2025 NCEA Assessment Report

Subject:	Physics
Level:	3
Achievement standard(s):	91523, 91524, 91526

General commentary

Each paper consisted of three questions with four parts. Candidates were expected to respond to all questions.

Candidates who demonstrated effective examination technique performed well and generally achieved higher grades. Successful candidates were able to show that they had a sound understanding of physics concepts at this level, and were not just relying on rote-learned answers. Candidates are encouraged to answer every question, not to be scared to write something down with a little thought, and most importantly NOT to cross out partial answers that do, in fact, contain some correct content. Candidates are encouraged to read the questions carefully to give themselves a chance to respond appropriately to what has been asked.

Report on individual achievement standard(s)

Achievement standard 91523: Demonstrate understanding of wave systems

Assessment

The examination consisted of three questions that covered Standing waves, Doppler Effect, Beats and Interference Patterns.

Commentary

The exam was generally straightforward, with many candidates delivering comprehensive answers and a good balance between calculations and written theory. Candidates are showing improvement in their responses to excellence level questions in this standard. Notable successes included a strong performance on monochromatic light questions. Several conceptual weaknesses emerged: many candidates confused diffraction with interference, incorrectly linked path difference to beats, and relied on lower-level terminology (like "peaks and troughs") rather than Level 3 concepts like phase. Furthermore, significant accuracy issues were caused by early rounding and inconsistent use of significant figures, leading to final answers that deviated from expected values by up to 15%. To improve, candidates should use precise Level 3 terminology and carry extra significant figures throughout their working.

Grade awarding

Candidates who were awarded **Achievement** commonly:

- attempted all questions even if they couldn’t finish them
- were able to identify the key concepts and keywords applicable to a question

- could draw and label standing waves
- could substitute into basic formula
- identified and described differences between patterns seen from double slits and gratings
- could use $v = f\lambda$
- could identify the correct doppler equation
- could solve doppler equations
- could describe beats in terms of volume fluctuations.

Candidates who were awarded **Achievement with Merit** commonly:

- used formula to justify their answers and rearranged formula successfully
- performed two step calculations correctly
- were able to identify and link relevant ideas together
- fully described and explained Doppler using $v = f\lambda$, including that the speed of sound is constant
- explained that the source frequency is heard when the source is not moving toward or away from the observer
- attempted to use relative velocity to describe doppler in non-straight line scenarios
- used $v = f\lambda$ to calculate velocity and length of given strings
- explained how beats form fully
- explained the roll of the path difference in the formation of interference patterns
- partially explained differences between the interference pattern seen from double slits and gratings
- used formula to explain the relationship between slit spacing and the angle to the maxima and to calculate the slit spacing for a given number of maxima.

Candidates who were awarded **Achievement with Excellence** commonly:

- used formulae and terminology appropriately
- showed they had very strong calculation / algebra skills and were able to solve multi-step calculations
- were able to identify and link relevant ideas and formulae, to construct logical and sequential answers
- explained how the component of a sources velocity toward an observer, results in the apparent frequency heard
- explained how a changing frequency effects beat frequencies
- fully explained the differences between two slit and multi-slit interference
- recognised the relationship between the maxima seen on a screen to the slit spacing when n is not a whole number.

Candidates who were awarded **Not Achieved** commonly:

- did not use the correct vocabulary
- did not know each of the variables in the formulae provided
- struggled with basic mathematical operations
- used pre-learned answers that were inappropriate to the question
- struggled to identify what the question was asking
- did not use the relevant formulae to guide or support answers
- confused volume and frequency with reference to the Doppler effect

- stated that waves bunch to explain doppler without referencing wavelength
- thought that distances alone affected the doppler effect
- drew waves with uneven proportions or that did not fit the string
- described a variable as “changing” (rather than increasing or creasing)
- confused crests, antinodes and antinodal lines as meaning the same things
- incorrectly used path difference to explain the formation of beats
- mixed up concepts between doppler, standing waves and interference.

Achievement standard 91524: Demonstrate understanding of mechanical systems

Assessment

The examination consisted of three questions that covered momentum, circular motion, rotational motion, and simple harmonic motion.

Commentary

Overall, while basic calculations were handled well, performance was often limited by a lack of technical precision and contextual application. Candidates struggled with vector directions and formal equations of motion, often bypassing algebraic steps or failing to correctly identify the forces involved. Significant gaps were noted in the application of Simple Harmonic Motion and phasor diagrams, alongside a tendency to substitute memorized definitions for situational analysis—most notably in the misuse of "constant" versus "conserved" momentum and the mechanics of resonance. Ultimately, errors in combining system components and an over-reliance on terrestrial analogies, such as applying roller coaster physics to space contexts, prevented many from reaching the highest levels of achievement. Candidates are relying too heavily on previous year’s papers to produce model answers. Those who know how to apply their knowledge to a range of situations perform well and achieve the higher grades.

Grade awarding

Candidates who were awarded **Achievement** commonly:

- could perform straightforward substitution calculations (e.g. p = mv, τ=Iα)
- recognised that orbital motion required that $F_c = F_g$
- calculated I from $I = mr^2$
- recognised conservation of momentum
- knew that moving inwards on a roundabout increased the angular velocity
- attempted to use trig relationships
- found the period of a pendulum
- recognised resonance.

Candidates who were awarded **Achievement with Merit** commonly:

- answered most questions
- found the COM of a system
- applied conservation of momentum in 2D correctly to find both momentum and direction
- applied $F_c = F_g$ correctly to find orbital velocity
- calculated the torque applied to slow a rotating roundabout

- applied conservation of angular momentum correctly
- fully and correctly linked two ideas to explain what happens to the rotational kinetic energy of a roundabout when the distribution of mass changes
- showed how angular frequency is calculated.

Candidates who were awarded **Achievement with Excellence** commonly:

- correctly found the total momentum, both magnitude and direction in 2D
- correctly found the period of orbit
- understood and explained gravitational force providing required centripetal force to remain in orbit and that reaction force is involved in weight
- understood and explained that resonance involves driving frequency matching natural frequency and linking it to the increases in specific energy types that lead to a larger amplitude
- showed a good understanding of SHM formulae when answering Q3(c).

Candidates who were awarded **Not Achieved** commonly:

- failed to state the base equation in "show" questions and omitted necessary algebraic steps
- incorrectly added vector magnitudes arithmetically for 2D momentum problems instead of using Pythagoras or trigonometric resolutions
- stated that velocity (linear or angular) was conserved rather than momentum and angular momentum
- improperly used constant speed formulas for systems that were clearly accelerating from rest
- neglected to account for the total rotational inertia of a system, often calculating the inertia for only one component while ignoring others, such as a person on a roundabout
- struggled to use rotational kinematic equations and lacked clarity on when to apply the conservation of angular momentum versus rotational kinetic energy
- did not use the displacement formula effectively and frequently made incorrect substitutions when calculating the time taken to travel specific distances
- identified terms like "resonance" or "natural frequency" by name but failed to provide a physical explanation of the underlying mechanics.

Achievement standard 91526: Demonstrate understanding of electrical systems

Assessment

The examination consisted of three questions that covered capacitors in DC circuits, transformers, inductors in DC circuits, and AC circuits.

Commentary

Many candidates struggled to understand the difference between inductors and capacitors and had an incorrect understanding of the role of capacitors in a parallel circuit when the circuit has an open or closed switch. Many candidates indicated that ‘current follows the path of least resistance’, leading to significant misconception around the flow of current in circuits. In addition, many candidates could not discuss the term emf outside of the topic of electromagnetic induction. This limited their ability to answer several questions. Many candidates made the error of putting the entire $2V_{RMS}$ under the square root sign when calculating the peak voltage.

Grade awarding

Candidates who were awarded **Achievement** commonly:

- calculated terminal voltage and correctly identified that it decreases as internal resistance increases
- sketched accurate current vs time decay curves and performed calculations for maximum current and the time constant
- recognized that total capacitance decreases in series and increases in parallel, noting the subsequent impact on the circuit's time constant
- explained how a rapidly dropping magnetic flux induces EMF when a circuit opens and identified that adding an iron core increases inductance
- calculated inductive reactance X_L and X_C and successfully identified resonant circuits by stating the condition $X_L = X_C$.

Candidates who were awarded **Achievement with Merit** commonly:

- explained how increasing internal resistance leads to a decrease in terminal voltage
- illustrated exponential decay in discharging capacitors through accurate I vs t graphing and analysis of series and parallel circuit variations
- described the production of back EMF due to changes in current and magnetic flux, and successfully calculated the energy stored in components
- analyzed voltage changes across resistors and inductors in AC systems and explained the physical conditions of resonance
- demonstrated that at resonance X_L and X_C cancel, resulting in minimum impedance (Z=R), although calculations failed to account for the inductor's internal resistance.

Candidates who were awarded **Achievement with Excellence** commonly:

- carefully analysed questions and demonstrated the exponential decay of a discharging capacitor through an accurate
- explained how series connections increase voltage but decrease capacitance and time constants, while parallel connections maintain initial current but increase capacitance and discharge time
- described how rapid current changes produce back EMF and magnetic flux changes, resulting in a small time constant
- explained how resonant frequency causes inductive and capacitive reactance to cancel out, leading to minimum impedance and maximum current
- successfully calculated the capacitance required to match an inductor's energy storage and determined impedance and current using total resistance and reactance values.

Candidates who were awarded **Not Achieved** commonly:

- only attempted the first two questions (Q1(a and (b)), leaving the remainder of the examination paper blank
- struggled with basic definitions, failing to distinguish between EMF and terminal voltage or the processes of charging versus discharging capacitors
- confused the functions of capacitors and inductors, incorrectly attributing the property of opposing current flow to the capacitor
- demonstrated no knowledge of inductor behaviour in open circuits or the specific conditions and identification of resonance frequency in a circuit.