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General Certificate of Education
January 2012

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Centre Number
71
Candidate Number

Chemistry

Assessment Unit AS 2

assessing

Module 2: Organic, Physical
and Inorganic Chemistry

[AC122]



THURSDAY 19 JANUARY, 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 sixteen** 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 six** 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 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	
Total Marks	



7512

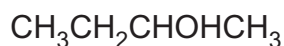
Section A

For each of the following 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 as illustrated on the answer sheet.

- 1 The standard enthalpy of formation of water is -286 kJ mol^{-1} . Which one of the following is the enthalpy change when hydrogen reacts with oxygen to form 1 g of water?
- A +15.9 kJ
 - B -15.9 kJ
 - C +31.8 kJ
 - D -31.8 kJ

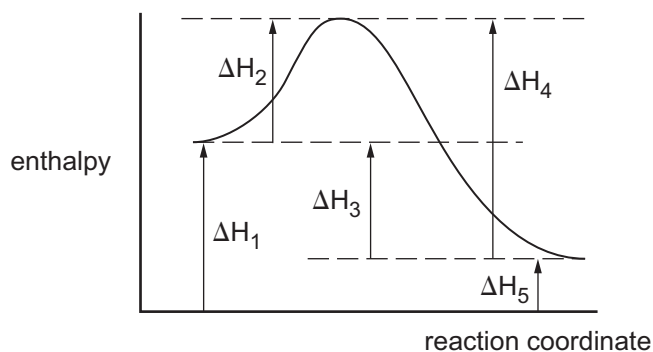
- 2 Which one of the following statements about the alcohol shown below



is **not** correct?

- A It takes part in the iodoform reaction
 - B It is oxidised to an aldehyde
 - C It has the molecular formula $\text{C}_4\text{H}_{10}\text{O}$
 - D It has the systematic name butan-2-ol
- 3 X and Y are two atoms which are joined together to form a covalent bond, X–Y. X is more electronegative than Y. Which one of the following pairs of species is produced by homolytic fission of this bond?
- A $\text{X}^+ + \text{Y}^-$
 - B $\text{X}^- + \text{Y}^+$
 - C $\text{X}^\bullet + \text{Y}^\bullet$
 - D $\text{X}^\bullet + \text{Y}$
- 4 In which one of the following pairs will **neither** hydroxide dissolve in an excess of aqueous sodium hydroxide?
- A aluminium hydroxide and magnesium hydroxide
 - B aluminium hydroxide and zinc hydroxide
 - C magnesium hydroxide and iron(II) hydroxide
 - D zinc hydroxide and calcium hydroxide

- 5 The diagram represents the enthalpy of a reversible reaction plotted against reaction co-ordinate.



Which one of the listed enthalpies would be altered by the use of a catalyst?

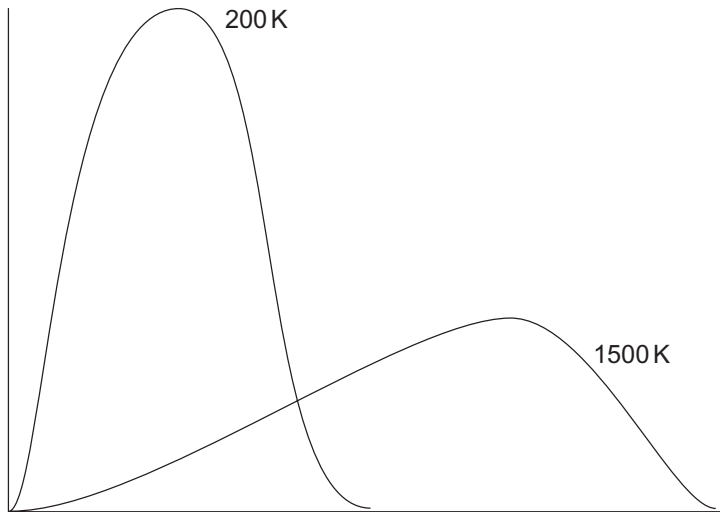
- A $\Delta H_1 + \Delta H_5$
 B $\Delta H_2 + \Delta H_3$
 C $\Delta H_2 + \Delta H_4$
 D $\Delta H_3 + \Delta H_4$
- 6 Which one of the following is the number of possible isomers of formula $C_2H_3Cl_3$?
- A 2
 B 3
 C 4
 D 5
- 7 Which one of the following processes is endothermic?
- A $Ba \rightarrow Ba^+ + e^-$
 B $Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$
 C $H^+ + OH^- \rightarrow H_2O$
 D $N_2 + 3H_2 \rightarrow 2NH_3$

- 8 Which one of the following equations represents the standard enthalpy change of formation of barium chloride?
- A $\text{Ba(g)} + \text{Cl}_2\text{(g)} \rightarrow \text{BaCl}_2\text{(s)}$
B $\text{Ba(s)} + \text{Cl}_2\text{(g)} \rightarrow \text{BaCl}_2\text{(s)}$
C $\text{Ba}^{2+}\text{(g)} + 2\text{Cl}^-\text{(g)} \rightarrow \text{BaCl}_2\text{(s)}$
D $\text{Ba}^{2+}\text{(s)} + 2\text{Cl}^-\text{(g)} \rightarrow \text{BaCl}_2\text{(s)}$
- 9 Which one of the following molecules can **not** act as a nucleophile?
- A CH_3NH_2
B CH_4
C H_2O
D NH_3
- 10 Which one of the following is the volume of oxygen required for the complete combustion of 100 cm^3 of butane at room temperature and pressure?
- A 400 cm^3
B 500 cm^3
C 650 cm^3
D 1300 cm^3

Section B

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

- 11** The diagram below shows the Maxwell-Boltzmann distribution curves for the molecules in a gas at temperatures of 200 K and 1500 K.



(a) Label the axes. [2]

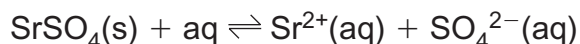
(b) Draw the shape of the distribution curve for 500 K on the same graph. [2]

(c) Explain why all the graphs start at point (0, 0).

_____ [2]

12 Strontium sulfate, SrSO_4 , is a white solid which occurs in nature as the mineral celestine. It closely resembles barium sulfate in many of its properties.

(a) Strontium sulfate is moderately soluble in water.



The table below shows the solubility of strontium sulfate at different temperatures.

solubility/g dm ⁻³	temperature/°C
0.0111	18
0.0135	25

(i) Explain whether the dissolving of strontium sulfate is an exothermic or endothermic process.

_____ [2]

(ii) Compare the solubility of strontium sulfate with that of calcium and barium sulfates.

_____ [2]

(b) Strontium sulfate may be prepared in the laboratory by reacting strontium with water and then mixing the strontium hydroxide produced with dilute sulfuric acid.

(i) Write the equation for the reaction of strontium with water.

_____ [2]

(ii) Write the equation for the reaction of strontium hydroxide with sulfuric acid.

_____ [2]

(c) Celestine and barite, BaSO_4 , are two minerals which may be distinguished from each other using a flame test. Describe how a flame test can be carried out and state the colour expected for barite. Celestine produces a red flame.

[4]

Quality of written communication

[2]

(d) Strontium sulfate decomposes on heating to form the oxide and sulfur trioxide. Its thermal stability can be explained in a similar way to that of the carbonate.

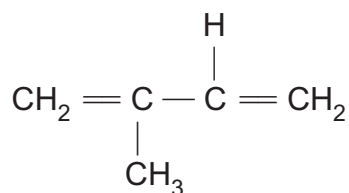
(i) Write the equation for the decomposition of strontium sulfate.

[1]

(ii) Explain the thermal stability of strontium sulfate.

[2]

- 13 Rubber is a polymer of isoprene, C₅H₈, whose structural formula is shown below.



- (a) (i) Draw the full structure of isoprene showing **all** the bonds present.

[1]

- (ii) Explain whether isoprene is capable of forming *cis* and *trans* (E–Z) isomers.

_____ [2]

- (b) Deduce the systematic name for isoprene.

_____ [1]

- (c) Isoprene is fully hydrogenated when it reacts with hydrogen in the presence of a metal catalyst.

- (i) Write the equation for the reaction.

_____ [1]

- (ii) Name the metal catalyst.

_____ [1]

- (iii) In what form is the solid metal used?

_____ [1]

- (e) Isoprene reacts with bromine to form a bromo-derivative with the following percentage composition:

carbon	26.3%
hydrogen	3.5%
bromine	70.2%

- (i) Deduce the empirical formula for the bromo-derivative.

_____ [3]

- (ii) Draw a structural formula for the bromo-derivative.

[1]

- (f) Mixtures of isoprene vapour and air are potentially explosive. Name **two** products which are formed during the incomplete combustion but not during the complete combustion of isoprene.

1. _____

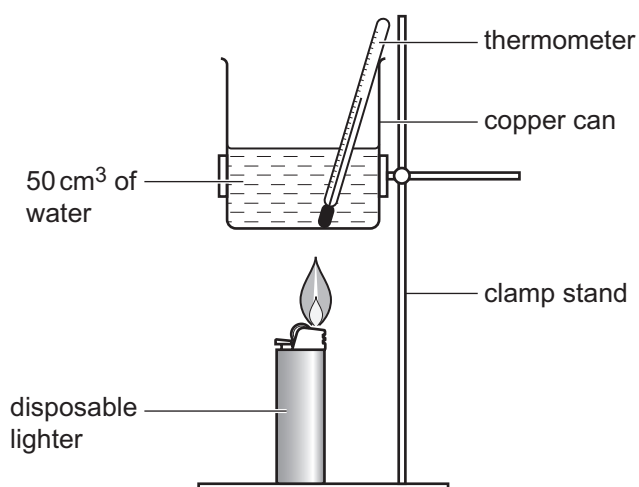
2. _____ [2]

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(Questions continue overleaf)

- 14 Disposable lighters contain liquid butane. When the pressure is released the butane forms a gas and escapes. A spark from the flint ignites the gas which burns to release energy.

The following experiment was carried out to determine the molar enthalpy of combustion of butane.



The lighter was weighed before the butane was ignited and weighed again after the butane had burned to raise the temperature of the water in the copper can by 55 °C.

Specific heat capacity of water is 4.2 Jg⁻¹°C⁻¹)

The following results were obtained:

mass of lighter before ignition	= 15.00 g
mass of lighter after burning	= 14.53 g
temperature of water before heating	= 25 °C
temperature of water after heating	= 80 °C
mass of water	= 50 g

(a) Calculate the molar enthalpy of combustion of butane using the following headings.

number of grams of butane burned

_____ [1]

relative formula mass of butane

_____ [1]

number of moles of butane burnt

_____ [1]

heat received by 50 g of water

_____ [1]

molar enthalpy of combustion of butane

_____ [1]

(b) A similar experiment was carried out to determine the molar enthalpy of combustion of ethanol. A value of half the theoretical value of $-1367 \text{ kJ mol}^{-1}$ was obtained.

State **three** reasons for the low experimental value.

_____ [3]

(c) Explain why the molar enthalpy of combustion of butane is theoretically more than that of ethanol.

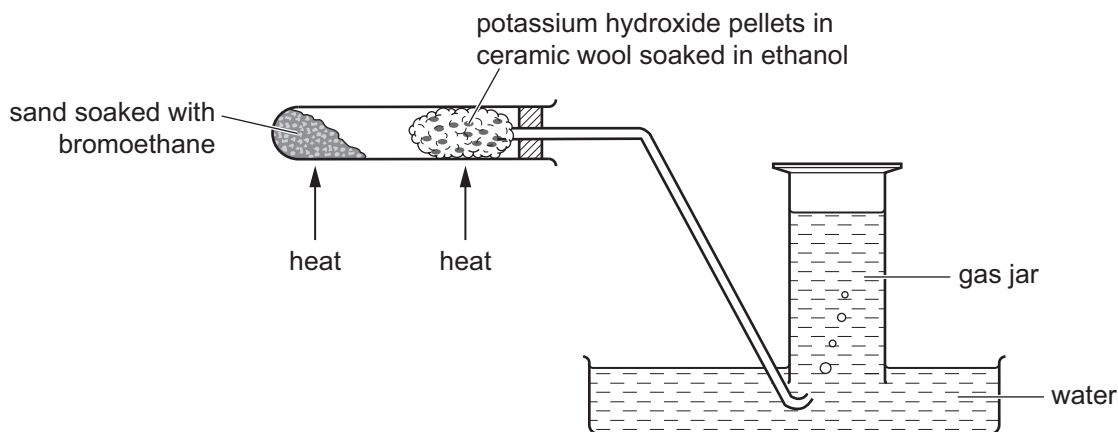
_____ [2]

(d) The butane is ignited using a spark from the lighter. State and explain whether the spark acts as a catalyst.

_____ [2]

15 Bromoethane is a colourless liquid which boils at 38 °C. 9.1 g of bromoethane dissolve in one litre of water at room temperature. It undergoes an elimination reaction with ethanolic potassium hydroxide.

(a) The following experiment shows the reaction of bromoethane with ethanolic potassium hydroxide.



(i) Write the equation for the reaction of bromoethane with ethanolic potassium hydroxide.

_____ [1]

(ii) Name the gas collected in the gas jar.

_____ [1]

(iii) Describe a chemical test to confirm the identity of the gas.

 _____ [2]

(iv) How does the collection of this gas prove that an *elimination* reaction has taken place?

 _____ [1]

(b) Bromoethane reacts differently with aqueous potassium hydroxide, as nucleophilic substitution takes place.

(i) Write the equation for the reaction.

_____ [1]

(ii) Explain the meaning of the term **nucleophilic substitution**.

_____ [2]

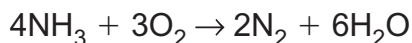
(iii) Draw a flow scheme to illustrate the mechanism for the reaction of bromoethane with hydroxide ions.

[3]

(iv) Explain, in terms of bond enthalpy and polarity why the hydrolysis of chloroethane is slower than that of bromoethane.

_____ [3]

16 Ammonia is made industrially from nitrogen and hydrogen. It does not burn in air but it will burn in oxygen.



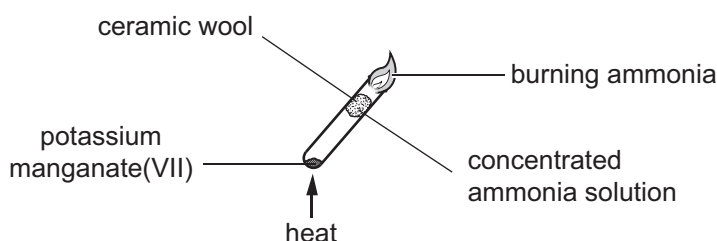
(a) (i) Name the industrial process used to make ammonia.

_____ [1]

(ii) Suggest why neither ammonia nor hydrogen burns during the manufacture of ammonia.

 _____ [1]

(b) The apparatus shows how ammonia can be burnt in a stream of oxygen provided by the decomposition of heated potassium manganate(VII).



(i) Potassium manganate(VII) thermally decomposes according to the following equation.



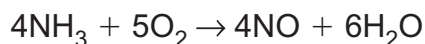
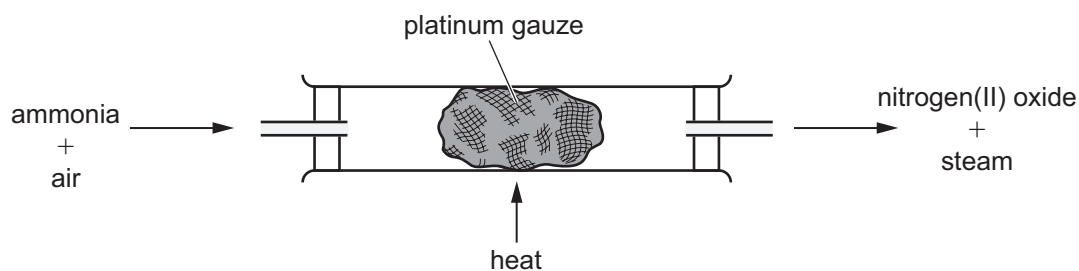
Calculate the volume of oxygen produced at 20 °C and one atmosphere pressure when 2.5g of potassium manganate(VII) are heated.

 _____ [3]

(ii) Before the ceramic wool is placed in the test tube the gas may be tested to see that oxygen is being given off. Describe the chemical test for oxygen.

 _____ [2]

(c) When mixed with air and passed through a heated platinum gauze ammonia forms nitrogen(II) oxide and steam.



(i) Suggest the purpose of the platinum gauze.

_____ [1]

(ii) Explain why gauze is used rather than a pile of platinum powder.

 _____ [1]

(iii) Explain why the laws of chemical equilibrium cannot be applied to this particular mixture of ammonia and oxygen.

_____ [1]

(iv) Using the bond energies below calculate the enthalpy change per mole of ammonia and state whether the reaction is exothermic or endothermic.

bond	bond energy/kJ mol ⁻¹
N-H	391
O=O	498
N=O	587
H-O	464

 _____ [4]

THIS IS THE END OF THE QUESTION PAPER

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