# Government of South Australia LogoSACE Board Logo2023 Physics Subject Assessment Advice

Overview

Subject assessment advice, based on the 2023 assessment cycle, gives an overview of how students performed in their school and external assessments in relation to the learning requirements, assessment design criteria, and performance standards set out in the relevant subject outline. They provide information and advice regarding the assessment types, the application of the performance standards in school and external assessments, and the quality of student performance.

Teachers should refer to the subject outline for specifications on content and learning requirements, and to the subject operational information for operational matters and key dates.

School Assessment

Teachers can improve the moderation process and the online process by:

* including a current Learning Assessment Plan
* combining all tasks for a single folio into one single pdf
* ensuring that the folio of tasks set enables students to meet all of the current performance standards at all grade levels
* providing evidence to support the grade awarded in each task

Assessment Type 1: Investigations Folio

Assessment design criteria to be used for this assessment type are focussed in Investigation, Analysis, and Evaluation with Knowledge and Application also forming a key part.

Teachers can elicit more successful responses by:

* minimising the amount of scaffolding in tasks and ensuring that at least one task in the folio enables students to present a full deconstruction that shows consideration of several lines of enquiry to a problem
* making it clear to the students that the Science as a Human Endeavour Report should be based on a contemporary focus, including some Stage 2 Physics concepts, clear links to the SHE strands, and some of the elaborations within the SHE concepts
* avoiding practical investigation tasks that require all students to follow a set method to take measurements and make calculations to confirm a value, rather than investigating a problem where students can select and investigate an independent variable to solve a problem.

The more successful responses commonly:

* included at least one detailed deconstruction question that did not have an obvious or previously known answer, considered a wide range of perspectives, showing several possible lines of enquiry and justification for some of the key selections made in forming the design, regarding the independent and dependent variables selected, the factors to be held constant, and the equipment selected to collect the data (IAE1)
* included a suitable graph in at least one of the investigations, with a line of best fit extrapolated back to the axis intercepts where appropriate, enabling students to show evidence of their understanding of random errors, precision, and the scatter of the data points around the line of best fit, and enabling a justified conclusion about whether the relationship between the variables showed proportionality (IAE2, IAE3, IAE4)
* presented justified conclusions that were consistent with the results, discussing whether or not the hypothesis was supported. They also discussed the reliability and validity of the investigations and the limitations, such as factors that could not be held constant or low sample size (IAE3)
* described errors that were specific to the equipment and data that was collected in the practical, clearly identifying and justifying them as random or systematic and explaining explicitly how they effected the data, including the graph. The responses also correctly distinguished between the terms accuracy, precision, and resolution when discussing the effects of errors on the data (IAE4)
* applied relevant physics concepts clearly, coherently, and concisely to explain the results and the conclusion (KA2)
* included a Science as a Human Endeavour report where some SHE strands and elaborations were clearly identified and meticulously discussed in relation to the topic selected (KA3).

The less successful responses commonly:

* did not include a separate deconstruction (IAE1)
* missed key elements, such as a hypothesis, identification of suitable variables, factors to control, safety considerations, a labelled diagram, a graph, a discussion of errors, or a conclusion that referred to the hypothesis (IAE1, IAE2, IAE3, IAE4)
* presented a brief set of steps for a procedure that did not describe what to record and how or what to change when repeating the trials (IAE1)
* consisted of a folio with investigations that only had a known outcome, such as a relative refractive index constant or Planck’s constant (IAE1, IAE4)
* included tables of results that used significant figures inconsistently or lacked clear headings and units (IAE2)
* presented a ‘join-the-dots’ graph or used a trendline that was linear when a curve was more suitable for the data points present (IAE2)
* discussed random and systematic errors without clearly differentiating between them, using only general terms for the errors (IAE4)
* had sections in tables that discussed ‘Improvements to the practical’, which is no longer in the performance standards, instead of describing how specific errors had effected the data (IAE4)
* made no distinction between the terms accuracy and precision and demonstrated confusion about how they were affected by random and systematic errors (IAE4)
* limited the Science as a Human Endeavour investigation to a description of how a piece of technology had developed over time and referred to this evolution as SHE development, or presented an issues investigation that was merely a discussion about the advantages and disadvantages of the topic selected (KA3)
* were based on SHE task sheets that contained suggested topics that were not suitable or contained student responses that needed more guidance and feedback to encourage the students to focus on the SHE concepts and some relevant Stage 2 physics concepts (KA1, KA2, KA3, KA4)
* applied Stage 1 physics concepts or minimal Stage 2 concepts to explain the investigation (KA2, KA3).

Assessment Type 2: Skills and Applications Tasks

Three or four skills and applications tasks provide evidence of students’ knowledge, understanding, and application of science inquiry skills, key physics concepts, and the connections with science as a human endeavour by discussing the interaction between science and society.

Assessment design criteria to be used for this assessment type are Investigation, Analysis and Evaluation, and Knowledge and Application. These tasks do not carry individual weightings.

Teachers can elicit more successful responses by:

* ensuring that a set of SATs are well designed, covering large sections of the course, including some science inquiry skills and science as a human endeavour questions and questions with a wide range of difficulties and instructions such as: state, describe, determine, calculate, draw, derive, show, explain (KA1, KA2, KA3, KA4, IAE2, IAE3, IAE4)
* avoiding using solely past examination questions in designing tests as it is likely the highest performing students will have previously studied these through a study guide (KA1, KA2, KA3, KA4)
* considering the amount of evidence present for each performance standard when designing SATs and when making assessment judgements, as some tasks seemed to be heavily weighted in practical skills (KA1, KA2, KA3, KA4, IAE2, IAE3, IAE4).

The more successful responses commonly:

* contained written responses that applied the correct physics concepts to answer the question posed, providing sufficient detail to obtain the number of marks assigned to the question (KA1, KA2, KA4)
* showed all working when applying formulas by including steps for rearrangement and substitution, using clearly labelled and correct vector diagrams when needed (KA1, KA2, KA4)
* clearly described and correctly applied some SHE strands and elaborations for science as a human endeavour questions (KA3).

The less successful responses commonly:

* did not show substitution or rearrangement steps in forming an answer that involved calculations, tried to apply irrelevant formulas, incorrectly rearranged formulas, or did not convert units correctly (KA1, KA2, KA4)
* gave an irrelevant written answer that was based on a lack of comprehension about what the question was asking (KA2, KA4)
* presented handwritten evidence that was unclear or difficult to interpret (KA1, KA2, KA4).

External Assessment

Assessment Type 3: Examination

General

Students still appear to have difficulty answering questions to an appropriate number of significant figures. The final calculated value in a question needs to be given to the lowest number of significant figures given in the question.

The command term ‘determine’ needs to be elaborated by teachers throughout the year so that students understand what is required in SATs and the end of year examination. When a question asks students to ‘determine’ a quantity then all relevant details and links to physics concepts need to be made explicit. Many students appeared to understand how to work through the required calculations in the paper, but did not provide sufficient detail when showing their working.

Rearranging formulas is an area for improvement for some students. Teachers should provide opportunities to practise this skill regularly throughout the year.

Many students do not appear to have a sense of reasonable values for some calculated quantities. For example, many students calculated the maximum number of orders present in the diffraction grating to be over 30 000, and other students calculated an orbital period of a satellite to be just 122 seconds. Teachers should encourage students to reflect on the values that they calculate and consider if they seem reasonable within the context of the question.

Question 1

This question was answered well by most students. Part (a) was routine in nature– the question stated that the transformer converted 220 V to 11 V and most students correctly stated that this was a step-down transformer. Many students were not awarded full marks in part (b) due to incorrectly rearranging the formula connecting the number of turns in the coil and the voltages.

Question 2

This question also proved to be fairly straightforward for most students. Part (a) required students to state whether the delivery van or the racing car would experience a smaller drag force. This question did not specify a particular explanation in order to make the question more inclusive of different physics concepts. Most students stated that the racing car would experience less drag forces due to the smaller cross-sectional area (or that the van would experience a greater drag force due to a larger cross-sectional area). Some students described the drag coefficient and referred to the aerodynamics of each vehicle. Some students appeared to have missed the statement that both vehicles were travelling at the same speed and attempted to answer the question by referring to the relative speeds of both vehicles. Part (b) was answered mostly well, with many students showing appropriate working to obtain a correct answer.

Question 3

This question was also generally answered well by most students. Most students were able to correctly state that wave was vertically polarised in part (a). Some students were not awarded full marks in part (b) due to incorrect rearranging or not showing the substitution of values into the wave equation.

Question 4

This question was generally answered well, but a significant proportion of students were not awarded full marks. Part (a) required students to substitute values into the formula for Newton’s Law of Universal Gravitation. Many students were able to show the correct substitution but were not able to calculate the force correctly. Other students did not square the separation of the Saturn and Titan in the formula and obtained an incorrect value of the force. Part (b) was not answered as well as (a). Many students attempted to explain Newton’s Third Law as ‘every action has an equal and opposite reaction’ rather than referring to the interaction of forces. Some students did not specify that the forces acted in opposite directions, and others incorrectly described the forces as ‘cancelling out’.

Question 5

This question provided students with an opportunity to use their science inquiry skills. Part (a) required students to recognise that the horizontal component of the velocity of the projectile remained constant. Students needed to calculate the speed using the time of flight (0.60 s) and the range (3.6 m). Part (b) was a little more challenging. Most students substituted the acceleration due to gravity and the time taken to reach the maximum height from the graph (0.30 s) to determine the initial vertical speed. Other students read the vertical displacement from the graph (0.44 m) and used a different formula to determine the initial vertical speed. Many students did not state that the vertical speed of the projectile at its maximum height was 0 ms-1, and others substituted the horizontal speed (6.0 ms-1) as the vertical speed at the maximum height.

Many students were not awarded full marks for (c)(i) due to lack of specificity. The question asked for a change to the projectile launcher, such as increasing the angle or adjusting the launcher to increase the initial vertical speed. Some students were not awarded full marks as they did not specify a change to the projectile launcher. For example, many students stated ‘launch angle’ rather than ‘increasing the launch angle.’ Many students provided correct and consistent explanations to the adjustment in (c)(ii). However, a number of the explanations were not sufficiently detailed. Many students did not link the increase to the initial vertical speed to the time taken for the projectile to reach its maximum height.

Question 6

This question proved to be difficult for many students. Parts (a)(i) and (a)(ii) were generally answered well. Both of these required students to substitute values into formulas. Some students incorrectly substituted the mass of the electron rather than the mass of the proton into the formula. Part (a)(iii) was not answered very consistently. Some students did not recognise that the initial vertical speed of the proton was 0 ms-1 as it entered the electric field and used the horizontal speed instead. Other students did not use the constant acceleration formulas given on the formula sheet and used average speed formulas or substituted the acceleration due to gravity rather than the value given in (a)(ii). Part (b) was also answered poorly. Students needed to recognise that the since the protons were accelerated towards the negative plate that the force due to the magnetic field must be upwards. The magnetic field must therefore be directed into the plane of the page.

Question 7

This question was generally answered well by most students. In part (a) students need to take more care when using the orbital radius in calculations. Many students substituted the altitude into the correct equation and many others substituted the radius of the Earth. Students need to clearly state how the orbital radius was determined, then use this correct value for all related calculations. Part (b) was not answered well. The orbital speed of a satellite decreases with orbital radius as the orbital speed is inversely proportional to the square root of the orbital radius. Many students incorrectly stated that the orbital speed would decrease by referring to $v=\frac{2πr}{T}$ , but the students did not appear to understand that the orbital period would also increase by a greater factor than the orbital radius. Most students obtained full marks for (c) by referring to the ability to take clearer images or higher resolution images.

Question 8

Most students were awarded marks for this question, but very few were awarded full marks. In part (a) many students were not detailed enough with their explanations. Many students did not state that the path difference between slits needed to be a half-integer multiple of the wavelength for destructive interference to occur. Some students incorrectly stated that the path difference needed to be an odd number of wavelengths or a wavelength plus a half. Most students attempted part (b) and the most common errors were incorrect conversions or substituting incorrect values.

Question 9

This question was generally answered well. Students were mostly able to show the correct calculation in part (a), and most students that attempted part (b) were awarded marks. Few students obtained full marks for part (b) as many students did not provide sufficient detail in their working. Students needed to clearly state that the magnitude of the magnetic fields at P must be equal, then substitute the magnetic field value into the correct formula. Students also needed to take more care in using significant figures in this question – the question consistently used two significant figures throughout, therefore, the final answer must also be given to two significant figures. Some students calculated this question correctly using ratios. Most students were awarded one mark for part (c) as most of the students lacked the detail needed. Students needed to clearly state that the fields from both conductors were directed into the plane of the page, therefore the net magnetic field was directed into the plane of the page.

Question 10

This question was generally answered well. Students should be familiar with calculating the forces between charged particles, and most students answered part (a) correctly. Some students were not awarded full marks due to forgetting to square the separation between the charged particles. Part (b) was not answered as well. Many students were able to state that the q1 was negatively charged, but the explanations were not always clear. The electric field lines around q2 indicate that it is negatively charged, and the force vector shows that q1 is repelled from q2. Many students did not provide sufficient justification for the charge of q2 in their responses. Other students appeared to misunderstand what the direction of the electric field lines represented and what the force vector represented in the context of the question.

Question 11

This question was answered well by most students. The rearrangement was usually completed correctly and the values from question substituted appropriately. The most common errors were students failing to convert the radius of the circular path to metres and incorrect rearrangement, but both of these errors were infrequent.

Question 12

This question was generally answered well, particularly part (a). Most students were able to correctly show the correct value for the wavelength of the laser light, but some details were missing. Students need to show explicitly how the separation between the slits in the diffraction grating was calculated and what order was being used in the calculation. Part (b) highlighted a significant gap in the use of physics terminology. The question asked for the maximum number of orders – the maximum value of m in the diffraction grating equation – but many students interpreted this question as the number of bright fringes that would be observed. Many students determined the answer to be seven – the central maximum and the three fringes either side of the central maximum. Many students also did not communicate that the maximum possible angle was ninety degrees.

Question 13

Some common areas for improvement on this question include:

* more about discrete frequencies
* emitted instead of transitioning downwards between energy levels
* jump/getting emitted instead of transition.

Question 14

This question was generally answered well by students. The following points highlight reasons for some students to not be awarded full marks:

* many students used a contradiction approach e.g. if the PD did not alternate then it would not function
* answering ‘will only complete half a rotation’
* significant figures in (d)
* a number of students who did not answer c correctly did not substitute into d correctly.

Question 15

Common misconceptions identified in this question include:

* few students stated that most energy converted to heat
* some students stated that it keeps the energy from escaping or weakening x-rays
* most students stated that the apparatus heated rather than the target and many students stated that the metal blocked the x-rays
* many students stated attenuation without giving detail on how it related to the context and did not relate the attenuation to the detection of x-rays.

Some of the stronger responses included students correctly describing the relative contrast in the images formed, and many students correctly discussed the relative density of olive oil and x-rays.

Question 16

A common issue for Question 16 was that many students did not read the scale on the vertical axis and gave approximately 4.2 eV. In addition, a large number of students stated ‘not accurate’ as their answer but it was important that they also went on to give an explanation

It was also important for students to convert the eV work function back to J for (b). Some students gave work function as a negative value.

Question 17

Many students were able to calculate 3.4 eV but stopped. A significant number of responses were given as positive values instead of negative for this question.

Question 18

This question proved challenging for a large number of students. Feedback to support students with this question is outlined below.

Many students attempted to use Lenz’s law (this does not explain the production of an emf). Higher performing students stated Faraday for clarity. Few students linked the changing flux from the graph to electric current but some went further and explained the alternating current. Moving magnetic field instead of alternating/changing was also something that was flagged during marking.

Question 19

Some students demonstrated the following areas of improvement for this question:

* ensuring to multiply by 2
* misunderstanding locom (change in p is zero no pi=pf)
* not restating that two gamma rays were produced because of locom
* some students attempted to use mvi = mvf for this question.

Question 20

This question showed a large spread in student performance. Development appeared to be the best choice for this question. However, many responses required greater detail for SHE about strands. Many students attempted to link to benefiting society.

The following list provides some more detailed feedback for teachers to understand common factors that were identified through the marking process:

* not specific enough for (b)(ii) e.g. lepton, anti-lepton, antineutrino
* table generally answered well; if not correct then balanced
* some students repeated the text too much in their response. It is important that students use small, targeted parts of the text in their response.
* use of E instead of x10^
* Students using length contraction in (a)(ii).

Question 21

It was noted that many vector diagrams were missing conventions around directions and labelling. There was also poor use of locom. Another common issue that was identified was that many students did not recognise equilateral and used 2costheta.

Question 22

This question was generally answered quite well by students. However, a number of students did not link work to \*change\* in KE. Similar to past derivations but not answered as well. Calculation errors were also an issue that was identified in this question.