Rewarding Learning

Centre Number	
71	

Candidate Number

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2010

Chemistry

Assessment Unit AS 1

assessing

Basic Concepts in Physical and Inorganic Chemistry

[AC111]

AC111

MONDAY 7 JUNE, MORNING

TIME

1 hour 30 minutes.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
Answer **all fifteen** questions.
Answer **all ten** questions in **Section A**. Record your answers by marking the appropriate letter on the answer sheet provided. Use only the spaces numbered 1 to 10. Keep in sequence when answering.
Answer **all five** questions in **Section B**. Write your answers in the spaces provided in this question paper.

INFORMATION FOR CANDIDATES

The total mark for this paper is 100.
Quality of written communication will be assessed in question **13(d)**.
In Section A all questions carry equal marks, i.e. **two** marks for each question.
In Section B the figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.
A Periodic Table of Elements (including some data) is provided.

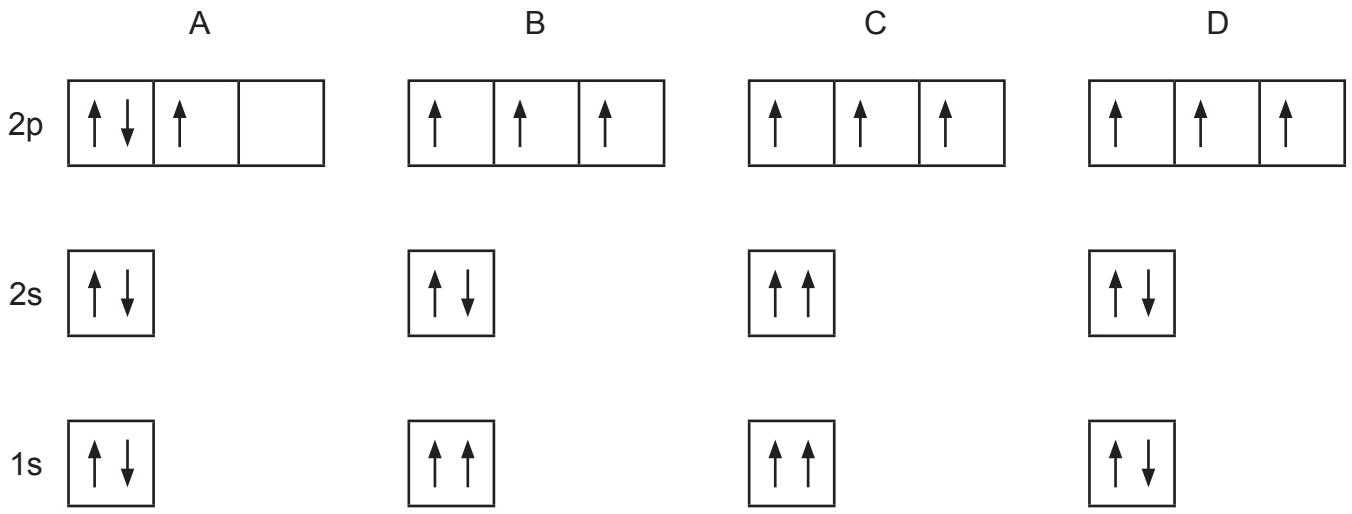
For Examiner's use only	
Question Number	Marks
Section A	
1–10	
Section B	
11	
12	
13	
14	
15	
Total Marks	

Section A

For each of the following questions only **one** of the lettered responses (A–D) is corre

Select the correct response in each case and mark its code letter by connecting the as illustrated on the answer sheet.

1 Which one of the following represents the ground state electronic configuration of a nitrogen atom?



2 When burned in a plentiful supply of oxygen, methane produces carbon dioxide and water.

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

What is the number of molecules of oxygen required for the complete combustion of 1.6 g of methane?

A 6.0×10^{22}
B 1.2×10^{23}
C 6.0×10^{23}
D 1.2×10^{24}

3 In which one of the following molecules are the bond angles closest to 107°?

A BF_3
B CH_4
C H_2O
D NH_3

4 Which one of the following gives the correct flame colour for the named co

A barium chloride red
B copper(II) chloride blue-green
C potassium chloride yellow/orange
D sodium chloride lilac

5 An element was analysed using a mass spectrometer. The spectrum showed that there were four isotopes. The relative isotopic masses and relative abundances are given below.

Relative isotopic mass	Relative abundance
50	2
52	35
53	4
54	1

The relative atomic mass of this element is

A 52.00.
B 52.05.
C 52.25.
D 52.50.

6 Which one of the following is produced when concentrated sulphuric acid reacts with solid sodium chloride?

A chlorine
B hydrogen chloride
C hydrogen sulphide
D sulphur dioxide

7 Titanium is extracted in a two-stage process. The first stage involves the conversion of titanium(IV) oxide to titanium(IV) chloride. In the second stage, the titanium(IV) chloride is reduced using magnesium.

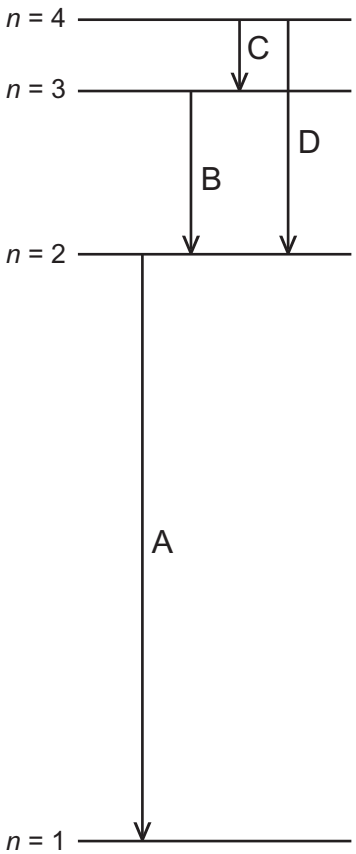
$$TiO_2 + C + 2Cl_2 \rightarrow TiCl_4 + CO_2$$

$$TiCl_4 + 2Mg \rightarrow Ti + 2MgCl_2$$

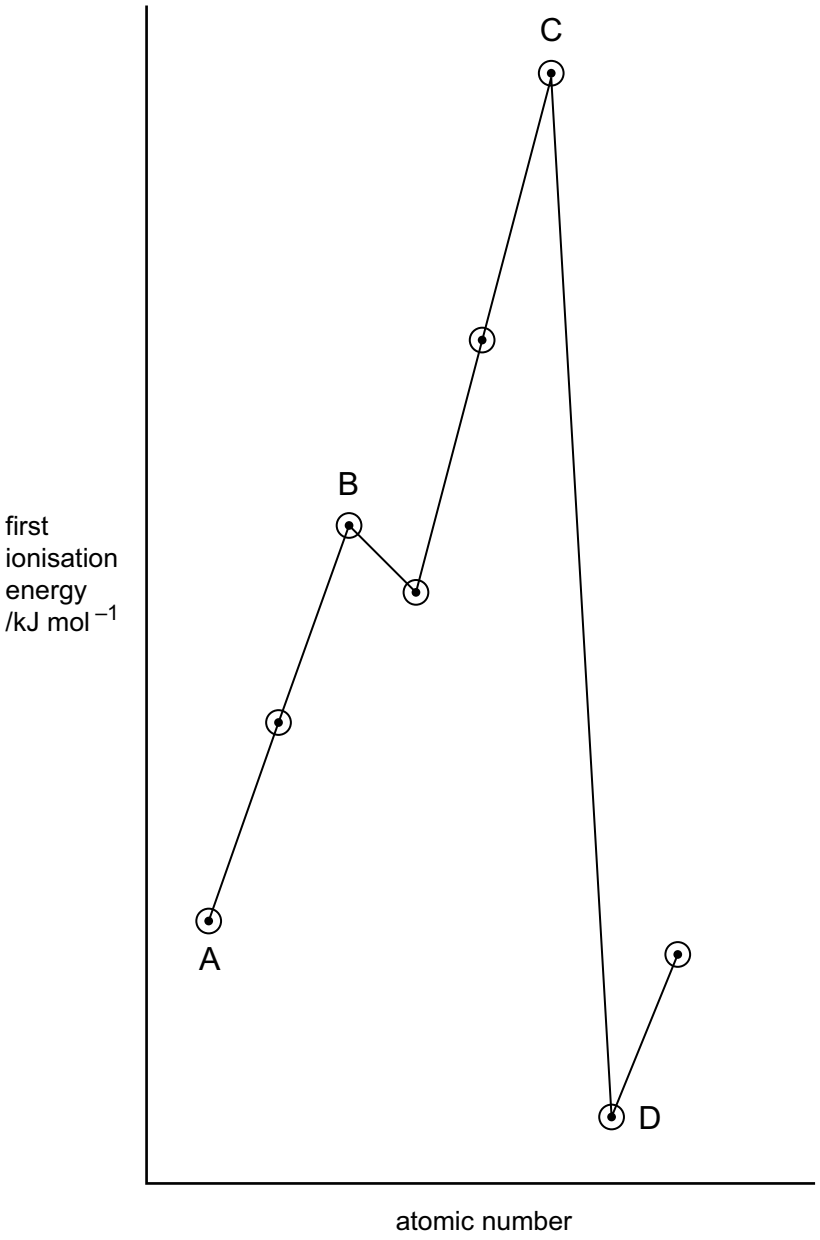
What is the maximum mass of titanium which can be obtained when 8.0 kg of titanium(IV) oxide is converted to titanium(IV) chloride and then reduced using 7.2 kg of magnesium?

A 2.4 kg
B 4.8 kg
C 9.6 kg
D 14.4 kg

8 Which one of the following electron transitions is responsible for the lowest frequency line in the visible region of the emission spectrum of atomic hydrogen?



9 Which one of the letters represents the first ionisation energy of an alkali m



10 The ionisation energy of hydrogen is 1312 kJ mol^{-1}. Use this value to calculate the frequency at convergence in the hydrogen emission spectrum.

A 2.179×10^{-21} Hz
B 1.312×10^{6} Hz
C 3.287×10^{15} Hz
D 1.979×10^{36} Hz

Section B

Answer **all five** questions in this section.

11 Aluminium is the most abundant metal in the Earth's crust. It is used in electrical cables and is present in high strength alloys.

(a) All atoms of aluminium have a mass number of 27.
How many neutrons are present in the nucleus of these atoms?

_____ [1]

(b) **(i)** Write the equation, including state symbols, which represents the first ionisation energy of aluminium.

_____ [2]

(ii) Explain why the first ionisation energy of boron has a larger value than the first ionisation energy of aluminium.

_____

_____

_____ [2]

(iii) Explain why the first ionisation energy of magnesium has a larger value than the first ionisation energy of aluminium.

_____

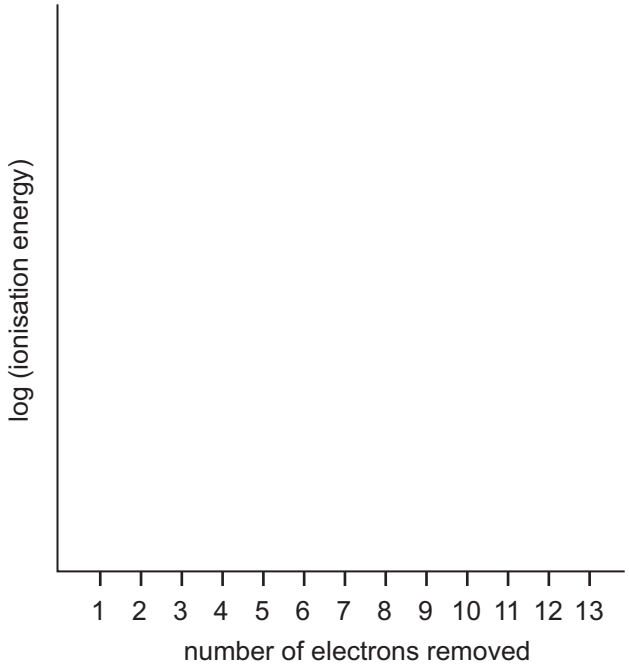
_____

_____ [2]

(iv) Give the ground state electronic configuration of the Al^{4+} ion.

_____ [1]

(v) Sketch a graph to show the successive ionisation energies of aluminium.



[2]

12 Fluorine is the most reactive non-metallic element. It combines with both metals and non-metals.

(a) (i) Using dot and cross diagrams, explain how strontium atoms combine with fluorine atoms to form strontium fluoride. Show the outer electrons only.

[4]

(ii) Compare the electrical conductivity of solid strontium metal with that of solid strontium fluoride. Explain your answer.

_____

_____

_____

_____ [3]

(b) Sulphur and fluorine combine to form a non-polar molecule sulphur hexafluoride, SF_6.

(i) Define the term **electronegativity**.

_____

_____ [2]

(ii) Label the diagram below to show the polarity of the S—F bond.

S—F

[1]

(iii) Draw a dot and cross diagram to show the bonding in SF_6 using outer shell electrons only.

[2]

(iv) Explain whether the SF_6 molecule obeys the octet rule.

_____

_____

_____ [2]

(v) Draw, name and explain the shape of the SF_6 molecule.

_____

_____

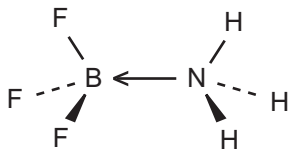
_____ [4]

(vi) Suggest why SF_6 is a non-polar molecule, even though it contains polar bonds.

_____

_____ [2]

(c) Boron trifluoride can combine with ammonia to form the following molecule.



(i) Name the type of bond formed between the boron and nitrogen atoms.

_____ [1]

(ii) Explain how this bond is formed.

_____

_____ [1]

13 Concentrated nitric acid (HNO_3) oxidises iodide ions to form iodine. In the reaction the nitric acid is reduced to form nitrogen monoxide (NO).

(a) Reduction and oxidation can be defined in different ways.

(i) Define oxidation in terms of electron transfer.

_____ [1]

(ii) Define reduction in terms of changes in oxidation state.

_____ [1]

(b) Deduce the oxidation number of nitrogen in

(i) HNO_3 _____ [1]

(ii) NO _____ [1]

(c) The half-equation for the reduction of concentrated nitric acid is shown below.

$$HNO_3 + 3H^+ + 3e^- \rightarrow NO + 2H_2O$$

(i) Write a half-equation for the oxidation of iodide ions to form an iodine molecule.

_____ [1]

(ii) Combine the reduction and oxidation half-equations to give the overall ionic equation.

_____ [2]

(d) At room temperature and pressure, iodine exists as a grey-black shiny solid. Describe the bonding in, and explain the structure of iodine crystals. Explain the relative solubilities of iodine in water and hexane.

_____

_____

_____

_____

_____

_____

_____ [5]

Quality of written communication [2]

14 Chlorine is produced by the electrolysis of concentrated sodium chloride solution (brine). It is then used by other industries to produce a variety of useful products.

(a) The reaction between chlorine and cold dilute sodium hydroxide is used in the manufacture of bleach.

(i) Write the equation for this reaction.

_____ [2]

(ii) This reaction is described as **disproportionation**. Explain the meaning of this term.

_____

_____

_____ [2]

(b) Chlorine reacts with hydrogen to produce hydrogen chloride.

(i) Write the equation for this reaction.

_____ [2]

(ii) Suggest why hydrogen chloride has a much lower boiling point than hydrogen fluoride.

_____

_____

_____ [3]

(iii) Explain why hydrogen chloride is more thermally stable than hydrogen iodide.

_____

_____

_____ [2]

(c) The presence of chloride ions in brine can be established by adding an aqueous solution of silver nitrate.

(i) What would be observed in this reaction?

_____ [2]

(ii) Write an ionic equation, including state symbols, for the reaction.

_____ [2]

(iii) State what is observed when an excess of dilute aqueous ammonia is then added.

_____ [1]

15 The degree of hydration in samples of hydrated sodium carbonate ($Na_2CO_3.xH_2O$) can be determined by different methods.

(a) When 10.04 g of a sample was heated to constant mass, 3.97 g of anhydrous sodium carbonate was obtained.

(i) Explain the term **anhydrous**.

_____

_____ [1]

(ii) Calculate the number of moles of anhydrous sodium carbonate obtained.

_____ [1]

(iii) Calculate the mass of water present in the sample.

_____ [1]

(iv) Calculate the number of moles of water present.

_____ [1]

(v) Calculate the value of *x* in the sample.

_____ [1]

(b) The degree of hydration can also be determined by dissolving the sample in water and titrating with a standard solution of hydrochloric acid.

(i) What is a **standard** solution?

_____ [1]

(ii) Give the equation for the reaction between sodium carbonate and hydrochloric acid.

_____ [2]

(iii) Name a suitable indicator for this titration.

_____ [1]

(c) 3.57 g of a second sample of sodium carbonate was dissolved in water and the resulting solution was made up to 250 cm^3 in a volumetric flask. A 25.0 cm^3 sample of this solution required 28.5 cm^3 of 0.1 mol dm^{-3} hydrochloric acid to reach the end point.

(i) Give the colour change which would be obtained at the end point, using the indicator given in **(b)(iii)**.

From _____ to _____ [2]

(ii) Calculate the number of moles of hydrochloric acid used in the titration.

_____ [1]

(iii) Calculate the number of moles of sodium carbonate present in 25.0 cm^3 of solution.

_____ [1]

(iv) Calculate the number of moles of sodium carbonate present in 250 cm^3 of solution.

_____ [1]

(v) Calculate the mass of sodium carbonate present in the second sample.

_____ [1]

(vi) Calculate the mass of water present in the second sample.

_____ [1]

(vii) Calculate the number of moles of water present in the second sample.

_____ [1]

(viii) Calculate the value of *x* in the second sample.

_____ [1]

THIS IS THE END OF THE QUESTION PAPER