Schola Europaea

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Pedagogical Development Unit

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Laboratory Syllabus – Physics – Supplementary Course

APPROVED BY THE JOINT TEACHING COMMITTEE ON the 9th AND 10th FEBRUARY 2017 IN BRUSSELS.

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1st September 2018 for S7

Attainment Descriptors:

1st September 2019 for S6

1st September 2020 for S7

Laboratory Physics - Syllabus

1. General Objectives of the European Schools

The European Schools have the two objectives of providing formal education and of encouraging pupils' personal development in a wider social and cultural context. Formal education involves the acquisition of competences (knowledge, skills and attitudes) across a range of domains. Personal development takes place in a variety of intellectual, moral, social and cultural contexts. It requires pupils to be aware of appropriate behaviour, to understand their environment, and to develop their individual identities.

These two objectives are nurtured in the context of an enhanced awareness of the richness of European culture. Awareness and experience of a shared European life should lead pupils towards a greater respect for the traditions of each individual country and region in Europe, while developing and preserving their own national identities.

The pupils of the European Schools are future citizens of Europe and the world. As such, they need a range of competences if they are to meet the challenges of a constantly changing world. In 2006 the Council of Europe and the European Parliament approved a European Framework for Key Competences for Lifelong Learning. It identifies eight key competences which all individuals need for personal fulfilment and development, for active citizenship, for social inclusion and for employment.

1. Communication in the mother tongue
2. Communication in foreign languages
3. Mathematical competence and competence in science, technology and engineering
4. Digital competence
5. Learning to learn competence
6. Social and civic competences
7. The spirit of initiative and entrepreneurship
8. Cultural awareness and expression

The European Schools' syllabi seek to develop all of these key competences in the pupils.

2. Didactical Principles

The overall objective of this course is to develop the skills, knowledge and understanding necessary to conduct experiments, research, and practical investigations. The course will focus on the principles and practice of investigative science as well as its communication.

The collection of experimental data will provide the opportunity to develop planning and organizational skills. Students will focus on research questions and will apply skills that will develop their scientific knowledge.

The course covers key areas such as scientific principles and methods, experimentation and critical evaluation in the field of scientific research.

Throughout this course, students will strengthen important skills in science such as the development of scientific thinking and analytical skills. These skills will enable them, among other things, to manifest an informed and ethical vision of complex issues.

Students will also be able to develop their communication skills, both written and oral, their ability to work in a group and to exercise their critical thinking skills in new and unfamiliar contexts, when solving problems. This will enable them to become scientifically literate citizens, capable of making rational decisions.

The order, nature and number of experiments are not fixed because there are many situations to be considered such as the availability of equipment and materials.

Since laboratory work requires considerable time, a laboratory session must be planned over two consecutive class periods.

3. Learning Objectives

At the end of the seventh year, students should be able to

- use scientific knowledge to analyse problems and apply it to new situations;
- process and analyse, qualitatively and quantitatively, scientific information and data from a variety of sources, including scientific publications and media reports;
- plan and design experiments, using reference information;
- identify the potential dangers of the experiments conducted, assess the associated risks and apply appropriate precautions;
- record detailed observations and collect data accurately;
- produce, describe and analyse different types of graphs;

- draw valid conclusions and give explanations supported by justifications;
- critically evaluate experimental procedures by identifying sources of error, suggesting and implementing improvements;
- communicate clearly, using appropriate scientific vocabulary;
- demonstrate strong presentation skills;
- work constructively as a member of a team.

4. Content

At least two of the proposed topics, must be covered in both S6 and S7. Complementary experiments to those indicated, can of course be conducted.

The key words, proposed for guidance in the following tables, should be able to help the teacher to delimit the scientific content of each topic.

S6

TOPIC	CONTENT	KEYWORDS
GEOMETRICAL OPTICS	- Convergent and divergent lenses - Plane, convex and concave mirrors - Optical instruments (magnifying glass, refracting telescope, reflecting telescope, microscope …) - Chromatic and spherical aberration - Equations (Descartes or Newton)	Refraction, reflection Dioptre Radii of curvature of the surfaces of a lens Focal length Vergence (Power of a lens) Real or virtual image Focus Light beam Paraxial condition Diaphragm Field of view Magnification
RIGID BODY MECHANICS	- Moment of a force; resultant moment - A Couple - Moment of Inertia - Conditions of equilibrium (translational and rotational equilibrium) - Solid body movement - Mechanical oscillators - Mechanical resonance - Coupled oscillators	Centre of gravity Moment arm Torque Parallel – Axis theorem (Huygens theorem) Simple vertical pendulum Horizontal spring pendulum Exciter Resonator Natural frequency Maintenance of oscillations Forced oscillations Damping
KINETIC THEORY OF GASES **FLUID STATICS/ FLUID DYNAMICS**	- Boyle's Law ($PV =$ constant if T = constant) - Gay Lussac – Charles Laws ($V/T =$constant if $P =$constant and $P/T =$ constant if $V =$ constant) - Microscopic aspect of gas pressure - Equation of state of an ideal gas - Hydrostatic pressure - Fluid Dynamics (Bernoulli Theorem)	Kinetic Pressure Kinetic temperature Pressure = Force/Area Collision frequency Elastic collisions Hydraulic press Density of a liquid Pascal's Theorem Manometer Hydrostatics Archimedes' Theorem Capillarity Laminar, transient and turbulent flows Reynold's number Bernoulli's equation Regular pressure loss Venturi Effect

MAGNETISM AND SOME APPLICATIONS	Measurement of the magnetic force due to a current (current balance, Barlow's wheel ….)	Loudspeaker Magnetic Couple on a mobile frame Bipolar direct current motor Stator Rotor Induced electromotive force Eddy (Foucault) currents Induction Coil

S7

TOPIC	CONTENT	KEYWORDS
WAVE OPTICS	- Spectroscopy (calibration of a prism spectrometer and determination of wavelengths) - Polarization of electromagnetic waves (light, microwaves, radio waves...) - Optical fibres	Spectral lamps Collimator Polarizer and analyser Polaroids Core and cladding Total internal reflection Multimode optical fibre
MUSICAL ACOUSTICS	- Natural scale, temperate scale - transposition - Physiological characteristics of sounds (pitch, intensity, timbre/quality) - Fourier analysis of a sound - Acoustics and architecture (reflection, absorption by materials)	Audiogram Sound Level Meter Sound processing Wind and string instruments, Electronic instruments Auditorium Reverberation Anechoic chamber Sound insulation Active noise control Reverberation time
ALTERNATING CURRENT	- Impedances - Voltage-current phase shift - R-L-C circuits (series - parallel) - R-C high-pass and low-pass filters - Analogy to mechanical oscillators - Single-phase transformers (step-down and step-up of voltage and current) - Power transmission (line losses)	Oscilloscope Fresnel Vectors Complex impedances (example: Steinmetz method) Tuning circuit (plug circuit) Cut-off frequency Critical Resistance Frequency response Current resonance Voltage resonance Quality factor Efficiency and power of a transformer
ELECTRONICS	- Semiconductors (diodes, bipolar transistors...) - Logic circuits - Transmission and reception of electromagnetic signals (amplitude modulation/demodulation, frequency modulation)	Resistivity p-n junction Switching Amplification Truth tables Binary adder Bandwidth Modulation of the carrier Multiplier Quality of modulation Demodulator

5. Assessment

The assessment can be based on the student's level of participation, the reports prepared by the student, their projects, presentations and communication skills (cf. Annex 1).
Formal long written tests should not be used for the assessment of students.

5.1 Suggested assessment activities for grades A and B

5.1.1 An A grade is awarded for each semester and must take into account the following elements:

- Observation of students during practical activities :
  - Classroom participation: skills in individual and group work
  - Compliance with health and safety regulations
  - Careful use of equipment

- The written reports will indicate
  - Objectives / hypotheses
  - Procedures / methods
  - Results in an appropriate format
  - Appropriate conclusions

- The ability to make oral and/or written presentation skills

5.1.2 A second grade, the B grade, is awarded for each semester and should be based on the carrying out of a simple experiment (not conducted during the year) with the preparation of a short written report (two class periods).

5.2 Attainment Descriptors

	A	B	C	D	E	F	FX
	9.0 - 10 Excellent	8.0 – 8.9 Very good	7.0 – 7.9 Good	6.0 - 6,.9 Satisfactory	5.0 – 5.9 Sufficient	3.0 – 4.9 Weak/Failed	0 – 2.9 Very weak/ Failed
Experimental work	Independently carries out an experimental set-up in accordance with instructions, observing safety regulations and ethical issues	Independently carries out an experimental set-up, in accordance with instructions observing safety regulations	Carries out an experimental set-up in accordance with instructions, observing safety regulations	Requires some assistance to carry out an experimental set-up in accordance with instructions, observing safety regulations	Requires constant assistance to carry out an experimental set-up in accordance with instructions	Has difficulty following instructions to carry out an experimental set-up	Cannot implement instructions to carry out an experimental set-up
Experimental results	Determines measurements of quantities carefully and independently taking measurement inaccuracies into account	Determines measurements of quantities independently taking measurement inaccuracies into account.	Determines measurements of quantities independently	Requires some assistance to determine the measurements of quantities	Requires constant assistance to determine the measurements of quantities	Has difficulty determining the measurements of quantities	Cannot determine the measurements of quantities
Data processing	Independently uses appropriate methods (graphical, mathematical …) to verify or to establish a relationship between different variables	Independently uses appropriate methods (graphical, mathematical …) to verify a relationship between different variables	Uses appropriate methods (graphical, mathematical …) to verify a relationship between different variables	Requires some assistance to use methods (graphical, mathematical …) to verify a relationship between different variables	Requires constant assistance to use methods (graphical, mathematical …) to verify a relationship between different variables	Has difficulty using methods (graphical, mathematical …) to verify a relationship between different variables	Cannot use methods (graphical, mathematical …) to verify a relationship between different variables

	A	B	C	D	E	F	FX
	9.0 - 10 Excellent	8.0 – 8.9 Very good	7.0 – 7.9 Good	6.0 - 6,.9 Satisfactory	5.0 – 5.9 Sufficient	3.0 – 4.9 Weak/Failed	0 – 2.9 Very weak/ Failed
Analysis	Produces detailed and critical analysis of the data in order to deduce further conceptual understanding	Produces detailed analysis of the data in order to deduce further conceptual understanding	Produces data analysis with an understanding of the concepts involved	Analyses and explains the data in a basic way involving understanding of the concepts involved	Demonstrates some ability to use the data with limited understanding of the concepts involved	Unable to use the data without considerable assistance and understands some of the concepts in a limited manner	Does not know how to use data adequately and shows very limited understanding of the concepts
Communication (oral and written)	Communicates logically and concisely using the correct scientific terminology. Excels in the presentation of work	Communicates clearly using the correct scientific terminology. Presents work very well	Communicates clearly most of the time using correct scientific terminology. Presents work well	Uses basic scientific vocabulary expressed with a fairly satisfactory structure. Presents work in a satisfactory manner	Uses basic scientific vocabulary although its expression may lack structure or clarity. Presents work in an acceptable manner	Inadequate or incomplete expression using limited scientific vocabulary. Presents work in an insufficient manner	Does not know how to communicate scientific information either in writing or orally
Teamwork	Takes initiatives, leads the team	Shows a constructive team spirit	Shows a good team spirit	Participates satisfactorily in teamwork	Can work as a member of a team	Needs help with teamwork	Is not able to work as part of a team

Annex 1. Suggested Assessment Criteria for Written Reports

Presentation

- appropriate and informative title
- page numbering
- summary indicating objectives and conclusions
- references cited in the text
- the report is clear and concise

Introduction

- gives a clear statement of objectives with hypotheses / questions
- highlights the science behind the objectives
- uses plain language
- the scientific importance is explained / justified

Procedures

- are appropriate to the objectives
- are clearly described
- demonstrate creativity and originality
- indicate the accuracy of the measurements/results and possible modifications for improving accuracy

Results

- relevant to the objectives
- data recorded within measurement accuracy limits
- the data presented summarize the overall results
- adequate quality, including headings / units / scales / labels / clarity
- brief description of trends and patterns in tables or graphs

Discussion

Conclusion:

- the conclusions relate to the achievement of the objectives
- the conclusions are valid for the results obtained

Evaluation of procedures: contains remarks on

- accuracy / sources of measurement errors
- solutions to problems encountered during the conduct of the experiment, and procedural changes

Evaluation of results: contains

- analysis and interpretation of results
- suggestions for future work
- a critical and scientific discussion on the importance of the results