Course report 2022

Subject	Physics
Level	National 5

This report provides information on candidates' performance. Teachers, lecturers and assessors may find it useful when preparing candidates for future assessment. The report is intended to be constructive and informative and to promote better understanding. It would be helpful to read this report in conjunction with the published assessment documents and marking instructions.

The statistics used in this report have been compiled before the completion of any appeals.

Grade boundary and statistical information

Statistical information: update on courses

Number of resulted entries in 2022	**13210**

Statistical information: performance of candidates

Distribution of course awards including grade boundaries

A	Percentage	34.9	Cumulative percentage	34.9	Number of candidates	4610	Minimum mark required	63
B	Percentage	20.9	Cumulative percentage	55.8	Number of candidates	2760	Minimum mark required	51
C	Percentage	18.2	Cumulative percentage	74.0	Number of candidates	2405	Minimum mark required	40
D	Percentage	14.5	Cumulative percentage	88.5	Number of candidates	1915	Minimum mark required	28
No award	Percentage	11.5	Cumulative percentage	N/A	Number of candidates	1520	Minimum mark required	N/A

You can read the general commentary on grade boundaries in appendix 1 of this report.

In this report:

- 'most' means greater than 70%
- 'many' means 50% to 69%
- 'some' means 25% to 49%
- 'a few' means less than 25%

You can find more statistical reports on the statistics page of SQA's website.

Section 1: comments on the assessment

Question paper

All questions were answered correctly by at least a proportion of the candidates, and there was a spread of performance across the range of available marks.

The general feedback from markers was that the question paper was of a similar standard to previous exams and that the paper included appropriate questions to provide good discrimination for candidates performing at grades A and B. Statistical analysis indicates that average marks were slightly lower compared to previous exams, but with a larger distribution, especially at the lower end.

There were some candidates who appeared to have been presented at an inappropriate level as they struggled to access most of the questions.

In Section 1 (objective test) question 6 was more demanding than expected, and in Section 2 (restricted and extended-response questions), questions 6(c)(ii) and 11(a)(ii) were more demanding than expected.

It was also identified that candidate’s responses in questions relating to practical activities were weaker than expected. It was clear that some candidates had had little or no exposure to active practical work and had therefore not developed the knowledge and skills associated with practical work.

Assignment

The assignment component was removed for session 2021–22.

Section 2: comments on candidate performance

Question paper

Section 1: objective test

Question 1	Many candidates were able to identify the option that contained a scalar quantity and a vector quantity.
Question 2	Most candidates were able to identify the correct row in the table.
Question 3	Many candidates were able to calculate the distance travelled correctly.
Question 4	Few candidates were able to identify the correct explanation for the water rocket launching. Some candidates incorrectly selected the reason the rocket launches as being because the force applied by the water on the ground is greater than the weight of the rocket, producing an unbalanced upward force.
Question 5	Some candidates were able to determine the change in gravitational potential energy and the kinetic energy correctly. Some candidates were able to calculate the change in the gravitational potential energy of the ball as it fell correctly, but were then unable to identify that, due to the principle of conservation of energy, this value is the same as that of the kinetic energy of the ball at that point.
Question 6	Few candidates were able to identify the correct statements relating to the astronauts experiencing ‘weightlessness’. Most thought the forces acting on the astronauts were balanced and a few thought that the gravitational field strength inside the space station was zero.
Question 7	Most candidates could identify the option that listed the distances in decreasing order.
Question 8	Most candidates could identify the possible orbital periods of the satellites.
Question 9	Most candidates could identify which rocket engines should be switched on.
Question 10	Most candidates could determine the weight correctly.
Question 11	Most candidates could calculate the electrical charge correctly.
Question 12	Some candidates could identify the correct statements relating to the graph.

Question 13	Some candidates could identify the possible readings on the meters in the circuit. Some candidates did not determine that the voltage across each of the two resistors in parallel in the circuit shown is the same as the voltage of the battery.
Question 14	Most candidates could identify the circuit symbol for a thermistor.
Question 15	Some candidates could identify the correct statements from the information in the graph. Some candidates incorrectly thought that the specific heat capacity of the solid substance X is greater than that of the solid substance Y. The graph shows that the temperature of solid substance X increases more rapidly than solid substance Y, when supplied with the same amount of energy per second. This indicates that solid substance X has a lower specific heat capacity than solid substance Y.
Question 16	Some candidates could calculate the minimum heat energy required correctly.
Question 17	Some candidates could calculate the average pressure correctly. Some candidates did not determine that the force contributing to the pressure exerted by the tyres on the road was the combined weight of the cyclist and bicycle. Instead, they simply divided the combined mass of the cyclist and bicycle by the total contact area between the tyres and the road.
Question 18	Many candidates could use the unfamiliar relationship to calculate the average kinetic energy of a gas molecule.
Question 19	Most candidates could identify that sound is a longitudinal wave.
Question 20	Some candidates could calculate the maximum wavelength correctly. Of those who couldn't, the common incorrect response was to use the maximum frequency to calculate the minimum wavelength.
Question 21	Most candidates could identify which two bands were in the wrong position.
Question 22	Many candidates could identify the radiation that would be detected at P and Q correctly.
Question 23	Most candidates could calculate the activity of the sample correctly.
Question 24	Some candidates could identify the most suitable substance to use as the radioactive tracer.
Question 25	Most candidates could calculate the activity of the sample correctly, given the time and the half-life.

Section 2: restricted and extended-response questions

Many candidates coped well with questions requiring the selection of a relationship, followed by a calculation and final answer.

In general, questions requiring justifications, descriptions or explanations are intended to be more demanding for candidates. There was often a lack of precision in candidates' responses, especially when using physics terminology and principles. Candidates who successfully answered questions that required justifications, descriptions or explanations were able to structure their answers to present information that was clear and relevant to the question being asked. They used correct terminology and referred to appropriate physics concepts (for example in question 3(b), the effect of increasing altitude on the acceleration of a spacecraft).

There was also evidence that questions relating to practical activities were done less well than in previous exams.

The standard of written English was often poor. Some candidates were not using appropriate scientific terminology, and, in some cases, poor spelling made it difficult to interpret whether the candidate's response was correct.

Question 1(a)(i)	Most candidates calculated the magnitude of displacement from Aberdeen to Glasgow correctly.
Question 1(a)(ii)	Many candidates were able to calculate an appropriate angle, but some were unable to then express their answer as a three-figure bearing or as an angle to a compass point.
Question 1(b)(i)	Most candidates could select an appropriate relationship, and some were able to calculate the average speed correctly. However, some candidates ignored the emboldened information about the return journey and used the data for the journey from Aberdeen to Glasgow.
Question 1(b)(ii)	Many candidates did not realise that the magnitude of the average velocity of the aeroplane was the same as the average speed of the aeroplane calculated in the previous part of the question and could simply be repeated in their response to this part. Instead, they attempted to calculate the magnitude of the velocity, often making errors in the calculation, particularly in the statement of the units for the final answer. In addition, few candidates correctly stated the direction of the velocity of the aeroplane for the return journey from Glasgow to Aberdeen.
Question 2(a)(i)	Some candidates did not produce an accurate graph for the data provided in the question. In particular, the use of non-linear scales by a few candidates meant that their points and line could not be checked for accuracy. There were also some candidates who did not draw a best fit straight line through their points, which was appropriate for the data provided in the question.

Question 2(a)(ii)	Only some candidates were able to use their graph to predict the range of the marble released from a particular height. This was often due to inaccuracy in the use of the scale they had selected for their graph in the previous part of the question.
Question 2(a)(iii)	Many candidates could suggest an improvement to the experiment.
Question 2(b)(i)	Many candidates could suggest another variable that could be investigated. Of those who couldn't, some suggested changing the speed that the marble leaves the ramp with, which is effectively what releasing the marble from different heights on the ramp is doing.
Question 2(b)(ii)	Only some candidates described experimental work that could be carried out to investigate how the variable they selected in the previous part of the question affects the horizontal range of a marble. Some candidates did not describe how their chosen variable would be changed, and some candidates did not indicate how a fair test would be achieved. A few candidates appeared to misinterpret the question and, instead, explained how their chosen variable would affect the range.
Question 3(a)(i)	Most candidates were able to calculate the weight of the spaceship on Mars, given the mass of the spaceship and using the value of the gravitational field strength for Mars given in the data sheet.
Question 3(a)(ii)	Many candidates were able to name the forces acting on the spaceship just after take-off and show their directions correctly. A notable number of candidates are still incorrectly labelling the downward force as 'gravity' rather than weight or gravitational force.
Question 3(a)(iii)	Some candidates were able to determine the acceleration of the spaceship correctly. Most candidates could select the correct relationship. Many did not use the resultant force in their calculation and used only the thrust instead.
Question 3(b)	Many candidates were able to state what happens to the acceleration of the spaceship and some were able to justify their answer correctly.
Question 4	Although many candidates identified a similarity or difference between space exploration and underwater exploration, only a few went on to develop their responses and demonstrate any depth of understanding. Often candidates discussed issues such as cost or 'difficulty', which included little or no physics. A few candidates provided spurious responses such as 'there are no sharks in space'. A few candidates provided insightful answers, such as discussing how the pressure acting on a spaceship and on an underwater vessel differed.

Question 5(a)(i)	Many candidates were able to calculate the distance from Rigel to Earth. A few candidates included an incorrect unit, despite the question asking for the distance in metres.
Question 5(a)(ii)	Many candidates could determine the approximate speed of the debris correctly.
Question 5(a)(iii)	Most candidates were able to calculate the time taken for the debris from the supernova to reach Earth using their responses to the previous two parts of the question.
Question 5(b)	Many candidates were able to explain why the supernova explosion may have already happened but has not yet been detected.
Question 5(c)(i)	Only some candidates identified the spectrum shown as being a line spectrum.
Question 5(c)(ii)	Although many candidates described how a line spectrum could be used to identify the elements present in a star, responses suggest that a few candidates were under the misapprehension that each individual line in the spectrum corresponds to an individual element.
Question 6(a)	Most candidates were able to state which of the two resistors would allow the greater current to pass, accompanied by a suitable justification.
Question 6(b)	Many candidates were able to calculate the reading on the voltmeter.
Question 6(c)(i)	Most candidates were able to calculate the combined resistance of two resistors in parallel.
Question 6(c)(ii)	Only a few candidates stated that the effect of adding another resistor in parallel with the two resistors in the circuit is to increase the reading on the ammeter. Even fewer were able to justify their answer by stating that the total resistance of the circuit would decrease (often omitting the 'total' aspect). Some candidates responded incorrectly that adding another resistor in parallel would increase the total resistance of the circuit and therefore decrease the current. A few candidates responded that adding another resistor in parallel would not affect the current, but that it would just have to 'split more ways'.
Question 7(a)	Only some candidates stated an appropriate fuse rating for the dehumidifier given its power rating. Candidates are expected to be able to select whether a 3 A or 13 A fuse should be used for an appliance, based on its power rating.
Question 7(b)	Many candidates were able to calculate the resistance of the dehumidifier. However, a few candidates used their chosen fuse rating as the current, which is not appropriate.

Question 7(c)(i)	Few candidates drew the correct symbol for an LED.
Question 7(c)(ii)	Few candidates explained how the circuit shown operates to turn on the LED when the moisture in the air increases above a certain level. Many candidates did not state that the voltage across the variable resistor would increase, and many candidates did not indicate that the transistor would switch on.
Question 7(c)(iii)	Few candidates explained the purpose of the variable resistor, in terms of it allowing adjustment to the moisture level at which the circuit operates.
Question 8(a)	Most candidates were able to calculate the current in an iron, given information about its operating voltage and power rating.
Question 8(b)(i)	Many candidates were able to calculate the temperature increase of the soleplate and some candidates were then able to determine the maximum temperature.
Question 8(b)(ii)	Some candidates were able to explain why the maximum temperature reached would be less than they had calculated. A notable number simply answered 'energy loss' or similar and gave no indication of where the energy was lost.
Question 9(a)	Only a few candidates used all the appropriate data to establish the relationship between the pressure and the temperature of the gas. Many candidates tried to explain the relationship in qualitative terms, rather than carrying out any numerical calculations or drawing a graph.
Question 9(b)	Many candidates were able to make an appropriate prediction for the pressure.
Question 9(c)	Only some candidates suggested an appropriate way in which the experiment could be improved. A common incorrect response was to 'insulate the apparatus', without being specific about what part of the apparatus should be insulated in such a way as to improve the experiment.
Question 9(d)	Most candidates were able to attempt an explanation using the kinetic model, and some candidates went on to give full and accurate explanations.
Question 10(a)(i)	Most candidates were able to determine the wavelength of a wave, given information about the number of waves and the total distance they occupy.

Question 10(a)(ii)	Most candidates showed all the stages of the calculation required to determine the frequency of a wave, given information about the number of waves and the time taken for them to be produced. These stages included starting with a correct relationship, making the correct substitutions, and ending with the correct final value, including the unit.
Question 10(a)(iii)	Most candidates were able to calculate the speed of a wave, using either the wavelength and the frequency of the wave, or the distance travelled by the wave and the time taken.
Question 10(b)	Some candidates were able to draw accurate diagrams showing the diffraction pattern produced in the ripple tank. Many candidates' drawings lacked the necessary accuracy, with straight lines drawn freehand, unequal spacing of wavefronts, and diffracted wavefronts that were straight rather than curved.
Question 11(a)(i)	Many candidates were able to name the effect as being refraction, with the correct spelling.
Question 11(a)(ii)	Few candidates were able to complete the diagram to show the path of the ray of red light through and out of the semi-circular glass block. In particular, many candidates indicated incorrectly that there would be a change in direction of the ray as it left the block. A few indicated a change in direction part way through the block.
Question 11(a)(iii)	Only some candidates stated that the wavelength of the red light in the glass would be less than the wavelength of the red light in air.
Question 11(b)	Many candidates were able to calculate the average time for each pulse. Some candidates included a unit that was not consistent with their substitution.
Question 12(a)(i)	Many candidates were able to state an appropriate conclusion using the data given in the graph.
Question 12(a)(ii)	Some candidates were able to add an appropriate line to the graph to show how the shiny silver side would compare with the matt black side.
Question 12(b)	Although many candidates demonstrated a limited understanding of how a solar shower operates, only a few went on to develop their responses in such a way as to demonstrate any depth of understanding. Those who did tended to make good use of the information provided in the previous parts of the question. However, candidates often made confused statements about the emission and/or absorption of radiation from the different surfaces on the bag. A few candidates incorrectly applied the kinetic model used to explain the gas laws, to explain the pressure of the water emerging from the hose.

Question 13(a)	Many candidates were not specific in the reason they stated as to why an alpha radiation source is used in a smoke detector (for example, by making statements such as 'alpha is stopped by a sheet of paper', when paper did not feature in the construction of the smoke detector).
Question 13(b)(i)	Most candidates were able to identify the alpha source with the longest half-life, given graphs showing how the activity for a selection of different sources varies with time.
Question 13(b)(ii)	Some candidates were able to explain why the sources would not be suitable for use in a smoke detector.
Question 13(c)	Many candidates were able to determine the equivalent dose received by the worker.
Question 14(a)	Only some candidates stated that nuclear fission involves the splitting of a large nucleus into smaller nuclei. Some candidates incorrectly used the term 'atom' instead of 'nucleus'.
Question 14(b)(i)	Few candidates were able to determine the minimum number of fission reactions correctly, although many were able to determine the energy produced by the reactor in an hour.
Question 14(b)(ii)	Many candidates did not describe a difficulty in sustaining nuclear fusion reactions in a reactor. Some described a difficulty in initiating the reaction in the first place, and others described socio-economic issues related to nuclear fusion, neither of which addressed the question asked. A few candidates even stated that nuclear fusion was not possible.

Section 3: preparing candidates for future assessment

Each year, the question paper samples the full range of course content. This means that candidates should be familiar with all aspects of the course.

Candidates sometimes did not give any answer to particular questions, which could suggest lack of familiarity with the relevant course content. The question paper assesses application of knowledge and understanding, and application of the skills of scientific enquiry, scientific analytical thinking and problem solving. Candidates should have the opportunity to practise these skills regularly to familiarise themselves with the type and standard of questions that may be asked.

Candidates **must** be given the opportunity to take an active part in a wide range of practical work, to develop the necessary knowledge and skills. This will help candidates with questions that ask about experiments and practical contexts. While demonstration of experiments, videos, and computer simulations may be useful additional tools, they cannot replace active experimental work and do not develop the knowledge and skills associated with practical work.

Many of the following issues were identified in the '2022 revision support for learners: National 5 Physics' guidance for the 2022 exam document published by SQA earlier this session and made available to candidates prior to the exam. It was therefore pleasing to note that there were some improvements in issues such as the use of superscripts and subscripts, candidate's responses to the 'show' question, and the spelling of key words such as 'refraction'. However, issues such as significant figures, intermediate rounding, and forcing lines of best fit to pass through the origin in graphs, when it was not appropriate to do so, continued to be evident.

Frequent use of physics terms and 'language' may help candidates develop their communication skills when answering questions.

Candidates should be familiar with the various 'command words' used in physics questions and how to respond to them. For example, when candidates are asked to 'show' a particular answer is correct, they should start their response with an appropriate relationship, show the correct substitutions and end with a final answer, including the correct unit, to obtain all the marks available. In a 'must justify' question, they must not only state or select the correct response, but also provide supporting justification to be awarded marks.

For questions requiring calculations, the final answer sometimes had the wrong or missing unit. Centres should remind candidates that a final answer usually requires both a value and a unit. Candidates should also be familiar with the full range of units used for quantities covered in the National 5 course.

In calculations, some candidates were unable to provide a final answer with the appropriate number of significant figures (or to round these correctly). It was evident that a few candidates confuse significant figures with decimal places. Centres should ensure that candidates understand and can use significant figures correctly.

Candidates should be strongly discouraged from copying down answers from their calculator containing a large number of significant figures, or using ellipses, as a penultimate stage in their response before stating their final answer, as often this can introduce transcription or rounding errors into their calculations. They should be strongly encouraged to show only the selected relationship, the substitution, and then the answer, including units, to the appropriate number of significant figures.

Candidates should be given the opportunity to practise open-ended questions at appropriate points during the course. They should be encouraged to both state relevant physics concepts and relate them to the situation described in the question. Having attempted such questions, it may be beneficial for them to have sight of a range of responses and to discuss how marks would be awarded for these responses. Such responses can either be generated by their peers or are available from sources such as the SQA Understanding Standards website.

Candidates should ensure that they write as neatly as possible so their answers can be clearly interpreted by markers. They should also check their spelling, particularly for scientific terms such as refraction.

The published marking instructions contain general marking principles, and also detailed marking instructions for specific questions. Candidates should be encouraged to become familiar with the allocation of marks and the importance of complete final answers when answering numerical questions. Candidates should have access to specific marking instructions when practising exam-type questions. The marking instructions published on SQA's website illustrate how marks are apportioned to responses.

Centres should also refer to the 'Physics: General Marking Principles' document on the SQA website for generic issues related to the marking of question papers in SQA qualifications in Physics at National 5, Higher and Advanced Higher levels. Centres are advised to adopt these general instructions for the marking of prelim examinations and centre-devised assessments for any SQA Physics courses.

Centres should ensure candidates are entered at an appropriate level.

Appendix 1: general commentary on grade boundaries

SQA's main aim when setting grade boundaries is to be fair to candidates across all subjects and levels and maintain comparable standards across the years, even as arrangements evolve and change.

For most National Courses, SQA aims to set examinations and other external assessments and create marking instructions that allow:

- a competent candidate to score a minimum of 50% of the available marks (the notional grade C boundary)
- a well-prepared, very competent candidate to score at least 70% of the available marks (the notional grade A boundary)

It is very challenging to get the standard on target every year, in every subject at every level. Therefore, SQA holds a grade boundary meeting for each course to bring together all the information available (statistical and qualitative) and to make final decisions on grade boundaries based on this information. Members of SQA's Executive Management Team normally chair these meetings.

Principal assessors utilise their subject expertise to evaluate the performance of the assessment and propose suitable grade boundaries based on the full range of evidence. SQA can adjust the grade boundaries as a result of the discussion at these meetings. This allows the pass rate to be unaffected in circumstances where there is evidence that the question paper or other assessment has been more, or less, difficult than usual.

- The grade boundaries can be adjusted downwards if there is evidence that the question paper or other assessment has been more difficult than usual.
- The grade boundaries can be adjusted upwards if there is evidence that the question paper or other assessment has been less difficult than usual.
- Where levels of difficulty are comparable to previous years, similar grade boundaries are maintained.

Grade boundaries from question papers in the same subject at the same level tend to be marginally different year on year. This is because the specific questions, and the mix of questions, are different and this has an impact on candidate performance.

This year, a package of support measures including assessment modifications and revision support, was introduced to support candidates as they returned to formal national exams and other forms of external assessment. This was designed to address the ongoing disruption to learning and teaching that young people have experienced as a result of the COVID-19 pandemic. In addition, SQA adopted a more generous approach to grading for National 5, Higher and Advanced Higher courses than it would do in a normal exam year, to help ensure fairness for candidates while maintaining standards. This is in recognition of the fact that those preparing for and sitting exams have done so in very different circumstances from those who sat exams in 2019.

The key difference this year is that decisions about where the grade boundaries have been set have also been influenced, where necessary and where appropriate, by the unique circumstances in 2022. On a course-by-course basis, SQA has determined grade boundaries in a way that is fair to candidates, taking into account how the assessment (exams and coursework) has functioned and the impact of assessment modifications and revision support.

The grade boundaries used in 2022 relate to the specific experience of this year's cohort and should not be used by centres if these assessments are used in the future for exam preparation.

For full details of the approach please refer to the National Qualifications 2022 Awarding — Methodology Report.

