National Certificate of Educational Achievement

2011 Assessment Report

Physics Level 3

90520 Demonstrate understanding of wave systems

90521 Demonstrate understanding of mechanical systems

90522 Demonstrate understanding of atoms, photons and nuclei

90523 Demonstrate understanding of electrical systems

COMMENTARY

Candidates achieving with Excellence demonstrated very good understanding of concepts, the ability to link concepts to given situations, and the communication skills needed for successful problem-solving.

90520 Demonstrate understanding of wave systems

ACHIEVEMENT

Candidates who were awarded Achievement for this standard demonstrated the required skills and knowledge. They typically:

- explained simple concepts
- understood nodes and antinodes on a string
- converted centimetres to metres
- solved single-step calculations
- understood that the Doppler effect caused bunching of wave-fronts ahead of a moving source.

NOT ACHIEVED

Candidates who were assessed as Not Achieved for this standard lacked some or all of the skills and knowledge required for the award of Achievement. They typically:

- did not explain simple concepts
- used inappropriate units in calculations
- did not understand the difference between refraction and diffraction
- did not rearrange equations
- did not select appropriate equations.

ACHIEVEMENT WITH MERIT

In addition to the skills and knowledge required for the award of Achievement, candidates who were awarded Achievement with Merit typically:

- explained the link between nodes and antinodes and interference
- understood how variables in an equation related to one another
- solved problems requiring more than one step
- showed understanding of the significance of values of $\sin\theta \geq 1$
- used scientific terms in an explanation.

ACHIEVEMENT WITH EXCELLENCE

In addition to the skills and knowledge required for the award of Achievement with Merit, candidates who were awarded Achievement with Excellence typically:

- solved complex problems
- explained the presence of nodes or antinodes in a string with reference to data
- showed understanding of the significance of diffraction over 90°

- brought explanation and calculation to bear on the same problem.

OTHER COMMENTS

Some candidates found difficulty converting cm to m, or even making an unknown the subject of a formula, such as f in the equation $v = f\lambda$.

Some candidates showed minimal working, despite clear instruction that when solving numerical problems working must be shown.

Using symbols in answers was acceptable as long as the symbols were explained or elaborated on.

A generally good understanding of the formation of harmonics, as well as ability to manipulate the Doppler equation, was shown by candidates.

90521 Demonstrate understanding of mechanical systems

ACHIEVEMENT

Candidates who were awarded Achievement for this standard demonstrated the required skills and knowledge. They typically:

- showed that they had learned the basic facts that relate to the subject. For example, they knew that the maximum speed of a particle in SHM is at the equilibrium position; they knew that gravity acts towards the centre of the Earth; they knew that a geostationary orbit has a period of 24 hours
- showed sufficient concept knowledge to be able to select the necessary formula and substitute the required values to solve a straightforward problem. For example, when calculating velocities in SHM, they recognised that the angular frequency must be determined
- showed sufficient concept knowledge to be able to recognise the concept that applied in given situations. For example, they recognised that the period of a pendulum depends on its length
- identified basic concepts. For example, they recognised that, for a relationship to be independent of a particular quantity, the quantity must cancel out of the relationship equation.

NOT ACHIEVED

Candidates who were assessed as Not Achieved for this standard lacked some or all of the skills and knowledge required for the award of Achievement. They typically:

- attempted very few questions
- made mistakes such as not squaring a value when the formula clearly indicated it should be squared
- did not recognise the key concept of a question. For example, when asked a question about power, they did not make the connection with energy
- confused concepts. For example, they thought that energy, power, momentum, and rotational inertia were all a type of force

- showed lack of knowledge of simple concepts. For example, they thought that any motion requires a force to be acting
- did not rearrange simple formulae in order to solve problems
- showed insufficient knowledge of constants. For example, they used g instead of G.

ACHIEVEMENT WITH MERIT

In addition to the skills and knowledge required for the award of Achievement, candidates who were awarded Achievement with Merit typically:

- made simple connections between concepts in order to solve problems. For example, they recognised that to calculate power, the energy of the object must first be found; they understood how the period relates to the position at which maximum velocity occurs in SHM; they recognised that the radius of a satellite's orbit includes the radius of the Earth as well as the height above Earth's surface
- recognised that when an explanation involves one quantity being proportional to another, the explanation is not complete unless the quantity that remains constant is also discussed, and if necessary, the reason why it remains constant is given. For example, maximum velocity in SHM depends on angular frequency only if the amplitude remains constant
- recognised that a statement of a fact must be supported by a reason.

ACHIEVEMENT WITH EXCELLENCE

In addition to the skills and knowledge required for the award of Achievement with Merit, candidates who were awarded Achievement with Excellence typically:

- made complex connections between concepts in order to solve problems. For example, they gave a diagrammatic interpretation of a real-life situation and used the angles in the diagram to solve the problem; they recognised the concepts involved in linking the period of a satellite with its orbital height
- recognised that when an explanation is asked for, any statement that is made in the explanation must be justified by giving a full and specific reason. For example, a statement that balanced torques will result in a steady angular speed must be accompanied by a full description of the forces that create the torques
- applied basic concepts to new situations and, as a result, discussed these situations and linked them to physics theory. For example, they recognised that the motion of a swinging pendulum is part of a vertical circle and that SHM is just an approximation of its motion.

90522 Demonstrate understanding of atoms, photons and nuclei

ACHIEVEMENT

Candidates who were awarded Achievement for this standard demonstrated the required skills and knowledge. They typically:

- balanced nuclear equations correctly using the principles of conservation of mass number and atomic number
- correctly identified neutrons as the particles released in uranium fission
- calculated mass deficits for given nuclear particles
- used $E = mc^2$ correctly to find the energy from a mass deficit

- correctly defined what a photon is
- correctly related a photon's frequency to its energy
- showed some understanding of mass-energy equivalence
- linked photon release to energy levels of an electron
- showed some understanding of the photoelectric effect
- understood that transfer of energy is the fundamental concept behind atomic spectra and the photoelectric effect
- substituted data into appropriate relationships
- showed some understanding of photon absorption.

NOT ACHIEVED

Candidates who were assessed as Not Achieved for this standard lacked some or all of the skills and knowledge required for the award of Achievement. They typically:

- applied relationships to incorrect contexts
- did not recognise the symbols of important physical constants and variables (e.g. h, c)
- incorrectly stated that binding energy is required to hold a nucleus together
- did not show why a quantity is negligible
- restated the question without adding new information
- did not distinguish between frequency and energy of a photon
- confused electron or proton with photon and vice versa
- could not describe how photons and electrons interact with one another
- showed little or no understanding of binding energy, the photoelectric effect, and absorption spectra
- did not use the term "photon" in explanations
- did not use or manipulate numbers in standard form.

ACHIEVEMENT WITH MERIT

In addition to the skills and knowledge required for the award of Achievement, candidates who were awarded Achievement with Merit typically:

- showed working
- understood and used numbers in general form
- addressed all parts of questions
- justified why a quantity is negligible
- combined relationships in calculations
- attempted to subtract products and reactants to find a mass deficit in nuclear reactions
- gave the correct definition of binding energy
- linked photon production to electrons moving to lower energy levels
- linked the energy of a photon and its absorption by an electron during the photoelectric effect
- showed awareness of discrete energy levels for electrons in an atom and linked this to specific photon energies.

ACHIEVEMENT WITH EXCELLENCE

In addition to the skills and knowledge required for the award of Achievement with Merit, candidates who were awarded Achievement with Excellence typically:

- produced chains of reasoning that were logical and clearly expressed
- showed clear working
- showed understanding of the structure of electron energy levels and how this influences the electron's interaction with a photon in absorption and emission
- correctly combined and further developed more than one relationship to solve numerical problems.

OTHER COMMENTS

Many candidates had the misconception that binding energy is required to hold the nucleus of an atom together. Rather, binding energy is the energy required to separate the nucleus into its constituent nucleons.

Many candidates did not fully understand mass-energy equivalence and talked of "mass changing into energy". Rather, mass is a measure of total energy, so a particle with more energy will have a larger mass.

90523 Demonstrate understanding of electrical systems

ACHIEVEMENT

Candidates who were awarded Achievement for this standard demonstrated the required skills and knowledge. They typically:

- recalled appropriate concepts and principles
- chose correct formulae and used them
- made appropriate sketches of graphs and phasors
- interpreted a circuit diagram correctly
- applied Ohm's law appropriately
- described induced voltage as a result of changing current/flux/magnetic field
- identified period/frequency of an A.C. supply from graphs
- stated the condition for resonance in an LCR circuit.

NOT ACHIEVED

Candidates who were assessed as Not Achieved for this standard lacked some or all of the skills and knowledge required for the award of Achievement. They typically:

- confused AC with varying DC circuits
- confused the role and properties of capacitors and inductors
- confused current with voltage
- wrote answers that did not relate to the question that was asked
- did not show understanding of the correct units and prefixes for physics quantities
- did not start the more difficult questions correctly
- applied Kirchhoff's laws incorrectly

- misidentified a combined series-parallel circuit as parallel only
- used incorrect percentages to calculate capacitor discharge.

ACHIEVEMENT WITH MERIT

In addition to the skills and knowledge required for the award of Achievement, candidates who were awarded Achievement with Merit typically:

- described and explained some concepts accurately
- linked calculations of different physics quantities
- drew labelled diagrams accurately and with details correctly shown
- used physics language appropriately
- explained how both capacitor and inductor reactance change with frequency
- identified rate of change of current / flux / magnetic field as important to the value of voltage induced in an inductor.

ACHIEVEMENT WITH EXCELLENCE

In addition to the skills and knowledge required for the award of Achievement with Merit, candidates who were awarded Achievement with Excellence typically:

- linked several calculations of different physics quantities accurately
- used physics language and vocabulary fluently to explain a situation
- accurately and thoroughly explained the effect of changing a circuit
- explained that induced emf will act to oppose the change that produced it
- drew a correct phasor diagram and completed calculations using it.

OTHER COMMENTS

A misunderstanding among many candidates was shown by use of the statement that “Kirchhoff’s voltage law does not apply in an open circuit”, when explaining how an induced emf can exceed the cell emf in a circuit. In fact, the circuit in question was not an open circuit. Regardless of this, the statement is incorrect. Kirchhoff’s voltage law is an expression of conservation of energy so will therefore always apply.