AQA

AS-level
CHEMISTRY
7404/2 Organic and Physical Chemistry
Report on the Examination

7404
June 2016

Version: 0.1

General comments

The first examination of the new specification provided new challenges for students alongside questions of a more familiar style. The higher proportion of level 2 mathematics challenged many students with the greater need to convert units, to manipulate data to reach conclusions and to give answers to the appropriate number of significant figures. In addition, the focus on practical work showed that many students were either unfamiliar with common techniques and/or did not understand these techniques. To a lesser extent, the need to write answers with extended responses that demonstrated a logical, structured and coherent argument was found difficult by some students.

Key lessons for teachers from this paper are the need to develop mathematical skills and to place a far greater emphasis on doing and understanding practical work.

Q1 Equilibria & K_c

Many students could write the correct expression for K_c in Q1.1 although some failed to use square brackets to show concentration. Students found it harder to derive the units for K_c. In the calculation of K_c in Q1.2, many students failed to use the concentration of each substance. They used incorrectly just the moles instead. A few students found the correct value of K_c but did not give it to the correct number of significant figures.

Q2 Enthalpy of combustion & calorimetry

In the calculation of the enthalpy of combustion from the experimental data, many students used the mass of the fuel (rather than the water) when using $q = mc\Delta T$. Others incorrectly added 273 to the temperature rise. When finding the moles of methanol burned, some students rounded this to 1 significant figure which gave inaccurate answers. Some students failed to include the minus sign on their final answer to show that the reaction is exothermic. In Q2.2 many students referred to the problems already stated in the question rather than an additional one. Many students suggested mistakes made during the experiment rather than design features. Many students scored the mark for Q2.3 but many others did not know where to start. The calculation of apparatus percentage uncertainties should be an important and routine part of practical work. Few students realised that Q2.4 related to the size of the uncertainty in the temperature rise compared to the actual temperature rise and/or heat loss in the experiment. Many students were uncertain how to start the calculation in Q2.5, namely by using the density to find the mass of the ethanol. Others struggled to convert the volume in dm^3 to cm^3.

Q3 Alkanes in fuels

The naming of the molecule, in Q3.1 was answered correctly by many students.

Most students realised that simple or fractional distillation could be used in Q3.2. However, many referred to the industrial fractional distillation process where the entire mixture is vaporised and then fed into a fractional column with a temperature gradient and collection trays, rather than referring to an apparatus that would be used in the laboratory. This may suggest a lack of familiarity with carrying this out in the laboratory. Q3.3 was well answered, although $8\frac{1}{2}O_2$ was seen often stemming from students not appreciating that there were two oxygen atoms in each CO_2 molecule. Many students could answer Q3.4 by explaining, in general terms, how a catalyst works and knew the equation for the reaction of NO and CO in a catalytic converter, answering Q3.5. Many students in Q3.6 could explain that a thin layer of catalyst was used on a ceramic support to increase surface area, but few also explained that this reduced the amount of catalyst needed (which would be expensive). Many students in Q3.7 knew the use of bromine (water) to show that a compound is unsaturated, but some referred to the mixture going from orange to clear rather than colourless.

Q4 Organic molecules with the same M_r

Many students could knew in Q4.1 that the three molecules had the same molecular formula or were isomers, but few stated that they had identical relative formula masses. Most students in Q4.2 could identify the prop-2-en-1-ol using the IR spectrum stating the use of the O-H or C=C absorption to do so. Q4.3 question proved challenging and discriminated well. The best students could identify the correct order of boiling points, identify the correct intermolecular forces and use good language to communicate this in a structured way. Many students could identify van der Waals' forces in butane and hydrogen bonds in prop-2-en-1-ol, but few could identify permanent dipole-dipole forces in propanal. Indeed, many students mistakenly thought that propanal had hydrogen bonding. In addition, many students referred incorrectly to the breaking of covalent bonds and referred to the strength of the covalent bonds, rather than concentrating on intermolecular forces.

Q5 Free radical reactions

In Q5.1the two equations showing how chlorine radicals destroy ozone were quite well known.Many students in Q5.2 could draw the correct displayed formula of chloropentafluoroethane. Many students in Q5.3 could explain why 1,1,1-trifluoroethane did not lead to ozone depletion. The simplest answer was that it contains no chlorine, but credit was given for students who stated that the C-F bonds were strong and so fluorine radicals were not released. Students in Q5.4 found the two propagation steps to convert CHF_2CH_3 into CF_3CH_3 more challenging, but a pleasing number could do this. The most common mistake was to remove a Hydrogen atom from the wrong Carbon atom in the first step. Students found Q5.5- the calculation for the number of molecules- challenging. Some had little idea where to start while many others failed to convert kg to g and/or give their final answer to the correct number of significant figures. Few students knew Q5.6 that molecules with vibrating polar bonds absorb IR radiation.

Q6 Oxidation of alcohols

This was the first paper to examine skeletal structures. Q6.1 was generally well done except for students who showed bonds going to the H of the OH group rather than the O. Q6.2 question proved to be very challenging with few students appreciating that both alcohol groups would be oxidised, and very few of those being able to balance the equation. The quality of the diagrams in Q6.3 was very poor and this is an area for students to work on. Many did not appear to know what refluxing was in the first place. Those that did often sealed the reflux condenser in some way, often with a bung. Openings were rarely shown for the water to enter and leave the condenser. Diagrams were also poorly labelled. Students are not expected to produce a work of art. Rough sketches can score but they must allow a way for chemicals to move through the apparatus. Very few students answered

Q6.4 by stating that anti-bumping granules lead to smaller bubbles, even though this question has appeared on previous EMPA/ISA papers and even though students should have used them in practical work. This question again showed the importance of students doing and understanding practical work. Q6.5 was answered better with a reasonable number of students drawing a correct oxidation product.

Q7 Electrophilic addition

7.1 Many students could draw the correct structure of the Z isomer in Q7.1.

Many students did well on Q7.2, but a significant number attempted to describe the curly arrow mechanism in words rather then drawing it. The phrase "outline the mechanism" has been used for many years and is explained in the specification to mean drawing a curly arrow diagram. On this occasion, it was decided that credit could stem from an accurate description in words but it was very hard for students to match the level of precision in words that is demanded in the drawing, and so most students who described the curly arrow diagrams did not score well at all. The final two marks were awarded for an explanation of why more of one product was formed than another. The explanation should refer to the relative stability of the two possible carbocation intermediates. Many students were confused and thought that the products were the carbocations. To score these marks, students had to be clear that carbocations are intermediates from which the products are formed and not the products themselves.

Q8 Reaction rates and limiting reagent

The best students knew in Q8.1 that the magnesium was in excess by calculation, but other students were confused. Some failed to convert mg to g. Many students wrote numbers with no explanation of what they represented. Many statements were seen of the type: '0.6 x 0.03 = 0.018/2 = 0.009', which is an incorrect mathematical statement. To score full marks, students had to explain how their calculation showed the magnesium was in excess. Many students realised in Q8.2 that the second reaction was faster than the first and drew their line steeper, but few could determine that 8/9ths of the volume of hydrogen would be formed.

Q9-23 Multiple-choice questions

Students generally did well on Q11 but many gave answers that demonstrated a lack of understanding about how to calculate percentage yield by dividing the mass of the product by the mass of the starting material. Students found Q19 challenging suggesting that this is a skill that they need to practise more, ultimately to have success in extended questions on calculating equilibrium constants. Many students were distracted by incorrect responses to Q21 due to a misunderstanding of the factors that affect the value of the equilibrium constant. Q22 involved several steps and many went wrong as they effectively used ΔH = [Sum bond enthalpies products] – [Sum bond enthalpies reactants] instead of ΔH = [Sum bond enthalpies reactants] – [Sum bond enthalpies products]. Q23 proved to be the most challenging multiple choice question. Errors may have stemmed from some students running short of time and/or not using SI units in the calculations.

Mark Ranges and Award of Grades

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