Rewarding Learning

Centre Number	
71	

Candidate Number

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2013

Chemistry

Assessment Unit AS 2

assessing

Module 2: Organic, Physical and Inorganic Chemistry

[AC122]

AC122

WEDNESDAY 19 JUNE, 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.
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 five** 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(c)**.
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 the 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	
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 Which one of the following compounds has the highest boiling point?

A 2,3-dimethylbutane

B Hexane

C 2-methylpentane

D 3-methylpentane

2 When a solution of potassium chromate is added to a solution containing barium ions

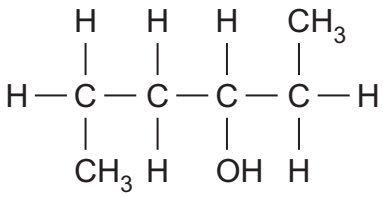
A a yellow precipitate forms.

B a white precipitate forms.

C an orange to green colour change occurs.

D the potassium chromate solution remains orange.

3 Which one of the following is the name of the alcohol below?



A 1,4-dimethylbutan-2-ol

B 1,4-dimethylbutan-3-ol

C Hexan-3-ol

D Hexan-4-ol

4 Methane reacts with excess chlorine to form tetrachloromethane.

$$CH_4 + 4Cl_2 \rightarrow CCl_4 + 4HCl$$

Which one of the following is the atom economy for the formation of CCl_4?

A 25.7%

B 44.2%

C 51.3%

D 80.8%

5 Which one of the following is a tertiary alcohol?

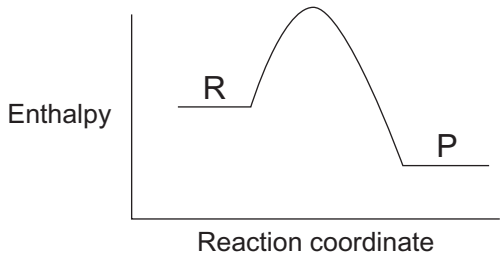
A 2-methylbutan-2-ol

B 2-methylbutan-3-ol

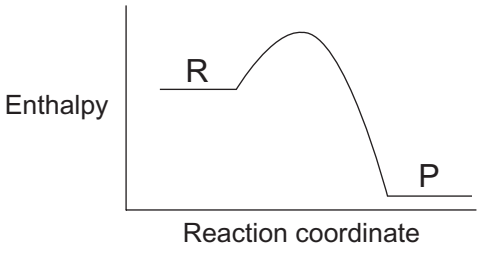
C Pentan-2-ol

D Pentan-3-ol

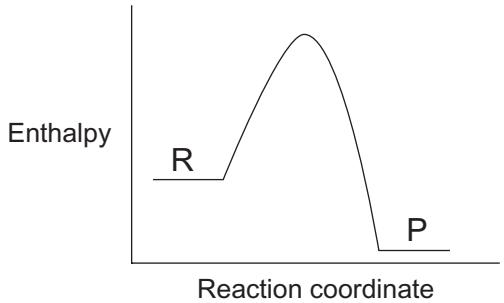
6 Which one of the following reaction profiles represents a reaction for which the enthalpy change is numerically greater than the activation energy?



A



B



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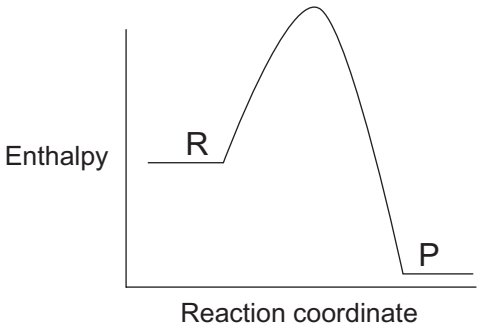
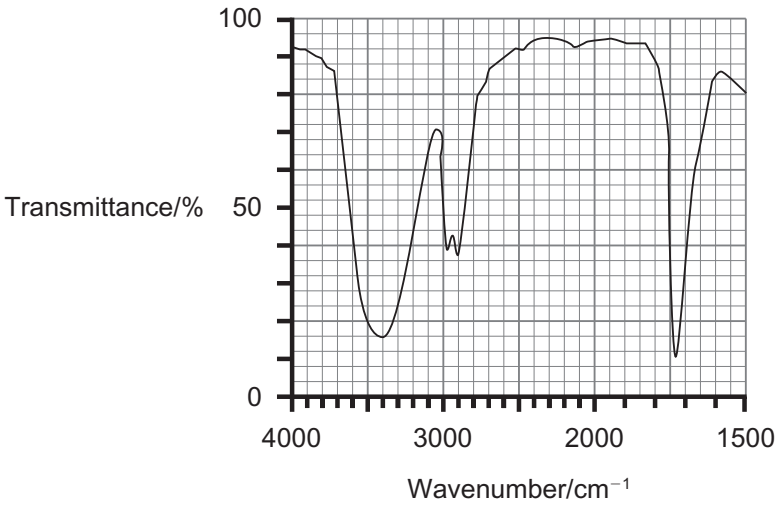


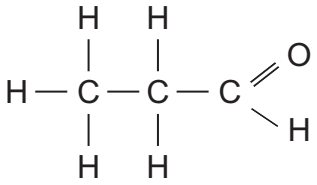
D

7 Which one of the following molecules produces the infrared spectrum shown?

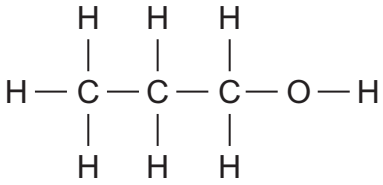


Bond	Wavenumber/cm^{-1}
O — H (alcohols)	3200–3700 strong broad
C — H	2700–3300 medium sharp
O — H (carboxylic acids)	2500–3200 strong broad
C ═ O	1680–1780 strong sharp

A



B



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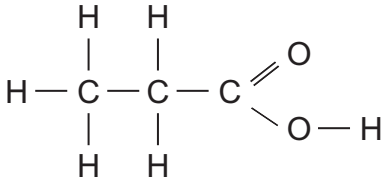
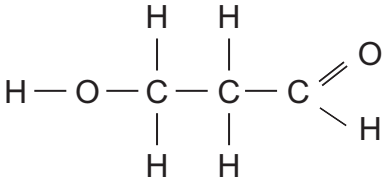


D



8 Which one of the following alkenes may be formed when 3-bromo-2-methylpentane reacts with ethanolic potassium hydroxide?

A 1,1-dimethylbut-1-ene

B 2-methylpent-3-ene

C 4-methylpent-2-ene

D 4-methylpent-3-ene

9 The standard enthalpies of combustion of carbon (C), hydrogen (H_2) and pr... (H_8) are -394, -286 and $-2219\,kJ\,mol^{-1}$ respectively. Which one of the following is the standard enthalpy of formation of propane in $kJ\,mol^{-1}$?

A -1539

B -107

C $+107$

D $+1539$

10 Which one of the following alcohols can be oxidised to form a ketone?

A Butan-1-ol

B Butan-2-ol

C 2-methylpropan-1-ol

D 2-methylpropan-2-ol

Section B

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

11 The elements in Group II of the Periodic Table, from magnesium to barium, have similar chemical properties and are known as the alkaline earth metals.

(a) The s-block of the Periodic Table consists of the elements in Groups I and II.

(i) Give the electronic configuration of a calcium atom.

_____ [1]

(ii) In terms of electronic configuration, what do s-block elements have in common?

_____

_____ [1]

(iii) Write an equation, including state symbols, to represent the first ionisation energy of calcium.

_____ [2]

(iv) State and explain the trend in the first ionisation energies as Group II is descended.

_____

_____

_____ [3]

(b) Magnesium reacts vigorously with both hydrochloric and sulfuric acids to form solutions of magnesium chloride and magnesium sulfate.

(i) Write the equation for the reaction of magnesium with hydrochloric acid.

_____ [2]

(ii) State **two** observations when this reaction is carried out.

_____

_____ [2]

(iii) Name a reagent which can be used to distinguish between solutions of magnesium chloride and magnesium sulfate.

_____ [1]

(iv) What is observed when this reagent is added to each solution?

_____

_____ [2]

(v) Write the ionic equation, including state symbols, for any reaction which occurs when the reagent named in **(iii)** above is used.

_____ [2]

(c) The hydroxides and sulfates of Group II show significant variations in solubility.

(i) Give the formula of the most soluble Group II hydroxide.

_____ [1]

(ii) Give the formula of the least soluble Group II sulfate.

_____ [1]

(iii) State and explain the trend in the thermal stability of the hydroxides as Group II is descended.

_____

_____

_____ [2]

(iv) Write the equation for the thermal decomposition of magnesium hydroxide.

_____ [1]

(d) The elements in Group II react with water.

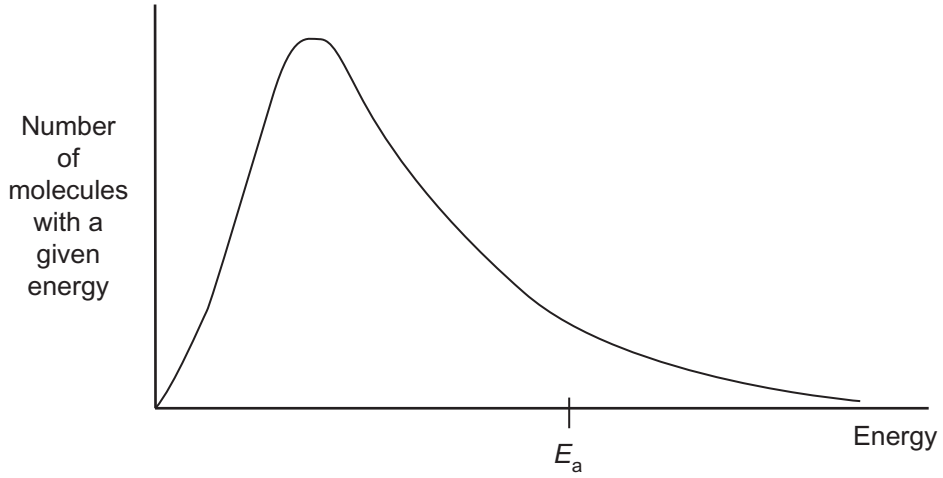
(i) State the trend in reactivity with water of the elements from magnesium to barium.

_____ [1]

(ii) Write the equation for the reaction of barium with water.

_____ [2]

12 The diagram shows a Maxwell–Boltzmann distribution curve for a mixture of sulfur dioxide and oxygen at temperature T.
E_a = activation energy



(a) On the diagram, sketch the distribution curve for the same mixture at a higher temperature. [2]

(b) Use these distribution curves to explain why the reaction between sulfur dioxide and oxygen is faster at the higher temperature.

_____

_____ [2]

(c) Use the distribution curve to explain the role of a catalyst and why the reaction between sulfur dioxide and oxygen is faster in the presence of a catalyst.

_____

_____

_____

_____

_____

_____

_____ [4]

Quality of written communication [2]

13 There are several compounds with the molecular formula C_6H_{12}. The molecules present in these compounds are described as structural isomers. Some compounds, with molecular formula C_6H_{12}, exist as geometric isomers.

(a) What are **structural isomers**?

_____

_____ [2]

(b) Give the name and structural formula for an isomer of C_6H_{12} which does not exist as a geometric isomer.

_____ [2]

(c) **(i)** What are **geometric isomers**?

_____

_____ [2]

(ii) Name an isomer of C_6H_{12} which exists as geometric isomers.

_____ [1]

(iii) Give **two** reasons why this isomer exists as geometric isomers.

_____

_____

_____ [2]

(iv) Draw the **two** geometric isomers and identify the Z isomer.

[3]

(d) Give the empirical formula of all the compounds with molecular formula C_6H_{12}.

_____ [1]

14 Ethene reacts with steam in a reversible reaction to form ethanol:

$$C_2H_4(g) + H_2O(g) \rightleftharpoons C_2H_5OH(g)$$

The reaction establishes a position of dynamic equilibrium.

(a) What is meant by the term **dynamic equilibrium**?

_____

_____ [2]

(b) Use the following average bond enthalpy values to calculate the enthalpy change for the reaction.

Bond	Average Bond Enthalpy ($kJ\,mol^{-1}$)
C — C	347
C ═ C	612
C — H	413
C — O	358
O — H	464

_____

_____

_____

_____ [3]

(c) **(i)** State and explain the effect of an increase in pressure on the yield of ethanol.

_____

_____ [2]

(ii) State and explain the effect of an increase in temperature on the yield of ethanol.

_____

_____

_____

_____ [2]

(iii) State the effect of using a catalyst on the yield of ethanol.

_____ [1]

(d) State the conditions and a catalyst used in the industrial production of ethanol from ethene and steam.

_____

_____ [3]

(e) Assuming an 80% yield, what mass of ethene would be required to produce 460 kg of ethanol?

_____

_____

_____ [3]

15 Methylpropene reacts with hydrogen bromide to form two products, the major product being 2-bromo-2-methylpropane.

(a) Hydrogen bromide is a polar molecule.

(i) Using the diagram below, show the polarity of the hydrogen bromide molecule.

H — Br

[1]

(ii) Use the polarity of the hydrogen bromide molecule to explain why it is attracted to methylpropene molecules.

_____

_____ [2]

(b) The formation of 2-bromo-2-methylpropane occurs in two steps.

(i) Write an equation for the first step of the mechanism showing the structure of the intermediate.

_____ [2]

(ii) Write an equation for the second step of the mechanism showing the structure of 2-bromo-2-methylpropane.

_____ [1]

(iii) Name the mechanism of the reaction.

_____ [1]

(iv) Suggest the name of the minor product.

_____ [1]

(c) Methylpropene is an unsaturated hydrocarbon.

(i) What is an **unsaturated hydrocarbon**?

_____

_____ [2]

(ii) Calculate the volume of hydrogen gas, measured at 20 °C and one atmosphere pressure, required to saturate 4.2 g of methylpropene.

_____

_____

_____ [3]

(d) Under suitable conditions, methylpropene can be converted into poly(methylpropene).

(i) Name the type of reaction occurring.

_____ [2]

(ii) Draw the structure of poly(methylpropene) showing three repeating units.

_____ [2]

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