NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

Level 2, 2003

Chemistry: Describe the nature of structure and bonding in different substances (90308)

National Statistics

Assessment Report

Assessment Schedule

Chemistry: Describe the nature of structure and bonding in different substances (90308)

National Statistics

Number of Results	Percentage achieved			
	Not Achieved	Achieved	Merit	Excellence
8,734	27.6%	45.9%	16.3%	10.2%

Assessment Report

General Comments

Every candidate for a National Certificate of Educational Achievement examination paper is expected to:

- read the question and do what the question asks
- allow adequate time to complete answers
- be accurate: check and/or proofread
- use appropriate technical terms
- bring the correct equipment
- write and/or draw clearly
- use pen if work is to be eligible for reconsideration.

Candidates were able to achieve reasonably well in answering questions requiring one-word answers or short phrases. However, they generally struggled with writing more detailed responses that were coherent and logical. This often limited their level of achievement as they were unable to clearly *link or explain selected properties in terms of structure and bonding.* For example, question 4 required candidates to 'Discuss the structure and bonding within diamond and graphite, and to relate this to the uses shown…'. Many candidates wrote a whole page about the uses of diamond and graphite while at the same time making little or no mention of the *structure and bonding* present or linking these to the uses given in the table.

Some candidates effectively made use of diagrams, particularly in their attempt to demonstrate understanding of concepts such as charge distribution in polar and non-polar molecules, or to explain why SO_2 is soluble in water. This practice is to be encouraged. When drawing Lewis diagrams, candidates should always start by ascertaining the total number of valence electrons that need to be shown in their final diagram.

While candidates often attempted to use the correct and appropriate language of chemistry, their answers showed some imperfections. The term 'electronegativity', for example, was incorrectly used in a variety of contexts particularly with regard to the polarity of molecules (rather than the polarity of a bond) as well as molecular shape. A number of candidates attempted to explain the larger bond angle of SO_2 by stating that the higher electronegativity of O causes more repulsion between the O atoms. Alternatively the explanation was that the larger size of the O atom (compared to the H atom) causes more repulsion, or the non-bonding pairs on O atoms (in SO_2) cause greater repulsion compared to the H atoms in H_2S.

This standard states that the '*description of nature of solids is limited to the type of constituent particles (ions, atoms or molecules) and attractive forces between them (ionic, covalent or metallic bonds or weak intermolecular forces)*'. Many candidates appeared to have little or no idea as to what answer was required in the column headed 'attractive force broken when solid melts' (question 2).

The main errors from those who did respond were to state that a covalent network solid is made up of molecules bonded together, and that ionic solids have low melting points.

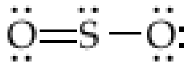
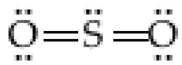
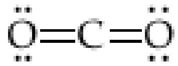
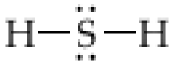
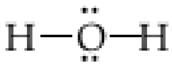
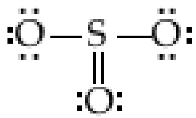
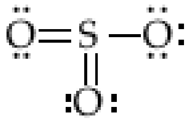
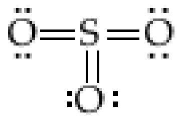
In answering Question 3, many candidates showed they were unable to *interpret trends in the third row halides* with regard to *types of bonding.* Few understood that $MgCl_2$ is a lattice of positive and negative ions rather than molecules of $MgCl_2$. There is a common misconception that 'the solid is made up of molecules having a positive Mg^{2+} connected to two Cl^- ions' or that 'both $MgCl_2$ and SCl_2 are ionic, with ionic bonding between the positive metal ions (both Mg and S), and the negative Cl_2'.

Candidates need to be able to differentiate between the *types of constituent particles* in halogens such as iodine, and in metal halides such as potassium chloride. There is a significant difference between the nature of the iodine molecule, I_2, iodine atoms, I, and the iodide ion, I^-. Sloppy use of language often limited the level of achievement, eg it is incorrect to state that 'iodine does not conduct electricity because particles are not free to move'. After all, the particles (molecules) move in liquid bromine but it is not a conductor of electricity. *Explanation of conductivity in terms of movement of charged particles (electrons or ions*) is expected.

Assessment Schedule

Chemistry: Describe the nature of structure and bonding in different substances (90308)

Evidence Statement

Question	Evidence	Evidence contributing to Achievement	Evidence contributing to Merit	Evidence contributing to Excellence
One (a)	 or      or  or 	Three of the Lewis structures correct (covalent bonds can be shown as a pair of electrons)	All structures correct showing all non-bonding valence electrons.	
One (b)	CO_2 : linear H_2S : bent / V-shaped / angular SO_3 : trigonal planar / triangular planar	**Two** shapes correctly identified OR 2 shapes corresponding to Lewis diagrams drawn.	**Three** shapes correctly corresponding to Lewis diagrams drawn.	
One (c)	CO_2 : non-polar H_2S : polar Both molecules have polar bonds (as the atoms have different electronegativity) and the symmetrical arrangement of C – O bonds around central atom means bond polarities cancel OR asymmetric arrangement for H_2S OR positive and negative centres of charge coincide for CO_2	Two molecular polarities correct with a correct supporting statement. Eg CO_2 is symmetrical shape OR has electrons distributed evenly OR polar bonds cancel	Two correct polarities and partial explanation, eg both have polar bonds but only CO_2 is symmetric shape	Two correct polarities and full discussion including mention of **polar bonds** as well as **symmetry of molecules** and **reason for overall polarity**

Question	Evidence			Evidence contributing to Achievement	Evidence contributing to Merit	Evidence contributing to Excellence
One (d)	SO_2 has three regions of electron density (electron clouds) around the central atom (or S) and repulsions between them result in a bond angle of 120°. H_2O has four regions of electron density around the central atom (or O) and repulsions between them result in a bond angle of 109°.			Identifies idea that S (not SO_2) has **less** lone pairs (electron clouds) than O (not H_2O) OR limited discussion of numbers of electron clouds in the molecules OR mention of repulsion between electrons	Answer identifies higher number of regions of negative charge (electron clouds) in H_2O **and** idea of atoms needing to be further apart due to repulsion between electrons	
One (e)	SO_2 is a polar molecule because the O atoms will attract bond pairs in the O – S bonds more closely. The two polar bonds are asymmetrically arranged, (therefore the dipoles will not cancel,) resulting in a polar molecule overall. H_2O is also a polar molecule for the same reasons as given above. Polar molecules will dissolve in a polar solvent, therefore, SO_2 is soluble in water. May discuss attraction between positive end of one molecule and negative end of other in solution.			Identifies both molecules as being polar and therefore are soluble in each other.	Links polarity of both molecules to the solubility of SO_2 in water AND relates polarity of molecule to shape or discusses nature of interaction between positive and negative ends of molecules.	
Two	(a) molecules	(b) van der Waals (or dispersion, london, dipole-dipole attractions, inter-molecular forces, hydrogen bonds)	(c) low	**Three** of (a) correct		
	Atoms atoms/ions (in sea of electrons) ions	covalent metallic ionic	high high high	**Three** of (b) correct OR **Three** of (c) correct	**Three** solids correct for each of (a), (b), and (c)	
Three (a) (i)	Gas Gas Liquid			**Two** correct.		
Three (a) (ii)	Bromine is a liquid as its melting point of $-7^{o}C$ is below $25^{o}C$ but its boiling point of $59^{o}C$ is above $25^{o}C$.			Justification makes reference to both the melting point and boiling point in relation to $25^{o}C$	.	

Question	Evidence	Evidence contributing to Achievement	Evidence contributing to Merit	Evidence contributing to Excellence
Three (b)	(i) Iodine molecules are held together by weak intermolecular forces. (ii) Iodine molecules are non-polar and will therefore be more soluble in a non-polar solvent such as cyclohexane than in water. (iii) Iodine contains no charged particles (electrons or ions) that are free to move to conduct electricity.	Identifies one simple idea relating to the nature of iodine eg it has weak attraction between molecules **OR** iodine and cyclohexane molecules are nonpolar **OR** iodine contains no charged particles that are free to move	Clearly explains two of the observations	Clearly explains all observations with appropriate detail.
Three (c)	(Strong) ionic bonding in $MgCl_2$ between positive and negative ions (Mg^{2+} and Cl^-) (Strong) covalent bonding between S and Cl atoms but (weak) van der Waals forces between SCl_2 molecules.	Identifies two of the three possible types of bonding - ionic bonding in $MgCl_2$, covalent bonding and van der Waals forces in solid SCl_2 **OR** Describes how $MgCl_2$ has positive and negative ions held together by ionic bonds OR covalent bonding between atoms in SCl_2 OR van der Waals forces between molecules of SCl_2	Correctly discusses ionic bonding in $MgCl_2$, and either covalent bonding between atoms or van der Waals forces between molecules in SCl_2	Full discussion of nature of bonding in both substances.
Four	Diamond is used to make saws as it is very *hard,* due to each of the carbon atoms being joined by strong covalent bonds to 4 other carbon atoms in a tetrahedral arrangement (3D lattice). Graphite is used as a lubricant as *layers* of graphite are *able to slide over each other*. This is because within each 2D layer each carbon atom is covalently bonded to 3 other C atoms but the layers are held together by weak (van der Waals) forces, which are easily broken. Graphite is used to make electrodes as it is a solid that is *able to conduct electricity.* This is because of the delocalised electrons between the layers that can move and conduct electricity.	Identifies *appropriate property* for two out of three stated uses. **OR** Briefly describes the structure and bonding of either diamond or graphite.	Links properties for two uses to the structure and bonding within the solid but explanations may be incomplete.	Clearly explains relevant properties for three uses, in terms of the structure and bonding within the solid.

Judgement Statement

Judgement statements (formerly referred to as sufficiency statements) help students understand how their overall results for each standard were arrived at.

Achievement: SEVEN of the opportunities at Achievement or higher.

Merit: FIVE of the Merit opportunities plus TWO other grades of Achievement or higher.

Excellent: TWO of the Excellence opportunities plus FOUR other grades at Merit or higher.