



Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2017

Centre Number

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Candidate Number

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Life and Health Sciences

Assessment Unit AS 3
assessing

Aspects of Physical Chemistry in
Industrial Processes

[SZ031]

FRIDAY 19 MAY, AFTERNOON



SZ031

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 five** questions.

Write your answers in the spaces provided in this question paper.

INFORMATION FOR CANDIDATES

The total mark for this paper is 75.

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 is included in this question paper.

You may use an electronic calculator.

Quality of written communication will be assessed in Question **3(a)(ii)**.

For Examiner's use only	
Question Number	Marks
1	
2	
3	
4	
5	
Total Marks	

1 Butane gas can be used in portable home heaters or camping stoves, however recently there have been some health and safety issues regarding the use of these. If there is not a sufficient supply of oxygen then the poisonous gas carbon monoxide will form on combustion rather than carbon dioxide.

(a) Define the term **enthalpy of combustion**.

 [2]

(b) A chemistry student has been asked to find the enthalpy change for the combustion of butane in the laboratory, using a camping stove as the source of butane.

(i) List the **main** pieces of apparatus and materials needed for this experiment.

 [3]

(ii) Suggest two sources of error for this experiment.

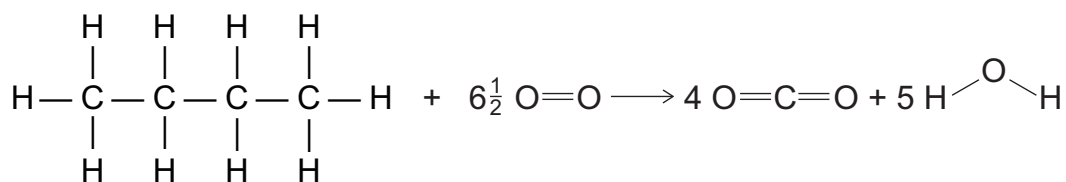
1. _____

2. _____

 [2]

Examiner Only	
Marks	Remark

(c) Butane burns to release energy according to the equation below.



- (i) Use the average bond enthalpy data given below to calculate the enthalpy change for the combustion of one mole of butane. Show your working.

Bond	Average bond enthalpy/kJ mol ⁻¹
C—C	347
C—H	413
C=O	799
O—H	467
O=O	495

_____ kJ mol⁻¹ [4]

- (ii) Suggest why the enthalpy change for the combustion of propane (C₃H₈) has a lower value than that of butane (C₄H₁₀).

 _____ [1]

Examiner Only

Marks Remark

(d) Hess's law can be used to calculate enthalpy changes such as the enthalpy of formation of butane (C_4H_{10}), which cannot be measured directly by experiment. Hess's law is based on the principle of conservation of energy.

(i) State the principle of conservation of energy.

_____ [2]

(ii) Complete and balance the equation for the enthalpy of formation of butane.



(iii) Use the standard enthalpy of combustion data below to calculate the standard enthalpy of formation of butane.

	Standard enthalpy of combustion/ kJ mol^{-1}
Butane (C_4H_{10})	-2877.5
Carbon (C)	-393.5
Hydrogen (H_2)	-285.8

_____ kJ mol^{-1} [3]

Examiner Only

Marks Remark

(iii) Explain, in terms of activation energy, why using a catalyst increases the rate of the reaction.

[3]

(iv) Describe how the Maxwell–Boltzmann distribution curve would change if this reaction was carried out at a higher temperature.

[2]

Examiner Only	
Marks	Remark

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(Questions continue overleaf)

(c) The student's results are shown below.

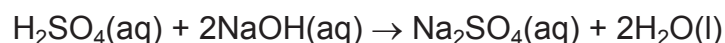
	Initial burette reading/cm ³	Final burette reading/cm ³	Titre/cm ³
Rough	0.00	24.50	24.50
1st accurate	24.50	47.90	
2nd accurate	0.00	23.30	

(i) Complete the results table above. [1]

(ii) Calculate the mean titre.

_____ cm³ [2]

(d) The equation for the reaction is:



(i) Use the mean titre from (c)(ii) to calculate the number of moles of 0.100 M sodium hydroxide used in the titration.

_____ moles [2]

(ii) Use your answer to (d)(i) and the equation to calculate the concentration of the sulfuric acid in the sample.

_____ mol dm⁻³ [2]

Examiner Only

Marks Remark

- 4 (a) Chemical engineers must consider many costs when developing industrial processes. Two of these costs are capital and direct. Explain these terms.

Capital costs _____

Direct costs _____

_____ [2]

- (b) Suggest three effects on the **environment** that the construction of a new chemical manufacturing plant may have.

1. _____

2. _____

3. _____

_____ [3]

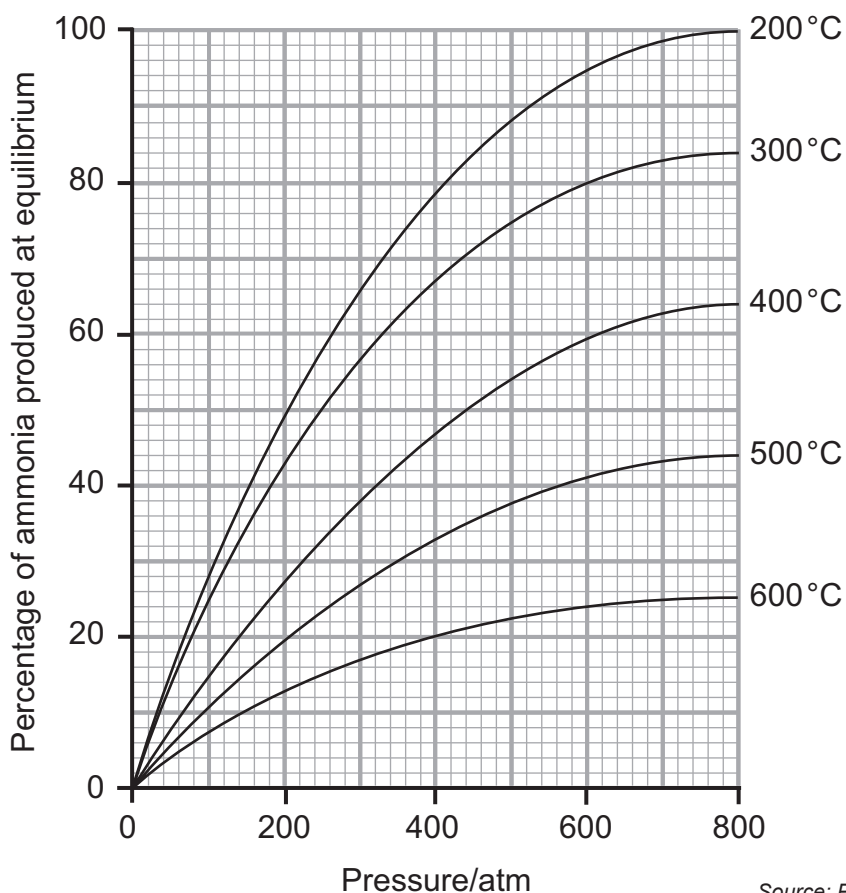
Examiner Only

Marks

Remark

5 Ammonia is produced using the Haber process. The conditions are carefully selected to produce the ammonia efficiently.

(a) The graph below shows the percentage of ammonia produced at equilibrium when different conditions of pressure and temperature are used.



Source: Principal Examiner

(i) Use the graph to describe the trends in the percentage of ammonia produced at equilibrium under different conditions.

[2]

(ii) Use the graph to determine the percentage of ammonia produced at equilibrium if a temperature of 400 °C and a pressure of 300 atm were used.

_____ % [1]

Examiner Only	
Marks	Remark

THIS IS THE END OF THE QUESTION PAPER

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