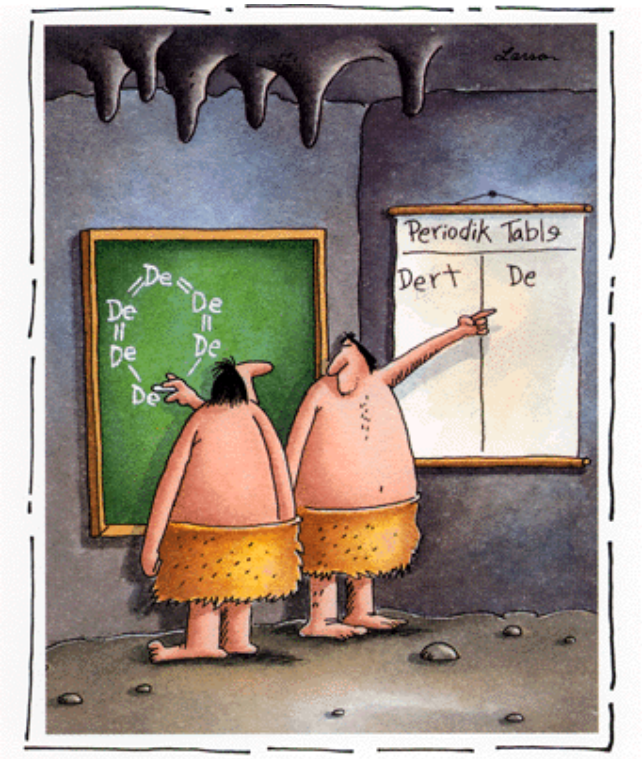
Yr 12 Chemistry

Christmas 2008

Exam Style Questions

The Specification can be found at

http://www.ocr.org.uk/Data/publications/key_documents/GCE_Chemistry_A_Spec.pdf



(a) A Period 3 element, **E**, forms an ion E^{2-} which has the electron arrangement shown below.

$$1s^2 2s^2 2p^6 3s^2 3p^6$$

Give the electron arrangement of an atom of element **E** and identify this element.

*Electron arrangement of an atom of **E*** .....

*Identity of **E*** .....

(2 marks)

(b) There is a trend in the electronegativity of the Period 3 elements Na to Cl

(i) Define the term *electronegativity*.

.....

.....

.....

(ii) State and explain the trend in the electronegativity of the Period 3 elements Na to Cl

Trend .....

Explanation .....

.....

.....

(5 marks)

(c) Some electronegativity values are given below.

	H	F	Cl	Br	I
Electronegativity value	2.1	4.0	3.0	2.8	2.5

(i) Explain why the covalent bond in HF is polar.

.....

.....

(ii) State and explain the trend in polarity of the covalent bonds in the hydrogen halides HF, HCl, HBr and HI

Trend .....

Explanation .....

(d) The boiling points of some hydrogen halides are shown in the table below.

Hydrogen halide	HF	HCl	HBr	HI
Boiling point / K	293	188	206	238

Explain, in terms of the intermolecular forces present, why

(i) the boiling point of HF is much higher than those of the other hydrogen halides.

.....

.....

.....

.....

(ii) the boiling points increase from HCl to HI

.....

.....

.....

.....

(6 marks)

Aqueous bromide ions can be detected by using either aqueous silver nitrate or chlorine.

(a) (i) State what is observed when aqueous silver nitrate is added to an aqueous solution containing bromide ions. Write an ionic equation for the reaction which occurs.

Observation .....

.....

Ionic equation .....

(ii) State what is observed when an excess of concentrated aqueous ammonia is added to the products formed in part (a)(i).

.....

(3 marks)

(b) (i) State what is observed when chlorine is added to an aqueous solution containing bromide ions. Write an ionic equation for the reaction which occurs.

Observation .....

.....

Ionic equation

.....

(ii) Identify one halide ion, other than chloride, which will not react with chlorine and explain why a reaction does not take place.

Halide ion .....

Explanation .....

.....

(4 marks)

(c) Bromine reacts with cold aqueous sodium hydroxide. The reaction is similar to the reaction of chlorine with cold aqueous sodium hydroxide.

Write an equation for the reaction of bromine with cold aqueous sodium hydroxide.

.....

(2 marks)

(a) Deduce the oxidation state of S in SO_3^{2-} and in SO_4^{2-}

Oxidation state of S in SO_3^{2-} .....

Oxidation state of S in SO_4^{2-} .....

(2 marks)

(b) A redox reaction occurs when Cl_2 reacts with SO_3^{2-} ions in aqueous solution.

(i) Write a half-equation for the conversion of Cl_2 into Cl^- ions.

.....

(ii) Write a half-equation for the conversion of aqueous SO_3^{2-} ions into SO_4^{2-} ions.

.....

(iii) Hence, write an overall equation for the reaction between Cl_2 and SO_3^{2-} ions.

.....

(iv) Deduce the role of SO_3^{2-} ions in this overall reaction.

.....

(4 marks)

(a) Ammonium carbamate contains 15.38 % of carbon, 7.69 % of hydrogen, 35.90 % of nitrogen and 41.03 % of oxygen by mass.

Use these data to confirm that the empirical formula of ammonium carbamate is $CH_6N_2O_2$

.....

.....

.....

.....

(2 marks)

(a) State and explain the trend in the atomic radius of the elements Na to Cl in Period 3.

Trend .....

Explanation .....

.....

.....

(3 marks)

(b) The table below gives the values of the first three ionisation energies of magnesium.

	First ionisation energy	Second ionisation energy	Third ionisation energy
Ionisation energy / kJ mol^{-1}	738	1451	7733

(i) Write an equation to illustrate the process occurring when the **first** ionisation energy of magnesium is measured.

.....

(ii) Explain why the third ionisation energy of magnesium is very much larger than the second ionisation energy of magnesium.

.....

.....

.....

(iii) State and explain the trend in the first ionisation energy of the elements Mg to Ba in Group II.

Trend .....

Explanation .....

.....

.....

(6 marks)

(a) Balance the equation below, in which nitric acid is formed by the reaction between dinitrogen tetroxide and water.

$$\ldots\ldots N_2O_4 + \ldots\ldots H_2O \longrightarrow \ldots\ldots HNO_3 + \ldots\ldots NO$$

(1 mark)

(b) A 150 cm^3 sample of 1.65 mol dm^{-3} aqueous nitric acid was completely reacted with copper. The equation for the reaction which occurred is shown below.

$$3Cu + 8HNO_3 \longrightarrow 3Cu(NO_3)_2 + 2NO + 4H_2O$$

(i) Calculate the number of moles of nitric acid in 150 cm^3 of 1.65 mol dm^{-3} aqueous nitric acid.

.....

.....

(ii) Calculate the number of moles, and hence the mass, of copper that would react completely with this amount of nitric acid.

(If you have been unable to obtain an answer to part (b)(i), you should assume that the total number of moles of nitric acid is 0.172. This is not the correct answer.)

Moles of copper .....

.....

.....

Mass of copper .....

.....

(5 marks)

Molecules of NH_3, H_2O and HF contain covalent bonds. The bonds in these molecules are polar.

(a) State what is meant by a *covalent bond* and by a *polar bond*.

Covalent bond .....

.....

Polar bond .....

.....

(2 marks)

(b) (i) Explain why the H–F bond is polar.

.....

.....

.....

(ii) State which one of the molecules NH_3, H_2O or HF contains the least polar bond.

.....

(iii) Explain why the bond in your chosen molecule from part (b)(ii) is less polar than the bonds found in the other two molecules.

.....

.....

(4 marks)

(c) The boiling points of NH_3, H_2O and HF are all high for molecules of their size. This is due to the type of intermolecular force present in each case.

(i) Identify the type of intermolecular force responsible.

.....

(ii) Draw a diagram to show how two molecules of ammonia are attracted to each other by this type of intermolecular force. Include partial charges and all lone pairs of electrons in your diagram.

(4 marks)

When an H^+ ion reacts with an NH_3 molecule, an NH_4^+ ion is formed.

(i) Give the name of the type of bond formed when an H^+ ion reacts with an NH_3 molecule. Describe how this bond is formed in the NH_4^+ ion.

Type of bond .....

Description .....

.....

.....

(ii) Draw the shape, including any lone pairs of electrons, of an NH_3 molecule and of an NH_4^+ ion.

NH_3 *NH_4^+*

(iii) Name the shape produced by the arrangement of the **atoms** in the NH_3 molecule.

.....

(iv) Give the bond angle in the NH_4^+ ion.

.....

(7 marks)

(a) Complete the following table.

	Relative mass	Relative charge
Proton		
Electron		

(2 marks)

(b) An atom has twice as many protons and twice as many neutrons as an atom of ^{19}F
Deduce the symbol, including the mass number, of this atom.

.....

(2 marks)

(c) The Al^{3+} ion and the Na^{+} ion have the same electron arrangement.

(i) Give the electron arrangement of these ions.

.....

(ii) Explain why more energy is needed to remove an electron from the Al^{3+} ion than from the Na^{+} ion.

.....

.....

.....

(3 marks)

(e) The table below shows the relative abundance of each isotope in a sample of platinum.

m/z	194	195	196	198
Relative abundance (%)	32.8	30.6	25.4	11.2

Use the data in the table to calculate the relative atomic mass of this sample of platinum.
Give your answer to **one** decimal place.

.....

.....

.....

.....

(2 marks)

(a) An acid, H_2X, reacts with sodium hydroxide as shown in the equation below.

$$H_2X(aq) + 2NaOH(aq) \longrightarrow 2Na^+(aq) + X^{2-}(aq) + 2H_2O(l)$$

A solution of this acid was prepared by dissolving 1.92 g of H_2X in water and making the volume up to 250 cm^3 in a volumetric flask.

A 25.0 cm^3 sample of this solution required 21.70 cm^3 of 0.150 mol dm^{-3} aqueous NaOH for complete reaction.

(i) Calculate the number of moles of NaOH in 21.70 cm^3 of 0.150 mol dm^{-3} aqueous NaOH

.....

(ii) Calculate the number of moles of H_2X which reacted with this amount of NaOH Hence, deduce the number of moles of H_2X in the 1.92 g sample.

Moles of H_2X in 25.0 cm^3 of solution .....

.....

Moles of H_2X in 1.92 g sample .....

.....

(iii) Calculate the relative molecular mass, M_r, of H_2X

.....

.....

.....

(5 marks)

(b) Analysis of a compound **Y** showed that it contained 49.31 % of carbon, 6.85 % of hydrogen and 43.84 % of oxygen by mass. The M_r of **Y** is 146.0

(i) State what is meant by the term *empirical formula*.

.....

.....

The table below shows the electronegativity values of some elements.

	Fluorine	Chlorine	Bromine	Iodine	Carbon	Hydrogen
Electronegativity	4.0	3.0	2.8	2.5	2.5	2.1

(a) Define the term *electronegativity*.

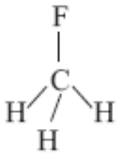
.....

.....

.....

(2 marks)

(b) The table below shows the boiling points of fluorine, fluoromethane (CH_3F) and hydrogen fluoride.

	F—F		H—F
Boiling point/K	85	194	293

(i) Name the strongest type of intermolecular force present in:

Liquid F_2 .....

Liquid CH_3F .....

Liquid HF .....

(ii) Explain how the strongest type of intermolecular force in liquid HF arises.

.....

.....

.....

.....

(6 marks)

(ii) Use the above data to calculate the empirical formula and the molecular formula of **Y**.

Empirical formula of ***Y*** .....

.....

.....

.....

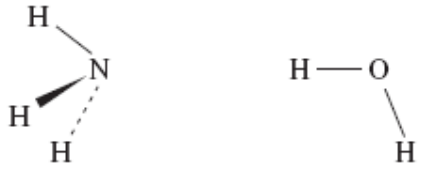
Molecular formula of ***Y*** .....

.....

(4 marks)

Ammonia is very soluble in water because it is able to form hydrogen bonds with water molecules.

(i) Complete the diagram below to show how an ammonia molecule forms a hydrogen bond with a water molecule. Include partial charges and all the lone pairs of electrons.



(ii) The bond angle in a molecule of water is about 104.5°. State the bond angle in an ammonia molecule and explain why it is different from that in water.

Bond angle in ammonia .....

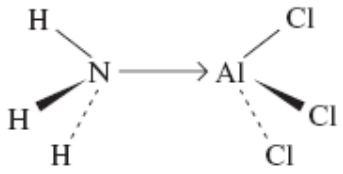
Explanation .....

.....

.....

(6 marks)

Ammonia reacts with aluminium chloride to form the molecule shown below.



Name the type of bond formed between the nitrogen and aluminium atoms. Explain how this bond is formed.

Type of bond .....

Explanation .....

.....

(2 marks)

(a) Give the formula of the least soluble hydroxide of the Group II elements Mg to Ba.

.....

(1 mark)

(b) An aqueous solution of sodium chloride may be distinguished from an aqueous solution of sodium sulphate using a simple chemical test.

(i) Identify a reagent for this test.

.....

(ii) State the observations you would expect to make if the reagent identified in part (b)(i) is added to a separate sample of each solution. Write an equation for any reaction which occurs.

Observation with sodium chloride .....

Observation with sodium sulphate .....

Equation .....

.....

(4 marks)

(a) State the meaning of the term *first ionisation energy* of an atom.

.....

.....

.....

(2 marks)

(b) Complete the electron arrangement for the Mg^{2+} ion.

$1s^2$ .....

(1 mark)

(c) Identify the block in the Periodic Table to which magnesium belongs.

.....

(1 mark)

(d) Write an equation to illustrate the process occurring when the **second** ionisation energy of magnesium is measured.

.....

(1 mark)

(e) The Ne atom and the Mg^{2+} ion have the same number of electrons. Give **two** reasons why the first ionisation energy of neon is lower than the third ionisation energy of magnesium.

Reason 1 .....

Reason 2 .....

(2 marks)

(f) There is a general trend in the first ionisation energies of the Period 3 elements, Na – Ar

(i) State and explain this general trend.

Trend .....

Explanation .....

.....

.....

(ii) Explain why the first ionisation energy of sulphur is lower than would be predicted from the general trend.

.....

.....

.....

(5 marks)

The compound HClO decomposes according to the following equation.

$$5HClO(aq) \longrightarrow 2Cl_2(g) + H^+(aq) + ClO_3^-(aq) + 2H_2O(l)$$

(a) (i) Deduce the oxidation states of chlorine in the following species

HClO .....

Cl_2 .....

ClO_3^- .....

(ii) Comment on the redox behaviour of HClO in this reaction.

.....

.....

(4 marks)

Nitroglycerine, $C_3H_5N_3O_9$, is an explosive which, on detonation, decomposes rapidly to form a large number of gaseous molecules. The equation for this decomposition is given below.

$$4C_3H_5N_3O_9(l) \longrightarrow 12CO_2(g) + 10H_2O(g) + 6N_2(g) + O_2(g)$$

(a) A sample of nitroglycerine was detonated and produced 0.350 g of oxygen gas.

(i) State what is meant by the term *one mole* of molecules.

.....

(ii) Calculate the number of moles of oxygen gas produced in this reaction, and hence deduce the total number of moles of gas formed.

Moles of oxygen gas .....

Total moles of gas .....

.....

.....

(iii) Calculate the number of moles, and the mass, of nitroglycerine detonated.

Moles of nitroglycerine .....

.....

Mass of nitroglycerine .....

.....

.....

(7 marks)