May 2017 subject reports

Nature of Science

Overall grade boundaries

Standard level

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 15	16 - 30	31 - 40	41 - 50	51 - 61	62 - 72	73 - 100

Standard level internal assessment

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 5	6 - 10	11 - 13	14 - 16	17 - 19	20 - 22	23 - 28

The range and suitability of the work submitted

In this first set of NOS internal assessments, there was a good range of topics contributing to an interesting moderation. Alternative medicine was a popular subject, along with energy-related topics. Most of the investigations submitted were suitable and included potential connections to the NOS. There were several instances where a similar topic was chosen, but the investigations were assessed at different levels of achievement depending on the strength of the NOS connections. Weak or missing NOS connections resulted in a lower assessment, even if the investigations were well written.

Some topics were unsuitable. Descriptive reports on history, machinery or personal activities were not appropriate. Vague models relating to some aspect of science met with little success unless the candidate was able to link the topic to appropriate NOS aspects.

Practical components were included with some of the submitted work. When the candidate designed a controlled experiment, detailing the protocol and presenting the data appropriately, this practical component was successful. However, in some cases the experiment was poorly done and detracted from the overall investigation.

Some IA submissions were clearly aligned with the strengths of the teacher, especially in physics.

Candidate performance against each criterion

Context

Establishing a coherent research topic with a strong connection to relevant NOS aspects helped candidates to focus their investigation on examining the issue from a NOS perspective. This approach increased the potential for a higher level of achievement. Without a focused research topic, candidates struggled to make the appropriate NOS connections.

Few candidates included a satisfactory discussion on the background NOS information to provide context to their investigation. This discussion should include more than one descriptive statement and offer a balanced review that includes a range of arguments, factors or hypotheses. Many candidates did not go beyond listing or providing a brief description of the NOS aspects relevant to their investigation. There were some introductions that did not include any reference to the NOS.

Strategy

In order to demonstrate a good understanding of the NOS, candidates must explain all references to NOS aspects. This can be done generically before specific connections to their topics are established. A plan on how the candidate will approach the NOS connections is also recommended. In some cases, candidates included a list of potential NOS aspects in the introduction, but failed to develop these ideas.

Most candidates used a wide range of resources in their investigation, but did not always justify their choices. It is also important that candidates recognize the importance of peer-reviewed scientific publications and include these resources in their investigation, not relying entirely on web-based resources.

Methodology is only applicable with a practical component. It does not refer to a description of how a particular scientist carried out their work. When including a practical component, the methodology should include a detailed description on how the experiment was carried out, identify the variables and provide a sufficient sample size. The experiment should also be clearly related to the candidate's topic.

Analysis

Assessment of the analysis criterion is firmly bound to an understanding of the connections to NOS. The research conducted by the candidate must be analysed through a NOS perspective. Candidates that established a strong NOS focus at the beginning of their investigations, generally did well in this criterion. Those investigations that were based on descriptive information did not lend themselves to a discussion on how the results connect to the NOS.

When an experiment was carried out as part of the investigation, appropriate data processing or manipulation of data is needed. A summary of the data patterns or trends should follow the

presentation of raw and processed data. In only a few cases did the candidates discuss the experimental results in the context of NOS.

Evaluation and conclusion

Within the evaluation and conclusion criterion, the conclusion aspect was generally better addressed than either the limitations or the modifications/further research. However, if the NOS connections were not established at the beginning of the investigation, the conclusion usually remained at the simplistic level. There were also instances of broad generalizations and questionable information found in some of the conclusions.

In some cases, candidates included inappropriate strengths and weaknesses, such as not having enough time or access to certain resources. This practice was not rewarded with a high level of achievement. Realistic suggestions for further research should be based on the conclusion and related to the research topic.

Scientific communication and engagement

Most investigations were clearly presented and easy to read, generating a satisfactory level of achievement. In all cases, consistent use of appropriate scientific terminology was recognized even if the investigation was descriptive with limited NOS connections. However, scientific conventions when presenting data were required, along with the correct classification of organisms, where relevant.

Several IAs were significantly over the recommended page limit and penalized. Alternatively, IAs that were too short in length could not provide the necessary breadth and depth of the topic.

Many candidates did not include any indication of personal relevance. Enjoyment of the NOS course or an expression of superficial interest does not provide personal relevance of the investigation.

Recommendations for the teaching of future candidates

Teachers have an important role to ensure that candidates are successful when structuring their investigations. They should use the time recommended for the IAs to brief candidates on the requirements. Candidates should be encouraged to establish a focused research topic of personal interest. Establishing strong links to the NOS in the title of the investigation should be a major focus. Candidates should be given effective feedback at the early stages of their investigation to help them develop an effective research topic.

A number of investigations presented a detailed description of the topic with minimal NOS connections. While interesting, they did not provide an opportunity for the candidate to apply a satisfactory understanding of the NOS. Although there was the potential to develop relevant NOS connections, this opportunity was not explored in some cases. A NOS focus for each of the general areas of research must be established to ensure that the investigation becomes a NOS study and not a general research paper.

As the NOS course is part of the Group 4 Sciences, the inclusion of a practical component in the IA is recommended. Although there were some satisfactory examples in this marking session, a number of experiments were of poor quality. Teachers are encouraged to guide candidates in designing appropriate experiments.

Candidates should be reminded that the recommended number of pages for their report is 10 - 15 pages.

Further comments

The first moderation of the NOS internal assessment went smoothly, indicating that the pilot teachers were aware of the procedures required for document submission. In most cases, names had been removed from the documents.

Some teachers designed different mark sheets listing the criteria and included this document with the investigation. This practice should be encouraged as there was better agreement between the moderator and teacher when the teacher provided annotated mark sheets and detailed comments. The teacher's comments were helpful to the moderator in understanding how the assessment levels were awarded.

Most teachers marked appropriately, although there seemed to be some optimism at both the higher and lower mark levels. There were also cases where teachers correctly identified a missing aspect of the investigation, but still marked inappropriately. Links to the NOS were applauded by some teachers that had no relevance to the research topic and were tangential to the arguments in the report.

The NOS aspect 2.7 regarding Occam's razor was often used without any real connection to the arguments in the investigation.

Teacher feedback to the candidates should include an indication of whether or not appropriate limitations and modifications have been addressed. In many cases, this aspect of the conclusion and evaluation criterion was weak or missing, contributing to a lower average mark.

Question	Avg. Question Item Mark	Highest Mark	Population std. dev. of Question Item Mark	Correlation coefficient
An	3.3	6	1.43	0.8427
Co	3.4	6	1.45	0.7739
Ev and Co	2.8	6	1.57	0.8774
SC and En	2.5	4	0.75	0.7307
St	3.2	6	1.45	0.9058

Standard level paper one

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 9	10 - 19	20 -24	25 - 31	32 - 37	38 - 44	45 - 60

General comments

This was the first examination for the Nature of Science pilot course.

This report should be read in conjunction with the question paper and mark scheme.

There was a poor response from the pilot teachers in sending in G2 forms on this examination. The comments in these forms are all read by the examining team and can sometimes be valuable during the marking and grade awarding process as well as providing feedback for future examination questions.

There was no evidence of lack of time for candidates to answer the paper. The statistics showed that the vast majority of candidates attempted all questions with very few parts being omitted by candidates.

There was lack of space in one or two boxes to be able to obtain the marks available. Several candidates used the additional 4-page booklet but rarely used more than 1 or 2 pages of this.

There were some strong candidates but also a small number of very weak ones. In general responses showed that candidates had been exposed to the nature and philosophy of the course as well as having a good understanding of the scientific contexts through which the course philosophy is delivered.

The areas of the programme and examination which appeared difficult for the candidates

Section A proved more difficult than section B with a lower average mark. Q7 on Matter and Q8 on GM rice proved to be more challenging while Q6 on old rocks on the earth posed the least level of difficulty.

The areas of the programme and examination in which candidates appeared well prepared

Candidate did better in section B. Q11 on drugs was the highest scoring question followed by Q10 on energy and Q9 on evolution. The average scores can be seen from the table of statistics.

The strengths and weaknesses of the candidates in the treatment of individual questions

Section A

Q1-5 The statistics table shows that the average mark out of 5 for these multiple-choice questions was 3.1. Question 4 proved the most difficult and Q3 the best discriminator.

These multiple-choice questions appear to have been a fair test with no issues with wording or ambiguity.

6 (a) Almost all candidates answered this correctly.

6 (b) “Carbon dating” was a common incorrect answer revealing a lack of knowledge that carbon dating is limited to a much shorter time scale. These old rocks require uranium dating.

6 (c) This was badly done with answers being too simplistic and too general.

7 (a) This was answered well with candidates showing a good understanding of the work of Mendeleev.

7 (b) This was not well done with few candidates obtaining marks for addressing the nature of science aspects. Many candidates missed points for not pairing contrasting arguments. Few candidates presented similarities.

8 (a) (i) Many candidates wrote about the importance of the rice itself or GM foods in general. The answer needs to focus on vitamin A and not on the rice.

8 (a) (ii) This question is about *the use* of scientific literacy. Candidates did not address the term scientific literacy in its widest sense and confined themselves to discussing one aspect only, losing the chance to pick up other marking points. The question can be looked at from both the point of view of scientists and the public and there are a wide range of possible answers.

8 (b) Candidates knew a lot about nutrients but the key point here is that nutrients are essential to human health whilst additives are not.

Section B

9 (a) There were Lamarckian interpretations of this question though many also answered well. The key is that pink iguanas already exist and are favoured. No iguana turned pink in its own lifetime.

9 (b) This question is now broader and about evolution in general and not focussed solely on The Galapagos. Some candidates did not realize that a wider range of answers was possible.

9 (c) There are many arguments that overcame the resistance to evolution before the evidence provided by genetics.

9 (d) This was answered well.

9 (e) This was not well done but candidates obtained marks from the full range of marking points available.

10 (a) (i) Most candidates got this correct.

10 (a) (ii) Again most candidates got this correct but some candidates did not use data from the table as required.

10 (a) (iii) This question was badly done. Some candidates simply repeated the general factors in the stem of the question. The question is about the production of geothermal energy and answers must relate to geothermal energy and not be general about other energy sources or about non-production aspects.

10 (b) Answers were good but it was clear that some candidates did not know how natural gas was produced. Very few mentioned high energy density as an advantage.

10 (c) (i) This was poorly done. The isotope must be named specifically.

10 (c) (ii) Although the question was reasonably well answered, the question is about the use of nuclear energy in general and is not confined to power stations. Very few picked up on this and simple marking points were missed.

10 (d) Two future developments are required. Some candidates talked about things that already exist. Developments can be wide ranging and can relate to things other than the cars themselves. e.g. higher oil prices, disruption of oil supplies, government measures, climate change agreements.

11 (a) (i) and (ii) Many candidates scored maximum marks on these two parts due partly to a wide range of marking points relating to minor as well as major trends. The command term “describe” and the 2-mark allocation indicated that it was insufficient to mention just one aspect of the graph.

11 (b) Those that obtained full marks showed there were two aspects to this - both supporting and not supporting the hypothesis.

11 (c) The scientific mechanism required for a causal effect was not mentioned by many candidates. The question was reasonably well done although there were not a wide range of answers. The large number of available marking points were not fully accessed.

11 (d) This was well answered but not many explained the process in a logical, chronological order.

Recommendations and guidance for the teaching of future candidates

Some candidates were familiar with the precise meanings of the command terms and were able to use this knowledge together with the number of marks allocated to maximize their marks. In general, a 4 marks allocation means there are 4 separate marking points available and it is counterproductive to write extensively to obtain 1 marking point and neglect the others available. It should be noted that although some questions may start from a specific context they can be become broader in scope as they develop. A lack of recognition of this disadvantaged some candidates. Nature of science aspects are frequently available as marking points and these were not always addressed by candidate thus losing the chance to score well in a question.

Statistics on part questions in examination

A high standard deviation indicates a wide range of performance by the candidates. A high correlation coefficient indicates that the question was a good discriminator with the question answered well by the high overall scoring candidate and badly by the low overall scoring candidates.

Question	Questions Attempted	Attempted % along Question	Avg. Question Item Mark	Highest Mark	Population std. dev. of Question Item Mark	Average per mark in question	Correlation coefficient	Sum of candidates
Q1	184	100.00%	0.6	1	0.5	0.60	-0.0057	184
Q2	184	100.00%	0.7	1	0.47	0.70	0.2653	184
Q3	184	100.00%	0.7	1	0.46	0.70	0.2811	184
Q4	184	100.00%	0.5	1	0.5	0.50	0.2461	184
Q5	184	100.00%	0.6	1	0.49	0.60	0.3226	184
Q6a	184	100.00%	0.9	1	0.3	0.90	0.1813	184
Q6b	184	100.00%	0.7	2	0.81	0.35	0.3487	184
Q6c	184	100.00%	0.6	2	0.64	0.30	0.2483	184
Q7a	182	98.91%	0.9	2	0.82	0.45	0.472	184
Q7b	181	98.37%	0.6	3	0.69	0.20	0.4246	184
Q8a(i)	182	98.91%	0.3	1	0.46	0.30	0.2601	184
Q8a(ii)	180	97.83%	0.9	3	0.77	0.30	0.4378	184
Q8b	184	100.00%	0.3	1	0.47	0.30	0.2399	184
Q9a	184	100.00%	2	4	1.29	0.50	0.5664	184
Q9b	184	100.00%	0.9	2	0.71	0.45	0.3094	184
Q9c	184	100.00%	1.5	3	0.93	0.50	0.4791	184
Q9d	182	98.91%	0.7	1	0.47	0.70	0.3127	184
Q9e	184	100.00%	1.7	4	0.83	0.43	0.3305	184
Q10a(i)	184	100.00%	0.9	1	0.27	0.90	0.1194	184
Q10a(ii)	184	100.00%	0.9	1	0.35	0.90	0.1883	184
Q10a(iii)	181	98.37%	0.4	2	0.64	0.20	0.2888	184
Q10b	184	100.00%	2.6	4	1.13	0.65	0.3809	184
Q10c(i)	178	96.74%	0.3	1	0.44	0.30	0.4689	184
Q10c(ii)	183	99.46%	2.1	4	0.98	0.53	0.4089	184
Q10d	183	99.46%	1.1	2	0.85	0.55	0.2733	184
Q11a(i)	184	100.00%	1.3	2	0.59	0.65	0.1762	184
Q11a(ii)	184	100.00%	1.4	2	0.59	0.70	0.1875	184
Q11b	183	99.46%	1.1	2	0.53	0.55	0.1337	184
Q11c	184	100.00%	1.1	2	0.67	0.55	0.1616	184
Q11d	183	99.46%	2.1	3	0.91	0.70	0.3599	184

Standard level paper two

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 5	6 - 10	11 - 15	16 - 19	20 - 24	25 - 28	29 - 45

General comments

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There was a poor response from the pilot teachers in sending in G2 forms on this examination. The comments in these forms are all read by the examining team and are valuable during the marking and grade awarding process as well as providing feedback for future examination questions.

There was no evidence of lack of time for candidates to answer the paper. We recognize that there was lack of space in one or two boxes to be able to obtain the marks available and we will aim at avoiding such issues in the future examinations.

Very few candidates used the additional 4-page booklet but rarely used more than 1 or 2 pages of this.

In general responses showed that candidates had been exposed to the nature and philosophy of the course as well as having a basic understanding of the scientific contexts through which the course philosophy is delivered.

Some candidates were familiar with the precise meanings of the command terms and were able to use this knowledge together with the number of marks allocated to maximize their marks. In general, a 4 marks allocation means there are 4 separate marking points available and it is counterproductive to write extensively to obtain 1 marking point and neglect the others available.

It should be noted that questions start from a context but as they develop they move away from the context and become broader. A lack of recognition of this disadvantaged quite some candidates.

Nature of science aspects are available as marking points in many questions and these were not always addressed by candidate thus losing the chance to score well in a question.

The areas of the programme and examination which appeared difficult for the candidates

The concept of star evolution proved difficult as well as answering the data based / case study questions. Some students struggled to include to relevant references to the fundamental NOS concepts in their responses.

The areas of the programme and examination in which candidates appeared well prepared

- Calculations
- Analysing diagrams
- Suggesting health policies and practices
- Understanding of peer review process

The strengths and weaknesses of the candidates in the treatment of individual questions

1 (a) Almost all candidates answered this correctly.

1 (b) A majority of candidates correctly identified ‘ethanol’ as the fuel with the highest energy density, however not all candidates justified that statement correctly.

1 (c) This was badly done with answers being too simplistic and too general. Accuracy / Errors in scientific experimentation should be core material for this course and well understood.

1 (d) Most candidates scored one mark for this question by addressing the higher number of bonds in ethanol versus methanol.

1 (e) There were so many correct and accepted answers to this question so most candidates got one mark.

1 (f) Many candidates wrote about the type of resources, i.e. metals or plastic; not all candidates received full marks.

2 (a) This question was correctly answered well by most candidates. However, a surprising number of candidates could not recall the name of the diagram.

2 (b) (i) This question was well answered.

2 (b) (ii) Again this question was poorly answered. Almost no candidate scored the maximum marks (2). The majority of candidates only mentioned the ‘main sequence’ and left it at that.

2 (c) Most candidates did not understand the relationship between surface temperature and the star’s lifetime. In fact, a lot of them reversed the relationship.

2 (d) The relationship between surface temperature and lifetime was only understood by a small minority of candidates.

2 (e) Quite baffling to see the range of incorrect answers. A surprising number of candidates were unfamiliar with the fusion reaction in the sun.

2 (f) Most candidates managed at least one mark. If scoring any marks at all it was usually marking point a. that got the credit.

3 (a) Most candidates got this correct.

3 (b) Again answered not as well as expected. Questions about ethics allow for a variety of acceptable answers, however, the vast majority of candidates did not score the maximum marks. Three marking points a, c and f were most frequently used. This may be a case where a lack of space contributed to the limited answers.

3 (c) Same as for 3 (b): most candidates used marking points a, g and c with a few referring to avoiding contact with infected animals (f). Very few candidates scoring 3 out of 3 marks.

3 (d) (i) Most answers were wrong or really confused.

3 (d) (ii) If the candidate gave the correct answer in (d) (i) in the vast majority of cases they got a mark for this question as well.

3 (d) (iii) Reasonably answered question. A variety of answers were given by candidates.

4 (a) Overall this was answered correctly.

4 (b) No candidates scored the maximum marks (4). Very few scored more than 1 mark, mostly because they referred to acquiring quantitative data, or collect more data. The notion of independent, non-biased research hardly ever came up. Some comparisons between diesel car emissions and petrol car emissions were made but a poorly answered question nevertheless.

4 (c) No candidates scored the maximum marks (3). Most referred to the cost of the program (marking point g) or to sampling size and or logistics (marking point e). A few mentioned replacements of old cars (marking point f).

4 (d) The question proved to be too challenging for most. Few candidates scored 2 marks the majority scored one for referring to the global dimension of the problem.

Question	Questions Attempted	Attempted % along Question	Avg. Question Item Mark	Highest Mark	Population std. dev. of Question Item Mark	Average per mark in question	Correlation coefficient	Sum of candidates
Q1a	182	99.45%	1.3	2	0.9	0.65	0.3801	183
Q1b	180	98.36%	1.1	2	0.82	0.55	0.1863	183
Q1c	179	97.81%	0.8	3	0.85	0.27	0.4821	183
Q1d	181	98.91%	0.8	2	0.6	0.40	0.2384	183
Q1e	179	97.81%	0.5	1	0.5	0.50	0.2345	183
Q1f	178	97.27%	0.9	2	0.78	0.45	0.3936	183
Q2a	179	97.81%	0.6	1	0.5	0.60	0.266	183
Q2b(i)	183	100.00%	0.8	1	0.42	0.80	0.2181	183
Q2b(ii)	181	98.91%	0.8	2	0.76	0.40	0.0847	183
Q2c	183	100.00%	0.2	1	0.43	0.20	0.1251	183
Q2d	182	99.45%	0.2	2	0.45	0.10	0.2452	183
Q2e	175	95.63%	0.6	2	0.67	0.30	0.2923	183
Q2f	165	90.16%	0.6	2	0.76	0.30	0.5019	183
Q3a	183	100.00%	0.9	1	0.33	0.90	0.2951	183
Q3b	182	99.45%	1.5	4	0.92	0.38	0.2873	183
Q3c	183	100.00%	1.7	3	0.83	0.57	0.319	183
Q3d(i)	174	95.08%	0.2	1	0.41	0.20	0.3495	183
Q3d(ii)	177	96.72%	0.2	1	0.43	0.20	0.2544	183
Q3d(iii)	181	98.91%	1.2	2	0.81	0.60	0.2698	183
Q4a	177	96.72%	0.5	1	0.5	0.50	0.0711	183
Q4b	182	99.45%	1.2	4	0.95	0.30	0.3431	183
Q4c	180	98.36%	1.2	3	0.8	0.40	0.3902	183
Q4d	178	97.27%	0.6	2	0.64	0.30	0.2211	183

Recommendations and guidance for the teaching of future candidates

Not all candidates were familiar with the precise meanings of the command terms. Like in Paper 1, some candidates applied the context provided in the stem to the all the questions rather than seeing them as being pertinent only to the initial questions

Candidates would benefit from more practice answering databased or case study questions.