2022 NCEA Assessment Report

Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

Subject: **PHYSICS**

Level: **3**

Standards: **91523, 91524, 91526**

Part A: Commentary

The examination was a paper based written examination covering wave systems, mechanical systems, and electrical systems.

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

Part B: Report on standards

AS 91523: Demonstrate understanding of wave systems

Examination

A paper based one hour examination covering Standing waves, Interference, and Doppler Effect.

Observations

Understanding key definitions and the variables used in formulae is essential to meet the criteria of this Achievement Standard. Recognition that higher harmonics are multiples of the first harmonic would have greatly assisted students formulating their answers. Candidates who were able to extract key information from the question performed well.

In “Show..” questions, candidates need to actually show the process used to come to the answer provided. Ideally this should include the relevant formula, correctly substituted values, working, and an “unrounded answer”. Some students continue to write close to the edge of the paper, resulting in some parts of the words missing when papers were scanned for marking.

Grade awarding

Candidates who were awarded **Achievement** commonly:

- substituted variables into simple formulas and solved for an unknown value
- carried out simple calculations correctly
- provided the end conditions in strings, open-open pipes and open-closed pipes
- recognised that maxima are the result of constructive interference
- recognised that in a spectrum, red light is furthest from the central maxima.
- recognised that a source moving toward an observer, results in a higher observed frequency

- confused frequency and volume in the Doppler effect.

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

- did not use the correct vocabulary or relevant formulae
- did not identify a wavelength
- did not calculate the slit width of a diffraction grating
- stated that white light had its own specific wavelength
- stated that the apparent frequency continued to increase as a source approached.

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

- used appropriate language and terminology
- rearranged formula successfully
- completed two step calculations accurately
- demonstrated understanding of the relationship between the length of a string/pipe and the wavelength
- explained that maxima are the result of waves being in phase.
- used the formula to explain the relationship between wavelength and the angle to the maxima
- explained the change in the perceived frequency of a moving sound source.

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

- provided clear answers, linking several concepts, in a clear and coherent manner
- manipulated and combined formulae to accurately perform calculations
- explained the link of the frequency/wavelength of the 1st harmonic to higher harmonics
- recognised that the path difference leads to a phase difference and hence a resulting interference pattern
- used the formula to explain the relationship between path difference and the angle to the maxima
- understood how relative velocity resulted in the observed Doppler effect.

AS 91524 : Demonstrate understanding of mechanical systems

Examination

The examination consisted of three questions that covered rotational motion, linear motion, and simple harmonic motion. Each question had four parts.

Observations

Some candidates were able to state the conditions required for rotational motion, both in terms of conservation of momentum, and application of force to cause a torque, but a few displayed significant misconceptions around the source of rotation, and confusion between rotational motion and circular motion.

Candidates who demonstrated practised algebraic skills and understood the concepts

behind the calculations were able to select appropriate formulae from the to perform accurate calculations. Candidates needed to demonstrate their working for show questions. This included choosing the right formula, substituting appropriate values, and coming up with the required answer. It is often a good idea to first write down the unrounded answer, before rounding to appropriate significant figures.

Some candidates were able to apply their physics knowledge to new situations and contexts, and provide detailed narratives to explain how change could take place. By reading the questions carefully, they were able to answer the question in front of them, rather than provide a set piece answer that did not meet the criteria.

Grade awarding

Candidates who were awarded **Achievement** commonly:

- completed the show questions by showing the working clearly, including the formula and substitution.
- calculated the position of the COM (centre of mass) between 2 masses
- used the Universal Law of Gravitation
- stated the conservation of linear momentum, and calculated the initial total momentum of the system
- used the equation provided to discuss the relationship between the natural period of a pendulum and the amplitude of its oscillations, but often without sufficient details
- explained the parts of the conservation of angular momentum and the relationship between rotational inertia and angular velocity, but did not interpret and discuss it with a system made of two parts
- described changes in rotational motion, but some confused rotational and circular motion
- did not answer a simple SHM (simple harmonic motion) question.
- did not calculate max SHM velocities, and used them to calculate difference in linear kinetic energies
- did not understand the role played by angles between Force and Distance to the centre of rotation for Torque or Velocity and Distance to the centre of rotation for Angular Momentum
- did not draw a conservation of linear momentum vector diagram without a 90-degree angle
- did not complete calculation using the conservation of linear momentum in 2D without a 90° angle.

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

- did not complete the show questions
- did not calculate the position of the COM between 2 masses
- did not use the Universal Law of Gravitation
- did not state the conservation of linear momentum and calculate the initial total momentum of the system

- did not use the equation provided to discuss the relationship between the natural period of a pendulum and the amplitude of its oscillations, but often without sufficient details
- did not properly explain the conservation of angular momentum and the relationship between rotational inertia and angular velocity, and could not interpret and discuss it with a system made of two parts
- did not understand the role played by angles between Force and Distance to the centre of rotation for Torque or Velocity and Distance to the centre of rotation for Angular Momentum
- did not draw a conservation of linear momentum vector diagram without a 90-degree angle
- did not answer a simple SHM question
- did not calculate max SHM velocities and used them to calculate difference in linear kinetic energy
- did not complete calculation using the conservation of linear momentum in 2D without a 90° angle
- did not differentiate between mass and weight.

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

- calculated angular deceleration correctly
- identified the relationship between inertia and angular velocity and link to $L = Iw$
- applied the law of universal gravitation equation and identify the validity of the calculation
- applied the law of conservation of linear momentum to calculate initial momentum and then final velocity of objects after a collision, with consideration of the 2D nature but with an error (e.g. used 50 000 instead of 25 000)
- proved that the momentums of two identical objects at the same but opposite angles to the horizontal have the same momentum, either through a properly labelled vector diagram (identifying the non-90° relationship), algebraic proof, calculation, or explanation
- calculated the angular frequency of a pendulum and used in an SHM equation, but frequently did not fully answer the question to give an exact position
- calculated the max velocity of an oscillating pendulum and the energy lost between two amplitudes
- applied the time period equation for a pendulum to identify that amplitude did not affect T with some justification
- identified the significance of a perpendicular (to radius) linear velocity / applied force in increasing the angular velocity of the roundabout through $T = Fr$ and / or $L = mvr$
- did not explain the effect on a rotating system when part of that system is removed. Often incorrectly identified L as constant and I decreasing (due to mass being removed) so w increases, or I increasing (due to r increasing) so w decreases
- confused the meanings of L3 symbols and equations occasionally, and so applied them incorrectly

- made occasional calculation errors.

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

- stated the conservation of linear momentum, and calculated the initial total momentum of the system
- used the equation provided to discuss the relationship between the natural period of a pendulum and the amplitude of its oscillations, but often without sufficient details.
- explained the conservation of angular momentum, and the relationship between rotational inertia and angular velocity, and sometimes interpreted and discussed it with a system made of two parts
- calculated max SHM velocities, and used them to calculate difference in linear kinetic energies accurately
- displayed understanding of the role played by angles between Force and Distance to the centre of rotation for Torque, or Velocity and Distance to the centre of rotation for Angular Momentum
- drew a conservation of linear momentum vector diagram without a 90° angle
- completed a calculation using the conservation of linear momentum in 2D without a 90° angle accurately.

AS 91526 : Demonstrate understanding of Electrical Systems

Examination

This examination consisted of three questions with four parts each. It consisted of a fair and evenly spread range of questions covering the standard. This year there were no questions on Kirchhoff's Laws and Electromagnetic Induction. The topics covered were AC circuits, electromagnetism and capacitors in DC circuits.

Observations

Candidates were able to provide evidence of their understanding if they read the question carefully. Those who were able to differentiate between I_{rms} with I_{max}, drew a phasor diagram correctly, including both resistance/reactance values and / or labels with voltage values / labels on the same phasor diagram, and understood the meaning of "electrically isolated" were able to access the higher grades. There were misunderstandings of what happens to charges on an isolated plate, confusing voltage and charges. Many responses stated that when the electrically charged plates were separated, the current would flow off, or used $V = Ed$ to claim that since d increases, V must increase (assuming E is constant – showing a lack of understanding of E).

Grade awarding

Candidates who were awarded **Achievement** commonly:

- did one-step calculations accurately
- identified one key idea relating to the question
- identified which formula and physical constant to use to calculate capacitance
- selected the required formula and substitute to calculate reactance

- used vector addition to calculate impedance
- drew and labelled phasor diagrams correctly, and recognised that current is in phase with the resistor voltage
- demonstrated understanding of the condition for resonance, and that the current was maximum
- stated that the voltage across an inductor was zero once the current was steady, and that the voltage across the resistor was equal to the supply voltage
- demonstrated understanding that doubling the resistance would mean current was halved in a RL circuit
- used the formula to calculate the energy stored in a capacitor
- calculated the total capacitance when there was a combination of capacitors in series and parallel
- identified one key idea relating to the question.

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

- did not respond to the question appropriately, or left questions blank
- did not demonstrate understanding of how variables related to each other in equations
- confused capacitance and inductance with the reactance of a capacitor/inductor
- did not draw phasor diagrams or applied trig to solve them
- did not recognise need for phasor addition
- did not express percentage / fractional change in relationships
- did not demonstrate understanding what resonance in an AC is
- did not calculate reactance or the capacitance of a capacitor
- did not understand how inductors in a DC circuit work.

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

- completed multi-step calculations correctly
- demonstrated understanding of what resonance is and the conditions for it
- included quantitative analysis in their explanations (e.g. since C increases 7 times, E will increase 7 times)
- calculated circuit current in RC circuits
- used phasor diagrams to calculate the phase difference between circuit current and supply voltage
- demonstrated understanding of the direction of the induced voltage for both rising and falling currents and how to calculate the size of the induced voltage
- demonstrated understanding of what happens to the charge on and the voltage across capacitor plates that were electrically isolated and pulled apart
- calculated total charge from a combination of capacitors connected together.

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

- completed multi-step calculations accurately

- answered all questions and all parts of a question, explaining their thinking with clear justifications, writing clearly and concisely
- demonstrated understanding of key physics principles in depth (e.g. the difference between voltage, charge and current)
- were able to follow the hints given in the question to structure their answers like; “electrically isolated” and “by first calculating the total capacitance”
- deduced the value of an inductor that needed to be added to bring a RC circuit to resonate, including the conditions needed for resonance
- demonstrated understanding of what happens to the current, time constant, and the energy stored in an inductor if the resistance was doubled
- demonstrated understanding of how to find the voltage across a combination of capacitors connected together.