No Brain Too Small ● PHYSICS

Demonstrate understanding of Modern Physics Level 3 Credits 3

Subject Reference	Physics 91525				
Title	Demonstrate understanding of Modern Physics				
Level	3	**Credits**	3	**Assessment**	Internal

Achievement Criteria

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of Modern Physics.	Demonstrate in-depth understanding of Modern Physics.	Demonstrate comprehensive understanding of Modern Physics.

Examples of phenomena, concepts, or principles of Modern Physics include:

- The Bohr model of the hydrogen atom: the photon; the quantisation of energy; discrete atomic energy levels; electron transition between energy levels; ionisation; atomic line spectra, the electron volt
- The photoelectric effect
- Wave-particle duality
- Qualitative description of the effects of the strong interaction and Coulombic repulsion, binding energy and mass deficit; conservation of mass-energy for nuclear reactions
- Qualitative treatment of special and general relativity
- Qualitative treatment of quarks and leptons.

Examples of Relationships:

$$E = hf \qquad hf = \phi + E_K \qquad E = \Delta mc^2 \qquad E_n = -\frac{hcR}{n^2}$$

$$\frac{1}{\lambda} = R\left(\frac{1}{S^2} - \frac{1}{L^2}\right)$$

Achievement criteria

The level of performance that you will gain will be determined by both the complexity of the situation and problem-solving process of aspects of atoms, photons, and nuclei.

Achievement

Make sure you can:

- Identify or describe aspects of phenomena, concepts, or principles.
- Solve problems involving a single process. The relevant concept or principle will be transparent, the method will be straightforward (a formula will need no more than a simple rearrangement), and the information will be directly usable.
- Recognise correct concept/phenomenon/principle and give a simple descriptive answer in both written and diagrammatic form, for example:
  - how binding energy relates to nuclear stability
  - photoelectric effect from described situation
  - how emission spectra are created
- Recognise the correct concept and apply reasonable mathematical skills, for example:
  - the relationship between nuclear mass and total mass of constituent nucleons
  - the relationship between the wavelength of a spectral line and the electron jump that caused it

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Achievement with Merit

Make sure you can:

- Meet criteria for Achievement.
- Give explanations in terms of phenomena, concepts, principles, and/or relationships.
- Solve problems where the relevant concept or principle is not immediately obvious, the method involves the use of a complex formula or rearrangement, or the information is not directly usable or immediately obvious. It may involve using a complex formula or rearrangement or some deduction as to the relevant concept or principle.

Achievement with Excellence

Make sure you can:

- Meet criteria for Merit.
- Give concise and accurate explanations that show full understanding clearly, in terms of phenomena, concepts, principles, and/or relationships. Your answers will typically have minimal irrelevancies. In other words you cannot include any explanations that are not relevant.
- Solve complex problems that involve more than one process. The recognition of at least two different concepts must be involved.
- Show numerical accuracy, correct rounding and use SI units in answers.

The photoelectric effect and atomic energy levels

You should be able to:

- ❒ Describe and explain the quantum theory including knowledge of the photon, the quantisation of energy, discrete atomic energy levels. Electron transition between energy levels; ionisation.
- ❒ Describe and explain the production of emission and absorption spectra
- ❒ Describe and explain Atomic line spectra (infrared, visible and ultraviolet): Rydberg formula for the hydrogen atom and the Lyman, Balmer and Paschen series.
- ❒ Calculate the energy associated with a particular emission or absorption line using $E = hf$.
- ❒ Define the electron volt.
- ❒ Describe the Bohr model of the hydrogen atom
- ❒ Understand how the energy level diagram arises and calculate the various energy levels.
- ❒ Describe and explain the photoelectric effect experiment
- ❒ Apply Einstein's equation for the photo electric effect to practical situations
- ❒ Describe the particle/wave duality of light

Nuclear reactions

You should be able to:

- ❒ Demonstrate an understanding of major conservation laws: Conservation of linear momentum, charge, nucleon number and mass-energy for nuclear reactions (fission, fusion: alpha, beta and gamma decay).
- ❒ Describe and explain atomic structure.
- ❒ Describe the effects of radioactive decay on atomic stability.
- ❒ Write and balance equations for nuclear transformations.
- ❒ Explain the terms "fission" and "fusion". Describe these terms using equations.
- ❒ Apply the equation $E = mc^2$.
- ❒ Describe the effects of the strong interaction and Coulombic repulsion on atoms
- ❒ Describe and explain the terms "binding energy", "mass deficit" and carry out numerical calculations.

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Relativity and Fundamental particles

- ❒ Describe basic general relativity
- ❒ Describe basic special relativity
- ❒ Describe the fundamental particles – quarks and leptons

Advice from previous years

(Thanks to http://www.studyit.org.nz/)

- Understand that a physics problem involves a process(es) to find a physical quantity.
- Show all working of your calculations including any rearrangement of formulae.
- Be aware of the appropriate use of significant figures and units. You may use both negative index (for example, $m\ s^{-2}$) and slash notation (for example, m/s^2) when writing units. However, the examination paper will supply data using negative index notation.
- In the examination, make sure you read all questions carefully. That way, you are clear about what is being asked for, and what information is given.
- Understand the binding energy graph and be able to explain why a higher binding energy means a more stable nucleus.
- Understand and be able to explain the transfer of energy between electrons and photons demonstrated by emission/absorption spectra, and in the photoelectric effect.
- Learn the meanings of 'S' (series) and 'L' (line) in Rydberg's formula and know which series is denoted by the S number. S=1 is the Lyman (ultraviolet) series; S=2 is the Balmer series (visible); and S=3 is the Paschen series (infrared).
- Understand the concept of mass/energy equivalence, and know how to use Einstein's formula $E=mc^2$ to calculate mass deficit or energy, in nuclear reactions.