Candidate Forename		Candidate Surname	

Centre Number						Candidate Number				

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

ADVANCED SUBSIDIARY GCE

F321

CHEMISTRY A

Atoms, Bonds and Groups

THURSDAY 14 JANUARY 2010: Morning
DURATION: 1 hour

SUITABLE FOR VISUALLY IMPAIRED CANDIDATES

Candidates answer on the Question Paper

OCR SUPPLIED MATERIALS:

Data Sheet for Chemistry A **(inserted)**

OTHER MATERIALS REQUIRED:

Scientific calculator

READ INSTRUCTIONS OVERLEAF

DC (AC) 22931/3

INSTRUCTIONS TO CANDIDATES

- **Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes on the first page.**
- **Use black ink. Pencil may be used for graphs and diagrams only.**
- **Read each question carefully and make sure that you know what you have to do before starting your answer.**
- **Answer ALL the questions.**
- **Write your answer to each question in the space provided, however additional paper may be used if necessary.**

INFORMATION FOR CANDIDATES

- **The number of marks is given in brackets [ ] at the end of each question or part question.**
-  **Where you see this icon you will be awarded marks for the quality of written communication in your answer.**

  This means for example you should:

  - **ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear;**
  - **organise information clearly and coherently, using specialist vocabulary when appropriate.**
- **You may use a scientific calculator.**
- **A copy of the *Data Sheet for Chemistry A* is provided as an insert with this question paper.**
- **You are advised to show all the steps in any calculations.**
- **The total number of marks for this paper is 60.**

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Answer ALL the questions.

1 Europium, atomic number 63, is used in some television screens to highlight colours. A chemist analysed a sample of europium using mass spectrometry. The results are shown in TABLE 1.1 below.

ISOTOPE	RELATIVE ISOTOPIC MASS	ABUNDANCE (%)
^{151}Eu	151.0	47.77
^{153}Eu	153.0	52.23

TABLE 1.1

(a) Define the term *relative isotopic mass*.

_____

_____

_____

_____ **[2]**

(b) Using TABLE 1.1, calculate the relative atomic mass of the europium sample.
Give your answer to TWO decimal places.

answer = _____ [2]

(c) Isotopes of europium have differences and similarities.

(i) In terms of protons, neutrons and electrons, how is an atom of ^{151}Eu <u>DIFFERENT</u> from an atom of ^{153}Eu?

_____

_____ **[1]**

(ii) In terms of protons, neutrons and electrons, how is an atom of ^{151}Eu <u>SIMILAR</u> to an atom of ^{153}Eu?

_____

_____ **[1]**

(d) Modern plasma television screens emit light when mixtures of noble gases, such as neon and xenon, are ionised.

The first ionisation energies of neon and xenon are shown in the table below.

ELEMENT	1ST IONISATION ENERGY / KJ MOL^{-1}
neon	+2081
xenon	+1170

Explain why xenon has a lower first ionisation energy than neon.

_____

_____

_____

_____

_____

_____

_____

_____

_____ **[3]**

[Total: 9]

2 A student carries out experiments using acids, bases and salts.

(a) Calcium nitrate, $Ca(NO_3)_2$, is an example of a salt.

The student prepares a solution of calcium nitrate by reacting dilute nitric acid, HNO_3, with the base calcium hydroxide, $Ca(OH)_2$.

(i) Why is calcium nitrate an example of a salt?

_____

_____ **[1]**

(ii) Write the equation for the reaction between dilute nitric acid and calcium hydroxide. Include state symbols.

_____ **[2]**

(iii) Explain how the hydroxide ion in aqueous calcium hydroxide acts as a base when it neutralises dilute nitric acid.

_____

_____

_____ **[1]**

(b) A student carries out a titration to find the concentration of some sulfuric acid.

The student finds that 25.00 cm^3 of 0.0880 mol dm^{-3} aqueous sodium hydroxide, NaOH, is neutralised by 17.60 cm^3 of dilute sulfuric acid, H_2SO_4.

$H_2SO_4(aq) + 2NaOH(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l)$

(i) Calculate the amount, in moles, of NaOH used.

answer = _____ mol [1]

(ii) Determine the amount, in moles, of H_2SO_4 used.

answer = _____ mol [1]

(iii) Calculate the concentration, in mol dm^{-3}, of the sulfuric acid.

answer = _____ mol dm^{-3} [1]

(c) After carrying out the titration in (b), the student left the resulting solution to crystallise. White crystals were formed, with a formula of $Na_2SO_4 \bullet xH_2O$ and a molar mass of 322.1 g mol^{-1}.

(i) What term is given to the '$\bullet xH_2O$' part of the formula?

_____ [1]

(ii) Using the molar mass of the crystals, calculate the value of *x*.

answer = _____ [2]

[Total: 10]

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3 This question is about different models of bonding and molecular shapes.

(a) Magnesium sulfide shows ionic bonding.

(i) What is meant by the term *ionic bonding*?

_____

_____ **[1]**

(ii) Draw a '*dot-and-cross*' diagram to show the bonding in magnesium sulfide.
Show outer electron shells only.

[2]

(b) '*Dot-and-cross*' diagrams can be used to predict the shape of covalent molecules.

Fluorine has a covalent oxide called difluorine oxide, F_2O. The oxygen atom is covalently bonded to each fluorine atom.

(i) Draw a '*dot-and-cross*' diagram of a molecule of F_2O.
Show outer electron shells only.

[2]

(ii) Predict the bond angle in an F_2O molecule.
Explain your answer.

_____

_____

_____

_____

_____

_____

_____

_____ **[3]**

(c) Liquid ammonia, NH_3, and water, H_2O, both show hydrogen bonding.

(i) Draw a labelled diagram to show hydrogen bonding between two molecules of liquid <u>AMMONIA</u>.

[3]

(ii) Water has several anomalous properties as a result of its hydrogen bonding.

Describe and explain <u>ONE</u> anomalous property of water which results from hydrogen bonding.

_____

_____

_____

_____

_____ **[2]**

[Total: 13]

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4 Chlorine and bromine are elements in Group 7 of the Periodic Table.

(a) Chlorine is used in water treatment.

State <u>ONE</u> advantage and <u>ONE</u> disadvantage of using chlorine in water treatment.

advantage: _____

_____

disadvantage: _____

_____ **[2]**

(b) The electron configuration of bromine contains outermost electrons in the 4th shell.

Using your knowledge of Group 7 elements, complete the electron configuration of bromine.

$1s^2 2s^2 2p^6 3s^2 3p^6$ _____ **[1]**

(c) Displacement reactions can be used to detect bromide ions in solution.

A student has a solution that contains bromide ions. The student carries out the following experiment.

STEP 1

- **She bubbles some chlorine gas through a sample of the solution.**
- **The mixture changes colour.**

STEP 2

- **The student then adds an organic solvent, cyclohexane, to the mixture.**
- **She shakes the contents and allows the layers to separate.**

(i) Write the IONIC equation for the reaction that takes place in STEP 1.

_____ **[1]**

(ii) What colour does the cyclohexane layer turn in STEP 2?

_____ **[1]**

(d) Chlorine reacts differently with dilute and concentrated aqueous solutions of sodium hydroxide.

- **When chlorine reacts with dilute sodium hydroxide, one of the products is sodium chlorate(I). This is the reaction that is used to manufacture bleach.**

- **When chlorine is reacted with hot concentrated sodium hydroxide, a different reaction takes place. One of the products is $NaClO_3$, used as a weedkiller.**

In each reaction, chlorine has been both oxidised and reduced.

(i) What term is used to describe a redox reaction in which an element is both oxidised and reduced?

_____ **[1]**

(ii) Write equations for these two reactions of chlorine with sodium hydroxide:

equation for reaction with <u>DILUTE</u> sodium hydroxide,

_____

equation for reaction with <u>HOT CONCENTRATED</u> sodium hydroxide.

_____ **[3]**

(iii) Chlorine forms another chlorate called sodium chlorate(VII), used in the manufacture of matches.

Suggest the formula of sodium chlorate(VII).

_____ **[1]**

[Total: 10]

5 Chemists use the Periodic Table to predict the behaviour of elements.

(a) Early attempts at developing a Periodic Table arranged elements in order of increasing atomic mass.

(i) State which two elements from the FIRST TWENTY elements of the modern Periodic Table are not arranged in order of increasing atomic mass.

_____ **[1]**

(ii) Why does the modern Periodic Table NOT arrange some elements, such as those in a(i), in order of increasing atomic mass?

_____

_____

_____ **[1]**

(b) Magnesium and strontium are in Group 2 of the Periodic Table.

(i) When reacted with oxygen, magnesium forms a white powder called magnesium oxide.

Write the equation for the reaction of magnesium with oxygen.

_____ **[1]**

(ii) Magnesium reacts with dilute acids.

Describe what you would expect to see when magnesium ribbon is added to an excess of dilute hydrochloric acid.

_____

_____ **[2]**

(iii) Strontium reacts in a similar way to magnesium.

Describe <u>ONE</u> difference you might observe if strontium, instead of magnesium, was reacted with dilute hydrochloric acid.

_____ **[1]**

(c) The third period of the Periodic Table features the elements magnesium and chlorine. The table below shows the melting points of these elements.

ELEMENT	MELTING POINT / °C
magnesium	650
chlorine	–101

Describe the structure and bonding shown by these elements. Use your answer to explain the difference in melting points.

In your answer, you should use appropriate technical terms spelt correctly.

_____

_____

_____

_____ **[6]**

(d) The element strontium forms a nitrate, $Sr(NO_3)_2$, which decomposes on heating as shown below.

$$2Sr(NO_3)_2(s) \rightarrow 2SrO(s) + 4NO_2(g) + O_2(g)$$

(i) Using oxidation numbers, explain why the reaction involves both oxidation and reduction.

_____

_____

_____

_____ **[3]**

TURN OVER FOR PART (d)(ii)

(ii) A student heats 5.29 g of $Sr(NO_3)_2$ and collects the gas at room temperature and pressure, RTP.

$$2Sr(NO_3)_2(s) \rightarrow 2SrO(s) + 4NO_2(g) + O_2(g)$$

Calculate the volume of gas, in dm^3, obtained by the student at RTP.

Molar mass of $Sr(NO_3)_2$ = 211.6 g mol^{-1}.

answer = _____ dm^3 [3]

[Total: 18]

END OF QUESTION PAPER

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