Centre Number

71

Candidate Number

Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
January 2013

Chemistry

Assessment Unit AS 1

assessing

Basic Concepts in Physical and Inorganic Chemistry

[AC112]

THURSDAY 10 JANUARY, MORNING

AC112

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 sixteen** 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 six** 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 **11(b)**.
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	
16	
Total Marks	

Section A

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

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 is the electronic configuration for the Fe^{2+} ion?

A $1s^2 2s^2 2p^6 3s^2 3p^6 3d^4 4s^2$

B $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$

C $1s^2 2s^2 2p^6 3s^2 3p^6 3d^6 4s^0$

D $1s^2 2s^2 2p^6 3s^2 3p^6 3d^6 4s^2$

2 Which one of the following lists the first four ionisation energies of a Group **II** element?

A 584, 1823, 2751, 11584

B 744, 1457, 7739, 10547

C 793, 1583, 3238, 4362

D 1018, 1909, 2918, 4963

3 Which one of the following is the mass of zinc chloride produced when 8.1 g of zinc oxide, ZnO, is added to 150.0 cm^3 of 1.0 mol dm^{-3} hydrochloric acid?

A 10.2 g

B 13.6 g

C 20.4 g

D 40.8 g

4 Which one of the following substances has coordinate bonding in its structure?

A Ammonia

B Ammonium chloride

C Carbon dioxide

D Water

5 Which one of the following, in the liquid state, has van der Waals' forces and permanent dipole attractions but **not** hydrogen bonds between the molecules?

A CH_4

B CO

C H_2O

D O_2

6 Chlorine does **not** undergo disproportionation when reacted with

A cold dilute sodium hydroxide solution.

B hot concentrated sodium hydroxide solution.

C potassium bromide solution.

D water.

7 Which one of the following solids will react with concentrated sulfuric acid to give hydrogen sulfide?

A Calcium bromide

B Magnesium iodide

C Potassium chloride

D Sodium fluoride

8 For which one of the following titrations would phenolphthalein be a suitable indicator?

A Ethanoic acid and sodium carbonate

B Ethanoic acid and sodium hydroxide

C Hydrochloric acid and aqueous ammonia

D Hydrochloric acid and sodium carbonate

9 Which one of the following increases as Group VII is descended?

A Atomic radius

B Electronegativity

C First ionisation energy

D Reactivity

10 Which one of the following is the bond angle in a water molecule?

A 104.5°

B 107.0°

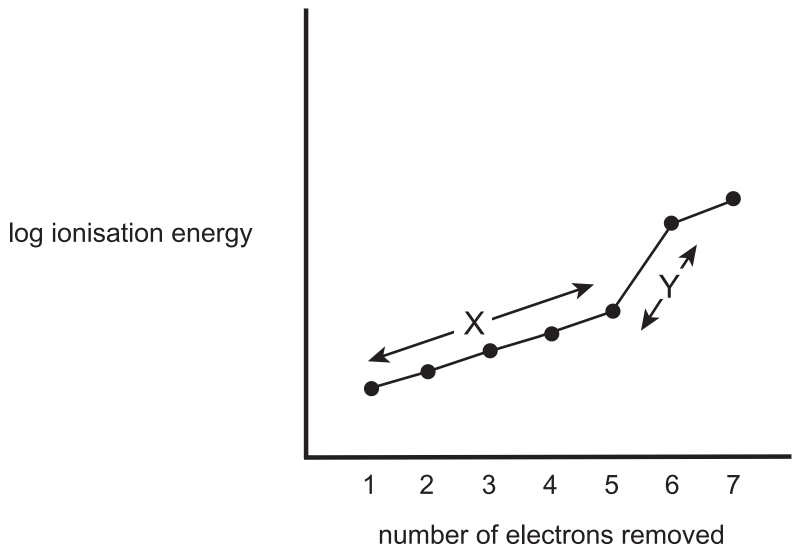
C 109.5°

D 112.0°

Section B

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

11 The graph below shows the successive ionisation energies of an element when all its electrons are removed.



(a) Name the element that gives rise to this graph.

____ [1]

(b) (i) Explain why the ionisation energies increase in section **X**.

____

____

____ [2]

(ii) Explain the large difference in ionisation energies in section **Y**.

____

____

____

____ [2]

Quality of written communication [2]

12 Caesium is a very reactive metal that has sky blue lines in the visible region of its emission spectrum (from the Latin *caesius* meaning "sky blue").

(a) (i) How are the lines in the emission spectrum of caesium formed?

____

____

____ [3]

(ii) Why do the lines in the emission spectrum of caesium converge?

____

____ [1]

(b) Caesium has one of the lowest first ionisation energies of all the elements in the Periodic Table.

(i) Write an equation, including state symbols, for the first ionisation of caesium.

____ [2]

(ii) The frequency at the convergence limit of caesium is 9.41×10^{14} Hz. Calculate the first ionisation energy of caesium in $kJ\,mol^{-1}$.

____

____

____

____ [3]

(iii) Give **two** reasons why the first ionisation energy of caesium is low.

____

____

____ [2]

(c) Caesium is so reactive that it will react with gold to form caesium auride, CsAu. The gold can be obtained from caesium auride by reacting it with water. Caesium hydroxide and hydrogen are the other products. Write an equation for the reaction of caesium auride with water.

____ [2]

13 Fluorine is the most electronegative element in the Periodic Table. Although the element is extremely reactive, fluoride ions can be safely added to water supplies and toothpastes.

(a) What is the meaning of the term **electronegativity**?

____

____ [2]

(b) Fluorine reacts with boron to form boron trifluoride.

(i) Draw a dot and cross diagram, using outer shell electrons only, to show the bonding in boron trifluoride.

[2]

(ii) State and explain the shape of a boron trifluoride molecule.

Shape: _______________________________________

Explanation: ___________________________________

____

____ [3]

(iii) State the **octet rule**.

____

____ [2]

(iv) Explain whether or not the elements in boron trifluoride obey the octet rule.

____

____

____ [2]

(c) Sodium fluoride is added to toothpaste to strengthen tooth enamel.

(i) The data on a 50 g tube of toothpaste states that it contains "1450 ppm fluoride"; ppm means "parts per million" i.e. there would be 1450 g of fluoride ions in 10^6 (1,000,000) g of toothpaste. Use the following headings to work out the concentration of sodium fluoride in the toothpaste. The density of the toothpaste is 1.6 g cm^{-3}.

Mass of fluoride ions in the 50 g tube

____

Number of moles of fluoride ions in the 50 g tube

____

Number of moles of sodium fluoride in the 50 g tube

____

Volume of toothpaste in the 50 g tube

____

Concentration of sodium fluoride in the toothpaste with units

____

____ [6]

(ii) Sodium fluoride is also added to some public water supplies. Why might some people be opposed to this?

____

____ [1]

(iii) Giving practical details, describe how you could prove that a sample of solid sodium fluoride contains sodium ions.

____

____

____

____ [4]

Examiner Only
Marks | Remark

14 Halide ions can be displaced from aqueous solutions of their salts using a more reactive halogen.

(a) A student bubbled excess chlorine into sodium bromide solution and the following reaction took place.

$$Cl_2(g) + 2NaBr(aq) \rightarrow 2NaCl(aq) + Br_2(aq)$$

(i) What change would be observed in the solution?

____ [2]

(ii) With reference to oxidation numbers explain why this is a redox reaction.

____

____

____ [3]

(iii) Describe how you could prove that there were no bromide ions remaining.

____

____

____

____ [4]

(b) Hydrogen halides are gases which are very soluble in water forming acidic solutions.

(i) State and suggest an explanation for the strength of hydrofluoric acid relative to the other hydrogen halides.

____

____

____ [2]

(ii) Silicon dioxide is used to make glass. Hydrofluoric acid has to be stored in plastic containers as it reacts with the "silicon dioxide" in glass to produce silicon tetrafluoride and water. Write the equation for this reaction.

____ [2]

15 Magnesium is an s-block metal which exists as the three isotopes, ^{24}Mg, ^{25}Mg and ^{26}Mg in a ratio of 8:1:1. It reacts with oxygen to form magnesium oxide which has a wide variety of uses including cement manufacture and heartburn medication.

(a) **(i)** Why is magnesium in the s-block of the Periodic Table?

____ [1]

(ii) Explain the meaning of the term **isotope**.

____

____ [2]

(iii) Calculate the relative atomic mass of magnesium to one decimal place.

____

____

____ [3]

(b) Magnesium oxide can be formed by the combustion of magnesium metal in oxygen.

(i) Draw a dot and cross diagram, using outer shell electrons only, to show how magnesium oxide is formed from a magnesium atom and an oxygen atom.

[3]

(ii) What type of bonding exists in magnesium oxide?

____ [1]

(iii) State **two** physical properties of magnesium oxide.

____

____ [2]

(c) The amount of magnesium oxide in heartburn tablets can be determined by adding a known excess of hydrochloric acid to the tablets.

$$2HCl(aq) + MgO(s) \rightarrow MgCl_2(aq) + H_2O(l)$$

The amount of unreacted hydrochloric acid is determined by titrating it against sodium hydroxide.

$$NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$$

(i) What is this method of titration called?

____ [1]

(ii) A student added 80 cm^3 of 2.0 mol dm^{-3} hydrochloric acid to five crushed heartburn tablets which contained magnesium oxide. The unreacted acid required 25 cm^3 of 2.0 mol dm^{-3} sodium hydroxide for complete neutralisation. Use the headings below to calculate the mass, in milligrams, of magnesium oxide in each tablet.

Number of moles of hydrochloric acid added to the tablets

____

Number of moles of unreacted hydrochloric acid

____

Number of moles of hydrochloric acid which reacted with the magnesium oxide

____

Number of moles of magnesium oxide present in five tablets

____

Mass of magnesium oxide per tablet in milligrams

____

____ [6]

16 The table below gives some information about three solids, aluminium, ice and diamond.

	Aluminium	Ice	Diamond
Density ($g\,cm^{-3}$)	2.70	0.92	3.52
Electrical conductivity	High	Low	Low
Melting point (°C)	660	0	3550

Use your knowledge of bonding and intermolecular forces to answer the following questions.

(a) Why is the density of ice lower than the density of water?

____

____

____ [2]

(b) Explain the high electrical conductivity of aluminium.

____

____

____ [2]

(c) Why does diamond have a high melting point?

____

____

____ [2]

THIS IS THE END OF THE QUESTION PAPER