Rewarding Learning

GCE AS A2 Chemistry Revised
Spring 2010

Chief Examiner's Report

GCE CHEMISTRY (REVISED)

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Grade Boundaries

Grade	Uniform Mark
Maximum Mark is 300	
A	240
B	210
C	180
D	150
E	120

ASSESSMENT UNIT AS 1 BASIC CONCEPTS ON PHYSICAL AND INORGANIC CHEMISTRY

The question paper was accessible to candidates of all abilities. There were no questions which were unanswered by the vast majority of candidates and there was no evidence that candidates had insufficient time to answer the questions. It was disappointing to see AS candidates giving poor responses in questions which only required a very basic knowledge and would not have caused problems for a good GCSE student.

Q11 In general this question was very well answered by the more able candidates. Surprisingly, it was not well answered by those candidates scoring a Grade E.

(a) The majority of candidates scored full marks here. However it was worrying that many candidates did not score full marks since the knowledge required was very basic.

(b) Again these were generally well known as this is basic GCSE chemistry. The use of the word "and" in both the mass number i.e. protons and neutrons and then again in atomic number i.e. protons and electrons created ambiguity. Candidates need to be more careful here. A small number had no concept of the correct definitions and many ignored the fact that the definitions needed to be in terms of protons and neutrons.

(c) (i) P and 33 were accepted and scored both marks. Many candidates correctly identified Cl but gave the mass number as 35.5.

(c) (ii) It was disappointing that few candidates were able to gain full marks in this part of the question. Many did not take the charges on the ions into account and some answers appeared to be pure guess work. Again 35.5 appeared as the mass number for Cl.

(d) (i) Most candidates were able to relate the relative atomic mass to the carbon-12 isotope but few used the weighted average, even amongst the more able candidates.

(d) (ii) This calculation was generally well done with the major source of error being the incorrect number of decimal places.

Q12 This question was reasonably well answered across the range of abilities.

(a) (i) This diagram was well drawn by the vast majority of candidates.

(a) (ii) Generally well answered with most candidates gaining both marks. Some candidates scored both marks by carrying an error through from part **(i)**. A small number of candidates drew the structure correctly but called it trigonal planar.

(a) (iii) Most candidates were able to give an adequate description and gained both marks. Those who did not gain both marks generally gained one mark for describing repulsion without mentioning the lone and bonding pairs. Some candidates described repulsion between the hydrogen atoms.

(a) (iv) Again this was well answered with most candidates recognising the extra repulsion between the lone pair and the bonding pairs.

(b) (i) This was well answered. A small number of candidates described it as a hydrogen bond.

(b) (ii) Most candidates gained at least one mark but many lost the second mark for inadequate descriptions, for example, many failed to mention the lone pair of electrons on the phosphorus atom or the hydrogen ion.

(c) Most candidates recognised the hydrogen bonds in ammonia but failed to describe the intermolecular forces in phosphine. Generally candidates gained at least one mark.

Q13 This question was reasonably well answered by the strongest candidates but many of the responses were very disappointing particularly in part (c).

(a) (i) Generally well answered although the spelling of phenolphthalein was usually poor.

(a) (ii) Again generally well answered. Many candidates scored both marks by carrying an error through from part (i) usually for suggesting methyl orange. Some candidates had the colours the wrong way round.

(b) (i) It was disappointing to note how many candidates had little idea of the formula for ethanoic acid and the overall equation for the reaction. A case of two marks or nothing with nothing being very common.

(b) (ii)-(v) These parts were reasonably well answered by the stronger candidates. Many candidates scored marks on the basis of carrying an error through.

(c) The answers to this question were very disappointing. Whilst many candidates were able to gain some marks in this question few gained full marks. Few mentioned both rinsings and many used a measuring cylinder. Also few candidates mentioned the use of a pipette filler. Most marks were awarded for filling the volumetric flask to the mark and mixing the solution. A few candidates failed to read the question correctly and described how to carry out the titration or how to pipette the diluted solution directly.

Q14 This question discriminated well between the strongest candidates and the rest.

(a) This was well known.

(a) (i) This was reasonably well done by the stronger candidates although some of the drawing was careless. A few candidates had little idea of the graph.

(a) (ii) Generally well answered with most candidates recognising the increase in nuclear charge across the period. Some stated that there was no shielding rather than no/little change in the shielding.

(a) (iii) Very well answered with few mistakes.

(a) (iv) Some reasonable answers but few candidates were able to gain both marks. Many correctly identified the stable filled s-subshell in magnesium but did not relate the remainder of the answer to aluminium.

(c) (i) Generally well answered with most candidates gaining both marks. A small number of candidates lost a mark for not labelling the subshells.

(c) (ii) This was generally very well answered. A mark was most commonly lost for the state symbols or removing four electrons instead of one.

(c) (iii) Many candidates gained one mark but few gained both. These candidates only made one point which is not advisable when 2 marks are available. A comparison was required here.

Q15 This question discriminated well. However even some of the stronger candidates gave disappointing responses scoring only in the low teens out of a total of 21

(a) (i) This definition was well known by the majority of candidates. The main error was in not including the word covalent when referring to the bond. A small number of candidates simply stated an atom attracting electrons.

(a) (ii) The trend was almost universally correct. Most candidates gained a second mark for the increased shielding but few gained the third mark by failing to refer to the shared electrons in the covalent bond, rather they referred to outer electrons as in ionisation energy answers.

(b) (i) This was generally well done and even if one was incorrect the other was usually correct. A few candidates had -6 and -4 and so gained no marks.

(b) (ii) Poorly answered with all sorts of species appearing.

(b) (iii) Reasonably well answered with most candidates gaining one mark for either balancing the elements or the charges. A small number of candidates added other species to the equation.

(b) (iv) This was reasonably well done, especially by those who had gained both marks in the previous part. A common error was the lack of hydrogen ions on the left hand side.

(b) (v) This was a simple question but poorly answered. Many mentioned the smell of rotten eggs. A few suggested the appearance of a yellow solid or a purple vapour.

(b) (vi) Reasonably well answered but many random guesses such as 'spectator ions'.

(b) (vii) Poorly answered with a wide variety of possibilities. Frequently the reducing power of chlorine was used instead of chloride.

(b) (viii) This equation has now appeared a number of times and had obviously been learned by many candidates so this question was well answered.

(c) (i) Generally well answered, again this had been asked previously and candidates had obviously learned the observation.

(c) (ii) The writing of ionic equations at this level is very disappointing. Many attempted to write an equation with no ions present and others had little idea of what was required. A number of those with the correct equation failed to include the state symbols.

This was generally well answered.

ASSESSMENT UNIT AS 2 FURTHER PHYSICAL AND INORGANIC CHEMISTRY AND INTRODUCTION TO ORGANIC CHEMISTRY

Q11 A similar pattern was observed with the answer to this question as seen in previous examinations. That is the question regarding the reaction of sodium with ethanol was the most difficult and the reaction of HBr with ethanol was the easiest. The common wrongly drawn products for the reaction of sodium were CH_3CH_2Na and CH_3CH_2OHNa.

Q12 (a) (i) The definition of thermal cracking was dominated by the mention of the conversion of less useful molecules into more useful ones. This was not the question asked and such extraneous detail was ignored. Answers were extremely good. The major error was to often omit the explanation of the meaning of the word thermal.

(a) (ii) Hardly any candidates deduced that the reaction was exothermic but far too many candidates ignored the exhortation to explain the reason. Some candidates simply placed the ΔH value by the side without any explanation. Despite these comments the vast majority obtained the available mark.

(a) (iii) Candidates presented many roundabout answers which first of all dealt with the reasons for not using high pressure and then finally stated that low pressure should be used. The mark for the effect of pressure on reaction rate was rarely mentioned and consequently the most common mark for this question was two.

(a) (iv) The performance on this part was better than the previous part with three marks frequently being obtained. The mention of high temperature led to the mention of an increased reaction rate. It was usual to mention that the reaction was endothermic and hence the use of the high temperature.

(a) **(v)** This question has been asked many times and there are still far too many candidates who do not mention the use of concentrated ammonia solution. Instead ammonia or ammonia gas is mentioned. There was no problem with the mention of white fumes.

Q12 **(b)** **(i)** This was a question that caused only a few problems because of minor errors in drawing the structure of the polymer. Occasionally the symbol n was placed in front of the polymer structure rather than behind it. The expression $(\text{-}CF_2\text{-}CF_2\text{-})_n$ was acceptable.

(b) **(ii)** Most candidates deduced that it was a double bond that caused tetrafluoroethene to polymerise. Unsaturated was also an accepted answer.

(b) **(iii)** Despite last year's report there were still a large number of candidates who stated that the polymerisation was additional rather than addition polymerisation.

Q13 **(a)** This was a relatively simple question and candidates inevitably obtained the mark.

(b) Candidates gave the standard response of "the same molecular formula with the atoms arranged differently" but there was the occasional exception when candidates stated that the structural isomers had a different shape which was not fully credited.

(c) Very few candidates failed to obtain the two marks available for fractional distillation. No candidate attempted to explain the process. Sometimes candidates stated that thermal cracking was the method used to obtain pentanes from petroleum but this was often given together with fractional distillation.

(d) There were serious problems with the answers provided by candidates e.g. 2-methyl butane and 2,2-dimethyl propane. The phenomenon of leaving gaps in the formulae last summer was repeated again. It was fortunate that two questions were asked as the penalty for creating spaces was only penalised once. This was exceedingly unfortunate for many candidates as the answers provided were essentially correct save for the unnecessary gaps between the words.

(e) This was a question that had not been asked before and the response was interesting. A small minority of candidates displayed an excellent appreciation of the variation in van der Waals forces with the structure of hydrocarbons. However, the most common response was in terms of the length of the carbon chain of the pentanes as displayed in the table in the question. Many answers seemed to suggest that the chain was increasing beyond the five carbon atoms of the pentanes which were not acceptable. However, the majority of candidates obtained a mark or more.

(f) **(i)** The equation for the complete combustion of butane was very accurately done with few candidates obtaining less than full marks.

(f) **(ii)** A similarly excellent performance was carried out for the incomplete combustion of pentane although a few candidates had hydrogen as the incompletely combusted product.

Q13 **(g)** **(i)** It was a complete mystery that so many candidates obtained either the answer $C_3H_6Cl_2$ or C_2H_3Cl for the chlorinated pentane. Only a very small minority indeed obtained a formula which included five carbon atoms despite the question saying that it was a chlorinated pentane. Virtually all candidates obtained one mark for obtaining the correct ratio of moles but the ratio 1.71:2.85:5.1 was rounded off with no consideration of the fact that the compound was a pentane.

(g) **(ii)** Even if candidates obtained the formulae $C_3H_6Cl_2$ or C_2H_3Cl for the chlorinated pentane these molecules were heavier than pentane or they were certainly more polar. However, there were many answers that followed through from the answer to part (e) which stated that the pentane would have a lower boiling point because it had a shorter chain length. Alternatively the electronegative nature of chlorine was mentioned but never in connection with the creation of polar bonds in the molecule which then led to increased attractions and then increased boiling point.

Q14 **(a)** Candidates correctly compared the stability of calcium carbonate with the rest of the group II carbonates. Those who compared them with the elements both above and below the calcium carbonate in the periodic table obtained the two marks. Those that stated a trend obtained one mark.

(b) The thermal stability of compounds such as carbonates is now based on the idea of charge density and not lattice enthalpy although a few candidates did quote lattice enthalpy in their explanation e.g. "the calcium cation is larger than magnesium, there is an increase in lattice energy going down the group". The answers were not as good as might have been expected following this change in the specification. Very often the concept of charge density was mixed up with candidates at a loss to explain it relative to cation size.

(c) To obtain a mark it was essential to mention that carbon dioxide was related to the Greenhouse effect. Occasionally mention was then made of the effect on the ozone layer which then lost the mark. Hardly any candidate spotted that carbon dioxide was also produced by the burning of the fossil fuels in the manufacture of calcium oxide.

(d) **(i)** The equation for the reaction of calcium oxide with hydrochloric acid was extremely well done with few exceptions.

(d) **(ii)** Although the equation for the reaction of calcium oxide with water was not as well done as the equation in part (i) it was still very well done.

(d) **(iii)** Not only did candidates state that a suitable catalyst was nickel it was inevitably described as finely divided nickel.

(e) The creation of a solution of limewater was the surprise of the examination paper. It was stated in the question that calcium hydroxide dissolves to form limewater. However, the great majority of the candidates stated that calcium oxide should be dissolved in water. There was a sizeable minority that even wished to dissolve calcium in water. Even more worrying were the number that wished to dissolve calcium carbonate!

In contrast there was no problem with the test for carbon dioxide using the solution produced.

Q14 **(f)** The equation for the reaction of calcium hydroxide with carbon dioxide was generally well known but there were frequent exceptions such as writing $CaCO_3(aq)$ and producing hydrogen instead of water.

(g) Although most candidates obtained five marks for the calculation it was a surprise to see the mass of one mole of calcium carbonate quoted as any other value except 100g. Values such as 0.05g and 0.01^{g} were frequently seen.

Q15 **(a)** **(i)** The equation for the manufacture of ethanol was well known. Lots of data was often given but it was omitted to state that the water was in the form of steam. However, any temperature which was above 100^{o} C was accepted instead of steam. The catalyst of phosphoric acid was the most popular but platinum and nickel were stated as alternatives.

(a) **(ii)** The specification does not state that ethanol is produced by the fermentation of glucose but this was the answer preferred by the vast majority of candidates. Fermentation was well known but it was surprising to see that yeast was frequently fermented.

Many routine answers were given which were about laboratory chemistry such as the hydrolysis of esters and alky halides to produce ethanol.

(b) A variety of chemicals were quoted as tests for ethanol e.g. acidified dichromate, phosphorus pentachloride, sodium and the iodoform test. All were acceptable. The major error with the test using acidified dichromate was to omit the use of heat.

(c) The enthalpy change question involved a large number of calculations hence the award of four marks. Virtually all candidates obtained at least one mark.

(d) **(i)** The conversion products from the exhaust gases were very well known with the possible exception of nitrogen oxides.

(d) **(ii)** It was very well known that leaded petrol was the cause of catalyst poisoning but it was not always clear whether it was the lead or the lead compounds that caused the poisoning although lead was the far more frequent choice. The majority of candidates obtained three marks for the question.

(d) **(iii)** Candidates performed well in drawing and labeling the enthalpy level diagram. The effect of the catalyst in lowering the activation energy of the reaction was well known. The weakest part of candidates' answers was in labelling the axes of the graph.

ASSESSMENT UNIT A2 1 PERIODIC TRENDS AND FURTHER ORGANIC, PHYSICAL AND INORGANIC CHEMISTRY

Grade Boundaries

Grade	Uniform Mark
A	96
B	84
C	72
D	60
E	48

Candidates responded well to the content of the new specification and scored well in mathematically based questions. As has been noted in recent reports, those questions requiring straightforward knowledge caused more problems. Descriptions of practical situations revealed that these too were less well known. New areas received a mixed response though it would appear that the removal of oxy-acids from this module has been of significant benefit to both teachers and candidates alike. The increased total raw marks and accompanying time appeared to raise no issues.

Q11 **(a)** Hydrogen bonding was identified by most but the second mark was generally not secured; the mention of such bonding between the relevant atoms was expected.

(b) **(i)** Well answered by most although a few did write methanol as the product.

(b) **(ii)** Half-equations or ionic equations generally cause more difficulties than standard full equations. Common errors included the wrong charge on the silver ion, oxidation rather than reduction and use of the complex which rarely led to a balanced and credible equation.

(b) **(iii)** Well known as expected.

(c) Although generally well known the familiar errors were noted including the incorrect placement of charges, the use of partial charges, omission of the hydrogen ion in the final step and the use of hydrogen cyanide rather than cyanide ions in the first step.

(d) **(i)** Very few candidates scored full marks in this question. Colorimetry was the most common choice as expected, but descriptions lacked essential detail. The calibration curve was often omitted as was the measurement of transmission/absorbance with time. Using the volume of carbon dioxide evolved was again acceptable but required considerable intricate detail to convince e.g. the use of multiple graphs and tangents. The use of pH was difficult as apparent on examining the equation. The quality of written communication was generally good.

(d) **(ii)** Well answered with the omission of seconds altogether or incorrect positive/negative signs being the most common errors.

(d) **(iii)** Whilst well known, too many candidates lost one mark by failing to start the first graph on the y axis. Zero and second order graphs were encountered as well as the two graphs appearing in the wrong order.

(e) **(i)** Few difficulties were noted with the omission of water and errors in the sequence of atoms in the organic product being the most common errors.

(e) **(ii)** Well answered with methyl ethanoate being the routine incorrect answer.

(e) **(iii)** The two roles were well known, namely as a catalyst and to improve yield. The use of "dehydrating agent" was penalised.

Q12 **(a)** A range of answers was accepted although breaking of bonds was commonly met and suitably penalised.

(b) **(i)** Well answered.

(b) **(ii)** Most candidates navigated their way successfully through the calculation. The use of kilograms did lead to some missing a factor of one thousand in the final answer.

(b) **(iii)** Well answered.

(c) Candidates were generally confident in handling this question.

(d) **(i)** Although heterogeneous, it was expected that candidates would apply knowledge of equilibria to explain their answer. A reduction in the amount of gaseous carbon dioxide gas was all that was sought but answers were often too loose in describing this, particularly given that carbon dioxide as a chemical appeared on both sides of the equation.

(d) **(ii)** Well answered.

(d) **(iii)** Few managed to explain this convincingly, indeed many did not even attempt an explanation at all despite the clear requirement from the stem. Some appreciation of the relative amounts of reactants and products was needed or reference to the low level of dissociation in weak acids.

Q13 **(a)** **(i)** Structures were generally well presented and accurate. The errors encountered included missing water as a product, using propanone as the ketone, incorrect bonding in and around the nitrogen atoms in both the reagent and final product, missing aromatic rings and excessive/too few hydrogen atoms.

(a) **(ii)** Well known. The mention of red was penalised.

(a) **(iii)** A full and detailed account was essential for full marks. Whilst candidates were not expected to identify the correct solvent most did use ethanol. Hot filtration was not expected for full credit but showed a sound appreciation of good technique.

(a) **(iv)** The scheme used followed familiar and well published steps.

Despite this most candidates did not secure full credit through omission of one or more key facts.

(a) **(v)** It was perhaps most surprising to note how few candidates that secured the two marks here as the effects were simply not well known. A significant number adopted a cautious approach stating that the melting point would be simply altered or that it would go up or down; neither case received credit.

(b) **(i)** Confusion between optical activity and chirality was rare. Candidates generally secured both marks with a few losing credit due to omission of the word "plane" or using loose terminology such as "bend", "reflect" or "change direction" instead of rotate.

(b) **(ii)** Well answered with the vast majority providing convincing 3D representations. Planar structures were penalised.

(c) **(i)** Few encountered difficulties with this part.

(c) **(ii)** As with most calculations in the paper this was well answered. Incorrect conversion to 1 dm^3 was noted.

(c) **(iii)** A straightforward step for most, any errors in part (ii) were carried through.

(c) **(iv)** Well answered with credit being lost through incorrect spelling (e.g. phenylphthalein) or the use of methyl orange.

(d) Initial steps in this part were carried out correctly in most cases. Some did use the RMM for hydrogen and oxygen incorrectly. The final step provided greater challenge as the ratios involved were not immediately obvious.

(e) **(i)** Errors in the sequence of atoms accounted for the main errors noted, particularly in the linkage between the glycerol stem and the fatty acid chains. A surprisingly large number of candidates placed the methyl group in the middle of the chain rather than at the end.

(e) **(ii)** Generally well answered regarding the definition with key errors including use of sodium hydroxide and noting grammes instead of mg. The reason for a high value was not well known with many incorrectly discussing issues surrounding unsaturation.

Q14 **(a)** **(i)** Most deduced that the molecule contained no asymmetric centres. The answer "1" was the most common incorrect one.

(a) **(ii)** Past experience has shown that students are quite careless in the use of commas and hyphens. It was most pleasing to note the confidence and accuracy encountered in responses to this question.

(b) **(i)** Marks were generally lost through use of sodium carbonate, reacting the hydroxyl group, errors in balancing and the use of H_2CO_3 instead of water and carbon dioxide.

(b) **(ii)** Candidates all too often described what would be observed as the reaction proceeds and did not answer the question as posed. Stating that gas is no longer evolved is not accepted as an observation.

(b) **(iii)** Each part of the symbol needed to be explained to gain full credit

			i.e. change, entropy and standard.
	(b)	**(iv)**	To proceed spontaneously ΔG must be negative hence the overall term TΔS must exceed the value of ΔH. Many candidates omitted temperature in their arguments.
	(c)	**(i)**	Many candidates interpreted this question as requiring the removal of an electron rather than release of a hydrogen ion.
	(c)	**(i)**	Well answered although many did use $[H^+]^2$ for the top line of the expression which was not accepted.
	(c)	**(ii)**	Excellent answers were noted with a few errors being noted in the use of squares and square roots.
Q15	**(a)**	**(i)**	Candidates at this level provided good answers which scored well.
	(a)	**(ii)**	As above although a few did confuse exothermic and endothermic reactions. Occasionally contradictory arguments appeared and undermined the answer.
	(a)	**(iii)**	Deducing the molar amounts present at equilibrium proved to be the most difficult step. Calculating the concentration using the volume too caused problems, most notably an error of omission.
	(a)	**(iv)**	Two aspects were required, energy generation and some issue relating to the use of excessive land / visual impact etc.
	(b)	**(i)**	Generally well answered with errors encountered surrounding the fluorine namely the use of F_2 rather than $\frac{1}{2}F_2$. The electron was sometimes missing after the sodium was ionised. Errors were carried through.
	(b)	**(ii)**	Well answered with errors from part (i) carried through.
	(b)	**(iii)**	A large proportion of the entry provided the configurations for the atoms rather than the ions.