, porcelain	32604-00	1
Disposable gloves, 100pcs, medium	46359-00	1
Pipettor	36592-00	1
Glass beaker DURAN®, tall, 1000 ml	36008-00	1
Glass beaker DURAN®, short, 1000 ml	36017-00	1
Pasteur pipettes, 250 pcs	36590-00	1
Tripod, ring-d=100 mm, h=180 mm	33299-00	1
Safety gas tubing, DVGW, sold by metre	39281-10	1

Volumetric pipette, 50 ml	36581-00	1
Lab thermom.-10...+100°C, w/o Hg	47040-00	1
Plasticine, 10 sticks	03935-03	1
Beaker, low, BORO 3.3, 1000 ml	46057-00	1
Graduated cylinder 25 ml	36627-00	1
Graduated cylinder 100 ml	36629-00	2
Glass beaker DURAN®, tall, 250 ml	36004-00	2
Rubber caps, 10 pcs	39275-03	1
Glass beaker DURAN®, tall, 50 ml	36001-00	2
Glass beaker DURAN®, tall, 100 ml	36002-00	8
Glass beaker DURAN®, short, 250 ml	36013-00	1
Volumetric pipette, 20 ml	36579-00	1
Magn. stirring bar 50mm, cyl.	46299-03	1
Glass tube, straight, l=80 mm, 10/pkg.	36701-65	1
Microspoon, steel	33393-00	1
Funnel, glass, top dia. 55 mm	34457-00	1
Rubber bands, 50 pieces	03920-00	1
Sieve, fine mesh, d=60 mm	40968-00	1
Magnetic stirring bar 30 mm, cylindrical	46299-02	1
Volumetric pipette, 1 ml	36575-00	1
Wash bottle, plastic, 500 ml	33931-00	1
Wire gauze 120x120mm, ceramic cen.	33287-03	1
Beaker, high, BORO 3.3, 250 ml	46027-00	2
Graduated pipette 10 ml	36600-00	2
Graduated pipette, 1 ml	36595-00	1
Beaker, 250 ml, low form, plastic	36013-01	1
Rubber tubing, i.d. 6 mm	39282-00	1
Rubber stopper 26/32, 1 hole 7 mm	39258-01	1
Hose clip, diam. 8-16 mm, 1 pc.	40996-02	2
Dropping bottle, plastic, 50ml	33920-00	1
Glass rod, boro 3.3, l = 200 mm, d = 3 mm	40485-01	1
Rubber stopper, d=22/17 mm, without hole	39255-00	7

**Chemicals set 65980-10  
Biochemistry & plant  
physiology**

Urease soln.in 50% glycerol, 10ml	31924-03	1
Silver nitrate, cryst. 15 g	30222-00	1
Tartrazine 25 g	48498-04	1
Patent Blue V (sodium salt), 25 g	48376-04	1
Hydrochloric acid, 1.0 mol/l, 1000 ml	48454-70	1
Buffer solution, pH 10.01, 1000 ml	46272-12	1
Buffer solution, pH 4.01, 1000 ml	46270-12	1
Caustic soda solution, 1.0 m, 1000 ml	48329-70	1
Hydrogen peroxide, 30%, 250 ml	31710-25	1
Water, distilled 5 l	31246-81	1
Urea, 250 g	30086-25	1
Glycerol 99% 100 ml	30084-10	1
Sodium hydrogen carbonate 250 g	30151-25	1

**Genetics**

**TESS advanced 15310-88  
Biology set Molecular Biology**

Electrophoresis chamber, horizon.	35023-00	1
Microliterpipette 2-20 µl	47141-10	1
Microliterpipette 20-200 µl	47141-11	1
TESS box, plastics, high, 305 x 425 x 150 mm	15200-00	1
Staining dish, UV permeable, PETG	35023-20	1
Lid for TESS box, plastic	15205-00	1
Pipette tips, 2-200 µl, racked	47148-11	1
Protecting glasses, clear glass	39316-00	1
Spoon, nickel-plated, 180 mm	33392-00	1
Spatula, steel, l=185mm	46952-00	1

## 8 Ordering overview

Scope of delivery of all sets

### TESS advanced 13446-88 Biology Set Molecular Biology, necessary accessories for 1 group

Electrophoresis power supply 100V/200V 65966-93 1

### TESS advanced 13447-88 Biology Set Molecular Biology, consumables and chemicals for 10 groups

Water, distilled 5 l 31246-81 1  
Cotton wool, white 200 g 31944-10 1  
Rubber gloves, size S (7) 39325-00 1

### TESS advanced 13448-88 Biology Set Molecular Biology, necessary accessories for 5 groups

Precision Balance, OHAUS AdventurerPro  
AV812, 810 g / 0,01 g 49275-93 1  
Grad.cylinder, high, PP, 500ml 46288-01 1  
Erlenmeyer flask, narrow n., 500 ml 36121-00 1  
Magn.stirring bar 50mm, cyl. 46299-03 1

## Nervous System

### Neurobiology Lab, 65963-11 230 V

Cobra3 BASIC-UNIT, USB 12150-50 1  
Neuro-simulator 65963-00 1  
Neuro-simulator, power supply 65963-93 1  
Software Cobra3 Universal recorder 14504-61 1  
Power supply 12V / 2A 12151-99 1  
Neurosimulator Handbuch 01191-01 1  
Neurosimulator Handbook 01191-02 1  
Laboratory Experiments Physics,  
Chemistry, Biology and Applied Sciences,  
CD-ROM, incl. operating manuals 16502-42 1



## Legal provisions



## General notes on safety

### Notes on safety

The regulations for dealing with electrical devices, lasers, radioactive materials and hazardous materials are not uniform worldwide. Before any experimentation, it is essential that you become familiar with the national and local laws, directives and ordinances regarding the handling of the-

se appliances and materials, as well as their storage and transport.

You can refer as an example to our notes on safety, which correspond to the high German and EU standards. The laws in the respective country are binding, however.

### 1.) Experiments using electrical energy

The utilisation of the electrically operated devices (mains power supply) that are offered herein is only allowed in science rooms of educational institutions, schools, universities, and laboratories, but NOT in residential areas.

Experiments at school usually use non-hazardous extra-low voltages ( $< 25\text{ V}\sim$  /  $< 60\text{ V}\sim$ ). The following safety notes provide information about the existing legal regulations. In addition, they include rules of conduct for the responsible teacher for the execution of experiments with hazardous voltage levels.

When performing experiments with electrical energy, it must be absolutely sure that the persons involved in the experiment cannot come into contact with hazardous voltage. The professional (teacher) who supervises/conducts the experiment is responsible for this.

In the "Safety requirements for electrical equipment for measurement, control, and laboratory use" (DIN EN 61010-1, VDE 0411 part 1) of the European Union, non-hazardous voltage is defined as voltage  $< 33\text{ V}\sim$  or  $< 70\text{ V}\sim$  or, in the case of higher voltage, with a limited current of  $0.5\text{ mA}\sim$  and  $2\text{ mA}\sim$  maximum.

Other restrictions for schools providing general education have been decreed by the standing conference of the minister of education and cultural affairs of Federal Republic of Germany in the "Directives concerning safety during lessons" (GUV-SI 8070) with reference to the standard VDE 0105 part 12 ("Operation of power installations - Particular requirements for experiments with electrical energy in lecture rooms"). In these directives, the voltage limits for students up to the German class level 10 (age approximately 16 years) have been fixed at  $25\text{ V}\sim$  and  $60\text{ V}\sim$  maximum.

Professionals (usually teachers) and students of class levels higher than level 10 may work with hazardous voltages in exceptional cases, if the teaching objective cannot be reached with non-hazardous voltage. In this case, the teacher must be present during the experiment.

The following rules and regulations should be observed:

#### 1. Electrical safety

(DIN EN 61010-1, VDE 0105 part 12, GUV-SI-8070)

Prior to the first experiments of students, trainees, or apprentices with electrical energy in a laboratory or classroom, the students, trainees, and apprentices must be informed in detail about the hazards of the electrical current and about the applicable safety instructions.

Prior to using the electrical devices, they must be checked for signs of damage! Do not use the device if it is damaged!

The operating instructions of the equipment that is used for the experiment must be followed!

Do not use hazardous voltages ( $> 25\text{ V}\sim$  and  $> 60\text{ V}\sim$ ) in student experiments!

The professional must re-check the experiment set-up (circuit) prior to the start of the experiment and inform the user of any potential hazards!

Modifications of the experiment set-up (set-up, conversion, and take-down) must only be performed when the set-up is completely disconnected from the power supply and when all poles of the supply voltage are switched off!

If measurements or adjustments are unavoidable during an experiment with hazardous voltage, work only with one hand and hold the other behind the back or put it in a pocket!

Ensure that there is a sufficient number of emergency OFF switches in the laboratory.

Use only 4-mm safety cables that are protected against accidental contact (e.g. PHYWE ref. no. 07336-01) when performing experiments with hazardous voltages!

After the completion of the experiment, it should be taken into consideration that component parts, such as capacitors, may supply hazardous voltage even some time after the equipment has been switched off!

Experiments with set-up transformers require special safety measures. Even if the primary side of the transformer is supplied with extra-low voltage (< 25 V~), very high hazardous voltages may be generated on the secondary side by the transformation, e.g. if the coils get mixed up!

If demonstration experiments are performed with hazardous voltages, the teacher or lecturer must ensure a sufficient safety distance from the students. In addition, these kinds of experiments must be marked with the danger sign "High voltage!" (PHYWE ref. no. 06543-00)!

Experiments that are directly supplied with mains power must not be performed unless a residual current circuit breaker (< 30 mA), e.g. a safety plug/socket assembly (PHYWE ref. no. 17051-93) or a variable isolating transformer (PHYWE ref. no. 13535-93), has been installed before the set-up. Do not plug the 4-mm connecting cables directly into the earthing contact socket outlet (SCHUKO socket)!

If power supply units (e.g. power supply unit for students, PHYWE ref. no. 13505-93) are used that do not produce hazardous voltages (extra-low voltages < 25 V~ and < 60 V~), simple, unprotected 4-mm connecting cables and other non-insulated components may also be used for student experiments.

**2. EMC (electromagnetic compatibility)**  
**(Technical recommendation concerning the application of the EMC Act on electrical teaching equipment, Reg TP 322 TE01)**

Experiment set-ups for the demonstration of physical processes must only be used in science rooms at schools, universities, and other educational institutions!

The teacher (expert) who sets up and performs the experiments is responsible for the compliance with the requirements for the EMC Act on the electromagnetic compatibility of equipment! The experiment set-ups do not require a CE mark or declaration of conformity, but the teacher as an expert must take all the necessary measures in order to avoid interferences in the environment!

Possible EMC measures:

- Ensure shielding and equipotential bonding!
- Keep a sufficiently large distance from sensitive equipment!
- Use short connecting cables (in order to reduce RF emission)!
- Floor coverings that may lead to static charges should be avoided and the body should be discharged prior to touching any sensitive experiment equipment!
- RF emitters, e.g. mobile phones, should not be used in close vicinity of the experiment set-up!
- Critical experiment set-up and devices (e.g. Van de Graaf generator, Ruhkoeff induction coil, transmitter), which can cause interferences even at a distance of several 100 metres should be switched on as briefly as possible.

## 2.) Experiments using lasers

In general, the "Directives concerning safety during lessons" (GUV-SI 8070) are applied at schools. In accordance with these directives, the following points must be observed when working with lasers:

1. Only lasers of class 1, 1 M, 2, and 2 M1 in accordance with DIN EN 60 825 may be used at schools.
2. Lasers of class 1 M, 2, and 2 M must be kept under lock and key.
3. Prior to setting up and performing experiments with lasers of class 1 M, 2, and 2 M, the students who observe or are involved in the experiment must be informed as to the risk to the eyes that is caused by the laser light.

These lasers must only be used under the supervision of the teacher.

4. The area in which experiments with lasers of class 1 M, 2, and 2 M are performed must be marked with laser warning signs during the operation of the laser. This laser area of experiment set-ups must be secured against accidental access by some form of delimitation.
5. The set-up and performance of experiments with lasers of class 1 M, 2, and 2 M must ensure that looking into the direct laser beam or into the reflected beam is avoided, e.g. with the aid of some kind of screening. If lasers of class 1 M and 2 M are used, the beam cross-section must not be reduced, i.e. these lasers must not be used

in combination with converging components (e.g. magnifying glasses).

6. The use of laser devices of class 3 B or 4 in other educational institutions (universities etc.) must be reported to the responsible accident insurer and to the responsible occupational safety and health authority prior to the first start-up of the lasers.

For the use of laser systems of class 3 B or 4, a competent person must be appointed the laser safety officer in writing.

Additional information concerning the use of lasers can be found in the documents of the German Social Accident Insurance "GUV-V B – Laser radiation" and "GUV-I 832 – Use of laser systems". These documents are mainly based on the EU standard "DIN EN 60825-1 – Safety of laser products".

### 3.) Handling of radioactive products

In Germany, the handling of radioactive substances is controlled by the German Radiation Protection Ordinance (Strahlenschutzverordnung, StrlSchV). The legal bases of this ordinance are articles 25 to 27 combined with appendix V of the ordinance dated 20 July 2001, last amended by article 2 of the law of 02/08/2008. Substances within the exemption limits (see Appendix V of the German Radiation Protection Ordinance (StrlSchV) for the exemption limits) can be supplied to schools without any conditions. If the exemption limits are exceeded, the school will need a special handling permit issued by the responsible supervisory authority prior to purchasing the substances.

If several substances within the exemption limits are owned and/or purchased, the sum formula that is stated in the German Radiation Protection Ordinance must be observed.

Radioactive substances must be protected against unauthorised persons, which is why they must be stored in a theft-proof manner. In addition, the handling regulations of the German Radiation Protection Ordinance must be observed. Substances that have become unusable must be handed over directly to the responsible collection centre or to a disposal company.

### 4.) Safety instruction for handling hazardous materials

Before any experimentation with hazardous materials, it is essential that you become familiar with the national and local directives and ordinances concerning the handling of hazardous materials, their storage and transport. The basic principle is that all hazardous materials must be dealt with cautiously and carefully. It is of course required that, in case of experiments, neither the students nor the teachers be exposed to any unnecessary dangers to health. The instructions

of the safety data sheets for the individual materials, in the most current version in each case, are to be considered, as well as the accident-prevention specifications and the respective workplace-related operating instructions. The waste disposal of used hazardous materials must be implemented according to recognized methods. The local specifications for the proper removal of chemical residues are to be considered in this case.



## General Terms and Conditions (GTC)

### of PHYWE Systeme GmbH & Co. KG

#### § 1 Application of Conditions

1. These General Terms and Conditions (hereinafter referred to as GTC) shall apply for all goods, services and offers of PHYWE Systeme GmbH & Co. KG (hereinafter referred to as PHYWE) for its customers (hereinafter referred to as Customer). They shall apply equally for all future business between the contract parties without requiring a repeated reference. General Terms and Conditions of the Customer shall apply only if expressly approved by PHYWE in writing.
2. All deviating agreements between PHYWE and the Customer shall be set down in writing; a waiver of the written form does not have any effect on the agreement's validity. In the event of such an agreement these GTC shall be of lesser importance and shall supplement the agreement.
3. PHYWE reserves all rights to PHYWE operational and offer documents. If no order is placed, all documents shall be returned immediately of the Customer's own accord. All information in them and from other transactions shall be treated as strictly confidential.
4. All offers, samples and test products as well as their technical data and descriptions in the respective product information and promotional materials on the PHYWE website are for information only and are not binding. They do not represent a warranty of quality or application.
5. Insofar as PHYWE considers it necessary for the completion of its performances, PHYWE is authorized to exchange job-related data with assistants or trading partners. If the Customer does not desire such an information exchange, the Customer may object to it in writing at any time.

#### § 2 Offer and Contract Conclusion

PHYWE's offers are not binding. PHYWE reserves an acceptance period of two weeks from receipt at PHYWE regarding the Customer's binding orders. Verbal statements of acceptance (by phone) and all Customer orders shall be confirmed by PHYWE in writing or by telex; a waiver of the confirmation does not affect the effectiveness of verbal statements of acceptance and orders (by telephone).

#### § 3 Prices

1. The prices given in the PHYWE price list or the PHYWE order confirmation, exclusive of the relevant applicable value-added tax in the respective country, shall be binding. Additional goods and services are charged separately.
2. The prices are "ex work PHYWE" and include PHYWE standard packaging. Special packaging or other requests from the Customer, such as packaging in certain lots, are charged separately. Deviating provisions may be agreed between PHYWE and the Customer or by PHYWE for a region or a country in writing from time to time.

#### § 4 Delivery and Performance Terms

1. Delivery dates or terms that may be agreed upon, both binding and unbinding, shall be set down in writing. Non-binding delivery terms may be exceeded by up to 8 weeks by PHYWE; only after expiration of this term we shall fall into arrears by reminder of the Customer. Delivery terms shall start as of contract conclusion and acceptance of payment details by PHYWE. In the event that changes to the contract are agreed upon, it is subsequently required to agree on a new delivery date at the same time. Claims for damages or recourse of the Customer towards PHYWE shall be excluded in any case.
2. In the event of delivery and performance delays due to force majeure, natural disasters as well as due to labour disputes, traffic or operation disturbances, lack of material through no fault of their own and similar reasons on PHYWE and its suppliers' part, the Customer is not entitled to withdraw from the contract or to assert claims towards PHYWE. The Customer is entitled to withdraw from the contract if the aforementioned reasons cause an extension of the delivery date by more than four months. PHYWE is entitled equally to withdraw from the contract. Claims for damages or recourse of the Customer towards PHYWE shall be excluded in any case.

3. PHYWE is entitled to make partial deliveries and partial performances at any time unless the deliveries and performances are to be made fully and completely in accordance with the contractual arrangements.
4. PHYWE's compliance with delivery and performance obligations requires the Customer's timely and proper compliance with its obligations.
5. If the Customer falls into arrears, PHYWE is entitled to demand reimbursement of the additional expenses it had to make for the unsuccessful offer and storage and maintenance of the owed object; with commencement of default of acceptance the risk of incidental deterioration and accidental loss is transferred to the Customer.

#### § 5 Export Business

PHYWE is entitled to withdraw from the contract regarding delivery of such products (partial withdrawal) that require approval of the federal ministry for economics and export control, the Federal Institute for Medicaments and Medical Products or a similar governmental institution for their export from Germany or their import in their country of destination pursuant to legal provisions in the event that the approval is not issued or probably may not be obtained until the agreed delivery date. PHYWE shall immediately advise the Customer of this and possibly reimburse a compensation for the part of the performance affected by the withdrawal.

#### § 6 Shipping and Transfer of Risk

1. Place of performance is Göttingen. The delivery condition is "ex works PHYWE". Other agreements must be made in writing.
2. The Customer may request PHYWE to ship the goods. It shall bear the costs and risk for it. In the case of a forwarding order the risk is transferred to the Customer as soon as the shipment had been handed over to the person executing the transport. If PHYWE is able to ship the goods at the time determined by contract and the shipment is delayed at the Customer's request the risk is transferred to the Customer at notice of readiness for shipment.
3. At the Customer's request shipments shall be insured in its name and on its account.

#### § 7 Claims for Defects/Guarantee

1. PHYWE is working pursuant to the guarantee claims typical in Germany and the EU. If a PHYWE product shows any other defect already present at delivery, the Purchaser shall advise it immediately and provide evidence. In such an event PHYWE shall repair the defect or deliver a product free of defects (supplementary performance) pursuant to legal provisions. PHYWE shall bear the expenses required for the purposes of supplementary performance, including but not limited to transport, labour and material cost. Additional expenses caused by the sold product being brought to a place other as the domicile or the branch office of the Customer shall not be borne by PHYWE.
2. Insignificant or commercial deviations of the delivered goods in size, shape and colour being in the material's nature do not establish claims for defects by the Customer. Article 377 German Commercial Code applies.
3. PHYWE reserves the right to changes to the PHYWE products required for technical or other reasons not affecting usability and not reducing the service's value and for technical improvements. They do not establish claims for defects, abatement or withdrawal from the transaction by the Customer.
4. If PHYWE's operation or maintenance instructions are not adhered to, changes to the products are made, parts are exchanged or consumables not complying with the original specifications are used, the Customer may not assert claims for defects if the Customer does not refute a substantiated claim to the effect that it was only one of those circumstances that had caused the defect.
5. The Customer must immediately inform customer service management/PHYWE's technical hotline of visible defects in writing, however, the latest within one week after receiving and/or accepting the



delivered goods. Defects that can not be discovered within this period even with careful examination shall be communicated and proven to PHYWE in writing immediately upon discovery.

6. Claims for defects for regular wear and tear are excluded.
7. Only the immediate Customer is entitled to claims for defects towards PHYWE and may not transfer them to third parties.
8. Claims for defects fall under the statute of limitations after 12 months as of delivery of the goods under contracts with the Customer. Retaining payments by the Customer is only admissible if the proportion of the occurred defect is appropriate.

### § 8 Repairs

If the Customer is not entitled to claims for defects pursuant to § 7 or if the statutory period of limitation pursuant to § 7.8 is expired and PHYWE and the Customer agree on a repair of the products § 7.8 applies equally to the limitation of a defect of the repair.

### § 9 Reservation of Title

1. PHYWE reserves title to the goods until fulfilment of all claims from the business relation for whatever legal reason including the claims arising in the future or conditional claims. If the realisable value of existing securities (goods subject to reservation of title pursuant no. 3 below and transferred accounts receivable pursuant no. 5 below) exceeds the secured claims by more than 10 % in total PHYWE is obliged insofar to release securities at the seller's discretion at the Customer's request.
2. Joint ownership rights arising from combination or mixing are deemed goods subject to reservation of title. PHYWE has an appropriate right to the reservation of title on these goods as well.
3. The Customer is entitled to process and sell the goods subject to reservation of title in the course of normal business unless it falls into arrears. Pledging or protective conveyance is inadmissible. By way of security the customer shall immediately transfer to PHYWE all claims (including any outstanding balance claims from the current accounts) arising from the resale or another legal reason (insurance, inadmissible action) in connection with the goods subject to reservation of title to their full extent. PHYWE shall give it the revocable authorization to collect the claims transferred to PHYWE for its account in its own name. This authorization for collection may only be withdrawn if the Customer does not properly fulfil its payment obligations.
4. In the event that the Customer behaves contrary to the contract – including but not limited to falling into arrears – PHYWE is entitled to take back the goods subject to reservation of title after expiration of an appropriate additional respite or demand the transfer of the Customer's claims for return towards third parties as the case may be. PHYWE taking back the goods subject to reservation of title does not constitute a withdrawal from the contract unless PHYWE has expressly stated such withdrawal.

### § 10 Payment

1. All payments exceeding the credit limit of the Customer with PHYWE confirmed by PHYWE in writing shall be made for payment in advance or confirmed with an irrevocable letter of credit from a large European bank accepted by PHYWE or an equivalent bank guarantee.
2. Within or above credit limit invoices shall be payable without deducting a cash discount or other discounts with PHYWE receiving the payment within 20 days as of contract conclusion and receipt of the invoice or an equivalent payment listing by the Customer.
3. In the event of orders with a purchase price surpassing € 25,000.00 the Customer shall make an advance payment of 40% of the purchase price for PHYWE products and 60% of the purchase price for third party products. The advance payment is due on contract conclusion and receipt of an invoice or equivalent payment listing.
4. A payment is only deemed made when PHYWE has the amount at its disposal. In case of cheques the payment is only deemed made when the cheque has been cashed.

5. The Customer shall fall into arrears 3 days after maturity of the claim by PHYWE and receipt of an invoice or delivery without it requiring a written reminder. If the Customer falls into arrears PHYWE is entitled to demand interest of 8% above the relevant basic interest rate of the European Central Bank at the respective point in time. PHYWE may submit evidence of a greater damage.
6. If PHYWE becomes aware of circumstances calling the Customer's financial standing into question, including but not limited to not cashing its cheque or stopping its payments, or if PHYWE becomes aware of other circumstances calling the Customer's financial standing in question, PHYWE is entitled to call the complete outstanding debts even if it had accepted cheques.
7. The Customer is only entitled to set off its debts if the counterclaims have been established as final and absolute or are undisputed. The same shall apply for the right of retention pursuant to article 273 German Civil Code, the commercial right of retention pursuant to article 369 German Civil Code and the right of refusal of services pursuant to article 320 German Civil Code.

### § 11 Copyright Infringements

1. PHYWE shall exempt the Customer and its customers from claims arising from infringements of copyrights, trade marks or patents unless the design of a delivery object had been made by the Customer. PHYWE's exemption obligations shall be limited to the amount of the predictable damage. An additional requirement for exemption is that in case of a legal dispute (article 72 German Code of Civil Procedure) the Customer informs PHYWE of the dispute and that the alleged legal infringement may be ascribed to the construction of PHYWE's delivery items without combination or use with other products.
2. Optionally PHYWE has the right to free itself from the obligations assumed in clause 1 by either
  - a) obtaining the required licences regarding the alleged infringed patents, or
  - b) providing the Customer with a changed delivery item or part of it that rectifies the infringement reproach concerning the delivery item by exchanging it for the infringing delivery items or their parts unless the changed delivery item (or parts of it) falls behind the original performance regarding the usability and/or its value.

### § 12 Liability

1. PHYWE shall be liable for breaches of contractual and non-contractual obligations, including but not limited to impossibility, delay and unlawful acts, only in cases of malicious intent and gross negligence – of its executive employees as well – limited to damages foreseeable at contract conclusion.
2. Claims for damages of material defects shall fall under the statute of limitation after 12 months as of delivery of the goods – with exception of personal injury or wilful or grossly negligent breaches of duty. The limitation of legal regress claims remains unaffected. The relevant legal provisions apply for claims for damages on account of other legal reasons.

### § 13 Applicable law, jurisdiction, partial invalidity

1. In addition to these provisions German law with exemption of the provisions of the UN Convention on Contracts for the International Sale of Goods dated 11/04/1980 (CISG) applies.
2. Place of jurisdiction is Göttingen
3. If a provision in these General Terms and Conditions or a provision under other agreements is or becomes ineffective the validity of all other provisions or agreements shall remain unaffected.

General Terms and Conditions of PHYWE Systeme GmbH & Co. KG, last updated on 01/08/2010

After announcement of new General Terms and Conditions all previous General Terms and Conditions lose their validity.

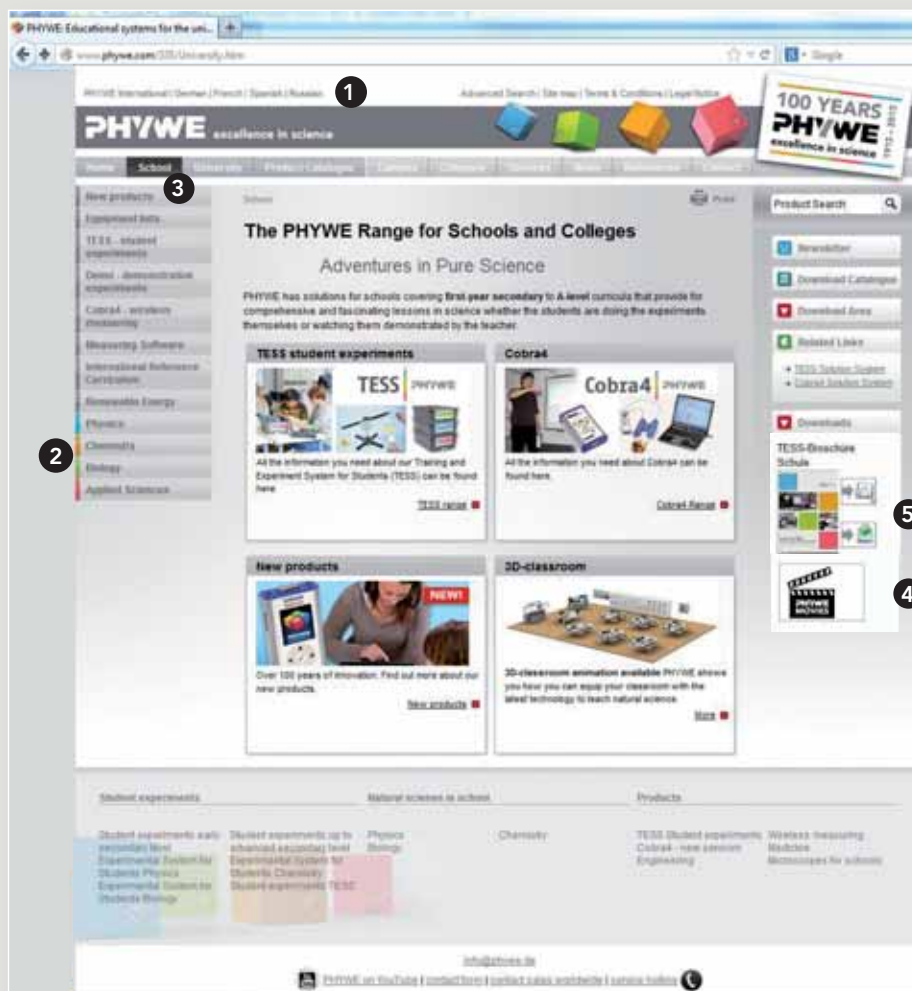
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