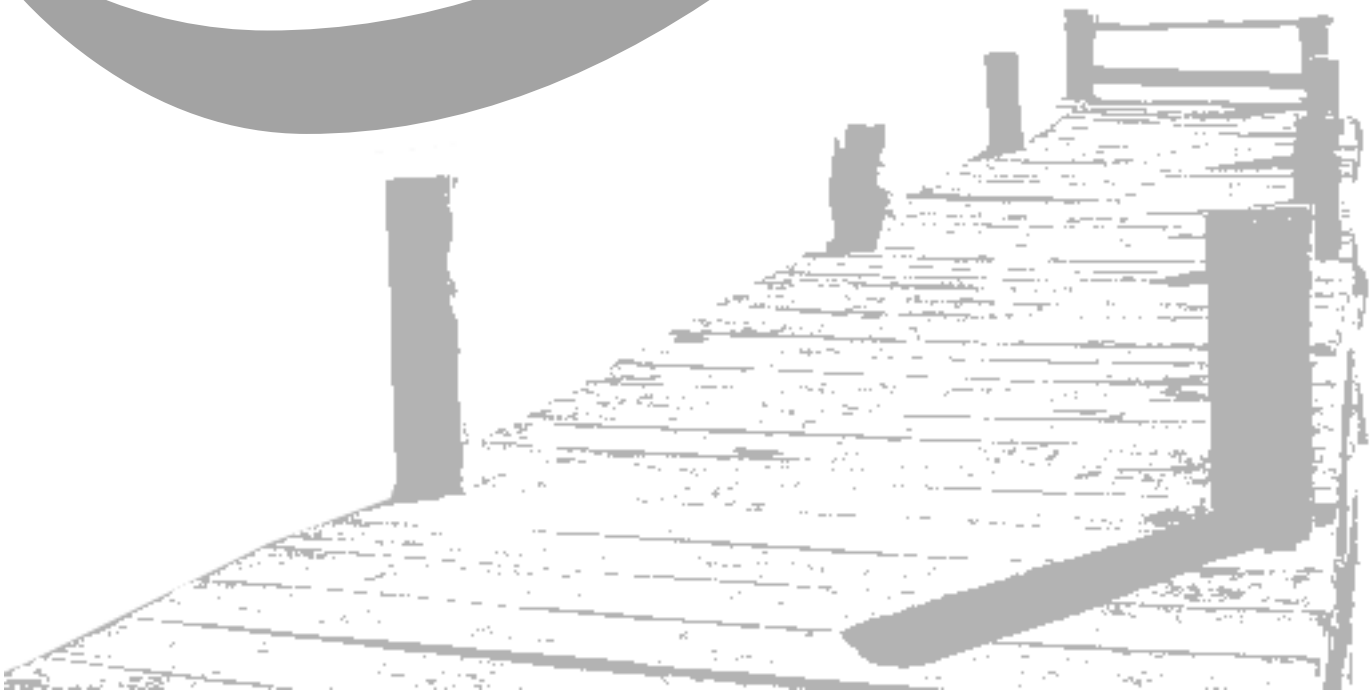
GCE
AS and A Level

Chemistry

AS exams 2009 onwards
A2 exams 2010 onwards

Unit 1:
Specimen question paper

Version 1.1



Surname		Other Names	
Centre Number						Candidate Number				
Candidate Signature										

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General Certificate of Education
2009
Advanced Subsidiary Examination

CHEMISTRY CHEM1
Unit 1 Foundation Chemistry

SPECIMEN PAPER

For this paper you must have
- A calculator
- Data Sheet / Periodic Table

Time allowed: 1¼ hours

Instructions
- Use blue or black ink or ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.

Information
- The maximum mark for this paper is 70.
- The marks for the questions are shown in brackets.
- You are reminded of the need for good English and clear presentation in your answers.

For Examiner's Use			
Number	Mark	Number	Mark
1		4	
2		5	
3			
Total (Column 1)			
Total (Column 2)			
TOTAL			
Examiner's Initials			

SECTION A

Answer **all** questions in the spaces provided

1 In one model of atomic structure, the atom has a nucleus surrounded by electrons in levels and sub-levels.

(a) Define the term *atomic number*.

.....

(1 mark)

(b) Explain why atoms of an element may have different mass numbers.

.....

(1 mark)

(c) The table below refers to a sample of krypton.

Relative *m/z*	82	83	84	86
Relative abundance / %	12	12	50	26

(i) Name an instrument which is used to measure the relative abundance of isotopes.

.....

(ii) Define the term *relative atomic mass*.

.....

(iii) Calculate the relative atomic mass of this sample of krypton.

.....

.....

.....

(5 marks)

(d) Give the complete electronic configuration of krypton in terms of s, p and d sub-levels.

.....

(1 mark)

(e) In 1963, krypton was found to react with fluorine. State why this discovery was unexpected.

.....

(1 mark)

(f) Use a suitable model of atomic structure to explain the following experimental observations.

(i) The first ionisation energy of krypton is greater than that of bromine.

.....

.....

(ii) The first ionisation energy of aluminium is less than the first ionisation energy of magnesium.

.....

.....

(4 marks)

13

Turn over for the next question

2 (a) Nitromethane, CH_3NO_2, is used as an 'energy rich' fuel for motor-racing. It burns in oxygen forming three gases.

$$2CH_3NO_2(l) + 1½O_2(g) \rightarrow 2CO_2(g) + 3H_2O(g) + N_2(g)$$

(i) A 1.00 mol sample of nitromethane was burned in oxygen forming the products shown in the equation above. Calculate the total volume of gases produced at 298 K and 100 kPa (assume that the water is gaseous).

.....

.....

.....

.....

.....

(ii) This combustion reaction is very exothermic and reaches a temperature of 1000 K. Determine the total volume of gases when the temperature is raised to 1000 K at a constant pressure.

(If you have been unable to determine a volume in your answer to part (a)(i), you may assume it to be 8.61×10^{-4} m^3 but this is not the correct answer).

.....

.....

(5 marks)

(b) It has been suggested that, instead of releasing it into the atmosphere, the carbon dioxide gas evolved during a combustion reaction can be absorbed by sodium hydroxide solution, as shown by the following equation.

$$2NaOH(aq) + CO_2(g) \rightarrow Na_2CO_3(aq) + H_2O(l)$$

(i) Give two reasons why this reaction might not be suitable for the removal of carbon dioxide from the exhaust gases of an engine.

Reason 1 ……

Reason 2…….

(ii) The sodium hydroxide solution for this reaction can be made on an industrial scale, together with chlorine gas and hydrogen gas, by electrolysis of a dilute solution of sodium chloride. Suggest one commercial advantage and one environmental disadvantage of this industrial process.

Commercial advantage …….

……

Environmental disadvantage……..……..

……

(4 marks)

(c) Nitrogen forms several different oxides. Calculate the empirical formula of an oxide of nitrogen which contains 26% of nitrogen by mass.

.....

.....

.....

.....

(3 marks)

(d) Another oxide of nitrogen, N_2O, decomposes on warming to produce nitrogen and oxygen. Write an equation for the decomposition reaction.

.....

(1 mark)

(e) Internal combustion engines burn fuels in air. Suggest one advantage of using air mixed with N_2O for this purpose.

.....

(1 mark)

14

Turn over for the next question

There are no questions printed on this page

3 The elements phosphorus, sulfur, chlorine and argon are in the p block of the Periodic Table.

(a) State why these elements are classified as p block elements.

.....

(1 mark)

(b) State the trend in atomic radius from phosphorus to chlorine and explain the trend.

Trend .....

Explanation .....

.....

.....

(3 marks)

(c) In terms of structure and bonding, explain why sulfur has a higher melting point than phosphorus.

.....

.....

.....

.....

(3 marks)

(d) In terms of atomic structure, explain why the van der Waals' forces in liquid argon are very weak.

.....

.....

.....

(2 marks)

9

4 (a) Hexane (C_6H_{14}) is a hydrocarbon which is a component of LPG (liquid petroleum gas), used as a fuel for heating. When burning fuels in boilers it is important to ensure complete combustion.

(i) Give two reasons why boilers are designed to ensure complete combustion.

Reason 1 .....

.....

Reason 2 .....

.....

(ii) Write an equation for the incomplete combustion of hexane.

.....

(iii) Suggest how an engineer or a chemist could demonstrate that the combustion of hexane in a faulty boiler was incomplete.

.....

(5 marks)

(b) Branched chain alkanes are often preferred as fuels. Draw the structure of two branched chain isomers of hexane and name the first isomer.

Isomer 1 Isomer 2

Name of isomer 1 .....

(3 marks)

(c) Hexane can be cracked in the presence of a catalyst to produce another hydrocarbon, Z, and methane.

(i) Draw a possible structure for Z.

(ii) Give a suitable catalyst for this reaction.

.....

(iii) Suggest why the product Z has more commercial value than hexane.

.....

.....

(3 marks)

(d) The overall equation for the production of dichloromethane from methane and chlorine is shown below.

$$CH_4 + 2Cl_2 \rightarrow CH_2Cl_2 + 2HCl$$

(i) Calculate the % atom economy for the formation of CH_2Cl_2 in this reaction.

.....

.....

.....

(ii) Give one reason why this atom economy of less than 100% is an important consideration for the commercial success of this process and predict how a chemical company would maximise profits from this process.

.....

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.....

(3 marks)

14

Turn over for the next question

SECTION B

Answer Question 5 in the space provided on pages 10 to 12

5 (a) Describe the bonding in, and the structure of, sodium chloride and ice. In each case draw a diagram showing how each structure can be represented. Explain, by reference to the types of bonding present, why the melting point of these two compounds is very different.

(12 marks)

(b) Explain how the concept of bonding and non-bonding electron pairs can be used to predict the shape of, and bond angles in, a molecule of sulfur tetrafluoride, SF_4. Illustrate your answer with a diagram of the structure.

(8 marks)

END OF QUESTIONS