AQA

A-LEVEL
CHEMISTRY

7405/2 Organic and Physical Chemistry
Report on the Examination

7405
June 2017

Version: 1.1

Further copies of this Report are available from aqa.org.uk

General Comments

The quality of work in this first Paper 2 of the new specification was good and especially so in topics common to the old specification. Questions on new topics were sometimes less well answered, but it was pleasing that many students showed an excellent understanding of these new areas. Some questions which required the use of mathematical skills showed a varied response. Some students were, for instance, unable to rearrange mathematical expressions reliably, while by comparison others scored highly on these questions.

Question 1

01.1 Although most students identified compound **J** as propan-1-ol, a surprising number failed to show the O–H bond as is necessary in a displayed formula.

01.2 Most students could name the mechanism, but the condition proved more difficult.

01.3 This calculation was done well and 56% of students scored full marks. The main errors were in working out or using the correct M_r values.

01.4 Only 30% of students scored both marks here. Others drew a primary amine or a non-skeletal structure.

01.5 Both the reagent (which must be a complete compound) and a condition were needed to score the mark; several omitted the condition.

01.6 This was a high scoring question for many. For others, the main errors were missing the negative sign or the lone pair on the hydroxide ion, or showing attack on the wrong hydrogen atom.

Question 2

02.1 Most students were able to draw a suitable tangent, although some drew a very small tangent which made calculating a gradient from it more difficult and less precise.

02.2 Calculating the gradient was well done by over two thirds of the students. A common mistake was to misread the scale on one or both of the axes.

02.3 This proved more difficult with over half of the students failing to score. Common errors were using their rate value from part 02.2 or failing to take the square root of 1.7.

Question 3

03.1 This kinetics question was answered well apart from occasional slips in deducing the units.

03.2 It was pleasing to see that 47% of students scored full marks in this topic which is new to the specification. The others made one or more errors in reading the given value of ln *A* as *A*, in wrongly rearranging the equation, or in using incorrect units.

Question 4

04.1 As usual, naming nitriles proved difficult for some, but 56% of students gave the correct answer.

04.2 Although this question was answered well by most, an appreciable number of students were careless with language and appeared to say that the enantiomers themselves rotate, or that the plane polarised light is 'refracted' or 'bent' rather than 'rotated in opposite directions'.

04.3 The first mark was less commonly scored than expected as many students wrote about a planar molecule or a planar bond rather than planar carbonyl group; the other two marks were frequently awarded.

04.4 A significant number were not able to deduce the correct product and many incorrect products were seen. These included the cyanohydrin formed from pentanal. This showed a lack of care in reading the question.

Question 5

05.1 The diester was drawn well and 61% of students gained the mark.

05.2 The equilibrium amounts were also answered well and nearly 75% of students scored three marks here.

05.3 Most students were able to write the K_c expression correctly, but weaker students were unable to explain clearly that the volume term cancelled in the expression.

05.4 Nearly 70% of students were able to calculate the equilibrium amount of ethanoic acid correctly. Mathematical aspects caused others to lose marks; incorrect rearrangement of the expression was the most common error, while some failed to give their answer to three significant figures – as expected in a question where all the data provided were to three significant figures.

Question 6

06.1 The zwitterion was drawn correctly by all except the weakest students.

06.2 The structure of the negative ion formed by serine in alkali was less well known and occasionally the response showed a hydrogen removed from the alcohol group, as well as from the acid.

06.3 Although the questions asked for 'both dipeptides', several students drew only one. The amide link was also occasionally drawn with an extra oxygen atom included, and occasionally cysteine was used instead of serine.

06.4 This question was well answered and 25% of students scored all six marks. The name of the organic product was the most common mark lost, closely followed by slips in the third or fourth marks in the mechanism.

Question 7

07.1 There were some very good answers to this question and nearly a fifth of the students scored full marks. The best answers followed a 'stage approach', in which a first test divided the four compounds into two groups. Subsequent tests were then made on each group.

Students generally knew the chemistry, but didn't always show a logical approach in their answers to the problem. Some suggested testing the same reagents on all four

compounds, failing to appreciate that once one compound was identified, further tests on it were unnecessary. Some suggested performing isolated tests on individual compounds.

Question 8

08.1 This was well known; most students gave an equation for a 1:1 mole ratio, although a 1:2 ratio and a two-step process were also seen and credited.

08.2 This was also well known and 35% of students scored full marks. In the mechanism, some students incorrectly showed a lone pair on the electrophile, or the horseshoe was sometimes drawn in an incorrect orientation relative to C1. Some students started from benzene and formed nitrobenzene first.

08.3 Only the very weakest 7% of students failed to calculate the correct R_f value.

08.4 This question tested understanding of the balance between solubility in the moving phase and retention by the stationary phase. Both parts were needed in the answer.

08.5 This question was found very easy by most, although weaker students discussed safety issues.

08.6 A third of students scored both marks, but sadly 7% of students made no attempt at the question. They were asked to deduce the answer to an unfamiliar practical situation, but one which is similar to those they will have met in Required Practical Activity 12. Many deduced that the 1,4 isomer was less polar, but then attempted to explain this relative polarity rather than answering the question asked.

08.7 This final part to the question was not attempted by 10.2% of students. The best answers demonstrated the ability of candidates to deduce that the student was correct, and to explain their deduction.

Question 9

09.1 This question tested a topic new to the specification and it was pleasing that just over half of the students were able to answer this part correctly.

09.2 This question proved more challenging. Many students were able to recognise that thymine was needed, but only 23% were able to draw thymine correctly, with the correct orientation, and linked correctly to adenine by two hydrogen bonds.

Question 10

10.1 The full IUPAC name of isomer P includes the letter Z to indicate its stereochemistry. Only 10% of students answered this difficult question correctly.

10.2 This extended response question was a good discriminator. An appreciable number of students failed to write an equation and, of those who did, many students forgot that **P** contains two oxygen atoms so used too much oxygen in their answer. It was expected that the volume of oxygen used (180 cm^3) would be deduced directly, and the amount of oxygen in moles calculated from this. Some answers contained calculation of the amount in moles of gas at the start and at the end and subtraction at this later stage. The main errors were in rearranging $pV = nRT$, in failing to convert the volume units to m^3, and then, most commonly, failing to divide the amount of oxygen by 6 to obtain the amount in moles of **P**. Sadly a number of students got this far but then gave their answer in g rather than mg.

10.3 The identity of **Q** discriminated well. Many students were not able to relate an aspect of its structure to a peak/signal. In the evidence from Figure 4, many students failed to state that the infrared absorption between 2500 and 3000 cm^{-1} showed the presence of an O–H bond **in an acid**. In the ^{13}C NMR evidence, many students thought that the structure was an aldehyde/ketone having been careless in reading the value of the chemical shift on the x-axis.

10.4 Few students gained full marks here. Although the number of peaks was deduced correctly, few gave a correct comparison of the spectra of **R** and **S.** The symmetry of each compound was not always noted, so the number of peaks given was double the correct value.

10.5 Again, the fact that the two CH_2 groups were identical, and would therefore produce a singlet, was missed by most students who predicted a triplet in the spectrum of R. The triplet and quartet for S were usually predicted correctly but full marks were obtained by relatively few students. Over 5% of students made no attempt at the question.

10.6 The two structures were found difficult, particularly that of **T**, and the polyester repeating unit was often shown as a double unit. The type of polymerisation, however, was well known.

10.7 The question was not attempted by 7% of the students. Of those who did answer, only the best scored all three marks. Many answers were vague and missed the required comparison of the position of the ester group. Large numbers either only gained the first mark or alternatively did not score, because their repeating unit was incorrect.

Question 11

11.1 The full range of marks was seen and included some excellent answers. Other responses did not contain accurate descriptions of the effect of the attached groups on the availability of the lone pair on the nitrogen atom. The idea that, for nitrogen atoms directly attached to the benzene ring, the lone pair was delocalised into the ring was often poorly explained. The (positive) inductive effect of alkyl groups was much better described.

11.2 Some excellent answers were seen, but overall this was not answered well. The fact that about 8% of students made no attempt at this part of the question perhaps indicated that a small number of students were short of time. Some students, confused by the presence of a benzene ring, started with nitration. This rarely led to any marks. For those who chose the correct route, the two intermediates were often correctly identified. The use of chlorine or bromine in UV in the first step was usually well known but use of the reagent KCN in a mixed aqueous/alcoholic solvent was less often correct in the next step. The expected reducing agent/condition for the final step was hydrogen with a nickel or platinum catalyst. $LiAlH_4$ in dry ether is not required knowledge for this specification, but was an acceptable answer.

Use of statistics

Statistics used in this report may be taken from incomplete processing data. However, this data still gives a true account on how students have performed for each question.

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results Statistics page of the AQA Website.