21ST CENTURY SCIENCE

Paper 0608/03

Paper 3 (Core Written)

General comments

There were very few scripts submitted in this examination, and those were from only two Centres. This report is based, therefore, on a very small sample, which is possibly unrepresentative of all the Centres taking this course. However, there are some general points revealed by these papers which will be of use to teachers, as well as some general points on the actual questions.

All candidates attempted all parts of the paper, and in each case a significant effort had been made in all parts, with no indication of candidates being short of time. The three questions on biological units (1 – 3) proved more accessible than those on chemistry (4 – 6) or physics (7 – 9), which were similar in difficulty. Free response questions, as might be expected, were found more difficult than those where candidates chose from a range of responses.

Comments on the questions

Question 1 (genetics) was done well, with most candidates well able to complete a Punnett square genetic diagram and to identify different ethical standpoints.

Question 2 (heart disease) was also well done. Most candidates were able to complete and read off from a best-fit line graph, and knew the factors reducing the risk of heart disease.

Question 3 (Iberian lynx) showed that candidates could identify factors due to habitat change which would affect the lynx population, but found it harder to explain fully, in free text, the effect on the lynx population of the myxomatosis virus, which kills rabbits.

Question 4 (air pollution) was successfully tackled by most candidates, who knew the term ‘outlier’, were able to calculate means and correctly identify a correlation. Explanations in free text were again more demanding, with few candidates giving a complete justification for repeated measurements giving a better estimate, and no-one in this small sample realising that solid particulates do not remain in the air because they precipitate out, depositing on surfaces.

Question 5 (hydrocarbons in crude oil). Only the better candidates were able to identify the oxygen molecule in the diagram of the combustion reaction, although most recognised the water molecule in the table following. Most recognised the term ‘polymerisation’, but no-one in the small cohort could explain it at all.

Question 6 (food additives) was not well done by many candidates. Most candidates could identify some, if not all, of the reasons for different additives being used, but not one response showed that scientific advisory committees need to perform risk assessments on food additives, and that these would allow them to determine the safe levels of additives in food.

Question 7 (galaxies) was the least well done question in the paper. Most, but not all, knew that galaxies were collections of very great numbers of stars, few seemed aware that Hubble had observed that they were all moving away from use, and no-one was able to suggest a sound reason why contemporary scientists did not accept Hubble’s explanations; many thought it might be due to religious reasons, which was not appropriate here.

Question 8 (global warming) was well done by most. The temperature rise graph was usually well interpreted, and the opinions of the three scientists with regard to causes of global warming were usually correctly identified.

Question 9 (generating electricity). Disappointingly, no-one was able to label the three parts [illegible] station, using the names given in the stylised block diagram provided, although the Sankey [illegible] diagram was correctly done by all. Most candidates were able to state what ionising radiation did [illegible] and to suggest how nuclear power station managers could reduce the risk to their workers, but only better candidates could perform the risk/benefit analysis to explain why people are prepared to work nuclear power stations.

21ST CENTURY SCIENCE

Paper 0608/04

Paper 4 (Extended Written)

General comments

All candidates attempted all questions on the paper and made a good attempt at each question. There was no indication that candidates were short of time. **Questions 1-3** proved to be more accessible to candidates than **Questions 4-9** although the most able were equally prepared for all questions. In general, those questions requiring recall of scientific facts were better answered than those requiring use of the information given. It was also the case that questions relying on knowledge of the Ideas about Science were least well answered. The standard of written English was very good. However, some careless errors arose from misreading question instructions.

Comments on specific questions

Question 1

This question was generally well answered by all candidates.

(a) (i) Most candidates were able to complete the Punnett square correctly to work out the outcome of the cross.

(ii) Equally most candidates were able to recognise the correct combination of alleles as 'ff'.

(iii) Many candidates had a clear understanding that carriers do not actually suffer from the disease. Fewer candidates were able to describe the fact that a carrier has the ability to pass the recessive allele onto their offspring.

(iv) This was the weakest part of the question. Many candidates were able to identify an advantage of testing the foetus, with the most common answer being so that decisions can be made about keeping or terminating the foetus. Fewer candidates were able to identify a clear disadvantage of testing although some described the potential risk to the mother of miscarriage. No candidates identified the fact that the test could have given false results or that having the test could be stressful for the parents. There were some vague ethical statements about the rights of the foetus as a human being, but this was not clearly linked to the question.

Question 2

This question was also well answered by all candidates.

(a) Most candidates drew a clear straight line of best fit as asked.

(b) Many candidates were able to identify that factors other than the amount of animal fat eaten would influence the chance of getting heart disease and good specific examples were given. Only the most able candidates were clearly able to state that a correlation does not necessarily indicate the cause.

(c) (i) Most candidates had learnt what peer review was and could recall it.

(ii) Far fewer candidates were able to explain why peer review was important with vague statements about how it makes the findings 'better'. Few candidates were able to use the terms 'reliable' and 'valid' correctly or indeed describe these ideas.

Question 3

This question was one of the best answered on the paper.

(a) Most candidates correctly showed the decrease as 92%.

1380/1500 x 100 = 92% (with 1380 being the difference between 1500 (population in 1978) and 120 (population in 2006)).

(b) Equally most candidates gained two marks here, successfully identifying that the rabbits are the main food of the lynx and that, since their numbers had dropped due to the virus, the lynx population would also drop.

(c) This was less well answered with most candidates able to give a valid reason why the population would decrease, but fewer using the terms 'endangered' or 'extinct'.

Question 4

This question was well answered by the strongest candidates but caused some difficulty for the less able.

(a) Most candidates understood that repeating measurements improves reliability of the data and it was common to see the term 'reliable' used correctly here. However, fewer could then develop their answer to gain the second mark. Weaker candidates made vague references to how it would mean there would be more results to compare.

(b) Most candidates correctly calculated the mean.

48/4 = 12

A small number of candidates did not remove the outlier (27) from their calculation (hence calculating the mean as 75/5 = 15) and could not be awarded two marks. Some of these candidates did not show their working which meant that, in some cases, no marks were awarded and yet the correct working would have gained one mark. Candidates need to show all working for calculations to gain full credit for their answers.

(c) (i) This question was poorly answered even by the most able candidates. When describing a correlation, candidates need to explicitly link the two variables they are given. In this case, the solid particulates in the air and the number of patients per day. Answers such as 'the more solid particulates in the air, the higher the rate of asthma attacks' could not be credited. It is likely the candidate had the correct understanding of the question but the rate of asthma attacks is not the same as the number of people having asthma attacks.

(ii) Very few candidates were able to suggest that a mechanism (a causal link) would need to be found as further evidence. Equally no candidates suggested looking at similar results from elsewhere as a comparison.

(iii) Very few candidates knew that solid particulates are deposited on surfaces and buildings.

Question 5

This question was well answered in some parts and poorly in others.

(a) (i) Few candidates answered this correctly and being unable to recognise that a mixture can be separated into its constituent components. Most just repeated the question, i.e. crude oil is a mixture of hydrocarbons.

(ii) Very few correctly identified a hydrocarbon as a compound, although most candidates understood the idea that it was composed of carbon and hydrogen only.

(b) This was generally well done by most candidates and clearly the best answered [illegible] question. Most candidates were able to correctly draw two water molecules and [illegible] dioxide molecule. A small number of candidates drew the correct molecules but label[illegible] incorrectly and lost a mark (candidates were not asked to label them as the different co[illegible] circles indicate the elements present). A number of candidates only drew one water molecule [illegible] the resulting equation was unbalanced.

(c) A surprisingly large number of candidates seemed to have a poor understanding of the formation of polymers. Whilst some identified polymers as long chain molecules, very few were able to describe that they are smaller molecules joined together.

Question 6

This was probably the weakest question on the whole paper.

(a) Some candidates could identify why emulsifiers are added to food, but it was rare to award two marks here. Weaker candidates made general references about 'stopping the food going bad'.

(b) (i) Few candidates understood the need for safety tests and, those that did, were then unable to link this to the process of setting safe standards in food.

(ii) Very few candidates were able to apply the precautionary principle in this context and it was not clear whether candidates even knew what the precautionary principle is. A few of the most able candidates recognised that everything carries a degree of risk for one mark.

Question 7

This was also generally a poorly answered question.

(a) Most candidates identified that galaxies are made up of stars but fewer made reference to the large number of stars.

(b) (i) Only very few candidates could correctly state that the galaxies further away are moving faster.

(ii) Equally only very few candidates seemed to have any knowledge of Hubble and his observations. Few scored any marks on this part question.

(c) Many candidates were able to make a comment about the fact that previous theories had worked well for a long time, but few candidates scored two marks here.

Question 8

This question was generally well answered.

(a) (i) Many candidates made reference to the large fluctuations on the graph and the fact that the recent rise could just be another fluctuation. Fewer were able to recognise that the data given was only from a very short time period (150 years).

(ii) Most candidates stated that, just because there is a correlation, this does not mean it is the cause, but far fewer candidates could then develop their answer to gain two marks. Few stated the need to identify a mechanism (causal link).

(b) Almost all candidates could state a consequence of global warming, but very few could explain it. The question asks candidates to state and explain for two marks.

Question 9

This question was well answered by the strongest candidates, but caused some difficulty for the less able.

(a) Very few candidates could label the generator, reactor and turbine correctly on the diagram.

(b) Many candidates calculated the energy efficiency correctly.

20/50 x 100 = 40% (with 20 being the electrical energy output)

As with question 4(b), some candidates did not show their working and so could have lost a m had their answer been incorrect but their working correct.

(c) (i) Very few candidates got this correct as most just repeated the question referring to the fact the cells become cancerous.

(ii) Some candidates were correctly able to identify reasons why a worker may accept the risks of working in a nuclear power station, with the most common answer being the good pay. A few of the weaker candidates misread the question and instead listed the risks of working in a nuclear power station.

(d) Very few candidates gained the mark for identifying the ALARA principle as 'As Low As Reasonable Achievable'. However, most candidates were able to identify a way in which the workers would be protected.

21ST CENTURY SCIENCE

Paper 0608/05

Paper 5 (Comprehension, Practical Procedures, Data Handling and Analysis)

General comments

Question 1, based on the article, required candidates to understand and interpret what they had read. Whilst some of the more able candidates made good attempts at this, many candidates simply copied parts of the article as their answers. In **Questions 2**, **3** and **4**, some candidates showed good knowledge and understanding of parts of the syllabus, but few showed a good overall grasp of the concepts involved. In particular, much of the Ideas about Science areas of the syllabus were poorly understood. The quality of written English from most candidates was very good, though instructions given in the questions were not always followed.

Comments on specific questions

Section A

Question 1

Whilst more able candidates made good attempts to put together a sensible answer to most of the questions, less able candidates often just copied irrelevant parts from the article.

(a) Most candidates realised that biodegradable refers to breakdown by bacteria to gain this mark.

(b) (i) More able candidates wrote of ethene being made from crude oil or that crude oil is not renewable to gain one mark. Fewer gave both ideas for both marks. Less able candidates copied irrelevant sections from the article.

(ii) Many candidates realised that poly(hydroxybutyrate) is made entirely from plant material, but few went on to explain that more plant material can be grown. Very few candidates made a comparison with poly(propene) being made from raw materials obtained from non-renewable crude oil.

(iii) Most of the more able candidates gained two or three marks from this question. The most common advantage was the ability to be broken down. Good answers generally gave two disadvantages such as slow breakdown in landfill and inability to be recycled. Less able candidates generally gave one creditworthy answer only.

(c) Many of the more able candidates gave a sensible reason such as use of the same data in different ways or reluctance to change ideas. Most of the less able candidates quoted irrelevant material from the article.

(d) (i) Most of the more able candidates made an attempt at writing this equation but gained no marks. Many of the less able candidates made no attempt.

(ii) Again only the more able generally made an attempt, with some gaining a mark. Few candidates successfully interpreted the diagram of poly(hydroxybutane) to give a good attempt at the structure of the monomer.

(iii) Candidates showed little understanding of the parts of a Life Cycle Assessment, with most scoring no marks. Many answers were simply quotes of irrelevant material from the article.

(e) (i) Few candidates followed the instructions to include ideas about forces and energy in [illegible]. Many quoted irrelevant material from the article.

(ii) Very few candidates knew any of the methods by which the properties of a polymer m[illegible] changed.

(f) (i) Even the more able candidates could not frame an answer based on ideas about variables and their control. Fair testing was a common answer that was given no credit.

(ii) All but the weakest candidates gave the correct range to gain this mark.

(iii) The majority of candidates realised that sample 5 is the outlier to gain this mark.

(iv) The majority of candidates correctly performed this calculation to gain both marks.

(87+92+89+91+91)/5 = 90 kN

A few candidates included the outlier and so gained only one mark. Less able candidates made errors in the calculation or did not attempt the question.

(v) Candidates had no idea of the significance of the term 'real difference' as it relates to the presence or absence of the mean of one set of measurements in the range of another set of measurements.

Question 2

More able candidates gained marks from interpretation and manipulation of data. Less able candidates showed little knowledge of understanding of the topic.

(a) (i) Most candidates suggested the use of tongs to gain one mark. Few made any other suggestion.

(b) Candidates did not appreciate the need to initially perform this experiment with no absorbers in position, or the importance of taking measurements over a measured time interval. Ideas of background radiation and of repeat measurements also were not seen.

(c) (i) Most candidates simply quoted from the results rather than giving an explanation. Only a few correctly identified the type of radiation and related its penetration to the results.

(ii) Again most candidates simply quoted from the results rather than giving an explanation. Only a few correctly identified the type of radiation and related its penetration to the results.

(d) Many of the more able candidates realised that the half life is five years. Fewer could explain why the radiation given out by the source decreased.

Question 3

Few candidates showed good knowledge and understanding of experimental methodology.

(a) Most candidates interpreted this question incorrectly and therefore did not relate the distance moved by the ruler with the reaction time.

(b) Most candidates had little idea of the variables involved or how they could be controlled.

(c) (i) Most candidates gained one mark and many gained both. A common error was taking the measurement from the top of the finger instead of the bottom as instructed.

(ii) Only the more able candidates realised that repeating and averaging measurements allows outliers to be identified and ignored and increases reliability.

(d) Only the most able could make sensible suggestions for a lack of accuracy in the experiment.

(e) (i) Very few candidates appreciated the significance of reaction time in starting and stopp

(ii) Only the most able made sensible suggestions such as use of a video.

Question 4

Most candidates performed well in the calculation and the graph plotting parts of this question.

(a) Most candidates made a sensible suggestion such as a clamp, stand or ruler.

(b) (i) Most candidates performed this calculation correctly.

(5.0+4.8+4.7+4.9+4.7+4.7)/6 = 4.8 cm

(ii) Most candidates identified the result for sample 4 as an outlier, but few could explain why this value was not used in the calculation of the average.

(c) (i) Most candidate successfully plotted all points on the grid.

(ii) Many candidates did not appreciate the meaning of the term ‘best fit line’. The lines drawn by many candidates were close to some of the plotted points but far away from others. A number of candidates did not use a ruler to draw their line.

(d) (i) Most candidates successfully read off the value from their line.

(ii) Most candidates successfully read off the value from their line.

(e) More able candidates correctly described the correlation. Many weaker candidates made no attempt at this question.

21ST CENTURY SCIENCE

Paper 0608/06
Paper 6 (Case Study)

Introduction

This was the first year of the pilot course and the number of Centres was very small. However, it was clear that some encouraging and appropriate work had been entered by candidates.

Administrative aspects

As a reminder, the following key points regarding the administration of coursework samples are described below:

- the MS1 sheet or other CIE approved method should be completed showing the total marks awarded
- candidates' work should be fastened in the left-hand corner with the appropriate CIE Candidate Record card
- details should be included of how each of the tasks used for assessment had been introduced and presented to candidates
- candidates' work in the sample should be annotated showing where and why the marks were awarded
- details of internal standardisation procedures should be described if appropriate.

Marking procedures

The award of marks is based on the professional judgement of the science teacher, working within a framework of descriptions of performance which are divided into **strands and aspects**. Each aspect of performance should be considered in turn, comparing the piece of work first against the lowest performance description, then each subsequent higher one in a **hierarchical** manner until the work no longer matches the performance description. Where performance significantly exceeds that required by one description, but does not sufficiently match the next higher one, the intermediate whole number mark should be given in Strands B and C. Thus, the level of performance in each aspect is decided. The single, overall, mark for the whole strand is determined by taking the average of the aspect marks and rounding to a whole number as shown in more detail below. If there is no evidence of achievement for an aspect, a mark of zero should be recorded and included in the calculation of the overall strand mark.

Strands A and D

There are three aspects for each of these strands. For example,

Marks for the three aspects in a strand	Formula to be applied	Mark to be awarded for the strand
(a) = 4, (b) = 4, (c) = 3	[(a)+(b)+(c)] / 3	= 3.66 round up = 4
(a) = 3, (b) = 4, (c) = 3	[(a)+(b)+(c)] / 3	= 3.33 round down = 3
(a) = 4, (b) = 3, (c) = 1	[(a)+(b)+(c)] / 3	= 2.66 round up = 3
(a) = 3, (b) = 3, (c) = 0	[(a)+(b)+(c)] / 3	= 3.0 = 3
(a) = 2, (b) = 3, (c) = 0	[(a)+(b)+(c)] / 3	=1.66 round up = 2

Strands B and C

There are only two aspects for each of these strands.

The average of the aspect marks may come to a whole number (N) or to N + ½.

If the average aspect marks of **either B or C** is a whole number and the other one is N + ½, then the ½ should be rounded up.

If the average aspect marks of **both B and C** average to N + ½, then one should be rounded up the other rounded down.

This gives a "best fit" for the achievement overall for the two strands.

For example,

Marks for the two aspects in a strand	Formula to be applied	Mark to be awarded for the strand
Strand B (a) = 6, (b) = 4 Strand C (a) = 6, (b) = 5	[(a)+(b)] / 2 = 5 [(a)+(b)] / 2 = 5.5	= 5 = 6
Strand B (a) = 7, (b) = 6 Strand C (a) = 6, (b) = 5	[(a)+(b)] / 2 = 6.5 [(a)+(b)] / 2 = 5.5	= 7 = 5

This general approach provides a balanced consideration of each aspect of performance involved in each strand and allows the marker to build up a profile of strengths and weaknesses in the work. Comparison of teacher and Moderator judgements in each aspect allows easy identification of where a Centre marks too severely, too leniently or where marking is inconsistent. This allows Moderators to make far more constructive reports back to Centres.

Case Studies

General comments

The purpose of the Case Study is to encourage candidates to use their scientific knowledge and understanding of the Ideas about Science (IaS) to make judgements when presented with controversial issues in science which have claims and opinions for both sides of the case. Where candidates use the language and concepts related to IaS, such as 'peer review', 'replication of evidence', 'correlation and cause' 'reasons why scientists disagree', 'precautionary principle', 'ALARA', 'risks and benefits', 'technical feasibility and values' it is easier to match the performance descriptions of the criteria and gain higher marks.

Case Studies are always best formulated in terms of a question to provide a focus in an area of controversy. For example, 'does air pollution cause asthma?' rather than just 'asthma'. A question will encourage candidates to look for different opinions and views, and to consider the evidence base on which they are based and the reliability of sources. The Case Study is not a report on a topic but a critical analysis of a controversial issue. Some topics are so uncontroversial that there are no valid opposing views. The key point is that the Case Study question must invite debate and discussion of both sides of the case and be firmly embedded in a scientific context so that candidates can use their scientific knowledge and understanding and their understanding of IaS to produce a balanced account.

Assessment

Strand A: Quality of selection and use of information

(a) The key aspect here is for candidates to use sources of information to provide evidence for **both sides** of their case study. If no sources are credited then a maximum of 1 mark will be allowed, unless annotation confirms that a suitable range of sources were used. Higher marks require that sources represent a variety of different views or opinions. In addition to the requirements of 3 marks candidates must assess their sources in terms of reliability in a meaningful and appropriate way.

(b) If only one or two incomplete references, e.g. website homepages, are given then 1 mark should be awarded and of course if no references are given then zero marks. For 3 marks candidates must include complete references to the exact URL address of the webpage which would allow direct access to the source of information, and when referencing books, title, author and page references would be required. Candidates awarded 4 marks included the date that the site was visited and also some information about the nature or sponsorship of the site.

(c) Candidates may copy some, if reasonably short, material from their sources. However, [illegible] that they make this completely clear with the use of quotation marks, use of a different font, highlighting etc. The better candidates included references or specific links within the text to show source of particular information or opinions. Some candidates gathered information from self-constructed questionnaires which also added to the pool of material for their Case Study, but occasionally this caused distraction from the underlying science and scientific evidence.

Strand B: quality of understanding of the Case

In simple terms this strand assesses candidates' ability to describe and explain the underlying relevant science and to recognise and evaluate the scientific evidence on which any claims are based (IaS 1, 2 and 3).

(a) Candidates often describe the relevant background science in the introduction to their case studies with the more able candidates going to a greater depth and detail. However, only the most able link their scientific knowledge and understanding to the claims and opinions that they had found from their sources. It is useful to look at the appropriate pages in the C21 textbook about Science Explanations and the Ideas about Science that are appropriate for each Case Study to give an indication as to what to expect before marking candidates' work.

For example, in the Higher Tier Science C21 Textbook

B1	You and Your Genes: 'genetic engineering' etc. Pages 34/5
C1	Air Quality: any pollution related Case Study. Pages 62 and 63
P1	The earth in the Universe: 'What killed the dinosaurs?' etc. Pages 90 and 91
B2:	Keeping Healthy: 'diets'; 'MMR' etc. Pages 118 and 119
C2	Material Choices: 'sustainability related' Pages 146 and 147
P2:	Radiation and Life: 'mobile phones'; 'sunbathing' Pages 174 and 175
B3:	Life on earth: 'evolution'; 'extinction' Pages 202 and 203
C3:	Food Matters: 'organic farming'; 'diet' Pages 230 and 231
P3:	Radioactive materials: 'radiation'; 'future energy needs' Pages 258 and 259

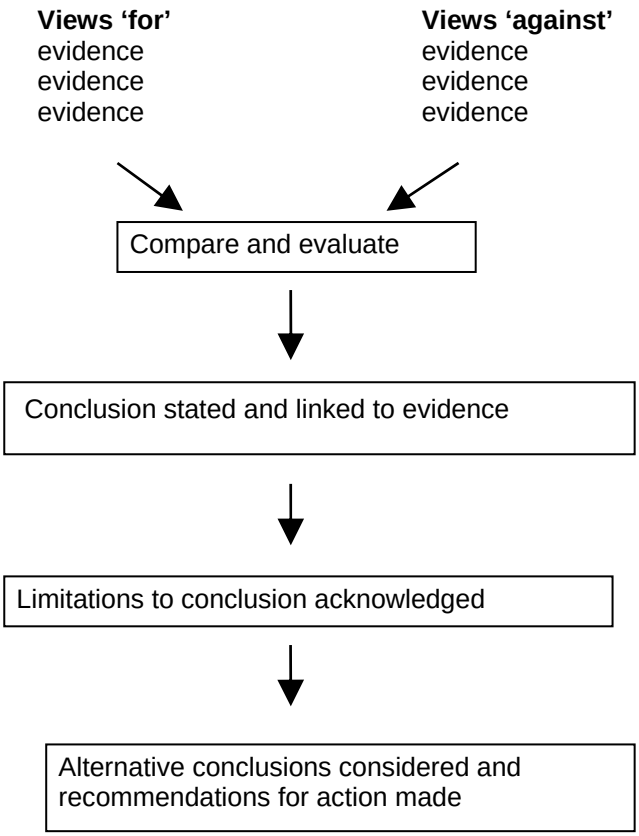
For topics which are related to course modules, it can be taken as a general guide that 6 marks requires all that is available in the candidate book. The 7th or 8th mark will come either for applying this correctly to the case, or for finding and explaining some more specialised knowledge.

(b) Candidates were awarded 4 marks if they were able to recognise and extract relevant scientific content and data in their sources. Candidates who were awarded 6 marks referred to the evidence base of the various claims and opinions e.g. an experiment, a collection and review of existing data, a computer simulation etc. Candidates obtaining 7 or 8 marks look more critically at the quality of the evidence. They used terms like 'reliability' and 'accuracy' when considering data, they looked at the design of experiments and the issue of sample size and they also compared the reliability of data between sources.

Strand C: quality of conclusions

In this strand candidates should consider aspects of IaS 5 about actual and perceived risks and the ALARA principle and in IaS 6 about how society should respond.

The aspects for Strand C can be summarised in the following simple flowchart:



Most candidates could sort the information that they had gathered into views 'for and against', sometimes in a tabular form if appropriate. Those who just listed it in this way were awarded 4 marks. Better candidates started to compare and balance arguments against one another in both their 'for and against' list and were awarded 6 marks. The best candidates began to analyse, compare and evaluate the claims and opinions, describing their own viewpoint or position in relation to the original question and justifying this by reference to the sources. Alternative conclusions should be considered where appropriate and recommendations for the future should also be included. Some candidates scored less marks than they were probably capable of because they simply chose to report information about their topic, without any real analysis of the scientific evidence it was based on.

Strand D: quality of presentation

(a) Most reports included headings and/or sub-headings to provide the necessary structure. The better candidates included a table of contents and numbered the pages in their report to help guide readers quickly to particular sections. Those reports which were presented simply as PowerPoint printouts achieved good marks in this aspect but often lacked sufficient detail for high marks in the other strands. However, those which had notes to accompany each slide were much more successful in obtaining higher marks.

(b) Suitable diagrams and graphics should be incorporated as appropriate to clarify difficult ideas and encourage effective communication but the visual impact was often variable. If there are no decorative or informative images included then zero marks is awarded. If one image is included, a decorative front cover or other low level attempt to add interest then 1 mark is appropriate. Two marks would be awarded for the inclusion of decorative images only or perhaps for the minimal use of informative images. Three marks would be given for including a variety of informative illustration e.g. charts, tables, graphs, or schematic diagrams and 4 marks if this is fully integrated into the text, referred to and used. Too often downloaded images from the Internet were not clear, too small and not referred to in the text.