AQA

# AS LEVEL
# CHEMISTRY

## 7404/2 Organic & Physical Chemistry

## Report on the Examination

7404
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## Section A

### Question 1 Rates of reaction

1.1 This question looked for a rate of reaction to be calculated from a time. Most students could do this although a few used a recurring dot above the last figure suggesting the rate could be known accurately to an infinite number of significant figures which is not appropriate.

1.2 This question looked for the independent variable. Most students could identify it.

1.3 This question looked for a way to determine the mean temperature during each reaction. This experiment is closely related to Required Practical 3 and the mean temperature can be found by measuring the temperature at the start and end of the reaction and taking a mean. Few students were familiar with a way to do this.

1.4 This question required students to draw a graph. Most students did this well, including drawing a suitable best fit curve.

1.5 This question required students to use a rate of reaction reading from their graph and then convert it to time. Most students did this well.

1.6 This question required students to explain why a small rise in temperature leads to a big increase in rate of reaction. Key to this question is why a small increase in temperature leads to a big increase in rate, rather than simply why an increase in temperature leads to an increase in rate. Few students referred to the idea that a rise in temperature causes many more particles to have the activation energy.

### Question 2 Distinguishing organic compounds

This question looked for chemical tests and then the use of spectroscopy to distinguish four organic compounds. Some students did not read the question carefully enough and did chemical tests for the carboxylic acids which was not necessary. Other students did not appreciate that both the aldehyde and the alcohol would turn acidified potassium dichromate(VI) from orange to green. Some students mixed up IR spectroscopy and mass spectrometry, while others did not appreciate that the two acids had the same formula mass which negated the way they suggested using mass spectrometry.

### Question 3 Isomers

3.1 This question looked for the displayed formula of a position isomer. This was answered reasonably well.

3.2 This question looked for the displayed formula of a chain isomer. Students found this more challenging to do than question 3.1.

3.3 This question looked for the skeletal formula of a functional group isomer using IR data. This was answered reasonably well.

3.4 This question looked for the skeletal formula of a structural isomer using IR data. Students found this more challenging to do than question 3.3.

3.5 This question required students to find an empirical formula and then suggest two compounds that it could be. The empirical formula was well answered, but students struggled more to suggest the correct names of the compounds.

**Question 4 Gas volumes**

4.1 This question required students to use the ideal gas equation. The use of the ideal gas equation, including unit conversions, was generally good. Students struggled to use the equation to work out the amount, in moles, of gas which was a combination of nitrogen, hydrogen and carbon dioxide. A number of students did not appreciate that the final answer will be a volume in $m^3$ and so used factors such as $10^3$ or $10^6$ in an attempt to put the volume into $m^3$.

4.2 This question used algebra to work out a gas volume. Many students struggled with this, possibly by being unable to work out the amount in moles of $CO_2$ in terms of $n$ from the general formula of an alkene, $C_nH_{2n}$.

4.3 This question required students to use algebra to balance an equation. Some students could do this, but it was too challenging for most.

**Question 5 Synthesis of propylamine**

5.1 This question required students to name and outline a mechanism. This was done well. One common issue was students thinking that ammonia is negatively charged in their mechanism.

5.2 This question required students to use the Avogadro constant to work out the number of molecules in a liquid. Many could do this, but some struggled to work out the mass via the volume and density, or the amount in moles from the mass or how to use the Avogadro constant.

5.3 This question required students to work out a percentage yield. Many could do this.

**Question 6 Refrigerants**

6.1 This question required students to calculate an atom economy. This was answered well.

6.2 This question required students to write a pair of propagation steps. Many could do this but a significant number did not appreciate the underlying principles of these pairs of propagation steps where the first step uses a free radical that is then reformed in the second step.

6.3 This question required students to write an equation for a termination step. Students found this challenging and many did not give the structural formula of the product as required by the question.

**Question 7 Fuels, energy and electrophilic addition to alkenes**

7.1 This question required students to justify that bioethanol use is carbon-neutral using equations. Few students could give the equations for photosynthesis, fermentation and combustion (of ethanol) needed to justify their answer. Overall this question was not answered well.

7.2 This question required students to justify why moving a product across the world is less likely to be carbon-neutral than using local materials. Many students could explain that the transport produced more $CO_2$ emissions.

7.3 This question required students to use data to judge the relative environmental impact of some fuels. This required students to work out the energy released per mole of $CO_2$ released, and many found it difficult to do this. Many also could not deduce that the fuel releasing the most energy per mole of $CO_2$ formed was the one with the lowest environmental impact.

7.4 This question required students to calculate the final temperature of some water after being heated up by a burning fuel. Students answered this well, including unit conversions where applicable.

7.5 This question required students to calculate a mean bond enthalpy. Students struggled with this for a number of reasons. Some were not sure if making or breaking bonds released energy. Some omitted to use the overall enthalpy change. Some did not include all the bonds in the reactants/products. Some thought there were four, not three, C-C bonds in butan-1-ol.

7.6 This question required students to name and outline a mechanism. This was done well. One common issue was students not putting the negative charge on the $HSO_4^-$ as it attacked the carbocation in the final step.

7.7 This question required students to explain why there are major and minor products in the electrophilic addition. Students struggled to explain this clearly. Students were not clear whether the relevant carbocations were intermediates or the products themselves.

## Section B

### Question 8 Cracking

This was answered correctly by a majority of students (68.9%).

### Question 9 Fractional distillation

Many students incorrectly thought that the fuel oil was more viscous than the residue, or perhaps did not realise there was any residue. Only 36.5% of students gained the mark.

### Question 10 Poly(ethene)

This was answered correctly by a majority of students (66.7%).

### Question 11 Poly(propanenitrile)

Students struggled with this question, with many believing that the polymer is unsaturated.

### Question 12 Dehydration of alcohols

This was answered correctly by a majority of students (69.2%).

### Question 13 Boiling points

This was answered correctly by a majority of students (66.8%).

### Question 14 Molecules in a gas

Many students incorrectly thought that as temperature increases, the number of molecules with the most probable energy increases.

### Question 15 Oxidation of alcohols

Many students struggled to work out which alcohol is oxidised to a given ketone.

### Question 16 Change of shape during a reaction

Students found this question challenging and struggled to work out whether the shape of an organic compound changes from the start to end of a reaction. Only 34.5% of students gained this mark.

### Question 17 Empirical and molecular formulae

This was answered correctly by a majority of students (67.2%).

### Q18 $K_c$ expression

This was answered correctly by a majority of students (80.1%).

### Q19 Moles at equilibrium

Students found it difficult to work out the amount, in moles, of the substances in an equilibrium mixture.

### Q20 Le Chatelier's principle

This was answered correctly by a majority of students (60.7%).

### Q21 Reaction of 2-bromobutane with hydroxide ions

Students found it difficult to deduce which compounds could be produced by substitution and/or elimination.

### Q22 Role of hydroxide ions in elimination

Students were unsure about the role of hydroxide ions in elimination from halogenoalkanes, although the majority (57.1%) answered it correctly.

**Mark Ranges and Award of Grades**

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