



*Rewarding Learning*

**ADVANCED**  
**General Certificate of Education**  
**2025**

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## **Chemistry**

Assessment Unit A2 1

*assessing*

Further Physical and Organic Chemistry

**[ACH14]**

**TUESDAY 27 MAY, MORNING**

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**MARK  
SCHEME**

## General Marking Instructions

### Introduction

Mark schemes are published to assist teachers and students in their preparation for examinations. Through the mark schemes, teachers and students will be able to see what the examiners are looking for in response to questions and exactly where the marks have been awarded. The publishing of the mark schemes may help to show that examiners are not concerned about finding out what a student does not know but rather, with rewarding students for what they do know.

### The purpose of mark schemes

Examination papers are set and revised by teams of examiners and revisers appointed by the Council. The teams of examiners and revisers include experienced teachers who are familiar with the level and standards expected of students in schools and colleges.

The job of the examiners is to set the questions and the mark schemes; and the job of the revisers is to review the questions and mark schemes commenting on a large range of issues about which they must be satisfied before the question papers and mark schemes are finalised.

The questions and the mark schemes are developed in association with each other so that the issues of differentiation and positive achievement can be addressed right from the start. Mark schemes, therefore, are regarded as part of an integral process which begins with the setting of questions and ends with the marking of the examination.

The main purpose of the mark scheme is to provide a uniform basis for the marking process so that all the markers are following exactly the same instructions and making the same judgements in so far as this is possible. Before marking begins, a standardising meeting is held where all the markers are briefed using the mark scheme and samples of the students' work in the form of scripts. Consideration is also given at this stage to any comments on the operational papers received from teachers and their organisations. During this meeting, and up to and including the end of the marking, there is provision for amendments to be made to the mark scheme. The document published represents the final form of the mark scheme.

It is important to recognise that in some cases there may well be other correct responses which are equally acceptable to those published: the mark scheme can only cover those responses which emerged in the examination. There may also be instances where certain judgements may have to be left to the experience of the examiner, for example where there is no absolute correct response – all teachers will be familiar with making such judgements.

Where one response is required to gain a mark, candidates will not gain credit if a correct response is given alongside one or more incorrect responses. This is referred to as listing.

**Section A**

- 1 D
- 2 A
- 3 C
- 4 D
- 5 D
- 6 B
- 7 D
- 8 C
- 9 B
- 10 C

[1] for each correct answer

[10]

**Section A**

**AVAILABLE  
MARKS**

10

**10**

## Section B

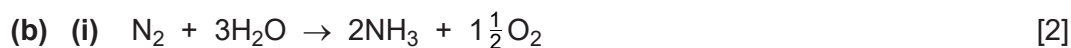
AVAILABLE  
MARKS

## 11 (a) Indicative content:

- entropy is a measure of disorder (randomness)
- $\Delta G = \Delta H - T\Delta S$
- $\Delta S > 0$ /increase in entropy
- $\Delta H < 0$ /reaction is exothermic
- $\Delta G < 0$  at all temperatures
- energy required to initiate reaction at room temperature/high activation energy barrier

Band	Response	Mark
A	Candidates must use appropriate specialist terms including a minimum of 5 points of indicative content. They use good spelling, punctuation and grammar and the form and style are of a high standard.	[5]–[6]
B	Candidates must use appropriate specialist terms including a minimum of 3 points of indicative content. They use satisfactory spelling, punctuation and grammar and the form and style are of a satisfactory standard.	[3]–[4]
C	Candidates' brief and partial response includes a minimum of 2 points of indicative content. They use limited spelling, punctuation and grammar and have made little use of specialist terms. The form and style are of a limited standard.	[1]–[2]
D	Response not worthy of credit	[0]

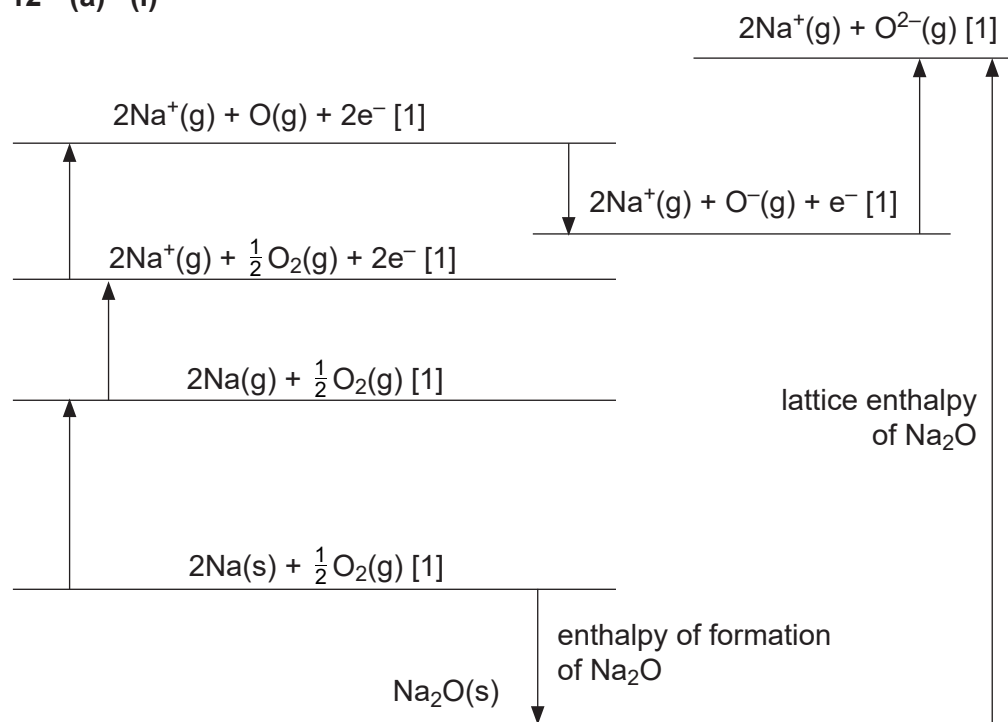
[6]



(ii)  $\Delta S = 82 + 189 + 2(193) + 1.5(205) - 114 = + 850.5 \text{ J K}^{-1} \text{ mol}^{-1}$   
 $\Delta H = -(-1801) + (-1128) + (-242) + 2(-46) = + 339 \text{ kJ mol}^{-1}$   
 $\Delta G = \Delta H - T\Delta S = 0$   
 $339 - T(0.8505) = 0$   
 $T = \frac{339}{0.8505} = 398.6 \text{ (K)}$  [4]

12

12 (a) (i)



[6]

(ii)  $\Delta H = -(-416) + 2(+108) + 2(+500) + (+249) + (-141) + (791)$   
 $\Delta H = + 2531 \text{ (kJ mol}^{-1}\text{)}$

[3]

- (b) Brønsted-Lowry acid =  $\text{H}_2\text{O}$  [1]  
 Brønsted-Lowry base =  $\text{O}^{2-}$  [1]  
 $\text{H}_2\text{O}$  donates a proton/ $\text{O}^{2-}$  accepts a proton [1]

[3]

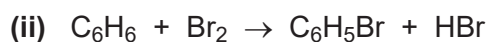
AVAILABLE  
MARKS

12

13 (a) (i)

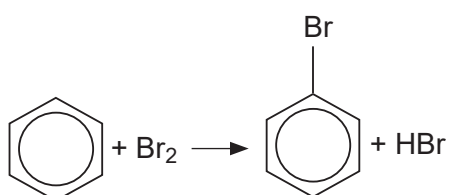
Reaction of benzene	Name of organic product	Name of catalyst
with bromine	bromobenzene	iron/iron(III) bromide/ aluminium bromide [1]
with ethanoyl chloride	phenylethanone [1]	iron(III) chloride/ aluminium chloride [1]

[3]



[1]

or

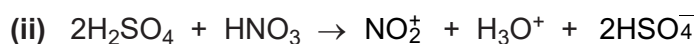


(iii) electrophilic substitution

[1]

(b) (i) concentrated sulfuric acid [1]  
concentrated nitric acid [1]

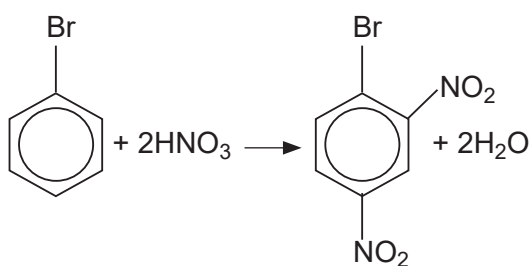
[2]



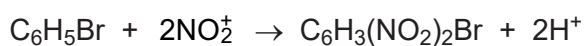
[2]



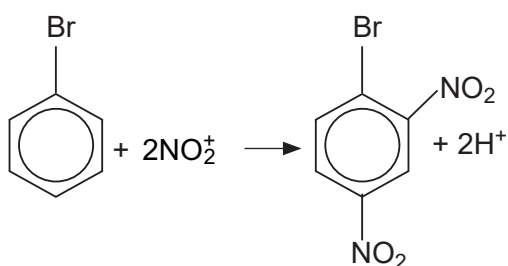
or



or



or



[1]

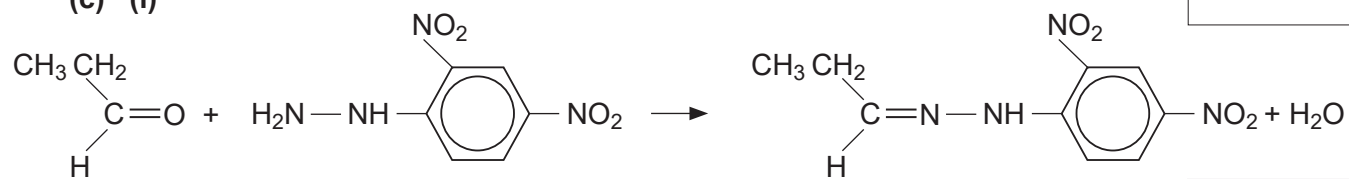
AVAILABLE  
MARKS

(iv)  $N_2H_4$

[1]

AVAILABLE  
MARKS

(c) (i)



[2]

(ii) condensation

[1]

14

14 (a) (i) moles  $\text{HNO}_3 = \frac{0.49}{63} = 7.78 \times 10^{-3}$

$$[\text{HNO}_3] = [\text{H}^+] = 0.0622 \text{ mol dm}^{-3}$$

$$\text{pH} = -\log_{10}[\text{H}^+] = -\log_{10}(0.0622) = 1.21 \quad [3]$$

(ii) salt of a strong base and a weak acid [1]

(iii)  $[\text{H}^+] = 10^{(-13.74)} = 1.82 \times 10^{-14} \text{ mol dm}^{-3}$

$$[\text{OH}^-] = \frac{1.00 \times 10^{-14}}{1.82 \times 10^{-14}} = 0.55 \text{ mol dm}^{-3}$$

$$\text{moles of NaOH added} = \frac{1.76}{40} = 0.044$$

$$\text{volume of solution} = \frac{0.044 \times 1000}{0.55} = 80 \text{ (cm}^3\text{)} \quad [4]$$

(iv)  $[\text{H}^+] = 10^{(-2.11)} = 7.76 \times 10^{-3} \text{ mol dm}^{-3}$

$$\text{moles of acid} = \frac{2.19}{108.5} = 0.0202$$

$$[\text{acid}] = 0.0404 \text{ mol dm}^{-3}$$

$$K_a = \frac{(7.76 \times 10^{-3})^2}{0.0404} = 1.49 \times 10^{-3} \text{ (mol dm}^{-3}\text{)}$$

$$\text{p}K_a = -\log_{10}(1.49 \times 10^{-3}) = 2.83 \quad [4]$$

**(b) (i) Indicative content:**

- pipette 25.0 cm<sup>3</sup> of sulfuric acid into a conical flask
- record the pH of the sulfuric acid using a pH meter or narrow range pH paper
- fill a burette with the sodium hydroxide solution
- add the NaOH in 5 cm<sup>3</sup> portions from a burette (mixing with a magnetic stirrer)
- record the pH, after each addition
- add the NaOH in 1 cm<sup>3</sup> portions as the end point approaches

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D	Response not worthy of credit	[0]

[6]

**(ii)** 20 (cm<sup>3</sup>)

[1]

**(iii)** 0.5

[1]

**(iv)** [H<sup>+</sup>] = 10<sup>(-0.5)</sup> = 0.316  
[H<sub>2</sub>SO<sub>4</sub>] = 0.158 (mol dm<sup>-3</sup>)

[2]

**(v)** phenolphthalein/methyl orange [1]  
colourless to pink/red to yellow [1]

[2]

AVAILABLE  
MARKS

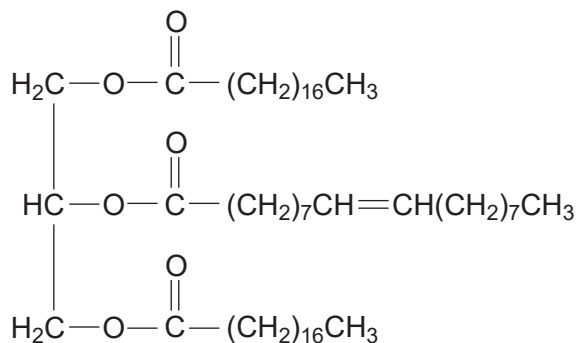
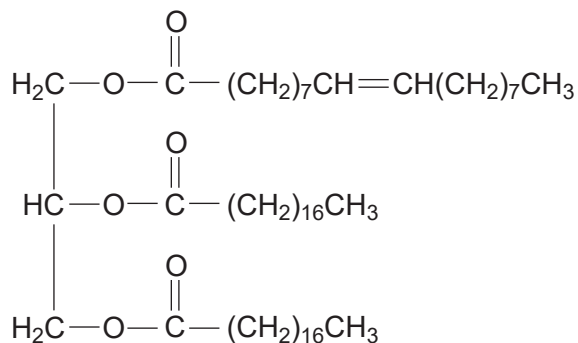
24



16 (a) glycerol [1]

(b) all contain 18 carbon atoms [1]

(c)



[1]

[1] [2]

(d) saturated = A  
unsaturated = B, C and D [1]

(e) (i) nickel [1]

(ii)  $\text{C}_{57}\text{H}_{94}\text{O}_6 + 8\text{H}_2 \rightarrow \text{C}_{57}\text{H}_{110}\text{O}_6$  [2]

(iii) 2 C and 1 D [1]

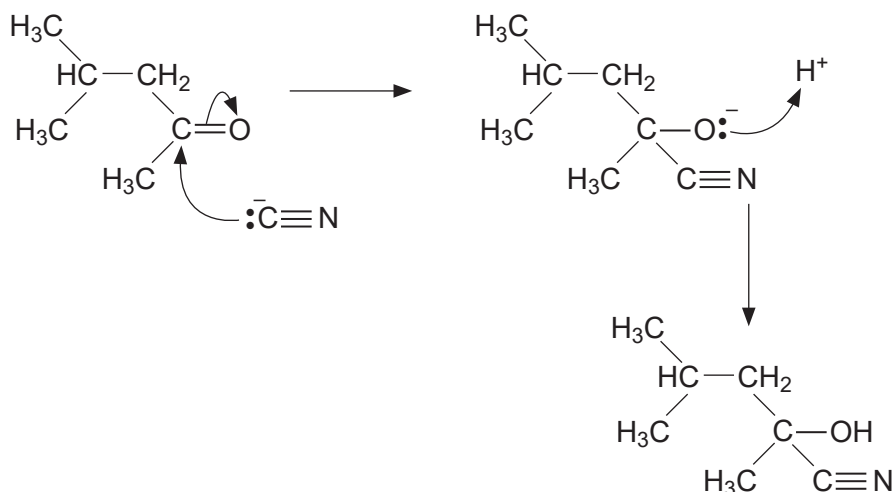
(iv) a reaction in which an alkyl group of an ester is exchanged with the alkyl group of an alcohol [2]

(v) biodiesel/margarine [1]

AVAILABLE MARKS

12
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17 (a) (i)



3 curly arrows correct [1]

correct charges on  $^-\text{CN}$ ,  $\text{O}^-$ ,  $\text{H}^+$  [1]

lone pairs on C of  $^-\text{CN}$  and  $\text{O}^-$  of intermediate [1]

[3]

(ii) nucleophilic addition

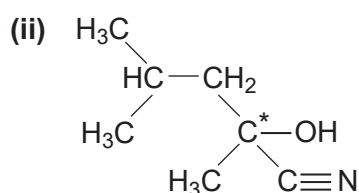
[1]

(iii) 4-methylpentan-2-one

[1]

(b) (i) an atom which has four different atoms or groups attached

[1]



[1]

(iii)  $\text{CN}^-$  attack equally probable from top or bottom/racemic mixture/equal concentrations of both optical isomers formed

[1]

(c) (i) 2-hydroxy-2,4-dimethylpentanoic acid

[2]

(ii) ammonia

[1]

(iii) ethanal

[1]

Section B

100

Total

110

AVAILABLE  
MARKS