university of groningen

faculty of mathematics and natural sciences

Appendices for the Bachelor's degree programme(s) in Physics

Appendix I Learning outcomes of the Bachelor's degree programme (Article 1.3.a)

A. Generic learning outcomes – Knowledge

A1. Bachelor's graduates have general knowledge of the foundations and history of mathematics, natural sciences and technology, in particular those of their own discipline.

A2. Bachelor's graduates have mastered the basic concepts of their own discipline (see Appendix 1 for further specification) to a certain extent and are familiar with the interrelationships of these concepts within their own discipline as well as with other disciplines.

A3. Bachelor's graduates have in-depth knowledge of several current topics within their own discipline.

A4. Bachelor's graduates are familiar with the quantitative character of the fields of mathematics and natural sciences and have an understanding of the methods used in these fields, and particularly within their own discipline, including computer-aided methods.

A5. Bachelor's graduates have sufficient knowledge and understanding of mathematics and natural sciences to successfully complete a follow-up Master's degree programme in their own discipline.

A6. Bachelor's graduates are aware of the societal, ethical and social aspects involved in the fields of mathematics and natural sciences.

B. Generic learning outcomes – Skills

B1 (Research) Bachelor's graduates are able to draw up a research question, design, plan and conduct research and report on it independently with a certain degree of supervision. Bachelor's graduates are able to evaluate the value and limitations of their research and assess its applicability outside their own field.

B2 (Designing and Modeling) Bachelor's graduates are able to translate a problem, in particular a design problem, into a plan of approach and – taking into account the requirements of the client and/or technical preconditions – find a solution.

B3 (Gathering information) Bachelor's graduates are able to gather relevant information using modern means of communication and to critically interpret this information.

B4 (Collaborating) Bachelor's graduates are able to collaborate in teams (including multidisciplinary teams) on technical-scientific problems.

B5 (Communicating) Bachelor's graduates are able to communicate orally and in writing in academic and professional contexts, with both colleagues and others. They are familiar with the relevant means of communication.

B6 (Reflecting) Bachelor's graduates are able to assess their own actions and those of others in a natural sciences context, bearing in mind the social/societal and ethical aspects.

B7 (Learning skills) Bachelor's graduates are able to apply learning skills that enable them to pursue a follow-up degree and acquire knowledge in new fields with a high level of autonomy.

B8 Additional subject-specific skills are listed in Appendix 2.

Appendix 1.1 Degree programme-specific learning outcomes – Basic Knowledge

The Bachelor's graduate in Physics has:

1.1. Knowledge of the most important subjects in the field of
- a) Classical Mechanics / Relativity
- b) Electromagnetism
- c) Quantum Physics
- d) Thermodynamics
- e) Statistical Physics
- f) Wave phenomena, Oscillations and Optics
- g) Structure and properties of matter
- h) Calculus, Linear Algebra and Numerical Mathematics

1.2. Knowledge of topics in at least one of the following research fields
- a) Theoretical Physics
- b) Particle Physics
- c) Nano Physics
- d) Energy and Environment
- e) Life and Health

1.3. Achieved in the Minor, a deeper knowledge of subjects within their own discipline or a broad general knowledge of a different discipline.

Appendix 1.2 Degree programme-specific learning outcomes – Skills

The Bachelor's graduate in Physics is able to:

2.1. estimate the orders of magnitude of various physical processes,

2.2. use specific software, such as a programming language or a (symbolical) software package,

2.3. setup and carry out an experiment, while taking into account the safety and environmental issues,

2.4. analyze experimental data in a proper and ethical manner, including an error analysis.

Appendix II Follow-on Master's degree programmes (Article 1.3.c)

The Bachelor's degree programme will grant unconditional admission to the following Master's degree programmes at the University of Groningen:

- Physics
- Education and Communication in Mathematics and Natural Sciences
- Energy and Environmental Sciences

Appendix III Majors and Minors of the degree programme (Article 2.1.2)

1) The total programme consists of a core part and an elective part that consists of a Major and a Minor, and which is chosen from the following three tracks:
   - Physics of Energy and Environment
   - Physics of Life and Health
   - Experimental and Theoretical Physics (NExT)
2) The Physics of Energy and Environment track includes the Minor Physics of Energy and Environment.
   The Physics of Life and Health track includes the Minor Physics of Life and Health.
   The Minor for the Experimental and Theoretical Physics track may be chosen from the collection of university and faculty Minors.

Appendix IV Course units in the propaedeutic phase

- **List of course units; Article 3.1.1**
- **Course units with one or more practicals; Article 3.2**
- **Compulsory order of examinations; Article 8.2**

Course unit name	ECTS	Practical	Entry requirements
Calculus 1	5	X	
Physics Laboratory 1	5	X	
Choice: ▪ Kaleidoscope Modern Physics ▪ Molecules: Structure, Reactivity, and Function ▪ Introduction to Mathematics	5	X	
Thermodynamics	5		
Mechanics and Relativity 1	5		
Linear Algebra 1	5	X	
Mechanics and Relativity 2	5	X	
Calculus 2	5		
Introduction to Research	-		
Choice: ▪ Introduction Astronomy ▪ Physics of Modern Technology ▪ Introduction NExT ▪ Introduction to Energy and Environment ▪ Physics of Life	5		
Mathematical Physics	5		
Electricity and Magnetism I	5	X	
Physics Laboratory 2	5	X	

The assessment method of the courses can be found in the assessment plan of the degree programme and on Ocasys

Appendix V Course units in the post-propaedeutic phase

- **List of course units (Article 6.1.1)**
- **Course units with one or more practicals (Article 6.2.1)**
- **Compulsory order of examinations; (Article 8.2)**

Course unit name	ECTS	Practical	Entry requirements
Introduction to Programming and Numerical Methods	5	X	
Electricity and Magnetism II	5		
Quantum Physics 1	5		
Waves and optics	5	X	
Statistical Physics	5		
Electronics and signal processing	5	X	
Structure of Matter 1	5		
Science, Ethics, Technology, and Society	5		
Structure of Matter 2	5		
Physics Laboratory 3	5	X	
Track ▪ Physics of Energy and Environment ▪ Physics of Life and Health ▪ Experimental and Theoretical Physics	55		
Bachelor Research Project (Physics)	15	X	Passed 135 ECTS of the Bachelor's degree programme

- The assessment method of the courses can be found in the assessment plan of the degree programme and on Ocasys
- In case of a double degree Physics and Mathematics a combined research of 20 ECTS is done and the total amount of credits of the combined degree must add up to 240 ECTS

Track: Physics of Energy and Environment

Course unit name	ECTS	Practical	Entry requirements
Geo-energy	5	X	
Climate System and Atmosphere	5		
Nuclear energy	5		
Physical and Chemical Kinetics	5	X	
Physics Laboratory 4	5	X	
Energy and Society	5		
Principles of Measurement Systems	5		
Solar Cells	5		
Energy from Gas	5		
Molecular Spectra and Structure	5		
Physics of Fluids	5		

The assessment method of the courses can be found in the assessment plan of the degree programme and on Ocasys

Track: Physics of Life and Health

Course unit name	ECTS	Practical	Entry requirements
Molecular Biophysics	5		
Structural Biology	5	X	
Ionizing Radiation in Medicine	5		
Molecular Dynamics	5	X	
Physics Laboratory 4	5	X	
Imaging Techniques in Radiology	5	X	
Nanophysics and Nanotechnology	5		
Principles of Measurement Systems	5		
Biochemistry	5	X	
Cellular Chemistry	5	X	
Physics of Fluids	5		

The assessment method of the courses can be found in the assessment plan of the degree programme and on Ocasys

Track: NExT

Course unit name	ECTS	Practical	Entry requirements
Complex Analysis	5		
Quantum Physics 2	5		
Minor	30		See table below
Choice: *Particle Physics* ▪ Astroparticle Physics ▪ Fundamentals of Particle Physics ▪ Symmetry in Physics *Nano Physics* ▪ Nano-probing and Nano-fabrication ▪ Device Physics* ▪ Materials Design: Theoretical Methods* ▪ Physics of Fluids* *Theoretical Physics* ▪ Astroparticle Physics ▪ Relativistic Quantum Mechanics ▪ Symmetry in Physics * Two of these three course must be chosen	15	 X X	

The assessment method of the courses can be found in the assessment plan of the degree programme and on Ocasys

Minor Experimental and Theoretical Physics 'Science for Scientists'

The Minor comprises a choice of 30 ECTS from the list below and is a coherent and deepening package of course units.

Course unit name	ECTS	Practical	Entry requirements
Atoms and Molecules	5		
Ionizing Radiation in Medicine	5		
Nuclear Energy	5		
Physical and Chemical Kinetics	5		
Physics Laboratory 4	5	X	
Solid State Physics 1	5		
Advanced Mechanics	5		
Energy and Society	5		
Experimental Techniques in Particle Physics	5		
Geo-energy	5	X	
Modern Developments Nanophysics	5		
Nanophysics and Nanotechnology	5		
Principles of Measurement Systems	5		
Subatomic Physics	5		
Onderwijs en Communicatie	5		See the programme-specific appendices IV and V of the Teaching and Examination Regulation.
Electives, courses from Bachelor's programmes Chemistry, Chemical Engineering, (Applied) Physics, Astronomy, (Applied) Mathematics, Industrial Engineering and Management, which are can be found on Ocasys	0-30		See the programme-specific appendices IV and V of the Teaching and Examination Regulation.
Other courses from above mentioned degree programmes, which are to be individually approved by the Exam Committee.	0-30		See the programme-specific appendices IV and V of the Teaching and Examination Regulation.

The assessment method of the courses can be found in the assessment plan of the degree programme and on Ocasys

Within the track NExT the student is allowed a minor outside of the degree progamme (e.g. a university minor or courses abroad)

Appendix VI Entry requirements (Article 10.1)

A. HBO (university of applied science) propaedeutic certificate

1. The following requirements apply to the entrance examination as defined in Article 7.28.3 of the Act:

Degree programme	**Subjects at VWO (pre-university) level**	Requirement: Dutch as a Second Language (programme II) for non-native speakers of Dutch
B Biology	wia or wib + na+sk+bio	Yes
B Pharmacy	wia or wib + na+sk	Yes
B Computing Science	wib	
B Artificial Intelligence	wia or wib	
B Physics	wib+na	
B Chemistry	wib+na+sk	
B Astronomy	wib+na	
B Mathematics	wib	
B Chemical Engineering	wib+na+sk	
B Industrial Engineering and Management Science	wib	
B Applied Physics	wib+na	
B Applied Mathematics	wib	

wia = Mathematics A; wib = Mathematics B; na = Physics; sk = Chemistry; bio = Biology

2. Non-native speakers of Dutch who wish to be admitted to the Bachelor's degree programmes in Biology, Life Science and Technology, or Pharmacy must also have passed the State Examination in Dutch as a Second Language, Programme II (NT2-II).

3. The Faculty Committee for Special Admissions will determine whether deficiencies have been compensated satisfactorily.

B. Foreign qualifications (EEA)

1. Any certificate that grants access to a university in a European country will also grant access to Dutch universities.

2. The same requirements that also apply to candidates with an HBO (university of applied science) propaedeutic certificate will apply to these candidates in the entrance examination as defined in Article 7.28.3 of the Act (see A).

3. Non-native speakers of Dutch who wish to be admitted to the Bachelor's degree programmes in Biology, Life Science and Technology, or Pharmacy must also have passed the State Examination in Dutch as a Second Language, Programme II (NT2-II).

4. In addition, candidates are required to be competent in English: an IELTS score of 6.5, a TOEFL score of 580 (paper-based), of 237 (computer-based) or of 92 (internet-based) or equivalent.

5. The Faculty Committee for Special Admissions will determine whether deficiencies have been compensated satisfactorily.

C. Foreign qualifications (German)

1. German candidates must have a Zeugnis der Allgemeinen Hochschulreife ('Abitur').

2. The following requirements apply to the entrance examination as defined in Article 7.28.3 of the Act:

Degree programme	
B Biology	wi (LK or GK) na (LK or GK) sk (LK or GK) bio (LK or GK) (at least one subject at Leistungskurs level)
B Pharmacy B Life Science and Technology B Chemistry B Chemical Engineering	wi (LK or GK) na (LK or GK) sk (LK or GK) (at least one subject at Leistungskurs level)
B Computing Science B Mathematics B Applied Mathematics B Artificial Intelligence	wi (LK)
B Physics B Astronomy B Applied Physics	wi (LK) na (LK or GK)
B Industrial Engineering and Management Science	wi (LK or GK) na (LK or GK) (at least one subject at Leistungskurs level)

wi= Mathematics; na = Physics; sk = Chemistry; bio = Biology
LK = Leistungskurs level; GK = Grundkurs level followed until end of Class 13 or Class 12 (if Gymnasium education lasts 12 years).

3. Non-native speakers of Dutch who wish to be admitted to the Bachelor's degree programmes in Biology, Life Science and Technology, or Pharmacy must also have passed the State Examination in Dutch as a Second Language, Programme II (NT2-II).

4. The Faculty Committee for Special Admissions will determine whether deficiencies have been compensated satisfactorily.

D. Foreign qualifications (International Baccalaureate)

1. The following requirements apply to the entrance examination as defined in Article 7.28.3 of the Act:

Degree programme	**from 2010/2011**
B Biology	Biology (SL or HL) Maths (SL or HL) Physics (SL or HL) Chemistry (SL or HL) two of these subjects at HL
B Pharmacy B Life Science and Technology B Chemistry B Chemical Engineering	Maths (SL or HL) Physics (SL or HL) Chemistry (SL or HL) two of these subjects at HL
B Computing Science B Mathematics B Applied Mathematics	Maths HL
B Artificial Intelligence	Maths SL **or** Maths HL
B Physics B Astronomy B Applied Physics B Industrial Engineering and Management Science	Maths HL Physics HL

SL = Standard Level, HL = Higher Level

2. Non-native speakers of Dutch who wish to be admitted to the Bachelor's degree programmes in Biology, Life Science and Technology, or Pharmacy must also have passed the State Examination in Dutch as a Second Language, Programme II (NT2-II).

3. The Faculty Committee for Special Admissions will determine whether deficiencies have been compensated satisfactorily.

E. Foreign qualifications (non-EEA)

1. A non-European certificate that according to NUFFIC and/or NARIC standards is equivalent to a Dutch VWO certificate will grant access to university in the Netherlands.

2. The same requirements that also apply to candidates with an HBO (university of applied science) propaedeutic certificate will apply to these candidates in the entrance examination as defined in Article 7.28.3 of the Act (see A).

3. Non-native speakers of Dutch who wish to be admitted to the Bachelor's degree programmes in Biology, Life Science and Technology, or Pharmacy must also have passed the State Examination in Dutch as a Second Language, Programme II (NT2-II).

4. In addition, candidates are required to be competent in English: an IELTS score of 6.5, a TOEFL score of 580 (paper-based), of 237 (computer-based) or of 92 (internet-based) or equivalent.

5. The Faculty Committee for Special Admissions will determine whether deficiencies have been compensated satisfactorily.

F. Entrance examination

1. The following requirements apply to the entrance examination as defined in Article 7.29 of the Act:

Degree programme	**Nature and Health VWO level**	**or**	**Nature and Technology VWO level**
B Biology	en, wia or b, sk, bio, na		en, wib, na, sk, bio
B Pharmacy	en, wia or b, sk, bio, na		en, wib, na, sk
B Life Science and Technology	en, wib, sk, bio, na		en, wib, na, sk
B Computing Science	en, wib, sk, bio		en, wib, na, sk
B Artificial Intelligence	en, wia of b, sk, bio		en, wib, na, sk
B Physics	en, wib, sk, bio, na		en, wib, na, sk
B Chemistry	en, wib, sk, bio, na		en, wib, na, sk
B Astronomy	en, wib, sk, bio, na		en, wib, na, sk
B Mathematics	en, wib, sk, bio		en, wib, na, sk
B Chemical Engineering	en, wib, sk, bio, na		en, wib, na, sk
B Industrial Engineering and Management Science	en, wib, sk, bio		en, wib, na, sk
B Applied Physics	en, wib, sk, bio, na		en, wib, na, sk
B Applied Mathematics	en, wib, sk, bio		en, wib, na, sk

en = English; wia = Mathematics A; wib = Mathematics B; na = Physics; sk = Chemistry; bio = Biology

2. Non-native speakers of Dutch who wish to be admitted to the Bachelor's degree programmes in Biology, Life Science and Technology, or Pharmacy must also have passed the State Examination in Dutch as a Second Language, Programme II (NT2-II).

1. The Faculty Committee for Special Admissions will determine whether deficiencies have been compensated satisfactorily.

Appendix VII Clustering of Bachelor's degree programmes (Article 4.3.6 and Article 4.4.2)

Degree programme CROHO code	Name of degree programme	Clustered with CROHO code	Name of degree programme
56286	B Life Science and Technology	56860 56157	B Biology B Pharmacy
56860	B Biology	56286 56157	B Life Science and Technology B Pharmacy
56157	B Pharmacy	56860 56286	B Biology B Life Science and Technology
56980	B Mathematics	56965	B Applied Mathematics
56965	B Applied Mathematics	56980	B Mathematics
50206	B Physics	56962 50205	B Applied Physics B Astronomy
56962	B Applied Physics	50206 50205	B Physics B Astronomy
50205	B Astronomy	56962 50206	B Applied Physics B Physics
56857	B Chemistry	56960	B Chemical Engineering
56960	B Chemical Engineering	56857	B Chemistry

Appendix VIII Admission to the post-propaedeutic phase Article 5.1.1

The following candidates will be admitted to the post-propaedeutic phase: holders of a propaedeutic certificate of the degree programmes in:

- Physics
- Applied Physics
- Astronomy

Appendix IX Contact hours propaedeutic phase (Article 2.3)

Bachelor's year 1	
Structure contact hours	**Contact hours per year**
Lectures	334
Tutorial	288
Practicals	71
Tutoring	8
Supervision during an internship	0
Examinations	45
Other structured hours	18

Appendix X University Minors of the faculty of Mathematics and Natural Sciences Article 7.5.1

1. Neurosciences Minor:
   - Neuroscience (18 ECTS)
   - Behavioral Neuroscience (6 ECTS)
   - Neuroscience essay (6 ECTS)

   People, Planet, Profit Minor:
   - Overview and Coherence People Planet Profit (10 ECTS)
   - People Planet Profit paper (5 ECTS)
   - Multidisciplinary Cooperation (5 ECTS)
   - Project Sustainability (10 ECTS)

   Astronomy in Space and Time*:
   - Astrobiology (5 ECTS)
   - Cosmic Origins (5 ECTS)
   - Evolving Universe (5 ECTS)

   * This university minor is not allowed for students of the degree programmes of Physics, Applied Physics and Astronomy

2. The Programme Committee for the Bachelor's degree programmes in Biology and Life Science & Technology also has authority in the field of the Neurosciences Minor and/or its course units.

   The Programme Committee for the Master's degree programme in Energy & Environmental Sciences also has authority in the field of the People, Planet, Profit Minor and/or its course units.

   The Programme Committee for the Bachelor's degree programme in Astronomy also has authority in the field of the Astronomy through Space and Time Minor and/or its course units.

3. The Board of Examiners for the Bachelor's degree programmes in Biology and Life Science & Technology and the Master's degree programmes in Biology, Ecology & Evolution, Marine Biology and Molecular Biology & Biotechnology also has authority in the field of the Neurosciences Minor and/or its course units.

   The Board of Examiners for the Master's degree programme in Energy & Environmental Sciences also has authority in the field of the People, Planet, Profit Minor and/or its course units.

   The Board of Examiners for the Bachelor's degree programme in Astronomy also has authority in the field of the Astronomy through Space and Time Minor and/or its course units.

4. These Teaching and Examination Regulations also apply in their entirety to the Minors in Neurosciences, People, Planet, Profit and Astronomy in Space and Time and/or their course units.

Appendix XI Extra effort for obtaining a bachelor's degree in a closely related programme (article 9.3)

If a student desires to obtain a Bachelor's degree in a closely related degree programme (e.g. Applied Physics or Astronomy) the student has to make an extra effort of at least 45 ECTS. This has to be built up in the following way:

- 15 ECTS for a separate Bachelor's research project
- 30 ECTS of course units within the specific degree programmes

In exceptional cases the division of the 45 ECTS (e.g. 5 ECTS extra for a combined research project (total of 20 ECTS) and 40 ECTS of course units) is possible with approval of the Board of Examiners of Physics and Applied Physics.

In case of the double degree of Physics and Mathematics the extra effort of at least 45 ECTS is met. This combined programme is officially defined as:

- 5 ECTS extra on a combined Bachelor's research project (total of 20 ECTS)
- 55 ECTS of course units within the specific degree programmes