GCE

Applied Science

Advanced GCE **A2 H575/H775**

Advanced Subsidiary GCE **AS H175/H375**

OCR Report to Centres June 2016

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of candidates of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, Cambridge Nationals, Cambridge Technicals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

It is also responsible for developing new specifications to meet national requirements and the needs of students and teachers. OCR is a not-for-profit organisation; any surplus made is invested back into the establishment to help towards the development of qualifications and support, which keep pace with the changing needs of today's society.

This report on the examination provides information on the performance of candidates which it is hoped will be useful to teachers in their preparation of candidates for future examinations. It is intended to be constructive and informative and to promote better understanding of the specification content, of the operation of the scheme of assessment and of the application of assessment criteria.

Reports should be read in conjunction with the published question papers and mark schemes for the examination.

OCR will not enter into any discussion or correspondence in connection with this report.

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OCR REPORT TO CENTRES

G620, G621, G624, G625, G626 AS Portfolio Units

General Comments:

A range of levels of portfolio work has been seen this session and some excellent work has been sampled. Care still needs to be taken to ensure that centres are not too generous in their decisions to award the highest marks at mark band 3. This work produced by candidates needs to reflect A grade work at AS. This was not always the case and it was sometimes necessary to reduce marks in the moderation process. Appendix A, page 93 of the specification, gives the performance descriptions for AS work. It was commendable, however, to see centres correctly awarding marks where work did reflect a high standard and did demonstrate independent work by the candidates. Centres also need to take care that when giving full marks at mark band 2, all the criteria in that strand are met at the appropriate level. Omissions and low level work were often seen where mark band 2 was awarded. It was good to see that many centres had acted upon advice given in previous reports which continues to be applicable. The quality of much of the practical work is still showing improvement in both the level required and accuracy of the presentation. However, candidates must demonstrate in their overall work a progression from GCSE. This was not apparent in some of the lower level work. Where Centres are offering the A2 qualification they are advised to ensure practical skills offered at AS allow candidates opportunity to build on these for the A2 investigative work in G627. Repetition and limited opportunities of the range of practical skills completed by the candidates was still evident in some centres. Credit is given to those staff and candidates who are using the assessment criteria and specification content appropriately at all levels and consequently work is being produced which is being assessed at the correct level.

All the portfolio units offered by the specification were moderated during this session. These were:

- **G620 Science at Work**
- **G621 Analysis at Work**
- **G624 Chemicals for a Purpose**
- **G625 Forensic Science**
- **G626 Physics of Sport**

Units **G620** and **G621** are taken by all candidates who complete the single AS qualification. Candidates completing the double AS qualification need to choose two units from **G624, G625** and **G626.** More candidates now are focusing just on the single award. Both the double and single qualifications will be available for certification until 2018.

The samples for moderation were again selected electronically and moderators found that the majority of work was returned efficiently with appropriate Centre Authentication Certificates. The URS forms were completed by the majority of centres although some were seen that were incomplete. It is essential that comments and page references are included to support the location of the evidence in the moderation process. The majority of portfolio work seen was stapled or collated using treasury tags which allowed moderators to easily read and locate the work. Annotation of candidates' work in the form e.g. AO1 - 6 (i.e. the assessment criteria reference) was also included in the majority of work seen and this is also appreciated. Several clerical errors, where the marks sent to OCR were not the same as the marks on the URS, were again evident this session.

To support centres with their candidates' portfolio assessment, OCR offers a free coursework consultancy service where up to three full or part completed portfolios for each unit will be moderated and the centre is issued with a report on the centre assessment decisions. Where a centre's decisions were not in agreement with those of the moderators, they are encouraged to use this service for future submissions.

To access this service, centres are asked to send photocopies of up to three pieces of marked, annotated work for the 2017 series to: *The Science Team, OCR, 9 Hills Road, Cambridge, CB1 2EU.* Please accompany the scripts with a letter on centre-headed paper detailing any issues and provide an e-mail address where the report is to be sent.

Accredited Centres need to ensure that the necessary Centre Authentication form is sent to OCR for each session that they are entering candidates and if there is a change in the staff named for the accreditation OCR is informed.

Internal moderation, although not mandatory, is highly recommended where more than one member of staff has assessed candidates' work. It is important that centres do encourage their candidates to follow guidance given in this report. This is essential if standards are to be maintained and scaling is to be avoided in future submissions.

Please note that the date for the final series in which units **and** certification will be available for GCE Applied Science is June 2018. This means that candidates can start a 2-year course in September 2016. For further information please refer to the OCR website/Applied Science Information for centres.

2. Comments on specific units

The guidance on the units given in this report again re-emphasises the need of centres to refer candidates to both the requirements of the specification and the assessment criteria when they are studying for this applied science qualification. Advice will always be given by OCR on the suitability of assignment ideas that centres may wish to offer.

G620 Science at Work

This unit is mandatory and candidates need to be demonstrating progression from level 2 courses in both their research skills and practical work. Improvement has been noticed but some centres are not providing suitable opportunities for their candidates to enhance their practical skills to a much higher level.

The assessment requirements for the specification include:

AO1 record of four surveys of science based organisations; one in depth study; work on health & safety laws and regulations

AO2 evidence of impact organisation has on society; calculations on provided data or data obtained from experimental work

AO3 two practicals with a vocational context with recorded processed and evaluated results

For AO1a the majority of scripts seen indicated candidates had researched four suitable science based organisations selected from e.g. hospital departments, water treatment works, pharmacies, beauty product development organisations, breweries, food outlets, zoos, university departments as well as major chemical and engineering companies. Where research material

had been extracted from a range of resources e.g. site visits, talks from professionals as well as web based information, the surveys were much more focused with purposeful scientific and health and safety content. It is emphasised that when completing the surveys for AO1a that it is selection and quality, not quantity that needs to be focused upon. Candidates who are structuring their surveys and using the guidance from the specification i.e. the products made or services offered; the type of work; the science involved; health & safety constraints alongside information taken from research, on the organisation, are producing suitable higher quality work. Lengthy reports with 'cut and pasted' evidence are not required. Recording of references used, although not a requirement of AO1a, is good practice.

Centres should be encouraged to give lower achieving candidates more guidance to help improve the quality of the selection of necessary information. They should be encouraged to review their first draft, which often contains historical facts, general information about targets, job advertisements, all of which may be interesting but not relevant.

For AO1b the in-depth study needs to include: an explanation of what is produced or details of the service offered; information about the organisation including the number and range of staff employed; details on the scientific job roles; some explanation and detail of the science involved; any further specific detail on research; quality control; details and specific links of health and safety laws and regulations. Candidates should be working towards producing a comprehensive researched study where information is selected and clearly and logically presented. The use of more than one web site resource and either primary or secondary sources are to be encouraged and independent work needs to be evident. Some evaluation and justification of the use of the material needs also to be included, supported by comments on the validity of the sources candidates have used.

For AO1c generally where assessment ranged from 3-5 marks, work tended to reflect the level and quantity of work produced. Several lower level candidates did successfully complete a research task using the detail given in 3.1.1 'The Importance of Health and Safety' from the specification which allowed them to show some knowledge of a range of health and safety laws and regulations. At the higher end, however, just brief links on how organisations comply with the legislation is insufficient to demonstrate a comprehensive knowledge and understanding required for mark band 3. There were, however, some very good reports and detail completed by some of the higher achieving candidates.

The report for AO2a was linked in many cases to the in depth study, and work showed, for the majority of cases, coverage of the requirements required. These included: benefits of the core business to the society; contribution to the economy; details on waste management and environmental issues (where appropriate); ICT uses (where appropriate); details on the effect on the community of employment, transport issues and reasons for the position of the organisation. Although much of the work seen was reflected of 3-4 marks, some candidates had worked to show a comprehensive and thoroughly researched study, but again the requirement is the impact of these issues on society - in some cases this was very brief or just an afterthought. There is much improvement, however, for this strand in many of the scripts seen.

Centres, however, are still continuing to generously assess AO2b. The assessment guidance states a number of complex and straightforward calculations should be completed. Appendix C, page 129 of the specification, gives guidance on the range of mathematical skills which may be covered during this GCE level course. If the data produced for practical work does not allow candidates to fulfil the higher mark bands, then data can be supplied. For AO2b mark band 3, work should be correct and answers given to the appropriate degree of accuracy with correct significant figures. Errors are still commonly seen here. Just the completion of one calculation that was completed in the practical work or repetition of the same calculation is insufficient evidence for mark band 3.

The AO3 practical work offered this session was much improved in many cases. However, centres still need to be encouraged to offer their candidates a range of practical activities. The opportunities are wide ranging and can include chemical, physical and biological experimental work as long as a clear progression from GCSE is demonstrated by the candidates. Examples can include inorganic volumetric exercises and analysis, organic preparations and analysis, microbiological techniques, vitamin C and food testing and colorimetric analysis, forensic focused analysis, optical and material investigations work, material and electricity investigations. Candidates need to carry out two practical activities which can be chosen by the centre but they need to show vocational links. The practical work chosen does not necessarily need to link to the organisations studied for AO1 and AO2, although it needs to have some vocational link. Research is usual to support this, but ensure it is relevant and not just 'cut and paste' interesting research. Candidates are now including risk assessments but they need to ensure that they are suitable working documents and do not include generic and unnecessary or repetitive information. Relevant information on chemicals is needed with particular focus on the concentration used in the actual experimental work. It is advisable that candidates learn different skills in this unit and it is therefore not advisable to carry out practicals demonstrating the same techniques.

For AO3b recording needs to be thoroughly checked by candidates to ensure accuracy, units and correct significant figures. Quite a lot of over assessment was seen for this strand. Candidates need to be providing evidence of accurate recording, either by repeats or comparison with staff or other candidates' results. 5-6 marks were given when work was not accurate and units were missing and observations were far from being detailed. Candidates need to be much more careful in their recording and results. Measurements and observations need to be presented in suitable tables where the reader is clear on the outcome. Results are still being just stated in a conclusion at the end of the work.

The advice again is that in AO3c much more accuracy is needed in processing and graph work. Many graphs are still being poorly drawn with inappropriate scales and units missing from labelling of axes. Answers from calculations need to be quoted with the correct numbers of significant figures. The inclusion of an evaluation does not automatically mean mark band 3. Candidates need to review the level of evaluations, much more scientific detail is needed to support basic evaluative comments made.

G621 Analysis at Work

This unit is also mandatory and candidates again should to be demonstrating progression from level 2. Candidates need to research and understand information as well as carry out a range of practical analysis. The level of the practical work and assessment decisions have shown improvement, but candidates still need to work on accuracy and the inclusion of the appropriate advanced science knowledge even to support mark band 2.

The assessment requirements for the specification include:

AO1 information showing an energy policy and energy usage of an organisation with a consideration of energy efficiency and environmental impact

AO2 study of large scale and small scale generation to include energy transfers with data and calculations to show a comparison of fuel costs

AO3 three practical analyses one qualitative analysis, one quantitative and a third investigation with results processed and interpreted

For AO1a candidates are given the opportunities to select any energy policy. However, where candidates are almost left to their own devices, work still did not clearly show the organisation's energy policy and work was not structured. Some excellent work, however, was seen where both energy policies were well selected and stated and candidates had evaluated ways in which the chosen organisation had limited their energy consumption. Centres are still advised to review the web sites that candidates are using to ensure that energy policy information is easily accessible. Retail stores, schools and universities were amongst the most popular this session. Centres are again advised to give guidance to their candidates on what is required in each section of AO1a, AO1b and AO1c. This seems to have happened in several centres as this does prevent candidates launching into extracting non related and disjointed information. Candidates need to explicitly state the energy policy so the reader is clear how energy and cost savings and environmental impacts are linked. It is not the job of the moderator or the teacher to track the required information with no identification from the candidate. Again, it is important to note that for mark band 3, reports need to not only include a detailed description of an energy policy but also an evaluation of how energy consumption is limited. The evaluation needs to discuss the ways in which the introduction of the energy policy enables the organisation to limit their energy consumption.

Work for AO2a was so much better this session. The descriptions and comparisons of large scale and small scale electrical generation from two chosen sources work was completed well by many candidates. Care still needs to be taken to ensure that mark band 3 work reflects candidates' own understanding as well as covering the requirements of the assessment criteria. Work needs to be both suitably detailed but selective.

Work, however, for AO2b was not so good at the higher levels. These candidates need to be showing independent research and not just rewriting or using work provided. A range of energy values and fuel/energy costs was evident in most candidates work seen but even for mark band 1, candidates should be displaying energy values and costs as well as completing calculations. For mark band 2 candidates need to be showing evidence of their own research. Assessment tended to be generous for this strand in many cases.

Practical work is continuing to improve in both the level of work completed and the assessment decisions made. The guidance stated below still holds and centres need to continue to work to improve the quality and accuracy of the write ups for this unit.

- Practical work needs to be a step up from that studied at GCSE, supported with good quality observations and accurate processing.
- Higher mark band work should be supported by correct balanced equations where appropriate.
- Risk assessments need to be workable documents and for those candidates aiming for high mark bands these should show selected focused hazards and risks associated to the chemicals/equipment used. Generic statements are not sufficient at the higher levels.
- Observations for qualitative analysis are still quite weak in both detail and accuracy. Just crosses and ticks are insufficient for observations at this level. Full detail is required e.g. white precipitate, bubbles of gas which turn limewater milky.
- Candidates need to be aware of the difference between observations e.g. a white precipitate is formed and a deduction e.g. barium sulphate has been formed.
- Evaluation needs to be focused on the method and outcomes of the specific experimental work completed, not just a generic statement of the success of the work. The inclusion of an evaluation does not automatically indicate candidates can gain mark band 3, the level of discussion needs to be reflective of A/B grade work.

Evidence of the use of the same practicals for G620 & G621 is still being seen and although this practice is not forbidden it is not recommended, especially when centres are familiar with the wide range of requirements needed for both G620 and G621. It does not allow candidates the opportunity to be taught and to cover a range of practical examples as stated in the specification. This is not good practice for candidates aiming for higher mark bands.

G624 Chemicals for a Purpose

Limited scripts were moderated for this unit although work was seen from almost the complete mark range e.g. 10 to 50.

The assessment requirements for the specifications include:

AO1 a description of two examples of inorganic and two examples of organic chemical compounds, discussing their chemical structure, properties and uses and a detailed account of two compounds one of which is made of oil

AO2 relevant research of one industrial process that involves the use of a catalyst. A report which includes an understanding of the social, economic and environmental impact of the product selected

AO3 a sample and account of the preparation of two products that have been synthesised, purified and analysed

For AO1a and AO1b candidates demonstrated a range of outcomes from their research of chemical compounds and their properties. Compounds did include those suggested for inorganic compounds: sulfuric, hydrochloric acids, sodium/potassium hydroxides, sodium/potassium salts, copper/magnesium salts, ammonia/ammonium salts, and carbon dioxide. For organic compounds: alkenes, alcohols, aldehydes (alkanals) and ketones (alkanones), haloalkanes, esters and carboxylic acids as well various polymers. Cut and paste is still predominant but higher level candidates are now showing more use and understanding. There are, however, still many inaccuracies with formula and information on bonding. Candidates making errors of this type should not be achieving full marks at mark band 3.

It is advisable to choose two different compounds for AO1c as there are a maximum of 11 marks for this strand. Candidates also need to ensure that one of their chosen compounds is made from oil. Lower level candidates were not always adhering to this guidance, and in some scripts elements were researched. For the higher achieving candidates they have in this strand the opportunity to demonstrate an understanding of higher level scientific terminology, physical and chemical properties and relevant reactions. Alkenes or alkanes could be used as examples as they give opportunity for suitable research on structure and accessible explanations of relevant reactions. Polymers e.g. nylon, polyethene are possibly not the best choices. Good practice is shown where a bibliography is included and evidence of where each reference is used throughout the report. Use of A level text books again would possibly help candidates to demonstrate more use of the research.

For AO2a full marks at mark band 3, candidates need to show completion of both simple and complex calculations which includes researched data on costs of chemicals and data obtained from at least one of the preparations. Structured, stepwise calculations for yield does not support mark band 3. Mark band 3 candidates should be demonstrating independent skills in calculating and work on researched data should not be totally directed by the centre.

The level of work for AO2b was reflected in the range of marks awarded, but coverage of all the bullet points does not automatically indicate full marks. Work needs to show a suitable selected account using the research to produce an accurate and detailed report. Centres need to note that even for mark band 2 work needs to include detailed descriptions of all the listed bullet

points with the report to include energy costs, waste products availability and sustainability of raw materials. These were often omitted. For mark band 3, candidates were suitably describing and explaining the role of the catalyst used, but an understanding of the social, economic and environmental impact of the product was not fully discussed. Researched information is still being 'cut and pasted' and not used by the candidates. Examples for this section could include nitric acid, sulphuric acid, ammonia and ethanol. Again, good practice is seen where candidates complete logically structured reports based on the bullet points listed in the assessment criteria. Referencing should be seen as well as detailed but focused work.

AO3a gives candidates opportunities to prepare, purify and analyse both an **organic** and **inorganic** compound. It is important that the two products chosen do include ONE organic and ONE inorganic. There are no restrictions of a choice of product but centres are advised to ensure that candidates are able to complete all three tasks for each: synthesis, purification and analysis. Preparative practical skills have been well demonstrated although recording of observations etc. is still not adequately detailed. Good practice is seen where candidates' research and reference each section for both compounds prepared. The following guidance is again given: recrystallisation is an example of purification and melting point will show purity but further analytical tests should also be completed where the higher mark bands are to be awarded. Initial and final weighings and accurate recording of melting points (start and finish values should be included) are required. Observations throughout the preparations, purification and the analysis need to be recorded. Processing needs to include calculations on theoretical, actual and percentage yields. For mark band 3 evidence of how the theoretical yield is calculated should be included to reflect suitable knowledge at this level. Work needs to be supported by suitably balanced chemical equations. For AO3c candidates need to show an awareness that the yield can be increased by changing conditions. Actual workable suggestions are needed for mark band 2 and a full evaluation of the methods chosen with a possible comparison of the suggestions is needed for mark band 3. This is still not adequately covered although some attempts were seen this session.

G625 Forensic Science

Limited scripts were moderated for this unit although work was seen from almost the complete mark range e.g. below 10 to 45. Again, some well selected and researched work was seen from a number of centres and both candidates and staff should be again congratulated on the level of work completed by their candidates.

The assessment requirements for the specification include:

AO1 a knowledge and understanding of the need to preserve and record the scene of crime; the chemical, biological and physical techniques used to collect and visualise forensic evidence; including ethical considerations

AO2 a report on a forensic case study on evidence and proof; work which demonstrates the use of calculations to support forensic measurements or observations

AO3 at least one forensic analysis in each of the following areas biological, chemical and physical techniques

The following guidance is suggested:
AO1a - research to include information of a range of techniques with a reasoned link to the recording and preserving of the crime scene. AO1b - detailed and in-depth work is needed for the higher mark bands which need to cover chemical, biological and physical techniques. Researched work should be referenced and evidence should show its use rather than 'cut and paste'. For AO1c mark band 3, a range of information of ethical issues needs to be logically discussed, with evidence of an understanding of the ethical code. Statements and information from relevant research or 'cut and paste' material is only applicable to mark bands 1 and 2.

Candidates should base their report on one case study for AO2a and use the bullet points listed in the assessment criteria. Although candidates need to be aware that coverage alone does not automatically lead to full marks, the level of consideration of the research needs to be at a high level to support mark band 3. Good practice is seen where reports are well structured and information listed in the criteria on both evidence and proof is understood. For AO2b candidates need to be showing evidence of completing a range of calculations. Suggested examples can include Rf values, RI calculations and bullet projectiles. Calculations can involve concentration and dilution. Candidates work needs to show evidence of less guidance and more independent thought.

AO3 experimental work can include fingerprinting and taking footprints, measuring and use of photographs, a range of microscopic techniques, chromatography, qualitative and quantitative analysis, and the measurement of refractive Index of glass. Higher level work needs to be supported by suitable scientific knowledge to support the interpretation of results e.g chemical equations, explained spectroscopic analysis, graphical methods, and mathematical interpretations. Mark band 3 candidates need to ensure detailed processing and interpretation of their results and a discussion of their significance.

G626 The Physics of Sport

Limited scripts were moderated for this unit although work was seen from almost the complete mark range e.g. below 10 to 44. This unit gives candidates the opportunity to research into the science involved in a range of sporting activities. Work completed this session showed a wide range of abilities.

The assessment requirements include:

AO1 a series of 4 short sport guidance leaflets for the coaches at a sport and recreation centre to help them answer questions of a technical nature for their trainees linked to Measurement; Seeing; Movement and Technique

AO2 a presentation which will discuss the required material properties and how these are achieved in sports equipment; evidence of the completion of a number of calculations related to the physics of sport

AO3 evidence of two investigations relating to the physics of sport

The following guidance is suggested:
AO1 - Work needs to be presented as leaflets. Candidates need to work on selective use of their research material. Centres are directed to the information on page 106 of the specification showing the assessment criteria regarding the target audience. Candidates should be suitably selecting material for their leaflets and using information from page 33 of the specification for the content. Work at mark band 3 needs to show detailed knowledge written where appropriate in candidates' own words with evidence on the linking of scientific knowledge to the chosen sport or equipment.

AO2 gives candidates the opportunity to display their research as a presentation linked to sporting equipment. They need to identify the relevant physics principles which relate to the choice of material. Examples which can be used could include tennis, golf, squash, cricket, football equipment and balls. Skate boards, surf boards and fishing tackle are also popular choices.

For AO3a candidates need to plan and conduct safely **two** investigations. Plans need to be sufficiently detailed. Many candidates are still only reproducing simple methods. Candidates should be choosing variables to show their planning skills. The choice of practical is left to the centre but it needs to relate to the content of the specification. Coefficient of restitution is completed by most centres and a range of other practicals covering the testing of different

properties of materials and a range of optical/lens work could be chosen. For AO3b candidates need to be collecting a wide range of suitable data and it needs to be suitably recorded. Even for mark band 2, repeats are required. Processing and interpretation of results needs to show progression from GCSE work and graphs need to be well drawn with fully labelled axes. Good practice is seen where error bars are included. Again, the inclusion of an evaluation does not automatically allow mark band 3 to be awarded. Conclusions need to link to the science involved and for mark band 3, the significance of the investigative work needs to be discussed.

G622 Monitoring the Activity of the Human Body

General Comments:

This paper appeared to be accessible to the majority of candidates. There were no obvious errors in relation to the use of rubric provided within the paper. A number of candidates used the additional sheets to further clarify their responses. The Level of Response (LOR) items enabled discrimination between candidates at the higher range of grades but they were challenging for many at the lower grades. Some candidates demonstrated very good recall of facts in terms of physiological values and they were able to utilise the data provided to good effect.

Comments on Individual Questions:

Question No.

1(a) This item confirmed that there appears to be a greater understanding of the difference between risk and hazard by many of the more able students. The item was completed successfully by many candidates without a clear pattern of alternative responses.

1(b)(i) Most candidates identified ECG as the correct equipment to be used. A small number of candidates incorrectly chose the sphygmomanometer.

1(b)(ii) Although many correctly calculated the answer of 60, some incorrectly calculated 72. Not all candidates made full use of the space provided to show the calculation.

1(b)(iii) It was good to observe the references to named heart abnormalities, with appropriate descriptions. Many candidates also realised that the ECG trace showed the health of the heart or person.

1(c)(i) This item was answered well. Candidates generally had a good understanding of the differences between the two types of sphygmomanometer but struggled to identify a second similarity to accompany the use of a cuff or band.

1(c)(ii) Candidates had good recall of the blood pressure readings but were occasionally challenged by the expression of the units.

1(c)(iii) Although a number of candidates realised that the blood pressure would increase, they struggled to provide a full explanation. The need of oxygen was often correctly given.

2(a) Most candidates correctly identified gas chromatography but some were tempted to choose calorimetery.

2(b) Some candidates realised that anaemia was linked to low red blood cell counts but relatively few understood the increase in white blood cells for leukaemia. Some failed to obtain the mark because they did not refer to ‘red’ or ‘white’.

2(c)(i) Almost all candidates provided the components of this reaction. There was no need for the candidates to state the number of ATP molecules generated.

2(c)(ii) Low oxygen levels and exercise were often referred to as correct responses. The other options in the mark scheme were rarely identified.

2(d)(i) It was encouraging to see that a number of candidates had an understanding of the key features of the ELISA test. The antibody/antigen interaction was frequently described. The colour change was commonly given as a correct key feature.

2(d)(ii) The lack of correct responses for this item was a puzzle. The response expected was a simple reference to the colour of red blood cells masking the colour change observed.

3(a) The presentation of the dialysis machine was a challenge for many candidates. They did not demonstrate a full understanding of the need for the pump, although some did correctly refer to maintaining the pressure of the blood flow.

3(b) Candidates showed a good understanding of the value of an ultrasound, with effective references to live images and good resolution of soft tissues. Some also correctly described the 3D nature of images generated.

3(c) There was also a sound appreciation of the key features of ultrasound technology, including use of gel, waves bouncing back from organs (although some candidates failed to describe the structures in the body in this context) and the formation of an image.

3(d)(i) Many correctly recalled the values. No clear alternative was identified as a trend for incorrect responses.

3(d)(ii) Again, many correctly recalled the value for this item. However, some gave a response of 0.9, rather than the correct value of 9.0.

3(d)(iii) Candidates responded well to this item and correctly described the comparative nature of the critical value. The other marking points were used across a wide range of responses, giving full marks for many.

3(e) There appears to be a greater understanding of the link between diet and the acquisition of diabetes type 2. Unfortunately, some candidates described the intake of fat in the diet and linked this to ‘blocking’ the release of insulin. This led to muddled responses and prevented the allocation of marks.

3(f) Some candidates were challenged by the ethical issues for this item. They unfortunately referred to religious reasons linked to transplants and the right for life. This form of response did not receive any marks for this section of the item.

4(a)(i) This item was designed to be open access and relatively simple to complete. Many candidates did very well and obtained full marks. Others suggested that the thermometer should be left in the mouth for only a few minutes, while some referred to setting the thermometer to ‘zero’.

4(a)(ii) Although a number of candidates appeared to identify the potential hazard they failed to describe the related precaution. Many referred to contamination or infection as the potential hazard. This was not acceptable because these terms were describing the risk caused by the hazard of bacteria, viruses, fungi etc.

4(a)(iii) This item did not present a problem to most candidates. They were able to correctly list the other types of thermometers.

4(b)(i) Many realised that the blood vessel is contracting or narrowing but very few referred to the arteriole in the process of vasoconstriction.

4(b)(ii) Some candidates correctly described reduced heat loss but there was a tendency to refer to the somewhat muddled view of blood vessels being pulled or moving away from the surface of the skin.

4(c) It was reassuring to see that many candidates correctly identified the symptoms of hyperthermia and hypothermia. There was a little uncertainty about referring to unconsciousness for both conditions. The tick box table seemed to guide the candidates to the correct options.

4(d) This free-response (or level of response [LOR]) item was answered very well by a number of candidates. It was unfortunate that some failed to provide an explanation. Such candidates gave many examples of descriptive valid points, as seen on the graph, but they could not move on to level 2 because they had not given at least one explanation. Both the description and explanation were described clearly in the stem of this item.

5(a)(i) This was a very challenging item for the majority of candidates. They struggled to appreciate that both the alveoli and blood vessels were damaged by the infection. This prevented them from realising that the surface area of the alveoli would be greatly reduced and that blood flow would be altered.

5(a)(ii) Some good descriptions were written for this item with references to oxygen diffusion at the alveolus, transport in the red blood cells and association with haemoglobin to form oxyhaemoglobin. The corresponding diffusion at the organ/tissue location was not generally described.

5(a)(iii) The circumstances outlined in this item seemed to be well understood. Good descriptions of limited airflow and ineffective cilia action were commonly observed. No other alternative responses were identified as a trend.

5(b) The use of a peak flow meter was understood by many candidates. However, it was important to describe the use of sealed lips to correctly use the mouth piece. There continued to be some misunderstanding of blowing hard as opposed to the incorrect description of blowing for long or deeply.

5(c) This was the second free-response (or level of response [LOR]) item for this paper. Candidates gave good descriptions of spirometer use and were aware of the safety issues for the patient. Many candidates did very well and achieved marks at level 3 for this item.

5(d) This item was introduced as challenging. Relatively few candidates correctly described ‘how’ to use a spirometer trace to determine the tidal volume and breathing rate. Many candidates simply gave descriptions of these two features, without the required description of how to use the trace.

5(e) Although a number of candidates correctly outlined the change in volume or pressure in the rib cage, they were confused about the contraction or relaxation of the diaphragm and intercostal muscles. They were required to think about the overall processes in a slightly different way and this presented a challenge to many.

G623/01 Cells and Molecules – Planning Exercise

General Comments:

Task: 'Plan an investigation to determine how the concentration of one named cell wall degrading enzyme affects the recovery yield of lycopene, extracted from tomato tissue'.

Most investigations centred on the use of colorimetry to measure lycopene yield, although few considered the use of a calibration curve to quantify values of absorbance. Cellulase and pectinase were the two most common named enzymes used.

A wide range of marks was achieved in this session. Some centres had clearly spent time working on this plan and a lot of individual candidate input was evident. In some centres, however, work was very prescriptive, with all candidates following the same method, stating the same variables and proposing the same limitations and improvements.

Limited direction is anticipated from subject staff, during initial discussions of the task. Centres however, must ensure that by including and signing the authentication clause, the work submitted is that of the candidate. It still remains a concern that plans from some centres had evidence of heavily guided & assisted work which should have been reported using the necessary paperwork provided. It is also important that centres ensure that attendance sheets are included to assist in the checking process. Centres are asked to dispatch the G623/01 Plan separately from the G623/02 Test, using the relevant dispatch labels and OCR stationery provided.

The overall performance of the candidates was generally of a similar standard to that of previous examinations. The marks ranged from 0 – 21 out of 25, with the majority scoring from 12 and 17 marks.

Comments on Individual Questions:

Question No.

The following summarises the major comments regarding the marking point criteria:

A Many candidates failed to gain this mark by not including hazards linked to the investigation. Instead, reference was made to general laboratory procedures (e.g. lab coats) and/or generalising 'chemicals rather than enzymes/buffers etc. Obvious hazards were not often recognised (water and electrical equipment) or risks were not stated.

B and C The majority of candidates earned B by linking concentration of a named enzyme to yield of lycopene. However, a lack of specific wording e.g. 'amount' of enzymes prevented the award of the mark. Justification, C, was not awarded often since candidates made no reference to enzyme collision theory.

D – G A wide variety of preliminary work was proposed and described for D and E, usually to determine the best pH, incubation time or type of tomato. A small minority of centres used entirely research as preliminary work, but higher ability candidates were still able to earn D, E, F and G where their work fulfilled the requirements of the Grading Criteria.

H – I The majority of candidates earned H, although 'OCR textbook' is not a full description of a named text. Marking Point I was less often awarded, sometimes because the relevance given did not relate to the final plan – for instance, a reference stating that 50^{o}C is the optimum temperature, when the main experiment was subsequently carried out at 37 ^{o}C.

J – K The main method was normally satisfactorily described for 'J', and in many cases, in sufficient detail to be awarded K.

L – M With a few exceptions, 'L' was awarded but the omission of either number/size/volume etc. when listing equipment and/or materials meant that 'M' was missed. Some candidates failed to score 'L' for missing major items of equipment such as tomatoes. The reference to 'cellulose' instead of 'cellulase' was not penalised here or in other sections but 'Y' was not awarded.

N Almost all candidates referred to the need for repeats, either directly in the method, or by their inclusion in a table of results.

O This was rarely awarded; when it was, it was often to do with limitations of the colour range obtained using a narrow range of enzyme concentrations interfering with colorimetry.

P Most candidates gave an appropriate range of measurements (again, often in the table) with few listing less than 5.

Q – R There were potentially many factors in this particular plan that needed to be controlled, and so the vast majority earned Q, and there seemed less confusion about dependent, independent and controlled variables than in previous sessions. Fewer went on to earn R by failing to give numerical values for controlled variables.

S The majority of candidates included a table for results in their plans and so 'S' was frequently awarded. Loss of this mark was often due to omission of or incorrect units in the headings i.e. where absorbance was quoted, many candidates presented values as a percentage rather than arbitrary units.

T Fewer candidates included graphs. Incorrectly labelled axes were the common error – although this was not penalised where an 'error carried forward from the table' existed. Imported graphs from the internet were not relevant to the experimental work proposed.

U Candidates who included a 'Table' often included an additional column for the mean. Others referred to the calculation of a mean in their method.

V This marking point was rarely awarded this time. Candidates failed to link their observations to changes in enzyme concentration and lycopene yield.

W Sources of error for 'W' were often too vague to be creditworthy. 'I could have made a mistake in measuring', but no clear explanation was provided.

X Similarly, methods for improving accuracy and validity, were often vague and unrealistic, or exactly the same as other candidates in the Centre. A significant number of candidates referred to practices included in their plan, e.g. 'repeats'; 'use of buffers' etc.

Y In the vast majority of cases, Y was almost always awarded to a large proportion of the entry. [See comments for L-M].

G623/02 Cells and Molecules – Test

General Comments:

The general standard of candidates' work was broadly similar to that in previous examinations. Marks ranged from 4 to 39 out of a total of 45. Approximately 50% of candidates gained marks between 22 and 27.

Each of the questions and the paper as a whole achieved good differentiation between candidates of varying ability. Questions which targeted the A/B grade boundary were within Q1(b)(ii); Q1(e)(ii); Q2(d); Q3(a)(ii); Q3(a)(ii); Q4(a)(i).

There was no evidence of candidates failing to complete the paper due to lack of time. The frequency of 'no responses' appeared lower than in the previous session. Where they occurred was mainly 2(e)(i) &(ii), 3(b)(i) &(ii). There was no common misinterpretation of the rubric.

The overall performance still varied between centres. Centres either had a good range of marks or had many poor scripts.

Comments on Individual Questions:

Q1 (a) and (b) were well answered. The most common credited answer for (b)(i) was 'cheap' and many earned full marks for (b)(ii). Stain was rarely named; otherwise the application of the coverslip and avoidance of air bubbles were often recognised.
Q1(c)(i) 'Coulter counter' was a very common incorrect response.
Q1(c)(ii) Problems with 'clumping' etc. was appreciated by a minority of candidates. References to living/dead cells were common and quite a few candidates cited 'human error'.
Q1 (d) Most candidates identified leukaemia but, often failed to gain the second mark (for normally offering 'anaemia'). A wide variety of phonetic spellings were credited.
Q1 (e) This was not well answered. Very few candidates were able to explain either 'magnification' but particularly 'resolution' sufficiently clearly to score marks. The majority simply repeated 'how much it is magnified'; some close attempts using the term 'zoom' were seen but most candidates failed to explain the size of the image is enlarged. Resolution was usually described as the clarity of the image, with no further detail given.

Q2 (a) The type of bond was not well known in (i) and although Benedict's reagent was often recognised, the appropriate colours were often confused – often with the starch test.
Q2 (b) With the exceptions of references to 'denaturing of the enzyme', correct reasons were rare.
Q2(c) This proved to be difficult for most candidates although occasional very good answers gained all three available marks. Common responses included 'because 24 is the optimum temperature' for part (i).
Q2(d) A significant number of candidates failed to attempt to sketch the curve on Fig. 2.1, which was by far the most frequent non response on the paper, probably because there was no 'dotted line' on which to write an answer.
Q2 (e)(i) The fact that the Coulter counter would be quicker or automated was often recognised.
Q2(e)(ii) Many candidates earned full marks for this section, often with 7,8 or 9 marking points achieved. As in previous sessions when a similar question has been set, a small minority confuse the Coulter counter with the haemocytometer.

Q3(a)(i) Many candidates named A as the nucleus instead of the nuclear membrane, and where B earned a mark, the vast majority used the plural 'mitochondria' instead of 'mitochondrion'.
Q3 (a)(ii) An appropriate adaptation was appreciated by many candidates but the second mark for explanation was rarely awarded. Most frequent responses for functions of the Golgi (packaging/vesicle formation) were seen; explanations for 'ribosomes/RER' failed as candidates talked of protein/antibody production, neither of which were creditworthy as they appeared in the stem of the question.

Q3 (b)(i) & (ii) Many candidates scored well in this section. Candidates knew details of protein synthesis and earned 4 marks or they didn't; there was no common error (other than forgetting about U replacing T in RNAs). In (iii) 'type of reaction' was better known than 'chemical bond'.

Q4 In general, this was a high scoring question. Part (a) earned the vast majority of candidates at least one mark, and in some candidates, full marks. The most common reasons were unreliable test results, risk of miscarriage, and whether to pursue an abortion, although in some instances candidate responses were vague, and so failed to earn that mark. For part (b), candidates were very familiar with symptoms of Huntington's disease, and, other than those who repeated the 'jerky movements' given in the stem of the question, frequently earned 2 marks.

G627, G629, G630, G631, G632, G633, G634 A2 Portfolio Units

General Comments:

A wide range of levels of portfolio work have been sampled and assessment decisions from centres have generally shown improvement. Care still needs to be taken to ensure that they are not too generous when awarding the highest marks at mark band 3. Please note there is a requirement to assess spelling, punctuation and grammar in the portfolio units, and opportunity to reach A* for the higher ability candidates. Work given full marks therefore should reflect A* work. This was not always the case and it was sometimes necessary to reduce high level marks in the moderation process. Appendix A, page 95 of the specification, gives the performance descriptions for A2 work. Centres are advised to be aware of these standards. Portfolio work at A2 must show progression from AS. It was commendable, however, to see centres correctly awarding marks where work did reflect a high standard and did demonstrate independent work by the candidates. A grade work needs to be detailed and accurate. All researched information should be suitably selected and referenced. Candidates aiming for such high grades should be producing work which reflects independent thought and high level scientific understanding. Although this was not evident in all work moderated at mark band 3, some excellent high level work was produced. Well done to those candidates. Centres also need to take care that when giving full marks at mark band 2, work may cover the requirements of the criteria but the standard needs to show progression from AS. It was good to see that many centres had acted upon advice given in previous reports which continues to be applicable and that candidates are aware of both the assessment criteria and the content of the specification.

All the portfolio units offered by the specification were moderated during this session. These were:

- **G627 Investigating the scientist's work**
- **G629 Synthesising organic chemicals**
- **G630 Materials for a purpose**
- **G631 Electrons in action**
- **G632 The mind and the brain**
- **G633 Ecology and managing the environment**
- **G634 Applications of biotechnology**

Samples for moderation were selected electronically and work was generally returned efficiently with appropriate Centre Authentication Certificates. URS forms tended to be accurately completed but it is still important to ensure that each contains detailed comments, centre and candidate numbers and page references. Most work was presented using either treasury tags or suitably collated. Annotation of candidates' work in the form e.g. AO1 - 6 (i.e. the assessment criteria reference) was also apparent on the majority of scripts seen. Clerical errors, where the marks sent to OCR were not the same as the marks on the URS, were quite common this year.

Internal moderation, although not mandatory, is highly recommended where more than one member of staff has assessed candidates' work. This had been carried out by many centres and did help to support overall centre decisions.

Candidates need to be reminded that work for A2 needs to demonstrate the appropriate use of scientific terminology, correct spelling, punctuation and grammar in scientific reports. Risk assessments need to be written and used by candidates and be suitably detailed and focused on the specific experimental work. The inclusion of COSHH guidelines and pages of useful but not necessarily relevant information does not automatically reflect higher mark bands. It is also

necessary for candidates now producing work at A2 level that they carry through referencing information and good practice when showing use of researched evidence by super/subscript referencing to a final bibliography.

To support centres with their candidates' portfolio assessment, OCR offers a free coursework consultancy service where up to three full or part completed portfolios for each unit will be moderated and the centre is issued with a report on the centre assessment decisions. Where a centre's decisions were not in agreement with those of the moderators, they are encouraged to use this service for future submissions.

To access this service, centres are asked to send photocopies of up to three pieces of marked, annotated work for the 2017 series to: *The Science Team, OCR, 9 Hills Road, Cambridge, CB1 2EU.* Please accompany the scripts with a letter on centre-headed paper detailing any issues and provide an e-mail address where the report is to be sent.

Accredited Centres need to ensure that the necessary Centre Authentication form is sent to OCR for each session that they are entering candidates and if there is a change in the staff named for the accreditation OCR is informed. It should also be noted that Centres need to be accredited separately for the AS and A2 qualification and that if accreditation is lost at A2 it is also lost at AS.

Please note that the date for the final series in which units **and** certification will be available for GCE Applied Science is June 2018. This means that candidates can start a 2-year course in September 2016. For further information please refer to the OCR website/Applied Science Information for centres.

Comments on specific units

The guidance on the units given in this report again re-emphasises the need of centres to refer candidates to both the requirements of the specification and the assessment criteria when they are studying for this applied science qualification. Advice will always be given by OCR on the suitability of assignment ideas that centres may wish to offer.

G627 Investigating the Scientists' work

Candidates' work covering the full range of marks for Unit G627 was moderated and consequently a number of different investigations and levels of quality were seen. This unit needs to show progression from the work studied in the AS units and unfortunately several scripts were seen where candidates had just completed one type of basic experiment with different variables. This is insufficient for this A2 investigative work. Centres need to suitably prepare their candidates during the AS course to ensure that practical skills from G620 or G621 for the single award or G624, G625, G626 for the double award are built on so that they will have a suitable knowledge of practical skills to carry out the required investigative work. Although some excellent work was seen at the higher end, centres need to be careful that this work is not too structured by the teacher. Candidates aiming for higher marks need to be able to demonstrate independent thought and the ability to develop their own practical work. In addition, work awarded with full marks at mark band 3 needs to be free of errors with evidence of high level scientific knowledge and understanding relevant to the investigation completed.

The assessment requirements for the specification include:

AO1 a detailed and workable plan for one scientific vocational investigation, to include the aims and objectives, full details of experimental work with constraints under which the work will take place, and documented evidence of appropriate research

AO2 evidence showing the tracking and understanding of the outcomes of the investigation with evidence that data collected has been processed and interpreted

AO3 evidence to show the investigation was implemented safely and an evaluative scientific report on the outcomes has been produced

AO1

For AO1a most candidates are now carrying out more holistic planning for their chosen investigation but many are quite brief and repetitive. Candidates need to be aware that even for mark band 2 they need to produce an achievable and logically presented plan, which has direct vocational involvement. A diary of what was done can support monitoring but does not suitably demonstrate planning and is not appropriate coverage of AO1a. Centres are tending to be over generous when awarding mark band 3 for both AO1a and AO1b. More specific experimental and selected and referenced researched material and detailed time information needs to be included to support both mark band 2 and mark band 3. It is also important that candidates clearly state the aim for their overall investigation so that the reader is clear about what the candidate is trying to achieve and the work is supported by information which shows understanding of the scientific principles involved. The work for this unit is not just a set of practicals that candidates follow. It needs to show the thought process of deciding which routes to take and how skills and scientific knowledge learned and researched can be suitably applied. Evidence of repetition of the same practical work does not allow candidates to reach the higher mark bands. Preliminary work is useful but it needs to be suitably presented and then used to support how the main investigation will proceed. Good organisational skills by the candidate are key to a good investigation.

Topics covered are in most cases giving candidates opportunities to investigate AS topics further and carry out different experimental techniques and procedures. Choices continue to cover similar themes, e.g. investigations into: organic preparative work - linked with qualitative and quantitative analysis, product/vitamin C testing – linked with various analysis both practical and research based, rates of reactions both biological and chemical – linked with catalysis and industrial processes, health related investigations – linked to sports centres, diets and monitoring methods and materials and their uses – linked with a range of different practical work to investigate properties. It needs to be emphasised that candidates wishing to access the higher mark bands need to be given opportunities to show they are competent in a range of experimental procedures using different techniques and can work independently. In addition, candidates need to check that any research on vocational links are fully referenced and validated, and health and safety guidance is detailed, clear and focused and not repetitive.

AO2

For AO2a centres need to check that monitoring for the higher marks does not include just basic generic statements about what was done, the time allocation, school holidays and the lack of equipment. Statements such as: ‘method worked well’ / ‘no changes needed’ /’ I worked to my plan’ are basic statements and are satisfactory for mark band 1 but modifications with scientifically supported reasons are needed for mark band 2. For AO2a mark band 3, candidates need to be providing explanations of strategies used to overcome any deficiencies or constraints of the plan. The discussion of the reliability again needs to be supported by suitable scientific treatment of arguments. For AO2b candidates need to show understanding of the outcomes of the investigation. This section needs to be completed at the end of the work and should be summarising all parts. Brief summaries at the end of each practical are only reflective of mark band 1. For the higher mark bands, a discussion of the reliability needs to contain suitable scientifically supported arguments. This is high level discussion and needs to be reflective of A grade explanations. When candidates are deciding on topics for their investigations,

consideration needs to be discussed about the data to be collected and the opportunity of the mathematical skills which can be demonstrated. There was some good work seen by a minority of centres and these candidates should be congratulated. For AO2c just one complex calculation or the repetition of the same skill is insufficient for top marks at mark band 3. The inclusion of additional unrelated mathematical exercises cannot be used in this unit to support mark band 3. It may be that a topic may not always offer the opportunity to the candidate to fulfil the higher marks for AO2c, but the candidate can demonstrate their skills through the other criteria.

AO3

Moderation does aim to support centre decisions particularly where assessment is covering candidates carrying out experimental work. Mark band 3 for AO3a needs to reflect the ability of candidates to have shown evidence in their investigation of covering a wide range of experimental techniques and procedures safely, skilfully, accurately and independently. All practical work completed also needs to be supported by detailed risk assessments that the candidates have produced. The centre therefore needs to ensure that opportunities to cover these requirements and evidence of accuracy of results can be demonstrated for the higher achieving candidates. A significant amount of the work seen was much more reflective of mark band 2 than mark band 3. Overall AO3 work assessed at mark band 3 needs to demonstrate high level practical skills with work reflecting A/A* work at A2. For AO3b, even for mark band 2, candidates need to be producing a logical and accurate report of the outcomes of their investigation. Again, assessment tended to be generous as many reports were not supported by evidence of understanding of high level scientific knowledge. The inclusion of research stating any applied implications does not automatically give candidates 6 marks. Centres need to take care that the reports completed by candidates are reflective of A2 work. This was not the case for much of the lower level work.

A range of processing should support the conclusions and this needs to be accurate and outcomes and findings critically analysed. Conclusions and evaluations need to be collated for the complete work rather than given at the end of each experiment. The level of the evaluation needs to show critical scientific reasoning behind the success or failure of the investigation completed. Evidence of candidates' own organisation and thoughts need to be demonstrated in the work where mark band 3 is to be awarded. Preformatted tables of results repeated several times, however accurate or precise, with no description or explanation are not worthy of higher mark bands.

G629 Synthesising Organic Chemicals

This unit continues to be a popular optional unit, but assessment is still quite generous. Centres need to be careful that they do ensure that candidates check all their work carefully. Work seen from this unit still has many careless mistakes on formulae, structure and detail which are overlooked.

The assessment requirements for the specification include:

AO1 a report or leaflet which demonstrates an understanding of organic chemistry by the correct identification and naming of functional groups, the importance of different types of isomerism and different types of reactions. An investigation of therapeutic drugs, their usage and mode of action in the body

AO2 research on a process used to manufacture an organic compound showing an understanding of factors to be considered by the manufacturer, to include information about costs and benefits of the product ; evidence of appropriate calculations

AO3 practical work on two organic compounds; detailing preparation and purification methods; (to include some planning); make, record and display observations and measurements; evidence of processing results (to include % yield); suitable conclusions and evaluation included

AO1
Although there was still a lot of generous assessment at the top end work seen was often of a good quality for mark band 2. Careless mistakes in structural formulae and equations were still evident, even when full marks were awarded. Candidates need to continue to work on accuracy of formulae and equations. For AO1a much work seen was really mark band 2 as although candidates had covered isomerism, explanations were only adequate with limited discussion of differences of properties between isomers, with only optical isomerism mentioned in many cases. For AO3b candidates need to be focusing on particular functional groups, general mechanisms seem to be stated, showing no understanding of why particular reaction types take place. Inorganic examples are still being seen, mainly for redox. Mark band 3 is still being awarded just for quantity rather than quality. AO1c was generally well covered and some good selective and independent work was seen. Most work was mark band 2 as the explanations and evaluated aspect were not fully demonstrated by candidates. A lot of cut and paste information is still being seen. Candidates must show use of their research. On saying that, some excellent detail and evaluative work was seen in a minority of cases.

AO2
Both for AO2a and AO2b, coverage seemed better this session. Aspirin was most popular in scripts seen and although work was possibly not always mark band 3, work tended to cover an adequate range of factors needed to manufacture the compound chosen. But candidates still need to be aware that even for mark band 1, they need to clearly present information on the manufacturing process, identify most of the factors needed to be considered for a safe AND economic process and show use of sources. For AO2b, they need to find and use information about some of the costs and benefits of the organic compound and its manufacture: individuals; companies; society.

For AO2c candidates aiming for the higher mark bands need to show their ability in a range of mathematical skills. Just a statement that candidates have worked independently does not automatically mean mark band 3 can be gained. The centre needs to ensure that candidates have access to more than one set of calculations. Again, just the inclusion of a simple or a complex calculation linked to preparative work and research, directed by the teacher and covered by all candidates in the same way, is not reflective of high level work suitable for A grade candidates. This continues to be over assessed.

AO3
Care needs to be taken again that over assessment doesn't occur for AO3 just because candidates have completed two practical preparations. Up to 26 marks can be gained from practical work and hence between 25 to 30 hours should be allocated to AO3 work. Compounds need to be chosen that are suitable for both preparation and purification. Melting point is a method of identifying the purity of a compound not a method of purification. Candidates need to demonstrate a variety of techniques which are available in preparation and purification of organic compounds. These can include e.g. refluxing, distilling, extraction, filtering under pressure and recrystallisation. Centres need to be aware that in order to gain 9-10 marks for AO3a, candidates need to skilfully and safely complete both the preparation and purification of their chosen compounds. They also need to be showing evidence of independent planning, justifying the reasons for using their chosen techniques and the independent production of a suitably detailed risk assessment. Assessment was generous and work, again, was more reflective of mark band 2. Preparations of aspirin, ethanoic acid, benzoic acid, iodoform (triiodomethane), paracetamol, various esters, alkanals and alkanones (aldehydes and ketones) were seen. Candidates need to show evidence that they are confident in using a range of techniques. It is

also necessary for candidates to purify - techniques such as recrystallisation, distillation or solvent extraction could be used. Risk assessments need to be workable documents. They need to be sufficiently detailed but relevant to the experimental procedure but not so many pages that they are unrealistic to use during the practical activity.

For AO3b detailed observations need to be recorded for both preparations. This continues to be over assessed. Much more detail is needed on the recording of both observations throughout the preparation as well as measurements of masses/volumes of reactants used and products made. Some excellent recording was however seen in the moderated samples where full observations were recorded as the preparations progressed. Data also needs to be displayed clearly and logically. This was apparent in some scripts. For AO3c, processing of results needs to include calculations of both actual and theoretical yields. Independent work should be demonstrated here. Structured worksheets with gaps for numerical values will only allow access to the lower level marks. For AO3d evaluation needs to be detailed and focused on the techniques used, sources of errors and reaction route. Again, even for mark band 2, explanations need to be suitably related to outcomes and supported by suitable scientific knowledge. Evidence for this strand was often very low level.

It was pleasing to see that some centres had taken advice given in their moderation reports and taken this general advice on board and work was assessed to the correct standard. Again, work assessed with full marks should have no errors and be A* level at A2.

G630 Materials for a purpose

This unit still has a limited entry, and assessment generally was supported. A full range of work was sampled ranging from above 45 to below 10.

The assessment requirements for the specifications include:

AO1 information (poster/leaflet) on structure of a polymer/metal/ceramic or glass/composite

AO2 one case study where candidates are required to select materials for a stated purpose; calculations to include tensile stress and strain, the Young's modulus and toughness by using graphical methods

AO3 evidence to show the following 3 sets of experimental work: a. design and use a testing device/plan/results; b. report and results from tests on samples that have been work-hardened, annealed and tempered; c. completion of experimental work on electrical conductivity or specific heat capacity

AO1
For AO1a candidates generally completed suitable research on polymers, metals, ceramics and composites. Although work covered the requirements, care again needs to be taken by the centres that quality is maintained at a high level particularly where candidates are aiming for mark band 3 by submitting more than two examples. Generally, the standard of the work was mark band 2.

AO2
Candidates are working to the requirements of the assessment criteria and are covering the bullet points listed. As stated in previous reports the step up from mark band 2 to mark band 3 is in the justification both in the shortlist of possible materials and in the use of the data in why the choice meets the objectives of the decision. Decisions need to be supported by suitable published scientific data. Mathematical requirements are generally covered well by the higher achieving candidates with coverage of tensile stress and strain, being suitably completed. Young's modulus and toughness from a graph of force against extension and cross sectional area of sample are not always fully completed. Please note this calculation is a requirement for

mark band 1. Evidence of accuracy and giving answers to the correct number of significant figures are needed for the higher mark bands. In addition, candidates need to be demonstrating their own understanding and competence in these mathematical skills.

AO3
Generally, a suitable range of practical work was seen supported by some clear and logical reports. Please be aware that the testing device needs to test either hardness or an impact (toughness). Assessment decisions for this range of practical work are based on the complete write up and although good work was seen please note that:

For AO3a, (use and design of a testing device) at all levels candidates need to be reporting on their design and evaluating the outcomes. Even for mark band 2, candidates should be demonstrating use of an unaided plan for the development of their testing device and for higher marks, improvements of a prototype and detailed evaluations of the test and design is needed. Discussion with reasons needs to be reflective of high A2 level work.

For AO3b, (tests: work hardened, annealed, tempered) even for mark band 1, a report is required to support evidence of completion of the tests. In addition, for the higher mark bands, a comparison of treated and untreated samples or for mark band 3 an evaluation relating to whether or not the treatments have produced the expected results.

For AO3c, even for mark band 2, candidates need to complete experimental work with repeat readings, calculations and estimate the uncertainty of their results. In addition, evaluations compared to data values are needed to support 8-10 marks, but the level of discussion needs to be at a high level to support a high grade at A2.

G631 Electrons in action

This unit also has limited entry and a range of scripts were seen. This is a challenging unit and the physical chemistry covered is quite demanding. Candidates who are aiming for top marks at mark band 3 in this A2 unit need to be showing work which reflects independent thought, evidence of a thorough knowledge and understanding of electrochemical theory and high level explanations supported by suitable planning of all the experimental work. These are needed to fully complete the requirements of AO3a, b and c at mark band 3.

The assessment requirements for the current specification include:

AO1 a report outlining the principles and application of electrochemical changes, to include research into the production of electric currents and metals

AO2 a comparison of commercial cells; calculations to include the EMF of cells and quantity of charge

AO3 practical investigations into the measurement of EMF of cells and mass of copper formed in copper plating

AO1
Guidance is as previously stated in that full coverage of the relevant requirements of the specifications reference 3.12.1; 3.12.2; 3.12.3 (pages 51 – 53 of the specification) need to be covered and tracked by the candidates. Good practice is where candidates complete written reports with appropriate side headings and demonstrate use and selection from their research. The higher level candidates should be explaining and giving detail which is in their own words. Even for mark band 2, explanations need to be clear with the use of correct scientific terminology.

AO2
For AO2a candidates need to take care that for the higher marks both quality and quantity of research is at the appropriate high level. Candidates need to present their research of commercial cells to show selection and use of their research. A lot of 'cut and paste' was evident. For all mark bands candidates need to compare cells for construction and method of producing the electric current, resources used in production, efficiency, safety and environment effect, sustainability and use. This is a challenging strand. For AO2b candidates need to be completing calculations of: EMF of cells, quantity of charge, mass of products and in addition for all mark bands, evidence of research and use of data to compare the efficiency of commercial cells. Generous assessment was often evident for this strand.

AO3
For AO3, some of the practical work again was of high quality. All candidates need to show evidence of planning suitable experiments. This again was not always evident. The minimum requirements include investigations of changing a condition on the EMF of a cell AND the mass of copper deposited during electrolysis. Higher mark band work needs to include an explanation of any practical techniques which will improve results. This was often not fully supported by suitable scientific reasoning. Portfolio work produced by candidates studying this unit showed good progression from AS, although for high mark band 3, more independent thought and structure needs to be encouraged.

G632 Mind and the Brain

Portfolio work produced for this unit indicates candidates' enthusiasm and interest in this topic. Most candidates are showing evidence that they are now working with both the assessment criteria and the specification content. Candidates' practical work, although showing improvement, is still for many not containing sufficient data and hence the level of processing and interpretation are only reflective of the lower levels. This session, however, some excellent work was moderated with candidates collecting a suitable quantity of diverse data for AO3. The higher levels, however, are still generously awarded by many centres.

The assessment requirements for the specification now include:

AO1 the production of two sets of fact sheets designed to raise mental health awareness, one set on stress and illness and the second set on research methods employed in the study of the healthy and damaged brain

AO2 an evaluation of the scientific methods and techniques used in the study of mind and brain, together with a consideration of associated ethical issues and evidence of statistical research

AO3 the design and safe execution of a simple experiment to investigate one aspect of cognitive function and an investigative study on memory

AO1
Candidates are generally producing fact sheets or leaflets rather than reports for this strand. Care needs to be taken that the work relates to a target audience which could use the information provided by the fact sheet to raise mental health awareness. Both this and the content of 3.13.1 'The mind, stress and illness' need to be considered when composing work for AO1a. Again, for AO1b content of 3.13.2 'Exploration of the healthy and damaged brain' needs to be used and for the higher mark bands, work needs to be sufficiently detailed but again focused on the requirement of a fact sheet to raise mental awareness.

AO2
For both mark band 2 and mark band 3, for AO2a, candidates need to show understanding of the methods used in studying the brain. Most scripts did contain selected research based on the methods listed in 3.13.3 'Methods and ethical issues in brain research' but candidates need to use this content to cover the requirements of the assessment criteria. Candidates are advised to read carefully the requirements of mark band 3. All the criteria for this strand need to be fully covered showing how methods are used in confirming hypotheses regarding normal brain function and in the diagnosis of brain disease. Work seen is still generally mark band 2. Generous assessment still continues to be seen for AO2b. Discussion of moral and ethical implications of brain research is needed even for mark band 2. Work for mark band 3 requires candidates to demonstrate an ability to identify the preferable methods for investigating a particular research question with an evaluation both for and against the methods chosen. The detail in coverage of the moral and ethical considerations needs also to be discussed in detail. The addition of statistical evidence to brief reasons of why it is not ethical to research certain methods of brain research does not automatically give candidates mark band 3.

AO2c does ask for a fact sheet detailing statistical evidence. This seemed to be omitted again this year. Assessment continues to be generous for this strand as repetition of one statistical test was automatically awarded mark band 3. Centres are asked to ensure candidates read carefully the requirements for this strand at all levels.

AO3
The detail and range of data required for AO3 showed some improvement this year. Well done to those centres who gave their candidates opportunities to extend their research to more than the members of their class. 26 marks are available for AO3 and therefore candidates need to spend the appropriate time in their experimental work (25-30 hours). The guidance given previously still needs to be worked upon. Participants of the investigations need to complete suitable risk assessments with evidence that they have been used. A copy of letters/risk assessments/guidelines followed could all be included within the portfolio work. For AO3c coverage of all the key statements needs to be considered: recording precisely a detailed data set, display of data accurately in a range of ways and to collect sufficient data to complete simple statistics on results. For AO3d candidates not only need to draw conclusions from the outcomes of their research problem but explain their results and make real-life applications where appropriate and for mark band 3, use further secondary sources to support their findings. This was apparent in some of the work moderated this session. Well done to those candidates. AO3e needs a basic evaluation just for mark band 1. In addition, examples of how their work could be improved upon with advantages and limitations identified are needed for mark band 2. For the top marks, a much higher level of evaluation linked to experimental design, modifications and further research supported by suitable scientific reasoning and analogies is required.

G633 Ecology and Managing the Environment

This continues to be a unit where candidates produce work which reflects both their interest and enthusiasm in this topic. Assessment decisions were more in line with the standards required although care still needs to be taken where full marks at mark band 3 are awarded. Centres need to ensure that candidates are fully covering the requirements of the higher level assessment criteria to the appropriate standard. Where assessment was generous, it tended to be here.

The assessment requirements for the specification now include:

AO1 a knowledge and understanding of the effects of change on ecosystems and biodiversity, describing ecological succession and researching the effects of agricultural practice, human habitation and greenhouse gas production

AO2 information on scientific, moral and ethical reasons for preserving ecosystems and species diversity; descriptions of methods used to manage ecosystems and to preserve species diversity with information on the success of a project managing one ecosystem; calculations on ecological data

AO3 a planned investigation of an ecosystem; with relevant observations made and recorded; data displayed, interpreted and results related to the occurrence and distribution of the species within the ecosystem

AO1
For AO1a there was considerable good work seen this session with candidates demonstrating clear understanding of the relationship between the organisms, their physical environment and each other in ecological succession with evidence of the use of independent research. Centres, however, need to ensure that any materials used for learning e.g. worksheets are further supported with evidence that candidates are showing research work to support work at A2 level. Much of the work seen was mark band 2 and was suitably assessed by centres. Candidates have completed the coverage but tended not to demonstrate thorough understanding. AO1b work did for the majority give coverage of agricultural practice, human habitation and greenhouse gas production on ecosystems and biodiversity but in several cases coverage was not suitably detailed in all areas to warrant mark band 3.

AO2
Work for AO2a continues to be very varied. Work again tended to be suitably assessed at mark band 2 where candidates had discussed scientific, moral and ethical reasons for preserving ecosystems and species diversity and then gone on to work independently on their research. Evaluations to support full marks at mark band 3 tended not to be at the required A* standard at A2 level. For AO2b some interesting projects were described and data interpreted but candidates need to ensure that they interpret both qualitative and quantitative data relating to the success of the project chosen. Again, where candidates had gone on visits or gained their research from primary sources, work was well understood and described. This practice is to be recommended if possible.

AO3
Candidates do generally seem to enjoy completing the practical work for this unit. There was some good evidence of interesting investigations this session. Well done to those candidates. Although moderation aims to support work for AO3a, evidence needs to show repeated measurements for mark band 2 and completion of measurements on a wide range of factors with explanations on why the chosen techniques and equipment were used and why particular measurements need to be repeated for mark band 3.This work needs to be at an appropriate high level to support the higher mark band 3 marks. Just a basic description of the equipment used is insufficient. Although group work is apparent in this unit, it is important that candidates do work to show independent recording of their own results. Some very directed work was still seen for AO3b from some candidates. Candidates need to show evidence of ‘relevant’ observations and therefore need to have opportunities to complete this. For AO3c the displaying of data needs to show a range of different ways. Kite diagrams are often seen to support data display, but accuracy needs to be maintained for work at mark band 3. Although candidates may have worked in groups to gather their data, again, independent data recording and displays are needed. The level of interpretation and conclusions are still varied with some candidates showing detailed evidence relating to the occurrence and distribution of the species investigated. It is, however, necessary to bring all the separate measurements and data together for a final conclusion. Even for mark band 1, data collected needs to be interpreted and related to the occurrence and distribution of species within the ecosystem studied. If work is at a low level for AO3d, candidates should not automatically be awarded 4 marks.

G634 Applications of biotechnology

A range of work (from 50 to below 10) was seen this session but care still needs to be taken where full marks are awarded, to ensure that there are no errors and work fully covers the criteria at a sufficiently high level. This work needs to show scientific knowledge and understanding to support A* at A2.

The assessment requirements for the specification now include:

AO1 the production of an information booklet to include information on the science of genetic engineering and the use of recombinant DNA technology in medicine or agriculture

AO2 description of how successful DNA technology is in food production with suitable conclusions based on evidence found; financial, statistical evidence involving calculations; consideration of the moral and ethical issues and the impact of legislation associated with using genetically modified food plants

AO3 a practical investigation into enzyme technology (including the production and use of an immobilised enzyme); to include the construction of a bioreactor and the effect of temperature on enzyme activity

AO1
Candidates are generally now presenting their research about the science of genetic engineering as a public information booklet, with work suitably targeted at the correct audience. Candidates need to show evidence of their understanding of the scientific background to recombinant DNA technology by focusing on the content stated in the specification. Scientific knowledge needs, where appropriate, to be supported by related diagrams and work needs to be clear and able to be understood by the target audience. Excessive 'cut and paste' information may indicate that candidates have carried out extensive research, but the key to higher marks is clear selection of the relevant research to enable understanding of a challenging topic. Assessment tended to be generous where full marks were awarded, but generally mark band 2 assessment was supported.

AO2
The main focus of AO2a is how successful recombinant DNA is in solving problems associated with food production. Again, overall assessment tended to be generous as even for mark band 1 candidates need to draw a suitable conclusion on the benefits of the technology. For mark band 2 evidence needs to be completed on two specific examples but again conclusions need to be drawn on the researched evidence of how the technology has been used in solving problems. General information of benefits was still seen with work not focused on the outcomes of solving problems. There is quite a step up in the requirements of work for mark band 3 in that 'a comprehensive evaluation of the success of the chosen examples' is required. Candidates in addition need to clearly reference their evidence and summarise their main findings. For AO2b, for mark band 3, candidates not only need to show independent competence, but also need to be demonstrating a range of mathematical skills linked to this area of study. If there is insufficient data from their experimental work, further statistical analysis can be completed on researched data. Over assessment was often seen for this strand. Limited or no statistical analysis was evident. For AO2b a summary of the moral, ethical and environmental issues concerning the use of DNA technology in GM plant production evidence should be seen for mark band 2 as well as an explanation of two controls placed on scientists. A fluent explanation is needed for mark band 3 in addition to an evaluation of the controls chosen.

AO3

The range of practical work completed this session tended to fulfil the requirements of the assessment criteria and link to the specification requirements 3.15.4 ‘Enzyme Technology’. Candidates own planning still needs to be seen for all mark bands. This needs to be worked on at all levels. Contingency work allowing selected repeats with reasons could also support top marks being awarded. Although moderation aims to support AO3b for mark band 2, evidence of repeated measurements must be evident and for mark band 3, in addition to the carrying out, candidates need to explain the use of a range of techniques and equipment. This discussion needs to be reflective of higher level thought and understanding. Basic statements of what a piece of equipment is or e.g. ‘use to find the rate of reaction’ are insufficient to support full marks. AO3c mark band 3 should demonstrate the collection of sufficient data from candidates to enable statistical analysis to be completed. Manual graph plotting in some instances was quite low level with missing labels and poor lines of best fit. Computer generated graphs were also, in some cases, inadequately labelled, with insufficient points plotted and poor scales. Accurate plotting and fully labelled axes are needed, even where the lower marks are awarded. For AO3d candidates need to use their findings from the experimental work to produce suitable conclusions and interpretation of results. For mark band 2, candidates need to check that as well as interpretation of results and basic conclusions, the advantages of using bioreactors and enzyme immobilisation are included. The level of the evaluations is showing some improvement and centres should continue giving guidance and support in teaching candidates the requirements of high level evaluations.

G628 Sampling, Testing and Processing

General Comments:

Many total marks were in the range 20 to 60 (out of 90). There seemed to be more candidates scoring less than 30 marks than in recent years. Very few candidates scored 55 or more. Candidates continue to prepare well for questions 1 and 2, which were based on the pre-release material. A number of responses indicated that candidates had taken the opportunity of practising for the examination by using papers from previous years. Numerical problems sometimes caused more problems than in some past papers and the use of percentages still remains a mystery for a few candidates who took the paper. The questions on graphs on this paper required more thought than the routine questions that had been set in the past, and as a result, these were not always answered in a competent manner.

The examiners have commented on a number of occasions in the past about many candidates' inability to design simple experiments. This seems to be a difficult area for study and this problem continued with this year's paper. The pre-release material gave hints about the areas to revise for these questions but a number of candidates clearly did not know where to begin. The question about the dry cell was often answered poorly and the responses provided often suggested that candidates had not read the question clearly before commencing their answers.

The questions on modern instrumental methods continue to be done poorly even though no experimental detail was required and only basic responses were expected.

As expected, the responses to question 3 (not based on the pre-release material) were often answered less competently than the first two questions. There was some indication that the examination was a little long for some candidates, who had to 'rush' this final question about the corrosion of brass.

Last year the examiners commented that a number of hand-written papers were difficult to read. The marking team commented that the problem seemed worse this year and that it was difficult (and time consuming) to read some responses. It is difficult to credit material if the response cannot be read very easily. Candidates are urged to use a good quality black pen for responses.

Comments on Individual Questions:

Question No.1
(a)(i) This was generally well answered. A response based on need or location was expected.
(a)(ii) The understanding of the word 'homogeneous' was not understood by many candidates. The examiners were looking for 'variation' but this was not often provided.
(a)(iii) Many candidates did not realise that the nodules should be stored in saline water, as on the sea bed where they were found.
(a)(iv) Most candidates gained both marks for this question.
(a)(v) The idea of avoiding contamination was well understood.
(a)(vi) There were two marks here – one for the problem and one for the necessary item of protection. Some candidates did not relate these two requirements.
(a)(vii) Most candidates realised the inadequacies of pie charts and gained at least one of the two marks available.
(a)(viii) Many candidates gained a mark for the environmental factor but were less clear on the technological aspects of deep sea mining.
(b) This was a basic question on mass spectrometry and was generally answered very poorly. References to the molecular mass of the alloy and even chromatography were common.

(c)(i) Candidates were required to obtain a dry sample of manganese dioxide from a dry cell. A number of candidates did not read the question correctly and attempted to construct the dry cell shown in the paper as Fig. 1.2. Some candidates did not realise that manganese dioxide is insoluble in water even though this was stated in the question. Some put the whole dry cell into boiling water in an attempt to dissolve the ammonium chloride present. A number heated the dry cell directly to melt the zinc case and brass cap. This question was often very poorly attempted. A significant number gave no response to this question.
(c)(ii) Most candidates gained this mark for a safety requirement.
(d)(i) Some candidates stated that a catalyst increased the reaction rate but did not then mention that the catalyst was not used up / remained unchanged at the end.
(d)(ii) It was surprising to see how many candidates could not change the subject of an equation and then substitute the numbers correctly.
(d)(iii) Many candidates gained both marks – often for leakages and an incomplete reaction.
(e)(i) The examiners were looking for the variation in manganese content from plant to plant. This response was not always provided.
(e)(ii) Most candidates were able to show that a colorimetry calibration graph is a straight line through the origin.
(e)(iii) A number of correct answers to this calculation were seen and many candidates gained a mark for the correct initial stage.
(e)(iv) This proved to be a difficult question with many candidates confusing mass and percentage. The answer to (ii) was the percentage of manganese in the **ash**. The percentage of manganese in the plant would obviously be much less.
(f)(i) Candidates were asked to think how large scale filtration might be carried out. The answers provided were generally disappointing. Responses such as 'very large filter papers' gained no credit. The examiners awarded the mark for a well-considered answer such as 'a number of very fine grids'.
(f)(ii) This was a difficult question and very few candidates noticed that there was a change in volume from the small scale cm^3 to the larger scale dm^3. Correct answers were uncommon.

Question No.2

(a)(i) The meaning of the word 'quarantine' was an easy mark for most candidates.
(a)(ii) Most candidates gained both marks for two desirable properties of the insecticide but some described the differences between contact and systemic insecticides.
(b)(i) Nearly all candidates gave a sound response to the need to identify the variable.
(b)(ii) There were many acceptable responses to this question. The most common answers were based on the need to reduce chances of deterioration and the economics of the process.
(c)(i) Many candidates were able to show that the mass of the box and the oranges was 20.36 (kg).
(c)(ii) Of the many acceptable answers to this question, strength and effective packing were most commonly seen.
(d) The completion of this table appeared to be difficult for many candidates. Perhaps it was the need to use the information in the question **and** also in the article that proved troublesome.
(e) This was the most difficult numerical question on this paper. The simplest way to answer the question was to start by considering the dilution factor (5.4). Mention of this factor gained one of the three challenging marks available.
(f)(i) In this question candidates were required to construct a simple hydrometer, given a list of available materials. The question also showed a commercial hydrometer in use and this was also seen in the pre-release material. The responses provided by the candidates were often very disappointing. For example, orange juice and / or water were often put into the test tube along with the lead shot. It was uncommon to see anything near a correct answer and the marks for this were often in the range of 0 to 3 out of a total of 6.
(f)(ii) Most candidates realised that the hydrometer need to be cleaned / washed before its next use.
(g) The straight line graph showed that the refractive index and the percentage of sugar were directly proportional to each other but very few candidates were able to access this mark.

(h) Infrared absorption spectroscopy is concerned with covalent bonds but this simple response was not often provided.
(i) Both simple distillation and steam distillation had been described (and questioned) on previous papers. Very few candidates could provide a clear distinction between these two methods, even though the use of steam distillation to obtain orange flower oil was mentioned in the insert.
(j) The use of steam distillation gives two layers. Candidates were asked to state two **conclusions** about the two layers obtained (which were shown in the article). Candidates too often described the two layers rather than giving conclusions about the products.
(k)(i) A number of candidates obtained the correct answer of 35%.
(k)(ii) The examiners required candidates to comment on retention times. A number of candidates described TLC or paper chromatography in their answer and lost the mark.
(k)(iii) Although this was thought to be a more challenging question, a number of candidates gave sensible answers that gained credit, for example – use a different column.
(l) This was an easy mark and the most common answers concerned home production, ease of production and safety of the product.

Question No.3

(a)(i) Very few candidates mentioned the use of a suitable solvent for removing the grease. The examiners thought that the use of abrasives or water was inappropriate. The use of soapy water or a detergent was, however, acceptable.
(a)(ii) The idea of drying to constant mass was not often provided in candidates' answers. The question asked how could the students **confirm** that the pieces of brass were completely dry. Many of the answers given by the candidates would probably dry the brass but not confirm that they were completely dry.
(b)(i) Many candidates gave the acceptable answers of 8.38 or 8.4 (g cm^{-3}). Those candidates who gave 8.37 (g cm^{-3}) gained no credit, as they have not used significant figures correctly when obtaining their answers.
(b)(ii) A number of candidates stated that there were insufficient points provided to indicate a straight line graph and this gained credit.
(c)(i) A number of candidates provided the correct range i.e. 3 to 5.
(c)(ii) Only a few candidates stated that the brass should be tested with fluorite.
(d)(i) It was surprising that so many candidates could not measure the diameter of the circle correctly and / or give the unit in which their answer was measured. Even fewer could then divide their answer by 300 to obtain the actual size of the indentation.
(d)(ii) Many candidates gained both marks here - for increased force and the length of time for which the force was applied.
(e)(i) Mass of the brass and the 'amount' of nitric acid were the responses needed but many candidates only gained one of these two marks.
(e)(ii) If the solution was pale blue then the apparent % of copper would be lower – this was a difficult idea and not many candidates gained credit. Very few candidates realised that the problem could be solved by dilution of the acid or by using an acid that did not attack copper.
(f)(i) The examiners were looking for the idea of rapid falling and then a measure of fluctuation. Many candidates provided an incomplete answer, just describing the initial rapid falling of the corrosion rate.
(f)(ii) Candidates were expected to link biomass increase with a decrease in corrosion and vice versa. A number of candidates gained partial credit for this question but it was rare to see a really sound answer.
(f)(iii) The commonest correct answer was an implication of increased rainfall.
(f)(iv) Acidity and temperature were the most common acceptable answers from a range of several possibilities.
(f)(v) This was the last question in the paper and some candidates seemed to rush their response. Many candidates obtained some credit for this question but missed a number of stages or were not logical in their approach.

G635 Working Waves

General Comments:

This is an Applied Science paper and as such it is hoped that candidates can relate their learning to particular applications, even when these are unfamiliar. For example:

- Some answers to question 1 presented standard descriptions of infra-red cameras with no reference to the context given.
- In question 2 stock definitions of analogue and digital did not get full marks and answers often revealed knowledge without proper understanding.
- In question 5(c) few candidates linked their answers to the number of repeater stations as asked in the question.

Comments on Individual Questions:

Question No.

1 (a)(i) Well answered. The most frequent response was ‘leaks in pipes’. 'Faulty circuits' was also common. Better answers made it clear how these would lead to temperature differences which would be detected by the infrared camera. A small number gave answers unrelated to the applied context given.

1 (a)(ii) Well answered. Most candidates suggested the detection of some sort of intruder or burglar. 'People' or 'bodies' were vaguer answers but acceptable. A very small minority suggested other possible security issues, such as fire, which were acceptable provided that a temperature difference might be expected.

1 (a)(iii) The majority of candidates identified the most important advantage - being able to see in the dark/at night. Suggestions that the IR camera is more accurate or efficient did not score, nor did the suggestion that IR cameras might detect a person hidden behind another object. A number of right and wrong answers added detail about false colours, which was not required by this particular question.

1 (b)(i) Many gave the correct answer. Omission of the unit was condoned on this occasion. Incorrect responses included all of the other figures suggested in the table, the temperature values being among the most common. Other answers were presumably obtained by arithmetical manipulation of the data given.

1 (b)(ii) A substantial number of candidates correctly mentioned small temperature differences or changes. Some confused thermal and spatial resolution and referred to detecting detail in objects. Others omitted 'small' or 'difference' or both. Some students talked about accuracy and precision.

2 (a) Some scored a mark for mentioning continuous variables, although in many cases the remainder of their answer suggested limited understanding. A substantial minority recognised that the FM and AM markings indicated that the radio uses analogue signals. Fewer explained what these initials stand for. Hardly any made reference to DAB.

2 (b) Although many recognised that the description of the device as 'digital' refers to the clock display, many answers were generic descriptions of the term digital with no reference to this application.

2 (c) A minority were able to complete binary conversion successfully. Many answers were apparently random lists of 1s and 0s. Responses such as '1 2' and '12:00' suggested a more profound lack of understanding of 'binary'.

2 (d) The three key elements that scored marks in this question were 'sampling', 'at regular or frequent intervals' and 'quantisation'. These were seen in that order of frequency. There was a clear divide between answers that recognised at least some of these elements and others who seemed unfamiliar with PCM and gave generalised answers about digital and analogue variables.

3 (a)(i) Correct answers were divided between those that referred to 'oscillation along the direction of propagation' and those describing 'compressions and rarefactions'. A substantial number of correct answers were expressed in 'everyday' language such as 'back and forth' and 'clumps of molecules'. 'Up and down' and 'side to side' were ambiguous when referring to these diagrams and could therefore not score.

3 (a)(ii) Many candidates struggled to express themselves clearly. Answers which, in effect, said that the waves were not standing because they were moving, did not score marks. Successful answers gave one or both of the two key elements - 'movement in the direction of propagation' and 'movement of the compressions/rarefactions'. Again, answers such as 'movement of clumps towards the ear' were acceptable. Some candidates failed to get the 2nd marking point as they were not specific about what had moved, only describing it as the 'wave'. Some unsuccessful answers referred to frequency either changing or not, 'moving along' or 'out of phase'.

3 (b)(i) Many gave correct answers, but others drew 2D or 3D waves, omitted labels, or showed arrows parallel or wrong angles. A number of students omitted to label their diagrams.

3 (b)(ii) Most marks were achieved for 'radio' and 'microwaves' in the first two lines ('micro' did not score). Many suggested other regions of the electromagnetic spectrum but other answers such as 'transverse' and 'longitudinal' were given. Very few candidates attempted to state **how** the frequency is limited and fewer still recognised that the limiting factor is available oscillators. Some got close to the answer by suggesting a limit of alternating current. A number stated that the current couldn't produce frequencies high enough but didn't link this to the limitations of the equipment itself.

3 (b)(iii) Only a minority correctly identified the regions of the EM spectrum. A number of those who did failed to realise that the question required a device and not merely the region.

3 (b)(iv) More than half answered correctly.

3 (b)(v) A pleasing number of fully correct answers. Many missed the 3rd marking point, by answering to 2 significant figures.

3 (b)(vi) Candidates are perhaps more familiar with results being expected to 2 or 3 significant figures. A number recognised that the precision of the answer should reflect the information given. A variety of incorrect answers included 'more accurate', 'a better estimate', 'standard form', 'value is large', 'gives a rounded number' and reference to the known value of the speed of light.

3 (c)(i) Square, sawtooth and more complicated repeating shapes were seen in approximately that order of frequency. Unfortunately many drew Sine waves despite being told expressly not to.

3 (c)(ii) More successful answers than (i).

3 (c)(iii) A number of candidates achieved one mark. Common errors included 'period', 'amplitude', 'frequency', 'distance from source', no units for time and the correct answers in the wrong order.

4 (a) Most candidates answered correctly, ABC being the most common incorrect response.

4 (b) As expected, more marks were scored for suggesting the colours than for explanations. Incorrectly stated colours included many combinations, including black and grey from those who thought that no visible light was emitted by star 'C'. Many answers were about hotter and colder. Few referred to the positions of the peak of the curves. Few achieved full marks.

4 (c) Most students knew it absorbed 'all' the radiation but didn't mention lack of reflected light or emission of colours. A number stated that it emits no radiation.

5 (a)(i) Many confused cladding with protective sheath.

5 (a)(ii) Fewer correct answers than might have been expected. Some simply got the refractive indices the wrong way round. Many were unclear about which layer was which, for example answers like 'the glass has a higher refractive index' suggested that candidates did not realise that there were two layers of glass. Many answers did not attempt to compare the RIs, e.g. '2 different materials used', 'these two layers would be decoded at the end', 'the angle of incidence is greater than the refractive index', 'the difference is of thickness and size', 'one gives out light the other does not'.

5 (a)(iii) A number of candidate recognised TIR. Some gave the alternative answer relating RI to the speed of light. As with part (ii), a number of seemingly irrelevant comments were seen which suggested that those candidates had limited understanding of optical fibres.

5 (b) A number of candidates scored one of the marks by stating that TIR will occur if the angle of incidence > C. Others got this the wrong way round or only stated that $i = C$ is the limiting condition. Very few were able to take the more difficult step of recognising that bending could change i and how this might affect whether TIR occurs. Some confused angle of refraction with refraction. Many wrote about critical angle changing. Although many drew diagrams, very few showed enough information which would gain marks.

5 (c) The most commonly scored point was that rays arrive at different times. Many of these candidates also linked this to distortion of the signal. A much smaller number gained a mark by using the term 'multipath distortion'. Many knew that rays travelled along different paths, but not all recognised that the path lengths were different. A considerable number incorrectly stated that the rays travel at different speeds. Only a small minority referred to the effect of the angle at which the rays entered or travelled along the fibre. Distortion was referred to but few correctly named it as multimode/multipath. Some candidates wrote about other types of fibre such as graded index. Some weaker candidates wrote about loss of signal strength. There was possibly some confusion about the diagrams in the question, a number thought they showed the path of light and therefore started writing about graded index fibres.

5 (d) Many candidates scored one of the two marks for either a 'single path', 'small diameter' or 'degradation'. Few candidates linked their answers to the number of repeater stations required. Some wrote about 'one signal' rather than 'one path'. Some confused 'attenuation' with 'distortion'. A few confused 'monomode' and 'graded-index' fibres.

5 (e) 'Cheaper' was a common answer which was accepted, although 'low material costs' was preferred. 'Faster data transmission' was also a common correct answer, but 'more data' or 'larger data capacity' did not score. The other marking points were all represented in a substantial number of answers, although only a minority achieved two marks.

5 (f)(i) Candidates who followed the instruction to 'describe the method used to trace the ray' scored well. Many, instead, gave details about measurements and calculations. There was a lot of unnecessary discussion about the full method for calculating the refractive index of a block so question requirements were often missed.

5 (f)(ii) Very few recognised that the incident ray should enter the block at right angles to the surface.

5 (f)(iii) It was noted that students who did not know the correct answers fell into two categories: those who made sensible guesses i.e. some sort of light source and some sort of detector, respectively; and those who suggested other technical terms from the specification.

5 (f)(iv) Most candidates were able to suggest some sort of communications and some sort of light application. Some who had learnt about the application of incoherent bundles to swimming pool lighting simply put 'swimming pools' and failed to score.

6 (a) Many recognised 'obstructions' and 'population density' as key factors. A minority gave circular arguments such as weak transmitters and small cells.

6 (b) Generally well answered. Some were too brief. A few failed to score because they substituted 'satellites' for 'base stations'. A minority were unfamiliar with these terms from the specification which have featured in previous papers.

6 (c) Generally well answered.

6 (d) A substantial number of candidates scored 2 to 4 marks by correctly stating 'adjacent cells which cannot use the same frequency as F', and vice versa and correctly listing appropriate letters. A large minority incorrectly stated that adjacent cells should have the same frequency so that they could communicate with each other. Some listed cells A to E in one category and G to K in the other. A number got side-tracked into talking about how multiple access systems enable cells to be reused.

7 (a) Many candidates understood that the grid absorbs unwanted rays. Some correctly identified these as scattered; others stated incorrectly that low frequency rays are absorbed (confusing the device with aluminium filters). Sometimes the terminology used was weak, e.g. ‘reflected’ rays rather than ‘scattered’ rays.

7 (b)(i) Correct answers were in a minority. There was a wide variety of incorrect answers, including 'screens brightening' and 'improved quality'.

7 (b)(ii) Few candidates were able to make the connection between film and digital X-ray processes.

7 (b)(iii) Candidates in general were able to distinguish between the effect of dense and less dense body parts on X-ray absorption. Little was seen about differential absorption between parts of the body other than bone.

7 (d)(i) Many candidates forgot to mention that this was reduced by half.

7 (d)(ii) Many candidates gave answers which ignored 'half'. Some recognised that excretion was involved. Poorer answers referred to the decay of radiation 'inside the body', or the length of time the radiation 'stays in' the body.

7 (d)(iii) Some achieved full marks. Others knew the formula but struggled with the maths. Those who did not know the formula tried a variety of combinations of the data given.

7 (e) Many candidates gave at least one valid answer. Incorrect responses included 'reduce the overall dose' sometimes by reducing exposure time (which might not kill the cancer), and 'use lead shielding' with no mention of covering healthy areas only. Some answers referred to methods of minimising dose to staff rather than to patients.

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