Rewarding Learning

71

Candidate Number

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
January 2014

Chemistry

Assessment Unit AS 1

assessing

Basic Concepts in Physical and Inorganic Chemistry

[AC112]

AC112

THURSDAY 9 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 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 **12(d)(iv)**.
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, containing some data, is included in this question paper.

For Examiner's use only	
Question Number	Marks
Section A	
1–10	
Section B	
11	
12	
13	
14	
15	
16	
Total Marks	

8786

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 An element in the Periodic Table has the following successive ionisation energies (kJ mol^{-1}).

590 1145 4912 6474 8144 10496 12320

In which one of the following groups is this element found?

A Group I

B Group II

C Group III

D Group IV

2 Which one of the following is the oxidation number of hafnium in HfF_7^{3-}?

A -3

B $+3$

C -4

D $+4$

3 Boron consists of the isotopes $^{10}_{5}B$ and $^{11}_{5}B$. The relative atomic mass of the element is 10.80. Which one of the following is the approximate ratio of the number of lighter atoms to heavier atoms?

A 1:3

B 1:4

C 1:9

D 4:1

4 Which one of the following equations shows hydrogen peroxide, H_2O_2, beha reducing agent?

A $2Fe^{2+} + H_2O_2 + 2H^+ \rightarrow 2Fe^{3+} + 2H_2O$

B $2I^- + H_2O_2 + 2H^+ \rightarrow I_2 + 2H_2O$

C $MnO_2 + 2H^+ + H_2O_2 \rightarrow Mn^{2+} + 2H_2O + O_2$

D $PbS + 4H_2O_2 \rightarrow PbSO_4 + 4H_2O$

5 The electronegativity values, not in order, for caesium, cobalt, fluorine and nitrogen are listed below. Which one of the following is the value for the cobalt atom?

A 0.70

B 1.80

C 3.00

D 4.00

6 Which one of the following molecules is linear?

A CH_3CH_3

B CO_2

C H_2O_2

D H_2Te

7 Which one of the following is the reason why water boils at 100 °C while the hydrides of the other Group VI elements boil below 0 °C?

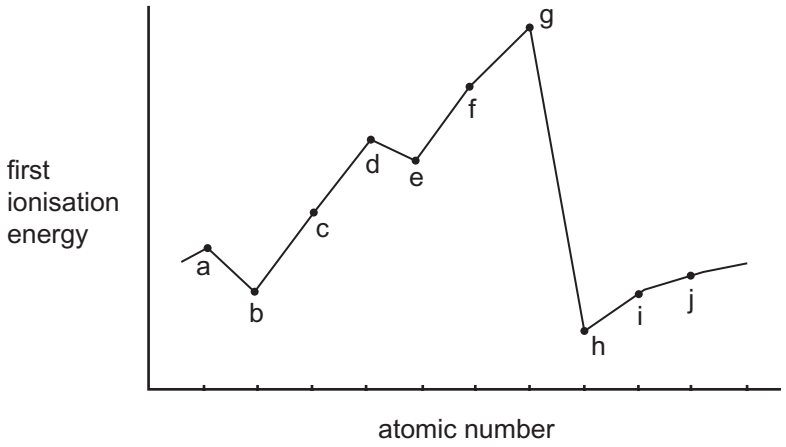
A Hydrogen bonding between water molecules

B Ionic bonding in water molecules

C The lower molar mass of water molecules

D The stability of the bonding in water molecules

8 The first ionisation energy is shown against increasing atomic number.



Which one of the following shows a Group I element together with a Group VII element?

	Group I	Group VII
A	b	f
B	b	g
C	h	f
D	h	g

9 Which one of the following properties is a characteristic of astatine?

A It has an electronegativity value greater than that of iodine.

B It is a solid at room temperature and pressure.

C It oxidises bromide ions to bromine.

D Its hydride exhibits more hydrogen bonding than hydrogen iodide.

10 3.12 g of MCl_2 were dissolved in water and made up to one litre of solution. 25.0 cm^3 of this solution reacts with 7.5 cm^3 of 0.100 M silver nitrate solution.

$$MCl_2(aq) \rightarrow M^{2+}(aq) + 2Cl^-(aq)$$
$$Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$$

Which one of the following Group II elements is M?

A barium

B calcium

C magnesium

D strontium

Section B

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

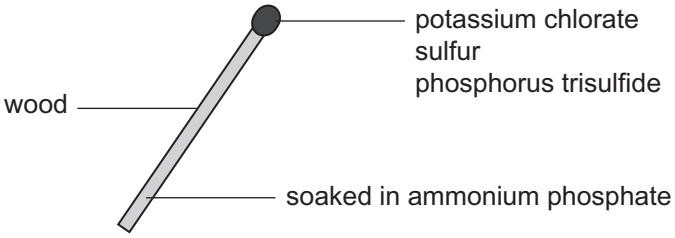
11 Complete the following table about the silver halides.

silver halide	formula	colour	ionic/ covalent	soluble in dilute ammonia solution	soluble in concentrated ammonia solution
silver fluoride	AgF	white	ionic	yes	yes
silver chloride					
silver bromide					
silver iodide					

[4]

12 The creation of the friction match took many years and involved a variety of chemicals based on phosphorus.

The modern match is shown below. The head is a mixture of potassium chlorate, sulfur and phosphorus trisulfide held together by glue. The wood is soaked in ammonium phosphate which acts as a fire retardant.



(a) Potassium chlorate reacts with the sulfur to form potassium chloride and sulfur dioxide as shown by the following equation.

$$2KClO_3 + 3S \rightarrow 2KCl + 3SO_2$$

(i) Deduce the oxidation number for each element in the reactants.

_____ [1]

(ii) Deduce the oxidation number for each element in the products.

_____ [1]

(iii) Explain, using these oxidation numbers, why this is a redox reaction.

_____

_____ [1]

(b) Potassium chlorate, $KClO_3$, is manufactured using the reaction between chlorine and potassium hydroxide.

(i) Write the equation for the reaction.

_____ [2]

(ii) State the conditions under which the reaction is carried out.

_____ [1]

(c) Phosphorus trisulfide is easily ignited. It provides the heat to initiate the reaction between potassium chlorate and sulfur.

(i) Phosphorus has an oxidation number of +3 in phosphorus trisulfide. State the formula of phosphorus trisulfide.

_____ [1]

(ii) Suggest whether phosphorus trisulfide is ionic or covalent. Explain your reasons.

_____

_____ [1]

(iii) Name the **two** products formed when phosphorus trisulfide is completely burnt. No oxidation numbers are needed.

_____

_____ [2]

(d) Ammonium phosphate is an ionic compound consisting of ammonium and phosphate ions, PO_4^{3-}.

(i) Write the formula of the ammonium ion.

_____ [1]

(ii) Name and draw the shape of the ammonium ion stating the interbond angle.

_____ [3]

(iii) Write the formula of ammonium phosphate.

_____ [1]

(iv) State and explain **three** physical properties you would expect ammonium phosphate to have.

_____

_____

_____

_____

_____

_____

_____ [3]

Quality of written communication [2]

13 Francium is found in Group I of the Periodic Table and was discovered by Marguerite Perey in 1939 in the Curie Laboratory in France. It was isolated from uranium ore. Since then it has been synthesised by the nuclear reaction of oxygen atoms with gold atoms. It exists as 34 isotopes.

In the Periodic Table it has an atomic number of 87 and is given a relative atomic mass of 223.

(a) Francium is found in period 7 of the Periodic Table and is regarded as an s-block element.

Suggest the subshell occupied by the outermost electron in a francium atom.

_____ [1]

(b) Francium was first synthesised according to the following equation.

$$^{197}Au + {}^{18}O \rightarrow {}^{210}Fr + 5n$$

The symbol n represents a neutron.

(i) What is the relative mass of a neutron?

_____ [1]

(ii) Using the relative mass of the neutron from part **(i)** show, by calculation, that the equation is balanced according to mass.

_____

_____ [2]

(iii) Why are electrons not used when balancing the equation according to mass?

_____

_____ [1]

(c) Francium is one of the least electronegative elements in the Periodic Table.

(i) Explain the meaning of the term **electronegativity**.

_____

_____ [2]

(ii) State how electronegativity values change on going across a period.

_____ [1]

(d) Francium has a melting point of 27 °C and would melt in the hand just as caesium does. It has the highest electrical conductivity of the alkali metals.

(i) Explain, in terms of metallic bonding, why francium has a low melting point.

_____

_____ [2]

(ii) Explain, in terms of metallic bonding, why francium has the highest electrical conductivity.

_____

_____ [2]

(e) Francium loses electrons when it reacts with chlorine and the chlorine gains these electrons.

(i) Write the equation for the loss of an electron from a francium atom.

_____ [1]

(ii) Write the equation for the formation of chloride ions from a chlorine molecule.

_____ [1]

(iii) Write the equation for the reaction of francium with chlorine.

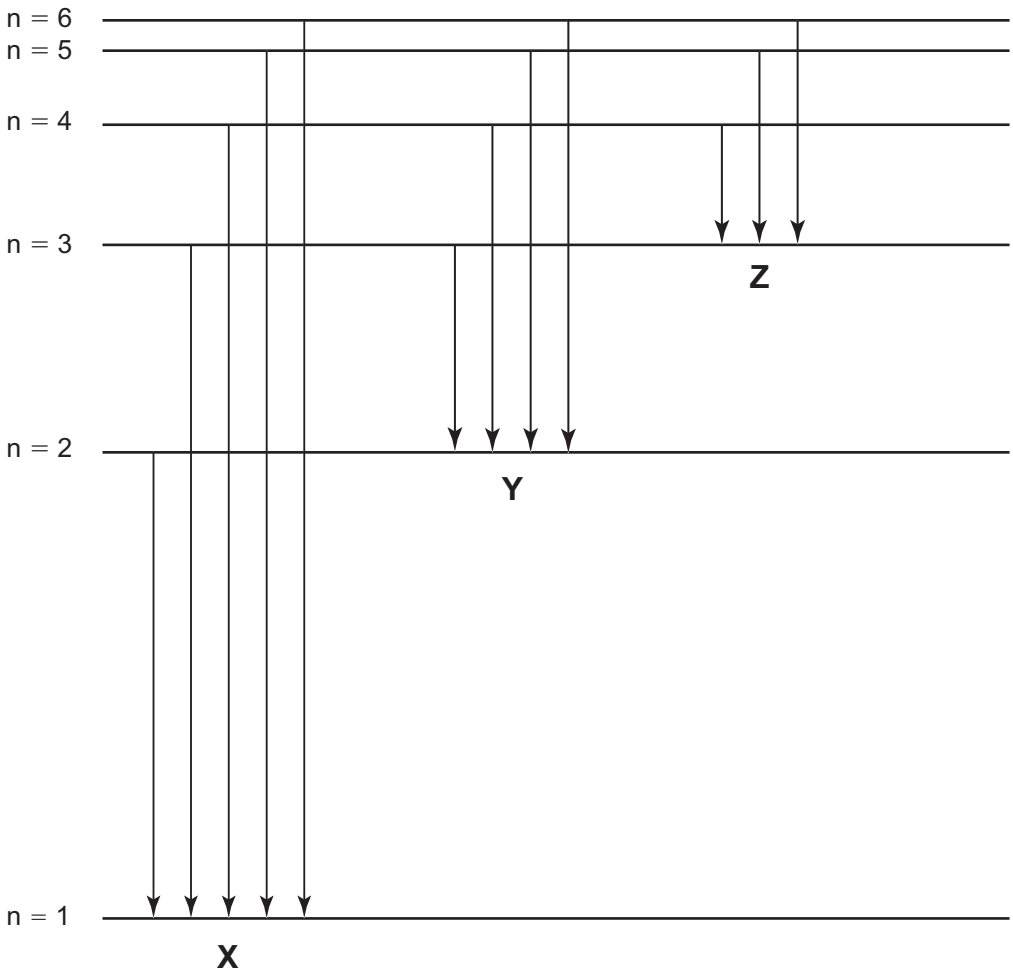
_____ [1]

(iv) Francium chloride exists as a lattice structure similar to that of NaCl. Explain the term **lattice structure**.

_____

_____ [1]

14 The energy levels of a hydrogen atom are shown below and the arrows indicate the transition of electrons between successive energy levels.



The electromagnetic spectrum is shown below.

Radio waves	Microwaves	Infrared	Visible	Ultraviolet	X-rays	Gamma rays

Energy increases →

(a) Write the equation that relates energy to frequency, explain the meanings of the symbols used and state the units in which they are measured.

_____

_____

_____

_____ [3]

(b) There are three series of lines. The first series **X** occurs in the ultraviolet region of the electromagnetic spectrum.

(i) In which part of the electromagnetic spectrum does the second series, **Y**, occur?

_____ [1]

(ii) Suggest in which part of the electromagnetic spectrum the third series, **Z**, occurs.

_____ [1]

(iii) What happens to the atom when its electron passes from energy level n = 1 to an infinite energy level?

_____

_____ [1]

(c) **(i)** Use the energy level diagram below to show the ground state of a sodium atom. Use arrows to represent the sodium electrons.

3s _____

2p _____

2s _____

1s _____ [2]

(ii) What is the predominant colour in the emission spectrum of sodium?

_____ [1]

15 Iron reacts with dilute hydrochloric acid to form iron(II) chloride, $FeCl_2$, and hydrogen. The solution deposits crystals of hydrated iron(II) chloride.

(a) Write the ionic equation, with state symbols, for the reaction of iron with hydrochloric acid.

_____ [2]

(b) A solution of iron(II) ions is oxidised by chlorine water to form iron(III) ions.

(i) Write the ionic equation for the reaction.

_____ [1]

(ii) Describe the colour of the solution after the reaction has taken place.

_____ [1]

(iii) Explain whether iron(II) ions would react with bromine water.

_____

_____ [1]

(c) Iron(II) chloride is extremely soluble in water. 69 g of the anhydrous solid dissolve in 100 cm^3 of water at 20 °C. Assuming there is no volume change calculate the molarity of the resulting solution.

_____

_____

_____ [3]

(d) 14.1 g of the hydrated iron(II) chloride crystals contain 6.5 g of water. Use these figures to calculate the formula of the crystals.

mass of iron(II) chloride

_____

moles of iron(II) chloride

_____

moles of water

_____

ratio of moles of water to moles of iron(II) chloride

_____

formula of iron(II) chloride crystals

_____ [5]

16 Sulfur forms the following fluorides:

sulfur difluoride	SF_2
sulfur tetrafluoride	SF_4
sulfur hexafluoride	SF_6

Sulfur hexafluoride is the best known and can be used as a safe electrical insulator. The other fluorides are toxic.

(a) Draw the dot and cross diagrams showing the outer electrons only for each of the fluorides.

[3]

(b) (i) State the **octet rule**.

_____

_____ [2]

(ii) Explain whether sulfur is obeying the octet rule in each fluoride.

_____

_____

_____ [2]

(c) Sulfur difluoride has the same shape as a water molecule but the bond angle is 6° smaller. Draw and name the shape of sulfur difluoride, stating its bond angle.

_____ [3]

(d) The sulfur hexafluoride molecule has an octahedral shape.

(i) State the bond angle(s) in the sulfur hexafluoride molecule.

_____ [1]

(ii) Explain why sulfur hexafluoride has an octahedral shape.

_____

_____ [2]

(iii) Explain why sulfur hexafluoride is a non-polar molecule.

_____

_____ [1]

(e) Sulfur tetrafluoride has a boiling point of –38 °C whereas sulfur hexafluoride has a boiling point of –64 °C.

(i) Which compound has the higher boiling point?

_____ [1]

(ii) Explain, in terms of mass, which compound has the greater van der Waals forces.

_____

_____ [1]

(iii) Explain, in terms of intermolecular forces, the difference in boiling points.

_____

_____ [2]

THIS IS THE END OF THE QUESTION PAPER