Rewarding Learning

71 [redacted] mber

Candidate N[redacted]

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2010

Chemistry

Assessment Unit AS 2

assessing

Module 2: Organic, Physical and Inorganic Chemistry

[AC121]

AC121

THURSDAY 17 JUNE, AFTERNOON

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 **16(b)(i)**.
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 the pages indicate the marks awarded to each question or part question.
A Periodic Table of Elements (including some data) is provided.

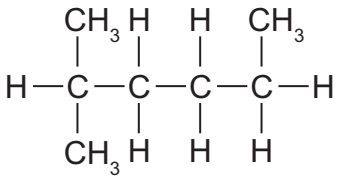
For Examiner's use only	
Question Number	**Marks**
Section A	
1–10	
Section B	
11	
12	
13	
14	
15	
16	
17	
Total Marks	

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 The correct name for the compound with the following structure



is

A 1,1,4-trimethylbutane.
B 1,4-dimethylpentane.
C 1,4,4-trimethylbutane.
D 2-methylhexane.

2 A mixture of two salts (X and Y) produced the following results.

Test	Observation
Flame test	Yellow/orange colour
Addition of $HNO_3(aq)$	No effervescence
Addition of $AgNO_3(aq)$	Yellow precipitate
Addition of $BaCl_2(aq)$	White precipitate

X and Y could be

A potassium iodide and potassium carbonate
B sodium chloride and sodium carbonate
C sodium chloride and sodium sulphate
D sodium iodide and sodium sulphate

3 When heated with acidified potassium dichromate solution, which one of the alcohols does **not** cause the solution to change from orange to green?

A butan-1-ol
B butan-2-ol
C 2-methylpropan-1-ol
D 2-methylpropan-2-ol

4 0.05 moles of a liquid fuel was used to increase the temperature of 200 g of water by 10 K. The heat capacity of water is 4.2 J $g^{-1}K^{-1}$.
What is the molar enthalpy of combustion of the fuel?

A $-8.4\ kJ\,mol^{-1}$
B $-168\ kJ\,mol^{-1}$
C $-420\ kJ\,mol^{-1}$
D $-8400\ kJ\,mol^{-1}$

5 The reaction between bromoethane and ethanolic potassium hydroxide is described as

A electrophilic addition
B elimination
C free radical substitution
D nucleophilic substitution

6 Which one of the following lists both sets of compounds in order of increasing solubility (least soluble first, most soluble last)?

	Sulphates	**Hydroxides**
A	$MgSO_4$, $CaSO_4$, $SrSO_4$, $BaSO_4$	$Ba(OH)_2$, $Sr(OH)_2$, $Ca(OH)_2$, $Mg(OH)_2$
B	$MgSO_4$, $CaSO_4$, $SrSO_4$, $BaSO_4$	$Mg(OH)_2$, $Ca(OH)_2$, $Sr(OH)_2$, $Ba(OH)_2$
C	$BaSO_4$, $SrSO_4$, $CaSO_4$, $MgSO_4$	$Mg(OH)_2$, $Ca(OH)_2$, $Sr(OH)_2$, $Ba(OH)_2$
D	$BaSO_4$, $SrSO_4$, $CaSO_4$, $MgSO_4$	$Ba(OH)_2$, $Sr(OH)_2$, $Ca(OH)_2$, $Mg(OH)_2$

7 Which one of the following alcohols gives a positive iodoform test?

A butan-1-ol
B butan-2-ol
C 2-methylpropan-1-ol
D 2-methylpropan-2-ol

8 Which one of the following hydrocarbons has the empirical formula C_3H_5?

A $CH_3CH{=}CH_2$
B $CH_3(CH_2)_3CH{=}CH_2$
C $(CH_3)_3CCH_2CH_2CH_3$
D $CH_2{=}CHCH_2CH_2CH{=}CH_2$

9 Which one of the following substances is **not** formed when methane reacts with chlorine in the presence of ultraviolet light?

A dichloromethane
B ethane
C hydrogen
D hydrogen chloride

10 An aqueous solution produced a precipitate on addition of a few drops of aqueous sodium hydroxide. The precipitate dissolved on addition of excess sodium hydroxide but not on addition of excess ammonia. The solution contains

A $Al^{3+}(aq)$.
B $Fe^{3+}(aq)$.
C $Mg^{2+}(aq)$.
D $Zn^{2+}(aq)$.

Section B

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

11 Analysis of a compound, which contains carbon, hydrogen and bromine only, showed that 22.2% of its mass is carbon and 3.7% is hydrogen. The relative molecular mass of the compound is 216.

Calculate the molecular formula of the compound.

_____

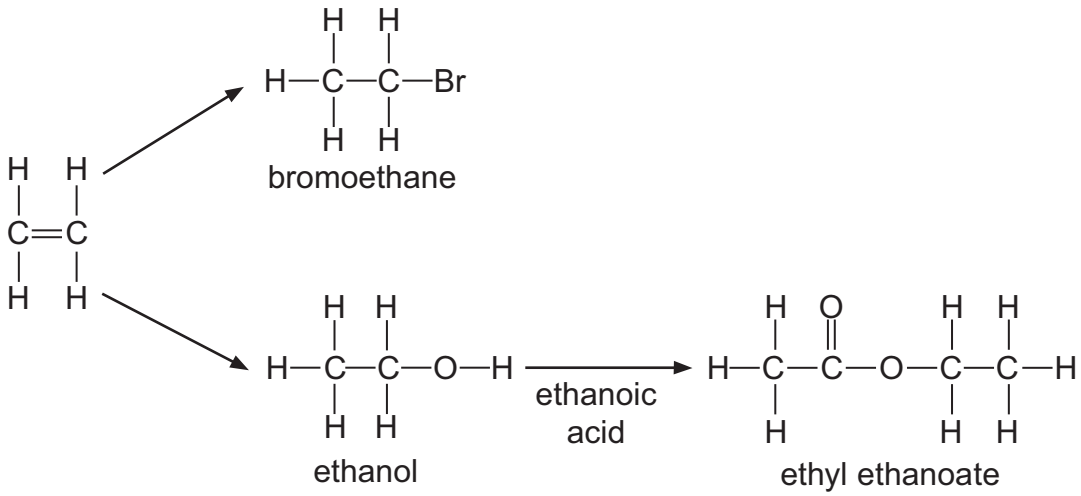
_____

_____

_____

_____ [3]

12 Consider the following sequence of reactions:



(a) (i) Name the mechanism for the conversion of ethene to bromoethane.

_____ [2]

(ii) Draw a flow scheme to represent the mechanism for the conversion of ethene to bromoethane.

[3]

(b) (i) Name the type of reaction which occurs when ethanoic acid and ethanol react to form ethyl ethanoate.

_____ [1]

(ii) Name another reagent which reacts with ethanol to form ethyl ethanoate.

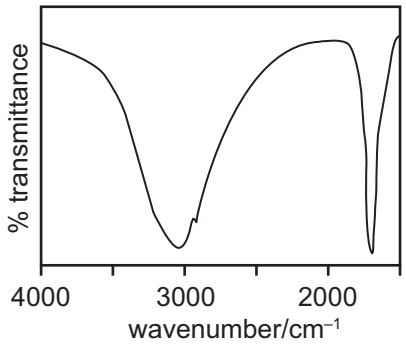
_____ [1]

(iii) Part of three infra-red spectra A, B and C are given below. The spectra are those of ethanol, ethanoic acid and ethyl ethanoate but not necessarily in that order.

- O—H bonds produce deep, broad absorptions between 2500–3500 cm^{-1}.
- C═O bonds produce deep, sharp absorptions between 1650–1750 cm^{-1}.

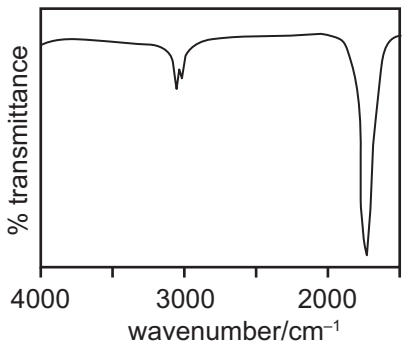
Identify each compound from its spectrum.

A



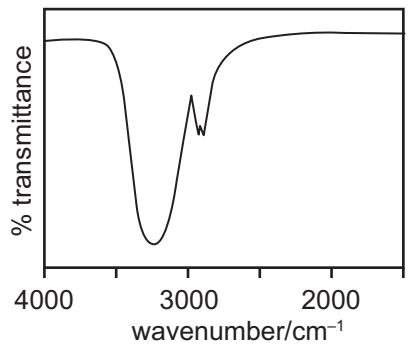
_____

B



_____

C



_____

[2]

13 Fractional distillation of crude oil is used to produce hydrocarbon fuels. The diesel fraction contains heptadecane molecules which have the formula $C_{17}H_{36}$. Incomplete combustion of diesel produces carbon monoxide.

(a) **(i)** Write an equation for the incomplete combustion of heptadecane to form carbon monoxide.

_____ [2]

(ii) What is fitted to the exhaust system of a car to change carbon monoxide into carbon dioxide?

_____ [1]

(b) Thermal cracking of long chain hydrocarbons produces shorter chain hydrocarbons.

Write an equation for the thermal cracking of heptadecane in which ethene and propene are produced in a 2:1 ratio with only one other product.

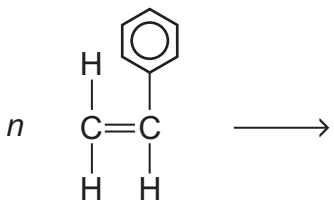
_____ [2]

(c) Ethene and propene can be converted into polythene and polypropene respectively.

(i) Name the type of reaction involved in the conversion of propene to polypropene.

_____ [2]

(ii) Suggest the equation for the conversion of styrene to polystyrene:



styrene

[1]

(d) Ethene and propene do not exhibit geometric isomerism.

(i) Draw the structure and give the name of a **branched** alkene, with molecular formula C_6H_{12}, which exhibits geometric isomerism.

_____ [2]

(ii) Draw the structures of the geometric isomers for the molecule identified in **d(i)**.

[2]

14 Many enthalpy changes, including enthalpies of combustion, can be determined by experiment. Others can be deduced using Hess's Law.

(a) (i) State Hess's Law.

_____

_____ [2]

(ii) Define the term **standard enthalpy of combustion**.

_____

_____

_____ [2]

(iii) Use the standard enthalpies of formation given in the table below to calculate the enthalpy change for the complete combustion of methane:

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

Compound	$\Delta H_f^{\ominus}$/kJ mol^{-1}
CO_2	–394
H_2O	–286
CH_4	–75

_____

_____

_____ [2]

(b) Enthalpy changes can also be calculated using average bond enthalpies. When bond enthalpies were used to estimate the enthalpy of reaction for the complete combustion of methane, it was found to have a value of -698 kJ mol^{-1}.

(i) Complete the enthalpy level diagram for this reaction.

[1]

(ii) What is meant by the term **average bond enthalpy**?

_____

_____ [2]

(iii) Using the estimated enthalpy of reaction and the bond enthalpies given in the table below, calculate the bond enthalpy of the C—H bond in methane.

bond	bond enthalpy/kJ mol^{-1}
C═O	743
O═O	496
O—H	463

_____

_____

_____

_____ [3]

15 The second stage in the production of nitric acid involves the reaction of nitrogen monoxide with oxygen to form nitrogen dioxide. When nitrogen monoxide and oxygen are mixed under suitable conditions a dynamic equilibrium is established.

$$2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g) \qquad \Delta H = -116\ kJ\ mol^{-1}$$

(a) Explain what is meant by the term **dynamic equilibrium**.

_____

_____ [2]

(b) State and explain how increasing the pressure will affect the equilibrium yield of nitrogen dioxide.

_____

_____

_____

_____ [2]

(c) State and explain how increasing the temperature will affect the equilibrium yield of nitrogen dioxide.

_____

_____

_____

_____ [2]

(d) State and explain the effect a catalyst has on the equilibrium yield of nitrogen dioxide.

_____

_____

_____ [2]

(e) The first stage in the production of nitric acid involves ammonia.

(i) State the temperature and pressure used in the production of ammonia by the Haber process.

_____

_____ [2]

(ii) Why is the temperature used in the Haber process described as a compromise temperature?

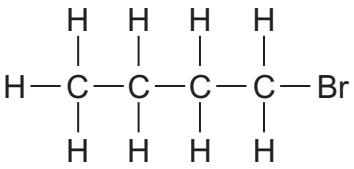
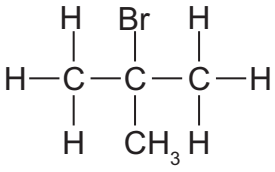
_____

_____ [1]

16 There are four bromoalkanes with the formula C_4H_9Br.

(a) Complete the following table by drawing the missing structures, giving the missing name and indicating the classification for each.

(P = Primary, S = Secondary and T = Tertiary)

Structure and Name	Classification
 1-bromobutane	P
 2-bromo-2-methylpropane	
1-bromo-2-methylpropane	
_____	

[6]

(b) **(i)** 1-bromobutane can be prepared by refluxing a mixture containing butan-1-ol, water, sodium bromide and concentrated sulphuric acid for 45 minutes. Describe the remaining steps required to produce a pure, dry sample of this haloalkane.

_____

_____

_____

_____

_____

_____

_____

_____ [4]

Quality of written communication [2]

(ii) 11.1 g of butan-1-ol was used to prepare 1-bromobutane and 12.3 g was obtained.

$$C_4H_9OH + HBr \rightarrow C_4H_9Br + H_2O$$

Calculate the percentage yield.

_____

_____

_____ [3]

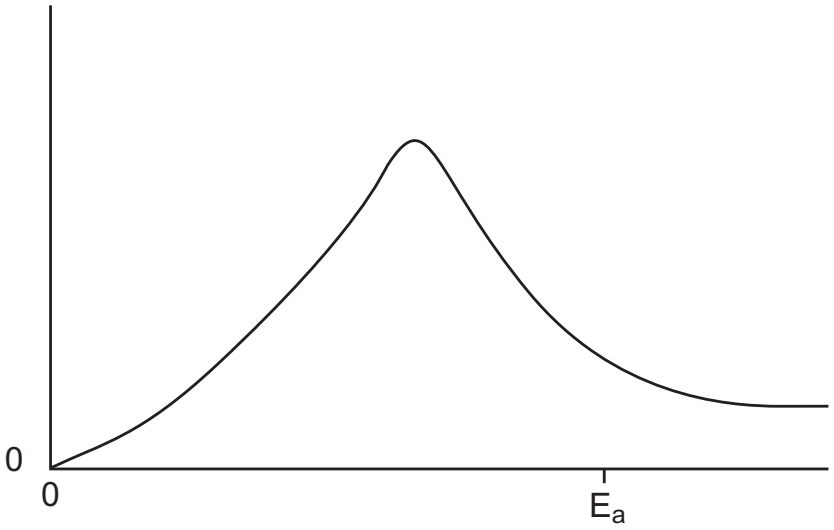
(c) When heated with aqueous sodium hydroxide 1-bromobutane was converted into butan-1-ol.

How could the resulting solution be tested to prove that it contains bromide ions?

_____

_____ [2]

17 The Maxwell-Boltzmann distribution for a mixture of SO_2 and O_2 which react to form SO_3 at 450 K is shown below.



(a) (i) Label the axes on the above diagram. [2]

(ii) Suggest why the curve starts at the origin.

_____

_____ [1]

(iii) Draw a second curve, on the same axes, for the same mixture of gases at 440 K. [2]

(iv) By making reference to the two curves, state and explain the effect of reducing the temperature on the rate of reaction.

_____

_____

_____

_____ [2]

(b) Catalysts are used in many industrial processes. Name the catalyst used in each of the following processes.

(i) the Contact process

_____ [1]

(ii) the conversion of sunflower oil to margarine

_____ [1]

(iii) the Haber process

_____ [1]

(iv) the reaction of steam with ethene

_____ [1]

(c) Manganese(IV) oxide catalyses the decomposition of hydrogen peroxide solutions:

$$2H_2O_2 \rightarrow 2H_2O + O_2$$

(i) Explain, in terms of activation energy and reaction pathway, how a catalyst works.

_____

_____

_____[2]

(ii) Calculate the volume of oxygen gas (measured at 20 °C and 1 atmosphere of pressure) which would be produced when a 50.0 cm^3 sample of 2 mol dm^{-3} hydrogen peroxide solution undergoes complete decomposition.

_____

_____

_____

_____[3]

THIS IS THE END OF THE QUESTION PAPER

935-063-1 6566.02 **R**