YEAR 2022-2023 First Term

'An ambitious curriculum that meets the needs of all'

Medium Term Planning - Topic: Quantum Physics

Curriculum Intent

In addition to working further on objectives from Year 12 Particle Physics, pupils will be taught, following National Curriculum guidelines, the following this term:

Skills/Assessment Objective Links

3.2.2 Electromagnetic radiation and quantum phenomena

3.2.2.1 The photoelectric effect

Content	Opportunities for skills development
Threshold frequency; photon explanation of threshold frequency. Work function ϕ, stopping potential. Photoelectric equation: $hf = \phi + E_{k\,(max)}$ $E_{k\,(max)}$ is the maximum kinetic energy of the photoelectrons. The experimental determination of stopping potential is not required.	**PS 3.2 / MS 2.3** Demonstration of the photoelectric effect using a photocell or an electroscope with a zinc plate attachment and UV lamp.

3.2.2.2 Collisions of electrons with atoms

Content	Opportunities for skills development
Ionisation and excitation; understanding of ionisation and excitation in the fluorescent tube. The electron volt. Students will be expected to be able to convert eV into J and vice versa.	

3.2.2.3 Energy levels and photon emission

Content	Opportunities for skills development
Line spectra (eg of atomic hydrogen) as evidence for transitions between discrete energy levels in atoms. $hf = E_1 - E_2$ In questions, energy levels may be quoted in J or eV.	**AT j / MS 0.1, 0.2** Observation of line spectra using a diffraction grating.

3.2.2.4 Wave-particle duality

Content	Opportunities for skills development
Students should know that electron diffraction suggests that particles possess wave properties and the photoelectric effect suggests that electromagnetic waves have a particulate nature. Details of particular methods of particle diffraction are not expected. de Broglie wavelength $\lambda = \frac{h}{mv}$ where mv is the momentum. Students should be able to explain how and why the amount of diffraction changes when the momentum of the particle is changed. Appreciation of how knowledge and understanding of the nature of matter changes over time. Appreciation that such changes need to be evaluated through peer review and validated by the scientific community.	**PS 1.2** Demonstration using an electron diffraction tube. **MS 1.1, 2.3** Use prefixes when expressing wavelength values.

Spiritual, moral, social, and cultural development

SMSC: Listening to each other and valuing each person's contributions in discussions, working together in lessons to problem solve and achieve a shared goal. Learning about different scientists and learning how their understanding of the world evolved.
PSHE/British Values: Working together in practical and problem-solving work. The practical work in this section requires two people to work together to take the measurements whilst holding the equipment in place.
Skills Builder: development of practical skills through the numerous practical activities.

Numeracy

Constant numerical development in every lesson. Measuring skills, graph skills, problem solving. Exam questions build on topics with mechanics components frequently brought in.

Literacy

Vocabulary Tier 2: energy, energy levels, particles, waves, collision, vibration, maximum, frequency, fluorescent light.
Vocabulary Tier 3: photoelectric effect, threshold frequency, max-KE, Plank's constant, emission spectrum, ionization, quantized, elastic and inelastic scattering, photons,
Reading: Reading of the booklet and questions. Students need to be able to read the methods for practical lessons and ensure they complete them in the right order, using the right equipment.

	Writing: Students are exposed to a number of questions, both numerical and short and long writte answers. Students need to be able to write in a concise way whilst using the key words. **Oracy:** Class discussions are incredibly important in physics where students regularly participate in discussion to discuss abstract concepts. Students need to be able to express their understanding o and theories.
Becoming future ready	**Careers/Employability:** Student's learn about Quantum Physicists and a touch of what their job entails.
Adaptation **QFT/SEND Provision**	Throughout this topic, quality first teaching will provide differentiation: **By product:** different learners are asked different questions, different level of detailed responses are expected and the level of scaffolding for the problem solving questions are varied. **By resource:** All booklets are the same, however, extra scaffolding and extension may be provided from the new Kerboodle resources. **By Intervention**: by providing different levels of supervision and support **By Progressive Questioning:** exploring pupils' understanding through interactive dialogue. **By Grouping:** according to prior attainment, gender, social preference, preferred learning style. **By Task:** Pupils should be involved in the identification of targets which are meaningful to them and in the selection of an appropriate task from the given range. **By Offering Optional Activities:** In class or as homework, to extend learning. This QFT/SEND provision will be explicit within the lesson-by-lesson schemes of work.
Implementation Curriculum Delivery **Learning Outcomes (Knowledge)**	• To be able to: 1. To know & describe how electrons move up and down in energy levels. 2. To know the energy levels are quoted in MeV and how to convert them to J. 1. To know the wave properties of photons. 2. To know the particle properties of photons. 3. To explain work function, threshold frequency and Ek-max 1. To know the photoelectric effect equation 2. To know about the stopping potential. 3. To know why emitted photoelectrons have a range of energies. 1. To apply the knowledge of the photoelectric effect to the questions. 1. To apply the knowledge on energy levels to emission and absorption spectra. 2. To apply the knowledge on energy levels to the fluorescent tube. 1. To know and explain that particles can behave as waves. 2. To know and use the formula for de Broglie wavelengths. 3. To explain diffraction of waves and how this proves electrons behave as waves. • Red denotes interleaving; aspects of knowledge covered previously.
Current learning to be developed in the future within:	This is linked to the nuclear physics topic in Year 13.
Assessment	Refer to assessment maps for formative and summative assessment opportunities.
Impact	Attainment and Progress – Refer to assessment results / data review documentation.