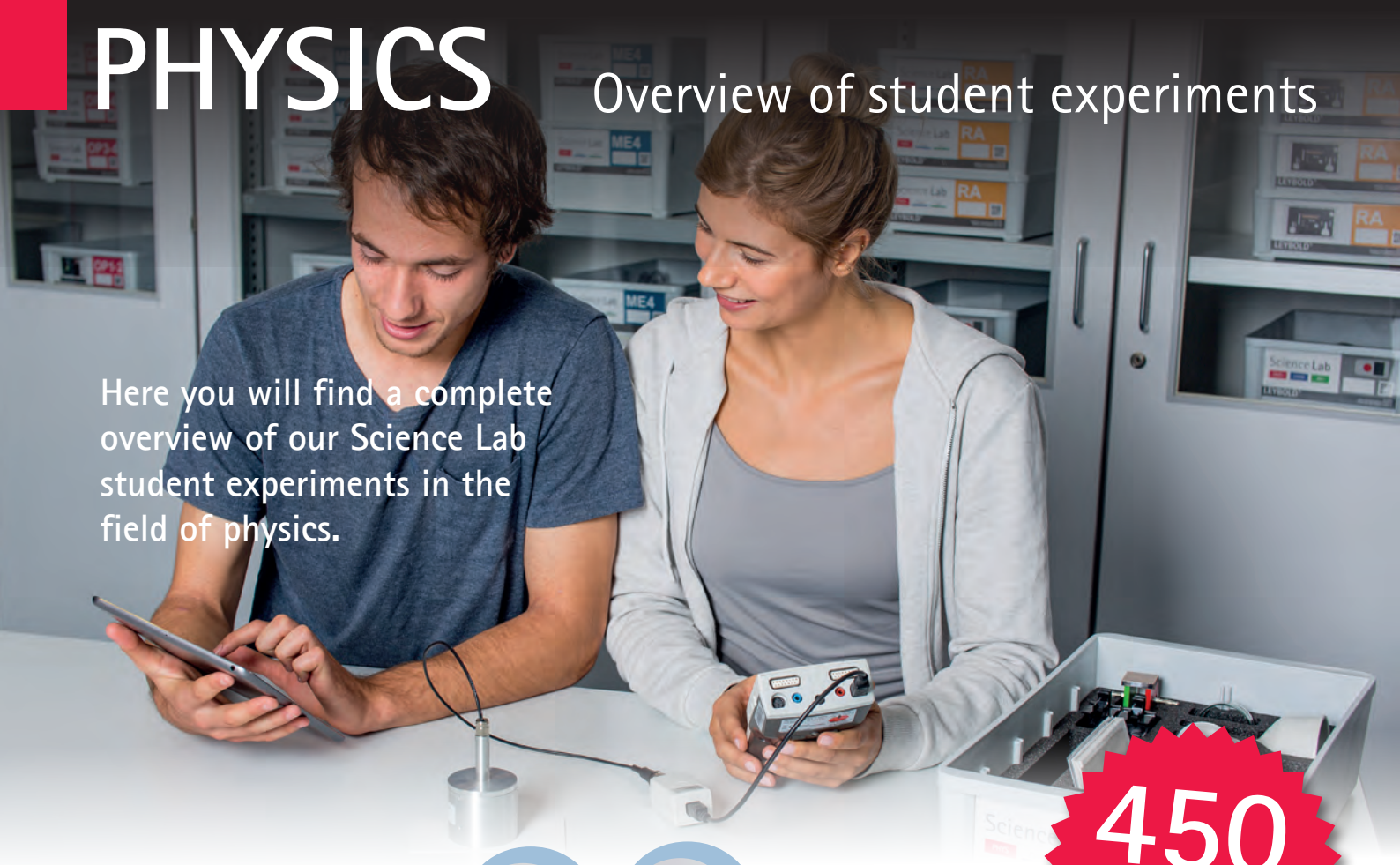
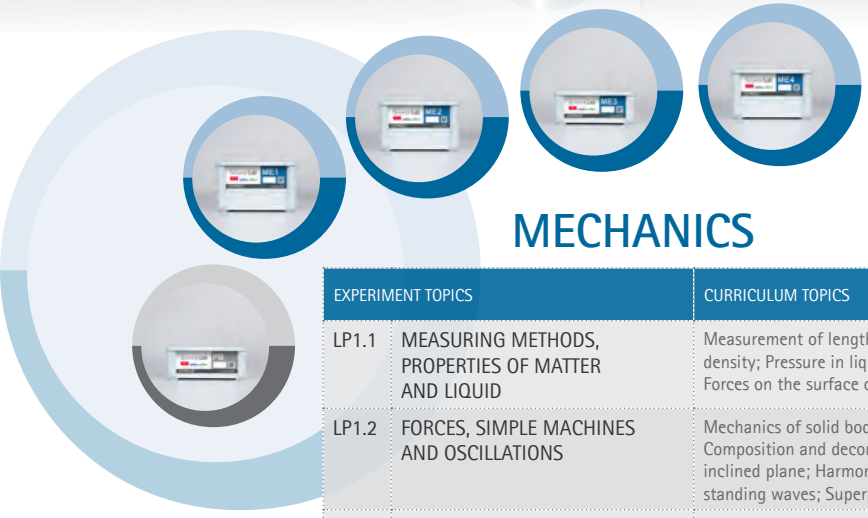
PHYSICS

Overview of student experiments



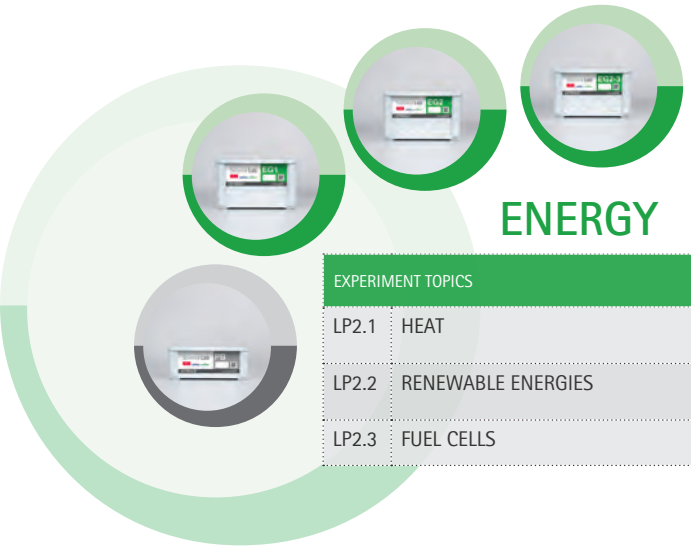
Here you will find a complete overview of our Science Lab student experiments in the field of physics.

450 EXPERIMENTS IN TOTAL



MECHANICS

EXPERIMENT TOPICS		CURRICULUM TOPICS	NO. EXPERIMENTS	DETAILS FROM
LP1.1	MEASURING METHODS, PROPERTIES OF MATTER AND LIQUID	Measurement of length and time; Measurement of mass and density; Pressure in liquids; Forces acting on bodies in liquids; Forces on the surface of liquids	15	PAGE 26
LP1.2	FORCES, SIMPLE MACHINES AND OSCILLATIONS	Mechanics of solid bodies; Deformation due to a force; Composition and decomposition of forces; Levers; Pulley and inclined plane; Harmonic oscillations; Forces oscillations and standing waves; Superposition of waves	41	PAGE 32
LP1.3	LINEAR MOTION, FREE FALL AND COLLISION EXPERIMENTS	Uniform motion; Uniformly accelerated motion; Newton's laws; Free fall; Experiments on elastic collisions; Experiments on inelastic collisions; Conservation of momentum	20	PAGE 38
LP1.4	ACOUSTICS	Propagation of sound; Oscillations and sounds; Noise analysis; Resonance and beating; Speed of sound	21	PAGE 44



ENERGY

EXPERIMENT TOPICS		CURRICULUM TOPICS	NO. EXPERIMENTS	DETAILS FROM
LP2.1	HEAT	Expansion of heat; Heat transfer; Thermal insulation; Heat capacities; Aggregation states and transitions	36	PAGE 52
LP2.2	RENEWABLE ENERGIES	Solar energy; Wind energy; Peltier effect; Energy storage; Energy conversion and efficiency	29	PAGE 58
LP2.3	FUEL CELLS	Reversible PEM fuel cell; The electrolyser; The fuell cell	20	PAGE 64

ELECTRICITY

EXPERIMENT TOPICS		CURRICULUM TOPICS	NO. EXPERIMENTS	DETAILS FROM
LP3.1	ELECTROSTATICS	Contact electricity; Forces acting between charges; Electrostatic induction; Charge storage; Electrostatic interaction; Insulators and conductors; Equipotential lines; Plate capacitor	25	PAGE 72
LP3.2	MAGNETISM	Magnetic forces and fields; Magnetic induction; Magnetic fields	12	PAGE 78
LP3.3	BASIC ELECTRICAL CIRCUITS AND ELECTROCHEMISTRY	Electrical circuits and switches; Electrical measurement methods; Ohmic resistance; Special resistors; Voltage sources; Electrical application circuits; Electrochemistry	40	PAGE 84
LP3.4	ELECTROMAGNETISM AND INDUCTION	Electromagnetism; Electromagnetism applications; Induction; Transformers; Applications of induction; Coils in direct and alternating current circuits	21	PAGE 90
LP3.5	MOTORS AND GENERATORS	Generators; Electric motors	14	PAGE 96

ELECTRONICS

EXPERIMENT TOPICS		CURRICULUM TOPICS	NO. EXPERIMENTS	DETAILS FROM
LP4.1	BASIC ELECTRONICS CIRCUITS	Capacitors; Relay circuits; Diodes; Transistors; Diode circuits; Flip-flops; Amplifier circuits; Solar cells	42	PAGE 102

OPTICS

EXPERIMENT TOPICS		CURRICULUM TOPICS	NO. EXPERIMENTS	DETAILS FROM
LP5.1	RAY OPTICS AND GEOMETRICAL OPTICS	Propagaton of light and shadow formation; Light and shadow in nature; Reflection in mirrors; Light refraction; Dispersing light and recombination of the spectrum; Lenses and lens aberrations; Optical instruments for angular magnification; Optical instruments and the eye	46	PAGE 110
LP5.2	CHROMATICS	Examination of the light paths through a prism; Spectral colours; Colour mixing	11	PAGE 116
LP5.3	WAVE OPTICS	Diffraction on diffraction objects; Diffraction on complementary apertures	7	PAGE 122
LP5.4	POLARISATION	Polarisation filters; Photoelastic double refraction; Polarisation due to reflection and diffraction; Polarisation due to scattering; Optical activity	8	PAGE 128

ATOMIC AND NUCLEAR PHYSICS

EXPERIMENT TOPICS		CURRICULUM TOPICS	NO. EXPERIMENTS	DETAILS FROM
LP6.2	ENVIRONMENTAL RADIOACTIVITY	Introduction to radioactivity; Investigating the influence of sample properties and the size of the measurement window; Environmental radioactivity; Statistics of radioactive decay; Radiation shielding; Distance; Investigating the radiation in a magnetic field; Half-life	42	PAGE 136

Science Lab

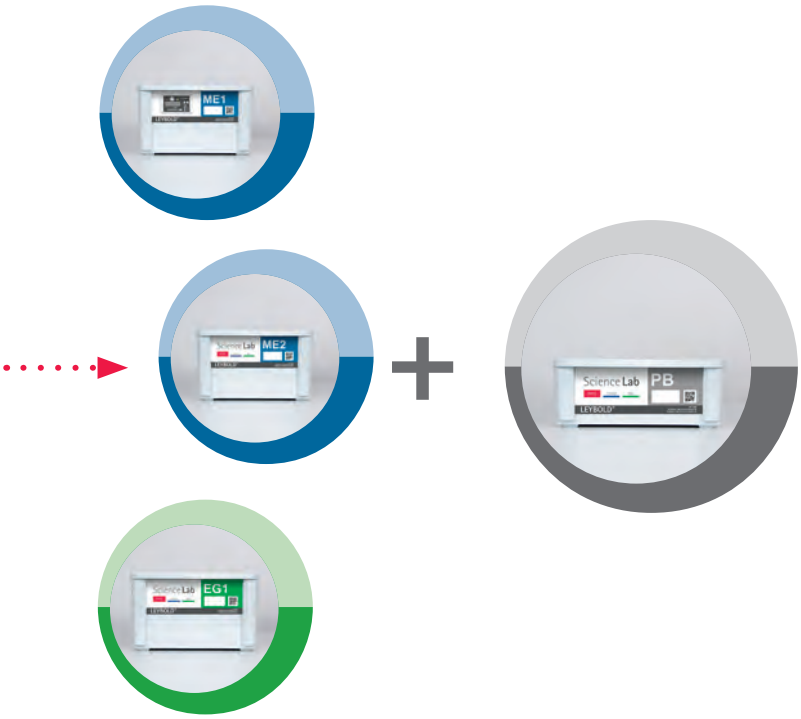
Physics Basic PB (207 100S)

BASIC SET FOR OUR INNOVATIVE STUDENT EXPERIMENT SYSTEM FOR PHYSICS

- This Basic Set contains **the basic devices** which are regularly needed for student experiments in physics.
- Each device has its own specified space in the pre-formed storage tray.
- In combination with the experiment set ME1 (207 111S) students can perform 15 experiments; with the experiment set ME2 (207 112S) 41 experiments and with the set EG1 (207 121S) 36 experiments can be realised.
- One Basic Set for the fields of mechanics and energy in physics and a maximum of two trays on the student workstation.

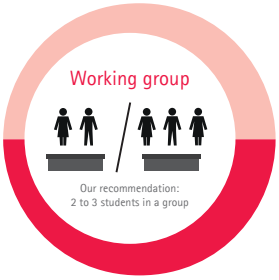
ADVANTAGES

- The Basic Set contains the material required for **one work group** consisting of 2-3 students.
- Experiments from the Science Lab Physics can then be carried out with only one additional set, depending on the topic.
- Same devices = always the same handling: no need to re-learn devices for every topic.



Science Lab Physics Basic PB (Set)

Student experiment set of the student experiment system Science Lab in the field of physics.
Basic equipment for mechanics and energy experiments. Set-up material for one working group in pre-formed tray.
The individual trays are stackable and can optionally be closed with a lid (647 003) .
The equipment set Science Lab Physics Basic PB, in combination with the Mechanics Sets ME1 (207 111S), ME2 (207 112S) and the Energy Set EG1 (207 121S), enables the performance of experiments at school, college and university level for worldwide curriculums.



Scope of delivery:

Count	Name
1	Bosshead S
2	Stand base MF
2	Support block
1	Stand rod 25 cm, 10 mm Ø
2	Stand rod 40 cm, 10 mm Ø
1	Pointer, pair
1	Universal pencil
1	Tape measure 2 m / 1 mm
1	Dynamometer, tension and compression, 1.5 N
3	Support clip, for plugging in
6	Weight, 50 g
1	Leaf spring 370 mm
1	Aluminium block
1	Tray, low
1	Universal bosshead
1	Scissors 125 mm, round-ended
1	Metal plate
1	Cord
1	Stopwatch, digital
207 100S	Science Lab Physics Basic PB (Set)

Additionally required:

Count	Cat.-No.	Name
1	207 111S	Science Lab Mechanics ME1 (Set)
1	207 112S*	Science Lab Mechanics ME2 (Set)
1	207 121S*	Science Lab Energy EG1 (Set)

* alternative

Additionally recommended:

Count	Cat.-No.	Name
1	647 003	Lid for tray

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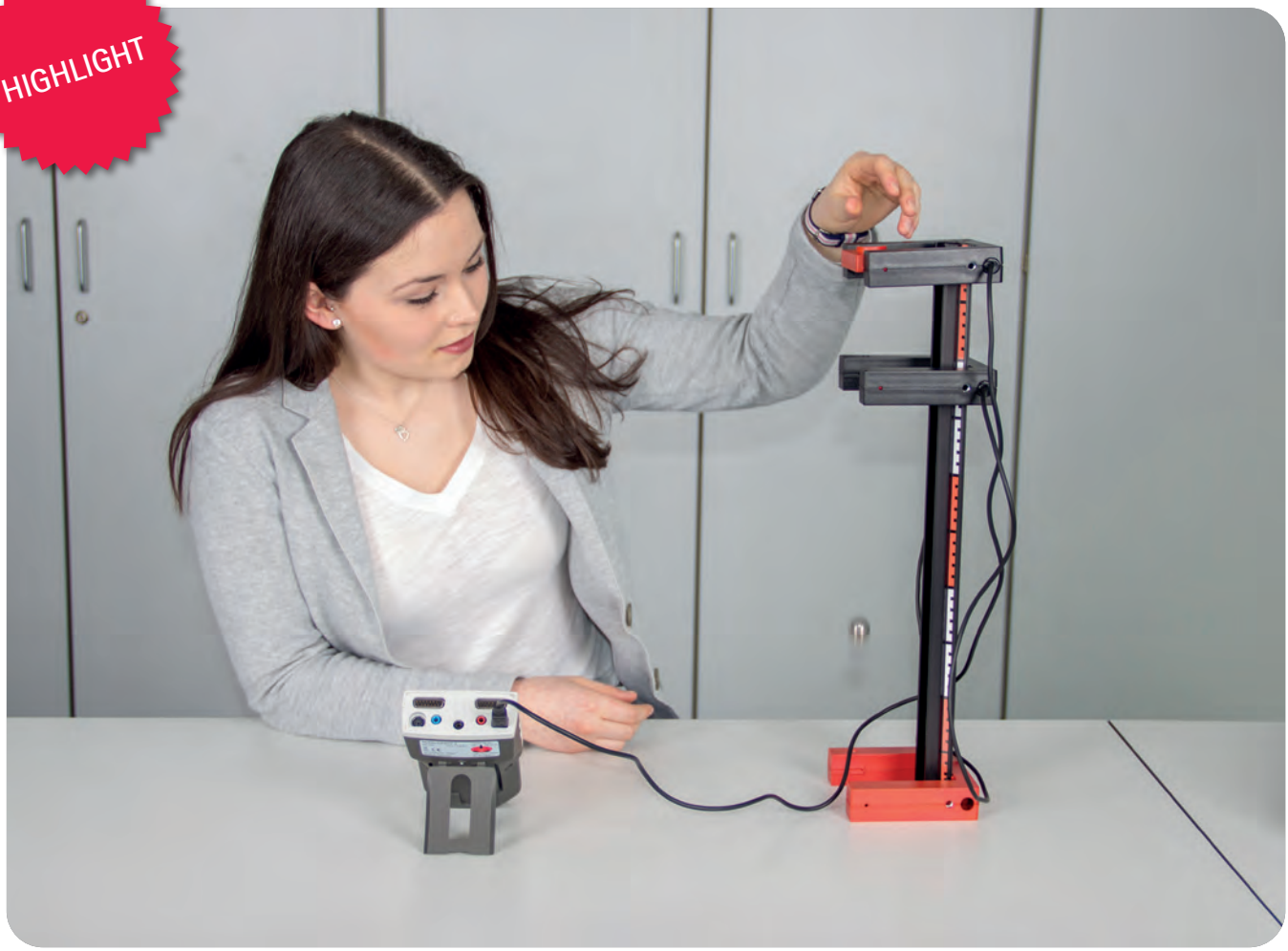
MECHANICS

Every physical variable also has a unit. To make students aware of this, the Science Lab for *Mechanics* starts with some very basic experiments on the topic of length and density. This also gives students the opportunity to concentrate completely on the description of the experiment protocol. Forces and oscillations as well as linear motion are included under the topic of mechanics. Here, time differences and velocities can be measured with the help of two light barriers. The topic of acoustics completes the mechanics section. From analysing noises to measuring the speed of sound - there is something for every age group.

One Basic Set and four Mechanics Sets provide *four* topic areas with 97 experiments. This perfect combination of experiments is suitable for perceivable experiments as well as for digital analysis with the Mobile-CASSY 2 WiFi and different sensors. For fast-working students additional tasks are available.

HIGHLIGHT



LP1.3.4.1C Determining the acceleration of gravity by plotting a *s*(t) diagram

Objects fall down when dropped. The gravitational acceleration involved can be measured in this experiment.
For this experiment you will need the set **Science Lab Mechanics ME3 (207 113S)**.

Overview of topics and sets

EXPERIMENT TOPICS		REQUIRED SETS	NO. EXPERIMENTS	DETAILS
LP1.1	**MEASURING METHODS, PROPERTIES OF MATTER AND LIQUID**			
LP1.1.1	MEASUREMENT OF LENGTH AND TIME	Basic PB + Mechanics ME1  207 100S + 207 111S	15	PAGE 26
LP1.1.2	MEASUREMENT OF MASS AND DENSITY			
LP1.1.3	PRESSURE IN LIQUIDS			
LP1.1.4	FORCES ACTING ON BODIES IN LIQUIDS			
LP1.1.5	FORCES ON THE SURFACE OF FLUIDS			
LP1.2	**FORCES, SIMPLE MACHINES AND OSCILLATIONS**			
LP1.2.1	MECHANICS OF SOLID BODIES	Basic PB + Mechanics ME2  207 100S + 207 112S	41	PAGE 32
LP1.2.2	DEFORMATION DUE TO A FORCE			
LP1.2.3	COMPOSITION AND DECOMPOSITION OF FORCES			
LP1.2.4	LEVERS			
LP1.2.5	PULLEY AND INCLINED PLANE			
LP1.2.6	HARMONIC OSCILLATIONS			
LP1.2.7	FORCED OSCILLATIONS AND STANDING WAVES			
LP1.2.8	SUPERPOSITION OF WAVES			
LP1.3	**LINEAR MOTION, FREE FALL AND COLLISION EXPERIMENTS**			
LP1.3.1	UNIFORM MOTION	Mechanics ME3  207 113S	20	PAGE 38
LP1.3.2	UNIFORMLY ACCELERATED MOTION			
LP1.3.3	NEWTON'S LAWS			
LP1.3.4	FREE FALL			
LP1.3.5	EXPERIMENTS ON ELASTIC COLLISIONS			
LP1.3.6	EXPERIMENTS ON INELASTIC COLLISIONS			
LP1.3.7	CONSERVATION OF MOMENTUM			
LP1.4	**ACOUSTICS**			
LP1.4.1	PROPAGATION OF SOUND	Mechanics ME4  207 114S	21	PAGE 44
LP1.4.2	OSCILLATIONS AND SOUNDS			
LP1.4.3	NOISE ANALYSIS			
LP1.4.4	RESONANCE AND BEATING			
LP1.4.5	SPEED OF SOUND			

Further information about our curriculum-compliant topics and student experiments as well as the corresponding sets can be found on the following pages.

MECHANICS – ME1

OVERVIEW OF OUR CURRICULUM-COMPLIANT EXPERIMENTS

Sensors		
	LP1.1	**MEASURING METHODS, PROPERTIES OF MATTER & LIQUID**
	LP1.1.1	Measurement of length and time
	LP1.1.1.1	Length measurement
	LP1.1.1.2	Calculating the volume of regularly shaped bodies
	LP1.1.1.3	Time measurement
	LP1.1.2	Measurement of mass and density
	LP1.1.2.1	Determining the density of regularly shaped bodies
	LP1.1.2.2	Determining the density of irregularly shaped bodies
	LP1.1.2.3	Determining the density of liquids
	LP1.1.3	Pressure in liquids
	LP1.1.3.1	Connected vessels
	LP1.1.3.2	Hydrostatic pressure
	LP1.1.3.3	The effects of air pressure
	LP1.1.4	Forces acting on bodies in liquids
	LP1.1.4.1	Buoyancy force as a function of depth of immersion and body mass
	LP1.1.4.2	Buoyancy force as a function of the density of a fluid
	LP1.1.4.3	Archimedes' principle
●	LP1.1.4.3C	Archimedes' principle (with Mobile-CASSY 2 WiFi) DIGITAL
	LP1.1.4.4	Sinking - floating suspended in a liquid - floating on a liquid
	LP1.1.5	Forces on the surface of fluids
	LP1.1.5.1	Capillary action

15 EXPERIMENTS

For experiments marked with „C", the measurements are carried out **digitally** with the Mobile-CASSY 2 WiFi.

● Force sensor M, ±50 N

LP1.1.4.3 Archimedes' principle

HIGHLIGHT

LP1.1.3.2 Hydrostatic pressure

Students use a U-tube manometer and a pressure probe to detect that hydrostatic pressure is increasing in proportion to depth.
For this experiment you will need the sets **Science Lab Physics Basic PB (207 100S)** and **Science Lab Mechanics ME1 (207 111S)**.

OVERVIEW OF EQUIPMENT REQUIRED FOR PERFORMING EXPERIMENTS

LP1.1 MEASURING METHODS, PROPERTIES OF MATTER AND LIQUID

BASIC SET	TOPIC SET	DIGITAL MEASURING DEVICE	LITERATURE
Physics Basic PB	Mechanics ME1	Mobile-CASSY 2 WiFi	Science Lab Mechanics digital

Detailed information on the above listed and **additionally required equipment** is available on the following pages.

Science Lab Mechanics ME1 (Set)

Student experiment set of the student experiment system Science Lab in the field of physics. Set-up material for one working group in pre-formed tray.
With the equipment set ME1, together with the Science Lab Physics Basic PB (207 100S), 15 experiments at school, college and university level for worldwide curriculums can be performed.
The students deal with the topics measuring methods, properties of matter and liquids. While working out the curriculum required topics, they are also trained in communication and assessment skills. In combination with the Mobile-CASSY 2 WiFi (524 005W), there are additional evaluation options which enable the students digital learning.

Scope of delivery:

Count	Name
1	Funnel PE 40 mm Ø
1	Vernier callipers
1	Rubber rings, set of 8
1	Double pipe support
2	Transparent tube with 2 caps
1	Pressure probe
1	Steel balls in can
1	Capillary apparatus
1	Measuring cylinder 100 ml
1	Tray, high

Count	Name
1	Beaker, PP, 250 ml, squat
1	Petri dish 60 mm
1	Connector, straight, 6/8 mm Ø
1	Plastic tube 240 x 25 mm Ø
1	Universal clamp 0...80 mm
1	Silicone tubing 7 mm Ø, 1 m
1	Rubber stopper with hole, 17...23 mm Ø
1	Rubber stopper solid, 19...24 mm Ø
1	Round tin with cap
207 111S	Science Lab Mechanics ME1 (Set)

ADDITIONALLY REQUIRED TO PERFORM ALL EXPERIMENTS

Additionally required per working group

Count	Cat.-No.	Name	Description
1	207 100S	Science Lab Physics Basic PB (Set)	
1	315 234	Electronic balance MAULtronic S	Measurement of mass and density experiments (LP1.1.2)
1	524 005W	Mobile-CASSY 2 WiFi	for digital experiments
1	524 434	Force sensor M, ±50 N	

Additionally required per class

Count	Cat.-No.	Name	Description
1	520 711	LIT: LP1 Science Lab Mechanics, digital	

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OVERVIEW OF ADVANTAGES

- Students learn about units of measurement
- Simple calculations to determine densities
- Includes a "pressure probe" for measuring the hydrostatic pressure
- Devices can be combined to perform many different experiments
- Acquired skills: writing experiment protocols; differentiation between observation, measurement and evaluation

STUDENT MEASURING DEVICE

DIGITAL CLASS / EDUCATION

Mobile-CASSY 2 WiFi

The universal student measuring device with WiFi for all measuring tasks in physics, chemistry and biology.

524 005W	Mobile-CASSY 2 WiFi

You can find detailed information on the Mobile-CASSY 2 WiFi on page 228.

SENSORS

Force sensor M, ±50 N ●

For measuring force components up to ±50 N (e.g. spring pendulum or centrifugal force components) with Mobile-CASSY 2 WiFi (524 005W). Its rigid design enables the measurement of force components in any position of the force sensor.

524 434	Force sensor M, ±50 N

You can find detailed information on this and other sensors from page 229.

LITERATURE PACKAGES

Here you will find an overview of our literature packages.
You can find detailed information on our literature on the internet at www.leybold-shop.com.

TOPIC

LIT: LP1.1 Measuring methods, properties of matter & liquids

Printed version available in ring file

Detailed experiment instructions relating to Science Lab Set ME1 (207 111S) and Science Lab Physics Basic PB (207 100S). Describes 15 experiments from the fields of measuring methods, properties of matter and liquids.

Topics:
Measurement of length and time; Measurement of mass and density; Pressure in liquids; Forces acting on bodies in liquids; Forces on the surface of liquids

520 7111EN	LIT: LP1.1 Measuring methods, properties of matter & liquids	

SUBJECT AREA

LIT: LP1 Science Lab Mechanics, digital

Includes only ONE subject area

Comprehensive physics experiment instructions in the field of mechanics for the Science Lab.
Contains 97 experiments on measuring methods, properties of matter and liquid; forces, simple machines and oscillations; linear motion, free fall and collisions experiments; acoustics.

Includes all interactive experiment instructions (Lab Docs) as html file.

520 711	LIT: LP1 Science Lab Mechanics, digital	

SUBJECT

LIT: LP Science Lab Physics, digital

Includes ALL subject areas

Comprehensive physics experiment instructions for the Science Lab. Contains 450 experiments in the fields of mechanics, energy, electricity and electronics, optics, atomic and nuclear physics.

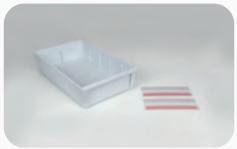
Includes all interactive experiment instructions (Lab Docs) as html file.

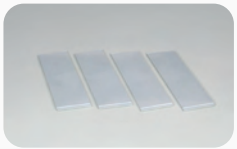
520 71	LIT: LP Science Lab Physics, digital	

Technical data of the digital version:

- Product key for literature (activation & selection of one literature language in LeyLab)
- Can then be used in LeyLab and Document Center (school/institute licence)
- System requirements:
  Document Center:
  - PC with Windows 7 or higher; internet access during installation; local network for distribution to students
  LeyLab:
  - PC, tablet or smartphone with a current browser; internet access

ADDITIONAL STORAGE ACCESSORIES



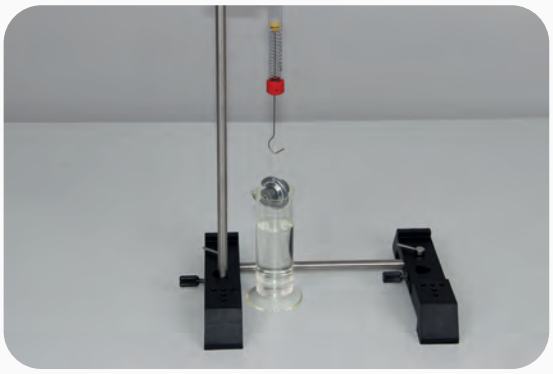

You can find detailed information on additional storage accessories from page 228.

INTRODUCING THE TOPIC

Introducing physical variables

IMPRESSIVELY ILLUSTRATED IN EXPERIMENTS

- Comprehensible introduction to the first physical variables
- Effective experiments which quickly teach content-related skills and make students enthusiastic about physics classes/lectures
- Creates links between "weighing" as an everyday experience with physics-related questions of "gravitational force"



SAFE AND EASY TO UNDERSTAND

- Easy-to-use devices
- Manageable number of devices
- Quick set-up

MECHANICS – ME2

OVERVIEW OF OUR CURRICULUM-COMPLIANT EXPERIMENTS

Sensors		
	LP1.2	**FORCES, SIMPLE MACHINES AND OSCILLATIONS**
	LP1.2.1	Mechanics of solid bodies
	LP1.2.1.1	Types of friction generated by solid bodies
	LP1.2.1.2	Sliding friction (quantitative)
	LP1.2.1.3	Centre of gravity
	LP1.2.1.4	Stability
	LP1.2.2	Deformation due to a force
	LP1.2.2.1	Elongation of a helical spring (Hooke's law)
	LP1.2.2.2	Elongation of a rubber ring
	LP1.2.2.3	Deflection of a leaf spring
	LP1.2.3	Composition and decomposition of forces
	LP1.2.3.1	Composition of forces in the same or opposing directions
	LP1.2.3.2	Composition of forces in specified amounts
	LP1.2.3.3	Decomposition of a force into force components
	LP1.2.4	Levers
	LP1.2.4.1	Two-sided lever
	LP1.2.4.2	Two-sided lever with several forces acting upon it
	LP1.2.4.3	Beam balance
	LP1.2.4.4	One-sided lever
	LP1.2.4.5	Shaft-mounted wheel
	LP1.2.4.6	Belt-driven gear
	LP1.2.5	Pulley and inclined plane
	LP1.2.5.1	Fixed pulley
	LP1.2.5.2	Movable pulley
	LP1.2.5.3	Hoist with two pulleys
	LP1.2.5.4	Block and tackle 1 (open type)
●	LP1.2.5.4C	Block and tackle 1 (open type) (with Mobile-CASSY 2 WiFi) DIGITAL
	LP1.2.5.5	Block and tackle 2 (compact type)
●	LP1.2.5.5C	Block and tackle 2 (compact type) (with Mobile-CASSY 2 WiFi) DIGITAL
	LP1.2.5.6	Forces on an inclined plane
●	LP1.2.5.6C	Forces on an inclined plane (with Mobile-CASSY 2 WiFi) DIGITAL
	LP1.2.5.7	Work on an inclined plane
●	LP1.2.5.7C	Work on an inclined plane (with Mobile-CASSY 2 WiFi) DIGITAL
	LP1.2.5.8	Conversion of energy
	LP1.2.6	Harmonic oscillations
	LP1.2.6.1	Thread pendulum (mathematical pendulum)
●	LP1.2.6.1C	Thread pendulum (mathematical pendulum) (with Mobile-CASSY 2 WiFi) DIGITAL
	LP1.2.6.2	Rod pendulum (physical pendulum)
●	LP1.2.6.2C	Rod pendulum (physical pendulum) (with Mobile-CASSY 2 WiFi) DIGITAL
	LP1.2.6.3	Helical spring pendulum
●	LP1.2.6.3C	Helical spring pendulum (with Mobile-CASSY 2 WiFi) DIGITAL
	LP1.2.6.4	Oscillation patterns
	LP1.2.7	Forced oscillations and standing waves
	LP1.2.7.1	Forced oscillations of pendulums
	LP1.2.7.2	Oscillations on a mechanically coupled rod pendulum
	LP1.2.7.2C	Oscillations on a mechanically coupled rod pendulum (with Mobile-CASSY 2 WiFi) DIGITAL
	LP1.2.7.3	Frequencies of standing thread waves
	LP1.2.7.4	Standing helical spring waves – nodes and anti-nodes as a function of the excitation frequency
	LP1.2.8	Superposition of waves
	LP1.2.8.1	Superposition of waves of the same frequency

41 EXPERIMENTS

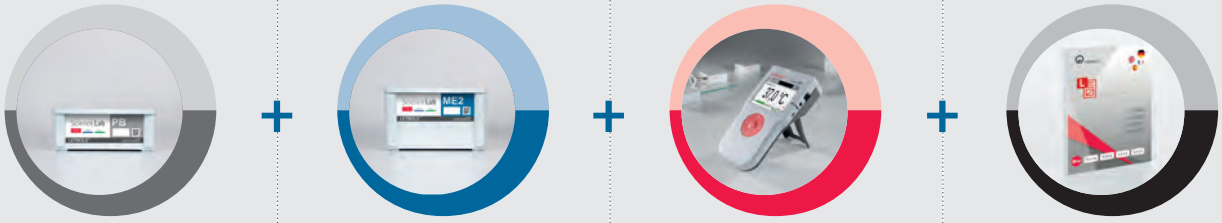
For experiments marked with „C", the measurements are carried out **digitally** with the Mobile-CASSY 2 WiFi. ● Force sensor M, ±50 N ● Light barrier M

LP1.2.5.5 Block and tackle 2 (compact type)

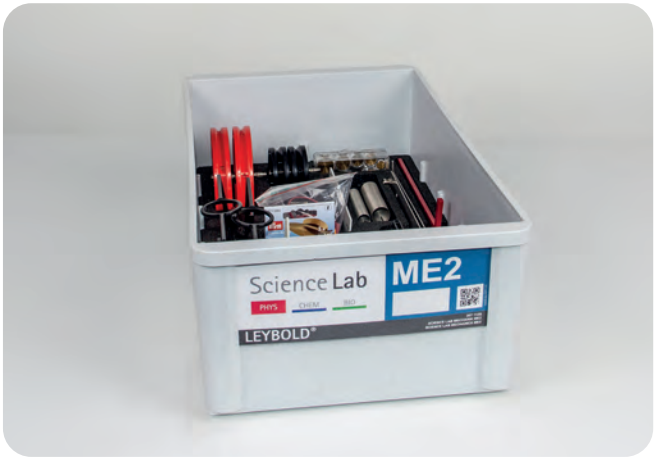
OVERVIEW OF EQUIPMENT REQUIRED FOR PERFORMING EXPERIMENTS

LP1.2 FORCES, SIMPLE MACHINES AND OSCILLATIONS

BASIC SET	TOPIC SET	DIGITAL MEASURING DEVICE	LITERATURE
Physics Basic PB	Mechanics ME2	Mobile-CASSY 2 WiFi	Science Lab Mechanics digital



Detailed information on the above listed and **additionally required equipment** is available on the following pages.



Science Lab Mechanics ME2 (Set)

Student experiment set of the student experiment system Science Lab in the field of physics. Set-up material for one working group in pre-formed tray. With the equipment set ME2, together with the Science Lab Physics Basic PB (207 100S), 41 experiments at school, college and university level for worldwide curriculums can be performed.
The students deal with the topics forces, simple machines and oscillations. While working out the curriculum required topics, they are also trained in communication and assessment skills. In combination with the Mobile-CASSY 2 WiFi (524 005W), there are additional evaluation options which enable the students digital learning.

Scope of delivery:

Count	Name
1	Dynamometers, tension and compression, 3 N
1	Plug-in axle
1	Double scale
1	Lever 37.5 cm
1	Load hook
1	Coupling plug 4 mm
1	Rubber rings, set of 8
2	Pulley Ø 50 mm, plug-in
2	Pulley Ø 100 mm, plug-in
2	Pulley bridge

Count	Name
2	Balance pan with stirrup
2	Bar pendulum 31.5 cm
1	Clamping block for pendulums
1	Helical spring 10 N/m
1	Helical spring 25 N/m
1	Set of weights 1 g to 50 g
1	Tray, high
1	Rubber cords 3 m

207 112S	Science Lab Mechanics ME2 (Set)

ADDITIONALLY REQUIRED TO PERFORM ALL EXPERIMENTS

Additionally required per working group

Count	Cat.-No.	Name	Description
1	207 100S	Science Lab Physics Basic PB (Set)	
1	524 005W	Mobile-CASSY 2 WiFi	for digital experiments
2	524 431	Light barrier M	
1	524 434	Force sensor M, ±50 N	
1	501 45	Connecting lead 19 A, 50 cm, red/blue, pair	Forced oscillations and standing waves experiments (LP1.2.7)
1	522 621	Function generator S 12	
1	579 42	Motor with rocker, STE 2/19	

Additionally required per class

Count	Cat.-No.	Name	Description
1	520 711	LIT: LP1 Science Lab Mechanics, digital	

leylab.de/207112S

OVERVIEW OF ADVANTAGES

- The term "lever" is illustrated with the help of a beam scale
- Versatile assembly options with our rollers: from fixed rollers to pulleys and gear units
- Experiments with manual induction of vibrations are equally possible as with controlled frequency (using an additional motor)
- Acquired skills: setting up more complex experiments

STUDENT MEASURING DEVICE

DIGITAL CLASS / EDUCATION

Mobile-CASSY 2 WiFi

The universal student measuring device with WiFi for all measuring tasks in physics, chemistry and biology.

524 005W	Mobile-CASSY 2 WiFi	

You can find detailed information on the Mobile-CASSY 2 WiFi on page 228.

SENSORS

Force sensor M, ±50 N ●

For measuring force components up to ±50 N (e.g. spring pendulum or centrifugal force components) with Mobile-CASSY 2 WiFi (524 005W). Its rigid design enables the measurement of force components in any position of the force sensor.

524 434	Force sensor M, ±50 N

Light barrier M ●

Cascadable photoelectric barrier for measuring period durations, travelling time, paths and velocities on the student track or during free fall with Mobile-CASSY 2 WiFi (524 005W).

524 431	Light barrier M	

You can find detailed information on these and other sensors from page 229.

LITERATURE PACKAGES

Here you will find an overview of our literature packages.
You can find detailed information on our literature on the internet at www.leybold-shop.com.

TOPIC

LIT: LP1.2 Forces, simple machines and oscillations

Printed version available in ring file

Detailed experiment instructions relating to Science Lab Set ME2 (207 112S) and Science Lab Physics Basic PB (207 100S). Describes 41 experiments from the fields of forces, simple machines and oscillations.

Topics:
Mechanics of solid bodies; Deformation due to a force; Composition and decomposition of forces; Levers; Pulley and inclined plane; Harmonic oscillations; Forced oscillations and standing waves; Superposition of waves

520 7112EN	LIT: LP1.2 Forces, simple machines and oscillations	

SUBJECT AREA

LIT: LP1 Science Lab Mechanics, digital

Includes only ONE subject area

Comprehensive physics experiment instructions in the field of mechanics for the Science Lab.
Contains 97 experiments on measuring methods, properties of matter and liquid; forces, simple machines and oscillations; linear motion, free fall and collisions experiments; acoustics.

Includes all interactive experiment instructions (Lab Docs) as html file.

520 711	LIT: LP1 Science Lab Mechanics, digital	

SUBJECT

LIT: LP Science Lab Physics, digital

Includes ALL subject areas

Comprehensive physics experiment instructions for the Science Lab. Contains 450 experiments in the fields of mechanics, energy, electricity and electronics, optics, atomic and nuclear physics.

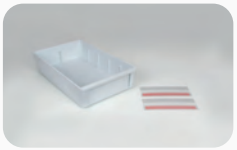
Includes all interactive experiment instructions (Lab Docs) as html file.

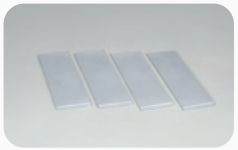
520 71	LIT: LP Science Lab Physics, digital	

Technical data of the digital version:

- Product key for literature (activation & selection of one literature language in LeyLab)
- Can then be used in LeyLab and Document Center (school/institute licence)
- System requirements:
  Document Center:
  - PC with Windows 7 or higher; internet access during installation; local network for distribution to students
  LeyLab:
  - PC, tablet or smartphone with a current browser; internet access

ADDITIONAL STORAGE ACCESSORIES





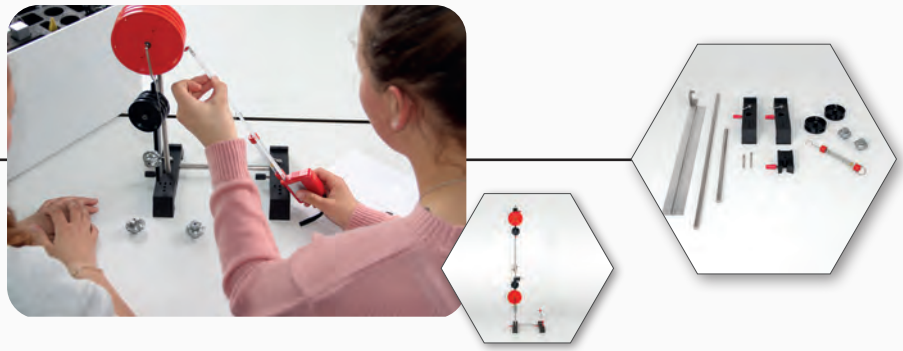
You can find detailed information on additional storage accessories from page 228.

INTRODUCING THE TOPIC

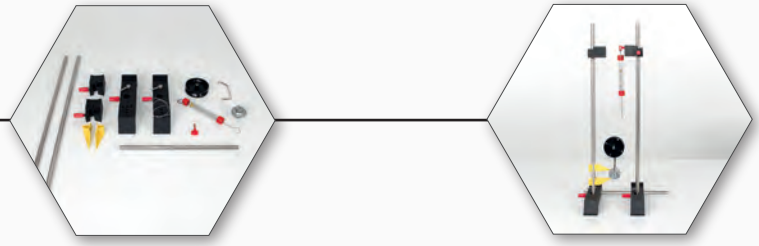
The fantastic four

JUST A FEW STEPS TO EXCITING EXPERIMENTS

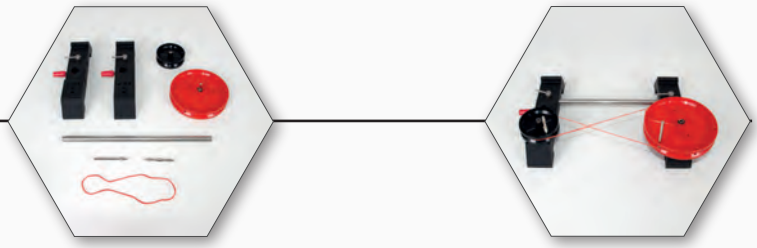
BLOCK & TACKLE



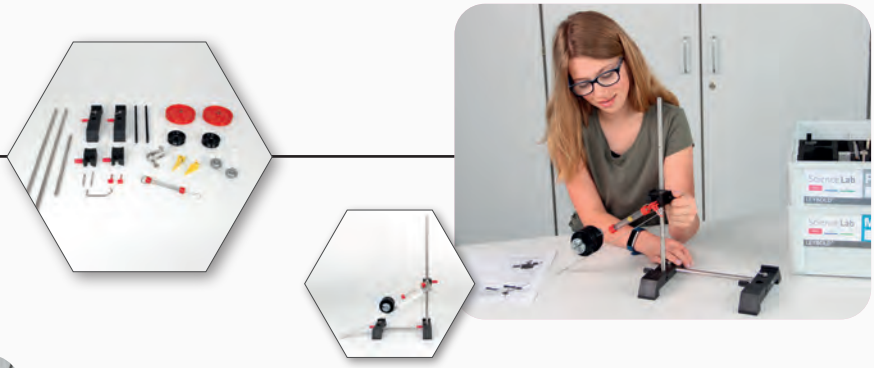
LOOSE PULLEY

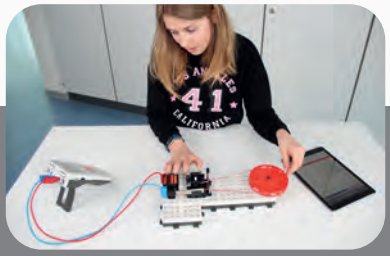


BELT DRIVE



INCLINED PLANE





The pulley is also used in student experiments on electricity.

MECHANICS – ME3

OVERVIEW OF OUR CURRICULUM-COMPLIANT EXPERIMENTS

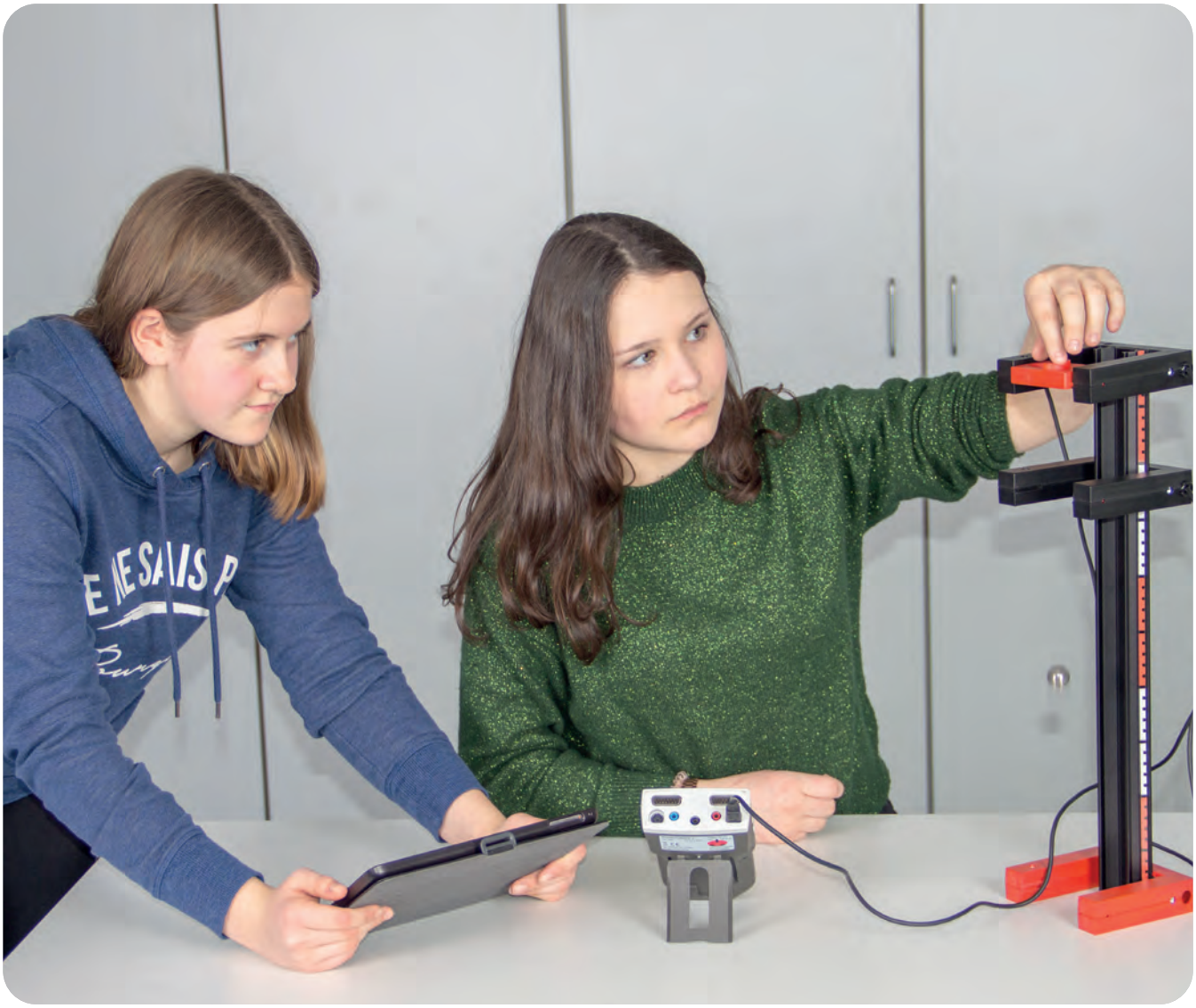
Sensors	LP1.3	LINEAR MOTION, FREE FALL AND COLLISION EXPERIMENTS	
	LP1.3.1	Uniform motion	
●	LP1.3.1.1C	Relation between distance and time (with Mobile-CASSY 2 WiFi)	DIGITAL
●	LP1.3.1.2C	Effect of friction - measurement of speeds (with Mobile-CASSY 2 WiFi)	DIGITAL
	LP1.3.2	Uniformly accelerated motion	
●	LP1.3.2.1C	Relation between distance and time (with Mobile-CASSY 2 WiFi)	DIGITAL
●	LP1.3.2.2C	Instantaneous speed (with Mobile-CASSY 2 WiFi)	DIGITAL
●	LP1.3.2.3C	Uniformly accelerated motion using a spoked wheel (with Mobile-CASSY 2 WiFi)	DIGITAL
●	LP1.3.2.4C	Relation between velocity and time (with Mobile-CASSY 2 WiFi)	DIGITAL
	LP1.3.3	Newton's laws	
●	LP1.3.3.1C	Relation between force and acceleration (with Mobile-CASSY 2 WiFi)	DIGITAL
●	LP1.3.3.2C	Relation between mass and acceleration (with Mobile-CASSY 2 WiFi)	DIGITAL
	LP1.3.4	Free fall	
●	LP1.3.4.1C	Determining the acceleration of gravity by plotting a $s(t)$ diagram (with Mobile-CASSY 2 WiFi)	DIGITAL
●	LP1.3.4.2C	Determining the acceleration of gravity by plotting a $v(t)$ diagram (with Mobile-CASSY 2 WiFi)	DIGITAL
	LP1.3.5	Experiments on elastic collisions	
●	LP1.3.5.1C	Elastic collisions between two moving trolleys of equal mass (with Mobile-CASSY 2 WiFi)	DIGITAL
●	LP1.3.5.2C	Elastic collisions between moving and stationary trolleys of equal mass (with Mobile-CASSY 2 WiFi)	DIGITAL
●	LP1.3.5.3C	Elastic collisions between moving and stationary trolleys ($m_1 < m_2$) (with Mobile-CASSY 2 WiFi)	DIGITAL
●	LP1.3.5.4C	Elastic collisions between moving and stationary trolleys ($m_1 > m_2$) (with Mobile-CASSY 2 WiFi)	DIGITAL
	LP1.3.6	Experiments on inelastic collisions	
●	LP1.3.6.1C	Inelastic collisions between two moving trolleys of equal mass (with Mobile-CASSY 2 WiFi)	DIGITAL
●	LP1.3.6.2C	Inelastic collisions between moving and stationary trolleys of equal mass (with Mobile-CASSY 2 WiFi)	DIGITAL
●	LP1.3.6.3C	Inelastic collisions between moving and stationary trolleys ($m_1 < m_2$) (with Mobile-CASSY 2 WiFi)	DIGITAL
●	LP1.3.6.4C	Inelastic collisions between moving and stationary trolleys ($m_1 > m_2$) (with Mobile-CASSY 2 WiFi)	DIGITAL
	LP1.3.7	Conservation of momentum	
●	LP1.3.7.1C	Explosive collisions in the case of trolleys of equal mass (with Mobile-CASSY 2 WiFi)	DIGITAL
●	LP1.3.7.2C	Explosive collisions in the case of trolleys of different mass (with Mobile-CASSY 2 WiFi)	DIGITAL

20 EXPERIMENTS

For experiments marked with „C", the measurements are carried out **digitally** with the Mobile-CASSY 2 WiFi.

● Light barrier M

LP1.3.2.3C Uniformly accelerated motion using a spoked wheel



LP1.3.4.1C Determining the acceleration of gravity by plotting a s(t) diagram

OVERVIEW OF EQUIPMENT REQUIRED FOR PERFORMING EXPERIMENTS

LP1.3 LINEAR MOTION, FREE FALL AND COLLISION EXPERIMENTS

TOPIC SET	DIGITAL MEASURING DEVICE	LITERATURE
Mechanics ME3	Mobile-CASSY 2 WiFi	Science Lab Mechanics digital
		

Detailed information on the above listed and **additionally required products** are available on the following pages.

Science Lab Mechanics ME3 (Set)

Student experiment set of the student experiment system Science Lab in the field of physics. Set-up material for one working group in pre-formed tray. With the equipment set ME3, together with the Mobile-CASSY 2 WiFi (524 005W), 20 experiments at school, college and university level for worldwide curriculums can be performed.
The students deal with the topics dynamic and motion. While working out the curriculum required topics, they are also trained in communication and assessment skills. And the combination with the Mobile-CASSY 2 WiFi (524 005W) enables the students to learn digitally.

Scope of delivery:

Count	Name
1	Fishing line
1 out of	Plasticine
1	Trolley
1	Spring and buffer
1	Driving weights, set
1	Additional weight 100 g
1	Additional weight 50 g
1	Steel ball 20 mm
2	Clamp rider

Count	Name
2	Light barrier M
1	Light barrier housing
1	Spoked wheel
1	Start jig, trolley
1	Start jig, ball
1	Tray, low
1	Extension pin

207 113S	Science Lab Mechanics ME3 (Set)

ADDITIONALLY REQUIRED TO PERFORM ALL EXPERIMENTS

Additionally required per working group

Count	Cat.-No.	Name	Description
1	460 81	Precision metal rail, 100 cm	
1	524 005W	Mobile-CASSY 2 WiFi	for digital experiments
1	337 00	Trolley	Collision experiments (LP1.3.5, LP1.3.6, LP1.3.7)

Additionally required per class

Count	Cat.-No.	Name	Description
1	520 711	LIT: LP1 Science Lab Mechanics, digital	

Additionally recommended per working group

Count	Cat.-No.	Name	Description
1	460 82	Precision metal rail, 50 cm	

leylab.de/207113S

OVERVIEW OF ADVANTAGES

- Light barrier with flexible mounting, e.g. for spoke wheel or start release (very precise switching due to small opening)
- Cascadable light barriers are included in the set
- Experiments in horizontal construction (Movements on a track) and in vertical construction (Free fall) possible
- Light precision metal rail is easy to handle and available in different lengths
- Trolley with low-friction operation, protected wheel bearings and roll-away protection
- Elastic and inelastic collision

STUDENT MEASURING DEVICE

DIGITAL CLASS / EDUCATION

Mobile-CASSY 2 WiFi

The universal student measuring device with WiFi for all measuring tasks in physics, chemistry and biology.

524 005W	Mobile-CASSY 2 WiFi	

You can find detailed information on the Mobile-CASSY 2 WiFi on page 228.

SENSORS

INCLUDED IN SCOPE OF DELIVERY

Light barrier M

Cascadable photoelectric barrier for measuring period durations, travelling time, paths and velocities on the student track or during free fall with Mobile-CASSY 2 WiFi (524 005W).

You can find detailed information on this and other sensors from page 229.

LITERATURE PACKAGES

Here you will find an overview of our literature packages.
You can find detailed information on our literature on the internet at www.leybold-shop.com.

TOPIC

LIT: LP1.3 Linear motion, free fall & collision experiments

Printed version available in ring file

Detailed experiment instructions relating to Science Lab Set ME3 (207 113S). Describes 20 experiments from the fields of linear motion, free fall and collision experiments.

Topics:
Uniform motion; Uniformly accelerated motion; Newton's laws; Free fall; Experiments on elastic collisions; Experiments on inelastic collisions; Conservation of momentum

520 7113EN	LIT: LP1.3 Linear motion, free fall and collision experiments	

SUBJECT AREA

LIT: LP1 Science Lab Mechanics, digital

Includes only ONE subject area

Comprehensive physics experiment instructions in the field of mechanics for the Science Lab.
Contains 97 experiments on measuring methods, properties of matter and liquid; forces, simple machines and oscillations; linear motion, free fall and collisions experiments; acoustics.

Includes all interactive experiment instructions (Lab Docs) as html file.

520 711	LIT: LP1 Science Lab Mechanics, digital	

SUBJECT

LIT: LP Science Lab Physics, digital

Includes ALL subject areas

Comprehensive physics experiment instructions for the Science Lab. Contains 450 experiments in the fields of mechanics, energy, electricity and electronics, optics, atomic and nuclear physics.

Includes all interactive experiment instructions (Lab Docs) as html file.

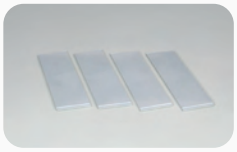
520 71	LIT: LP Science Lab Physics, digital	

Technical data of the digital version:

- Product key for literature (activation & selection of one literature language in LeyLab)
- Can then be used in LeyLab and Document Center (school/institute licence)
- System requirements:
  Document Center:
  - PC with Windows 7 or higher; internet access during installation; local network for distribution to students
  LeyLab:
  - PC, tablet or smartphone with a current browser; internet access

ADDITIONAL STORAGE ACCESSORIES




You can find detailed information on additional storage accessories from page 228.

INTRODUCING THE TOPIC

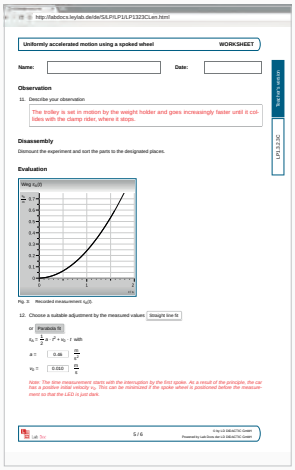
Benefit from digital measurement technology with Lab Docs

WORKSHEETS CAN BE ACCESSED AT ALL TIMES ON TABLET, SMARTPHONE OR LAPTOP

Experiment LP1.3.2.3C
Uniformly accelerated motion using a spoked wheel

TEACHER SECTION

- With sample answers and example measurements

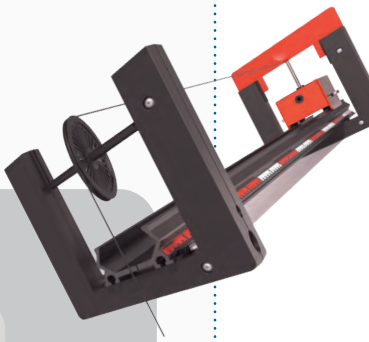


STUDENT SECTION

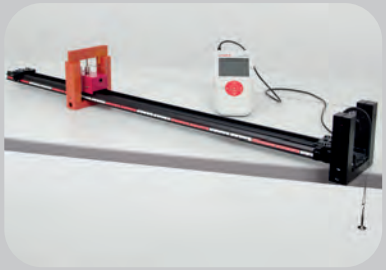
- While measuring, live measured values are transferred from the Mobile-CASSY 2 WiFi to the Lab Doc and ...
- displayed in the interactive measuring instruments, tables and diagrams in real time

In our example, you can see the currently measured distance s = 0.285 m both in the Mobile-CASSY 2 WiFi display and in the Lab Doc.

A SYSTEM FOR HORIZONTAL AND VERTICAL MOTION



HORIZONTAL: TRACK



Experiments on uniform and accelerated motion and experiments on collisions

VERTICAL: FREE FALL

Free fall experiments

- Devices such as the light barrier are used in many experiments and are familiar to students, meaning it takes less time to set up the experiment
- Efficient use of materials

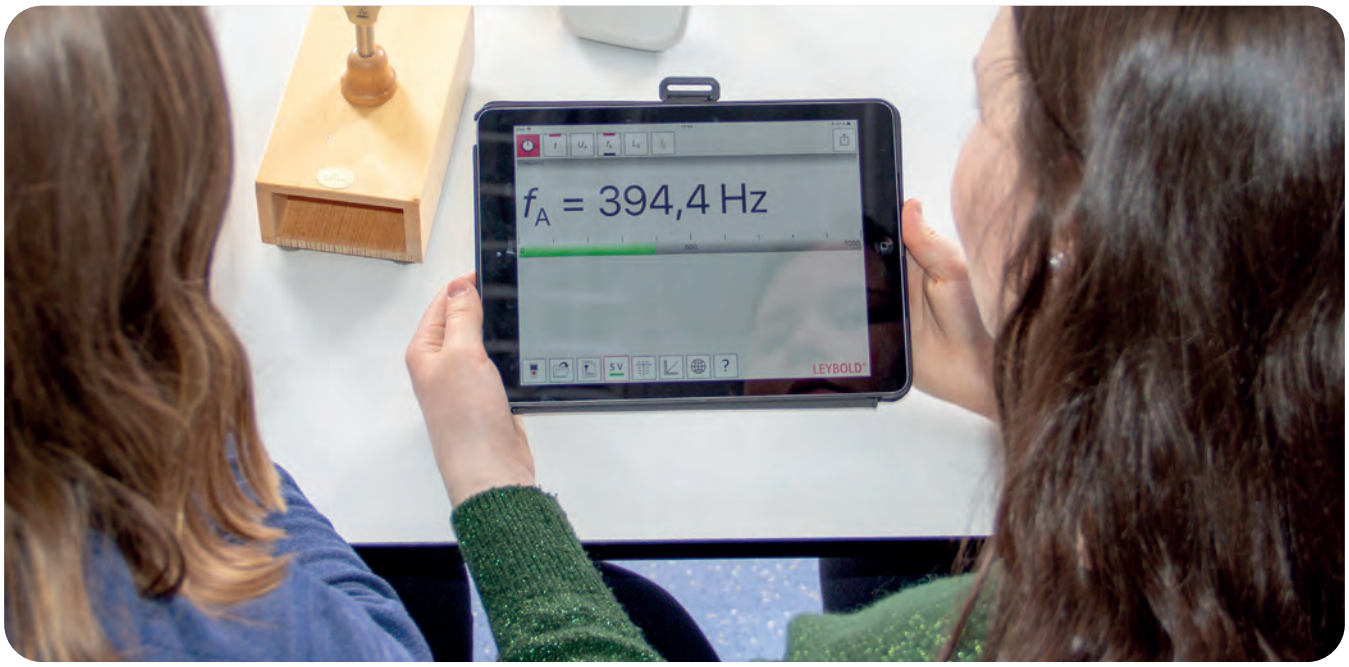
MECHANICS – ME4

OVERVIEW OF OUR CURRICULUM-COMPLIANT EXPERIMENTS

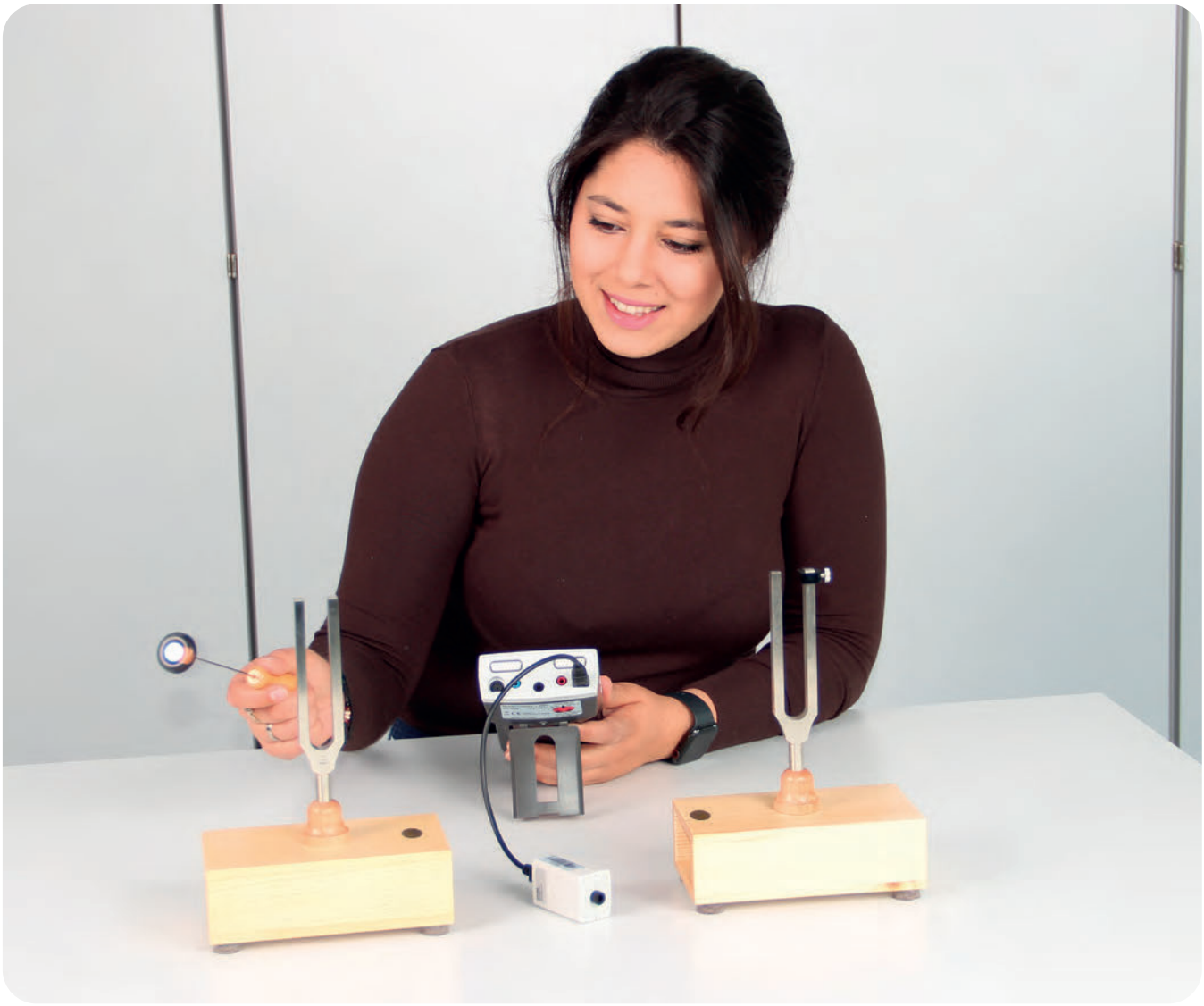
Sensors		
	LP1.4	**ACOUSTICS**
	LP1.4.1	Propagation of sound
	LP1.4.1.1	Propagation of sound in the air
	LP1.4.1.2	Propagation of sound in solids
	LP1.4.1.3	Propagation of sound in water
	LP1.4.2	Oscillations and sounds
	LP1.4.2.1	Oscillations of a tuning fork 1
	LP1.4.2.2	Oscillations of a tuning fork 2
	LP1.4.2.3	Sound generation 1
	LP1.4.2.4	Sound generation 2
●	LP1.4.2.5C	Oscillation patterns (with Mobile-CASSY 2 WiFi) DIGITAL
	LP1.4.3	Noise analysis
●	LP1.4.3.1C	Measuring sound levels (with Mobile-CASSY 2 WiFi) DIGITAL
	LP1.4.3.2	Noise vs. music
	LP1.4.3.3	Noise protection
●	LP1.4.3.3C	Noise protection (with Mobile-CASSY 2 WiFi) DIGITAL
	LP1.4.3.4	Reflection of sound
●	LP1.4.3.4C	Reflection of sound (with Mobile-CASSY 2 WiFi) DIGITAL
●	LP1.4.3.5C	Measurement of frequencies (with Mobile-CASSY 2 WiFi) DIGITAL
	LP1.4.4	Resonance and beating
	LP1.4.4.1	Resonating bodies
	LP1.4.4.2	Transmitter-receiver principle
	LP1.4.4.3	Beat
●	LP1.4.4.3C	Beat (with Mobile-CASSY 2 WiFi) DIGITAL
	LP1.4.5	Speed of sound
●	LP1.4.5.1C	Measurement of the speed of sound (with Mobile-CASSY 2 WiFi) DIGITAL
●	LP1.4.5.2C	Measurement of the speed of sound with 2 microphones (with Mobile-CASSY 2 WiFi) DIGITAL

21 EXPERIMENTS

For experiments marked with „C", the measurements are carried out **digitally** with the Mobile-CASSY 2 WiFi. ● Microphone M



LP1.4.3.5C Measurement of frequencies



LP1.4.4.3C Beat

OVERVIEW OF EQUIPMENT REQUIRED FOR PERFORMING EXPERIMENTS

LP1.4 ACOUSTICS

TOPIC SET	DIGITAL MEASURING DEVICE	LITERATURE
Mechanics ME4	Mobile-CASSY 2 WiFi	Science Lab Mechanics digital
		

Detailed information on the above listed and **additionally required products** are available on the following pages.

Science Lab Mechanics ME4 (Set)

Student experiment set of the student experiment system Science Lab in the field of physics. Set-up material for one working group in pre-formed tray.
With the equipment set ME4, 21 experiments at school, college and university level for worldwide curriculums can be performed.
The students deal with the topics acoustic oscillations and sound. While working out the curriculum required topics, they are also trained in communication and assessment skills. In combination with the Mobile-CASSY 2 WiFi (524 005W), there are additional evaluation options which enable the students digital learning.

Scope of delivery:

Count	Name
1	Tubing 8 mm Ø, 1 m, plastic
1	Ruler 15 cm
1	Rubber rings, set of 8
1	Resonance tuning fork
1	Adapter cable 9 V/4 mm
3	Test tube DURAN 16 x 160 mm
1	Tray, high

Count	Name
1	Beaker, PP, 250 ml, squat
2	Funnel PP 75 mm Ø
1	Rubber balloons, set of 10
1	Battery 9 V (block)
1	Sound absorber

207 114S	Science Lab Mechanics ME4 (Set)

ADDITIONALLY REQUIRED TO PERFORM ALL EXPERIMENTS

Additionally required per working group

Count	Cat.-No.	Name	Description
1	414 42	Resonance tuning fork	Resonance and beating experiments (LP1.4.4)
1	524 005W	Mobile-CASSY 2 WiFi	for digital experiments
2	524 442	Microphone M	

Additionally required per class

Count	Cat.-No.	Name	Description
1	520 711	LIT: LP1 Science Lab Mechanics, digital	

leylabde/207114S

OVERVIEW OF ADVANTAGES

- With Mobile-CASSY 2 WiFi and the microphone M, even challenging acoustics experiments are possible (e.g. vibrations)
- Investigation of own materials during noise analysis possible
- Acquired skills: Comparison of self-measured values with literature values using the speed of sound

STUDENT MEASURING DEVICE

DIGITAL CLASS / EDUCATION

Mobile-CASSY 2 WiFi

The universal student measuring device with WiFi for all measuring tasks in physics, chemistry and biology.

524 005W	Mobile-CASSY 2 WiFi	

You can find detailed information on the Mobile-CASSY 2 WiFi on page 228.

SENSORS

Microphone M

For measuring sound level, frequency and the voltage of acoustic signals with Mobile-CASSY 2 WiFi (524 005W).

524 442	Microphone M	

You can find detailed information on this and other sensors from page 229.

LITERATURE PACKAGES

Here you will find an overview of our literature packages.
You can find detailed information on our literature on the internet at www.leybold-shop.com.

TOPIC

LIT: LP1.4 Acoustics

Printed version available in ring file

Detailed experiment instructions relating to Science Lab Set ME4 (207 114S). Describes 21 experiments from the field of acoustics.

Topics:
Propagation of sound; Oscillations and sounds; Noise analysis; Resonance and beating; Speed of sound

520 7114EN	LIT: LP1.4 Acoustics	

SUBJECT AREA

LIT: LP1 Science Lab Mechanics, digital

includes only ONE subject area

Comprehensive physics experiment instructions in the field of mechanics for the Science Lab.
Contains 97 experiments on measuring methods, properties of matter and liquid; forces, simple machines and oscillations; linear motion, free fall and collisions experiments; acoustics.

Includes all interactive experiment instructions (Lab Docs) as html file.

520 711	LIT: LP1 Science Lab Mechanics, digital	

SUBJECT

LIT: LP Science Lab Physics, digital

includes ALL subject areas

Comprehensive physics experiment instructions for the Science Lab. Contains 450 experiments in the fields of mechanics, energy, electricity and electronics, optics, atomic and nuclear physics.

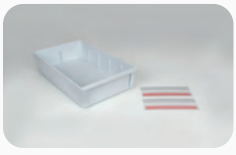
Includes all interactive experiment instructions (Lab Docs) as html file.

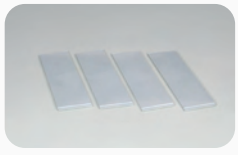
520 71	LIT: LP Science Lab Physics, digital	

Technical data of the digital version:

- Product key for literature (activation & selection of one literature language in LeyLab)
- Can then be used in LeyLab and Document Center (school/institute licence)
- System requirements:
  Document Center:
  - PC with Windows 7 or higher; internet access during installation; local network for distribution to students
  LeyLab:
  - PC, tablet or smartphone with a current browser; internet access

ADDITIONAL STORAGE ACCESSORIES

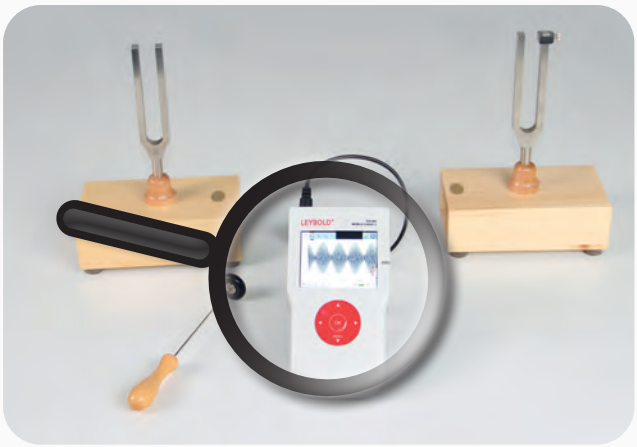



You can find detailed information on additional storage accessories from page 228.

INTRODUCING THE TOPIC

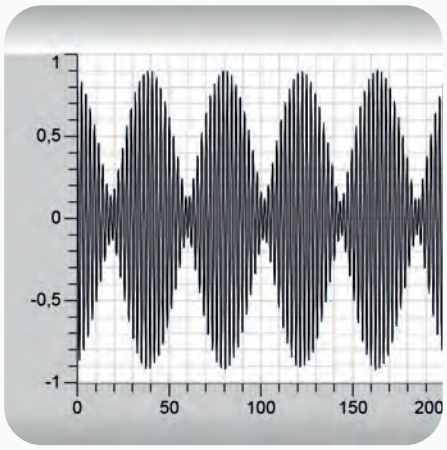
Make acoustic phenomena visible with Mobile-CASSY 2 WiFi



VISUALISE BEATS IN REAL TIME

- The beats resulting from the superposition of two oscillations can be measured and displayed easily on Mobile-CASSY 2 WiFi
- The complex graph with increasing and decreasing amplitude can only be detected digitally and with a fast measuring system

Explore well-known everyday experiences and physical phenomena using digital measuring devices



THE IDEAL STUDENT MEASURING DEVICE MOBILE-CASSY 2 WIFI

- Automatic recognition of microphone M sensor
- Easy connection to Lab Doc "Beats"
- Settings imported from Lab Doc
- Quick recording of measured values
- Measured values are directly transferred to the Lab Doc tables and diagrams
- Students have the measured values and the beat corresponding graph visualisation in their own digital protocol
- Can also be used as a standalone device with its large, graphics-capable display for high-contrast diagrams