

Natural Sciences Tripos

Part IB HPS, 2011-12

Senior Examiner's Report

1. Summary

This year the Examiners had a week in which to produce the final Markbook. Scripts were marked in a timely fashion, in large part owing to the dedication of the Examiners, of whom there were 6. Each Examiner marked $\frac{2}{3}$ of the total number of candidates' scripts for an individual Paper; as a result, each Examiner marked $\frac{1}{3}$ of the scripts 'against' one Examiner and $\frac{1}{3}$ 'against' the other. It was agreed that any smaller number of Examiners would make the task much more taxing, probably inducing errors due to fatigue and the required rapidity of producing marks.

Difficulties encountered by the Examination Board (on Bank Holiday Monday morning) entailed that examinations due to start at 9 a.m. did not start till past 9.30 a.m. As a result, students due to start examinations that afternoon at 1.30 p.m. were required to start at 2.00 p.m. in Arts Room C. Amongst those taking the examinations at this time were three candidates for NST Part IB HPS Paper 1. The arrangements for this extraordinary examination were entirely adequate and the students were not visibly disadvantaged; the Senior Examiner was able to attend. It must, nonetheless, have been a trying and nerve-racking experience for them; the Examiners agreed to notify the Examination Board that such disruption of the schedule should be avoided at all costs.

In addition, as usual, there were a number of candidates taking the examinations in College or elsewhere. The arrangements for delivery of these scripts were satisfactory, although the Senior Examiner was placed in a position of not knowing quite why scripts were missing for an extended period of time. One script did not arrive till well after 2 days following an examination. Given the few days the Examiners had to complete their task, these disruptions were rather disconcerting.

2. Candidates and Classes

72 candidates were entered for the examination. 2 candidates withdrew before the examinations began. The Examiners for Paper 2 (Philosophy of Science) received a script by a candidate not listed on any prior list of candidates; this turned out to be written by an MIT candidate who was submitted late for the examination. 1 candidate from MIT who took both HPS Papers is included in the figures below. Not included in the figures in the table below are 2 candidates who took NST Part II Physical Sciences (one II.i; one III) and 2 candidates from MIT who took only one HPS Paper; the withdrawn candidates are not included in the table below (but are included in the above total of 72 (73) candidates who were put forward by their Colleges to the University for the examination).

| [Class] | 2012 | 2011 | 2010 | 2009 | 2008 | 2007 | 2006 | 2005 |
|----------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| 1 (70-100) | 15 21% | 1 1% | 9 13% | 15 18% | 7 12% | 16 27% | 13 19% | 13 13% |
| 2i (60-69) | 27 39% | 48 61% | 34 48% | 37 45% | 27 46% | 22 37% | 29 42% | 46 47% |
| 2ii (50-59) | 21 30% | 29 37% | 24 34% | 26 32% | 25 42% | 22 37% | 27 39% | 35 35% |
| 3 (40-49) | 6 9% | 1 1% | 4 6% | 3 4% | 0 0% | 0 0% | 0 0% | 4 4% |
| Fail (0-39) | 0 0% | 0 0% | 0 0% | 1 1% | 0 0% | 0 0% | 0 0% | 1 1% |
| Total | 69 | 79 | 71 | 81 | 59 | 60 | 69 | 99 |

Marks for each Paper are out of 50; the sum of each candidate's mark for the two Papers is therefore out of 100. Classes are not awarded by IB HPS Examiners but the agreed marks fall into the following classes according to the NST classing criteria, shown here alongside previous years.

The NST Examiners require that 60% of candidates receive a mark of 60.0 or above, to one decimal place, with a deviation < 2 scripts. This requirement was met.

One candidate for Paper 1 History of Science answered only three questions; the coversheet also indicated only three questions as having been answered, thus eliminating to a high degree of probability the possibility of the loss in transit of a script. The Examiners decided they had no option but to mark the three questions in the normal fashion and give a mark on the basis of those three- questions.

3. General Performance of Candidates

Six candidates scored above 75 for the total of both Papers: these were outstanding performances. Six candidates also scored less than 50.

Detailed comments by the Examiners on the two Papers and on the answers to each of the questions are included below.

4. General Remarks

The Examiners noted that the Teaching Officers in the Department would be considering reforms of the NST IB HPS syllabus and teaching in the course of the next two years.



Prof. John Forrester, Senior Examiner

3rd October 2012

Detailed Comments on Candidates' Performance

Paper 1. History of Science.

General Remarks

The Examiners noted that some candidates enthusiastically deployed 'feet of clay' arguments in order to (purportedly) undercut the validity of science; while such arguments may have a corrective value, they often became in themselves barriers to historical understanding and judgement.

Question-specific comments

Section A

The Section A questions were regarded by the examiners as satisfactory inasmuch as they both covered a broad chronological period.

1. How has the identity of the scientific practitioner changed since 1500?

Not all candidates used this question as an opportunity to discuss the professionalisation of science. Some answers suggested confusion over dates and periods, e.g. Bacon's dates relative to the founding of the Royal Society. Some stronger candidates understood 'identity' to cover 'image' as well as 'occupation' or 'social position', and the examiners agreed that this could be an interesting line to take. Weaker answers assumed a simple relationship between science and technology, or between natural philosophy and artisanal practice; others confused 'identity' with 'occupation', for instance by describing specific tasks undertaken by scientists. Only a few candidates considered 'gender' or 'race' as categories in relation to scientific identity. The material used often overlapped with that deployed in answers to Q4, Q8 and Q11. Gratifyingly few candidates became overly entangled with the problem of the anachronism of the term 'scientific practitioner' across the long time-span of the question.

2. Are wars and political revolutions good for science?

A few candidates confused the question of the influence of 'political revolutions' with Kuhn's thesis concerning scientific revolutions. Only one answer – a very fine answer – resolutely refused the invitation to generalise about 'all wars' and 'all political revolutions', showing in their essay why the question presupposed implausible historical generalizations or laws. The overwhelming majority of candidates focused on the French Revolution, and assumed it was the only political revolution of relevance to the question. Some candidates were too quick to assume 'good for science' had an ethical meaning. Conceptual and technological developments were not always distinguished. Another fine answer observed that wars and political revolutions could function in the same way. Weaker answers employed standard examples also used in Q9 and Q11 and were marked down for this.

Section B

3. How did early modern anatomists and natural philosophers challenge Galenic views of bodies and diseases?

A considerable number of candidates overlooked the word 'How' in the question, providing a potted history of Renaissance anatomy and/or the discovery of the

circulation of the blood. Students did not always distinguish between challenges to Galen and challenges to Vesalius's medieval predecessors ('Galenic' could cover both), and several were confused over the identity of the four humours. The examiners agreed that some discussion of Paracelsus was important for answering this question well. The best answers could cover a range of topics from Mondino to Descartes. Some good answers also distinguished between form and function, discussing both anatomy and physiology.

4. 'From the closed world to the infinite universe': is this a good description of the changes in European cosmology between 1500 and 1800?

Unfortunately no candidate identified the source of the quote in Koyre's *From the Closed World to the Infinite Universe*. Although the question specified the period '1500-1800', very few candidates used examples later than Newton. The word 'cosmology' was sometimes ignored, with answers ranging over natural history and the New World as well as the heavens. Nearly all answers gave little sense of the meaning of 'infinity' in the question; no student observed that infinity might be a metaphysical category or introduce the mathematical conception of the infinite or indefinitely large, the indefinitely small or the infinitesimal calculus. No candidates discussed the Transit of Venus Expedition and Cook as part of the expansion of the cosmos (the distance of the sun from the earth). One candidate did mention the Transit of Venus, but only to illustrate the large-scale character of the cosmological projects engaged in from 1500 to 1800.

5. Isaac Newton's 'miraculous year' at Woolsthorpe occurred in the same decade as the foundation of the Royal Society. Which was more important for science?

This question was generally not answered well, with students struggling to differentiate individual from institutional contributions. Very few candidates were clear on what Newton actually achieved during his *annus mirabilis* (with several choosing to focus on the later *Principia*), and no student questioned whether Newton had in fact achieved what he later claimed for this period. Some stronger answers noted the role of institutions in testing and propagating individual findings.

6. Was there a chemical revolution in the eighteenth century?

Several candidates did not give any account of why phlogiston did not succeed as a theory, simply assuming that it was simply a weaker theory than Lavoisier's. No student mentioned 'elements' in the Lavoisierian rather than the Aristotelian sense, although a few mentioned Lavoisier's innovations in chemical nomenclature. Better answers discussed technology and mining. Some good answers used the question as an opportunity to discuss the historiography of scientific revolutions (for instance, by asking whether a century-long development could be classed as 'revolutionary'). As so often, weaker answers were very quick to set up straw men.

7. What led Charles Darwin to develop a theory of evolution?

Answers were generally satisfactory, although a large number used broadly similar material. The examiners felt that some discussion of Malthus was essential to a good answer. Stronger answers tied statements to evidence (e.g. when did Darwin read Malthus; evidence from Darwin's notebooks) rather than simply listing likely influences.

Weaker answers produced potted biographies of Darwin or discussed aspects of his work irrelevant to the question in hand (e.g. reactions to his theory). Several good answers considered whether Wallace was subjected to the same or similar influences.

8. How did scientific research emerge as a central activity of the modern university?

Answers tended to focus on Germany and France or on Cambridge (rather than all three or more), and to focus on the nineteenth century rather than more recent developments. There were some rather weak attempts to describe mediaeval universities.

9. 'The key feature of modern medicine is that its diseases are defined in laboratories.' Use examples from the eighteenth, nineteenth and twentieth centuries to assess this statement.

This question was generally not well answered. Very few candidates were sure which examples to take from the eighteenth century. Few answers really got to grips with the rationale for selecting 'key' features of modern medicine, although several suggested alternative contenders (e.g. pharmaceutical trials). The chronological scope of this question was very ambitious and therefore more akin to a Section A question.

10. Is it fair to suggest that the greatest legacy of the eugenics movement is The Pill?

Many candidates displayed confusion about definitions of 'eugenics.' No answer referred to Mendel, although Galton was mentioned in a few scripts. Most answers recognised that the relationship between eugenics and the Pill was not straightforward, although not all mentioned feminism.

11. Was the project to build an atomic bomb typical of the sciences in the twentieth century?

Candidates readily homed in on issues of funding, organisation and collaboration. Favoured comparators for the Manhattan Project were oceanography/continental drift and the discovery of DNA. Some of the strongest answers were those which considered the Bomb in relation to other examples of wartime science. Some weaker answers merely gave a history of the Bomb, before concluding that its development either was or was not typical of twentieth-century science (in some cases, twentieth-century was construed to mean 'up to the present day').

12. Discuss the respective roles of evidence and philosophical presuppositions in initiating major transformations in twentieth science, using as your principal example EITHER the debates about the theory of relativity OR the debates about continental drift.

There were relatively few answers to this question, suggesting that students recognised its difficulty. The continental drift option was more popular than relativity; a considerable number of answers involved the trotting out of prepared material.

Unfortunately exact numbers of answers to each question were not retained. As in previous years, the question on Darwin was the most frequently answered. The Examiners did note that there was an unusually gratifying spread of answers to all questions.

Paper 2 Philosophy of Science

General Remarks

As usual, the overall impression of this paper was that the candidates did a very good job at getting familiar with a new and 'different' discipline, requiring skills most of them have not cultivated since their GCSEs. The top c.20% of the candidates showed an appreciation of subtle aspects of the philosophy of science and a capacity to connect them both to the history of science paper and to their own experience as science trainees.

As in previous years there was a pronounced tendency for candidates to focus on the same handful of questions/issues: in particular, induction and the Popper/Lakatos/Kuhn debates. Furthermore, too many answers to these questions were essentially interchangeable reproductions of the lecture notes - this meant additionally that, rather than arguing for a particular viewpoint, too many candidates tended to rehash the usual reasons for and against before sitting on the fence.

In fact, a number of candidates seemed to have difficulties in producing actual arguments. An argument is not just a listing of all the pertinent considerations and then a summary — rather it is a unified structure where every component works as an explicit justification (or an objection to) the main claim which is the thesis. Thus an argument is stronger to the extent that it considers objections to itself and answers them. For example, when discussing the raven paradox one can't just claim that an observation of a white raven does confirm the law, but then go ahead and discuss all the responses to this claim without answering these responses. A summary is not an argument. Some general training on what is an argument and how to write an essay is needed at the Departmental level, probably in a general revision session.

A non-negligible number of scripts were marred by basic errors: for example, confusing conditionals and their inverse, or identifying abductive reasoning as reasoning which 'abducts' theories from the work of other authors.

There seemed to be an unusually high number of very uneven scripts (with marks on individual essays stretching 58-72).

Several candidates failed to finish. All other things being equal, it is preferable to have, say, two answers ranked at 65, rather than one massively long one at 73 and a single page that barely scrapes a 50.

Question-specific comments

SECTION A

Answers to Question 1 on the demarcation criterion were not really general — too many candidates went through exactly the same moves, and in the same order. Question 2 elicited more general answers, but here candidates often failed to use the relevant syllabus material to answer the question.

1. If scientists sometimes ignore inconvenient observations, how is science different from pseudo-science?

In answering Q1 many candidates raised the problem of induction as a key reason not to believe scientists' claims. Also, the problem of induction was often characterised very naively (in both Qs1 and 3). The 'problem of induction' is not that we cannot predict the future, but rather that we cannot justify relying on induction, or describe what we do when we produce correct inductive inferences.

2. Why should we believe scientists' claims?

SECTION B

3. Did Popper solve the problem of induction?
4. Is incommensurability compatible with scientific progress?

Most answers were somewhat routine, showing failure to appreciate the ways in which incommensurability may be thought to undermine scientific progress — and possible responses to this.

5. Do physicists and astronomers have good reasons to believe that the unobservable entities postulated in their theories are real?

There were good/very good answers on unobservables, and to Q6 pessimistic meta-induction and no-miracle argument. But candidates often claimed that constructive empiricism is a position that allows us to be confident in the theoretical claims of our most successful theories. It doesn't.

6. If most theories have been shown to be false, do we have any reason to have confidence in our theories?
7. Are explanations in chemistry incompatible with physics?
8. Understanding social action requires interpretation. Does this fact make the social sciences fundamentally different from the natural sciences?

Many candidates did not explore this question but rather went on to talk about laws in the social sciences, which is a different issue. There is no need to churn out the entire content of the four philosophy of social science lectures to answer this question. Candidates should be advised to concentrate on interpretation when the question asks for that. Working through an example of how interpretation enters into social and natural sciences would have been sufficient.

9. Is Darwin's case for evolution inductive, deductive, abductive or something else?
10. Does the observation of a white shoe confirm the hypothesis that all ravens are black?

Generally somewhat routine answers to this very popular question.

11. Is it wrong to fund research into racial IQ differences?

Although students like ethics questions (i.e. Q 11 and 12), they are often unable to construct an argument on it. They talk about their 'personal feelings' and 'what most people would believe', instead of giving genuine reasons to prefer one ethical claim over another. It is not an argument to say that informed consent is necessary except when it

isn't, because that's how the candidate feels. Candidates should explore what principle explains the exceptions to the informed consent rule. Is it the greater good consideration? Are there conflicts between principles scientists are committed to? Is that inevitable? On question 11 very few candidates brought up Kitcher's idea of a well-ordered science, which would be very pertinent.

12. Is informed consent of subjects necessary for medical research to be ethical?

The following numbers show the most and the least popular questions:

Q1: 33; Q2: 25; Q3: 36; Q4: 17; Q5: 21; Q6: 18; Q7: 4; Q8: 6; Q9: 12; Q10: 24; Q11: 9; Q12: 13