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Principal Examiner Feedback

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GCE

GCE Chemistry (6241) Paper 01

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General

This paper offered all candidates the opportunity to show their knowledge, understanding and application of basic concepts of chemistry. It was encouraging to see many candidates scoring high marks on this paper showing that they had prepared well for the examination. However, there were some candidates who were self penalising due to poor explanations, inadequate reading of questions and failure to check their answers. Many candidates interchanged the words atom, ion and molecule showing little understanding of these basic particles and they should have read through their answers to check that they had used the correct particle and not contradicted themselves within the same answer.

Some candidates were also confused about intermolecular forces and started an answer correctly mentioning Van der Waals' forces then discussed the strength of covalent bonds that need to be broken when a simple molecular substance boils. There was also confusion between polarity and polarisation, as well as misunderstanding of charge density and effective nuclear charge. Candidates should use the information they are given, for example, they should use the formulae given in the question in any equation they are asked to write.

Question 1

The majority of candidates knew the colours and physical states of bromine and iodine at room temperature and pressure, with just a few giving shades of purple or blue/black for iodine. A significant number of candidates were unable to give correct answers to (b). Many thought that the covalent bonds in the hydrogen halides had to be broken for these substances to boil and a significant number wrote about hydrogen bonding. Some candidates wrote about Van der Waals' forces but then got confused and wrote about breaking bonds instead of overcoming forces. Some candidates thought there were more forces rather than stronger forces between hydrogen iodide molecules. Some also commented incorrectly on the number of electrons in the bromide and iodide ions.

The ionic equation for the reaction between hydrogen bromide and water was correct for only a minority of candidates, with many not even giving the correct formulae for the reactants which had been clearly named in the question. Candidates were expected to apply their knowledge of the reaction between hydrogen chloride and water and deduce that a strong acid would be produced. Some candidates did not suggest a pH for the solution formed and just wrote acidic.

Question 2

Many candidates had a clear understanding of the processes occurring in a mass spectrometer and scored full marks for (a). Some candidates had memorised the processes, starting with vaporisation, and they did not read the question carefully enough to realise that the sample was already gaseous so they should have started with ionisation. A minority tried to explain the processes, often showing incorrect understanding. The calculation in (b) was different to questions usually asked about relative atomic mass. Candidates who had prior knowledge of the isotopic abundances used the values to show that the relative atomic mass was 10.8 and others used algebra to derive the percentages. A few candidates were unable to get very far as they assumed there was the same percentage of each isotope, calculated 51.4% and did not realise this could not be correct. Some candidates who knew the percentages would be different could not complete the calculation as they did not realise that the sum of the percentages must be 100.

Question 3

The answers to (a) proved to be good discriminators between those candidates who have a clear understanding of the factors affecting the size of atoms – nuclear charge and the amount of shielding between the **outer** electron and the nucleus, and those who just write down standard phrases such as 'more shielding' without knowing what it means. In (a) (i) many candidates scored a mark for knowing that chlorine has a higher nuclear charge than sodium but only the better candidates could explain that the outer electrons in the atoms experience the same amount of shielding. In (a) (ii) some candidates just referred to the extra shell of electrons in potassium, although some incorrectly described sodium with two shells and potassium with three. The better candidates realised that although potassium has a greater nuclear charge, this is off-set by the extra shell of electrons providing extra shielding of the outer electron from the nucleus. A few excellent descriptions of effective nuclear charge being approximately the same were seen, but these were rare. The majority of candidates could write the electronic configuration of aluminium but some looked up the relative atomic mass and tried to include 27 electrons. Candidates should look at the position of the elements in the Periodic Table and check that the electronic configuration is consistent with this. The majority of candidates could give the formula of an Al^{3+} ion, with just a few giving an aluminate ion. Not all candidates realised that the outer shell of electrons is lost when the ion is formed so it is much smaller than the atom.

The definition of first ionisation energy is well-known by the majority of candidates but a few show little understanding of it and write careless statements such as ' the energy needed to remove one electron from 1 mole of gaseous atoms' or 'the energy needed to remove 1 mole of electrons from one gaseous atom'. Some candidates had a clear understanding of successive ionisation energies and deduced that there would be a large increase between the third and fourth values. A few candidates confused group 3 with period 3 and compared the first ionisation energy of aluminium to those of sodium and magnesium.

Question 4

The majority of candidates could draw the 'dot and cross' diagram of boron trifluoride, although some added a lone pair of electrons to the boron atom, some omitted the three lone pairs on the fluorine atoms, some showed ionic bonding and some thought the symbol for boron is Br. Many candidates knew that fluorine was more electronegative than boron, although some just stated that it is very electronegative and did not make the comparison with boron. A large number of candidates realised that the molecule was symmetrical and that the dipoles would cancel but a significant number of candidates lost marks through poor explanations in (a) (iii). For example, some candidates referred to the symmetry of a dipole and others stated that the bonds or the charges would cancel. Although a lot of candidates did work out that there would be covalent and dative covalent bonding in the ion in (b) (i), a significant number also included ionic and negated their marks. Some candidates also mentioned various intermolecular forces which would not be present **in** the ion.

Part (b) (ii) was answered well by many candidates, although some were only awarded the mark for 'tetrahedral' as they did not explain the shape in terms of the repulsion between electron pairs. Some candidates found it difficult to correctly describe the situation where there is maximum separation and minimum repulsion so stated there is maximum repulsion between bond pairs and others think the hydrogen atoms are repelling. A significant minority of candidates included an incorrect bond angle for the tetrahedral shape, usually of 120^o. Some candidates were confused by the dative covalent bond so assumed it was a lone pair and they discussed lone pair-bond pair repulsion.

Question 5

It was very pleasing to see many candidates achieving full marks for this question. There were some excellent answers with the working clearly set out and explained. In (a) some candidates did not read the question carefully so they suggested propane, scandium or various other substances instead of an oxide of carbon. Some candidates just gave carbon dioxide as a final answer, with no working, so they could not score any marks. A few candidates ignored the 1:2 mole ratio of magnesium to hydrochloric acid in (b) (i) and others did not know how to use moles and concentration to calculate a volume. Some candidates gave an incorrect unit with their calculated volume. The majority of candidates scored both marks for (b) (ii), although a few used 35 as the molar mass for chlorine and calculated the molar mass of magnesium chloride as 94 g mol^{-1} and a few used atomic numbers instead of molar masses.

Question 6

A large number of candidates knew the colour of sodium in a flame test and gave clear explanations of the origin of the colour. A minority of candidates referred to atoms or ions gaining energy and being promoted, some referred to the production of colour instead of light or radiation and an even smaller number gave an explanation in terms of absorption. The structure of sodium chloride was well-known by many candidates, with the most common errors being referring to atoms or molecules and stating there were 4 sodium ions around each chloride ion and vice versa. A significant minority of candidates also referred to the strengths of the bonds between the atoms in the molecule of sodium chloride in (b) (ii) or discussed delocalised electrons in metallic bonding. It was disappointing to see how few candidates could write the equation for the thermal decomposition of lithium carbonate as they were given the formula, which many of them ignored. Only a minority of candidates could explain why lithium carbonate decomposes more easily than sodium carbonate. There were vague references to lithium being smaller than sodium, with no mention of ions and lithium being better at polarising than sodium, with no mention of what it is polarising. There were many confused answers in terms of the anion polarising the cation and many answers that re-stated the question as ‘thermal stability increases down the group’.

Question 7

The majority of candidates could give the oxidation numbers of manganese in the ions in (a). Although a large number of candidates could work out the overall equation in (b), there were many errors seen such as: not multiplying the equations in a ratio of 2:5 so that the electrons would cancel, canceling H_2O_2 with H_2O and omitting O_2 in the final equation. Some of these errors could have been avoided if the candidates had re-written the two half-equations, having multiplied them by 2 and 5, then shown the overall equation. They should also check their final equation is balanced in terms of atoms and charges. Some candidates were unable to work out the oxidation number of oxygen in hydrogen peroxide and some of those that tried left it as -2 for both atoms so they were unable to deduce that this was a disproportionation reaction. Candidates also needed to explain reduction and oxidation in terms of the changes in oxidation numbers and some omitted this or did not clearly relate these to the reaction. It was disappointing to see that many candidates thought that hydrogen was being oxidised or reduced.

Hints for revision

- Make sure you know and understand the difference between atom, ion and molecule.
- Make sure you know and understand the difference between ionic and covalent bonding and intermolecular forces.
- Read the questions carefully and use the information you are given, including any formulae.
- Make sure you understand why the thermal stability of carbonates increases down the groups 1 and 2, in terms of sizes and charges on the **cations**.
- Practice writing overall equations from half-equations.
- Learn how to spell disproportionation and practice working out oxidation numbers.