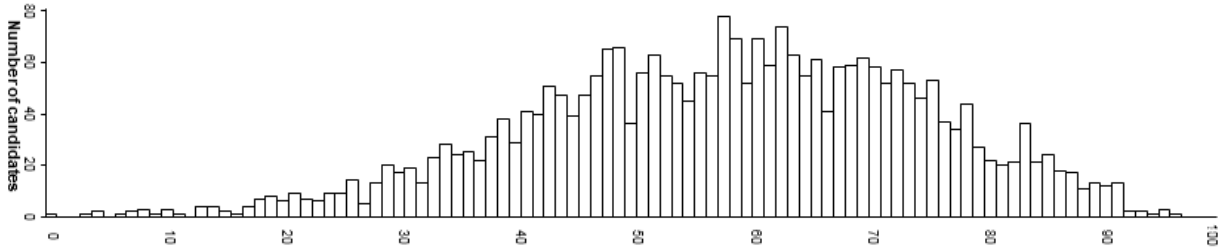
Government of **Western Australia**
School Curriculum and Standards Authority

WACE
Western Australian Certificate of Education

Report on the 2014 WACE examination in
Physics Stage 3

Year	Number who sat	Number of absentees
2014	2778	36
2013	3666	41
2012	3504	39

Examination score distribution



Summary

The examination was well received by candidates. Although slightly harder than last year's examination, the difficulty was judged to be appropriate. Section One: Short response had a mean of 61.0%; Section Two: Problem-solving had a mean of 60.7%; and Section Three: Comprehension had the lowest section mean of 47.4%. Section Three also had more non-attempts, which might indicate that the length of time required to complete the examination may have been insufficient for a minority of candidates. Most questions were straightforward with responses as expected, and every question had one or more candidates earning full marks. Use of scaffolding and direction of expected answer format, such as units and significant figures, continued to be successful. The paper had an overall mean of 58.1% and discriminated well, with scores ranging from 0% to 97%.

Section means were:

Section One: Short response	Mean 18.31(/30)	Max 29.72	Min 1.67
Section Two: Problem-solving	Mean 30.37(/50)	Max 48.33	Min 0.28
Section Three: Comprehension	Mean 9.48(/20)	Max 20.00	Min 0.00

General comments

Advice for candidates

- In graphing questions, it is important to read the question thoroughly and address the requirements. Ensure that you know how to construct a graph, and draw and use the line of best fit effectively.
- When drawing a line of best fit on a graph, all data points have equal value and should not be ignored or given extra weighting.
- Accuracy is important when drawing vector and free body diagrams, wave front diagrams, field line diagrams and sketch graphs; marks can be lost easily through carelessness, for example by drawing a straight line as a curve.
- When directed to 'Show **all** workings' in a calculation question, write down in a logical sequence the steps taken to work out the answer.
- When one object is in orbit around another, the radius of orbit is measured between the centres of the two objects, not their surfaces.
- Significant figures and units, when asked for in the question, allow you to obtain easy marks, if you follow the instructions.

Advice for teachers

- Areas of apparent weakness were in wave versus particle comparisons, and in describing the qualitative aspects of the special theory of relativity.
- The description of concepts should include, where possible, a mathematical relationship that shows the relationship between variables.
- Candidates should be encouraged to recognise which answers are clearly impossible, such as particles travelling faster than the speed of light, and to indicate this understanding if they do not have time to rework the problem.
- Section Three presented contexts that were unfamiliar to most or all candidates, and their performance was not as high in Section Three as in Sections One and Two. Candidates should have opportunities to apply physics principles across a variety of different contexts and situations.

Comments on specific sections and questions

Section One: Short response

Attempted by 2777 Candidates Mean 18.31(/30) Max 29.72 Min 1.67

Question 1 Attempted by 2773 Candidates Mean 1.90(/2) Max 2 Min 0
This was a very easy question although a few candidates reversed the order of the parts of the spectrum.

Question 2 Attempted by 2590 Candidates Mean 2.12(/4) Max 4 Min 0
This item proved to be more difficult than intended. Answers generally lacked clarity, making the allocation of marks difficult. Often, the cited example was related to a property. For example, the photoelectric effect was often cited to describe the particle nature of light but few explanations showed clearly how this could only be explained by the energy of light being quantised; i.e. particle-like.

Question 3 Attempted by 2748 Candidates Mean 1.87(/2) Max 2 Min 0
This question was generally done well, although some candidates arrived at a fractional charge (which is impossible) because they confused anti-down with anti-up.

Question 4 Attempted by 2770 Candidates Mean 2.42(/3) Max 3 Min 0
A high proportion of candidates demonstrated an understanding of blue shift and the constancy of the speed of light in this context.

Question 5 Attempted by 2759 Candidates Mean 2.72(/5) Max 5 Min 0
This vector subtraction problem proved difficult for the candidates as expected. Many candidates disregarded vector direction, did not draw a proper vector diagram or missed conversion of units.

Question 6 Attempted by 2671 Candidates Mean 2.52(/4) Max 4 Min 0
Many candidates correctly named the spectral types but did not describe adequately the mechanism of formation for each spectrum.

Question 7 Attempted by 2777 Candidates Mean 4.43(/5) Max 5 Min 0
Generally this question was done well. A few candidates reversed the direction of the magnetic field around the current carrying wire; others reversed the direction of the field lines.

Question 8 Attempted by 2705 Candidates Mean 1.43(/3) Max 3 Min 0
Very few candidates addressed this concept properly. A common incorrect response was to relate the kinetic energy increase to the mass increase, ignoring $E = mc^2$. Even those candidates who stated that as an object approaches the speed of light, its mass increases, rarely related this to mass-energy equivalence.

Question 9 Attempted by 2718 Candidates Mean 3.96(/5) Max 5 Min 0
This question was done well by the candidates. Some calculated the orbital radius and then added the radii of the planets.

Question 10 Attempted by 2728 Candidates Mean 2.53(/4) Max 4 Min 0
This more complex motion question was answered easily by better candidates. Some candidates appeared to have difficulty in visualising what was occurring in this moving frame of reference scenario, typically using only one equation. Some candidates who realised the need for more than one equation had some difficulty in combining the motion formulae correctly.

Question 11 Attempted by 2670 Candidates Mean 3.35(/6) Max 6 Min 0
This question involved combining the concepts gravitational acceleration and centripetal motion in what should be a familiar way. Common errors included simplifying the scenario to only one force; neglecting the non-vertical component of the tension; neglecting the mass of the seat; or dividing by four.

Question 12 Attempted by 2747 Candidates Mean 2.32(/5) Max 5 Min 0
Most candidates related red-shift to velocity but few described this relationship adequately. Few candidates realised that the maximum distance was limited by the speed of light. Most candidates calculated a gradient, but often, inappropriate choice of points led to a poor line of best fit.

Question 13 Attempted by 2707 Candidates Mean 2.05(/6) Max 6 Min 0
As expected, this question proved to be most difficult in this section and provided a good discriminator. Only the highest-performing candidates grasped that length was proportional to mass because of the uniform nature of the rod. The most common errors included using an overly simplistic drawing of a rectangle to calculate the geometric centre, failing to take moments perpendicularly about the pivot or reversing the trigonometric ratios.

Section Two: Problem-solving
Attempted by 2775 Candidates Mean 30.37(/50) Max 48.33 Min 0.28

Question 14 Attempted by 2735 Candidates Mean 7.09(/12) Max 12 Min 0
Candidates generally approached (a) correctly, but common errors were counting the strips rather than spaces between, or using an inappropriate number of significant figures. Many responses to (b) explained resonance correctly but failed to relate it to the situation given. In (c) the most common error involved using standing waves to incorrectly create nodes and antinodes.

Question 15 Attempted by 2769 Candidates Mean 7.59(/10) Max 10 Min 0
A generally well answered simple parabolic motion question. Common errors such as poor or repetitive use of descriptions of air resistance effects were evident in (b). In (c) and (d) some candidates did not take vertical and horizontal components separately, or interchanged them. Candidates who tried to use the quadratic equation, rather than use a multi-step approach, often made algebraic errors.

Question 16 Attempted by 2736 Candidates Mean 5.35(/10) Max 10 Min 0
A variety of methods was evident in (a). Most candidates used a moment formula, but too many simply equated the gravitational force to the moment, or took the distance of the bolt to the pivot as half of the actual value. Despite being used in the syllabus, the word ‘quantitative’ appears to have thrown many candidates. Very few received full marks in (b) and (c).

Question 17 Attempted by 2754 Candidates Mean 8.50(/17) Max 17 Min 0
Although (a) was done well, (b) highlighted a weakness in candidates’ electromagnetic induction knowledge. Too often, candidates quoted $F=I\ell B$ and hence stated that a force is needed to create a current, or else stated Lenz’s Law but did not explain the interaction properly. In (c), a difficult part-question, candidates most often drew a sine wave rather than interpreting the data. In (d) the graph was generally done well, with common errors showing rectified DC, or drawing more than one cycle. The responses to (d)(ii) commonly used, wrongly, a quarter of a turn as an approximation to calculate the average emf instead of calculating the

maximum emf, e.g. by using $emf_{max} = 2NB\ell v$. Those who used $emf = B\ell v$ usually failed to double it for both sides and many did not use metres for length or radius. Many who used $B\ell v$ did not calculate the tangential velocity correctly.

Question 18 Attempted by 2763 Candidates Mean 10.75(/13) Max 13 Min 0
Candidates generally did very well in this question, with common errors being to forget to use a negative sign in (b) or draw only the largest transition in (c). Some candidates neglected to calculate the wavelength in (d) after determining the frequency; others did not explain sufficiently their choice of colour for the transition.

Question 19 Attempted by 2718 Candidates Mean 4.10(/10) Max 10 Min 0
This question was one of the most difficult in the examination. In (a) the situation was simplified; candidates were directed to ignore gravity when drawing a free body diagram but too many included weight anyway. Extraneous forces were often added, while labels to indicate what the arrows represented were often omitted, making this question generally poorly answered. The inclusion of R_2 in the instructions for (b)(i) inadvertently made this confusing. Although most candidates started with appropriate formulae, the algebraic manipulation proved difficult for many. Too many tried to incorporate, incorrectly, Newton's Law of Universal Gravitation. The largest number of non-attempts of the examination was in (b)(iii).

Question 20 Attempted by 2765 Candidates Mean 11.70(/18) Max 18 Min 0
Few candidates realised that the rod was fixed and the magnets were being forced downwards, making (a) unexpectedly difficult. Performance on the graphing question, (b), was generally pleasing. Common errors in plotting the graph included reversing the axes, not using a continuous scale, using only a small part of the grid (and thus making it difficult to plot or read points accurately) and not incorporating the given (0,0) data point. Very few candidates provided any evidence (other than an answer) of using the line of best fit to determine the force or calculate the gradient. Use of suitable units and significant figures should have provided easy marks that were, too often, not earned.

Section Three: Comprehension
Attempted by 2765 Candidates Mean 9.48(/20) Max 20.00 Min 0.00

Question 21 Attempted by 2753 Candidates Mean 8.36(/18) Max 18 Min 0
Responses to (a) although generally done well often had too many significant figures or did not include a conversion of tonnes to kilograms. Candidates evidently had difficulty in visualising an impact window, with a significant proportion not achieving any marks for the second part of (b). Most candidates used the formula provided in the text for (c)(i), though some used units other than years for time, and (c)(ii) proved difficult for candidates who knew they needed to use Newton's Law of Universal Gravitation but did not realise that the quoted value for the change in velocity/time was in fact the acceleration. Responses to (d) tended to be simplistic, missing the idea that more time related to a smaller velocity change and even fewer related this to a smaller mass required.

Question 22 Attempted by 2717 Candidates Mean 8.90(/18) Max 18 Min 0
Although candidates generally made the connection between the peaks and falling electrons in (a), many incorrectly related fluorescence to the X-ray production and too few explained why the peaks were 'characteristic'. Responses to (b) demonstrated a generally poor understanding of the relationship between electron volts and joules, and of the limitations on particle speed. The electric field diagram was generally done well in (c), with incorrect field direction and non-uniform field being the most common errors. In (d) some candidates tried to relate the previous question into their calculation, though better candidates correctly identified and derived the correct relationship. This was a difficult part-question with a significant number of non-attempts.