cea
Rewarding Learning

Chemistry

Assessment Unit AS 1

assessing

Module 1: General Chemistry

[ASC11]

ASC11

FRIDAY 16 JANUARY, MORNING

For Examiner's use only

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 seventeen** 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 seven** 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 **15(d)(ii)**.
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	
17	
Total Marks	

4974

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

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

1   How many electrons are there in a calcium ion?

    A   18
    B   20
    C   22
    D   40

2   Which one of the following equations represents the second ionisation energy for barium?

    A $Ba(s) \rightarrow Ba^{2+}(g) + 2e^-$
    B $Ba(g) \rightarrow Ba^{2+}(g) + 2e^-$
    C $Ba^+(s) \rightarrow Ba^{2+}(g) + e^-$
    D $Ba^+(g) \rightarrow Ba^{2+}(g) + e^-$

3   Which one of the following shows the trend in electronegativity values of the elements in the Periodic Table?

	Across a Period	**Down a Group**
A	decrease	decrease
B	decrease	increase
C	increase	decrease
D	increase	increase

4   The element astatine lies immediately below iodine in the Periodic Table and is likely to

    A   be pale yellow.
    B   be a volatile liquid at room temperature and pressure.
    C   form a hydride which dissolves in water to give an acidic solution.
    D   oxidise iodide ions to iodine.

5 If the price of one tonne (1000 kg) of sulphur is £160, what is the cost (to the nearest pound) of the sulphur needed to make one tonne of sulphuric acid, H_2SO_4?

A £52
B £98
C £160
D £490

6 Which one of the following does not obey the octet rule?

A beryllium chloride
B carbon dioxide
C nitrogen
D oxygen

7 The orbitals of a nitrogen atom may be represented as shown.

1s   2s   2p

Which one of the following diagrams represents the arrangement of electrons in the ground state of the nitrogen atom?

A $\uparrow\uparrow$ $\uparrow\uparrow$ $\uparrow$ | $\uparrow$ | $\uparrow$

B $\uparrow\downarrow$ $\uparrow\uparrow$ $\uparrow$ | $\uparrow$ | $\uparrow$

C $\uparrow\downarrow$ $\uparrow\downarrow$ $\uparrow\downarrow$ | $\uparrow$ |

D $\uparrow\downarrow$ $\uparrow\downarrow$ $\uparrow$ | $\uparrow$ | $\uparrow$

8 Potassium iodide is formed when potassium is warmed in iodine vapour. W̶̶̶̶ the following describes the bonding in the three species?

	potassium	iodine	potassium iodide
A	ionic	covalent	ionic
B	metallic	ionic	covalent
C	covalent	covalent	ionic
D	metallic	covalent	ionic

9 Which one of the following has a bond angle of 109.5 °?

A $BeCl_2$
B BF_3
C CH_4
D CO_2

10 Which one of the following ions has the largest radius?

A F^-
B Mg^{2+}
C Na^+
D O^{2-}

Section B

Answer **all seven** questions in the spaces provided.

11 Metal ions are responsible for the flame colours produced by fireworks. Complete the table below by inserting the flame colour for each metal ion.

metal ion	flame colour
barium	
potassium	
sodium	

[3]

12 (a) Draw the shape of an s orbital.

[1]

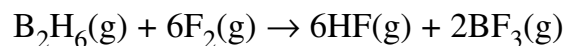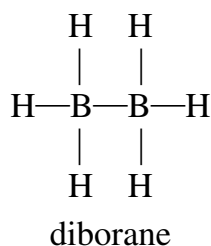**(b)** Draw the shape of a p orbital.

[1]

(c) Write the electronic configuration of a carbon atom in terms of s and p electrons.

_____[1]

[Turn over

13 Rocket fuels need to supply a large amount of energy, yet have a low mass i.e. a high power to weight ratio.

One potential reaction is that of fluorine with diborane (a boron hydride).

$$\begin{array}{cc} H & H \\ | & | \\ H-B-B-H \\ | & | \\ H & H \end{array}$$

diborane

$$B_2H_6(g) + 6F_2(g) \rightarrow 6HF(g) + 2BF_3(g)$$

(a) Calculate the enthalpy change when one mole of diborane reacts completely with fluorine given the following bond enthalpies.

bond	kJ mol^{-1}
F—F	158
B—H	389
B—B	293
H—F	566
B—F	627

_____

_____

_____[3]

(b) The bond enthalpy of hydrogen fluoride is 566 kJ mol^{-1} whereas that of hydrogen iodide is 299 kJ mol^{-1}. State what would be observed when hydrogen fluoride and hydrogen iodide are heated.

_____

_____

_____[2]

(c) Both HF and BF$_3$ are gases at room temperature and pressure. Calculate the total volume of gas produced at 20 °C and one atmosphere pressure by the complete reaction of 7.0 g of diborane with fluorine.

_____

_____

_____[3]

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

_____

_____

_____[2]

14 Silver occurs in nature as the sulphide and as the chloride. Although less malleable and less ductile than gold, the thermal and electrical conductivities of silver are greater than those of any other metal.

(a) (i) Explain what is meant by the term **malleability**.

_____

_____[2]

(ii) Explain what is meant by the term **ductility**.

_____

_____[2]

(iii) Explain how silver is able to conduct electricity.

_____

_____[2]

(b) Silver hardly dissolves in hydrochloric acid and the usual method of preparing silver chloride is to add a soluble metal chloride to a soluble silver salt.

(i) Name a soluble metal chloride.

_____[1]

(ii) Name a soluble silver salt.

_____[1]

(iii) Write an ionic equation for the reaction of the soluble metal chloride with the soluble silver salt.

_____[1]

(c) Silver chloride is virtually insoluble in water. Its solubility has been estimated at $0.4\,\text{mg}$ in $250\,\text{cm}^3$ of water at $20\,°\text{C}$.

(i) Calculate the molar mass of silver chloride.

_____[1]

(ii) Calculate the number of moles of silver chloride in $0.4\,\text{mg}$.

_____

_____[1]

(iii) Calculate the solubility of silver chloride in moles per litre.

_____

_____[1]

(iv) Name a solution that will dissolve silver chloride.

_____[1]

(v) Silver chloride is a white solid which is affected by light. Describe and explain the effect of light on silver chloride.

_____

_____[2]

15 Bromine was discovered in the residues from the manufacture of sea salt at Montpellier, France. The residues contain magnesium bromide.

The addition of chlorine liberates bromine.

(a) (i) Write an equation for the reaction of chlorine with magnesium bromide.

_____[2]

(ii) Using electron transfer, explain why this can be considered to be redox reaction.

_____

_____

_____[3]

(b) Bromine, Br_2, is a liquid at room temperature. Liquid bromine has a high density: 1 mol of bromine, Br_2, occupies $51\,cm^3$.

Calculate the density of bromine in $g\,cm^{-3}$.

_____

_____[2]

(c) Bromine is miscible with organic (non-aqueous) solvents, but its solubility in water is more limited. The aqueous solution is known as bromine water.

(i) Name a non-aqueous solvent that dissolves bromine.

_____[1]

(ii) Compare the solubilities of bromine and iodine in water.

_____

_____[2]

(iii) Describe what would be observed if bromine water was added to concentrated solutions of sodium chloride and sodium iodide respectively.

sodium chloride

_____[1]

sodium iodide

_____[1]

(d) The concentration of bromine in solution can be measured by reacting it with excess potassium iodide and the liberated iodine determined by titration with sodium thiosulphate solution.

(i) Write an equation for the reaction of sodium thiosulphate with iodine.

_____[2]

(ii) Describe, with practical details, how this titration would be carried out. Assume all the apparatus is clean and dry. Details of calculations are not required.

_____

_____

_____

_____

_____

_____

_____

_____[5]

Quality of written communication   [2]

4974   **11**   **[Turn over**

16 Oxalic acid (ethanedioic acid) is a weak dicarboxylic acid. It is similar to acetic acid (ethanoic acid) which is a monocarboxylic acid.

COOH CH_3COOH
|
COOH

oxalic acid   acetic acid
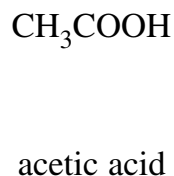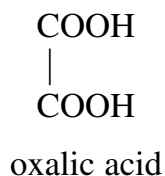
(a) Suggest the meaning of the term **dicarboxylic** acid.

_____

_____[2]

(b) Both of these acids react with alkalis. Write the equation for the reaction of oxalic acid with **excess** sodium hydroxide.

_____[2]

(c) Weak acids such as oxalic acid can be titrated with strong alkalis using phenolphthalein as indicator.

State the colour of phenolphthalein in alkaline and acidic solution.

alkali _____[1]

acid _____[1]

(d) If oxalic acid reacts with a small amount of phosphorus pentachloride a mixture of gases is produced:

How could you show that hydrogen chloride was a product?

_____

_____

_____[3]

(e) Oxalic acid reacts with excess phosphorus pentachloride to give oxalyl chloride which has the following percentage composition by mass.

element	% composition
carbon	18.9
chlorine	55.9
oxygen	25.2

Calculate the empirical formula of oxalyl chloride.

_____

_____

_____

_____[3]

17 Hydrogen has three naturally occurring isotopes: protium ^{1}H, deuterium ^{2}H and tritium ^{3}H.

(a) Draw an atom of tritium showing and labelling all the sub-atomic particles present.

[2]

(b) The relative atomic mass of hydrogen is 1.0079. Explain which one of the hydrogen isotopes is the most abundant in nature.

_____

_____[2]

(c) When subjected to an electrical discharge, atomic hydrogen emits electromagnetic radiation due to electron transitions between energy levels. The line emission spectrum of atomic hydrogen in the visible region is shown below.
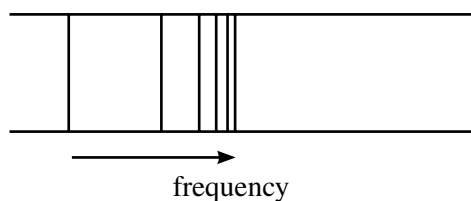
frequency

(i) To which energy level do electrons return to produce lines in the visible region?

_____[1]

(ii) The lowest frequency line in the visible region has a frequency of 4.568×10^{14} s^{-1}. Calculate the energy in kJ mol^{-1}, associated with this frequency.

_____

_____

_____

_____[3]

(iii) Explain why the lines in the emission spectrum converge.

_____

_____[2]

(d) It is possible to obtain pure deuterium oxide, D_2O, from sea water. Deuterium oxide boils at 101.4 °C compared to 100.0 °C for water.

(i) Name the two types of intermolecular forces which exist between water molecules.

_____

_____[2]

(ii) Draw a dot and cross diagram to show the bonding in deuterium oxide, D_2O, showing all the outer shell electrons.

[2]

(iii) Deuterium oxide can combine with deuterium ions, D^+, to form D_3O^+. Write an equation for this reaction.

_____[1]

(iv) Name the type of bond formed between the oxygen atom and the deuterium ion.

_____[1]

THIS IS THE END OF THE QUESTION PAPER

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