GCSE

Physics A
Twenty First Century Science

General Certificate of Secondary Education **J635**

Report on the Units

June 2008

J635/MS/R/08

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REPORTS ON THE UNITS

A331/01 – Twenty First Century Science Physics A (P1, P2, P3) Foundation Tier

General Comments

The paper was well attempted and produced a high mean result with 5% of candidates obtaining less than 20 marks out of the 42 available and 50% scoring more than 29. Very few candidates failed to answer all of the questions. As marking is from scanned images of scripts, candidates must be aware of the need for alterations to be unambiguous.

Comments on Individual Questions

Question 1

(a) Most candidates correctly placed the first two responses but many were incorrect with the order in which they placed the last two.

(b) Most candidates identified at least two of the three correct responses and many obtained full marks. The '..same pattern of rocks..' and '…shapes of continents' were identified as correct by most. '..movement of the continents..' was often incorrectly selected.

(c) Majority of candidates responded correctly with the 'Mid-ocean ridges…' sometimes incorrectly selected.

Question 2

(a) Most candidates identified at least one of the two correct statements about the star shades, the most common correct was the first one. A common error was to select the fifth response confusing seeing the planet and seeing organisms on the planet. Many neglected to note the thrusters information and did not indicate the second box.

(b) Several candidates ticked only one box when two were asked for in the question. Most commonly this was the 'Light pollution..' box.

Teacher Tip – this could be used to reinforce the need to read the stem of the question carefully.

(c) Most candidates responded correctly with first and last rows. A minority correctly answered the second row and very few were correct with row 3. Many thought that Churchill's reference to life on a distant planet meant that he was claiming there must be life on distant planets.

Question 3

(a) Only half of the candidates were able to answer this question correctly, but many identified the light box correctly, then incorrectly placing the other two. Many alterations to responses were made here as candidates appeared unsure of the correct answers.

(b) Most candidates correct with part (i), readily identifying Alex and Carys' actions to reduce risk. In (ii) nearly all candidates realised Derek was talking about dangers, but less identified Beth as well. In (iii), most identified Alex and many Carys. Almost all candidates scored at least three marks here.

Question 4

(a) Many candidates found this question difficult with more than a third scoring one mark and a quarter scoring zero. ‘Penetrating’ was a common response in the second sentence and ‘Ultraviolet’ common in both.

(b) About half the candidates scored here. ‘Light’ was a common incorrect response, despite the use of the word ‘invisible’ in the question.

(c) Most candidates scored one of the marks. ‘Temperature’ was a common incorrect response along with one of the two correct ones. ‘Shape’ was rarely chosen.

Question 5

(a) Most candidates correct with (i) and nearly all with (ii), indicating confidence of candidates in handling data in pie chart form.

(b) Most candidates correct with rows 1 & 2 and many correct with 3 or 4. Few obtained all four correct. Some candidates possibly unsure of meaning of ‘economic and ‘efficiency’.

Question 6

(a) Just over half the candidates were correct here. Many responded with ‘400’ presumably having read only part of the question.

Teacher tip – This question could be used to reinforce the need to read all parts of the question carefully.

(b) This proved a difficult question for most candidates. Although printed in bold, it would appear many candidates did not realise that the conclusions had to come from the bar chart information. Very few scored two marks and less than half, one mark. Many candidates ticked one, three or four boxes.

(c) (i) Candidates found the calculation difficult and only a third were correct. 80% was a common incorrect response presumably taken from the 800 figure on the bar chart.

(c) (ii) The majority of candidates were correct here with just a few selecting A or B.

(c) (iii) Most candidates scored all three marks, listing all of the statements in the correct order demonstrating good understanding of the concepts.

A331/02 – Twenty First Century Science Physics A (P1, P2, P3) Higher Tier

General Comments

It was good to find that the vast majority of candidates entered for this paper scored well, indicating that their Centres had entered them for the correct tier. Few candidates scored less than half marks.

Nearly all of the questions provided satisfactory discrimination between strong and weak candidates, with no question defeating all of them. Of course, with the majority of questions being worth more than one mark, a candidate who just guesses the answers would be unlucky to end up with zero. However, a weak candidate will think they know the answer and opt for an obvious distractor, so can easily do worse than by just chance.

Comments on Individual Questions

Question 1
Part (a) was an easy start to the paper, with most candidates earning full marks. Part (b) was more tricky, with many candidates opting for the obvious distractor that Wegener was not a trained geologist. Most candidates earned two of the marks for (c), quite often losing a mark by ticking a fourth box.

Question 2
The majority of candidates were able to absorb the information in the article and earn all three marks for (a). The commonest error was to assume that the telescope would search for planets within our own Solar System. Part (b) proved more difficult, with many candidates assuming the telescope would be closer to the planets being observed - suggesting that they have little idea of the distance between stars. In part (c) the majority of candidates earned all four marks, showing that they have had lots of practice at this sort of comprehension exercise.

Question 3
Part (a) required candidates to display some knowledge of the order of parts of the electromagnetic spectrum. Although nearly all strong candidates earned both marks, a significant number of weak candidates earned none. The correct names in the wrong order would be bad enough, but when alpha and beta turn up regularly ... Part (b) was about risk, dangers and benefits. The majority of candidates had no difficulty at all in showing that they understood the meanings of these terms.

Question 4
This question was about terahertz radiation. It was not expected that candidates had met this before, they were required to just use the information given to answer the questions. Both parts (a) and (b) provided good discrimination. For part (a) only strong candidates could match all three applications with the appropriate mix of properties; linking drugs investigation to penetration of the body was a popular mistake. Part (b) was not supposed to be as hard as it turned out to be, probably because candidates did not use the information provided, and went straight for X-rays, despite their ionising nature.

Question 5
Part (a) also proved to be unexpectedly discriminating, possibly because of the multistage nature of the calculation. Only half of the candidates managed to get a correct answer from what is little more than a commonsense sum. Many candidates had difficulty in part (b) with the term "environmental cost", with only a minority of candidates getting all three rows of the table correct.

Question 6
Nearly all candidates read part (a) carefully and earned the mark. Weak candidates found it difficult to decide how many of the statements of part (b) could be related to the bar chart, often ticking statements which were true in themselves but could not be proved from the information provided. Strong candidates had no problems with this. Weak candidates probably did not remember the information supplied in (b) when calculating their answer to (c), getting the wrong answer - but most candidates earned the mark. Part (d)(ii) was poorly answered by candidates of all abilities, suggesting that they had a shaky understanding of the term "precautionary principle". Keeping the house ventilated was the most popular wrong answer. However, many candidates earned at least three of the four marks for (e), showing a good grasp of cause and effect for the damage caused by radioactivity.

A332/01 – Twenty First Century Science Physics A (P4, P5, P6) Foundation Tier

General Comments

This paper is designed for candidates operating the G-C range. There was no evidence to suggest that candidates had been inappropriately entered for the paper. There was no evidence of candidates having time difficulties with the vast majority completing all questions in the time allowed.

Candidates should be aware that the marking is done from scanned images of their scripts. Consequently, if candidates change their minds, any alterations must be made clearly and unambiguously. Comments such as ‘please mark the pencil lines not the ink ones’ are impossible for markers to interpret. Any marks that are ambiguous – possibly made with the intention that the examiner could give credit either of two possible responses, where only one is correct – will not gain credit on this paper.

Comments on Individual Questions

Question 1
This question was answered correctly by most candidates. The most common errors were; reaction of air being sideways in part (a), graph D in part (c), and in part (d) kinetic energy.

Question 2
Candidates scored well on this question. In part (a) by far the most common error was to suggest the middle (horizontal) graph implied no movement. In part b most candidates scored one of the two marks, commonly the counter force statement. There was no apparent pattern to the incorrect choices.

Question 3
This question was a common question with the higher tier and was mainly targeted at the C/D area. In part (a) the most frequent correct response was the voltage being ‘greater than’, fewer candidates correctly gave the current as being ‘the same as’, the most common errors were the current being smaller or reversing the current and voltage.

Question 4
This question was a common question with the higher tier and was mainly targeted at the C/D area. Part (a) proved particularly demanding with few candidates scoring 2 marks. The most common error was ‘the arrow loses kinetic energy’. Some candidates may have not read the question carefully, which asks about when the arrow is released. In part (b) more candidates gave the correct response, and when incorrect there was no particular pattern of error.

Teacher Tip: This would be a good question to use to emphasise the importance of reading the question carefully.

Question 5
In part (a) nearly all candidates correctly identified electrons; however then most went onto to incorrectly say that gaining electrons made the plane positive. In part (b) most candidates gained 2 of the 3 marks, commonly for the current in the wire and moving electrons. The most common error was 'The wire is repelled by the charged plane'.

Question 6
The question was generally well answered by candidates. Most gained both marks for part (a) and b(i) the most common error in b(i) was magnet in place of iron for the material of the core of the transformer. The answers to part (c) appeared to be approximately equally distributed between the induced voltage, induced charge and induced resistance.

Question 7
This question was a common question with the higher tier and was mainly targeted at the C/D area. The high demand for foundation tier candidates was apparent with few scoring well on this question. In part (a) more identified beam A as refracted than beam B as reflected. In both cases diffracted was the most common error. In part (b) many candidates correctly identified the wavelength as changing, but were less confident about how it changed. Some candidates had the right idea but unfortunately choose decreasing frequency.

Question 8
This question was answered well by most candidates. A surprising number of candidates incorrectly put X-rays next to radio waves. Nearly all candidates scored full marks for (b).In part (c) the 'black' and 'white' proved strong distracters to the correct 'dense'.

Teachers Tip: Make sure candidates know the em spectrum can be drawn with frequency increasing to the right or with frequency increasing to the left.

Question 9
Candidates were not clear in their knowledge of digital signalling. Most knew the meaning of the key terms in part (a). Speed and direction proved strong distractors in part (b). In part (c)(i) about half could correctly identify the analogue signals. In part (c) (ii) nearly all knew that the microphone sending a digital signal made a difference, but only about half suggested the analogue signal would be worse.

A332/02 – Twenty First Century Science Physics A (P4,P5,P6) Higher Tier'

General Comments

The paper was generally well attempted, with a mean mark slightly down on January 2008, which was the first time the examination was offered.

An overall impression is that candidates were generally clear about their subject knowledge, and many showed impressive understanding of some very difficult concepts in electrical circuits, forces and waves.

Centres are reminded that questions on this paper will all be objective style. Most candidates correctly followed the instructions in the questions and most made their responses appropriate to the number of marks available. Candidates should be aware that the marking is done from scanned black-and-white images of their scripts and are marked online. Consequently, if candidates change their minds, any alterations must be made clearly and unambiguously. To put additional lines or write comments such as “please mark the pencil” or “the blue lines are correct” make it difficult for the examiner.
Any marks that are ambiguous – possibly made with the intention that the examiner could give credit for either of two possible responses, where only one is correct – will not gain credit on this paper.

All candidates seemed to have made good use of their time. The number of “No response” answers was very small indeed.

Comments on Individual Questions

Question 1
Few candidates managed to get all three correct statements about energy and momentum changes when a bow shoots an arrow, but almost everyone correctly joined boxes to give three correct statements about it.

Question 2
Most candidates showed good understanding of electrical circuits here and were able to calculate electrical power correctly.

Question 3
The forces involved in a balloon ride were found difficult, as expected: forces and counter forces are often confused. Most candidates could correctly identify the calculations needed for gravitational and kinetic energy, and virtually everyone identified the correct height-time graph.

Question 4
The speed-time graph from the lorry tachograph was found hard by most, with only the very best candidates identifying all three regions correctly.

Question 5
The sentence completion part of this question on static electricity was correctly done only by the most successful candidates. Most identified electrons correctly, but a significant number thought that they were positive.

Question 6
Reflection and refraction were correctly identified by stronger candidates, but weaker ones confusion diffraction with one of these. Only the best candidates were able to identify the correct changes to light as it leaves a dense medium.

Question 7
Alternating current was well remembered as both a graph and a name, but only the best candidates were able to complete the sentences about transformer action correctly. The sequencing exercise in 7bii was done well by most.

Question 8
Most candidates were able to describe the nature of the X-ray beam and its use in taking X-ray photos by joining boxes; only the most successful could relate the darkening of the film to absorption and transmission.

Question 9
The question about a radio microphone was well done; no-one seemed confused by the fact that it is referred to as a microphone, as it is in real life, whereas in reality it contains a microphone, amplifier, A-D converter and transmitter.

A333/01 – Twenty First Century Science Physics A (Ideas in context plus P7) Foundation Tier

General Comments

Generally candidates performed well on this paper. Most appeared to be entered for the correct tier although a small minority of very high scores suggest that some centres were "playing safe" with some students to ensure they got a grade C.

Candidates should be aware that the marking is done from scanned images of their scripts. Consequently, if candidates change their minds, any alterations must be made clearly and unambiguously.

The level of difficulty was appropriate for the ability range and most questions were accessible to candidates across the ability range. The majority of candidates generally performed well and marks were awarded across a wide range, demonstrating appropriate differentiation. Scores typically ranged from the high teens to the high thirties.

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.

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

Question one (15 marks) on this paper is based on the pre release article that centres received well in advance of the exam. Centres should be aware that this article can and should be used in preparing candidates for this exam.

Comments on Individual Questions

Question 1

(a) This question was answered very well with the vast majority of candidates gaining full marks. Although a significant minority of candidates only managed to write down one use of radioactive material despite five uses being listed in the article. Teachers should ensure that they have used the article in preparing candidates for this exam.

(b) The majority of candidates scored both marks on this question however many candidates scored 0. This appeared to be because they did not use the pie chart in the article and tried to remember the sources of radiation. "Background radiation" and "ionising radiation" were two common wrong answers that did not gain credit.

(c) This question differentiated well across most candidates, with many candidates gaining one mark usually for the example. There was confusion amongst weaker candidates as to the meaning of background radiation and "we are all exposed to it" "radiation that is already there" and "naturally occurring" were fairly common errors, being too vague to gain credit.

(d) This question was well answered by the majority of candidates, with over half gaining 3 or 4 marks. A significant minority gained no marks, mainly due to not attempting this question. Centres should be aware that candidates will be expected to write continuous prose in this paper, and marks will be available for communication, in this case a clear and ordered answer. For those who did address the question the quality of communication was very good.

There were still vague comments about nuclear power being “bad for the environment” as seen in previous specifications that have examined nuclear power, although these are becoming less common. Credit was not given for just repeating facts and figures from the article.

(e) This question was overlap with the higher tier paper. This question differentiated well especially amongst stronger candidates. A third of candidates gained no marks for part i although over half gained one mark. Common errors included electrons being removed from cells rather than atoms and repeating the stem of the question in their answers. Candidates were more successful at part ii were the majority of candidates gained 2 or 3 marks, showing that candidates are becoming more proficient at weighing up arguments for and against, and being able to back up their ideas.

Questions 2 to 5 were based on the P7 unit content and accounted for 40 marks.

Question 2

(a) This question was answered well with most candidates gaining 2 or 3 marks. The most common error was to confuse the object and the image whilst correctly knowing the lens and the focal point. 2 marks were given for correctly labelling 2 or 3 of the items.

(b) Part i of this question was well answered by the stronger candidates although almost a third of candidates gained no credit. The most common mistake was choosing A with the reason “it is thinner so more light will get through”. Those who chose C usually stated the correct reason. Candidates found part ii very hard with over 90% gaining no credit. Credit was given for the reason only, not for picking the correct lens. Centres are reminded that the lenses section of P7 is in the context of telescopes.

(c) Part i of this question was a very good at differentiating between candidates. Most candidates seemed to be familiar with the diagram, with a small minority of candidates gaining only one mark. Part ii was poorly attempted with many candidates referring to focal length, better magnification, and many vague comments about seeing more with a mirror. This question addressed the idea that very faint or very distant stars need large telescopes to collect the very weak radiation from them.

Question 3

(a) This question discriminated well across most candidates. In part i candidates should be aware that the marking is done from scanned images of their scripts. Consequently, if candidates change their minds, any alterations must be made clearly and unambiguously. Comments such as ‘please mark the pencil lines not the ink ones’ are impossible for markers to interpret. In part ii a surprisingly large number of candidates could not explain why the moon moves like this. Similarly in part iii a significant majority of the candidates did not know how long it took the moon to travel across the sky.

(b) Part i of this question was well answered by most of the candidates although again candidates are reminded that any alterations must be made clearly and unambiguously. Part ii discriminated well across candidates, with strong candidates scoring full marks.

Question 4

(a) Candidates generally did not know the location of a major astronomical observatory on earth. Very common errors included Hubble, and vague places such as England, or London. The mark scheme has a short list of some major observatories but other examples were allowed.

(b) Candidates answered part i very well and scored highly. Part ii was generally well done, although a significant minority chose arguments against the observatory. Candidates are reminded to read the question carefully.

(c) This question discriminated very well with the stronger candidates gaining full marks. Vague comments about “you can see everything” and “you can see more” were not credited. Comments about cost needed to be qualified and usually were.

(d) Most candidates scored on this question although a significant number were penalised for unspecific answers such a as “cheaper”, and “we will learn more”

Question 5

(a) Candidates found this question quite hard, with many answering “fusion” or “fission”.

(b) Part i was a very good discriminator. Most candidates knew that the pressure increased with temperature but only the stronger candidates went on to use a molecular model to explain this. Many students suggested “more energy” or “moves more” without sufficient explanation of collisions to gain the second mark. In part ii the vast majority of candidates could not convert correctly from Kelvin. The most common error was 3000 rather than –270.

(c) Part i was a good discriminator amongst the weaker candidates, with about half of candidates scoring one mark. Candidates knowledge of the repulsive electrical force inside the nucleus was very weak. Nearly all candidates got this wrong, with gravity being a common mistake.

(d) This question was a very good discriminator across all candidates but especially amongst the stronger candidates. Candidates tended to either get 2 marks or no marks in part i with neutrons and protons being the most common wrong answers. Candidates’ knowledge of the internal structure of a star was generally weak, with some confusing it with a diagram of the Earth. The mark scheme includes the radiative zone to allow credit for those candidates with further knowledge (beyond the specification) of the structure of a star.

A333/02 – Twenty First Century Science Physics A (Ideas in context plus P7) Higher Tier

General Comments

The Higher tier paper is designed to test the knowledge and skills of candidates performing at grades C to A*. It was a pleasure to see many candidates demonstrating an excellent grasp of the concepts, ideas and knowledge required for the exam. Clearly most candidates were well prepared for the exam and took the opportunity to show their knowledge and understanding. In general candidates made good use of time with little evidence that they ran out of time.

However there was evidence to suggest that a significant minority of candidates were inappropriately prepared for the higher tier paper. In particular some appeared unfamiliar with specification content specifically identified as higher tier and had difficulty expressing their ideas clearly in scientific language.

Unlike the objective style papers A331 and A332 this paper requires candidate's to express their ideas clearly using appropriate scientific terminology. Students aiming at a grade C should be entered for the foundation tier paper where they will be able to show what they know and can do. The higher tier paper is designed to differentiate between higher grades and many of the questions require knowledge specific to the higher tier and many questions require candidates to analyse and present answers at a much higher level than on the foundation paper.

Comments on Individual Questions

Question 1
This question was based on the pre-release article. Part (a) was common with the foundation paper.

(a) This was well answered by most candidates In part (i) candidates were aware ionising radiation causing damage/mutations/cancer, a common misconception was to confuse cells and atoms e.g. 'cells are ionised' and 'electrons are removed from cells'. Nearly all candidates could give examples of appropriate benefits and risks.

(b) The best answers were characterised by diagrams and descriptions that supported each. Many picked up marks for good diagrams. The most common error was failing to identify the neutron as the particle triggering decays. Weaker candidates suggested that the nuclei were subdividing and then subdividing again to give smaller and smaller nuclei. A significant number of answers were far too general and did not explain the chain reaction in the context given of Uranium fission, e.g. domino effect (complete with diagram of dominoes), or matches. Some weak candidates gave descriptions of the inner workings of a nuclear power station.

(c) This was generally answered well. Some candidates misunderstood what was meant by intervention, others just mentioned shut down rather than melt down.

(d) A significant proportion of candidates failed to realise the question was focused on the structure of the nuclei. These candidates tended to answer in terms of alpha radiation as a similarity and half lives different (some of these were the wrong way around as candidates missed the 4.5 billion and read it as 4.5 million). A mark was allowed for a correct half-life comment. A number of candidates had protons and neutrons confused.

(e) For most candidates the half-life calculation was a mystery. Some correctly identified 3 half-lives had taken place but then halved the time 3 times. Others just multiplied 4.5 billion by 7/8. Even those who gave a correct answer had difficulty laying out the calculation in a clear manner.

Question 2

This question was common with the foundation paper.

(a) This was correctly answered by most candidates.

(b) Almost all candidates knew that pressure increased for part (i). Typical inadequate responses were too vague for a second mark e.g. ‘moves more’ ‘vibrate more’ and ‘more energy’. In part (ii) a common error was 276. a significant number of candidates gave 3000 as an answer, suggesting they had not been introduced to the Kelvin temperature unit.

(c) Part (i) was correctly answered by most candidates, the most common errors being nucleus for neutron and reversing protons and neutrons. Part (ii) proved demanding, with many incorrect responses, e.g. gravity and many vague responses e.g. repulsive.

(d) Most candidates knew that hydrogen fused to form helium, a few reversed this to helium fusing to produce hydrogen. In part(ii) most candidates scored well the regions of the Sun were generally named well although a number gave the following incorrect answers ‘radioactive zone’ ‘connective zone’ and ‘protosphere’. Most knew that fusion occurred in core and energy emitted at the photosphere. There was confusion with the structure of the earth (inner and outer core, mantle, crust ideas) with weaker candidates. Some candidates suggested ‘fussion’ took place in the core, this did not gain a mark. Both radiative and convective zones were accepted for the middle region on the diagram and convective zone or photosphere for the outer region of the diagram.

Question 3

(a) Many candidates gave the too vague an answer of ‘about 1 hour’. Some candidates, probably through not reading the question, gave 24 H 49 min. Many weaker candidates said 28 days.
Few candidates linked the Earth’s rotation with the moons orbit and both in the same direction. Weaker candidates gave answers such as ‘the earth orbits the sun and the moon orbits the earth’ or mentioning the moon has a tilted orbit.

(b) This question was demanding and required the candidates to visualise the appearance of the Moon from the Earth. Most candidates correctly got the ‘E’ for the half Moon. Lots of apparent guesses – other letters came up in equal measure.

(c) Most got marks for Moon between Earth and Sun and nearly all were aware of the tilted orbit. However few were able to express the ideas clearly enough to explain why this leads to few solar eclipses.

Question 4

Most candidates named an example of a relevant international project. However very few candidates stated the purpose of the project, despite being asked for a description in the question. Lots giving the telescopes in Chile or Hawaii, and many naming Hubble, which was accepted. Weaker candidates suggested NASA or ESA which were not accepted. Most candidates gave ‘sharing cost’ with less recognising the ‘sharing of expertise’. Almost all got the communication mark for a clear and orderly answer which addresses the question.

Question 5

(a) Many candidates found this challenging, possibly because the rays were not parallel to the lens axis. Many candidates added their own light rays into the lens, often parallel to the axis. Often the top ray was continued through the focal point. Other common errors were not labelling the image, or indicating it as a line not a point.

(b) Candidates were usually able to select the correct equation, but some were unable to rearrange the equation successfully for part (i) often leading to an answer of 20. In part (ii) most were correct. The mistakes here were powers of ten mistakes or giving a unit (usually m or dioptres). Part (iii) was well answered on the whole with candidates applying the equation to the novel situation. Vague answers did not score marks e.g. they cancel each other out / get blurred image / not focused.

(c) Most scored a mark here. The best candidates referred to concave mirrors, many to just mirrors. Most weaker candidates gave an answer in terms of lenses, with the occasional convex lens. In part (ii) a majority of candidates scored both marks, but the most common error was to use a lens (even when quoting a mirror in part (i)).

(d) Most candidates scored the ‘wavelength’ mark although a significant number used poor scientific language such as ‘longer/bigger wave’ or just ‘long wavelength’ (not comparative). Other common errors were to talk of ‘distortion’ or ‘refraction’ and many weaker candidates were referring to the dish catching the whole wave. Only the best candidates gave a clear answer using correct scientific language to link wavelength to diffraction and aperture size.

A339 – Twenty First Century Physics A (Practical Data Analysis and Case Study)
A340 – Twenty First Century Physics A (Practical Investigation)

General Comments

This is the second year of the Practical Data Analysis and Case Study coursework. However, for many Centres this was the first year of presenting candidates' work for moderation. The scale of the assessment and moderation operation increased significantly this year. Last year some 200 Centres were involved in Practical Data Analysis and Case Studies. This year, 1000 Centres submitted work for more than 225,000 candidate entries across all the specifications within the Twenty First Century Science suite, representing a huge increase in the moderation required.

The moderation team had to be increased substantially and included a good mixture of experienced moderators from the legacy and Pilot specifications and new moderators with experience of teaching Twenty First Century Science.

In Biology A, there was approximately an equal number of candidate entries for the two different Skills Assessment routes, whereas in Chemistry A and Physics A there was approximately twice as many candidates opting for the Investigation route as compared to the Data Analysis and Case Study.

A substantial number of Centres made late (sometimes very late) entries for the Skills Assessment. One cause appeared to be lack of familiarity with UMS systems, so that Centres did not realise they needed to register candidates for coursework moderation as well as for the examination papers and subject aggregation. It is to be hoped that this will not occur again, as it put moderators under great time pressure to complete the work.

Considering the very large number of Centres involved, only a small proportion required mark adjustments to bring them into line with national standards which was very pleasing. However, there were a significant number of Centres that were very close to the tolerance allowed and will need to act on moderators' comments to ensure that there are no problems next year. The agreement between the moderator and Centre in the total marks awarded for each candidate's piece of work was generally quite close although the individual marks awarded for the strands and aspects in the assessment framework varied. Overall, teachers are to be congratulated on the very good transfer of assessment skills from the legacy to the new specifications.

It appears from discussions with people attending INSET that the Principal Moderator Report for 2007 had not always been seen and read. Therefore some of the comments and guidance has been repeated again in this report.

Structure of the report
This report is divided into the following sections:
- Administrative aspects
- Supervision and management of coursework
- Marking grids and best fit model of marking
- Marking strands B and C in case studies
- Marking strands I and P in data analyses and practical investigations
- Data Analysis
- Case Studies
- Investigations
- Grade Thresholds

Administrative aspects

Due to the large number of centres submitting coursework this year it was perhaps not surprising that there were a significant number of administrative problems. Moderators included in their request for the coursework sample a simple checklist for Centres to use to ensure that everything that was needed was included. This helped both centres and moderators to improve efficiency and effectiveness.

The best Centres followed this checklist and included:
- The MS1 sheet or other OCR approved method, clearly showing the total marks awarded
- A spreadsheet showing the rank order and teaching sets of candidates
- The centre authentication sheet (CCS160)
- Candidates work stapled in the left-hand corner with the appropriate OCR front cover showing the details of the mark breakdown
- Details of how each of the tasks used for assessment had been introduced and presented to candidates and any further supporting material
- Annotation on candidates' work in the sample showing where and why the marks were awarded
- Documentation with contact name, phone number and email address for the person responsible for administration of the sample of coursework
- Details of internal standardisation procedures. Some Centres marked the exemplar material provided at an OCR INSET session and discussed and noted good practice. and then selected work from within the Centre to cross-moderate.

However, a significant minority of centres did not appear to give enough care and attention to administrative aspects to ensure that their candidates received the correct total marks and that moderation proceeded smoothly. This caused numerous problems for the team of moderators given the short timescale for the completion of the moderation process.

The following were the most common problems:
- Errors in transcription to the MS1 form
- The copy of the MS1 sent to the moderator showing the marks of each candidate was often not legible
- Mark changes to candidates' work at the internal moderation stage not being carried forward to the MS1 sheet
- Misunderstanding of the best-fit approach to awarding marks
- Missing front coversheet on candidates' work
- Poor annotation showing where the marks were awarded. In some cases the annotations did not match the mark on the coversheet. In the Practical Data Analysis, those Centres who used a simple coding, such as I(a) 4, helped considerably to identify where the evidence could be found to help moderators confirm Centres' judgements.

- Minimal description of how tasks were introduced to candidates
- Little information about internal moderation procedures.

Following guidance from the Joint Council for Qualifications (JCQ), coursework can be submitted for as many specifications as it is valid for. This means that it has to match both type (e.g. Data Analysis and Case Study) and context (i.e. Biology, Chemistry or Physics) as appropriate for the specification concerned. A number of Centres did not follow these requirements with respect to context and this will not be acceptable next year. Furthermore, if the same piece of coursework is submitted for more than one specification then it must be photocopied and put into the appropriate sample. Many Centres did not help the moderation process work efficiently in this way.

Moderators also commented that there were a significant number of Centres that did not send the mark lists and samples promptly. On occasions it was difficult for moderators to make rapid contact with the person who was responsible for the administrative paperwork to sort out any problems and this slowed the moderation process. The position of half-term in many Centres in the middle of the moderating period was recognised as a contributing factor to some aspects of this problem.

Supervision and management of coursework

There was evidence that some coursework from a 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 which are available in all schools. This can be downloaded through the internet, at the following link:

(http://www.jcq.org.uk/attachments/published/315/ICE%20Coursework%202007%20FINAL.pdf)

The following quotes are from this document:

“Candidates should be clear about the criteria they are expected to meet in their coursework… they may need some further explanation or interpretation before they fully understand the nature of the skills they are expected to demonstrate.”

“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, there is no need to record this advice as assistance or to deduct marks. Generally one review would be expected to be sufficient to enable candidates to understand the demands of the assessment criteria.”

“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),”

“Once work is submitted for final assessment it may not be revised: in no circumstances are 'fair copies' of marked work allowed”.

Marking grids and best fit model of marking

The majority of Centres recorded their marking decisions on the OCR marking grids and used the completed grid as a coversheet for the work of each candidate as required. However, some Centres did not appreciate that in the best fit model of marking, **all** aspects of performance of a given strand must be assessed and then a 'best fit' mark selected. The award of marks is based on the professional judgement of the science teacher, working within a framework of descriptions of performance which are divided into **strands and aspects**. Each aspect of performance should be considered in turn, comparing the piece of work first against the lowest performance description, then each subsequent higher one in a **hierarchical** manner until the work no longer matches the performance description. Where performance significantly exceeds that required by one description, but does not sufficiently match the next higher one, the intermediate whole number mark should be given if available. Thus, the level of performance in each aspect is decided.

The single, overall, mark for the whole strand is then taken as the best fit to the level of performance shown. In the marking of the Data Analysis, each strand is divided into three aspects. Therefore the best fit strand mark would normally be the average of the marks judged for the individual aspects rounding to the nearest whole number. All aspects of that strand must be considered in arriving at the strand mark; if there is no evidence of achievement for an aspect, a mark of zero should be recorded and included in the calculation of the overall strand mark.

For example: E(a)5, E(b)4, E(c)6 Strand E = (5+4+6)/3 = 5 marks
E(a)6, E(b)4, E(c)6 Strand E = (6+4+6)/3 = 5 marks
E(a)7, E(b)4, E(c)6 Strand E = (7+4+6)/3 = 6 marks
E(a)7, E(b)6, E(c)2 Strand E = (7+6+2)/3 = 5 marks
E(a)7, E(b)6, E(c)0 Strand E = (7+6+0)/3 = 4 marks

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.
There was a tendency for some Centres to award marks on the basis of candidates matching one high level performance description rather than treating the descriptions in a hierarchical way and ensuring that the underpinning descriptions had been matched. A few Centres just counted the highest mark for any aspect to arrive at the strand mark.

Marking strands B and C in case studies

In the marking of the Case Study, strands A and D also have three aspects and a similar best fit procedure to that described above can be used.
However, in strands B and C there are only two aspects in each, and in some cases a professional judgement has to be made when arriving at the best fit strand mark from the average, for example, if 4 marks are awarded for B(a) and 3 marks for B(b). From experience in these cases 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 and C(a) 4, C(b)3 are awarded, 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.

Marking strands I and P in data analyses and practical investigations

In a few instances, dotted lines on the assessment scheme are used to indicate alternative ways of obtaining credit and a number of Centres did not seem to appreciate what to do in these circumstances. Aspect (a) of strand I and aspect (b) of strand P are sub-divided in this way. This allows increased flexibility, so that the scheme can be applied to a wider variety of different types of activity. This arrangement evolved gradually during the pilot stage of development of the specification and there are some documents with older versions of the assessment grid still in existence in some Centres. Centres should take care to use the version in the current specification, available on the web site www.ocr.org.uk.

Strand I aspect (a) involves awarding credit for processing the data which has been collected to display any patterns. This may be achieved either graphically or by numerical processing, whichever is most appropriate in a particular Data Analysis. If there is some evidence for both approaches, then both should be marked and the better of the two counted.

Strand	Aspect of performance	0	1	2	3	4	5	6	7	8	Strand mark
I	Graphical processing of data **or** numerical processing data										
	Summary of evidence										
	Explanations suggested										

Strand P aspect (b)
Strand P in Data Analysis is made up of three aspects:

- P(a) describing the work planned and carried out
- P(b) recording of data
- P(c) general quality of communication

Aspect (b) is sub-divided into three sections to allow it to cover a wider variety of different types of investigation.

	2	4	6	8
P(b)	Major experimental parameters are not recorded. Some data may be missing.	Most relevant data is recorded, but where repeats have been used, average values rather than raw data may be recorded.	All raw data, including repeat values, are recorded.	All relevant parameters and raw data including repeat values are recorded to an appropriate degree of accuracy.
	Labelling of tables is inadequate. Most units are absent or incorrect.	Labelling is unclear or incomplete. Some units may be absent or incorrect.	All quantities are identified, but some units may be omitted.	A substantial body of information is correctly recorded to an appropriate level of accuracy in well-organised ways.
	Observations are incomplete or sketchily recorded.	Recording of observations is adequate but lacks detail.	Observations are adequate and clearly recorded.	Observations are thorough and recorded in full detail.

The first row of aspect (b) is concerned with recording quantitative data (e.g. times, voltages, volumes etc). The second row deals with the use of conventions and rules for showing units or for labelling in tables etc. The third row of aspect (b) deals with recording of qualitative data (e.g. colours, smells etc). Most Data Analysis assessments are of a quantitative nature and will provide evidence for the first and second rows; they should be considered together and a best fit mark given for aspect (b), ignoring the third row because it is not relevant in this case. For those rare Data Analysis assessments which do not include quantitative but only qualitative evidence, the mark for aspect (b) should be based on the second and third rows only. Once the 'best fit' 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 a Data Analysis providing quantitative evidence:

Aspect of performance				**Strand P mark**
P(a)		7	7	
P(b)	(i)	6	5	**6**
	(ii)	4		
	(iii)	not relevant		
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.

Data Analysis

General comments

The Data Analysis task provides the opportunity to assess candidates understanding of 'Ideas about Science', particularly IaS 1, 2, and 3. Those candidates who used the language and concepts related to IaS, such as 'correlation and cause', 'outliers', 'reliability', 'accuracy', 'best estimate', and 'real difference' found it much easier to match the performance descriptions of the criteria and gain higher marks.

The majority of Centres clearly understood the information included in the specification about the nature of the Data Analysis task that can be used for assessment purposes. **Candidates must have personal firsthand experience of collecting data by performing a practical experiment.** Candidates then analyse and evaluate this data and are assessed against the criteria in the specification. 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 etc, is not acceptable. Centres which do not fulfil this requirement will put the marks of their candidates in jeopardy. Therefore, it is very important that Centres include details of how the task was presented to their candidates. It is also important that candidates record and present the data that they have collected and not just plot a graph or do numerical calculations without any reference to the original data.

The better Centres introduced their candidates to the data task and involved them in discussion of the procedures and apparatus rather than just presenting candidates with a detailed worksheet. The whole class situation allows interactive discussion of the experiment so that all candidates understand the reasons why particular methods or ranges of values were chosen. It also allows all candidates to have access to a substantial body of data to provide a firm basis for interpretation and evaluation.

The same Strand I and E assessment criteria are used in investigations in Additional Science and the same marks for I and E from investigations can be submitted for Data Analysis as well. A few Centres did not appear to appreciate this possibility and in a number of cases, on the advice of the moderator, the marks of their candidates had to be adjusted to produce a more favourable outcome.

Many candidates appeared to be better placed to make realistic evaluations of their procedures and data collected through an investigation, rather than through a standalone data analysis experiment. However, in the case of weaker candidates, the data collected was often poor in quality and quantity so that they found interpretation difficult. Therefore, in these cases data analysis activities involving whole class participation were generally the most successful.

In strand I, compared to the previous Sc1.2 criteria, there is an increased demand in the assessment of graphical/numerical skills and of the ability to summarise evidence. A similar, but less marked, effect occurs in strand E. This increased demand resulted in a greater spread of marks, reflecting the different abilities of candidates, and gave clearer differentiation and consequently more secure grading.

Data Analysis Tasks

There was a great variety of data tasks seen by moderators, which was very encouraging, such as:

stopping distances of bicycles;
comparing thermal insulators;
resistance of a wire;
viscosity experiments;
voltage of different batteries;
objects rolling down slopes

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

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. However, some Centres did not appreciate the nature of the 'dotted line' dividing aspect (a) into two approaches, graphical or numerical. As explained in detail earlier in this report, candidates can be assessed on graphical **and/or** numerical processing of data as appropriate and the higher mark can be used in the assessment of this aspect. There is, of course, an inherent understanding that there must be a level of comparability in level of demand between these two routes when awarding similar marks.

It was pleasing to see that the majority of candidates repeated their measurements and included range bars on their graphs indicating the spread and scatter of the results. However, in many cases the graphical work presented by candidates was not of suitable quality for the marks awarded. For example, poor care in general presentation, incorrectly labelled or scaled axes, incorrectly plotted points and poor accuracy of the best fit line. Computer-generated graphs are acceptable but it was noticeable that the best fit line was not always correctly produced and it was generally better for candidates to hand draw their own best fit line.

Some Centres were giving 7 or 8 marks for graphs which were not warranted. Centres must recognise that to be awarded 7 or 8 marks, an indication of the spread of data must be shown **in**

addition to the requirements for 6 marks. Candidates generally either plotted the averages with the appropriate range bars or plotted all their raw data with a suitable key.

The following guidelines might help to clarify the assessment of aspect (a) but it is not intended to be comprehensive and to cover all eventualities:

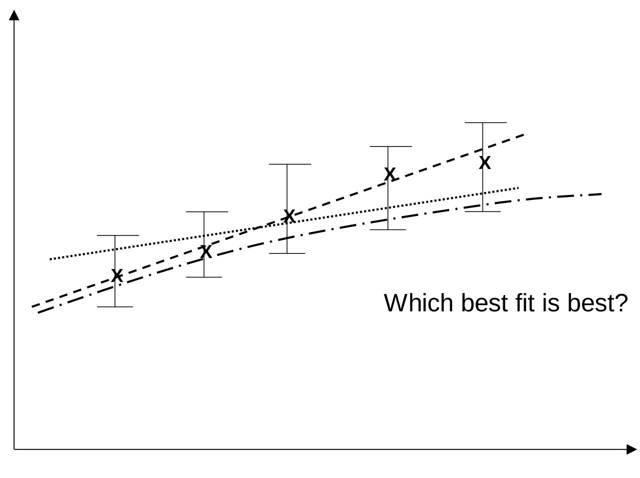
- I(a) 7/8 - accurately plotted graph including a line of best fit and evidence of awareness of uncertainty in data, e.g. range bars, scatter graphs
- I(a) 6 - graph with a best fit line, correctly plotted points, correctly labelled and scaled axes
- I(a) 5 – a dot-to-dot graph, or axes not labelled, or incorrectly plotted point(s), or poor quality best fit line
- I(a) 4 - simple charts, bar charts

For the numerical approach 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. There were cases when candidates used equations to process numerical data such as use of Ohm's Law, or energy change equations. The following guidelines might help when awarding marks but it must be stressed that level of complexity and demand must as always be taken into account.

- I(a) 6/7 – depending on complexity, a candidate substitutes appropriate measurements into an equation, correctly performs the appropriate calculation and excludes outliers when calculating
- I(a) 5/6 - depending on complexity, a candidate substitutes appropriate measurements into an equation, correctly performs the appropriate calculation but includes outliers when calculating averages or includes another minor error
- I(a) 4- a candidate substitutes appropriate measurements into an equation but does not calculate averages or calculates averages only.

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 to match I(b)6 with little evidence to support this award. Many candidates referred to 'positive correlation' when they should have said 'Y is directly proportional to X'.

Candidates should consider the patterns and trends and use their data to derive a more formal or quantitative relationship to ensure a secure match with I(b)6. For example, using and quoting the data to show 'as the concentration is doubled the rate doubles', or calculating slopes/gradients and then stating some formal or quantitative relationship between them and the variable studied. Candidates appeared to find it easier to express relationships when dealing with continuous variables. In those experiments which only involved categoric or discrete variables, candidates generally made simple comparisons of arbitrarily chosen pairs of results without bringing out any overall conclusion.



Aspect (b) at the highest level, builds on and extends that found in the previous Sc1.2 model. It requires candidates to review any limitations to their conclusions by considering such things as the scatter in the data, what might happen outside the range of values studied, any overlapping range bars between data points, 'real differences' and values of the best estimate, and whether the best fit line be precisely 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): In many cases candidates did not link their scientific knowledge and understanding to explain their particular conclusion, but related it to a more general situation. However, most candidates could secure a match to I(c)4 by explaining their conclusion using scientific ideas. Introducing scientific knowledge at this mark level is proving more demanding than the comparable level in the previous Sc1.2 model. However, there was some generous marking when matching to I(c)6 and I(c)8 in terms of the depth and quality of the scientific knowledge and understanding shown. In general terms, 5/6 marks would be expected to be awarded to an explanation at about the grade C standard and 7/8 marks at about the grade A standard.

Strand E: Evaluation

The importance of considering the accuracy and reliability of data and its consequent evaluation is an essential feature of this course. It is therefore of concern that the majority of candidates only achieved between 3 or 5 marks for this strand. Candidates should be encouraged to use the appropriate IaS (Ideas about Science) vocabulary and refer to ideas from IaS 1 when discussing the quality of their data.
In many evaluations, credit was given to candidates for describing what is human error rather than an experimental error.

E(a): Candidates are expected to comment on their procedures and to describe improvements or alternative ways to collect their data. Many candidates discussed improvements to their practical procedures, E(a)6, but failed to discuss the limitations of their procedures E(a)4. There was a tendency for some Centres to award marks on the basis of any hint of matching one performance description, rather than checking each level in a hierarchical way. The E(a)4 aspect of performance is really the 'gatekeeper' to access the higher marks. Many candidates suggested possible improvements although they were not always of sufficient quality to be creditworthy e.g. 'do it with a computer', 'repeat my measurements more times' without any justification or explanation, 'be more careful next time I do the experiment' etc. References to such things as better temperature control using a thermostat controlled water bath in a rates experiment or including a variable resistor in the circuit to keep the current constant in the resistance of a wire experiment were more suitable and creditable suggestions.

E(b): Candidates generally identified a data point as an outlier either in the table of results or on the graph although it was not always clear why a candidate had selected a particular result as an outlier. Few candidates considered the range in their repeat measurements to give an estimate of reliability and the general pattern in their results, closeness of data to the best fit line for example, as a basis for assessing accuracy. 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.

Better candidates made a decision about whether unexplained outliers should be included in the data and in ranges of repeat readings. Some candidates used simple statistics such as variations of the Q test procedure to try and be more objective when rejecting suspect observations and relating to confidence levels.

E(c): Marks were often rather generously awarded and this aspect was poorly addressed by candidates. Candidates often just discussed the reliability of their data without really linking it to their conclusion and saying whether the uncertainty in their data is sufficient to have any significant effect on the conclusion that they have made.

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, e.g. a limited range or not enough readings at certain values, or degree of scatter too large or variable, together with detailed suggestions about what further data could be collected to make the conclusions more secure.

Some candidates recognised that their conclusion can only apply to the range of values that were studied because outside this range other, specific changes may occur. For example, rates of reaction are bound to slow down as one of the chemicals gets used up, rubber bands eventually break, more exercise cannot always mean that pulse rate continues to increase, etc. Many candidates provided further comment about the confidence level 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, calculated resistivity and then compared this with data book values.

Case Studies

General comments

Case Studies continue to be a very successful aspect of the course and have drawn a most positive and enthusiastic response from candidates of all abilities. A number of comments made in last year's report are still appropriate and relevant this year. Case Studies are used to assess candidates' understanding of all aspects of 'Ideas about Science' (IaS), but particularly IaS 4, 5 and 6. The purpose of the Case Study is to encourage candidates to use their knowledge and understanding of the IaS to make judgements when presented with controversial issues which have claims and opinions for both sides of the case. There is still a great deal of evidence that many candidates are not being taught to use these skills when approaching their Case Studies. Where candidates 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', 'risks and benefits', and 'technical feasibility and values' they found it much easier to match the performance descriptions of the criteria and gain higher marks.

Case Studies are always best formulated in terms of a question to provide a focus in an area of controversy. For example, 'does air pollution cause asthma?' rather than just 'asthma'. A question will encourage candidates to look for different opinions and views, and to consider the evidence base for claims and the reliability of sources. Studies which were presented as questions to answer were always more effective than those which simply **described** a topic. The Case Study is not a report on a topic but a critical analysis of a controversial issue. Some topics are so uncontroversial that there are no valid opposing views.

In some Centres, all candidates were given the same topic title whereas in others a broader range of opportunities was given. In general, the latter approach was more successful. However, it is wise for teachers to closely monitor their candidates' choice and perhaps limit this to topics which have been covered in course modules. This means that candidates will have access to some basic explanatory science from their student book which will provide them with a good starting position for their study, and at least one book reference for their bibliography. However, whatever arrangements were adopted it was clear that students showed a sense of 'ownership' of the study, and even very weak students managed to produce sensible reports. The key point is that the Case Study question must invite debate and discussion of both sides of the case and be firmly embedded in a scientific context so that candidates can use their scientific knowledge and understanding and their understanding of IaS to produce a balanced account.

Choice of subjects for Case Studies

It was interesting to note that there appeared to be a slight shift in the popularity of subjects for Case Studies compared to last year, e.g. less on smoking and sunbathing issues but more on cloning and energy sources for the future. Case Studies will, and should, slightly shift and evolve as different issues arise in the news and also as new information and evidence is presented to change opinions and views. This will help to maintain motivation and enthusiasm.

Case Study titles included:

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 global warming natural or man-made?
Could life exist on other planets?

Some Centres used the film, 'The day after Tomorrow', as stimulus material for 'global warming'. Some centres picked on issues closer to home, e.g. 'dolphins caught in local fishing nets' as a stimulus for 'extinction' issues. There were some Case Studies which were founded on considerable ethical or moral viewpoints and limited science, and this made it difficult for candidates to access high marks in parts of Strands B and C.

Assessment

In general, candidates performed better in Strands A and D compared to B and C. The majority of candidates presented their work using good IT skills but the substance and quality of the work did not always match the high standard of presentation. However, many candidates did produce work which was quite outstanding and was a pleasure to read and moderate. The more successful 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 achieving 20 or more marks. Reports from the weakest candidates often consisted of perhaps two or three 'cut-and-paste' sections from a limited number of sources with minimal editorial comment from the candidate. Thus candidates in this group had selected relevant material from a source, made some attempt to link the facts together and present a report achieving perhaps 5 or 6 marks. Even middle-achieving candidates cut-and-pasted information from the internet and did not always comment on the information and interpret and analyse it sufficiently. The amount of added value in terms of analysis and evaluation by the candidate was often variable in these cases. This limited significantly the marks awarded in Strands B and C and also in D(c) where marks awarded for spelling, punctuation and grammar and the use of scientific vocabulary has to be decided on the words used by the candidate and not on the downloaded information.

It would be most helpful for moderation if more annotation or commentary was provided for each candidate in the sample selected so that the moderator could more easily identify the evidence to support the Centre's marks. In many cases only the final mark awarded was recorded.

Strand A: Quality of selection and use of information

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

A(a): The key aspect here is for candidates to use sources of information to provide evidence for **both sides** of their case study. Websites from the internet were by far the most common source but many candidates referred to their course textbook and their own class notes to collect information. The quality of extraction of information depends on careful selection of relevant extracts to quote directly, and the intelligent re-wording of content to bring out its relevance to the developing arguments in the study.
If no sources are credited then a maximum of 1 mark will be allowed by moderators, unless annotation confirms that a suitable range of sources were used. Higher marks require that sources represent a variety of different views or opinions, but there is not a 'magic number' of sources which divides 3 marks from 2,; quality is more important than quantity. Only the better candidates, in addition to the requirements of 3 marks, attempted to assess their sources in terms of reliability in any rigorous and appropriate way.
For 4 marks it would be expected that candidates consider, for example, whether the source of information is from a 'respectable pressure group' or from the 'quality media' or a school textbook or science magazine, or a peer reviewed science journal or government report. Just saying' I think that the information is reliable because it is from the BBC' is not sufficient. The status of the author and the author's affiliation/institution should also be considered. Therefore if the source of information is a peer reviewed journal, written by a leading expert in the field who is based in a major university then it is more likely to be considered a reliable source. Those candidates who used the language and ideas from IaS 4 in discussing the reliability of sources such as ideas about peer review, the nature of the source or the status of the author, invariably achieved higher marks.

The further to the right, the more reliable the source is likely to be. →

Publication	Website or newsletter of a private individual or a fringe group	Respectable pressure group website or newsletter	'Quality' media e.g. BBC, *The Times, The Independent, The Guardian, Daily Mail*	School textbook or science magazine e.g. New Scientist, Focus, Catalyst.	Peer reviewed science journal or government report
Nature of the data	Based on little or no data	Based on some data, but of questionable validity or reliability, e.g. small sample, not representative of population.	Based on just one study (or several small studies). Little information about sample, or procedures followed.	Valid and reliable method e.g. health study with large sample size, carried out over many years	Results repeated by different scientific studies, each using a valid and reliable method,
Science explanation	No support within the science community	New explanation, but with basis in accepted scientific ideas	One among several explanations discussed with the science community	Agreed by most, but not all, within the science community	Agreed by everyone within the science community
Status of the author	Someone who knows little or no science. Someone known to have a particular point of view	An inexperienced scientist or science student	A professional scientist whose expertise is in a different field	A professional scientist working in the area – though not regarded as a top expert by his/her peers	A recognised expert in this field of science
Author's affiliation or institution	A non-science institute	An scientific institute or company that represents particular views only	An scientific institute with a doubtful reputation	A recognised university or scientific institute	A leading university or scientific institute, or the research lab of a major company

A(b): The majority of candidates included a bibliography of sources at the end of their reports and most provided references to any websites that had been used. For 2 marks candidates identified their sources using incomplete references. In general, when applied to website addresses this meant that candidates referred to the homepages only e.g. www.bbc.co.uk. If only one or two incomplete references are given then one mark should be awarded and, of course, if no references are given then zero marks.
For 3 marks, candidates included complete references to the exact url address of the webpage which would allow direct access to the source of information. When referencing books, title, author and page references are required to match this mark. It was clear that more able candidates were including more detail, and this has begun to re-define the standard at 4 marks for 2009. Candidates working at this level included the date that the site was visited and also some information about the nature or sponsorship of the site. For example, a candidate presenting a Case Study on cloning included the following reference: *http://exchanges.state.gov/forum/journal* and went on to explain that it was the US Bureau of Educational and Cultural Affairs and included information from the Advances in Biotechnology journal to provide teachers with resources about breakthroughs in biotechnology.

A(c): Candidates were still not very good at clearly showing where sections of text were directly quoted. It should be made clear to candidates that they are expected to copy some, reasonably short, material from their sources but it is essential that they make this completely clear. 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 included references or specific links within the text to show the source of particular information or opinions using, for example, numerical superscripts linking to references in the bibliography. Credit is given, not so much for the quotation, as for the editorial comment to explain why it was chosen, and how the candidate thinks it contributes to the arguments being compared in the study. If this referencing is not done, then candidates may also suffer in strand B, where they cannot easily show that they have recognised and evaluated the scientific content of particular sources, and in strand C, where they compare different opinions.

A number of candidates handed in full print-outs of their sources which was not necessary. Some candidates gathered information from self-constructed questionnaires which also added to the pool of material for their Case Study, but occasionally this distracted them from the underlying science and scientific evidence.

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 Studies

In simple terms, this strand assesses candidates' ability to consider the claims and opinions they have collected from their sources, to describe and explain the underlying relevant science, and to recognise and evaluate the scientific evidence on which the claims were based (IaS 1, 2 and 3). Those candidates who had clearly been taught IaS used the appropriate language and concepts, and achieved higher marks. However, there was some general improvement in this area compared to last year with more candidates including relevant KS3 and KS4 scientific ideas and targeting their report towards the suggested audience of intelligent Year 9 students.

B(a): The majority of candidates described in the introduction to their case studies the relevant background science, with the more able candidates going in to a greater depth and detail. However, most candidates did not go much further and it was only the most able who could link their scientific knowledge and understanding to the claims and opinions that they had found from their sources. Reporting was too often still at the 'headline level', simply repeating claims without looking beyond the headline for the underlying science.

For topics which are related to course modules, it can be taken as a general guide that 6 marks requires all that is available in available supporting text books. The 7th or 8th mark will come either for applying this correctly to the case, or for finding and explaining some more specialised knowledge (e.g. the way in which up to 8 mobile phones can "time-share" a single frequency to reduce total radiation loads and increase capacity).

B(b): This aspect focuses on candidates' ability to recognise and evaluate the scientific evidence that any claims and opinions are based on. Most candidates were able to recognise and extract relevant scientific content and data in their sources and were awarded 4 marks. Candidates who were awarded 6 marks referred to the evidence base of the various claims and opinions, e.g. an experiment, a collection and review of existing data, a computer simulation etc. Candidates obtaining 7 or 8 marks looked more critically at the quality of the evidence. They used terms like 'reliability' and 'accuracy' when considering data, they looked at the design of experiments and the issue of sample size and they also compared the reliability of data between sources. For example, whether the evidence has been collected using a valid and reliable method, e.g. a health study with a large sample size over many years, or whether the results have been repeated by other people and the same conclusion drawn.
The information they find can be used towards credit for D(b) as well, if presented as graphs, charts or tables, or as informative schematic diagrams.

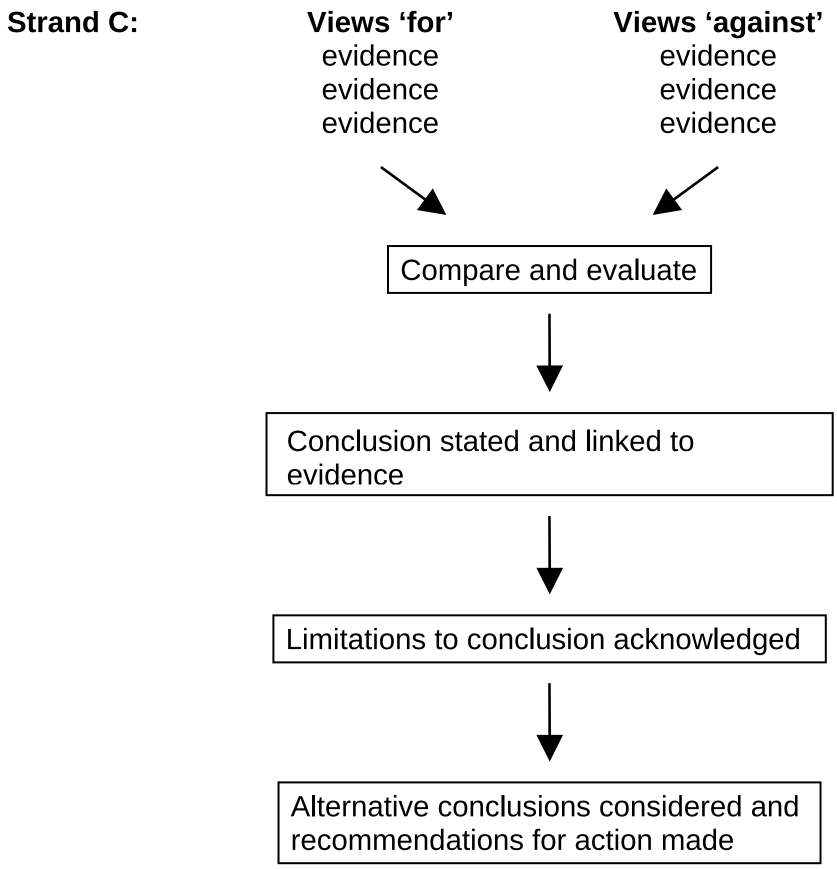
It was noted that in the Data Analysis component of this course, most candidates were able to some extent discuss and evaluate the data that they had personally collected in their practical experiments. However, in the context of the Case Study the vocabulary and use of terms from Ideas about Science were not used very frequently. Many candidates included tables/bar charts/graphs of relevant data but did not use or comment sufficiently on the information presented.

Strand C: quality of conclusions

In this strand, candidates should consider aspects of IaS 5 about actual and perceived risks and the ALARA principle and in IaS 6 about how society should respond. There was again evidence that candidates were not using and applying their 'Ideas about Science' sufficiently to warrant the higher marks in this strand.

The aspects for Strand C can be summarised in the simple flowchart overleaf.

Lower achieving candidates reported the information that they had collected without sorting it in any particular way and were awarded 2 marks. However, most candidates could sort the information that they had gathered into views 'for and against', sometimes in a tabular form if appropriate. Those who just listed it in this way were awarded 4 marks. Better candidates started to compare and balance arguments against one another in both their 'for and against' list and were awarded 6 marks. The best candidates began to analyse, compare and evaluate the claims and opinions, describing their own viewpoint or position in relation to the original question and justifying this by reference to the sources. There should be evidence that the sources used have been compared to check for consistency and to identify areas of conflict or disagreement. In this way it is clear that B(b) and C(a) are closely linked. There should also be evidence that the underlying science has been used to try to resolve any differences. Alternative conclusions should be considered where appropriate and recommendations for the future should also be included.



Several candidates scored less marks than they were probably capable of, particularly in Strand C, because they simply chose to report information about their topic, without any real analysis of the scientific evidence they were based on. Opinions from a variety of sources were often quoted but without reference to the source or to the evidence that the claims were based on. Although most candidates made an effort to give two different views in their studies, these were rarely compared, and conclusions often seemed to lack any clear basis in the evidence shown. This approach rarely leads to marks above 4 or 5. It was very rare indeed for even the better candidates to attempt any judgement of the quality or reliability of any of the scientific evidence offered by their sources. The best candidates will not simply state an answer to their own question ('I think mobile phones are dangerous', 'too much sun is bad for you') they will also use the evidence they have presented in their study as a basis for recommendations about what to do ('use a hands-free kit', 'text don't talk', 'avoid sunbathing at midday', 'wear sun screen' etc). Thus, the most successful titles were often questions where the answer would lead to some recommendations for action.

Strand D: quality of presentation

D(a): It was pleasing to see that the majority of reports included headings and/or sub-headings 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 to help guide readers quickly to particular sections. Those reports which were presented simply as PowerPoint printouts achieved good marks in this aspect but often lacked sufficient detail for high marks in the other strands. However, PowerPoint printouts which had notes to accompany each slide were much more successful in obtaining higher marks. It would be helpful for moderation purposes if these could be printed out in the format which gives one slide and the accompanying notes on a single A4 sheet. The slide can then concentrate on headings or visual impact, with the notes supplying the detail, references to sources, etc.

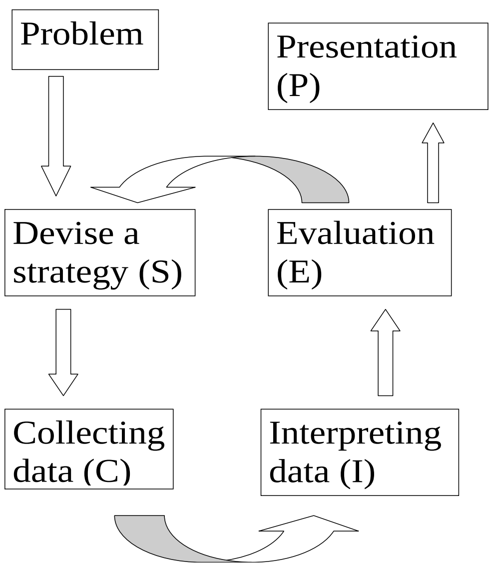
D(b): Suitable diagrams and graphics should be incorporated as appropriate to clarify difficult ideas and encourage effective communication, but in practice the visual impact was often variable. Too often images were decorative, rather than informative. Of course, many textbooks include decorative rather than always informative images and this may be a source of confusion for some candidates. A mixture of both is usually the best route to provide an interesting and informative report. Rather too little use was made of diagrams, charts, tables or graphs as compact ways of conveying large amounts of information, or to visualise difficult concepts. The best candidates always made good use of explanatory diagrams by referring to them and using the information that they contained. They integrated illustrations into their report, making comments about what was shown by the illustration, and how it was relevant to the study.

If there are no decorative or informative images included then zero marks is awarded. If one image is included, or a decorative front cover or other low level attempt to add interest is present, then 1 mark is appropriate. Two marks would be awarded for the inclusion of decorative images only, or perhaps for the minimal use of informative images. Three marks would be given for including a variety of informative illustrations, e.g. charts, tables, graphs, or schematic diagrams, and 4 marks if this is fully integrated into the text, referred to and used. Too often downloaded images from the internet were not clear, too small and not referred to in the text.

Some candidates included a useful glossary of scientific terms that had been used within the report.

Investigations

It was particularly noticeable that in this first year of the new specifications that require investigations many Centres continued to follow the previous Sc1 approach towards investigations. Many centres had not taken up the spirit and direction of Twenty First Century Science investigations and this made it difficult for candidates to access the higher marks.



The essential features of a scientific investigation have of course been maintained in this new model. However, the importance of candidates doing preliminary work, developing and exploring methods and techniques, and selecting appropriate apparatus rather than following a given or standard procedure are perhaps the key differences when developing a strategy.
Gathering initial data, making a preliminary analysis and evaluation to modify the initial method to obtain better and more reliable and accurate results, and informing the main method are key aspects which are essential for access to the higher marks.

Key differences between the Sc1 and the Twenty First Century Science model are

- more credit given for candidates who show innovation and imagination
- more credit given for the exploration and development of a strategy in terms of techniques and apparatus rather than following a standard/given technique
- less emphasis on candidates making predictions and knowing the answer before they start.

- more emphasis on rewarding the quality of the data collected
- a best fit approach to marking and assessment using a framework of performance descriptions
- uncoupling of 'sub-skills'
- total marks from one investigation count (no cherry picking of marks for different strands from different investigations or using the I and/or E marks from a data analysis task)

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. Many candidates used scientific knowledge to make predictions about the outcome of the investigation at the beginning of the investigation (Sc1 style) whereas the C21 model aims to give credit for candidates who process their results, look for patterns and then suggest explanations using their scientific knowledge and understanding.

Familiar investigations such as 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 beginning to be used, for example, stretching of plastics and other materials, exercise and fitness routines, efficiency of wind turbines, objects rolling down slopes or ski jumps, and which lemonade is best?

There was very often little information provided by Centres about how the investigation had been presented to candidates and this made it difficult to support the marks for S(c), the autonomy and independence aspect. This was particularly the case when it was clear that most of the candidates in the sample followed a very similar method and procedure.

Strand S: Strategy

Candidates who were awarded up to 6 marks were generally correctly marked. However, those candidates who were given higher marks were often not securely matched to the performance descriptions.

The intention is to encourage a more independent approach to investigation by candidates, and the mark awarded for the aspect, S(c), should reflect the 'value added' by the candidate, beyond the initial teacher stimulus. Most candidates developed their investigation from a more general brief provided by their teachers and this meant that few achieved higher than 6 marks for this aspect. It was noted that, in some cases, high marks were awarded even where candidates had identical ranges and values of the same variables, without any further discussion or justification. This indicated that limited individual decision making had occurred and consequently marks were adjusted downwards by the moderator putting the Centres concerned close to the tolerance limit or even beyond it.

In aspect (a), many candidates developed an investigation in a straightforward way and collected a good range of data, S(a)6, and used, but not necessarily selected, appropriate apparatus, S(b)6, from a general brief provided by their teachers, S(c)6. In aspect (b), whilst most candidates listed the apparatus and described the method they were going to use, only a few candidates described in sufficient depth and detail **why** they had selected the techniques and equipment used. For example, in the thiosulfate/acid investigation most candidates followed the familiar method of the 'disappearing cross' and measured the time when the cross could no longer been seen, obtaining 6 marks for this strand. Those candidates who were correctly awarded higher marks showed a more independent, thorough and rigorous approach. For example, candidates might consider what methods could be used to study the rate of this reaction such as measuring the volume of the sulphur dioxide gas, filtering off the sulphur and weighing it, measuring the pH of the solution or measuring any temperature change (etc). The candidate might consider each possible method and eliminate some and select the most appropriate method.

Candidates might directly suggest the disappearing cross technique from previous experience but they would need to perform preliminary work to find the best apparatus and the best conditions to produce accurate and reliable data e.g.

- a measuring cylinder to measure volumes +/- 1 cm^3
- a stop clock to measure to +/- 1 second
- a conical flask for shaking
- a thermometer to measure any change in temperature in the solutions
- use the same experimenter to ensure consistency of observation
- keep the depth of the solution the same to ensure consistency of observation
- experiment whether the solution should be left standing or shaken periodically
- experiment whether to change the concentration of the acid or the thiosulfate.

Therefore, even in what appears to be a straightforward investigation there are a number of possible routes that a good student could possibly explore. The complexity of a task represents an overall judgement about a number of things such as the familiarity of the activity and method, the ease of observation or measurement, 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. For candidates working at the high mark levels it would be expected that the candidate had some autonomy in deciding what preliminary work to do and in choosing the final technique and ranges used, so evidence related to S(b), S(c), C(b) and C(c) would all help to support the decisions in S(a).

Strand C: Collecting data

Many candidates generally achieved their best marks in this strand. Using suitable ranges of the appropriate variable to investigate and the need to repeat measurements were appreciated by the majority of candidates. However, in many cases the discussion about the identification and control of any interfering factors was surprisingly limited. Many candidates left it to be implicitly deduced from inspection of the table of results rather than any explicit discussion and comment about the need to control variables. Only those candidates who were awarded 7 or 8 marks provided further detail about how the factors had been monitored or controlled. In many cases when investigating rates, candidates stated that since the reaction had been carried out at room temperature the temperature had been controlled. In order to obtain a better match with the 8 mark criteria in aspect (a), candidates need to write much more fully about the context and purpose of their experiments and to discuss any factors which might interfere with the results.

Preliminary work is essential if candidates are to be awarded 7 or 8 marks in aspects (b) and (c). They must perform preliminary work to establish the range of values of the appropriate variable to be used in their investigation. Some candidates did perform preliminary work but did not use the results to explain how it informed their main method. Too often, candidates left consideration of reliability of their results until their evaluation, so that obvious outliers were either ignored, or included without comment in calculating average values. It was very rare to see a test repeated to check and obtain a more reliable result. The better candidates adapted and developed their initial work and modified their techniques accordingly to ensure that they produced data of the best quality.

Strands I and E.

In general candidates achieved their poorest marks in these two strands.
See the detailed comments in the Data Analysis section.

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 which would have helped many candidates who have language difficulties.
Data was generally accurately recorded and presented in appropriate tabular form, although the difficulty of recording 'time' in consistent and appropriate units was often seen. The allocation of marks for P(b) often proved problematic and more details can be found in the administrative section of this report.

Final comment

All members of the moderating team remarked on the care and effort put in by teachers to provide varied opportunities and motivating contexts for their candidates to achieve the best results in this new assessment framework. We would like to record our thanks and appreciation for a good job, thoroughly well done.
The importance of cluster group meetings, attendance at OCR INSET meetings both in- and out-of house, using the OCR consultancy service for checking marked scripts, and consulting and using the teacher guidance booklets on www.ocr.org.uk are all available methods to improve the awareness and understanding of this new assessment programme. It is highly advisable that staff have time during the year for internal standardisation meetings to share and develop expertise in the Science Department.

2008 Grade thresholds for Investigations

		Grade threshold							
Component	**Maximum mark**	**A***	**A**	**B**	**C**	**D**	**E**	**F**	**G**
Data Analysis and Case Study	16 + 24 = 40	33	29	25	21	17	13	10	7
Investigations	40	33	30	26	23	19	16	13	10

The grade thresholds have been decided on the basis of the coursework that was presented for award in June 2008. It should be noted that this was the first cohort of candidates to submit 'Investigations' for assessment purposes. Thus, the threshold marks will not necessarily be the same in subsequent awards. Some adjustments may be expected as experience with the criteria grows, and a wider range of Centres becomes involved.

Grade Thresholds

General Certificate of Secondary Education
Physics A (Specification Code J635)
June 2008 Examination Series

Unit Threshold Marks

Unit		Maximum Mark	A*	A	B	C	D	E	F	G	U
A331/01	Raw	42	N/A	N/A	N/A	31	26	22	18	14	0
	UMS	34	N/A	N/A	N/A	30	25	20	15	10	0
A331/02	Raw	42	37	33	28	23	18	15	N/A	N/A	0
	UMS	50	45	40	35	30	25	23	N/A	N/A	0
A332/01	Raw	42	N/A	N/A	N/A	27	23	20	17	14	0
	UMS	34	N/A	N/A	N/A	30	25	20	15	10	0
A332/02	Raw	42	34	29	23	18	13	10	N/A	N/A	0
	UMS	50	45	40	35	30	25	23	N/A	N/A	0
A333/01	Raw	55	N/A	N/A	N/A	27	22	17	13	9	0
	UMS	100	N/A	N/A	N/A	60	50	40	30	20	0
A333/02	Raw	55	42	33	23	14	9	6	N/A	N/A	0
	UMS	100	90	80	70	60	50	45	N/A	N/A	0
A339	Raw	40	33	29	25	21	17	13	10	7	0
	UMS	100	90	80	70	60	50	40	30	20	0
A340	Raw	40	33	30	26	23	19	16	13	10	0
	UMS	100	90	80	70	60	50	40	30	20	0

Specification Aggregation Results

Overall threshold marks in UMS (ie after conversion of raw marks to uniform marks)

	Maximum Mark	A*	A	B	C	D	E	F	G	U
J635	300	270	240	210	180	150	120	90	60	0

The cumulative percentage of candidates awarded each grade was as follows:

	A*	A	B	C	D	E	F	G	U	Total No. of Cands
J635	18.9	53.4	83.5	96.2	99.0	99.8	100.0	100.0	100.0	10 692

10 955 candidates were entered for aggregation this series

For a description of how UMS marks are calculated see:
http://www.ocr.org.uk/learners/ums_results.html

Statistics are correct at the time of publication.

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