2024 NCEA Assessment Report

Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

Subject: Physics

Level: 3

Achievement standard(s): 91523, 91524, 91526

General commentary

Each paper consisted of three questions with four parts. Each question had two opportunities for excellence. Candidates were expected to respond to all questions.

The knowledge of SI prefixes was extremely poor this year. Candidates need to be familiar with the SI prefixes giga, mega, kilo, milli, micro, and nano, and to convert measurements to base units.

Candidates should be using standard form / scientific notation and not “e” notation that is displayed on some scientific calculators.

Early truncating and rounding, led to significant differences from the expected answer. Candidates are advised to carry through two or three more significant figures than is expected in the final answer.

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. It’s very disheartening for the marker on the candidate’s behalf.

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

Many candidates incorrectly attributed path difference to the formation of beats. Diffraction was poorly understood and used interchangeably with interference.

Candidates continue to incorrectly use red diffracts more as reasoning to the order of colours produced from white light through a grating.

Many candidates attempted to discuss the train moving parallel or perpendicular to the observer or being in the same position (with difficulty), rather than “not moving toward or away from” to describe the relative motion toward the observer.

Grade awarding

Candidates who were awarded **Achievement** commonly:

- attempted all questions, even if they couldn’t finish them

- could draw waves in a pipe
- could substitute into basic formulae
- identified differences between double slits and gratings
- stated that red light has a longer wavelength
- could state that the frequency of an approaching source appeared to provide a higher pitch / frequency
- could use $v = f\lambda$
- could solve Doppler equations.

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

- used formula to justify their answers
- rearranged formula successfully
- calculated the frequency for a given pipe
- explained how only odd multiples of ¼ wavelengths can form harmonics in a open-closed pipe
- understood that $n\lambda$ = path difference
- calculated the number of maxima using the formulae
- partially explained differences between double slit and diffraction gratings
- used formula to explain the relationship between path difference and the angle to the maxima
- fully described and explained Doppler using $v = f\lambda$, including that the speed of sound is constant.

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

- identified and used physics formula to support their answer
- provided clear answers, linking several concepts, in a clear and coherent manner
- gave full descriptions of how waves form in a pipe, including relevant phase change / no phase change on reflection
- recognised the symmetry of an interference pattern either side of a central maxima
- explained why gratings and double slits produce different interference patterns
- could set up and solve a simultaneous Doppler equations to find the train's velocity
- identified that the train was accelerating in question 3(d).

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

- did not convert SI units
- did not use the correct vocabulary
- used pre-learned answers incorrectly
- struggled to identify what the question was asking
- did not know each of the terms / symbols in the formula provided
- did not use the relevant formulae to guide or support answers
- drew waves with uneven proportions or that did not fill the pipe
- confused crests, antinodes and antinodal lines as meaning the same things
- incorrectly used path difference to explain the formation of standing waves
- stated red diffracts more / blue diffracts less
- confused volume and frequency with reference to the Doppler effect
- stated that waves bunch to explain Doppler without referencing wavelength
- were not specific in their answers and described a variable as "changing" (rather than increasing or decreasing).

Achievement standard 91524: Demonstrate understanding of mechanical systems

Assessment

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

Grade awarding

Candidates who were awarded **Achievement** commonly:

- recognised the relationship between F_c and F_g
- drew free body diagrams correctly
- confused net force direction
- could not define centripetal force
- attempted to solve problems using conservation of energy
- could determine angular velocity
- calculated angular velocity using rotational kinematics
- recognised that a net torque was required to cause rotation and that this was caused by a net force
- identified the impact on rotational inertia when changing the distribution of mass
- stated the conditions for SHM
- were able to use a reference circle to calculate the angular frequency of a pendulum or the angle of rotation
- could identify damping as the cause of decreasing amplitude in an object that is oscillating with SHM.

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

- could use $F_c = F_g$ to calculate the maximum velocity
- recognised that the net force provided the centripetal force
- solved problems using the conservation of energy with mistake(s)
- were able to show working out, included the correct steps when using rotational kinematics
- could identify one of the two forces involved when calculating net torque but failed to identify that tension was producing the torque
- could explain why rotational inertia decreases using a valid formulae or relationship
- calculated the angular frequency and then the displacement from equilibrium but with a mistake (brackets, degrees, sin)
- drew a graph starting at maximum displacement, with a constant period or a decreasing amplitude
- identified that energy is lost as heat due to friction during damping.

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

- provided a comprehensive discussion of the net force acting on the ball bearing
- drew free body diagrams correctly with relative net forces for different positions
- discussed the relative net forces produced and the direction of the centripetal force to the centre of the circle
- calculated multiple part problems correctly
- produced clear logical and sequential layout to problems
- discussed the impact of changing the rotational inertia on the acceleration of a flywheel
- used equations to justify answers
- drew correct damping diagrams
- provided a comprehensive discussion for damping, with reference to all energy transformations and cause and impact of loss.

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

- could not produce basic definitions
- drew weight and support forces with incorrect directions
- mixed up the information provided in the question
- attempted at solving using the conservation of energy
- attempted to calculate angular
- did not recognise the effect of torque on rotational motion
- recognised damping decreased the amplitude over time.

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.

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 putting the entire 2VRMS under the square root sign when calculating the peak voltage.

Grade awarding

Candidates who were awarded **Achievement** commonly:

- explained the meaning of EMF
- identified that voltmeter readings were different in open and closed circuits

- attempted to use Kirchhoff's voltage law to calculate the current in a complex circuit
- knew that a lamp in series with an uncharged capacitor would glow initially
- calculated the self-inductance of a coil
- calculated the EMF induced in one turn of a coil
- identified that a bar magnet would slow down as it approached a metal ring
- calculated the time constant of a LR circuit
- used the rms voltage to calculate the peak voltage
- showed how to calculate the reactance of an inductor
- identified that a lamp would shine brighter if the iron core was removed from an inductor
- described what happens at resonance.

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

- explained why voltmeter readings were different in open and closed circuits
- used Kirchhoff's voltage law to calculate the current in a complex circuit
- correctly compared the brightness of lamps that were connected in series with a capacitor and a resistor
- calculated the EMF induced in a coil that had 25 turns
- explained why a bar magnet would slow down as it approached a metal ring
- calculated the current after one time constant in an LR circuit
- calculated the phase difference between the supply voltage and current and correctly stated that supply voltage leads current
- explained why the current would increase in a circuit if an iron core was removed from an inductor
- explained what happens to current and impedance when a circuit is at resonance.

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

- could explain how the internal resistance affected the EMF of a battery and were able to calculate the terminal voltage across a battery that was being charged
- gave an in-depth explanation of how capacitors and resistors affect the brightness of lamps
- showed a good understanding of Faraday and Lenz's Laws by explaining why the acceleration of a bar magnet would decrease as it approached and left a metal ring
- calculated the current after two time constants in an LR circuit
- demonstrated an understanding of how changing the inductance of an inductors would affect the brightness of a lamp in a circuit
- explained why reactance is zero and how current and impedance are affected when a circuit is at resonance.

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

- confused the EMF of a battery with the induced EMF of an inductor
- showed very little understanding of internal resistance
- could not distinguish between capacitors charging and discharging
- confused how inductors and capacitors affect the current in a circuit
- did not solve simple calculations
- did not distinguish between DC and AC circuits
- showed little understanding of Faraday and Lenz's Laws
- did not describe what happens when a circuit is at resonance.