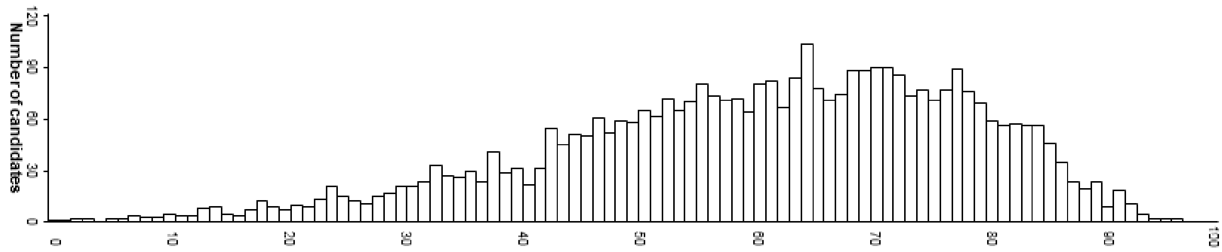
Government of **Western Australia**
School Curriculum and Standards Authority

Report on the 2015 WACE examination in
Physics Stage 3

Year	Number who sat	Number of absentees
2015	3802	65
2014	2778	36
2013	3666	41

Examination score distribution



Summary

Attempted by 3802 Candidates   Mean 60.78% Max 96.95%   Min 0

Section means were:
Section One: Short response
Mean 19.83%(/30) Max 30.00   Min 1.07
Section Two: Problem-solving
Mean 29.95%(/50) Max 48.86   Min 0.00
Section Three: Comprehension
Mean 11.18%(/20) Max 20.00   Min 0.00

General comments

The 2015 Physics Stage 3 examination was very successful. Overall performance was good with most candidates demonstrating a sound grasp of the concepts and skills of the course. The paper had a wide range of questions and problems that tested a variety of techniques and skills, including vector diagrams and free-body and field diagrams. Candidates' responses revealed areas of relative strength including gravity and orbits, circular motion, atomic energy levels and the graphing and analysis of scientific data. Areas of relative weakness included the drawing of diagrams; sketching diagrams to assist problem-solving as in Questions 5 and 8 and the application of fundamental concepts such as acceleration and force, Faraday's law and Lenz's law.

Advice for candidates

- When drawing diagrams of fields, pay careful attention to details such as the direction and relative spacing of the field lines, and field lines not crossing or touching.
- When drawing free-body diagrams, you should include only applied (not resultant) forces. For example, centripetal forces are always resultant forces.
- When drawing graphs, it is important to plot the error bars with care, and ensure that the line of best fit stays within the error bars.

Advice for teachers

- Free-body diagrams, especially for objects in circular motion, should be practised regularly. Students should have feedback about their errors, such as including centripetal force or showing a force acting outward from the centre.

- More exposure to scenarios in which the forces are not perpendicular to the moment arm could improve the scores of some students in questions involving moments.
- Teachers should emphasise the advantages of sketching a physical scenario before attempting to solve problems in calculation.
- Students should be encouraged to carry units through steps in solving a problem rather than guessing what the unit of the final answer might be.

Comments on specific sections and questions

Section One: Short response Attempted by 3801 Candidates
Mean 19.83(/30) Max 30.00 Min 1.07

Section One has an average of 65%. The questions were mostly on the fundamental principles in the syllabus and in general were answered well by most of the candidates. A number of candidates was able to attain near-perfect scores in this section.

Question 1 Attempted by 3798 Candidates Mean 1.46(/2) Max 2 Min 0

Most candidates attempted this question and achieved full marks. The most common error involved not knowing the difference between free, forced and natural oscillation.

Question 2 Attempted by 3797 Candidates Mean 2.27(/3) Max 3 Min 0

Most candidates were able to answer this question well. There was some level of general uncertainty in the red/blue shift concept, and many candidates did not understand that two objects are not necessarily on a collision course even if the distance between them is being reduced.

Question 3 Attempted by 3792 Candidates Mean 2.65(/6) Max 6 Min 0

Relatively few candidates could interpret the diagram and hence answer (a) correctly. Some candidates had the net force and acceleration in different directions, indicating a fundamental misunderstanding of the relationship between the two vectors. Responses to part (b) showed a general lack of understanding of acceleration as rate of change of velocity, specifically that an object whose velocity reverses direction while maintaining the same speed is accelerated more than one that simply picks up that speed from rest.

Question 4 Attempted by 3772 Candidates Mean 3.83(/4) Max 4 Min 0

Candidates generally did very well in this question. The main error was in using the wrong radius.

Question 5 Attempted by 3724 Candidates Mean 2.92(/6) Max 6 Min 0

Responses to this question highlighted candidates' general inability to draw suitable vector diagrams. The question proved challenging because a complete answer required working out the magnetic force, working out the electrical force and then the addition of two vectors. A few misread the question and drew the field lines instead of working out the forces due to the fields.

Question 6 Attempted by 3766 Candidates Mean 3.76(/5) Max 5 Min 0

Candidates generally did well although some were unable to draw a free body diagram, or could not work out the velocity required to keep a ball in a vertical loop. Too many candidates showed a separate centripetal force in their free body diagram, some even showing this as acting outwards.

Question 7 Attempted by 3760 Candidates Mean 5.55(/7) Max 7 Min 0

Most candidates who attempted the question had a good idea of the requirements. Some however were confused and did not take into account the relative velocities between the two moving objects, or worked the equations using km h^{-1}. A very small proportion of candidates used memorised formulae and lost their way in the calculation.

Question 8 Attempted by 3630 Candidates Mean 4.09(/7) Max 7 Min 0

Candidates generally understood and applied the wave formula successfully. They were also able to work out the standing wave's wavelength relatively well. Few candidates realised that the loudest point would be in the middle so an odd number of loud points must occur. Generally the internodal distance of half a wavelength was ignored with many candidates thinking the loud points would be one wavelength apart.

Question 9 Attempted by 3745 Candidates Mean 2.31(/5) Max 5 Min 0

Candidates who attempted part (a) generally did not pay enough attention to the details of their drawings. Common errors were missing a magnetic field line going straight through the middle and getting the field direction wrong. Most found part (b) to be very challenging. The better candidates knew there would be a force between the coils of wire but many stated that this would cause repulsion; top candidates worked out that there would be an attractive force and hence contraction.

Question 10 Attempted by 3612 Candidates Mean 2.70(/4) Max 4 Min 0

Although this was a predictable question, a surprising number of candidates did not calculate the correct answer. Some candidates apparently failed to read the question in its entirety and did not realise that the final answer was the diameter.

Question 11 Attempted by 3749 Candidates Mean 6.13(/7) Max 7 Min 0

Candidates attempted and answered this question extremely well. Errors mainly involved having an incorrect number of transitions between energy levels.

Section Two: Problem-solving Attempted by 3796 Candidates
Mean 29.95(/50) Max 48.86 Min 0.00

Section Two was generally done well with a mean somewhat lower than for Section One. Most of the Section Two questions had means around 60%, with Questions 12 and 14 being the easiest (both means over 70%) and Questions 17 and 18 the hardest (both means below 45%).

Question 12 Attempted by 3768 Candidates Mean 8.99(/12) Max 12 Min 0

The concepts in this question were familiar, although they were tested in an unfamiliar context. Candidates who read the text carefully and understood it did extremely well. The majority answered parts (a), (b) and (c) very well but most lost marks in part (d). Candidates seem to have memorised the definition of redshift but were unable to apply the concept part (d).

Question 13 Attempted by 3759 Candidates Mean 7.27(/12) Max 12 Min 0

Most candidates attempted and answered parts (a) and (b) of this question well. Many had trouble with (c)(i), in which few candidates appear to have internalised the fundamental relationship between potential difference, charge and energy. The very low mean of 37% was a surprise as this was supposed to show candidates' basic understanding of the definition of voltage. Clearly this fundamental concept is misunderstood. Despite this most were able to answer (c)(ii) (a calculation based on the same concept) quite well. Part (d)(iii) also proved to be challenging. Major errors were not using a quarter of a turn or forgetting to use the correct number of turns.

Question 14 Attempted by 3787 Candidates Mean 13.08(/17) Max 17 Min 0

Most candidates answered this question well. The question tested a range of skills involving graphing, and the high mean scores for most parts indicated that most candidates had achieved good to high levels of proficiency in these skills. In part (b) the most common error involved candidates forcing the line of best fit to go through the origin of the graph. A surprising number used difficult scales, which made accurate plotting of points and error bars nearly impossible. Weaker candidates had little idea about error bars. In part (c) quite a few candidates lost marks because they used data points from the table even though their graph did not go through these points.

Question 15 Attempted by 3754 Candidates Mean 6.31(/10) Max 10 Min 0

Most candidates did either very well or very poorly on this question. The dichotomy seems to have been due to confusion about when to use sine or cosine in a situation involving forces at angles other than 90° to the moment arm. As expected, the justification in part (b)(ii) was the most difficult part of the question.

Question 16 Attempted by 3764 Candidates Mean 8.01(/13) Max 13 Min 0

Most candidates answered this question well, the most common errors involving the free body diagram in part (a) and applying the tolerance in part (d). A very small number of candidates took the 10° angle to be between the string and the horizontal, despite the angle being described clearly both in the text and a labelled diagram.

Question 17 Attempted by 3685 Candidates Mean 5.15(/14) Max 14 Min 0

This question was the hardest question in the examination, with an overall mean of 37%. Part (a) was done relatively well. Lenz's Law was well understood but explanations tended to ignore that it is the rate of change of flux which leads to an emf, which then results in a current for a complete circuit. Weaker candidates stated that a magnetic field exists in the coil, which then creates a current, not vice versa. Parts (b) and (c) proved very challenging. In part (b), the great majority of responses showed poor application of Faraday's Law to the inside of the coil as the magnet moved through it. Some candidates stated in their explanation to part (a) that only a flux change would produce a current but could not then apply this in part (b). Part (c) tested three different concepts of physics in two graphs. The main errors among even the better responses involved the difference in time and peak current as the magnet first enters the coil then leaves it. Very few showed a longer time for the induced current on exiting but a number did show the peak current smaller due to the lower velocity. Many had the magnet constantly slowing down or no change in velocity at all on going through the second coil.

Question 18 Attempted by 3699 Candidates Mean 4.49(/10) Max 10 Min 0

Candidates attempting this question showed a rather poor understanding of the propagation of units through a problem. Thus, although the average mark for part (a) was quite high many candidates did not put in the correct units, writing metres, kilometres or inverse light years. Parts (b) and (c) were handled poorly by most candidates, and the general confusion about units contributed to their difficulties. Despite clear statements that these were estimation questions, few took any notice of significant figures and fewer still followed the instruction to state assumptions used, or supplied irrelevant assumptions.

Section Three: Comprehension Attempted by 3755 Candidates
Mean 11.18(/20) Max 20.00 Min 0.00

The mean of Section Three was lower than the means for Sections One and Two, reflecting the difficulty that candidates have in applying familiar laws and principles in unfamiliar situations.

Question 19 Attempted by 3739 Candidates Mean 13.34(/21) Max 21 Min 0

The mean of part (a) was high, indicating candidates' good understanding of the uniform electric field between parallel plates. In part (b), a common error was to plug numbers into the equation for kinetic energy rather than use the fact that work is equivalent to the change in kinetic energy. The high mean of part (c) reflected the ability of the candidates to apply equations of motion well or, despite an incorrect value in part (b), to use the kinetic energy formula. In part (d) candidates were good at calculating energy difference in atoms. Part (e) proved to be more difficult. Most candidates gave at least one method (usually heat) but few could come up with a reasonable second method. This was often given as sound, missing the point completely. Part (f) was generally answered well, showing that candidates understood that gas molecules would interfere with the electron's path. Some used poor wording such as friction with the air or did not commit to a definitive answer. Part (g) was the most difficult part of this question, with many incomplete or poor explanations. Many candidates simply repeated the passage; others mentioned a charge build-up but did not link this to a high potential difference. Few mentioned that the person was acting as an earth connection in the circuit.

Question 20 Attempted by 3691 Candidates Mean 6.39(/14) Max 14 Min 0

Question 20 was overall the third hardest question on the paper. Although this question was set in an unfamiliar context, many candidates were able to synthesise the information given and use learnt physics concepts to create a response which is commendable. Part (a) was a simple conversion which most did successfully. The most common error was to forget the 'kilo' prefix. Part (b) was done rather poorly. Better candidates used $E=mc^2$ but the majority used the classic formula for kinetic energy which was incorrect. Few stated explicitly that the mass of the electron and positron were equal, while others missed steps in their calculations. Part (c) was a difficult question to solve fully. The majority of candidates determined the difference in distance but could not then work out how far from the centre this had to be. In part (d) many understood that the change in speed was due to the density of the media changing but surprisingly a large number could not name this as refraction. Many confused this with diffraction and rarefaction. Part (e) was the second hardest question part on the paper. Candidates were not familiar with conservation of momentum and energy as indicative of particle behaviour and elastic collisions, as illustrated by two gamma rays being emitted in opposite directions.