Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2023

Centre Number

Candidate Number

Chemistry

Assessment Unit AS 1

assessing

Basic concepts in Physical and Inorganic Chemistry

SCH14

[SCH14]

TUESDAY 16 MAY, 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 in **Sections A and B**.
You must answer the questions in the spaces provided.
Do not write outside the boxed area on each page or on blank pages.
Complete in black ink only. **Do not write with a gel pen or a pencil.**

INFORMATION FOR CANDIDATES

The total mark for this paper is 90.
Quality of written communication will be assessed in Question **13(a)**.
The figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question.
A Periodic Table of Elements, containing some data, is included with this question paper.

13618.06**R**

Section A

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

Select the correct response in each question and write the appropriate letter in the space provided.

1 Which one of the following bond angles is **not** present in a PF_5 molecule?

A 90°

B 109.5°

C 120°

D 180°

Answer _____ [1]

2 Which one of the following gives the correct formulae for potassium chromate(VI) and potassium dichromate(VI)?

A $KCrO_4$ KCr_2O_7

B $KCrO_4$ $K_2Cr_2O_7$

C K_2CrO_4 KCr_2O_7

D K_2CrO_4 $K_2Cr_2O_7$

Answer _____ [1]

3 7.10 g of anhydrous sodium sulfate were dissolved in water and made up to 250 cm^3 in a volumetric flask. What is the concentration of sodium ions in this solution?

A 0.05 mol dm^{-3}

B 0.10 mol dm^{-3}

C 0.20 mol dm^{-3}

D 0.40 mol dm^{-3}

Answer _____ [1]

4 Which one of the following bonds is the least polar?

A O—F

B N—F

C Cl—F

D I—F

Answer _____ [1]

5 Which one of the following is **not** a disproportionation reaction?

A $Br_2 + H_2O \rightarrow HBr + HBrO$

B $Cl_2 + 2NaBr \rightarrow 2NaCl + Br_2$

C $Cl_2 + 2NaOH \rightarrow NaCl + NaClO + H_2O$

D $3Cl_2 + 6NaOH \rightarrow 5NaCl + NaClO_3 + 3H_2O$

Answer _____ [1]

6 Which one of the following is the number of atoms present in 3.20 g of sulfur dioxide?

A 3.01×10^{22}

B 6.02×10^{22}

C 9.03×10^{22}

D 6.02×10^{23}

Answer _____ [1]

7 Which one of the following shows the **incorrect** colour for the substance given?

	Substance	**Colour**
A	$I_2(aq)$	brown
B	$I_2(g)$	red-brown
C	$I_2(hexane)$	purple
D	$I_2(s)$	grey-black

Answer _____ [1]

8 Hydrated nickel(II) nitrate is a green crystalline solid which contains approximately 37% water by mass. Which one of the following is the correct formula of hydrated nickel(II) nitrate?

A $NiNO_3.4H_2O$

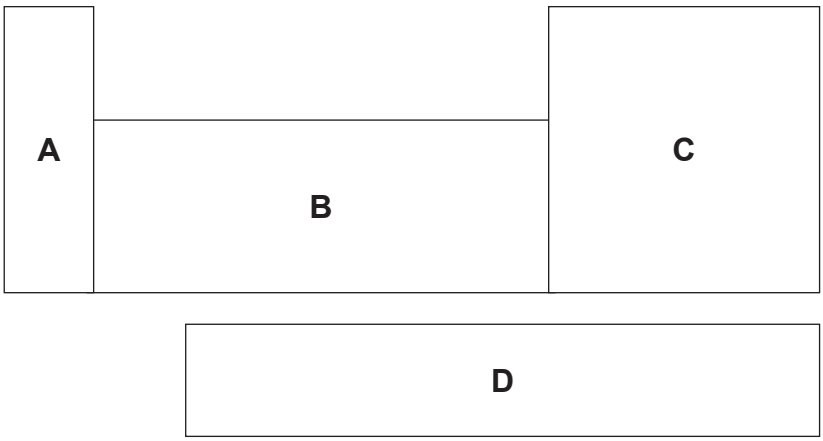
B $NiNO_3.6H_2O$

C $Ni(NO_3)_2.4H_2O$

D $Ni(NO_3)_2.6H_2O$

Answer _____ [1]

9 Which one of the following letters represents the d-block of the Periodic Table?



Answer _____ [1]

10 Which one of the following is correct for a p subshell?

	Number of orbitals	**Maximum number of electrons in subshell**
A	1	2
B	3	6
C	5	10
D	7	14

Answer _____ [1]

[Turn over

Section B

Answer all **five** questions in this section

11 Magnesium has three naturally occurring isotopes: ^{24}Mg, ^{25}Mg and ^{26}Mg.

(a) **(i)** State the number of protons, neutrons and electrons in an atom of the ^{26}Mg isotope.

protons _____

neutrons _____

electrons _____ [1]

(ii) Write the electronic configuration of an atom of the ^{26}Mg isotope.

_____ [1]

(b) The percentage abundance and relative isotopic mass of each isotope are given in the table below.

Isotope	Abundance /%	Relative isotopic mass
^{24}Mg	79.0	23.985
^{25}Mg	10.0	24.986
^{26}Mg	11.0	25.983

(i) Define **relative isotopic mass**.

_____

_____

_____

_____ [2]

(ii) Calculate the relative atomic mass of magnesium to 1 decimal place.

Answer _____ [2]

(c) The successive ionisation energies of magnesium give evidence for the existence of shells.

(i) Define **third ionisation energy**.

_____

_____

_____

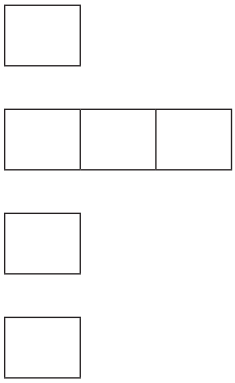
_____ [2]

(ii) Write an equation, including state symbols, which represents the third ionisation energy of magnesium.

_____ [1]

[Turn over

(iii) Label the subshells in the diagram and, using electrons in boxes notation, give the electronic configuration of the $^{26}Mg^{2+}$ ion.



[2]

(iv) The second ionisation energy of magnesium is 1500 kJ mol^{-1} and the third ionisation energy of magnesium is 7700 kJ mol^{-1}. State three reasons why the third ionisation energy of magnesium is much greater than the second.

_____

_____

_____

_____

_____

_____

_____

_____ [3]

(d) Magnesium reacts with chlorine to form magnesium chloride in a redox reaction.

(i) Write half-equations for the oxidation and reduction reactions which occur.

oxidation half-equation _____

reduction half-equation _____ [2]

(ii) Using a dot and cross diagram show how magnesium chloride is formed from magnesium and chlorine atoms.

[2]

12 Concentrated sulfuric acid reacts with the solids, sodium chloride, sodium bromide and sodium iodide. Concentrated sulfuric acid is a source of sulfate ions.

(a) Give the systematic name of the sulfate ion.

_____ [1]

(b) The reaction between concentrated sulfuric acid and solid sodium chloride is not a redox reaction. One of the products is hydrogen chloride.

(i) Write an equation for this reaction.

_____ [1]

(ii) Describe a test which would indicate the presence of hydrogen chloride.

_____

_____

_____ [2]

(c) During the reaction between concentrated sulfuric acid and solid sodium bromide, hydrogen bromide is formed and oxidised by the acid. Write an equation for oxidation of hydrogen bromide by concentrated sulfuric acid.

_____ [2]

(d) Iodide ions are stronger reducing agents than bromide ions.

(i) Define **reducing agent**.

_____ [1]

(ii) Suggest why iodide ions are stronger reducing agents than bromide ions.

_____

_____ [1]

(e) When concentrated sulfuric acid is added to solid sodium iodide, iodine and three sulfur containing products are formed.

(i) Determine the oxidation state of sulfur in each of the following sulfur containing products.

SO_2 _____

S _____

H_2S _____ [2]

(ii) What observation would suggest the formation of H_2S in this reaction?

_____ [1]

(iii) What observation would suggest the formation of sulfur in this reaction?

_____ [1]

(iv) Complete the half-equation for the formation of H_2S.

SO_4^{2-} + H^+ + → H_2S + H_2O

[2]

(v) Write a half-equation for the formation of iodine.

_____ [1]

(vi) Combine the half-equations in **(e)(iv)** and **(e)(v)** to give a balanced redox equation.

_____ [1]

[Turn over

13 Elements and compounds show different types of bonding and structure.

(a) Describe the bonding and structure of carbon (graphite) and oxygen and explain the difference in the melting points of the two substances.

In this question you will be assessed on your written communication skills including the use of specialist scientific terms.

[6]

(b) Carbon (graphite) reacts with oxygen and with ozone (O_3). Both reactions form carbon dioxide.

(i) Write an equation for the reaction of carbon (graphite) with ozone.

_____ [1]

(ii) Describe a chemical test for carbon dioxide.

_____

_____ [1]

(iii) Explain why carbon dioxide is non-polar.

_____

_____ [2]

(c) Carbon dioxide reacts with potassium hydroxide to form potassium carbonate. Potassium carbonate is an ionic compound which melts at 891° C and is very soluble in water.

(i) State how you could show experimentally that potassium carbonate is an ionic compound based on its physical properties.

_____

_____

_____ [1]

(ii) Write an equation for the formation of potassium carbonate from carbon dioxide and potassium hydroxide.

_____ [1]

(iii) Describe how you would carry out a flame test on a sample of solid potassium carbonate to show the presence of potassium ions.

_____

_____

_____

_____

_____ [3]

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(Questions continue overleaf)

14 Ethane (CH_3CH_3) and methylamine (CH_3NH_2) have similar relative molecular masses.

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

[1]

(ii) State the value for the H—C—H bond angles in a methylamine molecule.

_____ [1]

(iii) Suggest and explain the shape around the nitrogen atom in a methylamine molecule.

_____

_____

_____

_____

_____

_____ [3]

(b) (i) Define **electronegativity**.

_____

_____

_____ [1]

(ii) Show the polarity of the N—H bond below, using partial charges.

N—H

[1]

(iii) Predict which of the compounds, ethane or methylamine, has the higher boiling point. Explain the difference in boiling points between these two compounds.

_____

_____

_____

_____

_____

_____

_____

_____ [3]

[Turn over

(c) Methylamine is a weak base and a solution of methylamine reacts with strong acids to form the methylammonium ion ($CH_3NH_3^+$).

(i) Write an equation for the reaction of methylamine with sulfuric acid to form methylammonium sulfate.

_____ [2]

(ii) Explain, with reference to the type of bond formed, how a methylamine molecule forms a methylammonium ion.

_____

_____

_____

_____ [2]

(iii) Draw a diagram to show two hydrogen bonds which can form between one methylamine molecule and two water molecules. Show all lone pairs.

[2]

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(Questions continue overleaf)

15 Sodium hydroxide solution is used in precipitation reactions and in titrations.

(a) When a sample of 175 cm^3 of a 0.100 mol dm^{-3} solution of sodium hydroxide is added to 125 cm^3 of a 0.100 mol dm^{-3} solution of magnesium chloride, magnesium hydroxide forms as a white precipitate.

$$MgCl_2 + 2NaOH \rightarrow Mg(OH)_2 + 2NaCl$$

(i) Write an ionic equation, including state symbols, for this reaction.

_____ [2]

(ii) Calculate the maximum mass of magnesium hydroxide which could form. Give your answer to 3 significant figures.

Answer _____ [4]

(b) In a titration, 25.0 cm^3 of sulfuric acid were titrated using 0.18 mol dm^{-3} sodium hydroxide solution. The table below shows the titration values obtained. The mean titre was calculated to be 21.2 cm^3.

	Rough	**Accurate 1**	**Accurate 2**
Initial burette reading /cm^3	1.5		24.9
Final burette reading /cm^3	23.4	44.5	
Titre /cm^3			21.3

(i) Complete the table. [3]

(ii) Calculate the concentration of the sulfuric acid in g dm^{-3}. Give your answer to an appropriate number of significant figures.

Answer _____ g dm^{-3} [4]

(iii) Name a suitable indicator for this titration and state the colour change observed at the end point.

Indicator: _____

Colour change: _____ [2]

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

Examiner Number

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