OCR

RECOGNISING ACHIEVEMENT

CHAINS, RINGS + SPECTROSCOPY

Mark Scheme 2814
January 2002

ADVICE TO EXAMINERS ON THE ANNOTATION OF SCRIPTS

1. Please ensure that you use the **final** version of the Mark Scheme. You are advised to destroy all draft versions.

2. Please mark all post-standardisation scripts in red ink. A tick (✓) should be used for each answer judged worthy of a mark. Ticks should be placed as close as possible to the point in the answer where the mark has been awarded. The number of ticks should be the same as the number of marks awarded. If two (or more) responses are required for one mark, use only one tick. Half marks (½) should never be used.

3. The following annotations may be used when marking. No comments should be written on scripts unless they relate directly to the mark scheme. Remember that scripts may be returned to Centres.

   x = incorrect response (errors may also be underlined)
   ^ = omission mark
   bod = benefit of the doubt (where professional judgement has been used)
   ecf = error carried forward (in consequential marking)
   con = contradiction (in cases where candidates contradict themselves in the same response)
   sf = error in the number of significant figures

4. The marks awarded for each part question should be indicated in the margin provided on the right hand side of the page. The mark total for each question should be ringed at the end of the question, on the right hand side. These totals should be added up to give the final total on the front of the paper.

5. In cases where candidates are required to give a specific number of answers, (e.g. 'give three reasons'), mark the first answer(s) given up to the total number required. Strike through the remainder. In specific cases where this rule cannot be applied, the exact procedure to be used is given in the mark scheme.

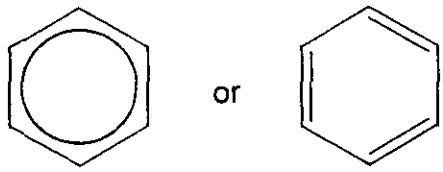
6. Correct answers to calculations should gain full credit even if no working is shown, unless otherwise indicated in the mark scheme. (An instruction on the paper to 'Show your working' is to help candidates, who may then gain partial credit even if their final answer is not correct.)

7. Strike through all blank spaces and/or pages in order to give a clear indication that the whole of the script has been considered.

8. An element of professional judgement is required in the marking of any written paper, and candidates may not use the exact words that appear in the mark scheme. If the science is correct and answers the question, then the mark(s) should normally be credited. If you are in doubt about the validity of any answer, contact your Team Leader/Principal Examiner for guidance.

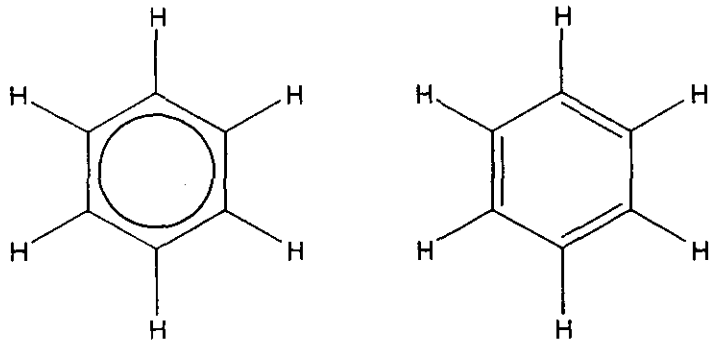
Abbreviations, annotations and conventions used in the Mark Scheme	/	= alternative and acceptable answers for the same marking point
	;	= separates marking points
	NOT	= answers which are not worthy of credit
	( )	= words which are not essential to gain credit
	____	= (underlining) key words which **must** be used to gain credit
	ecf	= error carried forward
	AW	= alternative wording
	ora	= or reverse argument

1 **(a)** structure: **[2]**



✓

accept:



empirical formula: CH ✓ **NOT** C_6H_6 or $(CH)_6$

(b) HNO_3 ✓ **[2]**
H_2SO_4 ✓
accept words or formulae
NOT <u>dilute</u> acids – penalise dilute ONCE only; so dil H_2SO_4 + dil HNO_3 gets (1)
NOT correct words with wrong formula eg nitric acid HNO_2
NOT wrong words with correct formula eg nitrous acid, HNO_3
ignore state symbols
mark any wrong answers and subtract from correct answers to min of 0

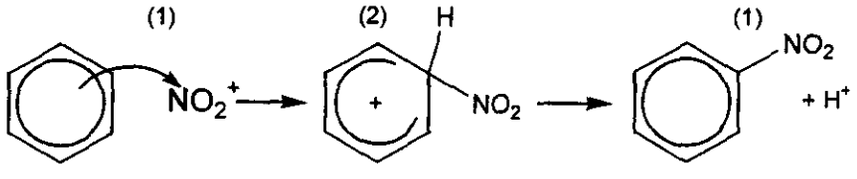
(c) **(i)** NO_2^+ ✓ **[1]**
NOT NO^{2+}

(ii) $HNO_3 + H^+ \rightleftharpoons H_2O + NO_2^+$ ✓ **[1]**
$HNO_3^+ \rightleftharpoons H_2O + NO_2^+$
or
$HNO_3 + 2H^+ \rightleftharpoons H_3O^+ + NO_2^+$
or
$2\,H_2SO_4 + HNO_3 \rightleftharpoons H_3O^+ + 2HSO_4^- + NO_2^+$
or
$HNO_3 + H_2SO_4 \rightleftharpoons NO_2^+ + HSO_4^- + H_2O$

equation must balance; $\rightleftharpoons$ not essential

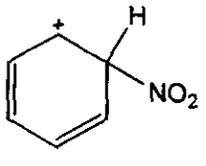
NOT $HNO_3 \rightleftharpoons NO_2^+ + HO^-$

(iii) electrophilic attack by NO_2^+ ✓ **[4]**
correct structure of cationic intermediate ✓ ✓
correct structure of product **and** H^+ ✓
(Kekulé structures accepted)
e.g.



arrow required, doesn't matter where it comes from but must be in **correct direction**

be careful with position of horseshoe and of +



both products required or $PhNO_2$ and arrow for loss of H^+
NOT H_2SO_4 as product unless HSO_4^- given as base to remove H^+

(d) M_r $C_6H_6 = 78$ ✓ **[4]**
M_r $C_6H_5NO_2 = 123$ ✓

all correct working ✓
allow e.c.f. from wrong M_r
e.g.

moles $C_6H_6 = \frac{10}{78} = 0.128$

100% yield = 0.128 x 123 = 15.77g

%yield = $\frac{13.3}{15.77}$ x 100 = **84.3%** ✓ (answer) must have 3 sig figs

accept any answer in the range 84.2 → 84.5 as 'correct'
Correct answer on its own = 4 marks

Total = 14

2 **(a)** Only one C substituent on N ✓ **[1]**
or two H substituents on N
or RNH_2 as a general structure
NOT attached to a C only attached to one other carbon ie RCH_2NH_2
NOT NH_2 is on the first/end carbon

(b) $C_2H_5NH_2 + H^+ \rightleftharpoons C_2H_5N^+H_3$ balanced eq ✓ **[2]**
structure ✓ (+ is essential)
any acid OR water accept in equation
or
$C_2H_5NH_2 + HCl \rightleftharpoons C_2H_5N^+H_3\ Cl^-$
($\rightleftharpoons$ not essential)

(c) **(i)** Stage I: **[5]**
H_2 + catalyst, or H_2 + specified metal catalyst e.g. Ni, Pd, Pt; or metal ✓ **NOT** acid catalyst

or Sn/HCl } words or formula
or Fe/HCl }
or Na in ethanol or liq. NH_3

Stage II:
$NaNO_2$ ✓, an acid e.g. HCl ✓
or HNO_2 ✓✓
HNO_3 / HCl gets (1)
NOT just HCl only; not eg $HCl + H_2SO_4$

Stage III:
Phenol ✓, (aq.) NaOH or base or alkali ✓

(ii) Stage I: **[2]**
$C_7H_7NO_2 + 3H_2 \rightarrow C_7H_9N + 2H_2O$ ✓
or 6[H]/6H

Stage III:
$C_7H_7N_2^+Cl^- + C_6H_5ONa \rightarrow C_{13}H_{12}N_2O + NaCl$ ✓
or without the Cl^- or without the Na^+ or without both
or $C_7H_7N_2^+Cl^- + C_6H_5ONa + NaOH \rightarrow C_{13}H_{12}N_2O + NaCl + H_2O$

Both equations MUST be balanced
ecf: if no base in Stage III then allow phenol giving HCl and product in equation

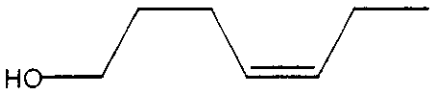
(iii) Dyes ✓ **[1]**
allow indicators, pharmaceuticals

Total = 11

3 (a) (i) Methyl butanoate ✓ **[1]**

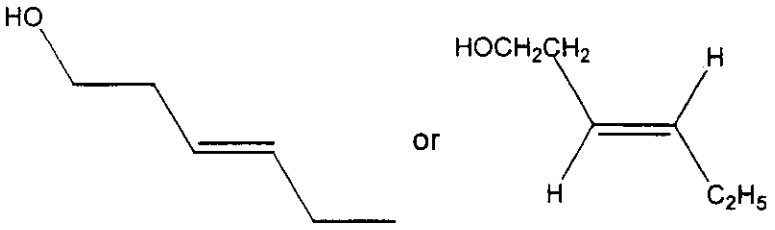
(ii) Warm / hot / boil / reflux ✓
water or aqueous or dilute✓
NaOH / KOH / HCl / H_2SO_4 ✓ } words or formulae
acid/alkali/base H^+ / OH^-
or any strong acid, **NOT** HNO_3 **[3]**

(b) (i)



ONLY ✓ **[1]**

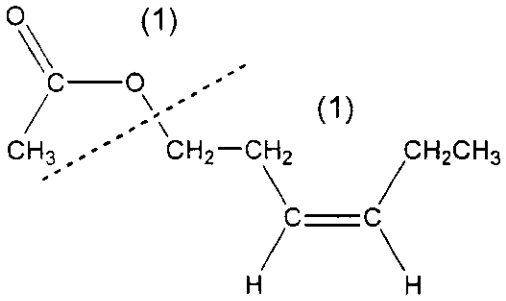
(ii)



✓

not necessarily skeletal; but MUST show the C=C stereochemistry
(right angles not penalised) **[1]**

(iii)

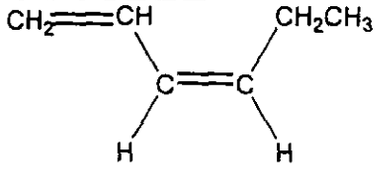


correct left of O-C bond✓
correct right of O-C bond✓
must show bonding in ester and alkene;
structure with CH_3COO... gets (1) only if rest is correct;
structure with trans double bond gets (1) if rest is correct **[2]**

(c) **(i)** M_r B: $C_6H_{12}O$ 72 + 12 + 16 = 100 ✓ **[1]**

(ii) Mass spectroscopy / spectrometer / spec / spectrum ✓ **[1]**

(iii) Structure of C: **[2]**



✓

or any other correct drawing of hexa-1,3-diene C_6H_{10}
or any hydrocarbon of M_r 82 correctly drawn

Type of reaction:
dehydration ✓
or loss of water or elimination
NOT condensation

Total = 12

4 (a) **Two** of: ethene, chloroethene, phenylethene or any alkene monomer ✓✓ **[3]**
One reason: eg all polymer monomers ✓ not benzene
NOT for cracking or fuels

(b) Diagram with correct structure of poly(propene), not necessarily 3-D (1) **[7]**
Polymer has chiral centres (1) ESSENTIAL MARK
can have: all methyls same chirality / 'side' of chain (1)
methyls alternating chirality / 'side' (1)
all methyls random chirality / 'side' (1)

same = isotactic, alt = syndiotactic, random = atactic
all 3 names correctly assigned (1)

(6) available for chemistry, of which
at least (1) must be for a diagram ✓

QWC: At least two coherent sentences with reasonable spelling and punctuation. Show as QWC x or ✓ (1)

MAX = 7

(c) **(i)** For each signal: (1) for identification and (1) for reason. **[6]**
δ 11.7: H of –OH or -COOH; one H: ✓
because it exchanges with D_2O/labile proton
or singlet because it has no ✓
H atoms on an adjacent atom
or data table 11.0 – 11.7

δ 2.4: 2H of $–CH_2–$ ✓
quartet because it has 3 H atoms on the adjacent carbon
(n+1) = 4 lines
✓
or data table 2.0 – 2.9 CHC=0

δ 1.1: 3H of $CH_3–$ ✓
triplet because it has 2 H atoms on the adjacent carbon
(n+1) = 3 lines ✓
✓
or data table 0.7 – 1.6 $CH_3–R$

(ii) It is due to OH and the proton can **[1]**
exchange/swap/substitute (1) with the D in D_2O ✓
or D replaces H
NOT just reacts with water

Total = 17

5 (a) $HOOC(CH_2)_4COOH$ ✓ } words or formula [2]
$H_2N(CH_2)_6NH_2$ ✓ }
(or any pair of monomers that would work)

(b) condensation polymerisation ✓ [2]
small molecule / H_2O is eliminated ✓

(c) **max of 6 marks from:** [7]

- structural similarity

e.g. peptide/amide link (1)

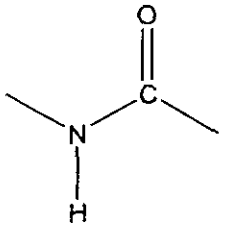


diagram (1)

both form H-bonds between molecules (1) picture of H-bond (1)
or can be in second bullet point

- chemical similarity

e.g. both condensation polymers (1)
$\sim NH_2 + HOOC\sim \rightarrow \sim NHCO\sim + H_2O$ equation (1)
both are hydrolysed (1) back to monomers (1)

- differences

e.g.
protein can be water-soluble, nylon not (1)
protein biodegradable, nylon not (1)
nylon regular, protein irregular (1)
nylon one or two monomers, protein many (1)
proteins are made from amino acids (1) which can be chiral (1)
proteins are natural and nylon is synthetic (owtte) (1)

At least one mark from each bullet point and not more than three from each bullet point. MAX = 6
Plus
Quality of written communication ✓
Correct reference to **two** chemical terms e.g. condensation, peptide, biodegradeable.
Show as QWC x or ✓

Total = 11

6 (a) (i) propanone ✓ **[1]**
accept acetone or propan-2-one

(ii) propanal ✓ **[1]**
accept propanaldehyde but **not** ethanal

(b) (i) *reagent(s):* e.g. 2,4-dinitrophenylhydrazine ✓ **[2]**
in words or formula
observation: e.g. orange / red / yellow precipitate / crystals ✓
no mark for observation if no reagent given

(ii) *reagent(s):* e.g. ammoniacal $AgNO_3$ ✓ or Ag_2O or Ag^+ or Tollens **[3]**
*observation for **D**:* No change ✓
*observation for **E**:* silver (mirror) ✓ grey ppte

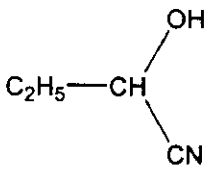
or similarly for another **chemical** test that works e.g. acid dichromate, Fehlings or CHI_3 test

(c) (i) Marked cross at $\nu \sim 1700$ ✓ **[2]**
D has carbonyl group or ketone or C=O ✓

(ii) e.g. Reduction $CH_3COCH_3 \rightarrow CH_3CHOHCH_3$ (1) **[2]**
(or product is an alcohol)

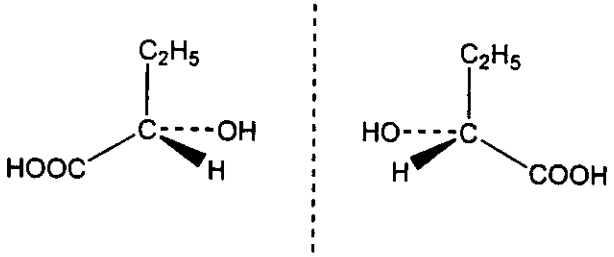
new (broad) peak at ~3230 – 3550 cm^{-1} (1)
loss of peak at ~ 1700 cm^{-1} (1)

any two good points ✓ ✓

(d) (i)  **[1]**

✓ allow $C_2H_5CH(OH)CN$

(ii) e.g.



✓✓

with at least one bond shown out of plane of paper
(1) for correct structure of K, but poor 3-D diagrams
(1) for correct 3-D structures of J
watch out for –CN instead of -COOH
allow ecf from (i) e.g. $-CH_3$ instead of $-C_2H_5$
allow correct 3-D diagrams of amide as hydrolysis product instead of acid

Total = 14

7 (a) $RCH(NH_2)COOH$ or $RCH(NH_3^+)COO^-$ ✓ **[1]**

(b) (i) $H_3N^+CH_2COO^-$ ✓ **[1]**
accept $NH_3^+CH_2COO^-$

(ii) COOH is acidic / loses H^+ ✓ **[2]**
NH_2 is basic / has a lone pair / gains H^+ ✓(not H transfer)

(iii) High m.p. means strong **intermolecular** / between molecules (1) forces in the solid glycine; ✓ **[3]**

coulombic (ion/ion) forces (1) in zwitterion are strong; ✓

any comment on why hydroxyethanoic acid is lower ✓
e.g. H-bonding (1) holds crystal together

(c) $H_3N^+CH_2COOH$✓←glycine→$H_2NCH_2COO^-$✓or H_2NCH_2COONa **[4]**

↓

$H_2NCH_2COOCH_3$ ✓
or $H_3N^+CH_2COOCH_3$

any correct balancing ion ✓

Total = 11