2015 NCEA Assessment Report

Physics Level 3 91523, 91524, 91526

Part A: Commentary

Comment on the overall response of candidates to 2015 examinations for all achievement standards covered by this report.

Most candidates attempted every question in the paper, allowing them the opportunity to gain a partial grade for the more complex questions.

Students were much better at calculating answers than they were at using physics concepts to explain the physics of situations.

It is important that candidates read the questions carefully and attempt to answer all questions. Unfortunately many candidates crossed out answers and either did not write something in its place or gave an incorrect answer when the original answer was correct.

Part B: Report on standards

1. Assessment Report for 91523: Demonstrate understanding of wave systems

Achieved	Candidates who were assessed as Achieved commonly: • knew that beats were related to interference or could give a basic description of beats • remembered that longer waves produced higher frequency sound • could apply the wave equation ($v=f\lambda$) • chose and applied the correct version of the doppler formula for an approaching source • stated some conditions necessary for the formation of standing waves • stated that pipe length affects wavelength and frequency • applied diffraction formulae to make predictions.
Not Achieved	Candidates who were assessed as Not Achieved commonly: • were unable to describe the features of a wave using correct terminology • could not link the variables used in formulae to the correct physical quantities • described interference using a simplistic model only • described beat formation as if it were a stationary interference pattern with nodes and antinodes.
Achieved with Merit	Candidates who were assessed as Achieved with Merit commonly: • could combine their knowledge of beats and the doppler effect mathematically • could explain the effect of changing a variable on another physical quantity with reference to a formula • could use wave theory to explain the cause of observed phenomena such as interference fringes or doppler shifted frequencies.
Achieved with Excellence	Candidates who were assessed as Achieved with Excellence commonly: • were able to follow several steps to arrive at a correct mathematical result • explained the link between phase, interference and observed outcomes in interference situations.

Standard specific comments	This paper required students to be able to explain wave phenomena in terms of phase difference. Some students were competent with equations and with explanations involving peaks and troughs but did not seem to be familiar with phase difference in the context of waves. Few students described sound waves in terms of compressions and rarefactions, with many incorrectly using the words crest and trough. Many students were confused about interference patterns, calling the angles at which nodes and antinodes appear "angles of diffraction".

2. Assessment Report for 91524: Demonstrate understanding of mechanical systems

Achieved	Candidates who were assessed as Achieved commonly: • relevant equations and used them in a one-step calculation, sometimes when a more complex calculation was required • recognised when rotational inertia increased or decreased • recognised that centripetal force equalled gravitational force for orbital motion • converted between days and seconds • described the motion of a pendulum • recognised that the forces on a pendulum are tension and gravitational force • recognised that the net force on an object in simple harmonic motion is towards the equilibrium position • used the equation for centripetal force, but used an incorrect force value • used the equation for period of a pendulum correctly • used the equation for momentum for simple calculations • used trigonometry to find an unknown angle • performed simple calculations using the equation for momentum, but did not show understanding of the vector nature of momentum • stated the relevant conservation law (e.g. linear momentum or angular momentum) • correctly used given numbers to get answers for "show that" questions, but equations stated were either omitted or incorrect.
Not Achieved	Candidates who were assessed as Not Achieved commonly: • chose irrelevant equations and substituted numbers from the question in an attempt to answer calculation questions • attempted to use irrelevant equations in explain questions to explain why some physical quantities increased, decreased or stayed the same • restated the question in explanation questions without stating any physical principles • confused momentum and angular momentum • stated that there was no gravity in space • incorrectly identified "g" as mass or gravitational force • answered questions about forces with a discussion on energy • confused the concepts of momentum, force and energy.
Achieved with Merit	Candidates who were assessed as Achieved with Merit commonly: • answered "show that" questions with correct equations or intermediate steps shown • linked changing radius to changing rotational inertia and changing angular velocity • equated the equations for centripetal force and gravitational force in the orbital motion question, and was able to perform some algebraic manipulation • clearly showed the forces on a pendulum • links the direction of the force on a pendulum to the acceleration • used trigonometry to calculate forces in a force diagram • selected correct equations and used them for multistep calculations • stated that momentum is conserved in the absence of external unbalanced forces, and linked this statement to the situation • used linking words in their explanations, showing that one event causes another event.

Achieved with Excellence	Candidates who were assessed as Achieved with Excellence commonly: • in explanation questions used conservation laws, relevant equations and causal links. E.g. they explained how the radius of the star links to angular velocity by stating conservation of angular momentum, the equations for angular momentum and inertia and making "therefore" or "because" statements correctly • correctly merged the equations for centripetal force, gravitational force, and speed, and correctly and clearly manipulated these algebraically. • clearly draws or explains the direction of forces on a pendulum, explains how these forces change and how the changes affect the motion of the pendulum. • draws triangles from force diagrams and uses trigonometry to identify unknown forces and recognises which side of the triangle is which force • showed a clear understanding of the vector nature of momentum by using Pythagoras correctly to identify an unknown momentum • correctly stated the conditions for conservation of momentum, and used this to make causal statements linking this to all the stated information about the situation.
Standard specific comments	A very small percentage of candidates used vectors to solve momentum problems. Many simply added and subtracted numbers. Many candidates did not fully address questions. For example, question 2b asked for an explanation using forces, and many candidates addressed the question using only energy concepts. There were a number of "show that" questions. Some candidates did not clearly show the equation they used, so missed out on credit for these questions. Some candidates were also fooled by a similar number appearing in their working, i.e. in question 2ci the answer was 18.0 N, and an intermediate step was 17.7 N, and many candidates stopped at this point because the numbers were similar. Not many candidates drew diagrams to help with their answers. Many answers to questions 2b, 2ci, 2cii and 3bii would have been improved by force or momentum diagrams. Candidates should draw diagrams where-ever relevant, even if the questions doesn't explicitly require a diagram to be drawn. Question 1d showed up some misconceptions. A fair percentage of students stated that the angular speed was unchanged because there is no gravity in space. Some of these students successfully identified Newton's equation for universal gravitation in the previous question. There are still many students who confuse concepts of force, energy, momentum and angular momentum in their answers. There are also many students who are unable to choose relevant equations for the situation, and do not know which letter corresponds to which physical variable.

3. Assessment Report for 91526: Demonstrate understanding of electrical systems

Achieved	Candidates who were assessed as Achieved commonly: • realised that rms voltage was not an average voltage • could calculate reactance of an inductor • knew that XL = XC at resonance • identified that conventional current travels from the higher potential to the lower potential • realised that an increase in internal resistance decreases the power output of a battery • understood how a capacitor charges • could calculate the energy stored in a capacitor

	• knew that an inductor affects a changing current • identified that energy is stored in the electric field of a capacitor or magnetic field of an inductor.
Not Achieved	Candidates who were assessed as Not Achieved commonly: • could not do basic calculations, particularly using square root and converting mH to H • confused capacitance and charge • could not distinguish between reactance of an inductor and inductance • battled to calculate current using Kirchhoff's equations • confused the terms emf and terminal voltage • thought that positive charges moved onto a capacitor when being charged • showed no understanding of how energy is stored by an inductor and capacitor.
Achieved with Merit	Candidates who were assessed as Achieved with Merit commonly: • could calculate impedance of a circuit by drawing a phasor diagram • could calculate the current in a resonant circuit • used Kirchhoff's equations confidently to calculate current in a circuit • identified that a decrease in power was as a result of current and output voltage decreasing due to internal resistance increasing • understood why the voltage across a capacitor increases as it charges • understood that an inductor produces an induced voltage due to a changing flux as a result of the current changing • could explain why the energy stored in a capacitor decreases as it discharges.
Achieved with Excellence	Candidates who were assessed as Achieved with Excellence commonly: • could calculate the Voltage across the components in an LCR circuit • showed a good understanding of the internal resistance and that emf remains constant in old and new batteries • understood that energy in an electric field of a capacitor depends on charge and that the energy of an inductor in the magnetic field depends on moving charge(current) • understood complex electrical circuits and could explain the electrical oscillations in a CL circuit.
Standard specific comments	Very few candidates were able to explain the difference between rms and peak voltage. Some candidates had a misconception that at resonance the VC and VL values are zero because XL and XC cancel each other and only the resistor has the maximum voltage. Many candidates thought that inductors create back currents, and some even provide more current than power supplies acting against them. This was possibly the first time that many candidates would have seen a question about a DC LCR series circuit - usually it is with an AC generator. The general physics remains identical however it was not apparent to most candidates. Only a handful of candidates appreciated this circuit would, in the fullness of time, act as a damped oscillator. Many tried to apply a pure DC line of reasoning to the capacitor/inductor charging/discharging.This meant ithat many believed the capacitor discharge was fast and that somehow this caused the inductor suddenly to store huge amounts of energy due to the instantaneous initial current from the capacitor as it quickly discharged its electrons.They then continued with their misconceptions stating BOTH the capacitor and inductor then lost their energy TOGETHER as lost heat in the resistor and circuit wiring. The alternating to-ing and fro-ing of the stored energy between the separate fields of the devices was not understood by the vast majority of candidates.