GCSE EXAMINERS' REPORTS

SCIENCE - CHEMISTRY

SUMMER 2016

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SCIENCE - CHEMISTRY

General Certificate of Secondary Education

Summer 2016

CHEMISTRY 1 – FOUNDATION TIER

1. (a) This question was poorly answered by many candidates. The quality of diagrams from those who did understand what was being asked was generally poor. It might have helped some candidates to label their diagrams. The question required candidates to show how they intended to use their selected apparatus/reagents.

   For example:
   Stage 1 – a diagram showing sulfuric acid in a beaker with copper(II) carbonate being added
   Stage 2 – a filter funnel and paper containing copper(II) carbonate (together with an evaporating basin containing copper(II) sulfate solution)
   Stage 3 – an evaporating basin containing copper(II) sulfate solution (with or without heating)
   The main reason for not obtaining a mark was including incorrect apparatus as well as the correct items.

   (b) Surprisingly this question was poorly answered.

   (c) Many candidates failed to gain this mark by choosing 'hydrogen' and /or 'copper (II) chloride' amongst the products.

2. Many candidates showed a lack of basic knowledge and understanding relating to the extraction of iron in a blast furnace.

   (a) 'Limestone' was generally correct but ‘hot air’, ‘slag’ and ‘iron’ were often mixed up. Weaker candidates gave ‘steel’, ‘coke’ and 'iron ore’ as products.

   (b) (i) Many candidates did not know that ‘coke’ is used to heat the furnace. ‘Iron ore’ or even ‘steel’ often given.

   (ii) Candidates chose substances at random to answer this question.

   (c) Generally well answered. The common incorrect answer for this question was ‘2’.

   (d) Common errors were either not multiplying by 100 or using 2000/1100.
   A few candidates did not attempt this question.

3. (a) Well answered.

(b) Most candidates gained the first marking point. However, those who failed to obtain this marked often used incorrect terminology. For example, 'jig-saw fit of countries', 'coastlines fit like a puzzle'. Common errors on the second marking point included 'similar plants' and 'similar animals' instead of 'similar fossils'.

(c) Generally well answered. However, weaker candidates often chose 'tsunami' as their answer.

4. (a) Generally well answered with the exception of part (iii). This was poorly answered with 'diesel oil' often given as having the largest boiling point range.

(b) Many candidates failed to gain marks on this question by not reading the question carefully. The question did not ask for 'three advantages of plastics' but required candidates to use their knowledge of plastics in the context of replacing underground gas pipes made of cast iron with plastic ones. Many candidates referred to cost although the stem stated that this should not be considered. Answers which gained no credit included, 'plastic can be recycled', 'plastics are durable', 'plastics are waterproof' and 'plastics are easily moulded'.

5. (a) This question required candidates to interpret the information from the diagram, namely that hydrogen and oxygen are formed in a ratio of 2:1. Most recognised that the gases formed were hydrogen and oxygen but most failed to gain the second marking point.

(b) This question was made more accessible by providing the symbol equation and a choice of answers for the candidate to select from. Unfortunately some candidates failed to use the equation or the key for the different atoms in the boxes. The most common incorrect answers were C and D but a few candidates drew their own incorrect answers instead of choosing a letter. The idea of 'no atoms being created or destroyed' is not well understood at this level.

6. (a) (i) Most candidates were able to plot points and draw a line of best fit so gained all three marks.

(ii) Weaker candidates were unable to read the x-axis scale accurately.

(iii) Few candidates applied their practical skills and stated that the copper needs to be dried. Incorrect answers included 'boil the copper', 'cool the copper' and 'clean the copper'.

(iv) Generally well done although '$MgCu + SO_4$' was commonly seen.

(b) Most candidates were able to put the three metals in their positions in the reactivity series. However, many candidates went on to simply state the order again, e.g. 'magnesium is the most reactive and silver the least reactive', 'magnesium is above copper and copper is above silver'. Candidates needed to refer to the practical information provided, e.g. 'magnesium can displace copper and copper can displace silver'.

7. Foundation tier candidates struggled with this question.

(a) (i) Although most candidates recognised that element **C** is in Group 2 they failed to give Period 3. The most common answer was to say element **C** is in Period 2.

(ii) Many candidates who correctly chose element **D** then went on to repeat the information from the stem i.e. 'it has both metallic and non-metallic properties'. This gained no credit. Other common incorrect answers included '…because it is brittle and shiny', '…because it is in Group 4' and 'because it is silicon'. Referring to the element being 'on the zig-zag' or 'in the middle' also failed to gain credit.

(b) Many candidates appeared to guess the value for the number of nitrogen atoms presents. Incorrect values included 1, 4, 6 and 9.

(c) Many candidates used the correct ions, namely Li^+ and CO_3^{2-} but were unable to give the correct formula for lithium carbonate. Common incorrect answers included $LiCO_3$, $Li^+CO_3^{2-}$ and $2LiCO_3$.

8. Generally well answered. The most common incorrect answers were as follows.

(a) 'no trend', 'decrease' and 'bromine'

(b) 'bromine'

(c) 'bromine'

9. (a) (i) Generally well answered. The most common incorrect answer was 'gas'.

(ii) Many candidates failed to appreciate that this question was worth three marks. Many gave the correct direction of movement of each ion but did not explain why the ions travelled in those directions. 'The anode is negative and the cathode is positive' was a common error. Many candidates failed to link movement to the 'attraction between opposite charges'.

(b) Candidates who failed to gain this mark failed to read the word '**unusual**' in the stem of the question. Most answers not gaining credit were general properties of metals e.g. ductile, malleable and shiny.

(c) This question required candidates to interpret numerical data and to know what is meant by an increase of 100%. Unfortunately many weaker candidates failed to gain marks. Some candidates gave the correct alloy but then misread the y-axis and described an increase from 21 to 42. These gained only one mark. The most common incorrect answer was 'alloy **D** because its strength goes to 100%'.

10. Most candidates did not read the question carefully and failed to notice the context of the question, namely *household waste.* Answers which included reference to 'landfill sites', 'litter', toxic gas/CO_2 formed on burning' were credited. Many candidates were unable to apply their everyday experiences to suggest some disadvantages of household recycling systems (see mark scheme). Many candidates were unable to organise their answer, use sentences, spell correctly or give a concise answer. Poor handwriting remains an issue.

SCIENCE - CHEMISTRY

General Certificate of Secondary Education

Summer 2016

CHEMISTRY 1 - HIGHER TIER

1. Generally well answered by higher tier candidates.

   (a) (i) Weaker candidates gave Period 2 instead of Period 3.

   (ii) Most candidates who correctly chose element **D** gained one of the two marks available. Common incorrect explanations included 'it has both metallic and non-metallic properties', 'because it is brittle and shiny', ' because it is in Group 4' and 'because it is silicon'. Referring to the element being 'on the zig-zag' or 'in the middle' gained no credit.

   (b) Well answered.

   (c) Generally well answered. Common incorrect answers included $LiCO_3$, $Li^+CO_3^{2-}$ and $2LiCO_3$.

2. Generally well answered. The most common incorrect answers were as follows.

   (a) 'no trend', 'decrease' and 'bromine'

   (b) 'bromine'

   (c) 'bromine'

3. (a) (i) Well answered.

   (ii) Many candidates failed to appreciate that this question was worth three marks. Many gave the correct direction of movement of each ion but did not explain why the ions travelled in those directions. 'The anode is negative and the cathode is positive' was a common error. Many candidates failed to link movement to the 'attraction between opposite charges'.

   (b) Candidates who failed to gain this mark failed to read the word '**unusual**' in the stem of the question. Most answers not gaining credit were general properties of metals e.g. ductile, malleable and shiny.

   (c) This question required candidates to interpret numerical data and to know what is meant by an increase of 100%. Unfortunately many weaker candidates failed to gain marks. Some candidates gave the correct alloy but then misread the y-axis and described an increase from 21 to 42. These gained only one mark. The most common incorrect answer was 'alloy **D** because its strength goes to 100%'.

4. Most candidates did not read the question carefully and failed to notice the context of the question, namely *household waste.* Answers which included reference to 'landfill sites', 'litter', toxic gas/CO_2 formed on burning' were credited. Only the stronger candidates were able to apply their everyday experiences to suggest some disadvantages of household recycling systems (see mark scheme). Although higher tier responses were better than those at foundation tier, many candidates were unable to organise their ideas clearly and answer concisely.

5. (a) Although candidates have many past papers to practise this style of question it is surprising how many failed to gain most of the marks. Weaker candidates selected their answers from the boxes.

Common incorrect responses were as follows.

A hydrogen, zinc sulfate …*although candidates were told that **A** is a metal and zinc sulfate is given in the box*
B copper …*although candidates were told that **B** is a compound* and copper oxide, copper sulfate
D sodium sulfate, sodium
E copper

(b) Most candidates used the correct ions but weaker candidates were unable to give the correct formula. Incorrect formulae included $NH_4^+SO_4^{2-}$, $2NH_4SO_4$, NH_2SO_4 and $NH_4(SO_4)_2$.

6. (a) Only the most able candidates understood the functions of coke in the blast furnace and gained the three marks available. This question relied on the recall of knowledge and evidently many candidates did not prepare for this topic. The best answers were supported with balanced symbol equations (which were not necessary to gain full marks). Stating that 'coke burns' gained the first mark. For the second marking point candidates needed to mention the formation of carbon dioxide and its conversion to carbon monoxide. Weak candidates gave vague or incorrect functions of coke, e.g. 'coke is added to extract iron' or 'coke is added to remove impurities'.

(b) (i) Generally well answered.

(ii) Some candidates gave 'iron and carbon' which did not gain credit – it is iron *oxide* that is reduced. The mark scheme credited those candidates who went on to correctly state that 'carbon gains oxygen'.

(c) Candidates who used the wrong terminology failed to gain credit, e.g. 'alloys are a mixture of *elements*' or 'alloys are a *compound* of two metals'.

7. (a) Most candidates gain two of the available three marks. 'Displacement' was well known and most candidates were able to name the two products. However, an explanation as to why the reaction occurs was often omitted. Weaker candidates confused the reaction completely referring to a 'metal + acid' reaction giving 'salt + hydrogen' or described it as a neutralisation reaction. Able candidates supported their answer with a balanced symbol equation.

(b) Poor writing skills often resulted in candidates failing to gain both marks for this question. One of the first marking points required candidates to state that nano-particles might be 'absorbed into the body', however a vague statement e.g. 'gets into the body' gained no credit. To be awarded the second marking point candidates needed to stress the uncertainty over long terms effects. e.g. '*could be* harmful in the long term' gained credit but 'can harm the body' did not.

8. Generally well done but a couple of marks were lost due to candidates either not reading the question carefully or not recognising the number of marks available.

(a) The explanation required candidates to answer in terms of 'atoms'. Many candidates gave a numerical explanation which gained no credit.

(b) (i) Well done.

(ii) Most candidates gained the first marking point by stating 'as the mass of magnesium increases, the mass of copper increases', however, many failed to obtain the second marking point by recognising the linear/proportional relationship between the two masses.

(iii) Well answered.

9. (a) Performance on this question was disappointing. Candidates have many past questions on which to familiarise themselves with this type of 'argument' style question. Most gained the 'support' mark, but poor writing skills resulted in many not gaining the second mark.

(b) A surprising number of candidates failed to gain both marks for this question. Only the able candidates realised they needed to complete a balanced equation for the reaction and use the same key shown in the reactants. This question discriminated well.

10. Many candidates are still not fully aware of the criteria used to mark 'Quality of Written Communication' questions. The main issues include poor punctuation and grammar, neglecting to link relevant points and poor hand writing.

Many candidates interpreted the question as simply asking for advantages and disadvantages of hydrogen as a fuel. Middle and higher band credit required candidates to use and expand on the information given. For example:

'The raw material for making hydrogen is water and the raw material for making petrol is crude oil' … simply re-states what was given in the table and gained no credit.

'The raw material for making hydrogen is water which is renewable, however, the raw material for making petrol is crude oil which is non-renewable' … expands on the information provided and involves the evaluation required.

SCIENCE - CHEMISTRY

General Certificate of Secondary Education

Summer 2016

CHEMISTRY 2 - FOUNDATION TIER

1. (a) Very well answered. Relatively few candidates failed to gain both marks.

   (b) Well answered though some candidates gave yellow for lithium and red for sodium. The sodium flame colour was better known than that for lithium.

   (c) Generally well answered. Some candidates failed to interpret the formula correctly and an M_r of 23 was a common error.

2. (a) Most candidates gave bubbles or fizzing as their answer. Some described the disappearance of calcium carbonate. Common errors included burning or gas given off.

   (b) Very poorly answered. The choice appeared quite random and conical flask was rarely given.

   (c) (i) The correct curve was usually chosen but the reason given was often incorrect. **A** produces the most gas was a very common error.
   (ii) Most candidates gave at least one correct factor. Common incorrect answers were volume of acid, mass of calcium carbonate, time and temperature.

   (d) (i) Very poorly answered. Some candidates stated that the mass would decrease but very few were able to explain why. Indeed, many thought that the cotton wool would prevent gas from escaping.
   (ii) Poorly answered. More accurate or to reduce human error were common responses.

3. (a) Very well answered with most candidates opting for **Y**.

   (b) Some candidates correctly identified both a similarity and difference. A significant number of candidates incorrectly related their answers to rates of reaction stating that solubility increased *faster* rather than *more*. A small number of candidates incorrectly compared the wrong pair of graphs.

   (c) (i) The points were plotted very well. The line was usually correct though some candidates drew a straight line of best fit or joined the points with a ruler.
   (ii) This was well answered. Some candidates used the graph for the calculation rather than the data in the table.

4. (a) This was not answered well. Few candidates gained both marks. The size of the particles removed was not well known with stones, mud and sand often given. Very few candidates described the particles as insoluble.

(b) Well answered. Most candidates were aware that bacteria were removed at this stage but some failed to link chlorine to the process.

(c) This was not well answered. Few candidates linked a hosepipe ban to saving/conserving water. Lack of rain and references to the water not being safe to drink were quite common.

(d) Fairly well answered with many candidates gaining 1 mark, usually for references to boiling the seawater. Explanations of what happens next were often vague and failed to state that condensation took place.

5. (a) Not well answered. Relatively few candidates were able to name both compounds. A very common response was to label them as alkane and alkene.

(b) Generally well answered. The commonest error here was to base the answer on the structures given rather than in terms of alkanes and alkenes generally. Hence, they have the same number of carbons was given as a similarity and a different number of hydrogens as a difference.

(c) Very well answered. A small minority put no bonds or a double bond between the carbons.

6. (a) Very well answered. Almost all candidates referred to the strong bonding between carbon atoms.

(b) Most candidates correctly identified graphite. Many failed to mention free **moving** electrons or referred to movement of the layers.

(c) Poorly answered in general. Many stated that the layers were weak.

7. (a) Many candidates correctly identified **D** and **E** and gave the correct reason; the presence of 2 shells of electrons. However, some lost this mark by referring to 2 *outer* shells. A significant number of candidates gave **C** and **D** because they have 2 electrons in the outer shell. Others gave either **D** or **E** only together with a correct reason for 1 mark.

(b) Generally well answered. Most identified **B** because it had 15 electrons. However, this mark was often lost due to reference to outer shells or atoms in shells.

(c) Generally well answered. Many candidates gained all 3 marks. A significant number restricted their answers to the electrons or the electronic structure thereby limiting themselves to a maximum of 2 marks and often only 1.

8. (a) Poorly answered. Many candidates gave the formula of sodium bromide as $NaBr_2$ and gained no marks. Others gained 1 mark for NaBr. Very few were able to write the complete balanced equation.

(b) Only a handful of candidates gained the mark for dissolving the solids in water. Most were able to identify the colours of the precipitates formed but many simply described the colour produced without reference to precipitate.

(c) (i) Generally well answered. Common errors were 2:2 or 2:3.

(ii) Most candidates gained at least 1 mark for the M_r of aluminium chloride or for the mass of chlorine in it. Incorrect values were often used in the calculation, e.g. M_r for AlCl. A minority of candidates incorrectly rounded their answer down to 79%.

(d) (i) Though candidates showed that they were perfectly able to calculate percentages they often used incorrect data from the question and gained no mark.

(ii) Poorly answered. Answers were vague or plucked from the air, e.g. it was only an estimate or there was not enough aluminium.

9. This question was generally well answered, with the majority of candidates achieving middle band marks for correctly being able to describe both types of smart material and giving a use for each of them. There were a number of candidates who failed to describe colour as the change in property for each type of material. There were also candidates who only described one of the smart materials, limiting them to bottom band. A number of candidates described both photochromic and thermochromic materials as changing colour and shape. Very few responses were awarded top band marks, for failure to describe smart materials in general (reversible change because of external condition/stimuli) or not fully explaining the uses given. A minority of candidates either failed to attempt the question or gave responses that were awarded no marks. It was also noted that there was some confusion between photochromic materials and reflective and phosphorescent materials.

SCIENCE - CHEMISTRY

General Certificate of Secondary Education

Summer 2016

CHEMISTRY 2 - HIGHER TIER

1. (a) Many candidates correctly identified **D** and **E** and gave the correct reason; the presence of 2 shells of electrons. However, some lost this mark by referring to 2 *outer* shells. A significant number of candidates gave **C** and **D** because they have 2 electrons in the outer shell. Others gave either **D** or **E** only together with a correct reason for 1 mark.

(b) Generally well answered. Most identified **B** because it had 15 electrons. However, this mark was often lost due to reference to outer shells or atoms in shells.

(c) Generally well answered. Many candidates gained all 3 marks. A significant number restricted their answers to the electrons or the electronic structure thereby limiting themselves to a maximum of 2 marks and often only 1.

2. (a) Some candidates gave the formula of sodium bromide as $NaBr_2$ and gained no marks. Others gained 1 mark for NaBr. Many were able to write the complete balanced equation.

(b) Only a handful of candidates gained the mark for dissolving the solids in water. Most were able to identify the colours of the precipitates formed but many simply described the colour produced without reference to precipitate.

(c) (i) Well answered with most candidates able to balance the equation. Common errors were 2:2 or 2:3.

(ii) Most candidates gained at least 1 mark for the M_r of aluminium chloride or for the mass of chlorine in it. Incorrect values were sometimes used in the calculation, e.g. M_r for AlCl. A minority of candidates incorrectly rounded their answer down to 79%.

(d) (i) Though candidates showed that they were perfectly able to calculate percentages they often used incorrect data from the question and gained no mark.

(ii) Poorly answered. Answers were vague or plucked from the air e.g. it was only an estimate or there was not enough aluminium. However, many candidates gained 1 mark for sensible responses e.g. the aluminium oxide was impure. Few gained 2 marks here.

3. This question was well answered generally, with the majority of candidates achieving middle band marks for correctly being able to describe both types of smart material and giving a use for each of them. There were also many responses that were awarded top band marks, for describing smart materials in general (reversible change because of external condition/stimuli) and giving full explanations for their uses. Very few candidates failed to attempt the question or gave responses that were awarded no marks.

4. (a) Most candidates were able to describe the link between temperature and oxygen solubility. Some went no further. Most were able to relate this to the ability of fish to survive.

(b) Nearly all candidates were able to read 9 mg/dm^3 from the graph but many were unable to convert this to g/dm^3. Many divided by 1000 to give 0.00 9g/dm^3.

(c) Many candidates gained a mark for putting the oxygen and carbon dioxide into the same units. A significant number also succeeded in calculating the final answer. An exact answer was usually given, rather than an estimated value as the question was designed to elicit, but this was credited.

5. (a) There were some very poor responses here. Most candidates recognised that the rate of reaction increased with increasing concentration. However, few explained this in terms of a greater number of particles in the same volume. Most simply stated that there would be more particles. A common error was to state that there would be a greater number of collisions rather than a greater chance of collision. Many candidates stated that because there were more particles they would have greater energy and there would be more successful collisions. Very few candidates linked the doubling of the concentration with a doubling of the rate. Awarding 2 marks or even 1 mark was not uncommon.

(b) (i) Poorly answered. Few candidates recognised that the fall in mass would be very small.

(ii) Most candidates were able to calculate the M_r values for hydrogen and carbon dioxide though these were sometimes described as the atomic masses. Most candidates stated that carbon dioxide was heavier than hydrogen. However, fewer related this to the fact that the fall in the mass would be greater in an experiment producing carbon dioxide.

6. (a) (i) This was answered well by many candidates. The majority of responses recognised there would be decolourisation in the bromine water. A minority of responses incorrectly referred to the solution becoming 'clear'. Explanations for the colour change were varied. Many candidates correctly explained that an addition reaction had taken place or that the double bond in the alkene had broken. Incorrect responses commonly referred to 'a reaction' taking place or polymerisation.

(ii) This was well answered. Most candidates gave the correct formula for 1,2-dibromoethane. Some candidates retained the double bond whilst others put both bromine atoms on the same carbon. A polymer structure was sometimes given.

(b) (i) Well answered in general. Common errors included omission of the n, a double bond between the carbons, n in front of the formula and terminal bonds not protruding beyond the brackets.

(ii) Most candidates gained at least one mark for recognising that the plastic would melt. Many candidates stated that there were strong crosslinks but often referred to them being between 'layers' rather than polymer chains. A small number discussed thermosetting plastics.

7. (a) (i) This was well answered with many candidates gaining full marks. The order of reactivity was well known though a few candidates listed chlorine, bromine and iodine without stating which was the most or least reactive. Very few failed to get the correct order of reactivity. A significant number of candidates incorrectly described displacement of iod*ide* and brom*ide* rather than iodine and bromine. Others did not mention displacement, merely referring to reacting.

(ii) Many candidates were able to produce a balanced equation. Others succeeded in giving the correct formulae for the reactants or the products. Common errors included Cl forCl_2, I for I_2, KCl_2 and KI_2.

(b) This was not well answered though many candidates did arrive at the correct answer. Some had difficulty in calculating the molar masses though many candidates gained a mark here. Unfortunately they did not always know how to use them.

8. This question was fairly well answered. Most candidates drew a correct diagram showing the bonding in water but many had difficulty with carbon dioxide. Responses generally described the sharing of electrons to obtain a full outer shell though sharing of a 'pair of electrons' was less common. The general concept of covalent bonding was quite well understood but candidates often failed to give a clear description of a double bond and few gave a reason why some molecules have double bonds. Relatively few candidates gained 5 or 6 marks, the majority gaining 3 or 4.

SCIENCE - CHEMISTRY

General Certificate of Secondary Education

Summer 2016

CHEMISTRY 3 - FOUNDATION TIER

1. (a) (i) A fairly well answered question although weaker candidates appeared to rely on guesswork.

(ii) Generally well answered. The majority of incorrect answers focussed on the products of the reaction by giving 'carbon dioxide' or 'water' as the answer.

(b) Good marks gained here with some link to alcoholic drinks being the most common acceptable answer.

(c) Most candidates gained two of the three marks for the identification of a damp cloth and the removal of oxygen; but very few managed to explain how the method works by mentioning the fire triangle. One fairly common incorrect response included the 'removal of the fuel by turning off the gas to the Bunsen burner'.

2. (a) A very well answered question. Some of the weaker candidates failed to include a double bond between the two carbons in the structural formula for ethene.

(b) Very well answered.

3. (a) (i) Generally very well answered by the majority of the candidates.
(ii) Generally poorly answered. Quite a variety of methods were attempted here. Many candidates failed to gain full marks by giving incorrect methods such as 'one third of 200 000'.

(b) (i) Well answered by the majority.
(ii) A poorly answered question. One common incorrect answer seen was that 'ethanoic acid did not react with magnesium'. Only a very small number of candidates mentioned the difference in the strength of the two acids.

4. (a) (i) Well answered.
(ii) Also well answered.

(b) Although well answered by many of the candidates some answers were rather vague and therefore failed to gain the mark.

(c) Most candidates gained some of the available marks here but only the better ones were able to give a clear account that was worth all three marks.

(d) Poorly answered by the vast majority of the candidates. The most common incorrect answer linked slaked lime with a 'fertiliser' or a 'pesticide'.

5. (a) A very poorly answered question with the vast majority of the candidates having no idea what a precipitate was.

(b) Generally a well answered question although the common incorrect answer

of 'carbon trioxide' was seen.

(c) (i) The majority of candidates were able to gain good marks here although weaker candidates often chose incorrect colours.

(ii) The majority of candidates were able to use the key correctly and gained both available marks.

(iii) Many of the candidates struggled to gain the mark here with the most common incorrect answer being 'potassium nitrate + bromide' as the products.

6. (a) Fairly well answered.

(b) (i) The majority of candidates seemed unaware of the expected observations during this experiment.

(ii) Poor answers seen here with very few candidates giving the correct formula for calcium hydroxide.

7. (a) The graph was very well plotted with most of the candidates able to draw a good suitable line.

(b) Well answered. The most common incorrect value given was '79'.

(c) Most candidates were able to express themselves clearly to gain both marks here. The common problem was linking the temperature with the yield.

(d) (i) Many candidates incorrectly gave the formula of ammonia as 'NH_4' and therefore also lost the balancing mark.

(ii) Very well answered.

8. (a) Although most candidates seemed to know the answer many failed to gain the mark by giving vague answers such as 'to show colour change'.

(b) Good candidates gave the correct answer and the reason. Weaker candidates however failed to give the correct reason and gained no credit.

(c) (i) Most of the candidates did not ignore the 33.5 result and therefore gave the incorrect mean. This was disappointing.

(ii) The most common missed marks seen here were for the omission of 'don't use the indicator' and 'the evaporation of the solution'.

9. (a) Although many of the candidates were able to give the correct tests and results for the three gases they did not make an attempt at the required plan. Others gave a good plan but did not give all three tests as asked for. Most candidates were therefore in the middle band scoring 3 or 4 marks.

(b) (i) Only the stronger candidates were able to name the correct gas here and a wide variety of incorrect answers were seen.

(ii) Candidates who named the correct gas in part (i) scored well in this part.

SCIENCE - CHEMISTRY

General Certificate of Secondary Education

Summer 2016

CHEMISTRY 3 - HIGHER TIER

1. (a) A very well answered question. Very good graphs and suitable lines were seen in this paper

   (b) Well answered.

   (c) Most candidates were able to express themselves clearly to gain both marks here.

   (d) (i) The majority of candidates were able to give the correct formula for ammonia and usually balanced the equation correctly gaining both marks.

   (ii) Very well answered.

2. (a) Although most candidates seemed to know the answer some failed to gain the mark by giving vague answers such as 'to show colour change'.

   (b) Good candidates gave the correct answer and reason. Weaker candidates however failed to give the correct reason and gained no credit.

   (c) (i) Some of the candidates did not ignore the 33.5 result and therefore gave the incorrect mean.

   (ii) The most common missed mark seen here was for the omission of 'don't use the indicator'.

3. (a) Although most of the candidates were able to give the correct tests and results for the three gases many did not make an attempt at the required plan. Others gave a good plan but did not give all three tests as asked for. The majority of candidates were therefore in the middle band and scored either 3 or 4 marks.

   (b) (i) Well answered.

   (ii) Also well answered.

4. (a) Although the majority of candidates identified that both carbonates gave off carbon dioxide only a small number gave an adequate difference with a significant number focussing incorrectly on flame colour.

   (b) Only the stronger candidates gained both marks here with a significant number unable to work out the correct formula for calcium carbonate.

   (c) Although some of the candidates were able to give a difference, very few were able to give a reason for this difference.

5. (a) Very well answered.

(b) The majority of candidates were able to identify the incorrect structural formula but many of them gave an unacceptable reason e.g. 'not enough hydrogens'.

(c) Generally well answered.

(d) Generally well attempted. Common unacceptable responses included reference to 'bromide' instead of bromine and vague statements such as 'one changes colour and the other does not'.

(e) The majority of candidates gave the correct answer of ethanol. Many, however, failed to score the other two marks by giving incomplete reasons.

6. (a) (i) A very well answered question.
(ii) A poorly answered question. Most candidates did not understand the meaning of an ionic equation and tried instead to give the complete balanced equation. The formula given for iron(II) hydroxide was very often incorrect.

(b) Generally well answered.

7. (a) Only the better candidates were able to gain good marks for this question as a whole. Part (a) was the best answered part.

(b) The majority of candidates did not know how to use the given equation to answer this part.

(c) Although only a small number of correct answers were seen here, a significant number of candidates did manage to gain marks by using the value obtained in part (b) and the examiners applying the 'error carried forward' rule.

(d) A very poorly answered question. Only a small number of correct answers were seen. Some gave twice the volume of sodium hydroxide (43 cm^3) and others gave half the volume of the sulfuric acid (12.5 cm^3).

8. This topic had been well covered and learnt by the majority of candidates. Any lost marks were due largely to vague answers or missed sections of the process in the account.

SCIENCE: CHEMISTRY

General Certificate of Secondary Education

Summer 2016

SCIENCE A CONTROLLED ASSESSMENTS

Overview

In general, the standard of the candidates' work was similar to the previous year. The candidates were well prepared and understood the controlled assessment system, but the strengths and weaknesses shown throughout the life of the specification remain largely the same. The research task continues to provide problems for a wide range of candidates.

Administration and marking

In general, samples were submitted on time and were well organised. A significant number of centres were found to be marking their candidates' work too generously. This particularly applied to those at the upper end of the mark range, but sometimes spread across the whole entry. The award of marks in the top band should indicate work of very high quality, both in the understanding of science and the communication of that understanding. Too often, very high marks were being awarded for work that was competent but showed significant weaknesses or omissions. In general, the safety task was the most accurately marked, and the main areas of marker generosity were in the research task. There were a number of instances of clerical errors by centres, but these were rare.

Pupil performance

Overall the standard appeared to be very similar to that shown in previous years. As always, there was some excellent work submitted, but the average candidates still have a weak understanding of some areas of scientific enquiry, most notably in designing investigations and in judging the strength of evidence. There are still significant gaps in their understanding of how science works in the real world, which were particularly evident in the research task.

RESEARCH TASK - GENERAL ISSUES

This task proves difficult as it combines the need for both a good understanding of the methods of scientific enquiry and good communication skills. In this task, the necessary communication skills required go further than simple spelling and grammar, although it is obvious that some candidates struggle in these areas. The best work shows a logical structure, an ability to discuss ideas and precise use of language.
The main issues in the research task are as follows.

- When judging strength of evidence, candidates focus far too heavily on the issue of bias. They do not consider the scientific methodology, e.g. sample size, confirmation by other data, significance of differences, the quality of fair testing and variability in results.

- On the issue of bias, candidates do not appreciate that data is usually correct, even in biased sources. The bias lies in the omission of data or information, and in the interpretation of the data.

- Candidates often do not seem to understand the nature and relevance of peer review. They sometimes seem to assume that 'professional scientists' are infallible and that media sources (especially the BBC) are inherently accurate and reliable.

- The descriptions of investigations in Part 2 are very often too vague. Candidates will sometimes ignore issues of practicality and ethics. They are far less confident about the design of a scientific study compared to that of a laboratory experiment.

PRACTICAL TASK – GENERAL ISSUES

Several problems listed in previous reports were still very evident this year. They were as follows.

- Candidates do not seem to understand the relationship between variability and repeats. They still often stick to the 'standard' 3 repeats, which would hardly ever be enough in a real research situation (but sometimes would be, if there was a *very* high degree of repeatability). Others seem to apply an approach of 'the more the better' which is not always either necessary or practical.

- Some candidates erroneously believe that doing more repeats improves repeatability or improves the accuracy of results (as opposed to accuracy of the *mean*, which is improved). Occasionally, a candidate would state (correctly) that doing repeats allows the identification of anomalous results. However, in such a situation, doing just three repeats would give limited evidence for any anomaly.

- Many candidates do not really understand the concept of outliers or anomalous results. They often use the term to refer to results that are unexpected, rather than anomalous. In particular, we saw examples of 'anomalous' points that were means. This should rarely happen. If the repeatability of that data set is good, the point is unlikely to be anomalous. If the mean is the result of one anomalous result within the dataset, that result should have been ignored when calculating the mean. Another fault was to pick one result as anomalous when, due to limitations in the number of data points, there were several possibilities depending on where the line of best fit was drawn. On occasions, where a curved line of best fit would have gone close to the points, a straight line was drawn and a point that did not fit it was described as being anomalous.

SAFETY TASK – GENERAL ISSUES

In both packs this task generally produced the best performances and the highest marks, and the quality of the risk assessments is gradually improving. Hazards were sometimes identified without stating their nature. Candidates failed to consider the precise risks brought about by the method used, and resorted to generic and largely irrelevant risks about chemicals splashing into eyes and glassware breaking without any reference to which parts of the method are likely to lead to these events, and how.

PACK A – RESEARCH TASK

PART 1

Most candidates produced reports that contained only relevant material, although sometimes too few sources were used, meaning that relevant material was missed out. The issues around bias, described in the general points above, were particularly evident here, where many of the sources available were from organisations which were clearly in favour or against badger culling.

Candidates seem to expect that a scientific study will always have very clear results, and therefore obvious conclusions. They struggle to draw sensible conclusions in situations like this, where the data is complex and not clear cut, and where badger culling may be appropriate in some circumstances but not in others. Some candidates with high marks gave very clear and balanced conclusions, but these were the exception rather than the rule.

PART 2

Many of the scripts seen gave very vague descriptions of the proposed methodology. For example, often there was no mention of standardising the dosage given to any test groups. A number of candidates (possibly with Jenner in mind) suggested deliberately infecting cattle with bovine TB. Ethically, this could be considered acceptable in a very small trial, but not when using hundreds of cattle from farmers' herds. Such obviously unethical or impractical designs should not be credited.

PACK A – PRACTICAL TASK

PART 1

There were relatively few specific issues with this practical task, apart from poor lines of best fit being drawn in some cases.

PART 2

No real issues with this part of the task, which was done well in many cases.

PACK A - SAFETY TASK

The only issues around this task were some weak risk assessments where the nature of the hazard and/or the action in the experiment which would lead to a risk were not defined. Some candidates ignored the message on the video and included repeats as an improvement (lack of repeat data was relevant in relation to strength of evidence, but not in relation to improvements).

PACK B – RESEARCH TASK

PART 1

The difficulty in this task was the lack of data on the topic. Nevertheless, many candidates still came to firm conclusions despite the fact that there is no clear justification either way at the moment given the lack of information. Their 'conclusions' were basically just gut feelings, which could not be justified scientifically.

PART 2

Once again the descriptions of the proposed study were very vague in many cases. Quite a number of candidates proposed deliberately exposing people to various levels of nanoparticles and seeing if they developed health conditions, which is clearly unethical and cannot be credited as a valid method.

PACK B - PRACTICAL TASK

PART 1

No specific issues with this part.

PART 2

Many candidates misinterpreted the hypothesis, which was, “the smaller the volume of a *filled* can of water, the faster it cools down”. They suggested using different volumes of water in a can of standard volume, rather than using filled cans of different volumes. Where this occurred, the centre marking often failed to pick this up. The overall effect of such a mistake was minimal, however, provided the candidate went on to design an experiment which fitted with their own idea of the hypothesis.

PACK B – SAFETY TASK

The quality of risk assessments was once again variable, but the main issue was that the candidates failed to appreciate that the experiment *was* repeated (each seed, if effect, being an experiment). Therefore, lack of repeats was not relevant either in dealing with the strength of evidence or with improvements.

SCIENCE: CHEMISTRY

General Certificate of Secondary Education

Summer 2016

ADDITIONAL SCIENCE & SEPARATE SCIENCES CONTROLLED ASSESSMENTS

Overview

This year's controlled assessment samples were similar in quality to those of previous years. Candidates now have a better understanding of the structure of the assessment and know what they ought to include but, perhaps unexpectedly, there are still significant gaps in their understanding of scientific methodology when considering the sample as a whole.

This report covers both the Additional Science and Separate Sciences investigations, as the structures of the schemes are identical and the Additional Science investigations could also be used for Separate Biology, Chemistry or Physics.

Administration and marking

In general, samples were submitted on time and were well organised, with helpful annotation.

The quality of marking by centres was generally good, and consistency of marking within centres has improved over the years, indicating good quality internal moderation. Where errors occurred, these generally involved over-generous marking, particularly for candidates at the top end of the mark range.

Where marking was inaccurate, it generally related to a failure to penalise candidates for the types of fault listed in the *Pupil Performance* section, below.

Pupil performance

The sections below indicate common faults that occurred in the different investigations. Certain things, however, occurred in all of the investigations, such as:

- Poor explanation of the scientific knowledge used to inform the hypothesis (even amongst the more able candidates).

- Failure to properly relate numbers of repeats to the repeatability shown in the practice work.

- Mis-identification of 'anomalous' results. Results which are generally consistent yet have anomalies are actually rare, and candidates should appreciate this. It is particularly unlikely for a mean result to be anomalous. If the mean is calculated from a set of data that has good repeatability, this suggests that it is not anomalous. If the mean has been influenced by one genuinely anomalous result, that result should have been ignored when calculating the mean. Candidates also refer to results as anomalous when they actually mean 'unexpected'.

- Lines of best fit drawn inaccurately, or when the data points did not provide enough information to judge the appropriate position. Sometimes, the line was also too thick or 'fuzzy' to be fit for purpose.

- Candidates tend to be too focussed on drawing straight lines of best fit. A number of examples were seen where the points clearly formed a curve, yet a straight (and therefore inappropriate) line of best fit was drawn, and sometimes the candidate went on to indicate that the points that did not fit the straight line were anomalous.

- Underlying the last point is a basic misunderstanding of scientific methodology, which is also sometimes evident in the conclusion. Candidates seem to regard experiments as a justification of their hypothesis, not a test. They work on the basis that the hypothesis is correct, and twist the presentation and analysis of their data to fit their pre-conceived idea.

- The erroneous belief that doing more repeats improves repeatability or the accuracy of *results* (only the mean is more accurate).

- Unscientific use of the term 'accuracy/accurate' unrelated to measurements. Also, confusion between accuracy and fair testing. When candidates refer to an experiment as accurate, it often seems to mean 'free of problems' or 'generally okay'.

BIOLOGY INVESTIGATIONS

CATALASE

This was a fairly standard enzyme experiment, and the only common specific issue was that candidates sometimes omitted to relate the theory to the factor that they were actually investigating, i.e. the rise of the paper discs. In both their hypothesis and conclusion, they dealt with the action of the variable on the enzyme, but did not go on to explain why that would affect the rising of the discs.

PHOTOSYNTHESIS

Relatively few centres used this investigation, and so it is difficult to make any generalised statements about candidate performance.

CHEMISTRY INVESTIGATIONS

MAGNESIUM AND HYDROCHLORIC ACID

The only recurring issue with this investigation was the plotting of a straight line of best fit when the candidate's data clearly showed that a curved line was more appropriate from the data.

NEUTRALISATION

This was done less frequently than the other investigation. The theory behind the hypothesis was sometimes poorly explained, but otherwise there were no specific issues.

PHYSICS INVESTIGATIONS

PAPER CAKE CASES

This was a very straightforward investigation to do. It was done by many centres for Additional Science, and almost exclusively for Physics. The main problem for candidates was the scientific explanation of the effect of their chosen variable on the drop time.

REFRACTION

This investigation was hardly seen during moderation and no general comment on candidate performance can be made.

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