New Specification

Rewarding Learning

Centre Number

71

Candidate Number

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
January 2010

Chemistry

Assessment Unit AS 1

assessing

Basic Concepts in Physical and Inorganic Chemistry

[AC111]

AC111

THURSDAY 14 JANUARY, 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(c)**.
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	

5623

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 2.65 g of anhydrous sodium carbonate, Na_2CO_3, was dissolved in water and the solution made up to 250 cm^3 in a volumetric flask. The concentration of the solution was

A 0.025 mol dm^{-3}
B 0.050 mol dm^{-3}
C 0.100 mol dm^{-3}
D 0.200 mol dm^{-3}

2 In which one of the following molecules does the central atom obey the octet rule?

A $BeCl_2$
B BF_3
C CF_4
D SF_6

3 Which one of the following statements about iodine is **not** correct?

A It has a molecular covalent structure.
B It contains non-polar molecules.
C It exists as a grey-black shiny solid.
D It is more soluble in water than hexane.

4 Elements Q and R have ground state electron structures $1s^2 2s^2 2p^6 3s^2$ and $1s^2 2s^2 2p^5$ respectively. Q and R combine to produce a compound with the formula

A QR
B QR_2
C Q_2R
D Q_2R_5

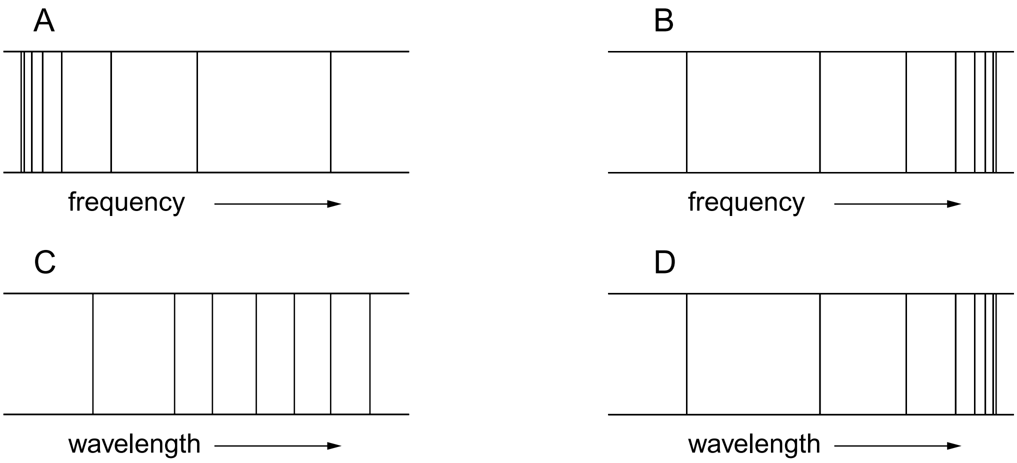
5 Which one of the following molecules is polar?

A BF_3
B CF_4
C OF_2
D F_2

6 4.88 g of hydrated barium chloride, $BaCl_2.xH_2O$, was heated to a constant mass of 4.16 g. What is the value of x?

A 1
B 2
C 3
D 4

7 Which one of the following represents the emission spectrum of atomic hydrogen in the ultraviolet region?



8 When burned in a plentiful supply of oxygen, propane (C_3H_8) produces ca[illegible]e and water.

$$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$$

What is the number of molecules of carbon dioxide produced when 4.4 g of propane are burned?

A 6.02×10^{22}
B 1.81×10^{23}
C 6.02×10^{23}
D 1.81×10^{24}

9 A compound produces a lilac colour in a flame test. When chlorine is bubbled into an aqueous solution of the compound, the solution changes from colourless to yellow-orange. The compound is

A potassium bromide
B potassium iodide
C sodium bromide
D sodium iodide

10 Iron(III) oxide can be reduced by carbon to form iron.

$$2Fe_2O_3 + 3C \rightarrow 4Fe + 3CO_2$$

What is the maximum mass of iron which can be produced when 3.20 kg of iron(III) oxide is heated with 0.72 kg of carbon?

A 1.12 kg
B 2.24 kg
C 3.36 kg
D 4.48 kg

Section B

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

11 There are five isotopes of germanium.

(a) Atoms of the ^{74}Ge isotope contain 32 protons, 32 electrons and 42 neutrons. Complete the following table which shows the properties of each of these particles.

Particle	Relative mass	Relative charge
Proton		
Electron		
Neutron		

[3]

(b) State, in terms of protons and neutrons, the meanings of the following terms:

Mass number ____

____ [1]

Atomic number ____

____ [1]

Isotopes ____

____ [1]

(c) The terms atomic number and mass number can be used to deduce the numbers of protons, neutrons and electrons in an atom or ion.

(i) An atom has 15 protons and 20 neutrons fewer than there are in the ^{70}Ge isotope. Deduce the symbol and mass number of this atom.

Symbol ______________ Mass Number ______________ [2]

(ii) Complete the table for the ions of the elements X, Y and Z. The letters X, Y and Z are not the symbols of the elements.

Ion	**Atomic Number**	**Mass Number**	**Number of Neutrons**	**Electronic Structure**
X^{2+}			20	$1s^2 2s^2 2p^6 3s^2 3p^6$
Y^{-}			18	$1s^2 2s^2 2p^6 3s^2 3p^6$
Z^{2-}		16		$1s^2 2s^2 2p^6$

[3]

(d) The mass spectrum of germanium is used to calculate its relative atomic mass.

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

____

____ [2]

(ii) The table below gives the percentage abundance of each isotope in the mass spectrum of germanium.

Relative Isotopic Mass	70	72	73	74	76
% Abundance	20.55	27.37	7.67	36.74	7.67

Use this information to calculate the relative atomic mass of germanium to one decimal place.

____

____

____ [2]

12 Phosphorus and nitrogen are in Group V of the Periodic Table. Nitrogen forms a hydride called ammonia and the hydride of phosphorus is called phosphine, PH_3.

(a) **(i)** Draw a dot and cross diagram to show the bonding in phosphine.

[2]

(ii) Draw and name the shape of a phosphine molecule.

______________________________ [2]

(iii) Explain why a phosphine molecule has the shape you have drawn.

____

____

____

______________________________ [2]

(iv) Suggest a value for the bond angles in phosphine. Explain your answer.

____

____

____

____ [2]

(b) Phosphine reacts with hydrogen ions to form phosphonium ions, PH_4^+. Ammonia similarly forms ammonium ions, NH_4^+.

(i) Name the type of bond formed when phosphine reacts with a hydrogen ion.

____ [1]

(ii) Explain how this bond is formed.

____

____ [2]

(c) Suggest, in terms of intermolecular forces, why ammonia has a higher boiling point than phosphine.

____

____

____

____ [2]

13 Analysis of a vinegar solution was carried out using the following procedure:

Transfer 25.0 cm^3 of undiluted vinegar into a 250 cm^3 volumetric flask and make the solution up to the mark using de-ionised water. Transfer 25.0 cm^3 portions of the diluted vinegar into three separate conical flasks and add a few drops of indicator to each flask. Titrate each solution with 0.1 mol dm^{-3} sodium hydroxide until an end point is reached.

A student obtained the following results:

	Initial burette reading (cm^3)	**Final burette reading (cm^3)**	**Titre (cm^3)**
Rough	0.0	21.7	21.7
1st accurate	21.7	43.1	
2nd accurate	0.0	21.3	

(a) (i) Name a suitable indicator for this titration.

____ [1]

(ii) State the colour change which would be obtained at the end point.

from ____________________ to ____________________ [2]

(b) (i) Write the equation for the reaction between vinegar (ethanoic acid) and sodium hydroxide.

____ [2]

(ii) Complete the results table and calculate the average titre.

____ [2]

(iii) Use the average titre to calculate the number of moles of sodium hydroxide used in the titration.

____ [1]

(iv) Calculate the concentration of ethanoic acid in the diluted vinegar.

_______________________ $mol\,dm^{-3}$ [1]

(v) Calculate the concentration of ethanoic acid in the undiluted vinegar.

_______________________ $mol\,dm^{-3}$ [1]

(c) Describe, giving practical details, how you would prepare the solution of diluted vinegar and then transfer $25.0\,cm^3$ to a conical flask.

____

____

____

____

____

____

_______________________ [4]

Quality of written communication [2]

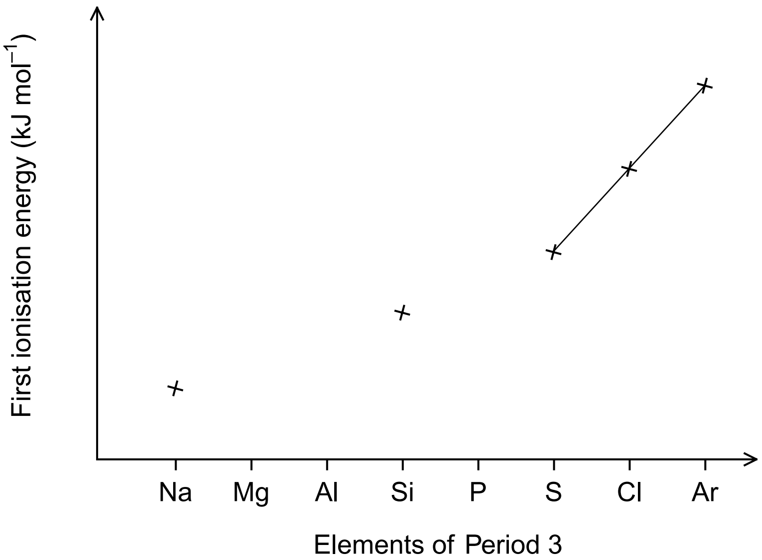
14 Ionisation energies provide evidence for the existence of shells and subshells in atoms.

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

____

____ [2]

(b) There is a general increase in the first ionisation energies across Period 3. The graph below shows the variation of the first ionisation energies of some of the elements in Period 3.



(i) Use crosses to mark the relative positions of the first ionisation energies for the elements Mg, Al and P. Complete the graph by joining the crosses. [2]

(ii) Explain the general increase in first ionisation energy across the period.

____

____ [2]

(iii) Using s, p and d notation give the ground state electronic configuration of a magnesium atom.

____ [1]

r Only
mark

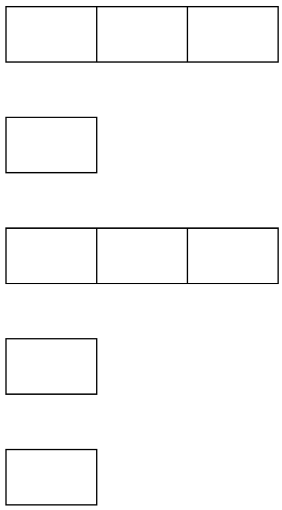
(iv) Explain the position of the first ionisation energy of magnesium relative to that of aluminium in your graph.

____

____ [2]

(c) The first four ionisation energies of aluminium are 578, 1817, 2745 and 11 578 kJ mol^{-1}.

(i) Label the subshells in the following diagram for an aluminium atom and use the electrons-in-boxes notation to show how the electrons are arranged in the Al^{2+} ion.



[2]

(ii) Write the equation, including state symbols, for the fourth ionisation energy of aluminium.

____ [2]

(iii) Explain why the third ionisation energy of aluminium is much smaller than the fourth ionisation energy.

____

____ [2]

15 The elements in Group VII are all reactive non-metals.

(a) There is a trend in the electronegativity of the elements in Group VII.

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

____

____

____ [2]

(ii) State and explain the trend in the electronegativity of the elements down Group VII from fluorine to iodine.

____

____

____

____ [3]

(b) When concentrated sulphuric acid is added to solid sodium bromide, the acid reacts with bromide ions to form sulphur dioxide and bromine.

(i) State the change in the oxidation number of sulphur in this reaction.

____ [2]

(ii) Write the half-equation to show how bromine is formed from bromide ions.

____ [1]

(iii) Complete the half-equation to show how sulphur dioxide is formed from sulphuric acid.

$$H_2SO_4 \quad + \quad H^+ \qquad\qquad \rightarrow \qquad SO_2 \quad + \quad H_2O$$

[2]

(iv) Write the overall ionic equation for the reaction of bromide ions with sulphuric acid.

____ [1]

(v) State **one** observation in the above reaction.

____ [1]

(vi) State the role of bromide ions in this reaction.

____ [1]

(vii) Why are sulphur dioxide and chlorine not formed when concentrated sulphuric acid is added to solid sodium chloride?

____

____ [1]

(viii) Write the equation for the reaction of solid sodium chloride with concentrated sulphuric acid.

____ [2]

(c) When sodium bromide is dissolved in water, the presence of bromide ions can be established by using aqueous silver nitrate followed by concentrated ammonia solution.

(i) What is observed when aqueous silver nitrate is added to sodium bromide solution?

____ [2]

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

____ [2]

(iii) What is observed when an excess of concentrated ammonia solution is added?

____ [1]