DAPTO HIGH SCHOOL
2009 PRELIMINARY EXAMINATION – CHEMISTRY
MARKING GUIDELINES

Section I

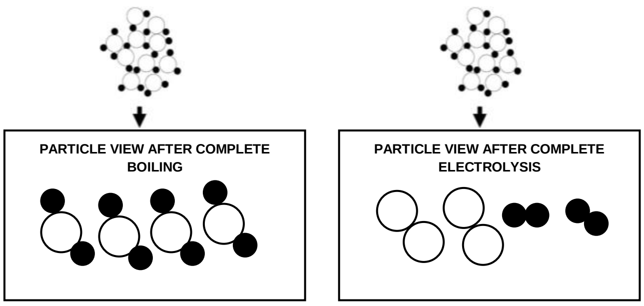
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
D	B	A	A	C	B	D	C	A	C	B	D	A	A	D

Section II

Question 16

Criteria	**Marks**
• Explains the difference between a physical and chemical change using boiling vs electrolysis of water, by describing changes in particle arrangements AND • Draws two correct particle diagrams to support the explanation.	**4**
• Response contains a correct and thorough written explanation and one aspect of the model(s) is/are correct. OR • Response contains correct models and one aspect of the written explanation is correct.	**3**
Written explanation OR diagram(s) contain some correct information.	**2**
Explanation OR diagram(s) contain one correct aspect.	**1**

Answers may include: A chemical change involves the breaking and making of chemical bonds. The atoms in particles are rearranged so that new substance(s) are created. On the other hand, a physical change simply changes the amount of space between, and energy of, particles. It is a change of state. Electrolysis of water is a chemical change, because water is converted into hydrogen and oxygen:
$2H_2O(l) \rightarrow 2H_2(g) + O_2(g)$, whereas boiling of water simply changes H_2O molecules from liquid to gas. There is no new product created; atoms are not rearranged.



Note:

- *for each, the number of O & H atoms is the same before and after*
- *phys change has change in space b/w particles*
- *both show the str. of H_2O, O_2 and H_2*

Question 17

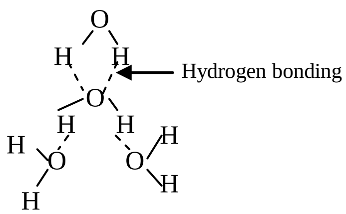
Criteria	**Marks**
Calculates the mass of aluminium oxide produced.	**2**
Calculates the number of moles of aluminium oxide produced.	**1**

Answers may include:
m(aluminium hydroxide) = 3.21 g
n(aluminium hydroxide) = m/MM = 3.21/78 = 0.04115
n(aluminium oxide) = 0.5 x 0.04115 = 0.02058
m(aluminium oxide) = n x MM = 0.02058 x 102 = 2.10 g.

Question 18

Criteria	Marks
Accounts for two identified physical properties of water in terms of the structure & bonding in water, including an appropriate diagram.	**4**
• Accounts for two identified physical properties of water, with a diagram, although explanations may be contain a minor error or omission OR • Accounts for two identified physical properties of water, without an appropriate diagram	**3**
Relates one physical property of water to its structure &/or bonding.	**2**
Identities one physical property of water.	**1**

Answers may include:



Water has a relatively high melting and boiling point compared to other molecular substances with comparable molecular masses. This can be explained by the fact that water molecules are polar and strong hydrogen bonds exist between molecules, as shown :

The stronger forces require more energy to overcome, and this accounts for the higher melting and boiling point.

Another property of water is that the solid form has a lower density than the liquid form. This is due to the open-cage structure formed when water freezes-hydrogen bonds join water molecules in a way which reduces the packing efficiency of water, leading to a lower density.

Question 19(a)

Criteria	Marks
Identifies the formula of the alkane with 11 carbon atoms as $C_{11}H_{24}$	**1**

Question 19(b)

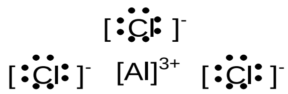
Criteria	Marks
Produces a correctly formatted, accurate graph of the results with a smooth curve of best fit and uses graph to provide an accurate estimate of the density of dodecane.	**4**
Produces a correctly formatted graph and provides an estimate the density of dodecane (from whatever graph is present); although graph contains one major error or omission	**3**
Produces a satisfactory graph of the data, although graph contains 2 or more errors or omissions and an accurate estimate of the density of dodecane cannot be provided.	**2**
Plots some data on any type of graph.	**1**

Answers may include: Density of $C_{12}H_{26}$ (g/mL) is approximately 0.75g/mL

Question 20(a)

Criteria	Marks
Draws an appropriate electron dot diagram of $AlCl_3$	**2**
Draws correct electron dot diagrams of Al^{3+} and Cl^-	**1**

Answers may include:



Question 20(b)

Criteria	Marks
Accounts for the different molecular shapes in the two molecules in terms of aspects of the VSEPR theory (does not have to identify actual name of theory) and includes at least 1 relevant diagram in answer.	**3**
Provides a satisfactory explanation of the different molecular shape; although response may include an error or omission OR Draws diagrams and identifies the molecular shape or both molecules with an insufficient explanation.	**2**
Identifies one aspect of the electron arrangement or molecular shape or either molecule (including drawing an electron dot diagram of either molecule)	**1**

Answers may include: The electron-dot diagrams for these molecules can be used to explain the different molecular shapes. BCl_3 has 3 pairs of bonding electrons around the central B atom. These repel each other and lead to a triangular shaped molecule with 120^o between each electron density.

NH_3 has 3 bonding pairs but also 1 non-bonding pair-the non-bonding pair alters the shape and forces the other pairs closer together. The resulting shape is pyramidal.

Question 21

Criteria	Marks
Outlines the work of Dobereiner, Newlands and Mendeleev.	**4**
Outlines the work of Mendeleev, and Dobereiner OR Newlands.	**3**
Outlines the work of Mendeleev, OR Dobereiner and Newlands.	**2**
Outlines the work of one of the scientists.	**1**

Answers may include: Dobereiner had identified groups of three elements with similar chemical properties, which he called "triads", for example chlorine, bromine and iodine. Then in 1860 international agreement was achieved in the adoption of a method to determine atomic weights. Following this, chemists began organising the known elements in terms of increasing atomic weight. Newlands organised the elements in this way, placing them into sets of seven elements. He placed the eighth element under the first, and so on, and noticed that there were some periodic trends within the groups thus formed. He called this the "Law of Octaves". While his efforts were very important, his scheme left no place for elements being discovered at that time, and some elements were clearly misplaced on the basis of their chemical and physical properties. Also, there were places in his table, in which two elements occupied the same place.

Mendeleev, in 1869, produced his Periodic Table, with elements organised based on increasing atomic weight. However, he placed elements according to their properties as well. This meant that he left some gaps in the table for elements unknown at that time, but which he assumed would be discovered. On this basis he also found that the some atomic weights had been incorrectly calculated, leading to more accurate experiments being done and the errors being corrected. Mendeleev was also able to make very accurate predications about the then undiscovered elements based on the properties of neighbouring elements in his table. Mendeleev's arrangement of the elements also allowed for the incorporation of the noble gases, discovered later, as a new column. Mendeleev's arrangement on the basis of atomic weight still produced some discrepancies on the basis of properties, and in the early 20th century Moseley corrected these discrepancies by ordering the elements on the basis of atomic number instead (which Mendeleev could not have done since the existence of protons was not known in his time). Our modern Periodic Table is based very largely on the work of Mendeleev.

Question 22(a)

Criteria	Marks
Identifies the glassware as a volumetric flask.	**1**

Question 22(b)

Criteria	Marks
Calculates the mass of solid required to weigh out and describes the correct method for making the solution from the calculated mass.	**3**
Calculates the mass of solid required to weigh out and outlines the method used to produce the solution (method may have error or omission) OR Describes the correct method for making a solution using the flask shown but with an error in the calculation.	**2**
Calculates the moles of solid required to weigh out. OR Outlines a basic procedure to produce the solution using the flask shown.	**1**

Answers may include:
n $(Cu(NO_3)_2)$ = c x V = 0.015 x 0.250 = 0.00375
m = n x MM = 0.00375 x 187.56 = 0.70g
Thus the student should:

1. Weigh out 0.70g of solid copper (II) nitrate on an electronic balance.
2. Dissolve the solid in some distilled water in a 50 mL beaker.
3. Volumetrically transfer all of the solution to the flask.
4. Fill with water to the calibration line.
5. Invert and swirl flask.

Question 26

Criteria	Marks
• Describes the structure and bonding of ionic and molecular substances AND • Relates this to the property of electrical conductivity for each type of substance AND • Identifies that YO and ZO could also be covalent networks AND • Identifies that MP or BP is also needed to distinguish between covalent networks and molecules AND • Gives an overall assessment of the student's work based on this information	**5**
• Describes the structure and bonding of ionic and molecular substances AND • Relates this to the property of electrical conductivity for each type of substance AND • Identifies that YO and ZO could also be covalent networks	**4**

• Describes the structure and bonding of ionic and molecular substances and relates this to their electrical conductivity & • Identifies that YO and ZO could also be covalent networks	**3**
• Response indicates limited knowledge of structure, bonding and properties for ionic and molecular substances	**1-2**

Answers may include: The student's conclusion is only partially correct on the basis of the information given. It is correct to say that XO is an ionic oxide because in ionic compounds the anions and cations are held together by strong electrostatic attraction, and are immobile in the solid state, and hence they do not conduct electricity in this state. However these forces of attraction are partially overcome in the liquid state, and the ions are free to move. Hence the liquid conducts electricity. It is also correct for the student to say that molecular substances do not conduct in the solid or liquid state, and thus YO and ZO *could* be molecular substances. However neither do covalent networks conduct electricity in the solid or liquid states. To accurately determine that YO and ZO are molecular compounds the student would also need to consider their melting points, because molecular substances have very much lower MPs than covalent networks. The student was only partially correct in their conclusion, because their conclusion was based on insufficient data.

Question 27

Criteria	Marks
Explains both trends across a period and down a group and explicitly shows why they are opposite.	**4**
Explains both trends across a period and down a group.	**3**
Explains one trend across a period and down a group.	**2**
Identifies the trends in atomic radius and first ionisation energy, across a period and down a group.	**1**

Answers may include: First ionisation energy decreases down a group and increases across a period. The opposite is true of atomic radius – it increases down a group and decreases across a period. Both of these trends are caused by "effective nuclear charge". Down a group there are an increasing number of full electron shells between the nucleus and the valence shell. This has the effect of both increasing the atomic radius, and decreasing the energy required to remove an electron from the valence shell. Hence the two trends down a group are opposite. Moving across a period there are an increasing number of protons in the nucleus, and electrons are being added to the same valence shell, with the same degree of shielding from the nuclear charge. Thus the valence electrons are held more tightly across a period. This also results in the two trends across a period being opposite – atomic radius decreases and first ionisation energy increases.

Question 28(a)

Criteria	Marks
Outlines a suitable procedure including any reagents required.	**2**
Identifies one correct aspect of a suitable procedure.	**1**

Answers may include: The student should add a few drops of a lead solution (eg lead(II) nitrate) to a few drops of a chloride solution (eg sodium chloride) in a test tube or 'spotting tile'. Any sign of a precipitate indicates lead(II) chloride is either insoluble or sparingly soluble.

Question 28(b)

Criteria	Marks
Identifies one way of reducing the impact on the environment. – Using microtechniques to minimise loss of lead.	**1**

Question 29(a)

Criteria	Marks
Identifies an appropriate metal. Eg copper	**1**

Question 29(b)

Criteria	Marks
Writes a correct, balanced chemical equation.	**1**

Answers may include: $2Al(s) + 3H_2SO_4(aq) \rightarrow Al_2(SO_4)_3(aq) + 3H_2(g)$

Question 29 (c)

Criteria	Marks
Writes one or two correct half equations.	**1-2**

Answers may include: $2H^+ + 2e^- \rightarrow H_2(g)$ $Al(s) \rightarrow Al^{3+} + 3e^-$

Question 29(d)

Criteria	Marks
Correctly calculates the concentration of sodium nitrate in the solution showing working.	**3**
Calculates moles of sodium carbonate and nitric acid AND identifies nitric acid as the limiting reagent.	**2**
Calculates moles of sodium carbonate OR nitric acid.	**1**

Answers may include:
n(Na_2CO_3) = m/MM = 0.88/105.99 = 0.0083 n(HNO_3) = CV = 0.12 x 0.125 = 0.015
Nitric acid is the limiting reagent and will be completely consumed. Thus 0.015 moles of sodium nitrate will be produced.
The concentration of sodium nitrate = n/V = 0.015/0.125 = 0.12 M.