



**GCE AS Chemistry Revised  
Summer 2009**

**Chief Examiner's and  
Principal Moderator's  
Report**

**GCE CHEMISTRY REVISED****Chief Examiner's and Principal Moderator's Report****Grade Boundaries**

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

**ASSESSMENT UNIT AS 1**

The paper was successful in giving all candidates an opportunity to answer at least some of the questions. It also discriminated between the more able candidates and the less able candidates. The mark scheme was easy to follow. The candidates appeared to have ample time to complete the paper.

- Q11** (a) This was generally well answered with most candidates gaining at least two marks. The intermolecular forces between methane molecules were least well known.
- (b) Most candidates gained at least one mark but many had difficulty explaining the more open structure of the ice. More hydrogen bonds, longer hydrogen bonds and permanent hydrogen bonds in ice all gained credit.
- (c) Most candidates were able to draw the shape of the ammonia molecule but the explanations were often unclear.
- Q12** (a) Most candidates gained full marks in this part of the question.
- (b) Most candidates gained full marks. Some candidates lost a mark for failing to give the answer to two decimal places as asked in the question.
- (c) Most candidates gained full marks in this question. A few candidates did not label the sub-shells correctly.
- (d) Virtually all candidates were able to draw the s and p subshell.
- Q13** (a) Most candidates were able to write the correct equation. A few candidates lost a mark for using the formula  $\text{H}_2\text{CO}_3$  instead of  $\text{CO}_2$  and  $\text{H}_2\text{O}$ . A few candidates did not balance the equation.
- (b) The definition of a standard solution was well known although a small number of candidates described it as being of 'known concentration and volume' or of having a concentration of 0.1M.
- (c) The calculation proved challenging for all but the best candidates. Many were able to gain some marks as errors were carried through. Most candidates were able to gain the first two marks.

- (d) The indicators, methyl orange or phenolphthalein, were both well known and the colour changes generally correct. Candidates were given a mark if the colour change was stated the wrong way round.
- Q14**
- (a) (i) Most candidates were able to answer this correctly. A notable number used atomic mass instead of atomic number and a few used the reactivity of the elements to attempt an answer to the question.
- (a) (ii) This was generally well answered. Marks were lost when candidates did not state that ‘electrons were being added to the outer d sub-shell’.
- (b) (i) The more able candidates gained both marks for this question. A number of candidates described the increase to silicon and the decrease from phosphorus but not the decrease between silicon and phosphorus and consequently lost a mark.
- (b) (ii) The change in atomic radius was well known but the explanations tended to lack the detail required in the mark scheme.
- (b) (iii) This graph was poorly drawn by many candidates. Lines going upwards and patterns which reflected successive ionisation energies were seen. Some candidates who gave the correct pattern lost marks by giving the drops in the wrong place.
- Q15**
- (a) (i) Many candidates were unable to describe a covalent bond as the ‘sharing of a **pair** of electrons between atoms’.
- (a) (ii) The structures of both graphite and diamond were generally well known although some of the descriptions were poor.
- (a) (iii) Many candidates were able to describe the ‘free’ valence electron in graphite but then described these electrons as carrying the electron current instead of explaining that they can move and so carry an electric current.
- (a) (iv) Most candidates recognised that diamond had strong (covalent) bonds throughout its structure.
- (b) (i) The ‘dot and cross’ diagrams were reasonably well drawn with carbon dioxide being most frequently incorrect. Some candidates showed six electrons around the central beryllium atom in the beryllium chloride, this error was carried through when necessary.
- (b) (ii) The octet rule was generally well known but often poorly stated. Beryllium chloride was often stated as having four outer electrons instead of the beryllium atom on beryllium chloride.
- Q16**
- (a) (i) The tests for sodium ions and chloride ions were well known and generally well described.
- (a) (ii) The dot and cross diagrams were quite well drawn. Candidates often lost marks for not including the charges on the ions. A number of candidates thought that sodium chloride was covalent.

- (b) (i) Too many candidates think that conduction in ionic compounds is due to electrons. A number described the ions as carrying the current instead of the ions being able to move and carry the current. A few candidates described conduction in the molten solid as opposed to the solution as asked.
- (b) (ii) The oxidation numbers and disproportionation were well known. A number of candidates did not link the rise in oxidation number to oxidation and the fall to reduction and so lost a mark.
- (b) (iii) This was reasonably well answered. Many candidates failed to recognise the solution as colourless and a number described the appearance of bromine instead of bromine solution.
- (b) (iv) This ionic equation was very poorly answered and this not well known by the candidates.
- (c) (i) This equation was generally well known although a number of candidates are still losing a mark for giving  $\text{Na}_2\text{SO}_4$  instead of  $\text{NaHSO}_4$ .
- (c) (ii) A wide range of observations are acceptable in this reaction and this was reasonably well answered. Although some candidates do not know the difference between an observation and a conclusion and terms such 'exothermic' did appear as well as 'iodine vapour given off'.
- Q17** (a) Few candidates were able to gain both marks, but many were able to gain one mark. The transition was often given incorrectly or both 'up and down arrows' were included.
- (b) The concept of the convergence limit was not well understood and many candidates simply described the diagram.
- (c) (i) This equation was reasonably well known. Some candidates lost a mark for using molecular hydrogen instead of atomic hydrogen. Marks were also lost for incorrect charges and incorrect state symbols.
- (c) (ii) This calculation was reasonably well attempted.
- (c) (iii) Any error was carried through from the previous part and most candidates who attempted this gained one mark. Most lost the second mark for not converting the answer to  $\text{kJ mol}^{-1}$  and instead using  $\text{Jmol}^{-1}$ .

## ASSESSMENT UNIT AS2

- Q5** This was not a question with regard to a specific test for ethanol. It was simply asking which one of the reagents would react with ethanol. Sodium of course is the only one and was the answer. Acidified potassium dichromate could have been used but then this would have stood out being three words. It was not envisaged that this question would be a problem. The reaction of sodium with ethanol is stated in section 2.6.8. It was quite legitimate to ask this question. The question was very discriminating with a discrimination value of 0.49 which is high. Anything around 0.3 is regarded as good/very good on a four option multiple choice question.
- Q7** This question was not about a eudiometer, the word was not mentioned and it was a visual way of asking a standard question. The equation for the reaction was given and the question was considered a straightforward one but needed some application of knowledge of a combustion reaction. The question was not very successful proving difficult for “top” and “bottom” candidates with the most popular option being “B”.
- Q11** There are often problems with the introduction of a new specification. Surprisingly new additions to the specification are frequently neglected. This occurred with this question. The test for chromate ions was new or rather using barium ions to test for chromate ions. The response to part D of question 11 was extremely poor. Very few candidates obtained the correct answer which was sodium chromate. The most common incorrect answer was sodium iodide presumably confusing the yellow precipitate with silver iodide. However there were many other sodium compounds quoted. Sodium sulphite was naturally popular but there were complete “guesses” including sodium carbonate, chloride, and fluoride. Even answers just quoting elements were given. Consequently very few candidates indeed obtained the four marks available for this question.
- Q12**
- (a) The interpretation of this question was not good despite section 2.9.5 of the specification stating the compromise between equilibrium and reaction rate in the chemical industry. Indeed, rate was not often mentioned. The mark scheme was written so that even credit was given to the interpretation of the word endothermic.
- (b) This was the first time atom economies had featured in a CEA chemistry examination and as mentioned earlier in this report there are often problems when examining new concepts. There was some comment on whether calculations on atom economies were acceptable in view of the way that the specification was written i.e. the specification states “understand the concept of economies” but does not say calculate atom economies. In view of such comments the mark scheme was altered so that maximum marks could be obtained without a calculation. Despite this, candidates displayed limited knowledge of the concept of atom economies. Even the definition was poorly expressed
- In future it will be expected that candidates are able to calculate atom economies in addition to understanding the “concept”.
- (c) Bond energy calculations are usually well done and there was no exception in this examination.

- (d) The vast majority of candidates mentioned high temperature and high pressure and obtained the two marks available. There was no need to explain but candidates usually stated that it was a high cost to produce and maintain these conditions.
- (e) (i) There was some quibbling with the phrase “environmentally undesirable”. This did not prove a distraction for candidates who consistently deduced that the reason was the toxic or poisonous nature of carbon monoxide.
- (e) (ii) Before the examination it was thought that this question would be quite difficult but candidates dealt very well with it. The most common error was to state that an excess or a good supply of oxygen should be used. Others thought that a catalytic convertor would convert the carbon monoxide into carbon dioxide and water.
- (e) (iii) Some candidates were unaware of the value, in kilograms, of a tonne. Due allowance was made for this fact with crediting reasonable “guesses” involving an estimate of the “powers of ten”. Despite this the attempts at the calculation were weaker than expected
- Q13** (a) (i) The test for hydrogen chloride was well known . If there was an error it was to omit to state the fact that the ammonia solution used was not concentrated.
- (a) (ii) The equation for the reaction of methanol with hydrogen chloride was inevitably well done because of its simplicity and there was no need to balance the equation.
- (a) (iii) Chloromethane was stated to be a gas and the answer expected was that it would “escape”. There were many variations on this theme and virtually all of them were credited e.g. “difficult to collect”, “it would escape into the atmosphere”, “it would be difficult to remove gaseous impurities”. However there were vague answers e.g. “it could not be contaminated with air, so you do not know if hydrogen chloride is produced”.
- (b) (i) The equation for the reaction of methane with chlorine was well known.
- (b) (ii) The electronic structure of the chlorine radical was well known although a small minority wrote  $3p^6$  instead of  $3p^5$ .
- (b) (iii) There were two marks for this question and it needed two points to be mentioned. Whilst it was often stated that the ultra violet light broke the covalent bond in the chlorine molecule it was less frequently stated that the ultra violet light supplied the necessary energy.
- (b) (iv) The fact that two methyl radicals joined together was known but occasionally they were described as molecules rather than radicals. Often an equation was written which helped the answer if inappropriate words were used in the explanation.

- (c) The flow scheme was generally well done but the reaction of  $\text{CH}_3\text{Cl}$  with  $\text{NaOH}$  frequently produced  $\text{CH}_3\text{ONa}$ .
- Q14**
- (a) (i) Candidates correctly labelled the vertical axis as either number of molecules or number of particles.
- (a) (ii) This question was new to a CEA examination but it has been set on other boards' papers. It proved difficult for some candidates to express their thoughts succinctly. There was often the idea that energy was needed for a reaction to take place even though the question stated that only one gas was present e.g. "when no energy is given to the reaction then no reaction takes place and there is no rate of reaction". Despite the fact that at the origin there are zero molecules candidates often stated "this is because *some* molecules contain zero energy".
- (a) (iii) Similar comments apply to part (ii) as to part (i). A comment was needed with regard to the fact that some molecules would always possess energy no matter how high the energy was. However a substantial number answered in terms of the "reaction" still continuing e.g. "At higher energies more molecules will have more energy to move about and collide and so they will not intersect the horizontal axis".
- (a) (iv) It was generally known that the shaded area represented particles that have enough energy to react but often it was not stated that it was the *number* of particles.
- (b) (i) The curve representing the distribution of energies at a higher temperature was mainly accurate but occasionally the curves crossed or appeared as though they would.
- (b) (ii) Increasing the temperature generally prompted the correct answer based on the increased number of molecules which possess the activation energy. However, some answers were simply based on more particles reacting and consequently increasing the rate of reaction.
- (c) A common problem in answering this question was to give the definition of a catalyst rather than to refer to the distribution curve. A mark was obtained for this answer because lower activation energy was mentioned but the number of particles having the activation energy was needed for the second mark.
- Q15**
- (a) The mark was obtained by the great majority of candidates. Sometimes, despite mentioning an s electron, the location was omitted.
- (b) The decrease in solubility of the sulphates down the group was well deduced.
- (c) (i) The calculation was very discriminating. A sizeable number of candidates confused the 34.4g with the 26.0g.
- (c) (ii) Candidates had no problem in deducing a very straightforward equation.

- (c) (iii) In the new specification the thermal stability of carbonates is now explained in terms of cation size and the distortion of the anion. A few candidates were still answering in terms of lattice enthalpies. Despite, often long answers, only a minority of candidates gained full marks.
- (d) (i) The definition of Hess's law was well known.
- (d) (ii) The calculation of enthalpy changes from experimental data including the use of  $\Delta H = mc\Delta T$  is mentioned in section 2.8.5 of the specification. Unfortunately many candidates were unable to handle the calculations. In some instances the masses of the magnesium compounds were used rather than the mass of water. In others the temperatures were either added or subtracted. In the end the calculation proved very challenging but highly discriminatory. The most frequent mark obtained was either one or two.
- (d) (iii) Candidates scored well on this question often obtaining maximum marks but it was a pity that mistakes were made which could have been avoided with a little more thought. For example, the temperature of the water was not measured before adding one of the magnesium compounds. The mixture was not stirred and water was frequently added to the solid rather than vice versa.
- Q16** (a) (i) All the reactants and the products for the reaction of propene with ammonia and oxygen were given which helped the success rate. A mark was frequently lost by failing to balance the equation.
- (a) (ii) The role of the molybdenum as a catalyst was well deduced by virtually all the candidates.
- (a) (iii) Candidates did not fare very well with this question which was unexpected although infra-red spectroscopy was previously part of the A2 examination. The expected answer was to simply compare the infra-red spectra of propene with propenonitrile. This answer was given by weaker rather than stronger candidates. Most candidates tried to state that a double bond was present in one molecule and not the other. Again, it was expected that the *position* of the double bond in the spectrum would be commented on but this answer was very rarely seen.
- (b) On the whole this question was well answered but there were some strange answers which produced sodium and hydrogen. Candidates caused problems for themselves by attempting to convert propenonitrile to  $C_3H_3N$  and then not balancing the equation.
- (c) (i) Despite the great majority of candidates obtaining the correct answer it is still disappointing that far too many gave  $C_2H_3CN$ .
- (c) (ii) The successes and problems in part(i) were repeated in part (ii)



- (c) (iii) Many candidates ignored the bold instruction to show all the bonds present and left the cyano group as –CN. The second error seen was to draw the structure correctly but to draw the cyano group as –C-N. Despite these errors the two marks were obtained by most candidates.
- (c) (iv) Although there were difficulties in explaining the concept of cis and trans forms candidates were able to convince sufficiently to obtain the two marks.
- (d) (i) Candidates who followed the instructions obtained the two marks. Those who presented three repeating units or used brackets and “n” lost a mark.
- (d) (ii) Addition polymerisation was the answer of nearly all candidates but some stated *additional*.

### ASSESSMENT UNIT AS3

The teacher marking of this unit was, in general, of a high standard. Centres tended to fall into one of three categories. Some centres were very rigid in their application of the mark scheme. Some were more flexible and used some common sense in its application. Others were unduly generous to their candidates. The standardisation process and remarking of all scripts means that candidates were not advantaged or disadvantaged in any way as a result of this.

#### Q1 TITRATION (PAPERS 1 AND 2)

The practical activity was similar in nature to those in previous AS3 papers on the old specification. However candidates had to decide for themselves how to carry out the titration. Candidates performed very well in this question.

- (a) Most candidates scored full marks in this part of the question. The absence of rinsing was the most common reason for loss of marks. The quantity of indicator was also an issue. 2-3 drops is appropriate. Just “add indicator” was not adequate for the mark.
- (b) A small number of candidates used the rough titration value when calculating the average. A few lost marks for not including units in the table or after the average value.
- (d) A large number of candidates lost one mark due to the use of incorrect state symbols.
- (e) In general the calculations were well done. Some candidates used the volume of ethanoic acid in (i) and the volume of sodium hydroxide in (iii).

#### Q2 OBSERVATION/DEDUCTION (PAPERS 1 AND 2)

In general, candidates performed very well on both papers with most candidates scoring a high mark. The tests were very similar to previous years.

- (a) In the first test many candidates did not use the word “ion” or “compound” in their deduction. The flame test was well done with most candidates scoring full marks. The observations obtained on addition of concentrated sulphuric acid were well understood. It was decided at the standardising meeting to accept some observations which were not on the original mark scheme. For

example, “rotten egg smell” and “bubbling” were allowed in Paper 2. However, the maximum number of marks for this part of the question was still three. There was some evidence of incorrect use of the words chlorine and iodine eg “iodine ions”. The deduction made in part 3 was often ignored in part 4. In both papers it should have been clear from part 3 that bromide ions were not present and the silver nitrate test in part 4 was being used to confirm the presence of chloride or iodide ions. Many candidates did not record an observation for the addition of nitric acid. Emphasis should be placed on the fact that when an acid is added to a solid (or precipitate) the absence of effervescence means that the solid is not a carbonate/hydrogencarbonate.

- (b) This part of the question caused very few problems. A significant number described the colour of bromine water as red/brown. Pure liquid bromine may well be red/brown but bromine water is a yellow/orange colour.

### Q3 PLANNING (PAPERS 1 AND 2)

- (a) (i) “contains water of crystallisation” is probably the best response here.
- (ii) The use of a pipe-clay triangle was credited and in fact is probably a better option than using a gauze. Care should be taken not to leave out the labels.
- (b) (i) Very well done by most candidates.
- (ii) Easy marks were lost by many candidates. The idea of repeated heating was often left out. Greater detail/clarity should be encouraged in similar questions on future papers.
- (c) These calculations proved to be relatively easy for most candidates.
- (d) These calculations proved much more challenging. The incorrect mass was often used in  $q = mc\Delta T$ . Scaling from J to kJ was often either ignored or incorrect as was scaling to kJ per mole. The negative sign was often missing.

### Q4 (PAPERS 1 AND 2)

Most candidates scored highly in this question. The most common errors were to leave out the units in part (a) and “100” in part (e).

### Q5 (PAPERS 1 AND 2)

The standard of diagrams for reflux and distillation continues to be quite poor. Candidates should be encouraged to improve in this area. “to ensure smooth boiling” as on previous mark schemes is the expected response in (b).

### Q6 (PAPERS 1 AND 2)

These qualitative tests were, in general, not well known. Some alternative tests were accepted however the observations had to match the reagent e.g. NaOH (aq) was accepted in Paper 2 however if it was then suggested that the blue precipitate dissolved in excess to give a deep blue solution a mark was lost since with NaOH (aq) the precipitate remains on addition of excess.

**Q7 (PAPERS 1 AND 2)**

The mark scheme answer is obviously the best response here. However, arguments based on density were accepted if it was clear that candidate understood that the density of the organic layer had to be known and compared to the density of the aqueous layer (approximately 1.0 g per cm<sup>3</sup>) to decide which was the upper layer. Many candidates seem to believe that the organic layer is always the upper layer. “Dehydrating” was often used instead of drying.