Rewarding Learning

71	

Candidate Number

ADVANCED
General Certificate of Education
2009

Chemistry

Assessment Unit A2 1

assessing

Module 4: Further Organic, Physical and Inorganic Chemistry

[A2C11]

A2C11

THURSDAY 21 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 sixteen** questions.
Answer **all ten** questions in **Section A**. Record your answers by marking the appropriate letter in 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 answer in the spaces provided in this question paper.

INFORMATION FOR CANDIDATES

The total mark for this paper is 90.
Quality of written communication will be assessed in question **14(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 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 Which one of the following substances, when added to water in equimolar amounts, will form a solution with the lowest pH?

A Na_2O
B CH_3COOH
C SO_2
D SO_3

2 Which one of the following equations represents the lattice enthalpy of calcium bromide?

A $Ca(s) + Br_2(l) \rightarrow CaBr_2(s)$
B $CaBr_2(s) \rightarrow Ca(s) + Br_2(g)$
C $Ca^{2+}(g) + 2Br^-(g) \rightarrow CaBr_2(g)$
D $CaBr_2(s) \rightarrow Ca^{2+}(g) + 2Br^-(g)$

3 The rate constants for the forward and reverse reactions in the formation of nitrogen(IV) oxide are k_1 and k_2 respectively.

$$2NO + O_2 \rightleftharpoons 2NO_2$$

The equilibrium constant for the forward reaction is K. What is the effect of a catalyst on k_1, k_2 and K?

	k_1	k_2	K
A	decreases	decreases	decreases
B	increases	increases	increases
C	increases	increases	no effect
D	increases	decreases	no effect

4 Concentrated nitric acid is used as

A a dehydrating agent.
B a hydrating agent.
C an oxidising agent.
D a reducing agent.

5 The rate equation for the reaction of iodide ions with hydrogen peroxide in acidic solution is

$$\text{rate} = k[H_2O_2][H^+][I^-]$$

What are the units of k?

A $mol^{-2}\ dm^6\ s^{-1}$
B $mol^{-1}\ dm^3\ s^{-1}$
C $mol\ dm^{-3}\ s^{-1}$
D $mol^2\ dm^{-6}\ s^{-1}$

6 Heating sucrose with dilute hydrochloric acid produces

A fructose only.
B glucose only.
C glucose and fructose.
D glucose and maltose.

7 Which one of the following compounds produced a silver mirror when heated with Tollen's reagent?

A CH_3COCH_3
B CH_3CO_2H
C CH_3CHO
D $CH_3CO_2CH_3$

8 Which one of the following molecules contains a chiral centre?

A $CH_3CH = CHCl$
B $CH_3CH_2CH_2CHO$
C $CH_3CH(CH_3)CO_2H$
D $CH_3CH(OH)CO_2CH_3$

9 Which one of the following equations does **not** represent a redox reaction of nitric acid or the nitrate ion?

A $8Al + 3NO_3^- + 30H^+ \rightarrow 8Al^{3+} + 3NH_4^+ + 9H_2O$
B $4H^+ + 2NO_3^- + 2I^- \rightarrow 2H_2O + 2NO_2 + I_2$
C $2HNO_3 + K_2CO_3 \rightarrow 2KNO_3 + H_2O + CO_2$
D $Pb + 4HNO_3 \rightarrow Pb(NO_3)_2 + 2H_2O + 2NO_2$

10 Given the following standard electrode potentials

	$E^{\ominus}$/V
$Fe^{2+}(aq) + 2e^- \rightleftharpoons Fe(s)$	–0.44
$Ni^{2+}(aq) + 2e^- \rightleftharpoons Ni(s)$	–0.25
$Sn^{2+}(aq) + 2e^- \rightleftharpoons Sn(s)$	–0.14
$Sn^{4+}(aq) + 2e^- \rightleftharpoons Sn^{2+}(aq)$	+0.15
$I_2(s) + 2e^- \rightleftharpoons 2I^-(aq)$	+0.54
$Br_2(l) + 2e^- \rightleftharpoons 2Br^-(aq)$	+1.09

which one of the following species is reduced by $Sn^{2+}(aq)$?

A $Br^-(l)$
B $Fe^{2+}(aq)$
C $I_2(s)$
D $Ni^{2+}(aq)$

Section B

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

11 Some Scotch whiskies have the fragrance of cut grass. This smell is attributed to *cis* hex-3-enal, an unsaturated aldehyde.

(a) Suggest a structure for *cis* hex-3-enal.

[2]

(b) What would be observed if *cis* hex-3-enal is warmed with Fehling's solution?

_____

_____ [2]

(c) Write the equation for the reaction between *cis* hex-3-enal and 2,4–dinitrophenylhydrazine. Represent the structure of *cis* hex-3-enal as $\rangle$C = O. There is no requirement to draw the full structure.

[3]

12 The wing of a hang glider is made from sheets of polyethylene terephthalate (PET). The frame is an alloy of magnesium and aluminium.

(a) (i) Draw the structures of the two monomers used to make PET.

[2]

(ii) Draw the structure for one repeating unit of PET

[2]

(b) Aluminium and magnesium have typical metal structures.

(i) Draw a labelled diagram to show the bonding within a metal such as aluminium.

[2]

(ii) State **two** properties of aluminium which make it suitable for use in the frame of a hang glider.

_____

_____ [2]

(c) If the frame is burned, the aluminium and magnesium form a mixture of oxides. Write the equation for the reaction between aluminium and oxygen.

_____ [1]

(d) Aluminium oxide is amphoteric, reacting with both acids and alkalis.

(i) Write the equation for the reaction between aluminium oxide and sulphuric acid.

_____ [2]

(ii) Write the equation for the reaction between aluminium oxide and aqueous sodium hydroxide.

_____ [2]

13 Car air bags contain a mixture of sodium azide, NaN_3, potassium nitrate, KNO_3, and silicon dioxide, SiO_2. In a collision, a series of chemical reactions produce nitrogen to fill the airbag.

(a) Firstly, the sodium azide decomposes.

(i) Write an equation for the decomposition of sodium azide to form sodium and nitrogen.

_____ [1]

(ii) The azide ion can be written as

$$\overset{-}{N} = \overset{+}{N} = \overset{-}{N}$$

Using a dot and cross diagram, draw the electron structure of the azide ion, showing the outer electrons of each atom.

[2]

(b) Secondly, the potassium nitrate reacts with the sodium metal to form potassium oxide, sodium oxide and more nitrogen.

(i) Write an equation for the reaction.

_____ [1]

(ii) Use dot and cross diagrams to show the formation of sodium oxide from sodium and oxygen atoms

[2]

(c) Metal oxides react with silicon dioxide to form metal silicates. Write an equation for the reaction of sodium oxide with silicon dioxide.

_____ [1]

(d) The table below gives the percentage by mass of the ingredients in a typical air bag.

Ingredient	Percentage by mass
sodium azide	65
silicon dioxide	25
potassium nitrate	10

Calculate the maximum volume of nitrogen which could be obtained from 100 g of this mixture at 20 °C and a pressure of one atmosphere.

_____

_____

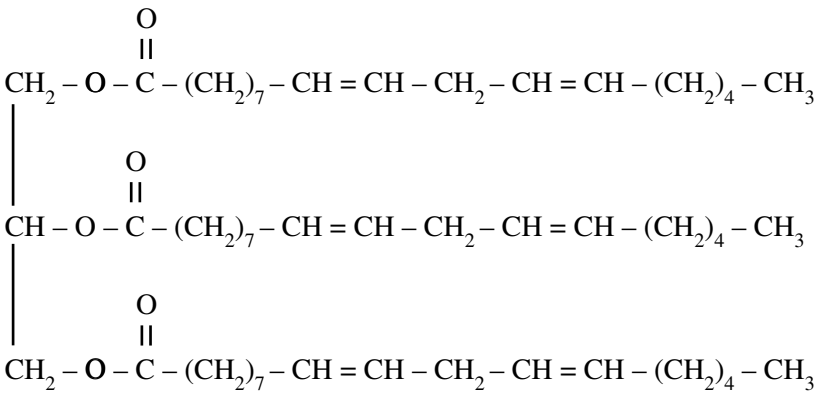
_____

_____ [3]

(e) Draw a diagram to explain the structure of silicon dioxide.

[2]

14 Rapeseed oil is a tri-ester of linoleic acid and has the structure shown below:



(a) Rapeseed oil can be converted into biodiesel. The tri-ester is hydrolysed to form glycerol and linoleic acid. Esterification of the linoleic acid with methanol produces biodiesel.

(i) Draw the structure of glycerol.

[1]

(ii) Draw the structure of a biodiesel molecule.

[2]

(b) Describe how Wij's solution is used to determine the iodine value of rapeseed oil. No reference need be made to calculating the iodine value and no equations are required.

_____

_____

_____

_____

_____

_____

_____

_____ [5]

Quality of written communication [2]

(c) Linoleic acid reacts with thionyl chloride to produce an acyl chloride. Write an equation for the reaction.

_____ [2]

(d) Calculate the volume of hydrogen needed to saturate the double bonds in 100 g of linoleic acid (RMM = 280).

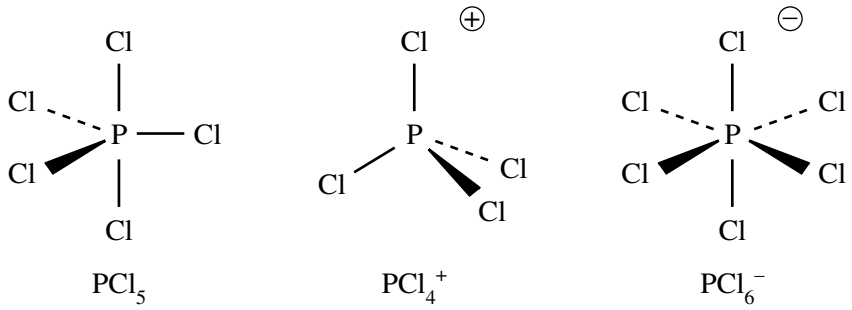
_____

_____

_____

_____ [3]

15 Phosphorus pentachloride when pure is an almost colourless solid. X-ray analysis shows that it is composed of $[PCl_4]^+$ and $[PCl_6]^-$ ions.



(a) (i) State the shapes of the $[PCl_4]^+$ and $[PCl_6]^-$ ions.

$[PCl_4]^+$ _____ [1]

$[PCl_6]^-$ _____ [1]

(ii) Calculate the oxidation number of phosphorus in $[PCl_4]^+$ and $[PCl_6]^-$.

_____ [1]

(b) Phosphorus pentachloride reacts with carboxylic acids. Write the equation for the reaction between phosphorus pentachloride and ethanoic acid.

_____ [2]

(c) When heated, phosphorus pentachloride vapourises and decomposes to form an equilibrium mixture.

$$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g) \quad \Delta H = +91\,kJ$$

(i) Explain the effect of increasing the pressure on the equilibrium system.

_____

_____ [2]

(ii) Explain the effect of increasing the temperature on the equilibrium system.

_____

_____ [2]

(iii) If the equilibrium mixture contains 0.11 mol of phosphorus trichloride, 0.11 mol of chlorine and 0.39 mol of phosphorus pentachloride in a 1 dm^3 container at 300 °C and 1.0×10^5 Pa, calculate the dissociation constant, K_p and state its units.

_____

_____

_____

_____ [3]

16 Bromothymol blue is an indicator which changes colour over a pH range of 6.0–7.8. At pH 6.0 it is yellow, above pH 7.8 it is blue.

(a) Bromothymol blue can be regarded as a weak acid HIn which is in equilibrium with the In^- ion.

$$HIn \rightleftharpoons H^+ + In^-$$

(i) State the conjugate base and conjugate acid in the equilibrium.

conjugate base _____ [1]

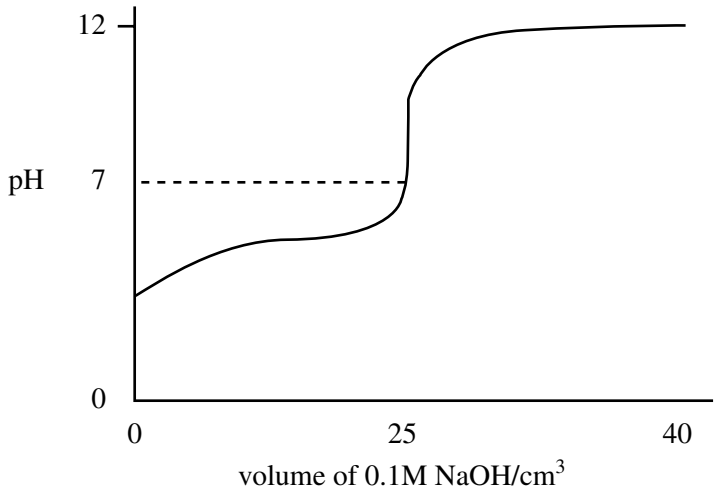
conjugate acid _____ [1]

(ii) Using the equilibrium equation, explain the colour changes that occur when acid and alkali are added separately to the indicator.

_____

_____ [2]

(b) The titration curve below shows the titration of 0.1M ethanoic acid with sodium hydroxide.



(i) Calculate the pH of the ethanoic acid solution at the start of the titration.

(K_a for ethanoic acid = 1.7×10^{-5} mol dm^{-3})

_____

_____

_____ [2]

(ii) Explain whether bromothymol blue would be a suitable indicator for the titration.

_____

_____ [2]

(iii) Write an equation for the reaction of ethanoic acid with sodium hydroxide.

_____ [1]

(iv) Explain why a solution of sodium ethanoate is alkaline.

_____

_____ [2]

THIS IS THE END OF THE QUESTION PAPER