AS LEVEL
CHEMISTRY

7404/2 Organic and Physical Chemistry
Report on the Examination

7404
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General Comments

This third examination of the new specification highlighted some key points for teachers going forward. Students need to:

- be very familiar with all the practical procedures contained in the specification and, very importantly, understand *why* they carry out the procedures that they do in practical work, rather than just know *what* to do;
- understand the appropriate precision for experimental data, for example titre values;
- appreciate that covalent bonds do not break when molecular substances melt or boil;
- be able to deduce the structure of the repeating unit of a polymer from its monomer;
- be able to convert ratios into the simplest whole number ratio when deducing an empirical formula.

Section A

Question 1 Reaction rates

01.1 Most students could explain how a catalyst works in general terms (73.3% gained both marks), but some gave specific details of how heterogeneous catalysts work rather than referring to catalysts in general.

01.2 Many students struggled to work out how the amount of H_2O_2 in similar reactions affects the relative amount of oxygen formed.

01.3 Many students referred to the number of successful collisions rather than the frequency of successful collisions when explaining why the concentration of hydrogen peroxide affects the rate of reaction.

Question 2 Titrations

02.1 Only a minority of students (42.3%) could explain why the final rinse of a burette in a titration should be done with the solution going into the burette rather than with water. This showed the importance of students understanding *why* they are doing what they are doing in a practical procedure rather than just following instructions.

02.2 Very few students (only 15%) could give the volumes in each titration to the appropriate precision, for example writing 23.9 instead of 23.90 cm^3.

02.3 Many students could identify the concordant titres to use to find the mean, although many did not, but few students quoted the mean to the appropriate precision.

02.4 The calculation of the uncertainty in the use of the burette in the titration was answered well, but a significant number of students did double the uncertainty perhaps because they did not appreciate the origins of the ±0.15 cm^3 uncertainty.

02.5 This calculation was done well, but some students used the wrong volume of alkali, using the volume of the acid instead. The conversion of g to mg was done well. This question discriminated particularly well.

02.6 Nearly half of students could find the percentage purity based on their answer to question 02.5. Worryingly, just over 20% of students made no attempt at all at this question.

Question 3 Calorimetry

03.1 Many students struggled with this question, though it did discriminate well. The main problem stemmed from an inability to find the heat released using the enthalpy change (per mole) and the amount in moles of the acid or alkali reacting. Many believed that q was the same as the enthalpy change. Some students also incorrectly thought that amount in moles reacting' was the amount in moles of acid + moles of alkali.

03.2 Very few students realised that the best-fit line was a curve and not a straight line. Some students also extrapolated to a time before the time of mixing. Only 3.8% of students gained both marks.

Question 4 Alkanes

04.1 Most students knew the general formula of alkanes and many could also deduce the M_r in terms of *n*, where *n* is the number of C atoms.

04.2 A lot of students believed that covalent bonds break when alkanes are boiled. Other students lost a mark for poor use of terminology by not referring to forces between molecules. 62.2% of students failed to score on this question.

04.3 Nearly all students (82.8%) could write the balanced equation for the complete combustion of nonane.

04.4 A good number of students knew how NO is formed in an engine, but many did not appreciate that the nitrogen comes from the air and that high temperatures are required for the formation of NO.

04.5 Most students (75.7%) knew that thermal cracking is used to form alkenes.

04.6 Few students (30.9%) could draw the repeating unit of poly(propene) correctly.

Question 5 Analysis of hydrocarbons

05.1 Some students could not convert the ratio 7.3 : 13.2 to a whole number ratio, but the question was answered well on the whole and discriminated well.

Question 6 Reactions of halogenoalkanes

06.1 Most students (56.1%) could name compound **A** correctly.

06.2 This question proved to be demanding. The calculation of the M_r of individual molecules containing different isotopes was a challenge for many students. 61.8% of students either failed to score or made no attempt; 33.4% did, however, score both marks.

06.3 The nucleophilic substitution mechanism was well-answered; 45.6% of students scored full marks here.

06.4 The elimination mechanism was more challenging, and many students did not know the role of the hydroxide ion. This question discriminated particularly well.

06.5 Just under half of students could determine that the IR spectrum was of an alkene rather than an alcohol and explain this by reference to the absorption for a bond and its wavenumber range.

06.6 Students struggled to explain the relative rates of reaction of the halogenoalkanes. The most common answer incorrectly referred to the reactivity of the elements bromine and chlorine, rather than looking at the C-Br and C-Cl bond strengths. Only 28.6% of students gained this mark.

Question 7 Analysis of organic molecules

07.1 Many students approached this question as if they already knew which compound was which. They did not appreciate the need to carry out the first test with all four compounds to start to work out which is which. Many used the test with acidified potassium dichromate(VI) but did not realise that butanal as well as butan-2-ol would react. Few successfully identified two compounds using two test tube reactions, leaving the other two compounds to be distinguished by IR spectroscopy or mass spectrometry. Many did not explain how one of these spectroscopic methods could actually be used to distinguish the final two compounds. Overall, though, the question discriminated well.

Question 8 Equilibria and K_c

08.1 Most students knew that a catalyst does not affect the equilibrium yield, but few could explain that this is because it increases the rate of both the forwards and reverse reactions equally.

08.2 Most students (78.5%) could write the expression for K_c.

08.3 The most common mistake in the calculation of K_c was to use the amount in moles rather the concentration of each reagent. Others failed to square the concentration of hydrogen. A good number of candidates (44.1%) did, however, gain all three marks.

08.4 The idea of the answer being equal to (1/answer to 08.3) was quite well known and many could deduce the units. A surprisingly high proportion of students (14.2%), however, made no attempt at this question.

Section B

Question 9 Diluting a solution

The most common answer, **C**, was incorrect. Students believed that 500 cm^3 of water should be added to the 10 cm^3 of solution, rather than adding 490 cm^3 to make the total volume 500 cm^3.

Question 10 Permanent dipole

A significant majority of students (74.1%) could deduce that CBr_4 had no overall dipole.

Question 11 Electrophilic addition

This question was challenging. The most common incorrect answer added the iodine and chlorine onto the two C atoms, but could not use the bond polarity in iodine monochloride to determine which way round they added. Pleasingly, though, 47.9% of students gained the mark.

Question 12 Equilibrium

Most students (60.1%) could use Le Chatelier's principle to deduce which statement was correct.

Question 13 Relative boiling points

Students found it hard to predict which compound had the highest boiling point. Many thought the fluoroalkane had the highest boiling point, possibly as they incorrectly believed it might contain hydrogen bonds between molecules.

Question 14 Fractional distillation of crude oil

Many students (57.3%) got this correct, but many incorrectly thought covalent bonds are broken when molecular substances boil.

Question 15 Isomers

Few students (28.7%) got this correct, with most believing there are fewer isomers than there actually are.

Question 16 Maxwell-Boltzmann distribution

Many students (58.9%) got this question correct but many confused the most probable energy with the mean energy of the particles.

Question 17 Yield

A good number of students (37.2%) could work out the percentage yield, but the many incorrect answers suggest that many students do not understand how to calculate percentage yield.

Question 18 Nucleophiles

Many students (46.8%) got this question correct but many others thought that NH_4^+ could act as a nucleophile, possibly due to confusion with NH_3.

Question 19 Poly(chloroethene)

Many students (52.2%) got this question correct but many others incorrectly thought that the polymer contained a C=C bond and would decolourise bromine water.

Question 20 Hess's cycle

Just over a third of students calculated the correct answer of +112 kJ mol^{-1}, but almost as many students gave –112 kJ mol^{-1}. A possible reason for this wrong answer is that students may use summary equations in calculations such as these and may be uncertain whether these involve (products – reactants) or (reactants – products).

Question 21   Number of molecules in a gas

Most students (70.6%) could correctly find the number of molecules in a sample of propane. The most common incorrect answer used C_3H_6 rather than C_3H_8 as the formula of propane.

Question 22   Density and volume of liquids

Most students (55.6%) could correctly find the liquid that had the greatest volume from its mass and density.

Question 23   Initiation reaction

A high proportion of students (73.9%) could identify the initiation reaction, but many thought that the propagation step from the decomposition of ozone was an initiation reaction.

Mark Ranges and Award of Grades

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