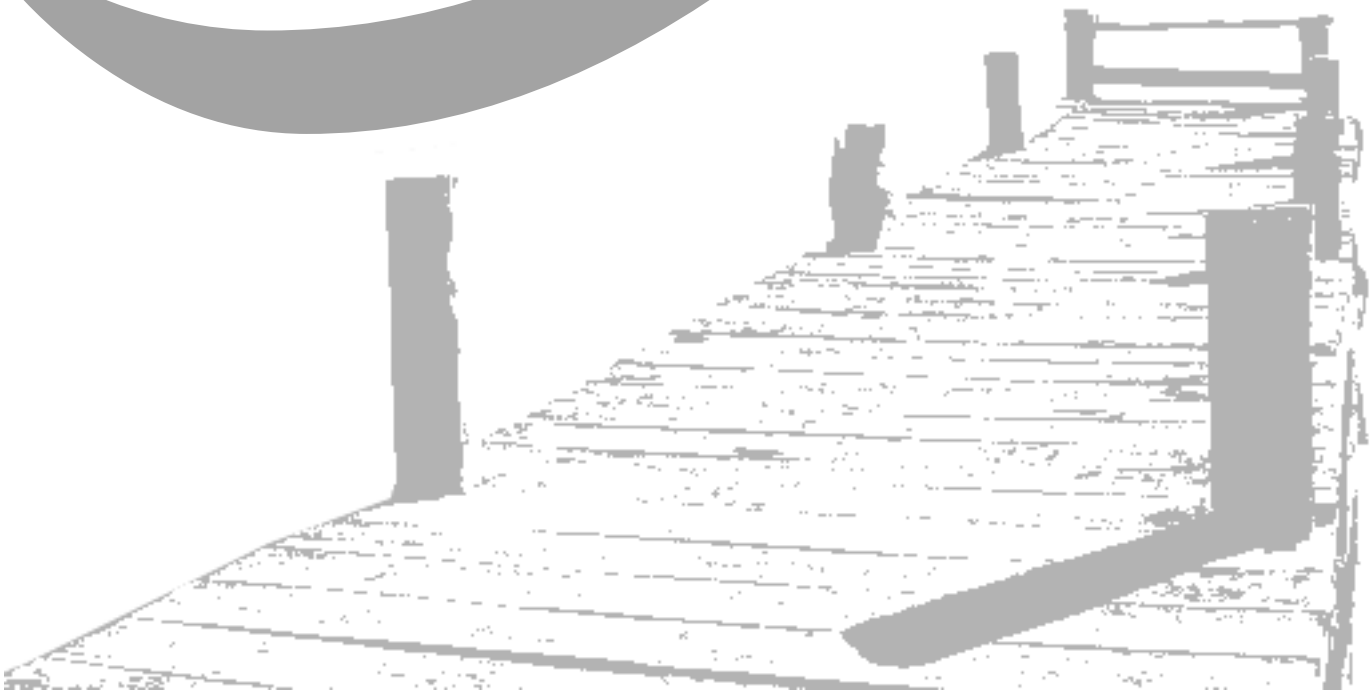
GCE
AS and A Level

Chemistry

AS exams 2009 onwards
A2 exams 2010 onwards

Unit 4:
Specimen mark scheme

Version 1.1



Version 1.1: 07/07

ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Chemistry 2420

CHEM4 Kinetics, Equilibria and Organic Chemistry

Mark Scheme

Specimen Paper

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. The specimen assessment materials are provided to give centres a reasonable idea of the general shape and character of the planned question papers and mark schemes in advance of the first operational exams.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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Dr Michael Cresswell Director General

Question 1

(a) (i) 2 (1)

(ii) 0 (1)

(b) (i) rate/$[NO_2]^2[O_2]$ (1)
13 (1)
mol dm^{-3} (1)

(ii) 1.9×10^{-3} (1)

(iii) Step 2 (1)

Question 2

(a) (i) $E + 3F \longrightarrow 2C + D$ (1)

(ii) mol dm^{-3} (1)

(iii) (forward reaction is) exothermic or more products formed (1)

(b) (i) Moles of iodine = 0.023 (1)

Moles of HI = 0.172 (1)

(ii) $K_c = \dfrac{[H_2][I_2]}{[HI]^2}$ (1)

(iii) V cancels in K_c expression (1)

(iv) $K_c = \dfrac{(0.023)^2}{(0.172)^2}$ (1)

$= 0.0179$ or 1.79×10^{-2} (1)

(v) $K_c = 55.9$ or 56 Conseq i.e. (answer to (iv))$^{-1}$ (1)

Question 3

(a) (i) **K** (1)

L (1)

J (1)

(ii) cresolphthalein or thymolphthalein (1)

(b) $pH = -\log[H^+]$ (1)

$K_a = \dfrac{[H^+]^2}{[CH_3COOH]}$ or $[H^+] = [A^-]$ (1)

$[H^+] = \sqrt{1.74 \times 10^{-5} \times 0.15}$ (or 1.62×10^{-3}) (1)

pH = 2.79 (penalise 1 dp or more than 2dp once in the qu) (1)

Question 4

(a) (i) addition of small amounts of acid send eqm to left or extra H^+ removed by reaction with HCO_3^- (1)

ratio $[H_2CO_3]/[HCO_3^-]$ remains constant hence $[H^+]$ and pH remain const (1)

(ii) pH = 7.41 ∴ $[H^+] = 3.89 \times 10^{-8}$ mol dm^{-3} (1)

$$K_a = \frac{[H^+][HCO_3^-]}{[H_2CO_3]} \quad (1)$$

$$= \frac{(3.89\times10^{-8})(2.5\times10^{-2})}{1.25\times10^{-2}} = 7.78 \times 10^{-8} \text{ mol dm}^{-3} \quad (1)$$

allow error carried forward mark. Do not penalise twice.

(b) (ii) moles H^+ added $= 10 \times 10^{-3} \times 1.0 = 0.01$ (1)

moles ethanoic acid after addition $= 0.15 + 0.01 = 0.16$ (1)

moles ethanoate ions after addition $= 0.10 - 0.01 = 0.09$ (1)

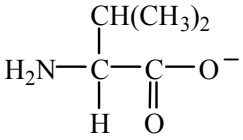
$$[H^+] = \frac{K_a[CH_3COOH]}{[CH_3COO^-]} \quad (1)$$

$$= 1.74 \times 10^{-5} \times \frac{0.16/V}{0.09/V} \quad (1)$$

pH = 4.51 (1)

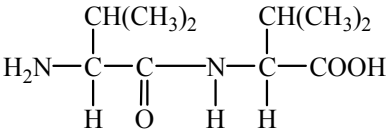
Question 5

(a) (i)



(1)

(ii)

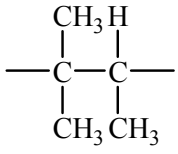


(1)

(iii) <u>hydrogen</u> bonding (do not allow H-bonding) **QWC** (1)

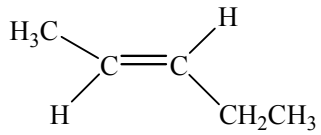
do not penalise any error twice.

(b) (i)



(1)

(ii)

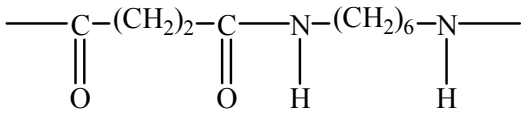


(1)

(iii) Isomer must be saturated or must not contain a double bond

(1)

(c)



(2)

(d) (i) heat/reflux with aqu NaOH (1)

poly(alkene) is inert/ no reaction (1)

polyamide is hydrolysed (or undergoes hydrolysis) (1)
to form acid salt and alcohol **QWC**

(ii) e.g combustion (1)
heat energy produced (1)
toxic gases produced (1)

Question 6

(a) GLC or distillation (1)

(b) C=O (1)

(c) (i) Cl has two isotopes (1)

(ii) $CH_3C{=}O^+$ (1)

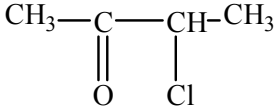
$C_4H_7ClO^{+\bullet} \rightarrow CH_3C{=}O^+ + C_2H_4Cl^\bullet$ (1)

(d) (i) e.g. $CDCl_3$ or CCl_4 (1)

(ii) $Si(CH_3)_4$ (1)

(e) 0 and 3 (1)

(f)



(1)

(g) $CH_3CH_2CH_2COCl$ or $(CH_3)_2CHCOCl$ (1)

Question 7

(a)	(i)	There are three pairs of equivalent carbon atoms	(1)
	(ii)	75ppm	(1)
(b)	(i)	4	(1)
	(ii)	2	(1)
(c)		Each structure can represent a pair of cis/Z and trans/E isomers OR Optical isomers	(1)

Question 8

Mark Range	The marking scheme for this part of the question includes an overall assessment for the Quality of Written Communication (QWC). There are no discrete marks for the assessment of QWC but the candidates' QWC in this answer will be one of the criteria used to assign a level and award the marks for this part of the question **Descriptor** an answer will be expected to meet most of the criteria in the level descriptor
4-5	- claims supported by an appropriate range of evidence - good use of information or ideas about chemistry, going beyond those given in the question - argument well structured with minimal repetition or irrelevant points - accurate and clear expression of ideas with only minor errors of grammar, punctuation and spelling
2-3	- claims partially supported by evidence - good use of information or ideas about chemistry given in the question but limited beyond this - the argument shows some attempt at structure - the ideas are expressed with reasonable clarity but with a few errors of grammar, punctuation and spelling
0-1	- valid points but not clearly linked to an argument structure - limited use of information or ideas about chemistry - unstructured - errors in spelling, punctuation and grammar or lack of fluency

(a) (i) M_r of $C_6H_5NH_2$ = 93 M_r of CH_3COCl = 78.5

total M_r of reagents = 264.5 (1)

$$\% \text{ atom economy} = \frac{M_r \text{ of wanted product}}{\text{total } M_r \text{ of all reagents}} \times 100$$ QWC (1)

$= \frac{135}{264.5} \times 100 = 51.0\ \%$ (1)

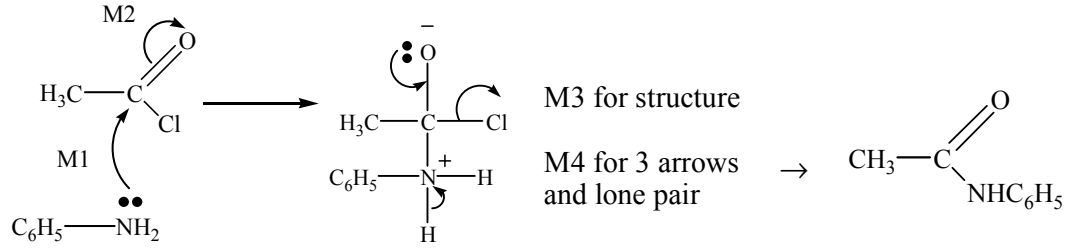
(ii)

expected yield $= \frac{10}{93} \times 0.5 \times 135 = 7.26$ kg (1)

% yield $= \frac{5.38}{7.26} \times 100 = 74.1\ \%$ (1)

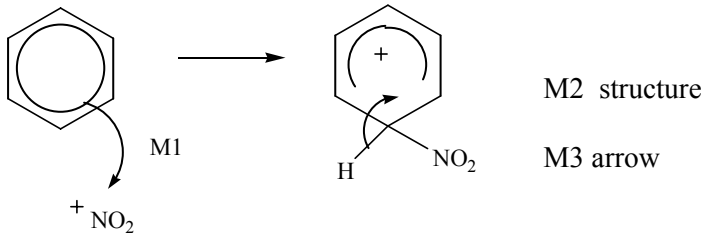
(iii) Although yield appears satisfactory (74%) % atom economy is only 51% QWC (1)
nearly half of the material produced is waste and must be disposed of QWC (1)

(b) (nucleophilic) addition-elimination (1)



QWC (2) (4)

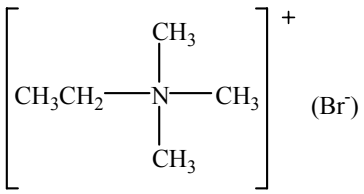
(c) $HNO_3 + 2H_2SO_4 \rightarrow NO_2^+ + H_3O^+ + 2HSO_4^-$ (1)



(3)

Question 9

H	CH_3CN or ethanenitrile	(1)
S	$CH_3CH_2NH_2$ or ethylamine	(1)
Step 1	KCN	(1)
	aq/alcoholic	(1)
Step 2	H_2	(1)
	Ni	(1)
W	secondary amine	(1)



(1)

nucleophilic substitution (1)

Question 10

Acidified potassium dichromate(VI) (1)
Turns green with propan-2-ol and propanal (1)
No reaction with hexene and 1-bromopropane (1)
Tollens (1)
with propan-2-ol and propanal
only propanal gives silver mirror (1)
Bromine water (1)
Decolourised by hexene (1)
No reaction with 1-bromopropane (1)
Warm NaOH followed by acidified $AgNO_3$ (1)
White ppt with 1-bromopropane (1)