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RECOGNISING ACHIEVEMENT

GCSE

Chemistry A

Twenty First Century Science Suite

General Certificate of Secondary Education **J634**

Report on the Units

June 2010

J634/R/10

Oxford Cambridge and RSA Examinations

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GCSE Twenty First Century Science - Chemistry A (J634)

REPORTS ON THE UNITS

Chief Examiner's Report

This is the first time that free response questions have been included in the June A321 and A322 examination papers. It was expected that this change would make the papers more challenging for candidates, and this assumption proved to be correct. Those candidates who had good knowledge and understanding across the six modules and a good grasp of the concepts involved performed well, but the free response questions exposed weaknesses in many candidates. Answers were often poorly expressed and some did not address the questions. Many of the less able candidates could not find direction, giving long but largely irrelevant answers. Weaker candidates also found difficulty in selecting relevant data and using it to present answers in a clear and logical manner. A significant number of candidates left some of the free response questions unanswered. There were encouraging signs, however, of some improvement from the performance on free response questions in the January 2010 series of papers.

Performance in the objective questions was similar to previous sessions. Few candidates left these questions unanswered though some failed to follow the rubric, particularly that relating to the number of ticks required. Overall these papers gave all candidates an opportunity to show their knowledge and understanding and discriminated well in both tiers and across all abilities.

In the A323 papers assessing unit 3 (Ideas in Context plus module C7), most candidates performed well on questions set from the pre-release material. However, knowledge and understanding of module C7 shown by many candidates was again far from satisfactory. A large number struggled to answer questions set on this part of the specification, with many showing very little familiarity with the concepts involved. There was little improvement in overall performance of candidates when compared with previous sessions.

All papers discriminated across the target ability ranges, affording more able candidates the opportunity to score highly whilst allowing weaker candidates to score a reasonable number of marks. It was again clear, however, that a number of candidates had been inappropriately entered for the higher tier papers.

A321/01 – Twenty First Century Science Chemistry A (C1, C2, C3) Foundation Tier

General Comments

This was the first June paper to include extended free response questions. Candidates and teachers are still learning the technique needed to answer this style of question effectively.

The area that candidates struggled with the most was the aspect of intensive and organic farming in question 6.

The identification of the range and the calculation of the best estimate were particularly well answered by most candidates. The connection of boxes and use of ticks where requested were also improved with fewer candidates drawing too many lines or ticks.

Comments on Individual Questions

Q1(a)i– Almost all candidates could identify burning fossil fuels containing sulfur as a source of acid rain.

Q1(a)ii – A large proportion of candidates failed to identify water as an essential reactant in producing acid rain.

Q1(a)iii – Some weaker candidates gained credit for either the name or formula for the gas causing acid rain, but many found it difficult to identify the correct pair of both formula and name.

Q1(b) – This was generally well answered.

Q1(c) – This was generally well answered.

Q2(a)i – Responses here were generally weak. Some candidates could identify one reason why increasing the number of measurements taken would improve the best estimate but they struggled to give two reasons. The most common error was for the candidates to talk in terms of there needing to be more results to make ‘a better average’. If only one result exists then an average or mean cannot actually be calculated. Responses were often descriptions rather than explanations of the science.

Q2(a)ii – Few candidates used the space provided to show working for the calculation of the best estimate so any minor errors in processing could not be given credit. Very few marks of 1 were awarded.

Q2(b) – The more able candidates understood the requirements of the question and could place a tick in the boxes on the left and right that represented the number of each drawing that should be added to balance the equation. However several candidates ticked too many boxes negating the marks for the correct responses.

Q3(a)i – This was well answered as most candidates could identify the best estimate from the information given.

Q3(a)ii – This was again well answered by most candidates and a significant improvement from past sessions.

Q3(a)iii – Whilst candidates could effectively identify the range, they struggled to answer questions about the range and the relationship to reliability.

Q3(a)iv – The responses here varied widely.

Q3(b)i – Some Candidates could identify the **lower** melting point as the reason for the company using polymer A, but few could explain the connection between a lower melting point enabling faster manufacturing or lower energy use for heating in the process.

Q3(b)ii – This was very well answered.

Q4(a) – This was a very open question and a very wide variety of responses were given. The number of candidates that chose not to respond to this question was high. Of those candidates that did respond the third box often had the idea of durability copied from the example given.

Q4(b) – Again a wide variety of responses were given here and the most common mark awarded was for the identification of two of the three correct boxes. Few Candidates could identify all the correct boxes.

Q4 (c) – The options given for this question are all correct statements, but only one actually answers the question. The candidates struggled to identify the best response here. This answer was quoted from the specification.

Q5(a) – Most candidates were awarded one of the two marks available here. There was not a clear pattern of errors made as every possible combination of boxes was ticked.

Q5(b)i – This was well answered. Almost all candidates scored at least 1 mark. A large proportion of candidates scored two marks.

Q5(b)ii – The quality of responses here were poor and many candidates failed to score. Responses given covered the idea of risk, lifestyle and taste or ease of preparation of food. Very few candidates scored both marks here.

Q6(a) – Candidates struggled to score here. Some candidates could identify that proteins were natural polymers but few candidates could name amino acids as the smaller molecules from which proteins are made.

Q6(b) – The responses here were disappointing. Very few candidates scored. Of those that could identify or describe a different way of adding nitrogen to the soil, even fewer could actually explain how that was done.

Q6(c)i – Candidates again appeared to struggle with this free response question as there were very few candidates who scored any of the marks available. The idea of introducing a predator was the most common correct response but few answers included ideas of how competition in weeds could be controlled.

Q6(c)ii – Few Candidates could explain why organic farming methods have a lower impact on the environment.

A321/02 – Twenty First Century Science Chemistry A (C1, C2, C3) Higher Tier

General Comments

This was the first June paper to include extended free response questions. As expected, these questions proved to be challenging to all but the most able candidates. Without the choice of statements to guide them, many candidates could not find direction and gave vague rambling answers that scored few marks. More blank answer spaces were seen on this paper than previously, largely in the free response questions.

As in previous sessions, more able candidates showed a broad knowledge and understanding of modules C1, C2 and C3. The most able could apply this knowledge and understanding successfully to the majority of questions on the paper, including the free response questions. Many weaker candidates, however, showed sound ability in some areas, but weakness in others, whilst some showed a general weakness across all three modules.

The majority of candidates followed instructions carefully. However, a number of weaker candidates ticked an incorrect number of boxes to that stated in the rubric, sometimes ticking more and at other times less than the required number.

Most candidates could interpret data well, but a surprising number did not identify and discard an outlier when calculating an average. The effects of factors on the outcome of an experiment and the need to control all but the factor under investigation were poorly understood by many. Other areas of the specification which many candidates found particularly challenging included the chemistry of pollutants from burning fuels, the nitrogen cycle and polymer modification, aspects of Life Cycle Assessments, and the significance of diet to those with diabetes.

The overall spread of questions gave all candidates of appropriate ability for this paper the opportunity to demonstrate their expertise. Most questions discriminated well, giving a good spread of marks across the ability range. It was clear, however, that a small number of candidates would have gained a more fruitful experience from sitting the Foundation tier.

Comments on Individual Questions

Q1 This was a challenging question for most candidates, but discriminated well. Many candidates had a poor appreciation of how pollutant oxide gases are formed as fuels burn.

(a) Most candidates scored at least one of the marks, and the more able scored both. ‘More cars were fitted with catalytic converters’ was a common error.

(b) Many candidates incorrectly thought that burning fuels give off sulfur that then reacts with oxygen in the air. Only the more able candidates realised that sulfur impurities in the fuel react to form sulfur dioxide as the fuel burns. Most of these went on to suggest that the sulfur dioxide reacts with water but very few included that it also reacts with oxygen.

(c) A large number of candidates incorrectly included statements B or D, or both, in their selection. Those who excluded these generally went on to give the correct combination (A)FGCE. The response FBCE was very common and gained one mark.

Q2 Most candidates performed quite well in this question, with only the very weakest gaining no marks.

(a) In (i) a large majority of candidates gained at least one mark, with the more able gaining both. The most common way of achieving a mark was to suggest that a single result could be an outlier or mistake. A second mark was often scored by adding that with more results, outliers could be identified. Fair testing was a common answer that gained no credit, and many candidates thought that by repeating the test it would become fairer. Few candidates appreciated that several results allow a mean to be calculated. Weaker candidates often gave vague answers that referred to accuracy or reliability without gaining credit.

Only the more able candidates discarded the outlier to correctly calculate the average as the best estimate as 0.168 in (ii). Many gained just one mark for an otherwise correct calculation that included the outlier.

(b) Most candidates correctly identified both reactant and product to gain both marks. Only the weakest candidates failed to score a mark. A significant number of these chose more than one reactant and/or more than one product.

Q3 This question allowed most candidates to score some marks, but discriminated well. The controlling of variables was clearly understood by only a few.

(a) Only the more able gained a mark from this question, with very few scoring two marks. Some realised that the only factor to be varied must be the one being investigated whilst others suggested that varying another factor would change the results. Rarely were both ideas expressed in the same answer. Many weaker candidates wrote vaguely about fair testing, accuracy and reliability without gaining any credit.

(b) Almost half of the candidates gained both marks in (i), whilst nearly as many gained one. Only a few of the weakest candidates failed to score. There was no obvious pattern amongst the incorrect answers.

In (ii) only the more able candidates framed answers that could gain a mark, and very few gained both. Ideas of increasing chain length, increasing crystallinity or adding/increasing cross linking were common correct answers. Many candidates missed out the idea of an increase and so lost the mark.

Q4 This proved to be a challenging question for most candidates, but discriminated well.

(a) A majority of candidates gained both marks in (i), with only a few of the weakest failing to score. There was no evident pattern to the incorrect responses.
In (ii) a very similar pattern was seen.

(b) Almost all candidates gained one or two marks, with just a few of the most able gaining all three. A significant number of weaker candidates ticked less than three boxes.

Q5 Most candidates found some marks to score in this question, though again it gave good discrimination.

(a) Most candidates gained one or both marks in (i), with a similar number for each. Many weaker candidates ticked both columns for one or more statements.
In (ii) a large majority of candidates scored both marks, with only a very small number of the weakest failing to score. ‘Only a few food items have a high sugar content’ was a common incorrect answer.

(b) Most candidates gained one mark, with very few scoring either two or none. All combinations were seen frequently amongst the answers

Q6 (a) Only a small number of the more able candidates could gain even one mark from this question. A very wide variety of incorrect responses were seen, from the more common nitrates, ammonia, glucose and starch to the unexpected polymers and plastics. A significant number of candidates made no attempt to answer the question.

(b) Most candidates gained at least one mark with the more able scoring both. From weaker candidates all of the distracters were seen many times.

(c) Only a minority of candidates gained even one mark, with just a few of the most able gaining both. Many candidates correctly suggested crop rotation or growing a named legume, but could not suggest how this would work. A significant number of candidates made no attempt to answer the question.

(d) The most common score here was two marks. Only a very small number of the most able scored three. Many candidates realised that synthetic fertilisers are too expensive and not readily available in developing countries. Few linked their use in the UK with a pressing need for higher yields or suggested that insufficient manure is available for the needs of UK farmers.

A322/01 – Twenty First Century Science Chemistry A (C4, C5, C6) Foundation Tier

General Comments
The performance of candidates was mixed.

The best candidates were able to link patterns and followed the rubric accordingly, eg question 1(cii) where good answers included actual patterns in reactivity and clearly described trends. Some candidates lost marks because they made general statements such as 'the higher the boiling point, the less reactive' rather than referring to patterns down the group as described in the question.

Most candidates were able to describe at least one way to decrease the rates of reaction (usually lower temperature) in question 6(ci) and most were able to describe at least one way to increase the amount of product formed in question 7(d).

Many candidates successfully identified one of the compounds containing the most elements in the Earth's crust (usually SiO_2), but not two.

Another question answered well was question 7(a), and here candidates were able to describe what they would see when magnesium and sulfuric acid reacted together.

Candidates struggled to identify the pH of pure water and also the pH of a strong acid in question 6(a).

Many candidates found it difficult to show the correct direction of the movement of aluminium ions in question 3(b) and clearly did not understand the concept of opposite charges attracting each other.

In addition, very few candidates were able to correctly identify the type of bonding holding aluminium atoms together.

Marks were lost unnecessarily because candidates had ticked only one box where two boxes were required. However, few candidates ticked more than the required number of boxes.

Comments on Individual Questions

Qu 1) Many candidates correctly identified the correct change of colour when iodine is heated. Many also correctly completed the symbol equation, although some were confused and wrote 'I' instead of I_2.

Common errors in part ci) usually included candidates writing KFl instead of KF.

(cii) This caused some problems for many candidates. They failed to describe the trends going down the group and linked boiling point with melting point (often incorrectly), eg 'the higher the melting point, the lower the boiling point'.

Qu 2) Many candidates had clearly remembered the reactions of lithium, and were also able to state the correct neutron number. Some merely added up the numbers for atomic number and mass, whilst others confused protons and neutrons, stating 3 instead of 4. Part (c) was answered correctly by many candidates who had correctly recalled the loss of electrons in

reactions. In part d) many candidates appreciated the difference in spectra but instead of identifying the different position of lines for different elements, described ‘different boxes’ or ‘bigger spaces’ and so lost marks.

Qu 3) In this question, candidates were able to recall the properties of aluminium for specific uses (part c), and were able to select ‘the ions become more free’ as a correct response to aluminium oxide melting, but were unable to select the arrangement of ions as becoming more random, frequently selecting ‘new bonds form’ and very few knew that metallic bonding holds the atoms together in aluminium.

Qu 4 (b) This caused some problems and few candidates received two marks; failing to select ‘sodium occurs in other compounds, not only sodium chloride’ as the reason for chlorine not appearing in the pie chart.

Qu 5 (a) Candidates were unable to relate the changes in levels of carbon dioxide and oxygen gas in a pond due to fish. Many understood the idea of elements as opposed to compounds but then used vague descriptions for responses which were not quite worthy of credit, eg ‘oxygen just has one thing and carbon dioxide does not’.

Qu 6 (a) Knowledge of the pH of strong acids and pure water was poor, and few correct responses were selected.

(b) Many candidates achieved at least one mark (usually fro H_2O and water), but marks were lost due to some confusion about how to fill in the boxes; answers here often included calcium / nitric / carbonate in successive boxes.

(c) Candidates were able to suggest one correct change to decrease rate, but common misconceptions included adding less acid, less powder, or, in some cases, less gas.

(d) Candidates confused change of state for reaction and lost marks because they described the acid changing into a gas rather than producing a gas.

7(a) Many good answers were offered here and most received at least one mark. Marks were sometimes lost because candidates just stated ‘I would see gas’ instead of ‘bubbling’ or ‘fizzing’.

(b) Few candidates correctly identified the sequence of method for producing salt crystals.

(c) Few candidates were able to correctly calculate yield.

(d) This was answered well by many candidates, although weaker candidates confused rate with more product.

A322/02 – Twenty First Century Science Chemistry A (C4, C5, C6) Higher Tier

General Comments

The paper was generally well attempted. Few gaps or unattempted questions were seen in the objective style parts of the paper. Some candidates did not answer some or all of the extended writing questions. Candidates were better prepared for the longer answers than in January and wrote their answers with more thought and structure. Where three marks were available, some candidates did not write enough points to access all the marks. Candidates should be advised that they should use the question mark allocation to help them to structure their answers.
Some candidates did not score highly on the paper. It should be noted that the higher tier paper is designed to differentiate between candidates at the higher grades. Candidates who aim at a C or D should be entered for the foundation tier paper, where they will have access to more of the questions.

Comments on Individual Questions

Question 1

1 **a** The colour changes for iodine changing state were not well known. 'Brown' as the colour of iodine vapour was a common incorrect answer.

b Not many candidates realised that the formula of iodine when dissolved in water is still 'I_2'. Many attempted to write a formula that included water, for example I_2H_2O.

c Many candidates gave the correct formula for potassium fluoride, but KF*l* was a common incorrect response. In describing the trends in the table, there was some confusion about the direction of the changes. 'Melting and boiling points decrease' and 'reactivity increases' were surprisingly common answers. Some candidates did not give three trends for three marks, implying that they did not use the mark allocation for the question to help them to structure their response.

d Most candidates scored a single mark, few gained all three. A common error was to say that astatine is a gas.

Question 2

2 **a** Candidates found it difficult to work out which structures were neutrons and which were protons in the diagram. 'Negative' was a common incorrect answer for the charge on a neutron, and electrons were sometimes seen given as nuclear particles. In (ii) many candidates drew 7 electrons around the atom, but the arrangement of a maximum of two electrons in the first shell seemed to be well known.

b Candidates needed to get four of the five rows correct to gain one of the two available marks. Commonly, candidates were wrong in two or more rows leading to no marks.

Question 3

3 (a) Most realised that oxide ions would move to the positive electrode, but few used the term 'electrode'. 'Rod' or 'side' were common terms used. Some described the movement of both ions, aluminium and oxide. This was not incorrect, but shows poor technique. There was some confusion over what happens to the oxide ions at the electrode. Many suggested that they gain electrons.

(b)(i) Only about a third of candidates managed to work out the mass of aluminium. 54 tonnes was a common incorrect answer, showing that the candidate had not doubled the aluminium mass due to the two atoms in the formula.

(ii) Again, only about one third of candidates managed to get this right. Many candidates were confused about what happens to aluminium ions during electrolysis.

Question 4

(a) Most candidates worked out the formula of the two compounds from the information. This was well answered.

(b) Most candidates gained at least one mark here, showing that they were skilled at processing the information about the abundances of the elements.

Question 5

(a) Candidates found translating information from a paragraph into a flow chart difficult. It was common for candidates to mis-copy formulae, losing 'easy' marks. Some confused the order of the ions in the boxes, and some did not give the names and the formulae, despite the instruction to do so appearing in bold in the question.

(b) (i) This was another question where the candidates had to discuss information given in a table form and use it to answer a longer question. Poor or vague wording caused most marks to be lost here. This question had a series of bullet points to help candidates to structure their answers. It was common that the candidates did not address all three bullet points, suggesting that they had not taken enough time to read the question fully before starting to write. Vague answers such as 'carbon has a higher mass' were not credited because it was difficult to tell if the candidates were talking about percentage mass or atomic mass. To gain three marks, candidates needed to discuss numbers of *atoms* (rather than 'there is more hydrogen') and *atomic* mass (ie carbon has a higher *atomic* mass).

(ii) Most candidates recognised that molecules from living things typically contain carbon, hydrogen and oxygen.

Question 6

(a) Another longer three mark answer that caused some difficulties for candidates. Some did not answer using ideas about particles or collisions. Some did not clearly state that an increase in concentration increases reaction rate. Some confused an increase in concentration with an increase in temperature and discussed activation energies and an increase in the energy of the particles. Most candidates gained a single mark. Again, candidates should be advised to read the question carefully and tailor their answer to hit the number of marks available.

(b) Many candidates knew that catalysts are not used up in reactions. Some used language that was too vague to score a clear mark at higher tier. Answers such as 'it is not worn away' or 'it does not break down' were not given credit.

(c) Most candidates knew the pH of water, but many failed to score because they did not link acidity with a very low pH. All pH values were seen for nitrogen dioxide, including 14.

(d) Most candidates worked out the name for calcium nitrate, but few knew that carbon dioxide and water are the other two products of a reaction between an acid and a carbonate. Hydrogen was a common incorrect answer. Some candidates did not recognise the nitrate formula and gave names such as 'calcium nitrogen oxide' as the name for the salt.

Question 7

(a) (i) About half the candidates correctly calculated the relative formula mass correctly. Others made small arithmetic errors.

(ii) Not many candidates correctly worked out the reacting mass of nitric acid from the information given. Some candidates gained a single mark for quoting a value half of the correct value (0.63 g), showing that they had not used the ratio of atoms in the equation to work out that two molecules of nitric acid react with each molecule of copper oxide.

(b) (i) Most candidates could not work out the charge on a copper ion from the formula. Of those who did, many lost marks because they did not clearly superscript the charge. Cu_2^+ was a common incorrect answer.

(ii) Most candidates knew that the acid to use was sulfuric. Some wrote 'sulfur acid' which was not credited.

(iii) In common with (b) (i), candidates found it difficult to translate between ionic charges and formulae. Few correctly wrote the formula for lithium nitrate. $Li(NO_3)_2$ was a common incorrect answer, probably modelled from the formula of copper nitrate at the top of the page.

A323/01 – Twenty First Century Science Chemistry A (Ideas in Context plus C7) Foundation Tier

General Comments

Most candidates performed well on this paper. The level of difficulty was appropriate for the ability range and many questions differentiated well giving a wide range of marks. Candidates appeared to be entered for the correct tier.

The foundation tier paper is aimed at candidates working at grade C or below. Questions 1b, 1ci, 2cii and iii, 3ai, 3c, 5a and 6b were all shared with the higher tier and tested at grades C and D standard. Most of these questions allowed stronger candidates to show their knowledge and understanding of the subject.

Most candidates correctly followed the instructions in the questions and most made their responses appropriate to the number of marks available. Some, however, did not read the questions carefully enough.

Definitions of words such as catalyst and bulk chemical were well known, but candidates found it more difficult to apply this knowledge in a chemical context. Although many knew the definition of exothermic they found it difficult to relate it to the diagram in question 3.

There were three questions on this paper, 2ciii, 4a, 5ai, that asked candidates to describe practical processes used in chemistry. These questions were not answered well. Candidates need practice writing the main points of practical processes in a way that is memorable.

Candidates were confused about the meaning of renewable and sustainability. These words are always likely to be on this paper and candidates need to be clear about their meaning and be able to use them in context.

All candidates seemed to have made good use of their time. There was no evidence of candidates running out of time.

Comments on Individual Questions

1 This question was based on the pre-release article, 'Which nappy is best for the environment?'. Most candidates could successfully find answers from the article, but fewer could link their knowledge of chemistry to the content of the article.

(a) In part i many candidates were unclear about the meaning of a renewable material. They did not link renewable with the source of cotton, the plant, which grows, but wrote that cotton could be recycled. Part ii was much better answered with most able to find correct information from the article saying why the use of cotton may not be sustainable, but in part iii few knew that polyethene and polypropene were made from crude oil which is non renewable and therefore not sustainable.

(b) This was well answered with most candidates able to suggest a reason why parents use disposable nappies.

(c) This question was about Life Cycle Assessment (LCA). In part i most candidates wrote that the lifetime was from making the product to disposing of it. They missed the point

that the LCA starts with obtaining the raw material. However part ii was well answered with most able to write down stages of the LCA.

(d) More than half the candidates were correctly able to write down the environmental impacts of the different types of nappies from the article. Many of those who failed to gain marks did so because they did not check what was written in the article.

2 (a) About half the candidates knew ethanol was an alcohol with more being able to correctly write its molecular formula. Common mistakes were to miscount the number of hydrogen atoms or not use subscripts for the numbers.

(b) This question, comparing the properties of ethanol and water, was well answered. Most gained two or three marks.

(c) Few candidates were able to answer this question on making ethanol by fermentation. Very few knew the substance used by yeast to make ethanol was sugar and fewer knew why it was not possible to make a concentrated solution of ethanol by fermentation. A quarter of candidates made no attempt to answer parts i and ii and more did not attempt part iii. In part iii a number of candidates were able to name distillation as the separation method but were unable to explain how it works. Some named distillation but went on to describe filtration.

3 (a) It was rare for candidates to score both marks in part i. Some described the diagram, but did not define exothermic whilst others were unclear about how to describe the diagram but gave the correct definition of exothermic. Candidates should have practise describing diagrams and graphs in words. Part ii was a discriminating question with many able to write the word equation. Those that missed the mark often omitted the arrow between reactants and products: dashes, pluses and reversible reaction signs were seen in place of an arrow.

(b) Most candidates mixed up the answers for bond breaking and bond making so failed to score on this question. As the answer is not intuitive, it would help candidates if they were given ways of remembering this information.

(c) Some candidates knew that activation energy was needed to start a reaction, but very few that this energy was needed to break the bonds in the reactants.

4 (a) Surprisingly, this question on paper chromatography was not done well. Candidates used the words ‘react’ and ‘reaction’ , incorrect in this context, and included irrelevant material, such as descriptions of the diagram given in the question. Candidates should be able to describe chemical processes such as chromatography or distillation (question2ciii). Bullet pointed lists are a useful way of recording and remembering this information and would be acceptable in exam answers.

(b) In part i the term ‘solvent front’ was not known. Most common wrong answers were that it was when the solvent stops moving or when the dyes reach the top of the paper. However, most candidates scored a mark in part ii saying that the ink would smudge or run.

(c) Parts i and ii were well answered with most candidates being able to identify dye C as the one containing the banned compound and explain why. The most common wrong answer was to identify dye B because it was the only dye to make one dot. Fewer candidates were able to state the two measurements needed to find R_f, though a small minority knew this very well and were able to write an equation for the calculation.

5 (a) Part i asked for a description of a chemical process. A third of candidates did not attempt this question. Those that did, often misinterpreted the question and failed to score marks. Many candidates did not read the rubric carefully and tried to use the numbers, given in the question, in a calculation. In part ii more were successful in adding the units of concentration. The most common mistake was to write 'g' alone instead of g/dm^3.

(b) More candidates were able to name a pipette than explain it is used because it is more accurate than a measuring cylinder. Candidates wrote that the measuring cylinder would overflow or it would overflow when indicator was added. These candidates often suggested using a larger measuring cylinder. In part iii, candidates knew that indicators were used to test for acidity / alkalinity, but few could interpret the question in the context of a titration. Scoring a mark for the indicator changing colour was more common than a mark for neutralisation.

6 (a) This question discriminated well amongst candidates. Many knew the definition of a bulk chemical and also recognised the reversible reaction symbol.

(b) Many candidates did not understand this question on the sustainability of raw materials used for making ammonia. They did not recognise natural gas as a fossil fuel but thought that as it was 'natural' it must be sustainable.

(c) This question was well answered with most candidates knowing the effect of a catalyst.

(d) Many candidates wrote about the purpose of Government safety regulations for public safety rather than explaining how this applied to road tankers carrying ammonia. Some thought the ammonia was liquefied so it could be seen if it leaked.

A323/02 – Twenty First Century Science Chemistry A (Ideas in Context plus C7) Higher Tier

General Comments

The majority of candidates could extract simple ideas and information from the article. Most of the more able candidates were also able to use their knowledge and understanding to process information from the article and formulate acceptable answers to some of the more complex questions. For many of the weaker candidates anything beyond finding and copying a relevant part of the article was too difficult. A number of the more able candidates successfully demonstrated sound knowledge and understanding of the extension material and the ability to use their skills in a variety of situations. Many of these candidates seemed better prepared than in previous sessions. For the majority, however, knowledge and understanding were patchy. This component is intended to assess candidates across the middle and upper levels of ability. Whilst many candidates could perform adequately in the more modest areas of this range, very few could consistently answer questions set nearer to the top end. It is expected that some questions will be answered well by only the more able candidates, for example those involving concepts such as dynamic equilibrium. There was, however, poor performance by many candidates in basic areas such as practical techniques and sustainability. Very few candidates could perform even quite simple calculations correctly. For the weakest candidates, who may have performed far better on the Foundation paper, sitting this paper cannot have been a pleasant experience. However, few candidates left many questions blank. There was no evidence that candidates had insufficient time to complete the paper.

Comments on Individual Questions

Question 1

This question, based on the article, discriminated very well across the ability range. An average candidate was able to gain 5 or 6 marks, whilst very few candidates failed to score any.

(a) A large majority of candidates gained both marks, usually for the idea that growing cotton uses pesticides and fertilisers. A few wrote about bleaching of cotton, which also gained credit. Only the weakest candidates gained no marks, often writing irrelevant ideas from the article.

(b) Most candidates gave a sensible reason, commonly based on convenience or the fact that no washing is necessary, to gain this mark. Other answers such as ‘more hygienic’ and ‘kinder to skin’ were sometimes seen and accepted.

(c) Only the most able candidates realised that this phrase refers to the lifetime from when the raw material is obtained to disposal of the product. Many began from manufacture of the product, which was not accepted.

(d) Most candidates quoted from the articles that the washing of reusable nappies uses electricity or detergent to gain one mark, but very few went on to explain how this causes an environmental impact for the second mark.

(e) Almost half of the candidates gained one mark, with the most common correct answers referring to difficulties that would be encountered in getting everyone to recycle the

nappies. Very few made other suggestions such as the lack of sufficient recycling plants or the uncertain market for the products of recycling. Only the most able gained both marks.

(f) The majority of candidates scored no marks in (i). Many of the more able candidates realised either that the forces between the polymer chains are weak or that little energy is needed to separate these chains, but very few gave both ideas for the two marks. Commonly answers did not refer to the polymer chains or molecules at all. Many candidates did not mention forces or energy in their answers. Another common error was to base an answer on the strength of the bonds in the polymer chain.

Again in (ii) only the more able gained any marks. Most of these suggested addition of a plasticizer to gain the first mark. Another common correct response was to decrease the polymer chain length. Very few candidates could successfully explain how their suggestion would reduce the melting point of the polymer.

Question 2

Some parts of this question were quite challenging. As a result, only the more able could gain more than half of the marks available. Lack of knowledge of simple experiments and practical techniques was evident for many candidates.

(a) Most candidates scored some marks from this question, with the more able gaining three or four. Many realised that sodium would 'fizz' in both ethanol and water, but only the stronger candidates realised that the reaction in water is more vigorous. A significant number incorrectly thought that sodium reacts with hexane. Other common errors were to include incorrect observations such as sodium burning in ethanol or carbon dioxide produced.

(b) Only the more able candidates could frame sensible answers to this question. Most of these realised that both water and ethanol react because they both have O-H, or that hexane does not react because it has only unreactive C-C and C-H. Few included both ideas. Many of the weaker candidates simply described what they had already written in part (a). A large majority of candidates scored no marks.

(c) Less than a third of candidates gained a mark in (i). More able candidates realised that yeast is killed at high ethanol concentrations. A wide variety of incorrect answers were seen, ranging from water being a product of the reaction to yeast being killed at high temperature.

In (ii) a majority of candidates knew that distillation is used and most realised that this involves heating the mixture or evaporation of the ethanol. Only the most able could explain how the separation depends on boiling points or describe how the ethanol is condensed and collected. A common error was to describe reflux instead of distillation.

Question 3

Most of this question was accessible to candidates in the middle and lower part of the ability range, allowing them to score well. Most even gained some marks from the calculations.

(a) Most candidates realised that energy was given out in this reaction and about half also observed that this was shown by the energy level of the reactants being higher than that of the products. Only the weakest candidates did not gain at least one mark.

(b) A large majority of candidates knew that activation energy is the energy required for a reaction to take place or begin. More able candidates also knew that this energy is needed to break bonds in the reactants.

(c) The calculation in (i) was successfully carried out by a large number of candidates.
(2 x 805 =) 1610
(4 x 464 =) 1856
energy released = 1610 + 1856 = 3466 kJ/mol
Those candidates who did not complete the whole calculation generally gained only one mark for working out either 1610 or 1856. A common error was to multiply the bond energy values by the wrong number of bonds. Few of those who worked out both of these figures correctly failed to work out the energy released. About a third of candidates gained no marks. Many of these wrote a jumble of figures with little relationship to the correct calculation. A significant number of more able candidates calculated the energy released and then went on in (i) to calculate the overall energy change that was in fact asked for in (ii).
Candidates who gained full marks in (i) generally gained the mark in (ii), and many who gave an incorrect answer in (i) then went on to use this answer correctly in their calculation in (ii). These candidates were allowed an 'error carried forward' to gain this mark. As a result, about three quarters of candidates gained the mark in (ii).

Question 4

This was a challenging question. Only the more able scored well.

(a) In (i) better candidates were able to correctly read off the value from the chromatogram and the more able of these could then calculate the Rf value.

4.8/7.0 = 0.69

Many weaker candidates incorrectly read off the value from the chromatogram. Others gave an answer with eight significant figures, obviously read off their calculator.
In (ii), very few candidates formulated sensible answers. Some of the more able realised that the Rf value is characteristic for the compound, but only a tiny number realised the significance of this in identifying spots on chromatograms. Very few realised that the solvent front could be different on separate chromatograms. Many candidates gave vague answers referring to the unreliability of visual comparison of chromatograms without suggesting why Rf values might be an advantage. Most simply said it was more accurate, which gained no credit.

(b) About a third of the candidates could identify which was the mobile phase and which was the stationary phase in this chromatography to gain the first mark. Far fewer could describe how the compounds in the dyes are in a dynamic equilibrium between these phases for the second marking point. A very small number of candidates could explain how different compounds travelled different distances on the chromatogram for the third marking point. Many of the weaker candidates used the three terms indicated in the question to make sentences that, whilst perhaps grammatically correct, made no scientific sense. About half of the candidates scored no marks.

Question 5

The calculations in this question were beyond the skills of almost all of the candidates. Many presented a meaningless jumble of numbers or left blank spaces. Over half scored no marks for the entire question and only a few of the most able scored more than half of the marks.

(a) Very few candidates had any clear idea of how to use a stock solution to make up a standard solution of defined concentration. Many of even the more able students began by calculating a mass of nitric acid to use, rather than measuring out 25 cm^3 of the stock solution. Similarly, very few candidates realised that what they had measured out needed to be made up to a total volume of 250 cm^3 by adding distilled water. Very few candidates scored even one mark, and only a tiny number scored both. A common error amongst weaker candidates was to describe adding alkali to the acid solution.

(b) in (i) only the more able candidates could set out the calculation for the mass of nitric acid in the titre of 28.2 cm^3.

28.2 x 6.3/1000 = 0.178 g

The answer of 6.3 x 0.0282 = 0.178 was sometimes seen, but only accepted if the candidate made clear how they obtained the 0.0282, eg by showing an additional calculation or using the unit dm^3. Many candidates put forward an arrangement of numbers that arrived at the value 0.178 but were not a calculation of the mass of nitric acid. Most had little idea of how to formulate an answer and wrote a jumble of meaningless figures.

Likewise in (ii) most of the candidates had little idea of how to proceed with the calculation,
0.178 x 40/63 = 0.113 g

0.113 x 1000/25 = 4.52 g/dm^3

Over three quarters of candidates scored no marks.

Amongst the most able, some candidates scored one mark, commonly for an 'error carried forward' from an incorrect mass calculated for the sodium hydroxide in 25 cm^3 of solution used correctly to calculate a value for the concentration. Very few were able to calculate the correct mass of sodium hydroxide.

Very few candidates understood what was required in (iii). Some of the more able correctly concluded that there was little uncertainty in the value or observed that there was only a narrow range in the titration values, but only a tiny number linked these two observations. A number of the weaker candidates compared the titration results to their calculated concentration, and so thought that there was a high level of uncertainty.

Question 6

Candidates across the ability range found marks to score in this question, but it gave very good discrimination.

(a) This question elicited a wide range of responses, with a significant number of candidates scoring at each of the four marking points. Common errors were to neglect any mention of the effect on the sustainability of the process for either or both of air and natural gas. This immediately reduced the possible mark to two. However, these candidates often gained one or both marks for explaining the effects. A number of the weaker candidates thought natural gas to be renewable.

(b) Many candidates explained that a catalyst lowers the activation energy, gaining both a mark for this idea and the QWC mark for correct use of the term activation energy. Far fewer went on to explain that the catalyst provides an alternative route to gain the second mark. Over half of the candidates gained no marks from the question.

(c) Only about a third of the candidates gained at least one mark, usually for an explanation of how the unused nitrogen and hydrogen are recycled to react into ammonia. Many candidates simply said that 85% of the products were recycled, which did not gain credit. The second marking point required an explanation based on the position of the equilibrium, and this was rarely seen.

Principal Moderator's Report

Skills Assessment Report 2010

Specification	Code	Skills Assessment
Science A	A219/01	Practical Data Analysis and Case Study
Additional Science A	A220/01	Practical Investigation
Biology A	A229/01	Practical Data Analysis and Case Study
	A230/01	Practical Investigation
Chemistry A	A329/01	Practical Data Analysis and Case Study
	A330/01	Practical Investigation
Physics A	A339/01	Practical Data Analysis and Case Study
	A340/01	Practical Investigation

General Comments

The number of candidates being entered for this specification continues to be very large and the balance between the specifications continues to shift slightly towards a higher entry for the separate sciences compared to Science and Additional Science. The sampling procedures have been modified and streamlined this year in the light of new guidance from the Joint Council for Qualifications (JCQ).

As the interpretation and application of the assessment criteria has improved it is not surprising that the there has been an increase in the percentage of candidates achieving certain aspects of the assessment criteria. However, whilst there has been improvement in some areas, other aspects of the criteria continue to be demanding and challenging for candidates and the spread of marks over the cohort allows secure differentiation between grades.

This report will highlight those areas where there has been improvement and also those where there is still significant opportunity for development. The reports from 2008 and 2009 will still be available online at www.ocr.org.uk to provide further detailed guidance.

The skills assessment component of each of the above specifications is weighted at 33% and it was still evident that some Centres were not developing the underlying skills, knowledge and understanding of Ideas about Science in their candidates before an assessment took place.

Structure of the report
Vertical black lines in the margin throughout this report highlight important areas of concern, advice and guidance by the moderating team.

This report is divided into the following sections

- Administrative issues
  - General comments
  - Annotation
  - Internal moderation
  - Type and context of assessed work
  - Nature of practical work
  - Candidate helpsheets and teacher review of coursework
  - Plagiarism
- Assessment and marking framework
  - Calculating the Strand mark
  - Marking strands I and P in Data Analysis and Investigations
  - OCR cover sheet for candidates' work
- Data Analysis
- Case Studies
- Investigations
- Grade Thresholds

Administrative issues

General comments

Those Centres that responded to the early introductory letter to establish an email contact between the Centre and the moderator improved the efficiency and effectiveness of the moderation process and this was much appreciated by moderators. However, there were still too many Centres who did not send the paperwork and coursework samples promptly by the OCR deadline. Centres that followed the advice on the checklist included with the introductory letter and provided all the relevant information, in particular details of how each of the tasks used for assessment had been introduced and presented to candidates, greatly facilitated the moderation process and helped moderators to support the marks awarded by the Centre.

Annotation

Too often there was little or no indication of how marks had been awarded. The minimum notation acceptable is to use the assessment criteria codes, eg I(b)6, at the appropriate point in candidates' work. For Case Studies it was noted that where Centres provided further commentary this was particularly helpful. Suitable annotation makes it more likely that the moderator will be able to support the mark awarded. However, it is important that annotations accurately reflect the criteria. In some cases, it was noted that the annotation was a very generous interpretation of the criteria and occasionally completely incorrect.

Internal moderation

Effective internal moderation ensures that candidates are placed in the appropriate order of merit. If the order is felt to be unsound because marking is inconsistent between different teachers the Centre may be required to provide further samples of work and possibly re-mark the work of all their candidates. There were more incidences of unsatisfactory internal moderation reported by the moderating team this year.

Type and context of assessed work
In line with guidance from the Joint Council for Qualifications (JCQ), coursework can be submitted for as many specifications as it is valid for. In the case of Twenty First Century Science, this means that it has to match both type (ie Data Analysis and Case Study or Practical Investigation) and context (ie Biology, Chemistry or Physics) as appropriate for the specification concerned. Only a few Centres did not meet these requirements this year. Please note that if the same piece of coursework is requested for moderation in more than one specification, then it must be photocopied and put into the appropriate coursework sample package.

Nature of Practical work
The Data Analysis and Practical Investigation must involve candidates having personal first hand experience of collecting data in a practical experiment. **Coursework which does not fulfil this requirement cannot be submitted for assessment.**

Computer simulations or sole use of teacher demonstrations are not acceptable substitutes. In the Practical Investigation, marks awarded for Strategy (S) and Collecting Evidence (C) Strands must be based on an individual's contribution and not on a shared approach or shared class data or data from other secondary sources.

In the Data Analysis an individuals' data can be supplemented with additional data from secondary sources to enable assessment of Strands I and E.

Candidate helpsheets and teacher review of coursework
There was evidence that some coursework from a small minority of Centres had been reviewed and annotated by teachers giving candidates specific guidance about how to improve their marks. **This is not acceptable practice**. The Joint Council for Qualifications (JCQ) have published appropriate guidelines and Centres are required to consult and abide by this document.

www.jcq.org.uk/attachments/published/315/ICE%20Coursework%202007%20FINAL.pdf
The following quotes are from this document:

> "Teachers may review coursework before it is handed in for final assessment ... ... provided that advice remains at the general level, enabling the candidate to take the initiative in making amendments …". "Having reviewed the candidate's coursework it is not acceptable for teachers to give, either to individual candidates or to groups, detailed advice and suggestions as to how the work may be improved in order to meet the assessment criteria. Examples of unacceptable assistance include detailed indication of errors or omissions, advice on specific improvements needed to meet the criteria, the provision of outlines, paragraph or section headings, or writing frames specific to the coursework task(s)."

Candidate help sheets of the generic type which are applicable to any task are allowed. Whilst helpful for lower achieving candidates these can restrict the opportunities for higher achieving candidates. There was evidence that some Centres were providing help sheets which, rather than giving broad headings to guide their candidates, were providing a very detailed breakdown of points and leading questions involving particular words or phrases in the mark descriptions which went beyond the spirit of teacher support and guidance. In these cases Centres sometimes awarded marks when candidates repeated the same words and phrases without demonstrating any understanding. Centre marks could not be supported by moderators in these situations.

Plagiarism
Quoting from the same JCQ document as previously mentioned, "Candidates must not copy published material and claim it as their own work. If candidates use the same wording as a published source, they must place quotation marks around the passage and state where it came from. **Candidates must give detailed references even where they paraphrase the original material"**. There was evidence that in some cases, particularly in the Case Study, candidates were not following these procedures. The JCQ document goes on to say: "These actions constitute malpractice, for which a penalty (eg disqualification from the examination) will be applied".

Assessment and marking framework

Calculating the Strand mark
A significant number of Centres are still not following the correct procedure for calculating the Strand mark from the appropriate aspect of performance marks and are being required to re-mark all their candidates' work.

There was a tendency for some Centres to award marks on the basis of candidates matching one high level aspect of performance description within each Strand without ensuring that the underpinning descriptions had been matched. 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 if available. Thus, the level of performance in each aspect is decided.

Three aspects of performance per Strand
Where there are three aspects for each of the Strands (which applies to all Strands except Strands B and C of the Case Study) the following examples illustrate how to convert aspects of performance marks into Strand marks.

Example	Marks for the three aspects in a strand	Formula to be applied	Mark to be awarded for the strand
1	(a) = 4, (b) = 4, (c) = 3	[(a)+(b)+(c)] / 3	= 3.66 round up = 4
2	(a) = 3, (b) = 4, (c) = 3	[(a)+(b)+(c)] / 3	= 3.33 round down = 3
3	(a) = 4, (b) = 3, (c) = 1	[(a)+(b)+(c)] / 3	= 2.66 round up = 3
4	(a) = 3, (b) = 3, (c) = 0	[(a)+(b)+(c)] / 3	= 2.0 = 2
5	(a) = 2, (b) = 3, (c) = 0	[(a)+(b)+(c)] / 3	= 1.66 round up = 2

Two aspects of performance per Strand (B and C of the Case Study)
From experience it is often best to consider both strands B and C together when arriving at the final strand mark for each. For example, if B(a) = 4, B(b) = 3, C(a) = 4 and C(b), then it would be appropriate to award B = 4 by rounding up and C= 3 by rounding down (or vice versa), for a total of 7 marks for these two strands taken together.

This 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.

Marking Strand I aspect (a)
This aspect involves awarding credit for processing the data which has been collected to display any patterns. This may be done either graphically or by numerical processing, whichever is most appropriate in a particular Data Analysis or Practical Investigation. If there is some evidence for both approaches, then both should be marked with **the better of the two being counted (but not both marks)**. Some Centres counted both marks which produced an incorrect aggregate for the Strand.

Marking Strand P aspect (b)
The first row is concerned with recording quantitative data, the second row deals with the use of conventions and rules for showing units or for labelling in tables, and the third row deals with the recording of qualitative data. Most Practical Investigations are of a quantitative nature and will provide evidence for the first and second rows. In these cases, the aspect mark will be determined by averaging the mark in these two rows only, ignoring the third row completely. For those rare investigations which include qualitative evidence but no quantitative evidence, the mark for Aspect b should be based on the average of the second and third rows only. Where averaging results in half marks, professional judgement should be used to determine the best fit mark of the two alternatives. Once the mark for aspect (b) has been decided, it can be combined with the marks for (a) and (c) to provide the average, and so the best fit mark, for the strand.

For example, in an investigation providing **quantitative** evidence

Aspect of performance			**Strand P mark**
P(a)	7	7	**6**
P(b)	(i) 6 (ii) 4 (iii) n/a	5	
P(c)	7	7	

Sub-dividing aspect (b) in this way allows flexibility in marking the recording of data without allowing aspect (b) to dominate the mark for the whole strand.

Candidate coversheet
All marks must be recorded on the OCR cover sheet which is attached to candidates' work. A number of Centres did not use the latest format of the OCR cover sheet or, in a very few cases, did not use a cover sheet at all.

Data Analysis

General comments
Candidates must have personal, firsthand experience of collecting data by performing a practical experiment. The data that they collect can be supplemented by further data from, for example, incorporating a class set of results. Work which is based purely on teacher demonstrations, computer simulations, given sets of results or similar is not acceptable.

Many Centres used whole class practical activities as a basis for Data Analysis exercises and this clearly worked well. Therefore it is very important that Centres include details of how the task was presented to their candidates eg briefing sheets etc. The better candidates included a description of their experimental method, their own results table and the class data set which made the marks awarded for evaluation easier to support.

It is most important that candidates record and present the data that they have collected and not just plot a graph or do numerical calculations without the inclusion of a data table in their report. It would also be helpful if candidates or teachers included the method that they used to collect data so that marks for E(b) could be more securely supported.

The same Strand I and E assessment criteria are used in Practical Investigations and the same marks for I and E from Practical Investigations can be submitted for Data Analysis in another specification **provided the subject context is appropriate**. Many Centres used this opportunity to obtain the optimum marks for their candidates. In these cases, Centres must indicate this on the appropriate coversheet and also include copies of the work in both samples which are sent to the moderator, if the same candidate is selected.

Data Analysis tasks
There was a continuing variety of data tasks seen by moderators such as:

Resistance of a wire	Stretching elastic bands, springs
Osmosis	Stopping distances of bicycles
Cooling curves	Clotting of milk
Crater impact	Bouncing of squash balls
Rates of reaction	Pulse rate and exercise

Centres are encouraged to be innovative but must consider the science that might be required to explain any conclusion drawn by the candidates. As in all assessments of this type, Centres should match the task to the ability and expectations of the candidates involved.

Those candidates who understood and used the terminology and concepts related to Ideas about Science, such as ‘correlation and cause’, ‘outliers’, ‘reliability’, ‘accuracy’, ‘best estimate’, and ‘real difference’ found it easier to match the performance descriptions of the criteria and gain higher marks.

The majority of candidates at nearly all levels repeated their measurements when performing practical tasks, which is most encouraging. However, many candidates do not necessarily appreciate the reasoning behind such practice and often those results which were clearly outliers were included in average calculations and incorporated into conclusions. It was very rare to see that a candidate had performed further repeats to replace the outlier to ensure that the data was reliable and of the best quality. Plotting rough graphs as the data is collected may help candidates to identify outliers as they are collected so that marks for E(b) can be awarded and their conclusion may be more clearly and confidently established gaining credit in both I(b) and E(c).

Strand I: Interpreting data

I(a): Most candidates analysed their data using bar charts or graphs to illustrate and process the data that they had collected rather than carrying out a numerical analysis. Whilst many candidates now plot all their data and often include range bars, the quality of graph-drawing often shows a lack of care in plotting the points accurately, using suitable scales, labelling axes correctly and drawing a line of best fit accurately and carefully. Many members of the moderating team felt that the standard of graph-drawing had certainly not improved since last year. Many graphs were given high marks when one or more of these aspects were not of the accepted quality and more scrutiny is needed by Centres.

The following guidelines provide more guidance about what is required but they are not intended to be comprehensive and to cover all eventualities:

- I(a) 4 - simple charts, bar charts
- I(a) 5 – a dot-to-dot graph or axes not labelled or incorrectly plotted point(s) or poor quality line of best fit.
- I(a) 6 - graph with correctly plotted points, correctly labelled and scaled axes and correctly drawn line of best fit.
- I(a) 7/8 – in addition to the requirements for 6 marks, candidates must show evidence of awareness of uncertainty in data eg range bars, scatter graphs.

If candidates use a numerical approach to analyse their data it is expected that candidates will be able to correctly calculate averages from repeat readings for 4 marks, do more complex calculations such as calculate percentage differences for 6 marks and for 8 marks calculate gradients from graphs or use simple statistical methods such as box and whisker plots. Those candidates who have drawn a poor line of best fit on their graph but succeeded in calculating a gradient correctly may be awarded up to 5 or possibly 6 marks.

Some candidates included range bars when plotting bar charts and were wrongly awarded 8 marks. At best this approach might merit 5 marks.

The same standards for hand-drawn graphs apply when marking computer-generated graphs ie they must be correctly sized and scaled with suitable grid shown and with the appropriately sized plotting points. However, it is generally better for candidates to hand draw their own line of best fit

Centres are reminded that only one single mark must be used for I(a), either that for graphical or that for numerical work, but not both when determining the overall Strand I mark. Further information about the award of marks for numerical approaches is contained in the 2008 Report.

I(b): The match to I(b)4, 'identifying trends or general correlations in the data', was well appreciated and most candidates could summarise the patterns in their data with a suitable qualitative statement. However, candidates were often given 6 marks with little evidence to support this award. Many candidates referred to 'positive correlation' which only merits 4 marks. For 6 marks candidates should derive a more quantitative statement using their data to show what happens when, for example, concentration or lengths are doubled and noting the direct proportionality between variables.

Very few candidates matched the requirements for I(b)8. Candidates should review any limitations to their conclusions by considering such things as the scatter in the data, overlapping range bars between data points, 'real differences' and values of the best estimate, and whether the best fit line be accurately defined. Candidates who have derived a quantitative relationship should consider what effect the position of the best fit line might have if the scatter in the data is taken into account.

I(c): Many candidates introduced their experiment by describing any related background theory even if it was not all relevant to the particular experiment they were doing. Candidates are better served if they link their conclusion directly with the appropriate scientific explanation that applies. Most candidates could secure a match to I(c) 4 by explaining their conclusion using scientific ideas. However, there was still some very generous marking when matching to I(c)6 and I(c)8 in terms of the detail and quality of the scientific knowledge and understanding shown. It is not just a few key words that must be considered, but the actual meaning and correctness of a candidate's explanation of their conclusion that must be judged when arriving at the final mark.

Strand E: Evaluation

The majority of candidates achieved between 3 or 5 marks for this strand, showing improvement in E(a) and (b) but much less so in E(c). Those candidates who used the appropriate IaS vocabulary, and the knowledge and understanding of IaS 1, invariably achieved higher marks. Those candidates who used sub-headings such as 'Evaluation of procedures', 'Evaluation of data', 'Confidence level of conclusion' were more likely to focus on each area in turn and be more successful in their overall evaluation.

E(a):

The E(a)4 performance description is really the 'gatekeeper' to access the higher marks. It requires candidates to identify any limitations or problems in their procedures that they encountered during their practical work. However, in many cases comments were limited to human error rather than systemic experimental ones. Many candidates suggested possible improvements to match E(a)6 although they were not always of sufficient quality to be creditworthy eg 'do it with a computer' or 'repeat my measurements more times' without any justification or explanation.

E(b):

The majority of candidates generally identified a data point as an outlier either in the table of results or on the graph, but only the better candidates provided an explanation of why a particular result had been chosen. The majority of candidates now regularly draw lines of best fit and range bars on their graphs but many of them do not make the connection when discussing reliability and accuracy of their data. A limited number of candidates used more objective ways of assessing reliability and accuracy using simple statistics such as variations of the Q test procedure. Candidates' attempts to explain anomalous results were often generously marked and it is important to mark the **quality** of what has been written and not the fact that just **something** has been written.

E(c): Marks were often very generously awarded and this aspect still continues to be poorly addressed. This aspect involves bringing together the discussion about the range and reliability of the data collected and the procedure to establish a level of confidence in the conclusion. Better candidates referred back to their conclusion in I(b) expressed in either qualitative or quantitative terms and used their discussion in E(a) and E(b) to link them all together in establishing the appropriate level of confidence. Those candidates who had expressed a conclusion in quantitative terms had more opportunity to provide a more detailed analysis and evaluation to access the higher marks.

For the award of 6 marks, candidates should bring together a discussion of the accuracy and reliability of their data and the precision of the apparatus they have used to establish a level of confidence in their conclusion. Further support for this can come from awareness in I(b) about the limitations in the conclusion. In addition, for 8 marks weaknesses in the data should be identified, eg a limited range or not enough readings at certain values, or degree of scatter too

large or variable, as well as detailed suggestions about what more data could be collected to make the conclusions more secure for the particular variable under investigation.
Some candidates used other data from secondary sources to support (or otherwise) their conclusion. Some candidates recognised that their conclusion could only apply to the range of values that were studied because outside this range, other factors may act. For example, in chemical reactions the rate is bound to slow down as one of the chemicals gets used up, rubber bands that are stretched will eventually break, more exercise cannot always mean that pulse rate continues to increase etc.

Case Studies

General comments

The Case Study is a critical analysis of a controversial scientific issue in which candidates use their knowledge and understanding of Ideas about Science. Those candidates who were able to 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', and 'risks and benefits' found it much easier to match the performance descriptions of the criteria and gain higher marks.

Most candidates title their Case Study in terms of a question but many still tend to present a report describing a topic rather than collect evidence for both sides of a case and use their own judgements to derive a personal conclusion. There is, of course, not always a right or wrong answer in these controversial issues and marks are awarded for the way that the candidate has presented and argued the case.

Many Centres provided a short list of appropriate Case Study titles for their candidates to choose from, thus allowing them to select one which is the most appealing on an individual basis. It is important that titles for Case Studies do provide the necessary focus for candidates and, rather than just illiciting a yes/no response, encourage a more thoughtful response with possible suggestions of future action. Those Centres who allow a more open selection of topic must closely monitor their candidates' choice to ensure that it is appropriate and firmly embedded in a scientific context, with opportunities to gather evidence both 'for' and 'against'. Surprisingly, many candidates did not make full use of the relevant information and material in their student textbook, often preferring to use only material from the internet.

A number of familiar examples were seen again this year but some, such as 'should smoking be banned in public places?', were seen much less frequently as their relevance diminishes.

Some examples of Case Study titles included this year:

Should human cloning be allowed?
Are mobile phones bad for your health?
Is nuclear power the answer to our energy needs?
Should we spend more developing alternative energy resources?
Is the MMR jab safe?
MRSA – is hospital the best place to be when you are ill?
Is global warming natural or man-made?
Is sunbathing safe?
Does pollution from traffic cause asthma?
What killed the dinosaurs?

The approach adopted by candidates who presented Case Studies on the following issues seemed to provide limited access to the higher levels of the assessment criteria:

Is organic food best?
Aspects of diet eg "Is obesity inherited?"
Should animal testing be allowed?

Assessment

In general, candidates continued to perform better in Strands A and D compared to B and C. Higher achieving candidates described the relevant science needed to understand their chosen topics and produced high quality, clearly structured, well resourced and illustrated reports involving critical analysis and individual thought with considerable personal input. It was this latter aspect of personal analysis and evaluation which often differentiated candidates in terms of level of performance.
Lower achieving candidates relied too heavily on copying and pasting information from sources without the appropriate level of individual analysis and evaluation. Those candidates who did not acknowledge their sources either when they copied and pasted information or when paraphrasing original material could be regarded as plagiarising material and risk incurring a significant penalty.
Those reports which were presented simply as PowerPoint printouts almost always lacked sufficient detail to access the higher marks.

Strand A: Quality of selection and use of information.

There was continuing evidence of improvement in the marks awarded for this strand compared to last year.

A(a): Candidates must select and use sources of information to provide evidence to support both sides of the argument in their Case Study. They must select relevant extracts to quote directly and then, in their own words, explain what its relevance and importance is to the developing arguments in the report. It was this latter aspect that the better candidates were able to show.

If no sources are credited then a maximum of 1 mark will be allowed by moderators. Higher marks require that sources represent a variety of different views or opinions and it is quality, rather than quantity, which separates the award of 2 or 3 marks. Many candidates who were awarded 4 marks incorrectly often made token reference to reliability but did not explain why they thought their sources were reliable. Those candidates who used the language and ideas from IaS 4, eg ideas about peer review, the nature of the source or the status of the author, were much more likely to secure the top mark.

A(b): The majority of candidates included a bibliography of sources at the end of their reports. Candidates who identified their sources using incomplete references, eg website homepages, should be awarded 2 marks. If only one or two incomplete references are given then one mark should be awarded, and if no references are given then zero marks are appropriate. For 3 marks candidates included complete references to the exact url address of the webpage and, when referencing books, the title, author and page references were given. For 4 marks it is expected that candidates include some information about the nature, purpose or sponsorship of the website. Candidates should also be encouraged to record the date when they accessed the information from an internet site.

A(c): Candidates were still not very good at clearly showing where sections of text were directly quoted. Use of quotation marks, use of a different font or colour highlighting, were some of the methods used by the better candidates. The better candidates also included references within

the text to show the source of particular information or opinions, quoting the specific author and then using, for example, numerical superscripts linking to detailed references in the bibliography. Credit is given, not so much for the quotation itself but for the comment made by the candidate to explain why it was chosen, and how the candidate thinks it contributes to the arguments being compared in the study.

Failure to discuss reliability of the sources, failure to fully indicate and reference quotations and failure to indicate the relevance of the quotations selected in the study prevented many candidates from being awarded 4 marks in this strand.

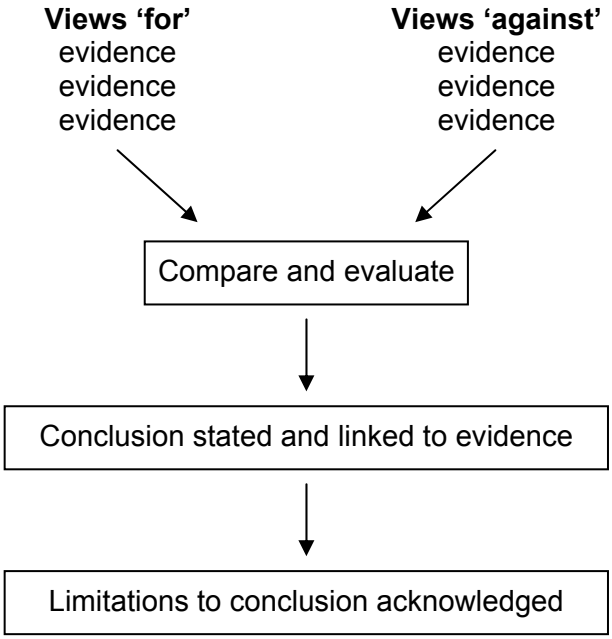
Strand B: Quality of understanding of the case

The majority of candidates described the relevant background science in the introduction to their Case Studies. However, it was only the most able who could integrate their scientific knowledge and understanding with the claims and opinions reported in their studies or extend the scientific knowledge base to more advanced concepts. Reporting was too often still at the 'headline level', simply repeating claims without looking behind the headline for the underlying science and/or evidence. It is useful before marking candidates' work to look at the appropriate pages in the Twenty First Century Science specifications about Science Explanations and the Ideas about Science, and also the published OCR exemplars to know in advance about what material should be included. The most successful Case Studies are usually closely related to topics in the course and it can be taken as a general guide that 6 marks in B(a) requires all of the relevant science from the student book. The seventh or eighth mark will come either for applying and integrating this correctly to the case, or for finding and explaining some additional science related to their Case Study.

Aspect B(b) focuses on candidates' ability to identify, report and evaluate the scientific evidence that any claims and opinions are based on. Most candidates were able to recognise and extract relevant scientific content from their sources and were awarded 4 marks. Candidates who were awarded 6 marks referred to the evidence base of the various claims and opinions providing generally quantitative information from research studies. Candidates obtaining 7 or 8 marks looked more critically at the quality of the evidence. They used terms like 'reliability' and 'accuracy' when considering data, they looked at the strategies involved in collecting the data and they also compared the reliability of data between sources. For many 'life-science' studies, for example the popular MMR study, the evidence is largely drawn from epidemiological studies and good candidates should be looking for evidence of factors such as sample size, or how subjects were selected to evaluate the importance of the evidence. Even strong candidates tended to rely too much on summaries of conclusions rather than describing the evidence base.

Strand C: Quality of conclusions

Strand B gives credit for the level and detail of the relevant science described and for reporting the associated evidence underpinning the various claims and opinions. Strand C awards credit for candidates who provide individual input comparing and evaluating the evidence, considering its significance, importance and reliability and using their own judgement to arrive at a suitable conclusion on a controversial issue. There was evidence that many candidates were not using and applying their Ideas about Science sufficiently, particularly IaS 5, to warrant the higher marks in this strand.
Those Centres who had guided their candidates to organise their reports with the following headings in mind and to encourage them to develop their critical skills invariably achieved higher marks.



Most candidates could sort the information that they had gathered into views 'for' and 'against' and were awarded 4 marks in C(a). Better candidates started to compare similar aspects in both their 'for' and 'against' list and were awarded 6 marks. The best candidates built on this foundation and provided detailed comparisons and evaluation demonstrating considerable analytical and evaluative skills.

When making their conclusions, many candidates referred to the evidence that they had gathered and were awarded 4 marks in C(b); those who omitted any reference were limited to 2 marks. Better candidates described their own viewpoint or position in relation to the original question justifying this by reference to the sources and to the evidence that the claims were based on. Far too often the conclusion was limited and too brief. Alternative conclusions should be considered where appropriate and recommendations for action in the future should also be included. Many candidates simply chose to report information about their topic, without any real analysis of the scientific evidence and incorporation of personal decision making.

Strand D: Quality of presentation

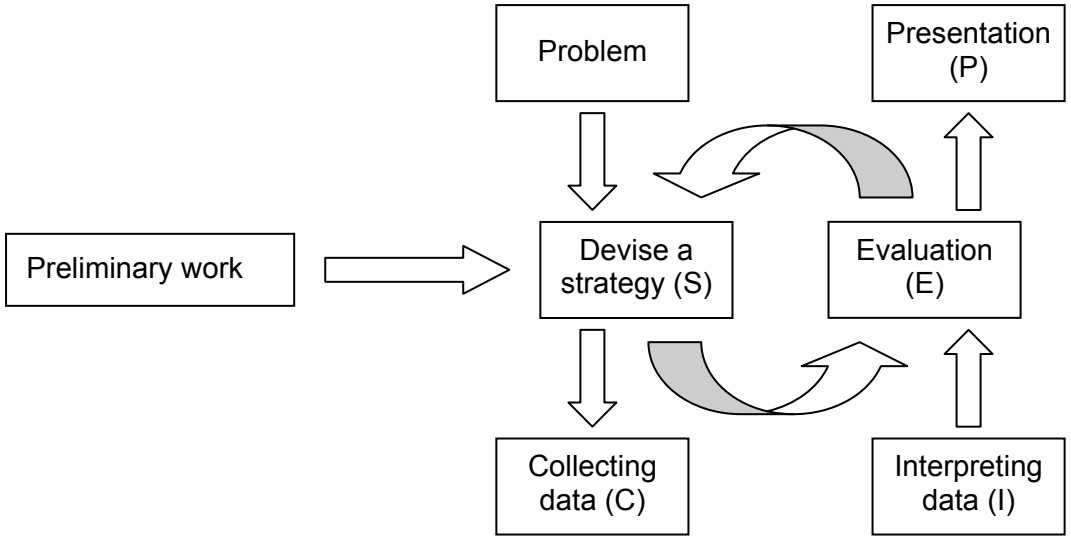
D(a): The majority of reports included headings and/or sub-headings (2 marks) to provide the necessary structure. There was a definite improvement in this aspect and the better candidates included a table of contents and numbered the pages in their report (3 marks) to help guide readers quickly to particular sections. Those candidates who, in addition, presented a report which had a coherent, logical and consistent style were awarded 4 marks.

D(b): Many candidates only included images which were decorative rather than informative and therefore failed to clarify difficult scientific ideas and improve effective communication. 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 one 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, eg 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.

D(c): The assessment of the use of scientific terminology and the level of spelling, punctuation and grammar was generally very fairly assessed by Centres.

Practical Investigations

There was continuing evidence this year that Centres were moving away from the previous Sc1 methodology to investigations and a more open ended exploratory approach was being developed. The importance of candidates doing preliminary work to inform the strategy of the main experiment was clearly being recognised and encouraged.



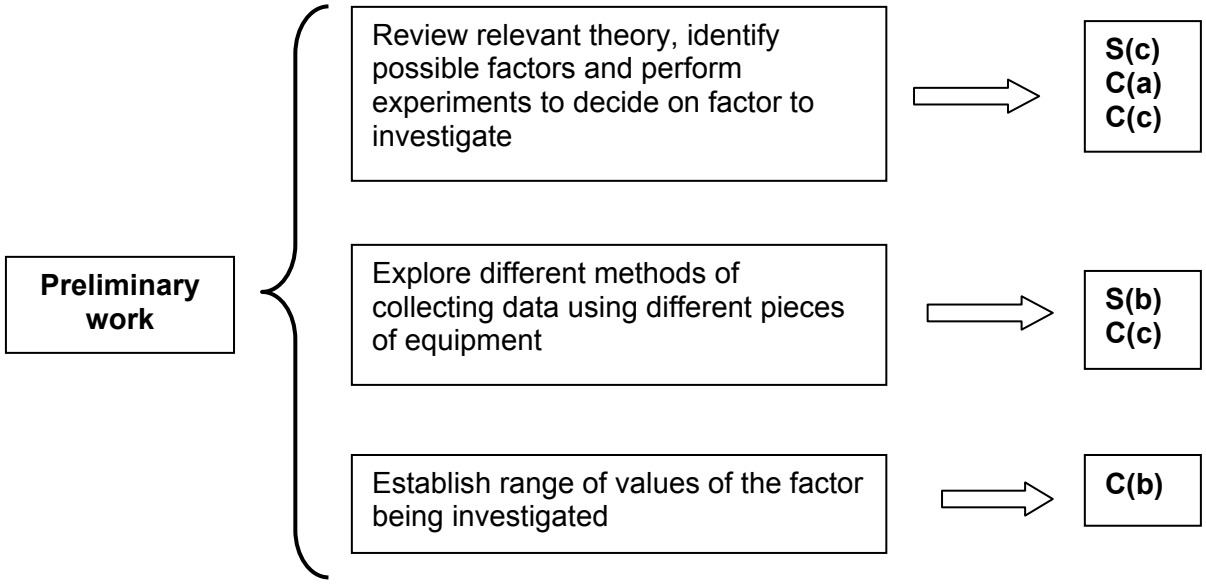
From an assessment point of view the 'performance descriptions' should be used to reflect the quality and performance of candidates' work, rather than a formal/legalistic interpretation of particular words and phrases. There were a number of examples where credit had been incorrectly given for the inclusion of a key word or phrase but, on reading the context in which it was written, it was clear that the candidate had not understood or appreciated the correct meaning.

Rates of reaction, resistance of a wire and osmosis were still the most common investigations seen from Centres. However, there was evidence that other topics were being developed by more Centres who had gained confidence from previous years, for example, stretching of plastics and other materials, exercise and fitness routines, efficiency of wind turbines, objects rolling down slopes or ski jumps, electrolysis, investigations involving titration and electromagnets.

Strand S: Strategy

Centres were generally matching candidates' work correctly to the 6 mark performance description but higher marks were being very generously awarded.

The intention is to encourage a more independent approach to investigations and the mark awarded for the aspect, S(c), should reflect the 'value added' by the candidate, beyond the initial teacher stimulus. To justify high marks in S(c) candidates should show independent thinking and the importance of preliminary work cannot be over emphasised in the introductory phase of an investigation; the appropriate amount of time must be given to this aspect.



Candidates should consider what factors or conditions might affect the results they will get. This will usually involve a brief review of the relevant scientific theory supported by one or two simple practical experiments to compare the magnitude of the different effects and ease of experimentation. This will allow candidates to decide which factor it would be best to study and also provide evidence which can contribute towards credit for C(a) and C(c).

High marks cannot be supported unless the Centre has provided details of how the task was presented to candidates (eg copies of briefing sheets etc.) or moderators, after inspecting different scripts in the sample, can see that candidates had freedom of choice between different approaches and apparatus. In too many cases moderators noted that candidates had identical ranges and values of the same variables without any further discussion or justification indicating that limited individual decision making had occurred, yet high marks were still being awarded. This necessitated a downward adjustment to the marks for S(c) in a number of Centres. Where candidates had been given the opportunity to show autonomy they performed well across many of the Strands.

It is important for candidates to record their preliminary data and to use it to inform and develop the main experiment. Often preliminary work appeared to provide just a limited extra set of results and did not shape the investigation in any way. Sometimes preliminary work was carried out but it was clear that candidates had not really understood why they were doing it.

Many candidates provided a list of appropriate apparatus for their investigations but had not linked it to their preliminary work or indicated why it had been selected in preference to alternative equipment. Those candidates who exerted some choice over the apparatus they used were in a better position to achieve higher marks in S(b) and also when evaluating their procedures and methods in E(a). Candidates need to explore different methods and choose between different pieces of apparatus to find the best way to collect good quality data. Some candidates provided very simplistic justifications and Centres are reminded that it is **quality** of response in this context that is being rewarded. Many Centres provided a fixed, limited set of apparatus for candidates to choose from and this did not allow candidates the flexibility to try various approaches to obtain the best quality data set.

The complexity of a task, S(a), represents an overall judgement about the way a candidate has approached the task. Therefore, two candidates doing the same investigation might approach it differently and therefore achieve different marks. Complexity depends on the demand and

challenge involved in the approach adopted by the candidate and includes such indicators as the familiarity of the activity and method, the skills involved in making observations or measurements, single or multi-step procedures, the nature of the factors which are varied, controlled or taken into account, the precision of the measurements made, and the range, accuracy and reliability of the data collected. Too often 7 or 8 marks were awarded for straightforward approaches to the task. 'Resistance of a wire' investigations were frequently over marked in this aspect.

Strand C: Collecting data

It was pleasing to see that the majority of candidates used suitable ranges of the appropriate variable to study, and appreciated the need to repeat their measurements to obtain a wide range of data. However, a discussion of the factors to control was often rather limited for C(a) and only by inspection of the results table could any evidence be found. Better candidates described in detail how the factors had been controlled and, even more importantly in some cases, monitored them during the experiment. Weaker candidates often stated that factors such as pH, surface area, current or temperature were kept the same, but failed to explain how this was actually done or monitored. Often room temperature was mentioned as being the 'variable controlled' in rates of reaction or resistance investigations which was not the key 'temperature' variable involved.

Preliminary work is essential because, if done properly, it can allow candidates' access to the higher marks of 7 or 8 in aspects (b) and (c). There was more evidence this year that candidates were doing preliminary work to establish the range of values of the appropriate variable to be used C(b). However, although some candidates presented their results in a table they did not use the results to explain how it informed their main method. Centres are reminded again that it is the quality of response and its relevance that is rewarded, and not just that preliminary work has been done so 'jumping through hoops' is not sufficient criteria for success. Too often, candidates did not consider their results as they were being collected so that obvious outliers were either ignored, or included without comment when calculating average values. It was very rare to see that a candidate had performed further repeats to replace the outlier to ensure that the data was reliable and of the best quality. Plotting rough graphs as the data is collected may help candidates to identify outliers as they are collected which can contribute towards credit for E(b), towards defining the trend in the results more clearly, I(b), and for an improved level of confidence in the conclusion E(c).

From inspection of results tables it was pleasing to see that candidates were taking more care and data was generally of good quality. However, there was little evidence of candidates performing preliminary work which involved making decisions about the type of apparatus, equipment and method to choose, to ensure the collection of the most accurate and reliable data [C(c)]. Preliminary work was often simply a shortened version of the main experiment with no attempt to use it to decide on a technique.

Strands I and E.

In general, candidates achieved their poorest marks in these two strands. For more details see the comments in the Data Analysis section. Many candidates still followed the previous Sc1 approach to investigations and used scientific knowledge to make predictions about the outcome of the investigation at the beginning of the investigation whereas the Twenty First Century Science model aims to give credit for candidates who process their results, look for patterns and then suggest explanations using their scientific knowledge and understanding. Very often candidates did not link their conclusions with their scientific explanations, I(c); detailed explanations using relevant scientific theory are best left until they are needed in Strand I.

Some candidates provided further comment about the confidence level E(c) in their conclusions in terms of how close the agreement was to their predictions using scientific theory. Some candidates whilst investigating the effect of length on the resistance of a wire plotted appropriate data and calculated resistivity, and compared this with data book values.

Strand P: Presentation

This Strand was generally fairly and accurately marked by Centres. Spelling, punctuation and grammar were sound and the majority of candidates' reports were well structured and organised. However, experimental methods were rather briefly described and lacked sufficient detail. Diagrams of apparatus were not always included and although data was generally accurately recorded and presented in appropriate tabular form, units were occasionally incorrect or missing.

Final comment

All members of the moderating team recognise the considerable effort needed by Centres in assessing and presenting candidates' work for moderation. We would like to record our thanks and appreciation for a thorough and professional job carried out by the majority of Centres. However, there appeared to be an increase in **errors in calculating the Strand marks for candidates** which resulted in considerable extra work for both moderators and Centres (please consult the administrative issues section in this report).

Attendance at cluster group meetings and OCR INSET meetings both in- and out-of house, using the OCR consultancy service for checking marked scripts, consulting and using the teacher guidance booklets and exemplars on www.ocr.org.uk are all available methods to improve the awareness and understanding of the assessment procedure. It is highly advisable that staff have time during the year for internal standardisation meetings to share and develop

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