

OXFORD

INTERNATIONAL  
AQA EXAMINATIONS

# INTERNATIONAL A LEVEL CHEMISTRY

(9620) Unit 3: Inorganic 2 and Physical 2  
Report on the examination

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January 2020

## REPORT ON EXAMINATION: INTERNATIONAL A LEVEL CHEMISTRY 9620 CHO3 JANUARY 2020

As was the case in previous series, students were able to access all the marks on the paper. Answers that required sentences to be written often lacked clarity and full credit could not be awarded. Whilst the students were more able to answer numerical questions, they are advised to set out their working clearly and include appropriate units. Students also need to be familiar with all the practical procedures contained in the specification. Many students found writing chemical equations difficult and often did not include state symbols, where required, or gave unbalanced equations.

### QUESTION 01

This question was about thermodynamics

- 01.1 The vast majority of students were able to answer this question accurately with very few errors. Any errors present in answers were often due to transcription or arithmetic errors.
- 01.2 A very good number of students were able to answer this question accurately, although students did not always recognise the need to use the stoichiometric coefficients for hydrogen when calculating the total entropy of the products.
- 01.3 Although a good number of students answered this question accurately a large number did not convert the value of  $\Delta S$  to  $\text{kJ K}^{-1} \text{mol}^{-1}$  before using it in their calculation for  $\Delta G$ . Equally a small number of students did not convert the temperature to K.
- 01.4 Likewise, students did not always convert units in this calculation and many missed the final step and did not record the final temperature in  $^{\circ}\text{C}$
- 01.5 This question was well completed and many students answered this correctly.

### QUESTION 02

This question was about compounds of silicon

- 02.1 Although students generally answered this question well, there were common occurrences of incorrect formulae such as  $\text{SiCl}_2$  rather than  $\text{SiCl}_4$  and a good number of equations were not correctly balanced.
- 02.2 This question posed more of a challenge to students. There were a number of misconceptions evident in answers. These included discussions of intermolecular forces between atoms in  $\text{SiCl}_4$  and/or  $\text{SiO}_2$  as well as covalent bonds between molecules. A significant number of students stated that  $\text{SiO}_2$  was molecular and then based their answer on differing molecular size rather than a different structure type. Finally some students thought that bonds are broken in molecules when a compound melts.

### QUESTION 03

This question was about silver bromide and included a Born-Haber cycle

- 03.1 The Born-Haber cycle was generally well completed, although a number of students did not include state symbols, or included incorrect state symbols. Additionally a number of students included additional electrons – particularly on their answer line on the right hand side of the cycle following the electron affinity step.

- 03.2 Although many students gave correct answers for the calculation of the electron affinity, a significant number did not appreciate that this was an exothermic change and so gave a positive final value. There was also evidence on students halving the value for the enthalpy of atomisation of bromine, and not appreciating that this is the enthalpy change to form one mole of gaseous atoms.
- 03.3 Although most students understood the presence of covalent character, few appreciated that the additional covalent character strengthened attractions in the lattice. Unfortunately many students just compared the strength of an ionic bond and a covalent bond.

## QUESTION 04

This question was about hydrated ammonium iron(II) sulfate

- 04.1 Students needed to give a change in colour for this question and many only gave one colour. A number of students who did give a colour change often gave the change the wrong way around. Students need to consider the species present in the conical flask when thinking about the correct colours present in solution. The end point of this titration would be when the solution just turns pink – when a tiny excess of  $\text{MnO}_4^-$  ions are present.
- 04.2 This calculation was well completed, although a number of students used incorrect reacting ratios and did not scale up their quantities to  $250 \text{ cm}^3$ .
- 04.3 This was generally gone very well, and students who had not been able to answer question 04.2 successfully were often able to use the given value correctly to determine the value of x.

## QUESTION 05

This question was about oxides and chlorides of Period 3 elements.

- 05.1 Although this was well answered by many students, some answers focussed on observations seen when magnesium burns in air rather than when sodium burns in air. A number of students incorrectly suggested that a precipitate was formed in this reaction.
- 05.2 A good number of students were able to draw the structure of  $\text{Al}_2\text{Cl}_6$  and correctly show the covalent bonds and coordinate bonds. Some students did not draw molecules with the correct formulae and it was not uncommon for students to draw a pair of electrons and a coordinate bond. A few students drew two  $\text{AlCl}_3$  molecules joined by a coordinate bond between two aluminium atoms.
- 05.3 Generally correct equations were given, although it was common for students to write equations that formed phosphorus oxide rather than phosphoric acid.
- 05.4 Equations written by students were often not balanced correctly. The structure of  $\text{H}_3\text{PO}_4$  was not widely known and many students, even those who were able to write a correct equation, did not attempt this.

## QUESTION 06

This question was about complexes containing transition metal ions.

- 06.1 This was well completed and nearly all students know the colour of  $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$ . Fewer students were able to give the correct oxidation state of copper in the  $\text{CuCl}_4^{2-}$  complex instead confusing overall charge with oxidation state.
- 06.2 A significant number of students answered this question in terms of the types of ligands bonded to the central metal ion rather than considering the change in disorder. Many student answers considered changes in the strength in bonding, although the enthalpy change for this substitution is small. There was some confusion over the differences between molecules and ions with a number of students referring to all the reactant and/or product particles as molecules.
- 06.3 Answers to this question were often a little too generic and only explained why complex ions are coloured rather than explaining why a solution containing  $[\text{Cu}(\text{NH}_3)_4(\text{H}_2\text{O})_2]^{2+}$  was blue. Only a few students stated that visible light was absorbed.
- 06.4 This question was not well answered. Students needed to make up multiple solutions in order to plot a calibration curve. Only a few students referred to the colorimeter measuring absorbance of light.
- 06.5 Although most of the students were able to draw the cis isomer of the square planar complex correctly, there were a significant number of students who drew a cis isomer of the octahedral complex.

## QUESTION 07

This question was about Bronsted-Lowry acids and bases

- 07.1 Many students wrote equations that were unbalanced for either atoms or charge or both. A good number of students understood that for the  $\text{HPO}_4^{2-}$  ion to act as an acid it needed to donate a proton or react with  $\text{OH}^-$  ions and for the  $\text{HPO}_4^{2-}$  ion to act as a base it needed to accept a proton or react with  $\text{H}^+$  ions.
- 07.2 This question was often well done by students, although a significant number did not give the answer as a negative value. A few students showed calculations that involved the use of  $K_w$
- 07.3 Although many students gave correct answers a number misread the value of  $K_w$  off the graph and some did not square root the value of  $K_w$  to calculate the concentration of  $\text{H}^+$  ions.
- 07.4 A good number of students were correctly able to calculate the concentration of  $\text{H}^+$  ions in the acid. A few students, however, then went on to calculate the pH of the solution and then quoted this as their final answer.
- 07.5 This calculation was generally well completed, although many students did not consider the stoichiometry of the reaction in their calculation and a good number of students did not use the correct  $M_r$  value when calculating the number of moles of the hydrated sodium carbonate, and they did not include the water in their values.

## QUESTION 08

This question was about solutions containing metal ions.

- 08.1 This was generally well completed, although there were many references to differences in electronegativity rather than consideration of the charge density of the  $\text{Fe}^{2+}$  and  $\text{Fe}^{3+}$  ions.
- 08.2 There were many correct answers to this question, although some students did not include all the water ligands on their hydroxide complexes and others included charges on the complexes that are formed as precipitates and are neutral.
- 08.3 This was well completed by students, although the observation that carbon dioxide is formed is not worthy of credit.
- 08.4 Many students gave incorrect equations on this question that formed  $\text{AlCl}_3$  and  $\text{H}_2\text{O}$  without realising that in this reaction the aluminium-containing product would be the complex ion  $[\text{Al}(\text{H}_2\text{O})_6]^{3+}$ . Aluminium chloride hydrolyses readily in water to form the hexa-aqua complex so this would not be formed in this reaction.
- 08.5 The term amphoteric was not well known by students and many stated that this behaviour was one of neutralisation.
- 08.6 This was well completed by students, with many providing the correct answer.

## QUESTION 09

This question was about the variation of the value of the rate constant,  $k$ , with temperature.

- 09.1 This was well completed by students, with many providing the correct answer for both the value of temperature and the value of the rate constant.
- 09.2 Although a good number of students plotted the graph correctly, a significant number incorrectly plotted the point where  $\ln k = +0.6$  at  $\ln k = -0.6$ . A few students draw graphs where the y-axis was the wrong way around. Additionally, many students did not label their y-axis.
- 09.3 Many students did not appreciate that the gradient of their line of best fit was equal to  $-E_a/R$ , and some students did not quote the activation energy as being a positive value.
- 09.4 Some students correctly used their graph to determine the value of the rate constant at 675 K, but many tried to use the Arrhenius equation to do this. A few students correctly determined the value of  $1/T$  and then misread their graph and so did not use the correct value of  $\ln k$  to determine their final answer.

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