Summary

Unit 12 - Quantum Physics

Subject	Year	Start date	Duration
Physics	IB1, IB2	Week 3, January	5 weeks 16 hours

Course Part

IB2 Additional

Curriculum

Aims

Appreciate scientific study and creativity within a global context through stimulating and challenging opportunities

Acquire a body of knowledge, methods and techniques that characterize science and technology

Apply and use a body of knowledge, methods and techniques that characterize science and technology

Develop an ability to analyse, evaluate and synthesize scientific information

Develop a critical awareness of the need for, and the value of, effective collaboration and communication during scientific activities

Develop experimental and investigative scientific skills including the use of current technologies

Develop and apply 21st century communication skills in the study of science

Become critically aware, as global citizens, of the ethical implications of using science and technology

Develop an appreciation of the possibilities and limitations of science and technology

Develop an understanding of the relationships between scientific disciplines and their influence on other areas of knowledge

Objectives

Demonstrate knowledge and understanding of

- facts, concepts and terminology
- methodologies and techniques
- communicating scientific information

Apply

- facts, concepts and terminology
- methodologies and techniques
- methods of communicating scientific information

Syllabus Content

Additional higher level

12. Quantum and nuclear physics

12.1 – The interaction of matter with radiation

Nature of science:

Observations: Much of the work towards a quantum theory of atoms was guided by the need to explain the observed patterns in atomic spectra. The first quantum model of matter is the Bohr model for hydrogen. Paradigm shift: The acceptance of the wave–particle duality paradox for light and particles required scientists in many fields to view research from new perspectives.

Understandings:

Photons

The photoelectric effect

Matter waves

Pair production and pair annihilation

Quantization of angular momentum in the Bohr model for hydrogen

The wave function

The uncertainty principle for energy and time and position and momentum

Tunnelling, potential barrier and factors affecting tunnelling probability

Applications and skills:

Discussing the photoelectric effect experiment and explaining which features of the experiment cannot be explained by the classical wave theory of light

Solving photoelectric problems both graphically and algebraically

Discussing experimental evidence for matter waves, including an experiment in which the wave nature of electrons is evident

Stating order of magnitude estimates from the uncertainty principle

12.2 – Nuclear physics

Nature of science:

Theoretical advances and inspiration: Progress in atomic, nuclear and particle physics often came from theoretical advances and strokes of inspiration. Advances in instrumentation: New ways of detecting subatomic particles due to advances in electronic technology were also crucial. Modern computing power: Finally, the analysis of the data gathered in modern particle detectors in particle accelerator experiments would be impossible without modern computing power.

Understandings:

Rutherford scattering and nuclear radius

Nuclear energy levels

The neutrino

The law of radioactive decay and the decay constant

Applications and skills:

Describing a scattering experiment including location of minimum intensity for the diffracted particles based on their de Broglie wavelength

Explaining deviations from Rutherford scattering in high energy experiments

Describing experimental evidence for nuclear energy levels

Solving problems involving the radioactive decay law for arbitrary time intervals

Explaining the methods for measuring short and long half-lives

ATL Skills

Approaches to Learning

Thinking

- In this unit, we will

ask students to formulate a reasoned argument to support their opinion or conclusion

give students time to think through their answers before asking them for a response

reward a new personal understanding, solution or approach to an issue

ask open questions

set students a task which required higher-order thinking skills (such as analysis or evaluation)

build on a specific prior task

help students to make their thinking more visible (for example, by using a strategy such as a thinking routine)

require students to take an unfamiliar viewpoint into account when formulating arguments

ask questions that required the use of knowledge from a different subject from the one you are teaching

include a reflection activity

make a link to TOK

Social

- In this unit, we will

  have students work in small groups

  allocate, or ask students to allocate among themselves, different roles in a classroom discussion or activity

  have students peer assess their group performance or process

  support students in resolving a conflict in a team

  give a group assessment task

  give students feedback on how they worked as a group

  have students discuss their understanding of a text or idea among themselves and come up with a shared understanding

  provide an opportunity for students to analyse the impact of their behaviour on the class or on a group performance

  encourage students to consider alternative points of view or to take the perspective of others

  provide opportunities for students to make decisions

Communication

- In this unit, we will

  ask students to explain their understanding of a text or idea to each other

  construct a task around the use of different vocabulary and examples when speaking to different audiences

  have students give an oral presentation without reading from their notes

  ask students to monitor and check the quality of their writing

  construct a task so that students practise their listening skills

  assess or give feedback on speaking or writing concisely

  provide opportunities for students to read and understand different types of texts

  encourage or require students to plan a response before they begin

  ask students to formulate arguments clearly and coherently

  encourage all students to contribute to discussions

Developing IB Learners

Learner Profile

Inquirers

Knowledgeable

Thinkers

Communicators

Risk-takers (Courageous)

Balanced

Reflective