Examiners' Report
Principal Examiner Feedback

November 2021

Pearson Edexcel Advanced GCE
In Chemistry (9CH0)
Paper 01: Advanced Inorganic and Physical Chemistry

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Introduction

Whilst many students were well prepared for this examination and demonstrated a good knowledge of the topics in the specification, it was also clear that a sizeable number of candidates were lacking knowledge and understanding in a number of key topic areas. The level of demand of the 9CH0_01 paper seemed comparable to those of previous years.

Question 1

The first two multiple choice questions served as a ‘gentle’ introduction to the paper and were relatively straightfroward. The relative atomic mass calculation was correctly carried out by the majority of candidates. However, some candidates who, despite correctly writing the sum the be determined, evidently input the wrong values in their calculators thus obtaining an incorrect answer. Double-checking the sum would have proved beneficial in such circumstances.

Question 2

The three multiple choice questions on flame tests required some recall of the technique and colours observed.

Question 3

The description of metallic bonding in part (a) proved to be an opportunity for most candidates to score at least one mark with about half of all resposnes referring to the electrostatic attraction between the metal cations and the delocalised ‘sea’ of electrons. One mistake seen was the reference to the attraction between the positively-charged nuclei and the electrons which reflected a misunderstanding of the situation. Another mistake was the omission of the “electrostatic atttraction” between the cations and electrons which could have been more of a lack of understanding of the question demand rather than the situation. A significant number of candidates gave a drawing of metallic bonding which was acceptable. A point worthy of note is that there should be an approximately equal number of electrons to that of the positive charges on the metal ions. Occasionally an excessive number of either electrons or cations was seen.

It was evident that the three stages of the heterogenous catalyst required in (b) had been taught effectively as they were generally well-described. It was pleasing to see very few references to ‘absorption’. The most noteworthy error was reference to incorrect gases being formed by the catalytic converter. Nitrogen dioxide was frequently seen and often stated to be a harmless gas which is incorrect.

Question 4

The task in (a) required the giving of a reason for the incorrect word in the first ionisation energy definition. Hence it was insufficient to simply state that the word should be ‘required rather than released’ without giving a reason. A small number of candidates wrote a correct definition, but this alone does not answer the question and so did not score both marks.

Many correct second ionisation energy equations were seen but there continue to be a large number of candidates who ionise the oxygen molecule instead of the oxygen atom. The stronger candidates included the fact that the increasing nuclear charge is outweighed by the larger atomic raidus and greater shielding when answering part (c). Hence this proved an effective discriminator at the ‘top end’ of ability.

The task on successive ionisation energies in (d) also proved a useful discriminator of candidates. The majority appreciated the value of logarithms to provide a scale which is easier to plot and likewise most understood why each successive ionisation increases. Graph drawing continues to be a challenge for many and it is worth reminding candidates that the plotted point must cover over half the graph paper on both axes. This meant that those who started on the y axis from zero lost at least one mark. The less able candidates were confused by part (d)(v) and circled a wide variety of points but the more able normally understood the task and answered correctly.

It was disappointing to see very few correct answers to part (e). It seemed apparent that most candidates had forgotten that there is a small decrease in the first ionisation energy from nitrogen and oxygen due to the pairing of two electrons in the 2p orbital.

Question 5

In part (a)(i) many candidates were able to deduce the number of bonds in phosphorus from the diagram but there were still examples of candidates doing the sum ‘bonds broken – bonds made’ the wrong way round. A sizeable number of candidates also got part (ii) incorrect by stating that bond enthalpies are exothermic.

The familiar use of oxidation numbers to demonstrate disproportionation in part (b)(i) was answered correctly by most candidates. A small minority continue to fail to link the terms “oxidation and reduction” with these changes and consequently lost a mark. It was pleasing to see many correct answers to the task of balancing the equation in (ii). This was not an easy example, but the majority scored the mark.

It was surprising to see a significant number of candidates select a distractor in (c) which stated that chlorine was “orange”.

Part (d) was an effective discriminator at the ‘top end’. It proved worthwhile to award two marks for the ionic equation with state symbols in (i) because it gave the opportunity for some candidates to get one mark for a ‘near miss’. The question in (ii) serves as a good example of the need for candidates to take greater care in their answers. It was not uncommon to see a candidate deduce correctly the identity of the ion but then to refer to it as “Bromine” instead of ‘Bromide’. Reference to the halogen did not score the first mark.

Question 6

The reasoning required for the positive entropy change of the system in (a)(i) was that often sought and candidates who had practice this type of question did well. Occasionally a candidate would negate their correct comment on the increase in the number of moles of product by stating incorrect molar ratios such as 11 to 13 instead of 3 to 13. An error like this resulted in the mark being lost so candidates need to take care if they given molar ratios.

There were many unusual answers given to part (a)(ii). For example, the formation of steam causing the wooden block to rise was seem more than once, and the cohesive nature of hydrogen bonding was also given as a reason for the wooden block being attached to the flask. It may have been that candidates have not seen many demonstrations due to the impact of COVID but candidates are expected to have some practical awareness. The endothermic reaction between hydrated barium hydroxide and ammonium thiocyanate is explicitly stated in the specification at 13B 14iii and so candidates should have realised that heat energy would have been withdrawn from the surroundings causing the water to freeze.

Question 7

The reasoning required in part (a) is challenging and this question was targetting the more able and this proved to be the case. The only MS alternative seen was the reference to the difference in the bond polarity between the carbon-hydrogen bond and the oxygen-hydrogen bond.

Misunderstandings of the term ‘acid-conjugate base pair’ was evident in a significant number of candidates chosing distractor D (H2O – NH4+). Dilution tasks such as part (c) can prove challenging for candidates but many correctly carried out the calculation and it was pleasing that there was little evidence of candidates being perturbed by the resultant negative pH.

The calculation of the pH of the weak acid in (d) was generally done well and the majority of candidates knew the necessary assumptions. A common error was to give two statements of the same assumption by referring to the hydrogen ions and the acid salt concentrations were the same and to add that the ionisation of water was negligible. This is the reasoning behind the concentrations being equal and so such answers only scored 1 mark.

The pH calculation of the buffer in part (e)(i) was often incorrect because of a failure to read the question correctly. The introduction stated that the buffer was made from simply mixing the acid and its conjugate base or salt. This is not the situation where the buffer is made by the partial neutralisation of the weak acid and which therefore requires a substraction to determine the concentration of the weak acid.

The explanation of the action of a buffer in (e)(ii) was poorly answered. The question stated an equation or equations were required and the most common one seen was for the partial ionisation of the weak acid. This equation is useful in the general explantion of buffer action but more is needed to illustrate the effect of addition of a base. The equations which did include sodium hydroxide or hydroxide ions did not always make chemical 'sense' as they were often unbalanced for atoms, for charge or for both. Some candidates gave the equation for the reaction between hydrogen ions and the hydroxide ions from the base which was allowed with some explanation. However, it is worth emphasising that the weak acid is in a much higher concentration that the hydrogen ions, so it is a much better answer to refer to the weak acid reacting with the base.

Question 8

In part (a) there was a question on the origin of complex ion colour which proved to be an effective discriminator as it has in the past. Candidates still need to take care with the terms used, for example when referring to the splitting of the d subshell and not a single d orbital or the reflection and not emission of light from the complex. Occasional confusion with the electronic transitions of flame tests was also seen.

The command or instruction for part (c) was "Compare and contrast" and so this should have elicited some similiarities and some differences. However responses which scored 3 or 4 marks tended to be rare. Consolidation of this area of complex ions is needed.

The correct formula of the complex in part (d) was not often seen and hence the justification even less so. Candidates appreciated that there was a 1:2 molar ratio but failed to appreciate that the two moles of chloride ions able to react with the silver nitrate are not those in the complex.

Question 9

In part (a) there were some good explanations of the effect of polarisation by the small, highly charged magnesium cation. The mark most frequently missing was the refence to the iodide ion being large and therefore easily polarised. It was good to see the majority of candidates referring to the ions rather than the elements as has been an issue previously.

The completion of the Born-Haber cycle produced the full spread of marks and so proved to be an effective discriminator. Thos who took extra care with the respective species tended to do very well.

There were a few blank responses to the Hess' law application in part (c) but generally one if not both marks were scored.

Question 10

There were some good answers seen that gave a clear and accurate account of the thermodynamic feasibility of reactions. However, there were also some answers which were very poor giving very low scores. Common errors were those who compared the entropy change of the system to Gibbs Free Energy change instead of the enthalpy change or those who wrote about exothermic and endothermic reactions stating that their enthalpy change signs were the determining factor in feasibility.

It was a challenge for students to be clear when referring to the effect of a change in the sign of the entropy change of the system in the expression TΔSsystem because the sum has a minus sign in front of this expression. Hence some candidates made good use of tables in their answers.

The marks most frequently scored were the reference to the need for Gibbs Free Energy change to be negative for feasibility and that feasibility was affected by a high activation energy.

Summary

In order to improve their performance, students should:

- read the question twice and make sure that they are answering the question that has been asked
- note the mark allocation for each question and ensure that the answer addresses this number of points
- check graphs have labelled axes, correctly plotted points and cover over half the graph paper along both axes

- show all working for calculations and give final answers to an appropriate number of significant figures, including stating any units if required
- consider if the final answer 'looks right' or sensible for the topic area concerned
- ensure that the answer given matches the command word or phrase of the question
- keep some time back towards the end of the examination in order to reread the questions and answers which is a very effective way of avoiding or removing careless mistakes.

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https://qualifications.pearson.com/en/support/support-topics/results-certification/grade-boundaries.html

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