National Certificate of Educational Achievement

2012 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

This was the final year for examinations to assess these achievement standards.

STANDARD REPORTS

90520 Demonstrate understanding of wave systems

ACHIEVEMENT

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

- recognised wave phenomena such as diffraction/interference
- identified the position of nodes and antinodes when standing waves form in pipes
- made correct substitutions into equations and solved them
- converted quantities into SI units.

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 correctly interpret questions
- confused similar physics terms or concepts
- made errors in arithmetic
- substituted values into equations in the wrong place.

ACHIEVEMENT WITH MERIT

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

- were able to rearrange and solve equations
- were able to link concepts to the observed effects
- addressed all the requirements of the questions
- wrote unambiguous statements to explain phenomena (e.g. “wavelength of the standing wave” rather than just the “the wavelength”)
- avoided using factually incorrect statements in arguments to explain phenomena.

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 complete and accurate interpretations of the questions and provided unambiguous answers
- articulately demonstrated depth of understanding of the phenomena of beats or resonance
- applied thorough understanding of situations to correctly calculate the answers to complex problems
- could explain the significance of formulae (e.g. beat frequency or Doppler effect).

OTHER COMMENTS

Some candidates attempted to answer the wrong question (e.g. described the phase relationship of two waves rather than the phase of vibrating air molecules), misapplied physics terms (e.g. the terms “node” and “antinode’ were incorrectly used to describe constructive and destructive interference in a question about interference over time), or wrote good physics but did not answer the question (e.g. explained how the Doppler Effect works but did not answer the question asked). Thorough proofreading of answers may help reduce these, as well as simple arithmetic errors.

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 maximum acceleration in simple harmonic motion occurs at the end point; they knew which of the displacement formulae must be used when the timing of a simple harmonic motion starts at the end point
- had sufficient concept knowledge to be able to select the necessary formula and substitute the required values to solve a straightforward problem. For example, they recognised that an angle in radians is not sufficient when rotations has been asked for
- recognised the concept that applied in given situations. For example, they recognised the situations in which angular momentum is conserved and the situations in which kinetic energy is conserved; they recognised that rotational inertia will change if mass or mass distribution changes; they recognised that the period of a pendulum depends on its length; they recognised that rotational motion is caused by a torque
- were able to identify basic concepts. For example, they recognised that an increase in mass means an increase in rotational inertia; they recognised that an impulse must be caused by a force; they recognised that the momentum of a system is the sum of the momentums of its parts; they had some understanding of vector addition and subtraction.

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 read the question properly. For example, they answered the question as if chemicals had caused the explosion rather than a spring
- made mistakes for example, did not put their calculator into radian mode when solving a problem that involved a cosine value; not squaring the radius in $I = mr^2$
- showed lack of knowledge of simple concepts. For example, they thought that kinetic energy is conserved whenever momentum is conserved; they thought that momentum is always conserved in an explosion, they thought that a changing impulse was caused by a changing gravity force
- confused concepts. For example they thought that energy is conserved in a situation where momentum is conserved; they thought that if two momentums add to a particular value then the associated velocities will also add together; they used force

when they should have used torque; they were unable to recognise the difference between the SHM and the rotational motion of a swinging action.

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 the rotational inertia of a system is the sum of the individual rotational inertias of the components of the system; they recognised that when momentum values are supplied in a problem that relates to velocities, momentum values need to be changed to velocity values
- were able to identify the concept that applied in given situations. For example, they recognised the situations in which angular momentum is conserved; they recognised that gravity would affect vertical momentum not horizontal momentum; they recognised that the effective length of a pendulum changes if the centre of mass of the bob moves its position; they selected and used correctly the displacement functions for SHM
- 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, torque is not proportional to rotational inertia unless angular acceleration is constant; torque is not proportional to force unless the radius of the application of the force is constant; rotational inertia is not inversely proportional to angular velocity unless angular momentum is constant.

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 were able to recognise that the result of a force acting in a particular direction is not necessarily limited to a change in motion in that particular direction
- 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 angular acceleration is constant is justified only if a specific change in angular velocity occurs in the same time period
- applied basic concepts to new situations and as a result could discuss these situations and link them to physics theory. For example they recognised that a push that is applied before a person starts to swing is not part of the simple harmonic motion of the swing and so has no effect on the restoring force; they recognised that conservation of momentum and conservation of energy are not directly related and were able to carry out an independent analysis of the situation in relation to both these quantities; they understood the meaning of the displacement functions for SHM and hence were able to used them correctly.

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:

- recognised that binding energy increases with the number of nucleons in a nucleus
- were able to match symbols to name of quantities to perform simple calculations
- stated that there was a minimum frequency of light needed to cause the photoelectric effect
- were able to use key words correctly
- showed some understanding of the photoelectric effect
- stated ideas rather than linking them
- rearranged equations correctly
- were aware of the difference between binding energy per nucleon and total binding energy
- recalled that stars undergo fusion reactions.

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:

- could not recall the symbols for common Physics constants (e.g. speed of light)
- ignored parts of equations (e.g. the squared in $E=mc^2$)
- confused atomic spectra with the photoelectric effect or nuclear physics
- incorrectly used the words photon and electron
- were unaware that H-1 is only one nucleon and therefore cannot split into nucleons
- compared two different physical quantities (e.g. stated a wavelength was larger than an energy)
- mixed standards or curriculum areas (e.g. discussing nodes/antinodes or activation energy)
- did not use the terms photons or electrons
- repeated information given in the question in their answers
- failed to distinguish between frequency, wavelength and energy
- confused absorption and emission spectra.

ACHIEVEMENT WITH MERIT

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

- used the terms “photon” and “electron” correctly
- correctly used standard form
- understood that electrons have quantised energy levels
- understood the meaning of binding energy (that it is not a type of energy, but the energy needed to split apart nucleons)
- distinguished between and linked binding energy, BEPN and fusion
- had a good understanding of the Bohr model of the atom and its effects on photons and electrons
- were able to provide comparisons between ideas
- linked the energy of a photon to the work function of a metal in the photoelectric effect
- carried out multi-step calculations.

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:

- clearly explained how the Bohr model is linked to atomic spectra
- had well laid-out and easy to follow calculations that showed sufficient detail
- explained concepts concisely without irrelevancies
- linked photon energy to energy loss or gain of an electron in the Bohr model of the atom.
- clearly explained how the process of fusion of Hydrogen releases energy and linked this to binding energy per nucleon of the products and reactants.

OTHER COMMENTS

Bohr's model of the atom as outlined in this Achievement Standard only applies to atoms in low density gases. Electrons in solids, especially in metallic solids, behave very differently than electrons in the atoms of gases.

The photoelectric effect only occurs in metallic solids, so candidates should not use concepts such as energy levels to explain the behaviour of electrons in these metals.

90523 Demonstrate understanding of electrical systems

ACHIEVEMENT

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

- converted prefixes to SI units correctly
- identified correct physical quantities and chose correct formulae to perform basic calculations
- described how the total capacitance increases when capacitors are added in parallel
- stated the condition for resonance in an LCR circuit

  identified EMF and internal resistance off a V-I graph
- sketched a discharging graph for a capacitor to show the effect of increased capacitance on the time constant.

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 correctly convert prefixes to SI units
- did not choose correct formulae to perform basic calculations
- did not identify the difference between adding capacitors in series and parallel
- did not state the condition for resonance in an LCR circuit
- did not identify the significance of the gradient and the y-intercept in a V-I graph.

ACHIEVEMENT WITH MERIT

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

- used vector addition correctly to calculate the impedance in an LCR circuit
- performed two-step calculations correctly
- explained the difference between the rate of change of magnetic flux and the change of magnetic flux
- could explain how the current in an LCR circuit depends on the frequency of the supply
- calculated capacitance correctly using the condition for resonance
- explained and calculated EMF and internal resistance correctly from a V-I graph
- calculated the time constant of a capacitor correctly from a discharging graph.

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:

- performed complex multistep calculations correctly
- explained coherently how the induced EMF is related to the rate of change of flux and its effect on the current in a DC circuit
- could explain the effect of changing a variable on the gradient and the y-intercept of a V-I graph.

OTHER COMMENTS

Candidates had mixed ideas associated with electromagnetic induction (emf generation) from an external field due to the motion of a coil and that of self-inductance (creation of a ‘back’ emf due to the commencement of a current through a coil). Some candidates also confused AC induction with a DC situation.

Candidates equated the ‘lower performance’ of a flattening battery with a parallel line shifted down. They did not see that identical slopes equated to identical internal resistance values.

Candidates who could have gained Excellence may have underachieved due to the lack of literacy skills rather than the lack of content knowledge and skills in Physics.