AS

CHEMISTRY

7404/2: Paper 2: Organic and Physical Chemistry
Report on the Examination

7404
June 2019

Version: 1.0

Question 1: Chemical tests for organic compounds

1.1 This question looked for a test to distinguish a ketone from a carboxylic acid. Some students thought that the ketone, shown by a skeletal structure, was an aldehyde and tested for an aldehyde rather than using a test for the carboxylic acid.

1.2 This question looked for a test to distinguish a ketone from an aldehyde. This was answered well, but many who used Fehling's solution referred to a colour change and did not include the idea that a precipitate was formed.

Question 2: Reaction of a halogenoalkane with potassium cyanide

2.1 The mechanism was done very well in the main. The most common error was to omit the negative charge from the cyanide ion.

2.2 Students struggled to name the propanenitrile formed. It seemed that few knew how to name nitriles.

2.3 Students did very well calculating the atom economy for the reaction and giving the answer to the appropriate number of significant figures.

Question 3: Calorimetry

3.1 Students had to calculate the expected temperature rise in a calorimetry experiment. Most errors stemmed from not converting kJ to J at an appropriate time and/or using the mass of the cyclohexane in place of the mass of water heated in the equation $q = mc\Delta T$. Some students did not appreciate that this was an exothermic reaction and there would be a temperature rise.

3.2 Most students could explain why the temperature rise recorded would be less than that expected, with most explaining it by heat loss.

3.3 Students were asked to calculate an enthalpy change using enthalpies of combustion in a Hess cycle. This was done reasonably well.

Question 4: Burning fossil fuels

4.1 Most students could write the equation for the complete combustion of octane.

4.2 An equation for the removal of NO in a catalytic converter was not well known.

4.3 Students handled this question quite well, but most errors came from incorrectly converting tonnes to grams and grams to kilograms. Some students did not give their answer in standard form as required.

Question 5: Methanol

5.1 Students did not score well when asked to draw the hydrogen bond interaction between two methanol molecules. Some showed only one and not two lone pairs on the O atoms. Some showed the attraction going from the O to H bonded to C on a neighbouring molecule. Very few students drew a linear arrangement around the H in the hydrogen bond.

5.2 In this question, students had to explain why the H−O−C bond angle in methanol is less than 109.5°. Many could explain this, but some did not give a comparison between the repulsion from a lone pair of electrons and that from a bonding pair of electrons.

5.3 Students answered the level of response question well. The question asked students to ‘describe’ the effects of a catalyst, pressure and temperature on the yield, rate and cost of the reaction. Many also ‘explained’ the effects, which was not required. Students should note the specific command word and answer accordingly. The most significant misunderstanding was that some students thought the use of a catalyst would change the equilibrium yield.

Question 6: Addition to alkenes

6.1 The mechanism was done quite well. The most common error was omitting the negative charge on the hydrogensulfate ion.

6.2 Most students could draw the structure of the minor product.

6.3 Students struggled to explain why the major product was formed. Many students referred to the structure of the product and its stability, rather than that of the carbocation intermediate from which it was formed. Some students clearly thought, incorrectly, that the products were carbocations.

Question 7: Propanedioic acid

7.1 Most students could draw the skeletal formula, but a significant number did struggle.

7.2 This question asked students to describe how to prepare a standard solution. Many gave methods where they would not know the mass that they had dissolved. There are different ways in which the mass can be found, but many found the mass of an empty weighing boat and the mass of the weighing boat with sample, but did not either wash all of the solid into the solution or re-weigh the weighing boat after adding it. Other incorrect procedures were described by students who did not use a volumetric flask, those who added 250 cm^3 before dissolving, those who did not state that they would dissolve the solid and those who did not invert the flask after making up the solution.

7.3 Students did well calculating the mass of propanedioic acid needed to prepare the solution, including converting g to mg.

Question 8: Equilibria and K_c

8.1 This calculation was handled well by students, including finding the mass from the volume and density of a liquid. However, some gave 66.6 cm^3 as an answer where they had incorrectly rounded 66.666666….. cm^3. This may stem from poor understanding of the 66.6 dot seen on a calculator.

8.2 Many drew a reflux apparatus rather than a distillation apparatus, but even those who did draw a distillation gave inaccurate drawings. Diagrams must be in cross-section and so, in this example, there is a continuous flow through the apparatus from the flask to the receiver-container. The openings for water in the condenser should also be open and not closed as it is a cross-section. The water should enter the condenser at the bottom and not the top.

Question 9: CFCs

9.1 Many students could write an equation that gave chlorine radicals, but many missed a radical dot on one or both of the products.

9.2 Most students could write one or both of the equations for the decomposition of ozone by chlorine radicals. However, even though these two equations are in the specification, many did not score both marks.

9.3 Students did well on this question. Most mistakes stemmed from incorrect unit conversions to find the gas volume in cm^3. A lot of students who had made errors finding the gas volume divided the liquid volume by the gas volume rather than vice versa.

Question 10: Ethanol concentration in blood

This calculation was done correctly by the majority of students.

Question 11: Maxwell-Boltzmann distribution curve

This question was answered correctly by the majority of students.

Question 12: Equilibrium moles

Students struggled with this question, possibly due to misunderstanding the concept of 50% dissociation.

Question 13: Isomers

Only about half the students could do this. This may stem from poor understanding of the number of H atoms in a skeletal structure.

Question 14: Isomers

Few students got this correct, with most missing one or more isomers.

Question 15: Propagation step

Most students could identify a propagation step from the options.

Question 16: Reaction of ammonia with propylamine

This was answered correctly by a good majority of students.

Question 17: Alkenes

This was answered correctly by a good majority of students.

Question 18: Oxidation of alcohols

Students found this question more challenging. It would help students if they drew structures.

Question 19: Nucleophiles

This question was not as well answered as expected. There was only one species with a lone pair, but only about half the students could identify this as the nucleophile.

Question 20: Dehydration of alcohols

This was answered correctly by a good majority of students.

Question 21: Intermolecular forces and boiling points

This was answered correctly by a majority of students.

Question 22: Reaction of hydroxide ions with halogenoalkanes

Students found this question more challenging. It would be helpful to draw structures.

Question 23: IR spectroscopy

The infrared spectrum showed both a C=O stretch and an O−H stretch. Many students thought it was a carboxylic acid, but the peak centred on 3400 cm^{-1} should have been recognised as due to an alcohol O−H group not an acid O−H group.

Question 24: Heat released by each molecule on combustion

Students found dealing with units and the Avogadro constant to be challenging.

Mark Ranges and Award of Grades

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