



Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education

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

[SZ031]

Assessment

TIME

1 hour 30 minutes.

Assessment Level of Control:

Tick the relevant box (✓)

Controlled Conditions	
Other	

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.

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

Answer **all seven** questions.

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.

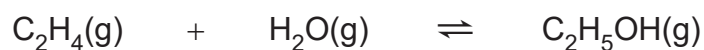
You may use an electronic calculator.

Quality of written communication will be assessed in Question **6(c)**.

For Examiner's use only	
Question Number	Marks
1	
2	
3	
4	
5	
6	
7	

Total Marks	
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- 1 (a) Ethene reacts with steam to produce ethanol. The equation is shown below:



- (i) What does the symbol (g) mean?

_____ [1]

- (ii) What does the symbol \rightleftharpoons mean?

_____ [1]

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

_____ [2]

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

_____ [1]

- (iii) What additional information would be needed to be able to consider the effect of temperature change on this reaction?

_____ [1]

Examiner Only

Marks Remark

(c) (i) Calculate the relative formula mass of ethanol.

_____ [1]

(ii) Calculate the maximum mass, in kilograms, of ethanol that could be produced from 105 kg of ethene. Give your answer to 3 significant figures.

You are advised to show your working.

_____ kg [4]

(iii) In this reaction, a yield of 125 kg was obtained.
Using your answer to (c)(ii), calculate the percentage yield for this reaction.
Give your answer to 1 decimal place.

You are advised to show your working.

_____ % [2]

(iv) Suggest **two** reasons why the yield of a reaction may not be 100%.

1. _____

2. _____ [2]

Examiner Only

Marks Remark

2 Carbon monoxide (CO) and nitrogen dioxide (NO₂) can be produced when fuels are burned in car engines. These gases can combine to form less harmful products (carbon dioxide and nitrogen monoxide) in the catalytic converter.

(a) (i) Complete the balanced symbol equation for this reaction.



(ii) Name **one** metal used as a catalyst in a catalytic converter.

_____ [1]

(iii) Why is the reaction involving carbon monoxide and nitrogen dioxide in a catalytic converter described as **heterogeneous** catalysis?

_____ [1]

(iv) Explain fully why leaded petrol should not be used in a car that has been fitted with a catalytic converter.

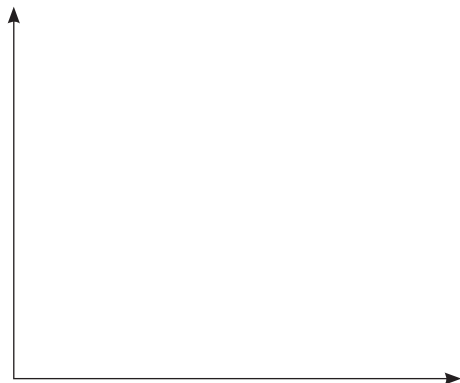
_____ [2]

Examiner Only	
Marks	Remark

(b) (i) Draw, on the axes below, a **labelled** reaction profile diagram for an exothermic reaction.

You must label:

- both axes
- reactants/products



[3]

(ii) Show, using a dashed line on the diagram drawn in (b)(i), how the reaction profile would change with the addition of a catalyst. Label this line catalysed reaction. [1]

(c) The table below gives information about the processes and conditions needed to manufacture some chemicals.

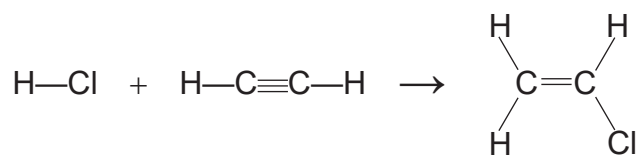
Complete the table.

Chemical	Process used to manufacture the chemical	Catalyst	Temperature /°C	Pressure /atm
Ammonia		Iron	400–500	
	Contact	Vanadium(V) oxide		1–2
Nitric acid	Ostwald		800–1000	4–10

[5]

Examiner Only	
Marks	Remark

- 3 Hydrogen chloride reacts with ethyne to form chloroethene, as shown in the equation below:



The table below gives average bond enthalpies for the bonds involved in this reaction.

Bond	C—Cl	H—Cl	C—H	C=C	C≡C
Average bond enthalpy /kJ mol ⁻¹	346	432	413	612	838

- (a) Using the data in the table, calculate the enthalpy change for this reaction.

You are advised to show your working.

Enthalpy change _____ kJ mol⁻¹ [4]

- (b) Why might your answer for (a) be different from the accepted value for the standard enthalpy change for this reaction?

 _____ [1]

Examiner Only

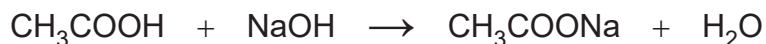
Marks Remark

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(Questions continue overleaf)

- (c) The student carried out the titration, and the mean volume of 0.25 mol dm^{-3} sodium hydroxide needed to neutralise the vinegar sample was found to be 28.0 cm^3 .

The balanced symbol equation for this reaction is:



- (i) Calculate the number of moles of sodium hydroxide used in this titration.

_____ moles [1]

- (ii) What is the number of moles of ethanoic acid present in the 25.0 cm^3 vinegar sample?

_____ moles [1]

- (iii) Calculate the molarity of the ethanoic acid in the vinegar sample.

_____ M [1]

- (d) The student compared his calculated vinegar concentration to that on the vinegar bottle. The two concentrations were not the same. Suggest **one** reason why his value may be incorrect.

_____ [1]

Examiner Only

Marks Remark

- 5 A student planned to investigate the effect of different factors on the rate of reaction of magnesium and hydrochloric acid.

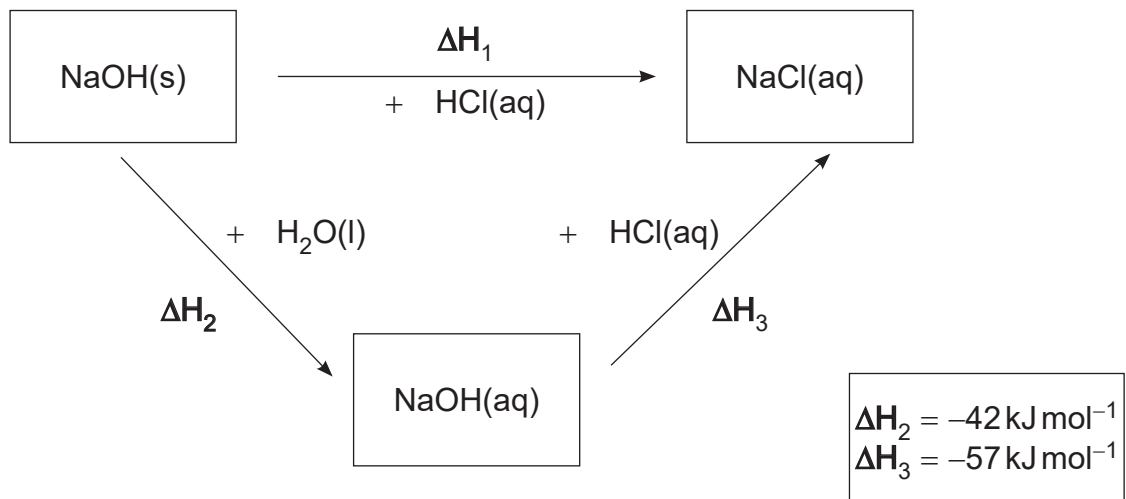
50 cm³ of 1 mol dm⁻³ hydrochloric acid and 0.5 g of magnesium ribbon were placed in a conical flask which was immediately sealed and connected to apparatus used to collect and measure gas. The volume of gas was recorded over a four-minute period.

- (a) Draw a labelled diagram of the assembled apparatus which could be used to collect and measure the volume of gas produced over the given time period.

[3]

Examiner Only	
Marks	Remark

6 The diagram below shows an enthalpy cycle based on Hess's law.



(a) State Hess's law.

[2]

(b) (i) Write an expression for the enthalpy cycle above using the terms ΔH_1 , ΔH_2 and ΔH_3 .

[1]

(ii) Use your answer to (b)(i) to calculate the enthalpy change, ΔH_1 , for this reaction.

kJ mol⁻¹ [1]

Examiner Only	
Marks	Remark

7 (a) Outline **two** differences between industrial scale and laboratory scale production of chemicals.

1. _____

2. _____

[2]

(b) When scaling up an industrial process it is important to take costs into consideration.

(i) Define and give an example of a **capital** cost.

_____ [2]

(ii) Define and give an example of a **direct** cost.

_____ [2]

(c) Describe the general link between production costs and the selling price of a chemical.

_____ [1]

Examiner Only

Marks Remark

THIS IS THE END OF THE QUESTION PAPER

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