A Level

Chemistry

Session: 2000 June
Type: Mark scheme
Code: 9254

Oxford Cambridge and RSA Examinations

OCR

RECOGNISING ACHIEVEMENT

A LEVEL
(former linear Cambridge syllabus)

A 9254

CHEMISTRY

MARK SCHEME FOR COMPONENTS
TAKEN IN JUNE 2000

INVESTOR IN PEOPLE

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by Examiners. It does not indicate the details of the discussions which took place at an Examiners' meeting before marking commenced.

All Examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the Report on the Examination.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

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Publications
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CAMBRIDGE LINEAR A LEVEL CHEMISTRY 9254
JUNE 2000 ASSESSMENT SESSION

Component Threshold Marks

Component	Maximum Mark	A	B	C	D	E	N	U
1	72	54	48	41	35	28	22	0
2	48	39	34	30	26	23	20	0
3	40	30	26	24	22	19	17	0
4	40	29	26	23	20	17	14	0
5	75	54	49	45	41	37	33	0
7	36	33	29	26	23	20	17	0
9	36	34	31	28	25	22	19	0

Overall Threshold marks

Option (components)	Maximum Mark	A	B	C	D	E	N	U
A (1, 2, 3, 4, 5)	250	183	163	148	130	112	95	0
C (1, 2, 3, 4, 7)	248	194	173	153	134	114	95	0
D (1, 2, 3, 4, 9)	248	194	174	154	136	121	104	0

The cumulative percentage of candidates achieving each grade was as follows:

Grade	A	B	C	D	E	N	U
Cumulative percentage	27.6	47.2	63.3	75.3	86.3	94.2	100
Number of candidates	260	185	152	113	104	74	55

Chemistry Special Paper, 9434

Maximum Mark	Distinction	Merit	Unclassified
100	56	43	0

The cumulative percentage of candidates achieving each grade was as follows:

Grade	Distinction	Merit	Unclassified
Cumulative percentage	33.9	62.9	100
Number of candidates	21	18	23

OCR

RECOGNISING ACHIEVEMENT

Markscheme 9254/01
June 2000

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)
   ˆ = 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.

1. (a) (i) *isotopes are atoms* of the same element
or having /same atomic number/number of protons/
(any reference to allotropes negates this mark) [1]

but have different numbers of neutrons
or different /mass/nucleon/ number [1]

(ii) *isotopic mass is* the /mass/weight/ of 1 (mole of) atom(s) of an isotope /relative to/divided by/ 1/12 the mass of a (mole of) ^{12}C (atoms) [1]

3

(b) (i) **P** is ^{14}C symbol (½) + mass no. (½) [1] a charge on C negates this mark

Q is $[^{14}N]^{3-}$ symbol (½) + mass no. (½) [1] *charge* [1]

R is $[^{15}O]^{+}$ symbol (½) + mass no. (½) [1] *charge* [1]

add up the ½ marks, divide by 2, and round ½ down
mass numbers can be detached from the symbol

(ii) $^{(14)}C$ **and** $^{(15)}O$ *or* P **and** R (are not the usual isotopes) [1]

6

(c) (i) plate A must be negative, **and** because /positive (particles)/nuclei/ (are attracted) [1]

(ii) because m/e of ^{1}H is half that of ^{4}He *or* mass of He is 4x mass of H, but charge is 2x that of H (**not** because mass of H is half that of He) [1]

(iii) (^{2}H has the same m/e as ^{4}He, so:) **deflection of 2°** [1]

(^{3}He has m/e of 3/2 = 1.5, so:) **deflection of 2.7°** [1]
(or 2.6° or 2 $^{2}/_{3}$ ° but NOT 2.5° or 3°)

4

13 max 12

2. (a) assumptions: molecules/particles/atoms/ have /zero/negligible/ size/volume
or can be considered as points
no intermolecular attractions *or* attractions between particles
NOT between atoms
elastic collisions/ no loss of KE on collision
IGNORE mention of random motion *any two* [2]

CO_2 /molecules/particles/ have a large size (or larger than H_2)
NOT larger mass. NOT that CO_2 **gas** has greater volume.
CO_2 molecules have large /intermolecular forces/ attractions between particles/
CO_2 molecules experience inelastic collisions *any two* [2]

4

(b) **low** pressure [1]
high temperature [1]

2

(c) (i) Graph: (axes can be interchanged) *labelled axes*
[1]

plotting (4 points) [1]
(ignore any line that is drawn. Scale must be 2cm square ≤ 50 pV units. Must be on graph paper)

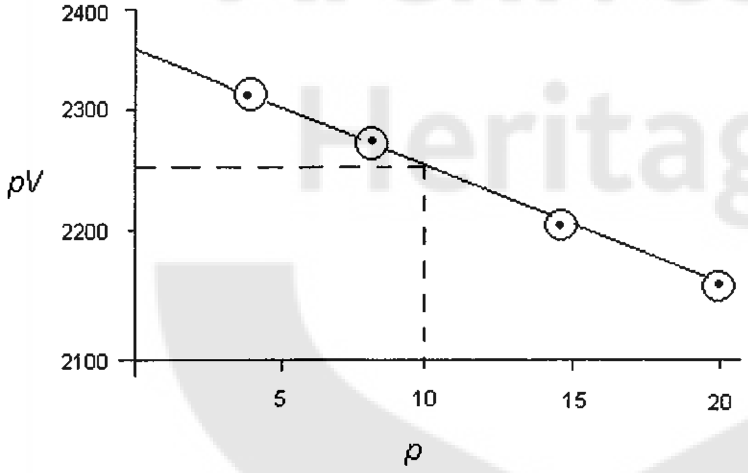


Table: *2320*
2280 ⎫
2190 ⎬ [1]
2140 ⎭
(can be read from graph)

(ii) pV should be constant *or* a horizontal line [1]

(iii) from graph: PV = 2250 (= *x*) (or what they correctly read from *their* graph)
∴ V = **2.25×10^{-3}** (m^3) (*or* 2.25 dm^3) (method: = $x \times 10^{-6}$) [1]
(assume m^3 unless otherwise stated
V_{ideal} = RT/P = $8.31 \times 285/10^6$
= **2.37×10^{-3}** (m^3) (2.36, 2.4 but NOT 2.3) [1]
Valid comment about intermolecular attractions occuring [1]

7

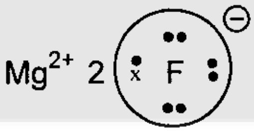
13 max 12

3. (a) (i) MgF_2 is /ionic/electrovalent/ **and** SF_2 is /covalent/simple molecular [1]

reason: Mg is /electropositive/a metal/
or the (sum of 1st two) ionisation energies is low
or large difference in electronegativity (between F and Mg) [1]
whilst S is /electronegative/a non-metal/has high IE/
or small difference in electronegativity (between Sand F)

MUST be a comparison

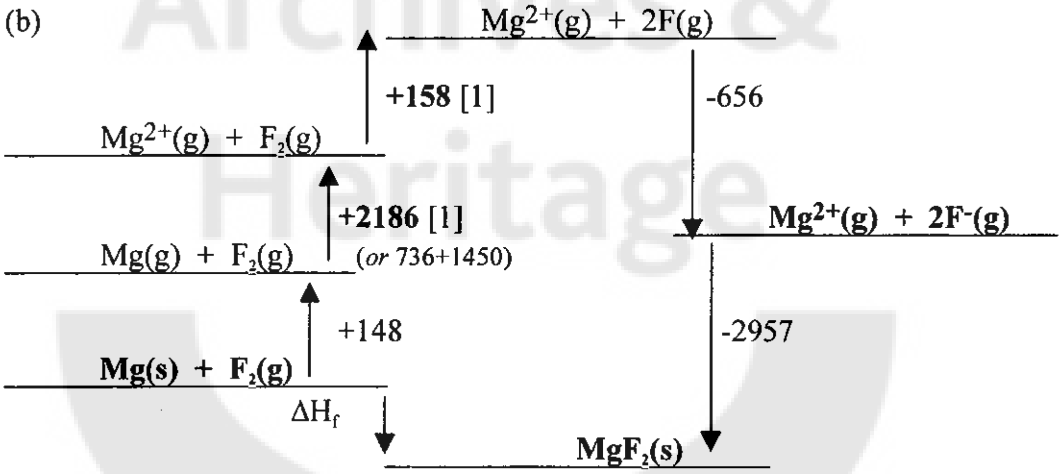
(ii) FINAL STATE needed, + an indication of where the electrons have come from - either by dot and cross, or arrows showing electron movement in atoms



(allow all dots)

electrons (including **2** F^- ions) [1], **both** charges [1] [1] **5**

(b)



*limited cycle (**those in bold**) with state symbols* [1]
state symbols for all other steps in their cycle (even if incomplete or not a cycle) [1]
*extraction of data (in **bold**) above* [1]+[1]

ΔH_f = 148+2186+158-656-2957 = **-1121** kJ mol^{-1} *answer* [1]
units [1]u/c

(N.B. correct answer + units can gain [4] marks) **6**

(c) mark by impression, [1] mark for something valid about SF_2 and [1] for MgF_2.
e.g.
If SF_2 reacts with F_2, two S-F bonds are formed, but only one (weak) F-F bond is broken *or* S can use d-orbitals/expand its octet/
If MgF_2 reacted with F_2, a further 2 electrons need to be removed from Mg^{2+} - this /needs too much energy/involves breaking into another shell/

2
13 max 12

4. (a) Cr is $1s^22s^22p^63s^23p^63d^44s^2$ *or* $[Ar]3d^44s^2$ *or* $...4s^23d^4$ [1]

or $1s^22s^22p^63s^23p^63d^54s^1$ *or* $....4s^13d^5$ NOT $....3d^6$

likely oxidation states are (+)6, 5, 4, 3, 2, 1 *(any two. O.N.>6 negates)* [1]

allow Cr^{2+}, Cr^{3+} but no other "ions", allow Cr(VI) etc **2**

(b) (i) $Cr_2O_7^{2-} + 14H^+ + 6Fe^{2+} \longrightarrow 2Cr^{3+} + 6Fe^{3+} + 7H_2O$ [1]

E_{cell} = +1.33 - 0.77 = (+)0.56 (V) (-0.56 does NOT score) [1]

(ii) $Cr_2O_7^{2-} + 14H^+ + 6I^- \longrightarrow 2Cr^{3+} + 3I_2 + 7H_2O$ [1]

E_{cell} = +1.33 - 0.54 = (+)0.79 (V) (allow ecf for -0.79) [1]

4

Allow ecf in correctly calculated E_{cell} values if the wrong oxidant (e.g. $KMnO_4$) is used. This will give a max of [2] ecf marks.

(c) (i) 53.3/137 = 0.39

21.7/55.8 = 0.39 *(method)* [1]

24.9/16 = 1.56

∴ $BaFeO_4$ [1]

∴ O.N. of Fe is (+)6 [1]ecf

(ii) M_r of red solid = 137 + 55.8 + 64 = 256.8 [1]ecf

1.00 g is 1/256.8 = 3.9×10^{-3} moles [1]ecf

This needs 6 x 3.9×10^{-3} = 0.023 moles of electrons *(use of 6e⁻)* [1]

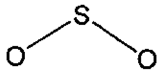
Which is 0.023 x 96500 = 2.25×10^3(C)

(method: their no. of e⁻ x 96500 and correct calc) [1]ecf

7

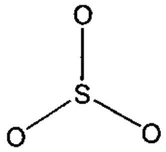
13 max 12

5. (a) SO_2: a **bent** molecule *or* diag:



[in general, ignore bond angle in SO_2] [1]

SO_3: /triangular/trigonal/ (planar) *or* diag.



[correct drawn shape **and** words overrrides
incorrect angle. If words contradict
drawn shape, mark is forfeited] [1]

reasoning for **both** [1]

(i.e. no lone pairs in SO_3 - in WORDS **and** one lone pair on SO_2 - can be read into diag.)

3

(b) *The Contact Process:*

$$S + O_2 \longrightarrow SO_2$$
$$2SO_2 + O_2 \longrightarrow 2SO_3$$

(**both** equations) [1]

(pass SO_2 and more air over) V_2O_5 *or* name *or* Pt *or* name [1]

at 400-500°C **and** with pressure of between 1 and 10 atmos [1]

pass the SO_3 into (conc) H_2SO_4 **and** /dilute with/add/ water *or*
SO_3 + $\mathbf{H_2SO_4}$ → $H_2S_2O_7$ **and** $H_2S_2O_7$ + $\mathbf{H_2O}$ → $2H_2SO_4$ [1]
(only those bits in **bold** in equations needed)

Temperature is kept low(ish) because of the exothermic reaction [1]
(ignore any ref. to pressure)

conc. H_2SO_4 is used as absorber to prevent a mist forming [1]
(*or* SO_3 + water too exothermic/violent.dangerous)

reaction is speeded up by *either* the V_2O_5 *or* temperature not too low [1]

7 max 6

(c) vol. of greenhouse = 2 x 3 x 4 = 24 m^3

volume of SO_2 = 24 x 50/10^6 = 1.2 x 10^{-3} m^3 (= 1.2 dm^3) [1]

moles of SO_2 = 1.2/24 = 0.05 (÷24) [1]ecf

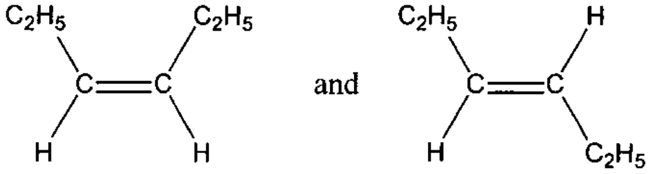
mass of S = 0.05 x 32 = 1.6(g) (×32) [1]ecf

3

12

6 (Sticks: -[1] for whole question)

(a)



[1]

(allow Et for C_2H_5. allow "right-angle" versions of displayed formulae)

correct labelling of isomers, *or* mention of cis-trans *or* geometrical isomerism [1]

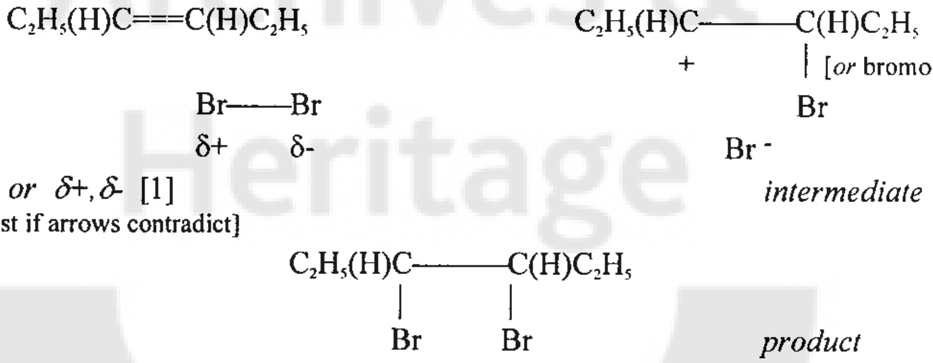
cyclohexene can only be the **cis** isomer (*or* hydrogens have to be on same side) [1]

3

(b) electrophilic addition [1]

in the dark *or* at room temp. *or* in water *or* in solvent or UV is NOT used
use of UV or Lewis acid negates the mark [1]

[allow sticks
in mechanism]



[*or* bromonium ion]

arrows or δ+, δ- [1]
(mark lost if arrows contradict)

intermediate [1]

product [1]
[allow bromohydrin if water is solvent]

5

(c) Cis-trans isomerism is destroyed during the addition of HBr (or similar) [1]
or alkene is symmetrical *or* same groups on each end of double bond
The product has chiral carbon atom *or* shows optical isomerism *or* diag [1]

2

(d) $CH_3CH_2CO_2H$ [1]

$HO_2CCH_2CO_2H$

([1] for $-CH_2OH \longrightarrow -CO_2H$, even in starting alkene)
([1] for $=CH- \longrightarrow HO_2C-$) [2]

3

13 max 12

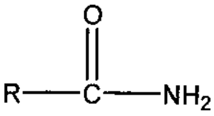
7 (Sticks: -[1] for whole question)

(a) I: PCl_5 *or* $SOCl_2$ *or* PCl_3 *or* in words [NB (aq) negates mark] [1]

II: NH_3 *or* in words [1]

2

(b) (di)amide [1]

$H_2NCOCH_2CH_2CONH_2$ *or* 

$R-C(=O)-NH_2$

or $RC(=O)NH_2$ [1]

2

(c) reduction [allow 'reduction by addition', but NOT 'reduction by hydrolysis'] [1]

1

(d) (i) condensation [1]

(ii) $COCH_2CH_2CONHCH_2CH_2CH_2CH_2NH$ *(-1 for each error)*[2]
[allow $-(CH_2)_2-$ etc, but NOT $-C_2H_4-$]

3

(e) **C** contains the $\overset{\delta+}{-C}\overset{\delta-}{=O}$ with $Cl^{\delta-}$ below C group, (so) the carbon is much more δ+ than the carbon in a chloroalkane. (or similar)

(*or* the group is **very** polar/more polar than C-Cl in chloroalkane) [1]

Product is **B** *or* $HO_2CCH_2CH_2CO_2H$ *or* name [1]

2

(f) (i) dehydration *or* condensation *or* removal/elimination **of water/H_2O** [1]

(ii) $\begin{array}{l} CH_2\text{-}CO_2C_2H_5 \\ | \\ CH_2\text{-}CO_2H \end{array}$ [2] *or* $\begin{array}{l} CH_2\text{-}CO_2C_2H_5 \\ | \\ CH_2\text{-}CO_2C_2H_5 \end{array}$ [1]

[allow Et for C_2H_5]

3

13 max 12

8 (Sticks - -[1] for whole question)

(a) $2CH_3CO_2H + CaCO_3 \longrightarrow Ca(CH_3CO_2)_2 + CO_2 + H_2O$ [2]

[salvages: allow [1] for $CaCO_3 \rightarrow CO_2$. allow [1] for equ with H_2CO_3 instead of $CO_2 + H_2O$]

[ignore Ca-O bonds in the product]

2

(b) moles = PV/RT = $(1 \times 10^5 \times 55 \times 10^{-6})/(8.31 \times 383)$

= 1.728×10^{-3} moles [1]

M_r = $0.1/(1.728 \times 10^{-3})$ = **58** (57.8, 57.9) [1]ecf

[ecf: e.g. allow 0.058 etc] **2**

(c) NB:

1. Context is important - if conclusions are not related to the tests, deduct max [1] for whole of part (c).
2. Candidates may identify G first, and then justify their answer (as the question asks them to do!), so may not state explicitly the conclusions to the tests. e.g. "G is propanone, because it is neutral, does not react with Na,... etc". In this case, deduct max [1] also.

G is polar *or* hydrogen-bonded (water solubility) [1]

G is **not** RCO_2H/carboxylic acid (neutral) [1]

G is **not** an aldehyde (Fehling's test) [1]

G is **not** an /alcohol/acid/phenol/ *or* does not contain -OH group (Na metal)[1]

G must contain the /CH_3CO/$CH_3CH(OH)$/ group *or* is a methyl ketone etc (OH^-/I_2) [1]

gives a /yellow/cream/ /ppt./solid/ *or* /iodoform/CHI_3/ [1]

G is CH_3COCH_3 [MUST be the **formula - NOT name**] [1]

7 max 6

(d) $Ca(CH_3CO_2)_2 \longrightarrow CH_3COCH_3$ (*or* C_3H_6O) + $CaCO_3$ [1] **1**

(e) Add (2,4-)DNP(H) (dinitrophenylhydrazine) (Brady's reagent)*(allow c.e.)* [1]

G will give a yellow/orange/red ppt. *(allow c.e.)* [1]

2

(f) $CH_3CH_2COCH_2CH_3$ or Et_2CO [1]

1

14 max 12

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RECOGNISING ACHIEVEMENT

Markscheme 9254/02

June 2000

Marking Chemistry

1. It is essential that a red pen is used for all marking; a tick or a cross should be placed as near as possible to the point in the text, calculation or diagram where a mark has been awarded/not awarded.

2. As you mark each question, each marking point earned should be clearly marked with a tick. For example, show two ticks for two valid points.

3. It may be helpful to give some indication about why a mark has been awarded when the answer is one not explicitly mentioned in the marking scheme.

   - "ecf" is useful for indicating 'error carried forward' in consequential marking.
   - "bod" is useful for indicating 'benefit of doubt' (where you have used professional judgement).
   - Also, feel free to use your own comments to justify a mark.
   - Inverted Vs are useful for quickly indicating omissions.

   If an answer is disjointed, then arrows can be used to link together the parts to the answer.

4. The totals for each part, i.e. (a), (b), (c) etc, of a question should be clearly shown in the margin.

5. If the mark scheme for a particular section has more marking points than marks available, then tick each point, count the ticks and if greater than the maximum mark, write the maximum mark with 'MAX' next to it in the margin.

6. No page or part of question should be left without evidence that it has been read and assessed. If no marks have been gained for a part question, then a cross on the page and a zero in the margin will indicate that it has been seen.

7. At the end of each question, you should put a total in a circle. This must tally with both the mark totals in the margin *and* the ticks within the question (except where 5 applies). Please use both of these to help you to check your marking.

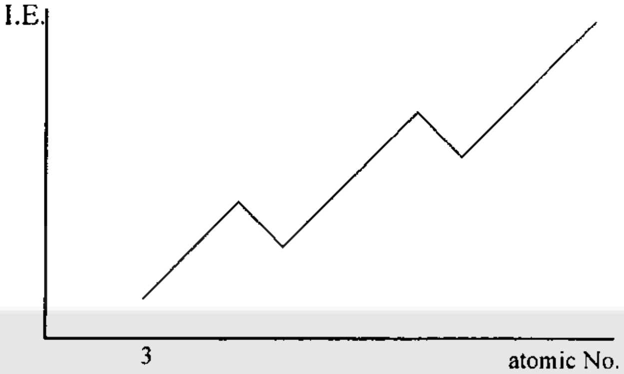
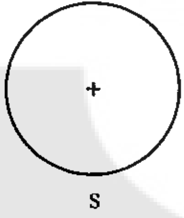
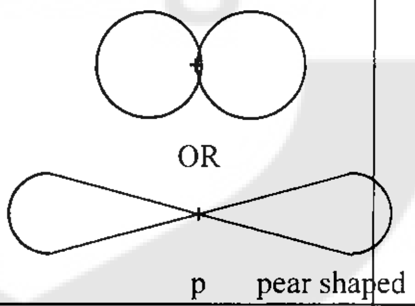
8. The total for each question should then be added together to provide the Grand Total for the front of the paper.

9. As a check, the Grand Total should be equal to the number of the ticks on the paper (except where 5 applies) *and* to the sum of the totals for each question.

10. Finally, please check your adding up!! It is surprising how many cases there are of incorrect marks due to arithmetical errors or missed ticks. This is the biggest single source of error in the marking of scripts.

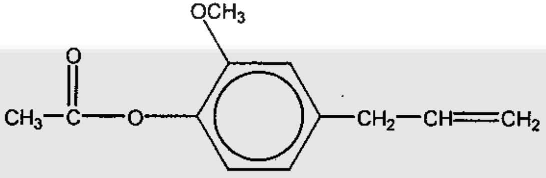
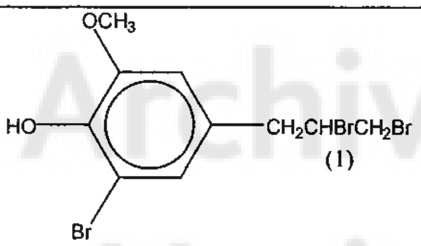
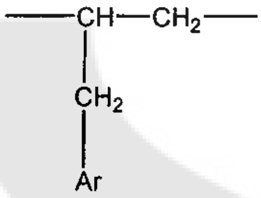
Use one tick for each valid marking point.
Every part of a question must show evidence that it has been seen by you.
There should be no gaps.
The number of ticks on the paper must match the Total Mark, except when 'MAX' appears.
Check your arithmetic!!!!

Question Number	Mark Scheme Details	Part Mark
1 (a)	$Mg^{2+}(aq) + 2OH^-(aq) \longrightarrow Mg(OH)_2(s)$ OR $MgCl_2 + 2NaOH \longrightarrow Mg(OH)_2 \downarrow + 2NaCl$ Equation (1) (s) or ↓ (no mark if state symbols incorrect) (1)	2
(b)	$\frac{NaOH}{MgCl_2}$ $\frac{2}{1} = \frac{20x1.0}{50xM}$	
	$M = \frac{20}{2x50} = 0.20$ *units in Q* ecf if 1:1 mole ratio in (a)	1
(c) (i)	pH = 9.0 $[OH^-] = 10^{-5}$ (1)	
(ii)	$[Mg^{2+}] = 0.10$ (1) ecf from (b)	2
(d) (i)	$K_{sp} = [Mg^{2+}][OH^-]^2$ (1) must include charges, ignore state symbols	
(ii)	$= 10^{-11}$ mol^3 dm^{-9} (1) ecf from (b) or (c) numerical answer (1), units (1) ecf unit mark from (d)(i)	3
(e)	The mixture is as if 10 cm^3 of 1.0 mol dm^{-3} NaOH is diluted to 80 cm^3	
	$[OH^-] = 0.125$ mol dm^{-3} (1)	
	which gives pH = 13.1	1
	Total	**max 8**

2 (a) (i)	 Must start at atomic no. 3. Accept x (does not have to join up)	1
(ii)	$N(g) \rightarrow N^+(g) + e^-$ or $e^- + N(g) \rightarrow N^+(g) + 2e^-$	1
(iii)	O has one paired p orbital OR nitrogen has three p and oxygen four p electrons (1)	
	The 3 unpaired electrons of N confers extra stability (symmetry) OR The shared pair undergo electron repulsion reducing the IE (1)	2
(b) (i)	$1s^2\ 2s^2\ 2p^3$ (1)  	3
	Total	7

3 (a)	NO_2 +4, N_2O +1 (4 and 1 assumed to be plus) NH_2OH -1, NH_4^+ -3 3 correct (1), 2 or less correct (0)	2
(b)	$Cu - 2e^- \rightarrow Cu^{2+}$	
	$NO_3^- + 2H^+ + e^- \rightarrow NO_2 + H_2O$	
(i)	$Cu + 2NO_3^- + 4H^+ \rightarrow Cu^{2+} + 2NO_2 + 2H_2O$ (1) OR $Cu + 4HNO_3 \rightarrow Cu(NO_3)_2 + 2NO_2 + 2H_2O$	
	$Al - 3e^- \rightarrow Al^{3+}$	
	$NO_3^- + 10H^+ + 8e^- \rightarrow NH_4^+ + 3H_2O$	
(ii)	$8Al + 3NO_3^- + 30H^+ \rightarrow 8Al^{3+} + 3NH_4^+ + 9H_2O$ (1) mark allowed if very nearly correct	
(iii)	Al is stronger reducing agent than Cu (or equivalent)	
	[has larger negative $E^\ominus$*]* (1)	3
(c) (i)	2 mols of Fe^{3+}	
(ii) (iii)	Two/ -1 to +1 N_2O (1)	
(iv)	$4Fe^{3+} + 2NH_2OH \rightarrow 4Fe^{2+} + 4H^+ + H_2O + N_2O$ (2)	4
	All species correct (1), at least one of H^+, H_2O included (1) Allow $2Fe^{3+}$: NH_2OH and consequential nitrogen product.	
	Allow 1 for unbalanced $2Fe^{3+}$: $1NH_2OH$ and consequential N product	
	Total	**9**

4 (a)	$NaOH + CO_2 \rightarrow NaHCO_3$ (1) OR $2\,NaOH + CO_2 \rightarrow Na_2CO_3 + H_2O$	1
(b) (i)	$R\text{-}Br + OH^- \rightarrow ROH + Br^-$ OR $R\text{-}Br + NaOH \rightarrow ROH + NaBr$ (1)	
(ii)	nucleophilic substitution (1)	2
(c) (i)	white/cream precipitation (1)	
	$Ag^+(aq) + Br^-(aq) \rightarrow AgBr(s)$ (1) OR $AgNO_3 + HBr$ (or $NaBr$) $\rightarrow AgBr + HNO_3$ (or $NaNO_3$) [precipitation must be mentioned somewhere in answer]	
(ii)	yellow/orange/red/brown (1)	
	$2Br^- + Cl_2 \rightarrow Br_2 + 2Cl^-$	4
(d)	C – Br is longer/weaker/smaller bond energy than C-Cl or C – F (1)	1
	Total	**8**

5 (a)	The phenol Ar – OH forms a salt $ArO^- Na^+$ (1) Ar = C_6H_5–	
	The ionic salt will be more soluble than the [H-bonded] phenol (1)	2
(b) (i)	Ar – CH_2 – CHOH – CH_2OH (1)	
(ii)	Ar – CH_2 – CO_2H , Ar-CO_2H , $ArCH_2CHO$ *[ignore CH_2O, CO_2 and rest of molecule]* (1)	
(iii)	 (1)	
(iv)	 (1) (1) *Allow substitution of Br at other hydrogen atoms on benzene ring.*	5
(c) (i)	addition (1)  (1)	2
	Total	**9**

6 (a)	Fractional distillation used to separate crude oil into bp/M_r fractions (1)	
	Catalysts used to dehydrogenate for aromatic (or cyclic, reformation or branch chain) compounds (1)	
	One suitable example (1)	
	max	2
(b)	One suitable example of this type:	
	e.g. $C_{16}H_{34} \rightarrow C_8 H_{18} + C_6H_{12} + C_2H_4$ (1)	
	One discussion of usefulness of one product e.g. C_8H_{18} as gasoline OR alkenes for polymers, chemicals etc (1)	2
	Communication (2)	
	S&P(1) G (1)	
	Quality of language	4
	Total	**8**

Paper maximum raw mark **48**

OCR

RECOGNISING ACHIEVEMENT

Markscheme 9254/03
June 2000

Multiple Choice

Question No.	Correct Answer
1	C
2	A
3	B
4	B
5	C
6	B
7	C
8	A
9	C
10	C
11	D
12	C
13	D
14	C
15	A
16	B
17	A
18	D
19	A
20	C
21	C
22	B
23	D
24	B
25	A
26	C
27	A
28	C
29	A
30	C
31	D
32	B
33	C
34	B
35	B
36	D
37	B
38	B
39	D
40	D

RECOGNISING ACHIEVEMENT

Markscheme 9254/04
June 2000

Marking Chemistry

1. It is essential that a red pen is used for all marking; a tick or a cross should be placed as near as possible to the point in the text, calculation or diagram where a mark has been awarded/not awarded.

2. As you mark each question, each marking point earned should be clearly marked with a tick. For example, show two ticks for two valid points.

3. It may be helpful to give some indication about why a mark has been awarded when the answer is one not explicitly mentioned in the marking scheme.

- "ecf" is useful for indicating 'error carried forward' in consequential marking.
- "bod" is useful for indicating 'benefit of doubt' (where you have used professional judgement).
- Also, feel free to use your own comments to justify a mark.
- Inverted Vs are useful for quickly indicating omissions.

If an answer is disjointed, then arrows can be used to link together the parts to the answer.

4. The totals for each part, i.e. (a), (b), (c) etc, of a question should be clearly shown in the margin.

5. If the mark scheme for a particular section has more marking points than marks available, then tick each point, count the ticks and if greater than the maximum mark, write the maximum mark with 'MAX' next to it in the margin.

6. No page or part of question should be left without evidence that it has been read and assessed. If no marks have been gained for a part question, then a cross on the page and a zero in the margin will indicate that it has been seen.

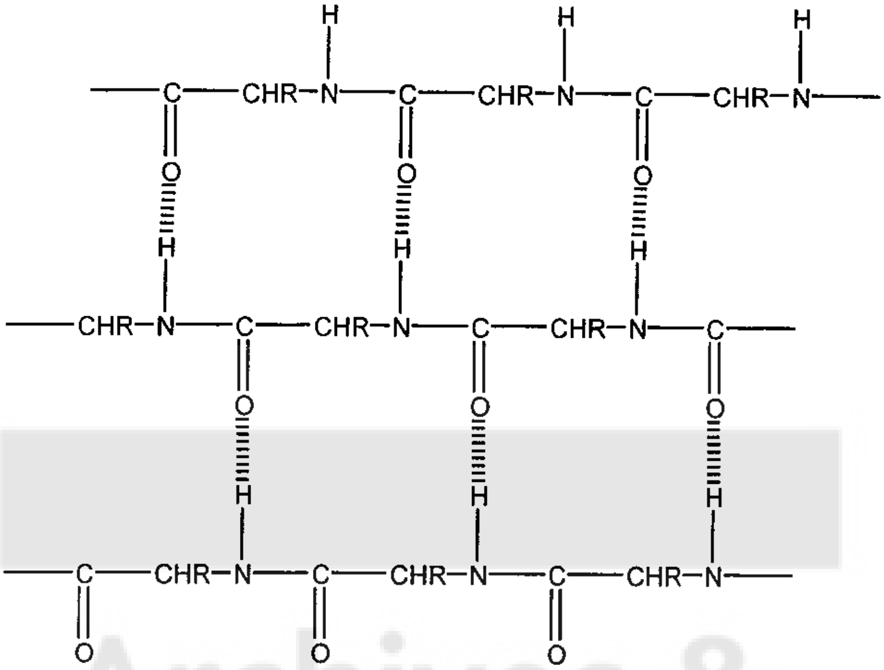
7. At the end of each question, you should put a total in a circle. This must tally with both the mark totals in the margin ***and*** the ticks within the question (except where 5 applies). Please use both of these to help you to check your marking.

8. The total for each question should then be added together to provide the Grand Total for the front of the paper.

9. As a check, the Grand Total should be equal to the number of the ticks on the paper (except where 5 applies) ***and*** to the sum of the totals for each question.

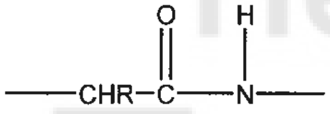
10. Finally, please check your adding up!! It is surprising how many cases there are of incorrect marks due to arithmetical errors or missed ticks. This is the biggest single source of error in the marking of scripts.

1 (a) (i)



[4 x 1] mark by omission
should be no free NH or CO groups

For partial answers



$$-\mathrm{CHR}-\overset{\overset{\displaystyle O}{\|}}{C}-\overset{\overset{\displaystyle H}{|}}{N}-$$

(displayed) (1)

$C{=}O\cdots\cdots H-N$

3 strands drawn (1)

(ii) Structural/muscle/silk /fibrous/hair/keratin (1)

(iii) above and below the sheets/outwards (1)

[6]

(b)

van der Waals/hydrophobic	-H or -CH_3 or -R	(1)
hydrogen bonds	-OH or -NH_2 or -NH	(1)
ionic/electrostatic	-CO_2^- or -NH_3^+	(1)
disulphide (covalent links)	-S--S- / -SH	(1)

[4]

2 (a) Haemoglobin is a quarternary structure (1)
formed from (4) polypeptides/tertiary structures / 2α +2β
OR are oligomeric (1)

Labelled diagram is acceptable

contains iron as iron^{II}/Fe^{2+} (1)

combines with oxygen by weak/reversible/dative bond
/ oxygen is a ligand (1)
[4]

(b) (i) At low O_2 pressure absorption is first order /directly proportional (1)

haem + O_2 → O_2 haem (1)
(oxyhaemoglobin)

At high O_2 pressure, haemoglobin molecules saturated (1)

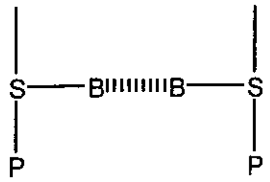
1 mole of haem absorbs 4 moles of oxygen (1)

zero order with respect to O_2 / rate is constant (1)
[4 max]

(ii) 10$\pm$ 2 (1)

(iii) Vertical axis in enzyme kinetics is rate (1)

3 (a) double helix (stated) **NOT** strand (1)



or described (must have S-P backbone) (1)

H bonds between bases (or labelled in diagram) (1)

which are easily broken/unzipped/for replication (1)

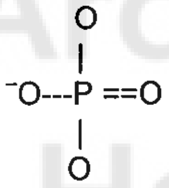
4 bases A,G,T,C (1)

S is deoxyribose (1)

[6]

(b) S contains -OH groups which H-bond with water (1)

P is ionic



$$^{-}O\text{---}\overset{\overset{O}{|}}{\underset{\underset{O}{|}}{P}}==O$$

(hydrophilic understood) (1)

[2]

(c) (i) ester / phosphate ester (1)

(ii) S-P + H_2O → S + P

alcohol acid

polarised bond is easily attacked by OH^- (1)

[2]

4 (a) (i) UV causes oxygen molecules to break into atoms (1)

one of the atoms is excited (1)

and reacts with oxygen molecules to make ozone (1)

in the presence of an inert molecule which absorbs excess energy (1)

ozone, using UV of <u>different wavelengths</u> (1)
breaks into an oxygen molecule and an oxygen atom.

The oxygen atom reacts with another ozone molecule to make two molecules of oxygen (1)

Any 4 points. Precise wavelengths **not** required. Accept if some points given as equations.

(ii) Absorbs UV (1)

(iii) Restricted free radical reactions at the Earth's surface (1)

[6]

(b) produced in car engines or other high temperature combustion (1)

$O_3(g) + NO(g) \rightleftharpoons O_2(g) + NO_2(g)$ (1)

$NO_2(g) + O(g) \rightleftharpoons NO(g) + O_2(g)$ (1)

O(g) in second equation from other free radical breakdowns (1)
Any one NO(g) molecule is recycled to cause destruction of many ozone molecules (1)

Any 4 points

[4]

5 (a) (i) Joins two silicate layers (1)

by sharing oxide or hydroxides (1)

(ii) Al ions have a smaller positive charge which gives the clay a positive ion deficiency (1)

this is compensated by cations adhering to the clay surface (1)

(iii) plants use the surface store to provide the ions for growth (1)

[5]

(b) (i) The strongly polarising Al^{3+} ion causes water molecules to break down forming hydrogen ions (1)

$Al(H_2O)_6^{3+} \rightleftharpoons Al(H_2O)_5(OH)^{2+} + H^+$ (2)
(1 for formulae, 1 for correct charges)

(ii) Lead is usually present on the Earth's surface as very insoluble ores (1)

These ores are more soluble (react) in acid solution (1)

[5]

6 (a) Partial pressure of carbon dioxide is 0.035/100 x 101.3 = 0.0355 kPa (1)

Henry's Law then gives $[CO_2(aq)] = k(0.0355)$ (1)

Therefore $[CO_2(aq)] = 3.34 \times 10^{-4} \times 0.0355 = 1.18 \times 10^{-5}$ mol dm^{-3} (1)

[3]

(b) (i) $K = [H^+][CO_3^{2-}]/[HCO_3^-]$ mol dm^{-3} (1)

(ii) $4.7 \times 10^{-11} = [H^+]/10$ (1)

pH = 9.3 (1)

(iii) 1 pH unit difference (1)
means concentration of hydrogen carbonate is now 100 times that of carbonate (or show by calculation) (1)

(iv) decaying organic matter will increase acidity and lower pH (1)

because -COOH groups are present or carbon dioxide is released by decaying material (1)

[7]

7 (a) $CH_2 - O - CO - (CH_2)_{16}\,CH_3$
|
$CH - O - CO - (CH_2)_{16}\,CH_3$ (1)
|
$CH_2 - O - CO - (CH_2)_{16}\,CH_3$

Accept any saturated fatty acid residue inc R and /\/\/\/\/\ etc.

The fatty acid is saturated (animal source) (1)

[2]

(b) Both a hydrophobic and a hydrophilic part (1)
(accept non-polar/polar)

Non-polar part bonds to the lipid and the hydrophilic part to the water (1)

Hydrophilic part will be ionic or form H-bonds (1)
Natural emulsifiers are glycerol monostearate (GMS)
also lecithin, phosphoglycerides (1)
[**Not** ascorbic acid)

[4]

(c) (i) Vit A is fat / oil/ lipid soluble (1)

(ii) Eye problems/night blindness, skin problems (1)

[2]

(d) The absorption of Ca^{2+} is assisted by vit D (1)

necessary for healthy strong bones / teeth / prevents rickets (1)

equilibrium between Ca^{2+} in body fluids and Ca^{2+} in bones (1)

any 2

[2]

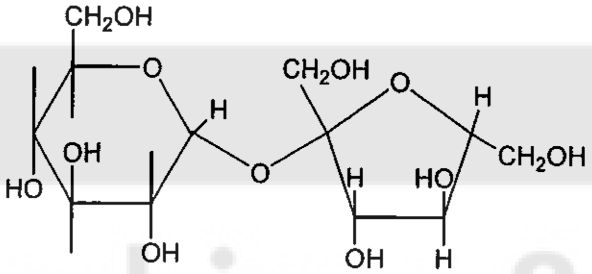
8 (a) (i) sucrose is a disaccharide (1)

(ii) sucrose + water -> glucose + fructose (1)

the acid is a catalyst for hydrolysis (1)

the products alter the rotation of polarised light (or equivalent in terms of optical isomers) (1)

sucrose



formula (1)

[Max 4]

(b) (i) Jams are examples of a <u>gel</u> the gel agent is <u>pectin</u> (1)

(ii) Formed by 3 dimensional structure which 'ties up' small molecules and water (1)

Boiling removes water by evaporation (65-68% sugars) (1)

sugars help orientate the (branched) pectin chains (1)

<u>over-boiling</u> (chains break)
hydrolysis of pectins to lower M_r values - reduces gel making (1)

hydrolysis of methyl groups (pectins contain methyl ester groups) (1)

a good firm gel depends on:
amounts of sugar,
pectin,
average M_r of pectin, (three of these for 1 mark)
no of the groups,
pH (1)

[Max 6]

9 (a) (i) The breakdown of food (caused by enzymes) is autolysis (1)
After autolysis, food is vulnerable to attack by micro-organisms:

Moulds/fungi are branching, intertwined filaments eg on bread, jams, fruit etc - food looks unacceptable (1)

Yeasts reproduce by budding, grow in varied conditions, anaerobic often (1)

$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$ (1)

Affect the taste of food - make food unpalatable (1)

Bacteria eg souring of milk due to lactic bacillus
OR grey rot of strawberries due to botrytis cinerea (1)

Can cause food poisoning eg botulism or salmonellosis (1)
[2]

(b) (i) Vinegar produced by oxidative and bacterial action (1)

$C_2H_5OH + O_2 \rightarrow CH_3CO_2H + H_2O$ (1)
Allow 2[O]
[2]

(ii) No demand for concentrated vinegars (1)

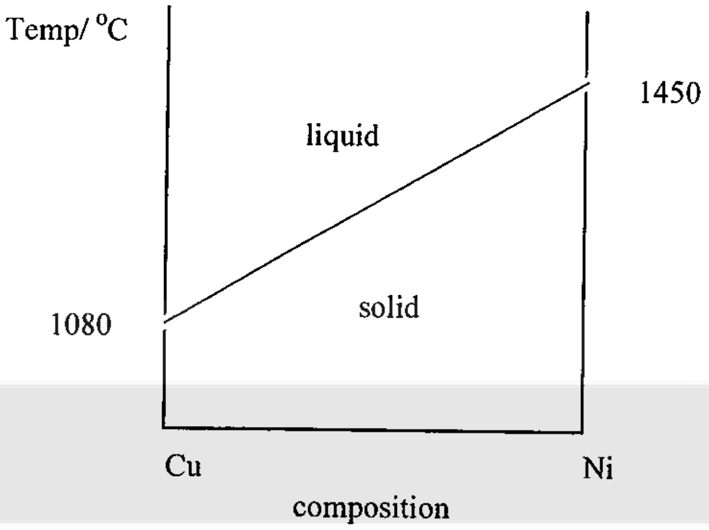
OR vinegars are a condiment (added in small quantities) (1)

distillation would alter the complex mixture of ingredients of the range of natural vinegars (different sources) (1)

b.p >100°C c.f. ethanol <100°C (1)
[Max 2]

10 (a)

axes and areas (1)
points or line (1)



[2]

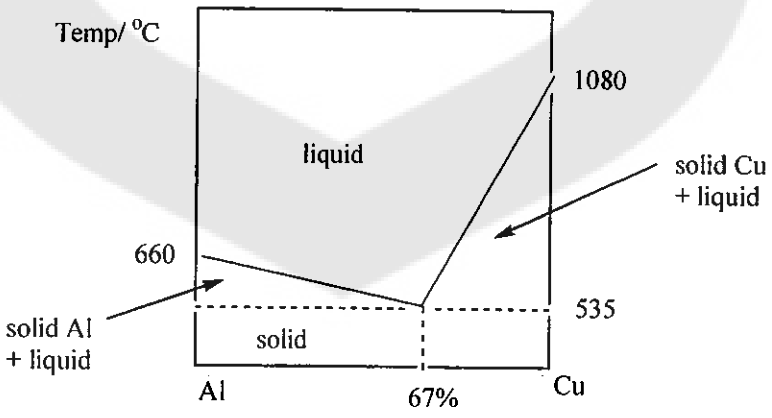
(b) (i) more expensive/difficult to produce. More difficult to counterfeit (1)

(ii) The blind will have a greater feel for the coin (1)

[2]

(c)

axes (1)
lines (1)
areas (1)



(d) (i) Atomic radii quoted from Data Booklet (1)

Ni 0.115 nm	Cu 0.117	similar will fit into same lattice
Al 0.143 nm	Cu 0.117	different

(1)

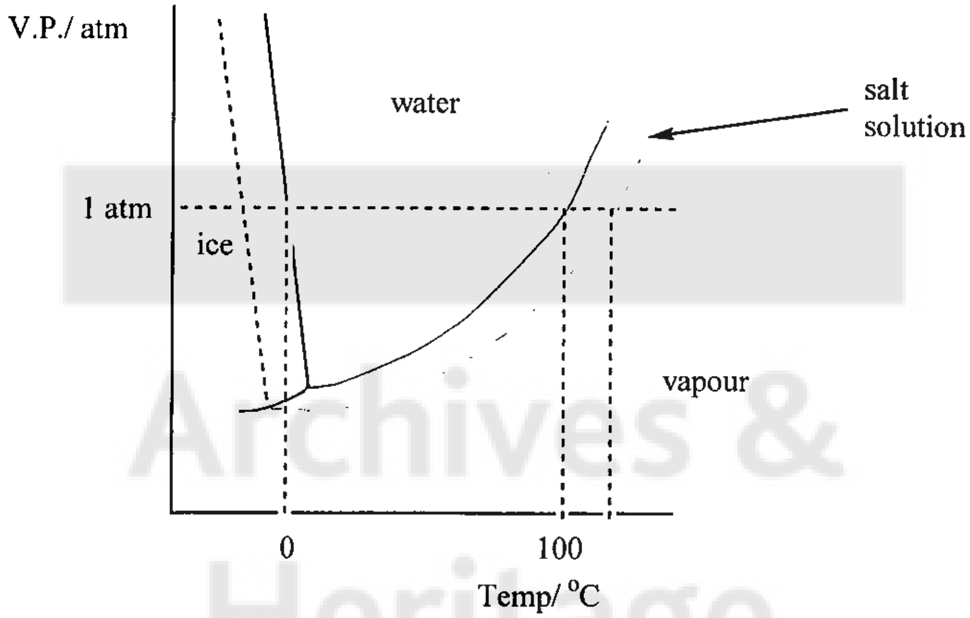
(ii) Cu/Ni homogeneous
Cu/Al mosaic/conglomerate/two crystalline forms (1)

[3]

11 (a) m.p. is the temp at which the liquid and solid phases are at eqbm
b.p. is the temp at which the liquid and vapour phases are at eqbm
(once) (1)

at a pressure of 1 atmosphere (101 kPa) (1)
[2]

(b)



3 phases (1)
0°C /m.p. and 100°C /b.p. and lines (1)
[2]

ice = water at 0°C water denser (1)
Negative slope – requires explanation (1)
Formation of water favoured at high pressures (1)
[2 max]

(c) Attraction of ions/salt in sea water for water molecules (1)

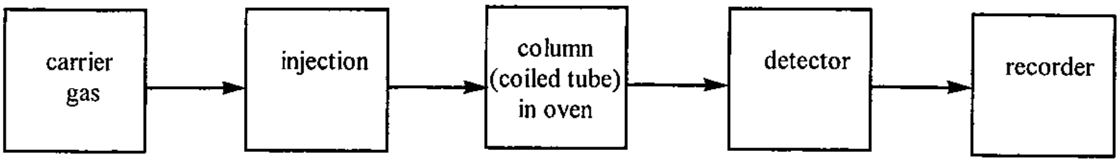
causes v.p. to fall (1)

Bulk of sea water c.f. keeps temperatures stable (1)

2 lines added to diagram (1)

New f.p. is below 0 °C (1)
[4 max]

12 (a)



(2)

Adsorption (1)

[3]

(b) (i) Volume of tube = 200 x 0.06 cm^3 = 12 cm^3

Time taken for gas to pass through take = $\frac{12}{30}$ = 0.4 mins (24s) (1)

(ii) Ethanol peak at 1.5 ± 0.1 mins

1.5 x 30 = 45 cm^3 (1)

[2]

(iii) The sample is very small (1)
The alcohol needs to be vapourised only: its VP at 100°C will be high enough (1)

(iv) hexan-1-ol has the largest R gp of the alcohols (1)

It is adsorbed most / stronger van der Waals' bonds hence hydrophobic (1)

(v) The area under each peak is the same (1:1:1:1 mixture) (1)
Area is proportional to the amount of substance (1)
With longer retention times, the samples are less precise/exact in their adsorption (1)
[max 5]

13 (a) Two of (Nujol) mull, solution and KBr disc 2 x (1)

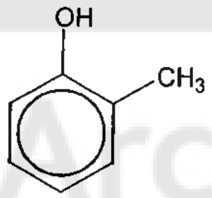
<u>Mull</u> - grind solid with hydrocarbon (1)
use NaCl plates (1)

<u>KBr disc</u> - mix solid with KBr (1)
compress under vacuum (1)

<u>Solution</u> - dissolve in solvent (with few i.r. absorptions) (1)
use solvent blank (1)

2 x (2)
[6]

(b) **J** is or isomers (1)

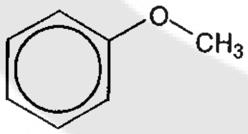


High C:H ratio suggests aromatic ring / C=C at 1600 cm^{-1} (1)

Broad OH peak at 3400 cm^{-1} (1)

C-O peak at 1250 cm^{-1} (1)

K is



CO peak around 1250 cm^{-1} NB only if not given in **J** (1)

No broad OH (1)

[Max 4]

14 (a) (i) Allow no broad -OH in Nandrolone (1)

C=C from aromatic ring (1)

comment on intensity of C=O (1)

(ii) Delocalised ring/carboxyl fragment (1)

(iii) 5 equivalent protons or ring (1)

Missing -OH proton (1)

[5 max]

(b) (i) It has extended chromophores (1)

Lone pairs on oxygen and double bonds in rings (1)

This shifts absorption from uv to visible (1)

Allow any of $\pi \rightarrow \pi^*$, $n \rightarrow \pi^*$, $n \rightarrow \sigma^*$ (1)

(ii) Energy gap in red larger / Shifts energy absorbed to higher level (1)

Adding acid reduces the length of the chromophore
(less delocalisation) (1)

Absorbs more blue thus appears red (1)

[5 max]

15 (a) Spectrum I is produced by **Q** (1)

Shows loss of 15, 29, 45) 2 of these 2 x (1)
i.e. CH_3, C_2H_5, C_2H_5O)
Could be answered in terms of remaining fragments
i.e. $CH_3CH_2OCH_2^+$, $CH_3CH_2O^+$, $CH_3CH_2^+$

Spectrum II is produced by **P**

Largest peak at 43 i.e. loss of CH_2OH or C_3H_7 (1)

[4]

(b) M/M+1 = 100/1.1n

therefore $n = \dfrac{100 \times M+1}{1.1 \times M}$ (1)

$= \dfrac{43}{1.1 \times 9.6} = 4.07$ or 4 (1)

[2]

(c) Label ester with ^{18}O (1)

Hydrolyse ester and analyse products (1)

If C-O bond breaks alcohol mass will show ^{18}O (1)

If R-O bond breaks acid mass will show ^{18}O (1)

[4]

16 (a) Some complexes contain unpaired electrons (1)
Unpaired electrons are responsible for paramagnetism (1)
[2]

(b) (i) +4 (1)

(ii) With MnO_4^- final oxidation state is +5 (1)

Since $MnO_4^- \rightarrow Mn^{2+}$ is $5e^-$ change, and Mn:V = 1:5 (1)

$MnO_4^- + H_2O + 5VO^{2+} \rightarrow Mn^{2+} + 5VO_2^+ + 2H^+$ (1)

With Sn^{2+} final oxidation state is +3 (1)

Since $Sn^{2+} \rightarrow Sn^{4+}$ is a $2e^-$ change, and $V:Sn^{2+}$ = 2:1, (1)

$Sn^{2+} + 4H^+ + 2VO^{2+} \rightarrow Sn^{4+} + 2V^{3+} + 2H_2O$ (1)

(iii) With MnO_4^- solution turns yellow (1)

Wirh Sn^{2+} solution turns green (1)

V^V has no unpaired e^- (1)

V^{III} has more unpaired e^- than V^{IV} (hence paramagnetism increases) (1)
[max 8]

17 (a) (i) catalyst: speeds up a reaction by lowering E_a (1)
(**OR** offers an alternative route)

heterogeneous: different phases (often solid + gas) (1)

homogeneous: catalyst + reagents - same phase (1)

[3]

(ii) e.g. Fe(s) Haber: $N_2 + 3H_2 \rightarrow 2NH_3$ (1)

role: adsorption of $N_2 + H_2$ (- dative bond) (1)

Fe^{2+} or Fe^{3+} in $I^-/S_2O_8^{2-}$: $2I^- + S_2O_8^{2-} \rightarrow 2SO_4^{2-} + I_2$ (1)

role: redox intermediate: $I^- + Fe^{3+} \rightarrow \frac{1}{2} I_2 + Fe^{2+}$) (1)
$2Fe^{2+} + S_2O_8^{2-} \rightarrow 2Fe^{3+} + 2SO_4^{2-}$)

[4]

(b) Data: Fe^{3+}/Fe^{2+} = +0.77V : $O_2 + 4H^+/H_2O$ = +1.23V

$Fe(OH)_3/Fe(OH)_2$ = -0.56V : O_2/OH^- = +0.40V 2 x (1)

so difference is 0.46v in acid sol) (1)
but 0.96v in basic sol)

ppte is $Fe(OH)_2$, goes to $Fe(OH)_3$ (1)

[max 10]

18 (a) (i) Cu^{I} is d^{10}, so no empty higher d orbitals (1)

so colourless / white (1)

[2]

(ii) $Cu^{+}/Cu = +0.52$) therefore $2Cu^{+} \rightarrow Cu + Cu^{2+}$
$Cu^{2+}/Cu^{+} = +0.15$) (1)

$E^{\ominus} = 0.37v$ (1)

$E^{\ominus}$ is positive, hence the reaction is feasible (1)

[max 2]

(b) (i) $Cu^{2+} + 2I^{-} \rightarrow CuI + {}^{1}/_{2}\, I_2$ (1)

white ppte (1)

in a brown/purple sol (1)

[max 2]

(ii) $2S_2O_3^{2-} + I_2 \rightarrow S_4O_6^{2-} + 2I^{-}$ (1)

$n(\text{thio}) = 0.1 \times \frac{15.8}{1000} = 1.58 \times 10^{-3}$ moles (1)

therefore $n(I_2) = 0.79 \times 10^{-3}$ moles
$n(Cu^{2+}) = 2n(I_2) = 1.58 \times 10^{-3}$ moles (1)

therefore mass of Cu $= 63.5 \times 1.58 \times 10^{-3} = 0.10$g
therefore % $= \frac{0.1}{2.0} \times 100 = \underline{5\%}$ (1)

[4]

OCR

RECOGNISING ACHIEVEMENT

Markscheme 9254/05
June 2000

STANDING INSTRUCTIONS FOR 9254/5

June 2000

(a) Subtractions

Check every subtraction in both Supervisors' reports and candidates' scripts. Indicate that you have done so by a tick or a cross, and if the subtraction is incorrect write down the correct figure without obscuring any of the original figures.

(b) Session Numbers

Where a Centre has candidates in more than one session indicate on the front of each script which session the particular candidate attended. (A ringed 1,2,3,4 to the right of the word CHEMISTRY is sufficient.)

(c) Supervisor's Reports, i.e. the answer book or photocopy containing Supervisor's Results.

Make sure that the Centre Number (and Session Number, where applicable) is clearly written on the Report.

Evaluate carefully, following the instructions in the Marking Scheme, and using the values in the Report, the quantities to be used in assessing the candidates' accuracy in quantitative experiments.
In checking the values to be used for the accuracy standard **do not just tick** the Supervisor's values.
When calculating a ratio the expression for the ratio should be clearly indicated on the script and its evaluation shown to the appropriate number of decimal places.
Record these values (a) on the front of the Supervisor's Report, and (b) on each script at the point you use the value to assess accuracy. Ring these values to distinguish them from the candidates' values, which are left un-ringed.

For each quantitative experiment, list on the Supervisor's script at the appropriate place the candidates' values used to award accuracy marks. For large Centres it may be necessary to use a separate piece of paper, tuck this into the Supervisor's script. and label it with the Centre number.

(d) Weighings Tables

Candidates are expected to weigh accurately to at least 2 d.p., and calculate the correct mass used from their weighings. Unless changed in a particular marking scheme three marks are given for this Table.

One mark is for recording both weighings to 2 d.p. and recording them in the correct spaces in the Table. This mark can be given for one weighing only, provided that the candidate states that he/she used a balance with a Tare facility, or the Supervisor at the Centre states that all candidates at the Centre used a balance with this facility. A recorded figure of 0.00 is acceptable as a weighing.

The second mark is given if the mass recorded as being used is within the range stated in the question. This includes the mass being equal to an extreme limit stated. This mark is given on the uncorrected mass recorded by the candidate.

The third mark is given for a correct subtraction of the recorded masses. This mass does not have to be recorded to
2 d.p. provided any figures after those shown are 0. If masses are recorded to 4 d.p. then the figure after subtraction will need to be correct to 4 d.p. (unless last figures are 0).

If a candidate repeats the experiment and obtains two sets of results without making it clear which is the one to be assessed, mark the weighings recorded in the correct space. Note that this applies to the Table of weighings and not necessarily to the assessment of accuracy.

(e) Temperature Tables

Candidates are expected to read temperatures to 1 d.p.. The principles used in awarding marks are similar to those for weighings and will be detailed in the Marking Scheme.

(f) Tables of Burette Readings for the main Titration

1. Candidates are expected to record their final burette reading to 0.05 cm^3 or better. If the second figure after the d.p. is 0 it must be recorded. As the candidate can choose to start the titration at a graduation mark the initial burette reading need not be recorded to 2 d.p. (and could be a whole number). If candidates use 50.00 as initial volume (instead of 0) count this as 0.00 when deciding the titre to use for assessing accuracy. The candidate will lose the marks for correct recording of titrations and for calculating a correct average.

Correct any errors of subtraction in the titres.

Give ONE mark if all burette readings are in the correct spaces in the table, the volume used has been filled in, and all final burette readings are to at least 2 d.p. Ignore any titre which has been labelled **Rough**, unless the titre value has been ticked.

Give ONE mark for a sufficient number of titrations (any two titres differing by 0.10 cm^3 or less). Award this mark on uncorrected titres - **Rough** values may be included in assessing sufficient number of titrations.

Give ONE mark for a value of volume used from the burette and **quoted in the Summary**, which is clearly justified by the candidate's indication of the results used. **Do not give the mark if no value is quoted in the Summary**. This will usually be the value of two identical titres or any other average provided it is correct to at least 2 d.p. or to the nearest 0.05 cm^3 (first and second d.p.s may be omitted here if they are 0).
Where a candidate calculates an average such as 23.666; 23.67 is acceptable to 2 d.p., and 23.65 is acceptable to the nearest 0.05 cm^3. In this case accept also 23.66 which lies between 23.65 and 23.67.
(The candidate is allowed to round .025 up to .05 or down to .00, and .075 up to .10 or down to 0.05, but should not be penalised for failing to round any answer to 2 d.p. The examiner working on Supervisor's results will always round up to 2 d.p.) Withhold this mark if the candidate performed only one titration or selected only one titration value for the "average", if there has been an error in subtraction in the Table of Burette Readings, if the candidate fails to indicate by appropriate ticks, words and/or figures which titres have been used to obtain the average, or the average is inconsistent with what has been stated._ **The average being assessed is the one recorded in the summary** which is sometimes different from the one found in the candidate's indication of how it was found.

2. If one titration is obviously absurd (e.g. 28.00 - 10.00 = 28.00) ignore that titration **for the purposes of sufficient titrations and for accuracy**. Assess accuracy as if the other titrations were the only ones performed. This may or may not involve a deduction of 4 marks for "onlv one accurate titration", depending on how many other titrations were performed.

3. Candidates who fill in only the final burette reading in the titration table; **leave the initial reading blank** or **enter a zero** or **a dash** will lose the first mark for completing the table but may gain the mark for sufficient titrations and can be given the average mark **if the appropriate final burette readings are ticked**.

(g) Accuracy

If the candidate earned the mark for correct average (above) use this value in assessing accuracy.
If the candidate **performed** only one titration, use the value of that one titre to assess accuracy but deduct four marks from the subsequent accuracy score (no negative marks).
If the candidate **selected** only one titration, use the value of that titration to assess accuracy (and also see below under **spread penalty**).
If the candidate performed only two titrations (which have gained the second mark for a sufficient number of titrations) but one of these has an arithmetic error that would result in a Spread Penalty on accuracy of more than 4 marks; **assess the accuracy on the one correct titre**, and apply the same penalty (-4) as for a candidate who performs only one titration.

If nil was earned for average solely because of a failure to indicate how it was obtained, accept the average if it is the value of identical titres or the correct arithmetical mean of all the titres or a sensible (Examiner's opinion) selection from the titres.

If the candidate earned nil for other reasons (error in subtraction, inclusion of rough value, average inconsistent with statement) then the Examiner selects a suitable average using the first one of the following possibilities to permit **one single value** to be obtained from the corrected titres.

1. Follow the candidate's instructions if the only error was in the arithmetic of averaging (not in the subtraction of burette readings), or if the candidate selected a single titre.

2. Use the value of any two or more identical titres. In the special case of two or more groups of identical titres, use the mean of the values. This will require you to apply a spread penalty if the values are more than 0.20 cm^3 apart.

Examples. For 23.00. 22.80. 23.00 use 23.00

For 23.00, 22.80, 22.80, 23.00 use 22.90

For 23.00, 22.70, 22.70, 23.00, use 22.85 and apply a penalty for a spread of 0.30 cm^3.

3. Take the average of all titres within a range of (i) 0.05 cm^3, (ii) 0.1 cm^3, (iii) 0.2 cm^3, (iv) 0.3 cm^3 etc., ignoring any titres outside the range and any which the candidate has indicated are to be disregarded. Use the first range to produce **one single value** and quote this to 2 d.p.

Examples For 23.0, 23.1, 23.2 use 23.1 (mean of all three).

For 23.0, 23.3, 23.1 use 23.05 (mean of first and third).

For 23.0, 23.3, 23.4, 23.1 use 23.2 (spread penalty) as two answers (23.05 and 23.35) can be obtained with answers 0.1 cm^3 apart.

A SPREAD PENALTY is applied if the titres used by candidate and/or the examiner in calculating the average cover a range greater than 0.20. Titres not used in calculating the average of the titres are not included in the range. **Where the examiner has used a different range to the candidate in calculating the average - apply whichever spread penalty is the greater.** If a candidate selected only one titre, use that and the next closest value to assess whether a spread penalty is to be applied.

Supervisor's Average Titre

Ignore any value calculated by the Supervisor and use Rule 2 above, or if this does not give one single value, use Rule 3 to derive the standard to be used.

(h) Suspect Supervisor's Results.

The actual treatment of suspect results to be adopted for each question will be given at the co-ordination meeting. but will be either

(i) If you suspect that the Supervisor's results are unreliable make a note to this effect on the Supervisor's Report. Results may only be considered unreliable if more than half the candidates at a Centre with more than five candidates score less than half marks for accuracy. Keep a list of such Centres and send the list to your team leader immediately after the examination (Nil returns are required). It is helpful if this list includes, for each Centre, the fraction of candidates with less than half marks, e.g. 10/30.

OR (ii) If you suspect that the Supervisor's Results are unreliable list the candidates' values and find from them a suitable mean or mode, excluding any which are obviously wrong. A scatter graph is very useful as a tool for deciding (a) whether the standard should be changed and (b) the values to use in calculating a mean; it often precludes the necessity for an actual calculation. If using this value gives significantly higher marks to the candidates, particularly the better ones, use it instead of the Supervisor's value. Results may only be considered unreliable if more than half the candidates at a Centre with more than five candidates score less than half marks for accuracy. You should indicate on the Supervisor's Report the action you have taken, and the calculations you do should be on the Report or on a sheet of paper attached to it. Keep a list of such Centres and send the list to your team leader immediately after the examination. It is helpful if this list includes, for each Centre, the fraction of candidates with less than half marks, e.g. 10/30 (Nil returns are required).

(i) Calculations

(i) Simplify any complex expressions to the form shown in the mark scheme and compare the two expressions in order to assess marks.

(ii) A repeated error in a M_r or molarity ratio is only penalised once.

(iii) Most calculations are done in small steps. If a candidate makes an error in any stage, he can earn full marks for subsequent stages by continuing with his incorrect answer. He can also earn full marks for the later stage if it is fully correct. i.e. the earlier error is corrected, but marks lost in the earlier section cannot be transferred back.

(iv) If a candidate fails to copy correctly an answer from one section that is used in a later section the error is penalised in the evaluation mark.

(j) Qualitative Tests

Unless otherwise stated in the Marking Scheme, marks should only be given for a deduction if it is preceded by the fully correct observation.

In tests when more than one reagent is added the candidate should make it clear at what stage the change(s) take place, either by writing the observation opposite the name of the reagent stated in the Test column or by naming the reagent in the Observations column. In the Observations column reject phrases such as "sparingly soluble", "slightly soluble", and "partially soluble". Where the marking scheme allows a range of colours for an observation, allow all colours within that range but do not extend the range.

Where marks are given in an observation for colour of precipitate (one) and solubility of the precipitate in excess reagent (one), the second mark can be given for correct solubility if the first mark has not been given as incorrect colour or no colour of precipitate recorded.

In deductions ignore ions which are correct apart from their charge (except Fe^{2+}, Fe^{3+}), and those that are not in the syllabus. Ions on the syllabus are NH_4^+, Mg^{2+}, Ca^{2+}, Cr^{3+}, Mn^{2+}, Fe^{2+}, Fe^{3+}, Al^{3+}, Cu^{2+}, Zn^{2+}, Ba^{2+}, Pb^{2+}, CO_3^{2-}, NO_3^-, NO_2^-, SO_4^{2-}, SO_3^{2-}, Cl^-, Br^-, I^-, and CrO_4^{2-}. Names of ions are also acceptable. (Zinc is acceptable, Zn is not). To secure a mark an ion must have the correct charge, but ignore ions with incorrect charges etc. in multiple deductions. Do not ignore ions of opposite charge to the correct one. but judge them on their merits.

In multiple deductions of ions or gases correct answers must exceed incorrect ones by the number of deductions required for the mark.

If a candidate unambiguously refers back to a test, marks not given for that test should be awarded

(k) Co-ordination.

After the co-ordination meeting, mark ten scripts carefully and send them by first class post to your team leader. A stamped, addressed script envelope should be enclosed for the team leader to return your scripts. You can continue with the marking of your scripts before your co-ordination scripts are returned, but you may have to look through them again to correct any errors shown up in the co-ordination scripts. If your marking does not agree with your team leader's marking you will be asked to send a second batch of ten scripts.

If major changes to the mark scheme are made at the coordination meeting you will receive a revised mark scheme containing amendments. This is deemed to be the Final Mark Scheme. No marks should be submitted to UCLES until all scripts have been checked in the light of this Final Mark Scheme.

The ten scripts sent to your team leader should be from three different Centres. The Supervisor's Reports for the three Centres should also be sent. Scripts from these Centres should not be in Batch 1 subsequently sent to Team Leaders.

(l) Batch 1 and the Final Sample

Instructions for Batch 1 and the Final Sample will be found in the Instructions to Examiners Booklet issued for the current examination session and will be explained at the coordination meeting.

(n) Conclusion of marking

At the conclusion of the marking send to your team leader, **on the forms provided at the co-ordination meeting,** a list of the accuracy distribution for all Centres. This will highlight where further action may be required because the action taken in (h) has not proved satisfactory and will facilitate further consideration at the Grade Review.

At the same time send your report on the work of the candidates to your team leader. Send these two reports as soon as you have finished marking the main batch of your scripts, and do not delay because one or two packets have not arrived.

Practical Examination (Chemistry A)

N.B. Boxed references within this marking scheme relate to the accompanying booklet of Standing Instructions

1

Titration table

Mark this as (f) after first checking as (a). Then use (g) to calculate the Candidate's average, if this is necessary

3

Accuracy

See section (g).

Assign accuracy marks by comparing the candidate's average titre (corrected as necessary) with the Supervisor's value.
Apply spread penalty as shown below

Accuracy marks	
Mark	Difference from Supervisor / cm^3
12	up to 0.10
11	0.10+ to 0.20
10	0.20+ to 0.25
9	0.25+ to 0.30
8	0.30+ to 0.35
7	0.35+ to 0.40
6	0.40+ to 0.50
5	0.50+ to 0.60
4	0.60+ to 0.70
3	0.70+ to 0.80
2	0.80+ to 1.00
1	1.00+ to 1.50
0	Greater than 1.50

Spread Penalty	
Range used / cm^3	Deduction
0.20+ to 0.25	1
0.25+ to 0.30	2
0.30+ to 0.35	3
0.35+ to 0.40	4
0.40+ to 0.45	5
0.45+ to 0.50	6
0.50+ to 0.60	7
0.60+ to 0.70	8
0.70+ to 0.80	9
0.80+ to 1.00	10
1.00+ to 1.50	11
Greater than 1.50	12

12

Suspect Supervisor Values

Adopt procedure (ii) in (h) for any suspect Supervisor results

If there is not an obvious value from the Candidates' results, use 25.00 as the Standard Value. Report your action to Team Leader on the Centre Accuracy Return.

1 **(a)** Give one mark for M_r of $Na_2S_2O_3.5H_2O$ = **248.2** (248 is not correct)

Ignore evaluation errors if working is shown

Give one mark for **0.150** or $\frac{\textbf{37.23}}{\textbf{Candidate } M_r}$ 2

In awarding the second mark, assume the candidate has divided 37.23 by their molar mass unless it is clearly not the case.

(b) Give one mark for

$\frac{\textbf{Titre}}{\textbf{1000}}$ **x answer to (a)**

(c) Give one mark for

$\frac{\textbf{Answer to (b)}}{\textbf{2}}$ Ignore evaluation errors if working is shown

1

(d) Give one mark for

$\frac{\textbf{25}}{\textbf{1000}}$ **x 0.05** or **0.00125** Ignore evaluation errors if working is shown

1

(e) Give two marks for

2 x answer to (c) [1] x $\frac{\textbf{1}}{\textbf{answer to (d)}}$ **[1]** $\left\{\frac{\textbf{answer to (c)}}{\textbf{answer to (d)}}\right.$ is given 1**mark**– $\}$

or $\frac{\textbf{answer to (b)}}{\textbf{answer to (d)}}$ **[2]** Ignore evaluation errors if working is shown

Give **one** further mark for the evaluation of a **fully correct** answer to 1%. (Ignore rounding)
Use of 248 instead of 248.2 is allowed for the evaluation mark

Correct answer is given by the expression Titre x 0.120

3

(f) Give **one** mark for Cr^{3+}, chromium(III), +3, 3+, +III or III

1

(g) Give **one** mark for a balanced ionic equation **using the mole ratio, to nearest 0.5, derived from practical work in (e) and the ion in (f).**
If there is no answer to (e) or (f) no mark can be given in (g).

If all parts of the calculation are correct, the equation is:

$$CrO_4^{2-} + 3I^- + 8H^+ \rightarrow Cr^{3+} + 1\tfrac{1}{2}\ I_2 + 4H_2O$$

1

Total for question 1 25

2 **(a) Weighing Table 2.1**

Give **one** mark if **all three weighings** are to at least 2 decimal places
Give **one** mark for a recorded mass of **FA 3 between 0.50 g and 0.65 g** (both values inclusive)
Give **one** mark for a correct subtraction
(correct to number of decimal places shown in weighing table. Final zeros may be omitted).

If there is no mass of weighing bottle plus residual magnesium or there is a value that is nonsense, use the difference in the first two weighings in assessing accuracy.

3

(b) Temperature Table

Give **one** mark if all **recorded** thermometer readings are to at least 1 decimal place (the table does not have to be complete).

1

Accuracy marks

Subtract the candidate's temperature at 2.5 minutes (or at 2 minutes, 1½ minutes etc or from graph if no temperature is given for 2.5 minutes) from the highest value reached, both values being taken from the table. **Ignore any temperature recorded at 3 minutes – even if this is the highest temperature recorded.**

Record the temperature rise on page 5 and calculate, correct to 1 decimal place, the rise in temperature per gram of magnesium $\frac{\Delta t}{\textbf{mass of FA3}}$

Compare this with the Supervisor's ratio calculated in a similar way. **Where there is a very low Supervisor's Standard (< 35.0) use the reduced differences in the table below in assigning marks.**

Assign accuracy marks as follows:

	$\frac{\Delta t}{\text{mass FA3}} \geq 35.0$
Mark	Difference to Supervisor
5	up to 4.0
4	4.1 to 8.0
3	8.1 to 12.0
2	12.1 to 16.0
1	16.1 to 20.0
0	Greater than 20.00

$\frac{\Delta t}{\text{mass FA3}} < 35.0$
Difference to Supervisor
up to 2.0
2.1 to 4.0
4.1 to 6.0
6.1 to 8.0
8.1 to 10.0
Greater than 10.00

5

Adopt procedure (ii) in (h) for suspect Supervisor's results

Graph

(c) Check the plotting of **three representative points**, e.g. 2 min, 6½ min and 10 min. (If other values have to be selected, one should be at a half minute)

Look for crosses or dots as evidence of points being plotted. Take care where no points are apparent, there may be small dots under a drawn line and only evident as indentations in the paper.

Give **one mark** for each correctly plotted point

The *x* co-ordinate must be correctly placed on the grid, the *y* co-ordinate ≤ half a small square from its correct position.

Give **one mark** if:

(i) an approximately horizontal line has been drawn before the addition of magnesium powder, and

(ii) a line or curve of best fit, with mainly negative slope, has been drawn after the addition of magnesium powder.

Candidates do not have to link the graphs between 2½ and 3½ minutes.

Give **one mark** if the line with negative slope has been extrapolated to 3 minutes.

5

(d) If the extrapolation mark has been given in (c) give **one** mark if the candidate correctly reads from the graph the extrapolated temperature at 3 minutes. This should be correct to half a square, the nearest 0.25°C.

1

(e) Give **one** mark for

$$\frac{\textbf{mass of magnesium}}{\textbf{24.3}}$$

Use of **24** is incorrect

1

(f) Give **one** mark for

50 x 4.3 x Temperature rise in (d)

Examiners do not have to check the value of Δt on page 6. This value should be used by the candidate in **(f)** unless a new acceptable value for Δt is obtained from the graph or table.

1

(g) Give **one** mark for

$$\frac{\textbf{answer to (f)}}{\textbf{answer to (e)}}$$

If this mark has been given:

Give **one** further mark if the answer is given to at least three significant figures and the sign and units are correct. (Accept J, kJ, J mol^{-1}, kJ mol^{-1}).

2

2 **Evaluation of the experiment**

Six marks are available for the evaluation of the experiment.

Mark (h) and (I) as one section

(h) Sources of error

- **(a)** heat loss (to the surroundings, apparatus etc.)
- **(b)** Inadequacy of a thermometer (graduated in single degrees)
- **(c)** Difficulty in preventing spray on mixing, splashing, solid remaining on cup etc.
- **(g)** Old or oxidised magnesium

(i) Suggested changes

- **(d)** increased lagging, insulation, use of thermos flask – practical reduction of heat loss
- **(e)** use of a cover, sealed or closed apparatus
- **(f)** use of a thermometer which enables temperature to be read to a greater degree of accuracy. Digital thermometers or data loggers are only acceptable if increased accuracy is emphasised.
- **(g)** use of fresh / non oxidised magnesium powder

Use of a Bomb Calorimeter **on its own** earns 1 mark (point d). If the candidate amplifies its use to explain that no heat is lost and all material is contained within the calorimeter points (d) and (e) are covered.

Letter each scoring point where it appears in the script and tick the corresponding letter in the margin check box.

Cancel marks in excess of 6 by recording the mark awarded to the left of the margin, crossing through this mark and writing 6 max in the margin.

6

Total for Question 2 25

3

Apply (j) to all marking

FA 5 is a 50:50 mixture of anhydrous calcium chloride and anhydrous sodium ethanoate
FA 6 is a solution, 1 mol dm^{-3}, with respect to Ca^{2+}, and CH_3COO^-

Test	*Observations*	*Deductions*	
Tests on FA 6 (a) HCl $BaCl_2$	No precipitate or no reaction (against HCl) or No reaction, no effervescence, no gas (against HCl) No precipitate or no reaction (against $BaCl_2$) *If there is a single general observation of no reaction which cannot be linked to HCl or $BaCl_2$ the only allowable deduction is no sulphate*	No Pb^{2+} or No CO_3^{2-} or NO_2^- or SO_3^{2-} [1] Ions which cannot be eliminated by addition of HCl are wrong. CrO_4^{2-} is wrong (colour). Sulphate, SO_4^{2-} absent [1]	2
(b) $AgNO_3$ Ammonia soln	White precipitate [1] Precipitate dissolves [1]	Chloride [1] from both observations (Ignore carbonate and sulphite)	3
(c) NaOH	White precipitate – Insoluble in excess (not precipitate formed in excess) [1] from both observations	Mg^{2+} or Ca^{2+} (Ignore Ba^{2+}) [1] The deduction mark can be given providing a white precipitate is present in excess (insoluble or formed in excess)	2
(d) Ammonia solution	No precipitate, no reaction, no change, colourless solution or remains clear [1]	Ca^{2+} (Ignore Ba^{2+} or NH_4^+) [1]	2
(e) Iron(III) chloride	Orange, orange/red or red coloration in the solution (not precipitate) [1] (no brown colours. not blood red)		1

Test	*Observations*	*Deductions*	
Tests on FA 5 (f) Warm with H_2SO_4	White precipitate or white solid remains	Ca^{2+} or Ba^{2+} or Pb^{2+} [1]	3
Test gas with litmus	(Blue) litmus turns pink / red [1] **not** bleached. Accept any appropriate colour change for universal indicator paper (even if described as litmus paper)	Volatile or carboxylic acid (displaced). Accept any named carboxylic acid or vinegar. [1]	
(g) Warm with ethanol and conc sulphuric acid	White precipitate.............................	Ca^{2+} or Ba^{2+} or Pb^{2+} [1] (if not already given in (f))	2
Pour into sodium carbonate	Smell of ester, "fruity" smell [1] (The observation can be given if a smell is recorded and ester deduced.) (White precipitate may be recorded on pouring into sodium carbonate)	Organic salt or suitable named example **not** carboxylic acid [1] (The deduction can be given from a sweet smell, smell of nail varnish or smell of solvent)	

Cation and Anion from list are Ca^{2+} and Cl^- **[1]**
Ignore position in the Summary

Second anion is a salt of an organic acid or named appropriate carboxylate **[1]**

17 Marks available - <u>15 Maximum</u> **15**

Record the sub-total in a square box below the summary on page 11

Record and cancel any marks in excess of 15 maximum

3(g) **ASSESSMENT OF PLANNING SKILLS**

Plan (page 12 of question paper) - Reasoning

General Principles for marking the plan:

Each valid step that will identify
a single cation or
a pair of cations where they cannot be separated at that stage
will earn a mark

A step will only be valid if the reagent to be used has already been identified in a previous step

A step is valid if the candidate uses a reagent they believe to have been identified

Do not allow a mark if other reagents or laboratory reagents are clearly used

Do not allow a mark in any test where FA numbers are used.

Tick each scoring point at the point it occurs in the script. (Ignore the margin tick box)

The five methods below are exemplar material – other methods may be encountered.

METHOD 1

Give **one mark** to candidates who state that **potassium chromate** will give a **yellow precipitate** with the solution containing the **barium ion**.

Give **one mark** for use of the **barium chloride**, stating that a **white ppt** will identify **magnesium sulphate** or **aluminium sulphate**

Give **one mark** for using the **magnesium sulphate** or **aluminium sulphate** to identify the **sodium hydroxide** by the formation of a **white ppt**.

[**Sodium hydroxide** may be found on addition of **barium chloride**, certainly in the practical on page 13, as a faint white precipitate if impurity is present in the barium salt or sodium hydroxide contains absorbed CO_2.] If a candidate identifies the sodium hydroxide in this way the mark may be given from addition of barium chloride]

Give **one mark** for reference to solubility of precipitate in **excess sodium hydroxide** (leading to identity of **magnesium sulphate** and **aluminium sulphate**

Give **one mark** for using the **sodium hydroxide** to identify **zinc ion (white precipitate, soluble in excess) or** stating that the **zinc ion** is identified by default.

METHOD 2

Give **one mark** to candidates who state that **potassium chromate** will give a **yellow precipitate** with the solution containing the **barium ion**.

Give **one mark** to candidates who state that **potassium chromate** will give an **orange solution** with the solution containing the **aluminium ion.**

Give **one mark** for use of the **barium chloride**, stating that a **white ppt** will identify **magnesium sulphate**

[**Sodium hydroxide** may be found on addition of **barium chloride**, certainly in the practical on page 13, as a faint white precipitate if impurity is present in the barium salt or sodium hydroxide contains absorbed CO_2.] If a candidate identifies the sodium hydroxide in this way the mark may be given as an alternative to (b)

Give **one mark** for use of the **magnesium sulphate**, stating that a **white ppt** will identify **sodium hydroxide**

Give **one mark** for using the **sodium hydroxide** to identify **zinc ion (white precipitate, soluble in excess) or** stating that the **zinc ion** is identified by default.

METHOD 3

Give **one mark** to candidates who state that **potassium chromate** will give a **yellow precipitate** with the solution containing the **barium ion**.

Give **one mark** to candidates who state that **potassium chromate** will give an **orange solution** with the solution containing the **aluminium ion.**

Give **one mark** for use of the **aluminium sulphate**, stating that a **white ppt** will identify **sodium hydroxide**

Give **one mark** for use of the **sodium hydroxide**, stating that a **white ppt, insoluble in excess** will identify **magnesium sulphate**

Give **one mark** for using the **sodium hydroxide** to identify **zinc ion (white precipitate, soluble in excess) or** stating that the **zinc ion** is identified by default.

METHOD 4

Give **one mark** to candidates who state that **potassium chromate** will give an **orange solution** with the solution containing the **aluminium ion.**

Give **one mark** for use of the **aluminium sulphate**, stating that a **white ppt** will identify **sodium hydroxide**

Give **one mark** for use of the **sodium hydroxide**, stating that a **white ppt, insoluble in excess** will identify **magnesium sulphate**

Give **one mark** for using the **sodium hydroxide** to identify **zinc ion (white precipitate, soluble in excess)**

Give **one mark** for using **magnesium or aluminium sulphates** to identify **barium ion**, white precipitate, **or** stating that the **barium ion** is identified by default.

METHOD 5

Give **one mark** to candidates who state that **potassium chromate** will give a **yellow precipitate** with the solution containing the **barium ion**.

Give **one mark** for use of the **barium chloride**, stating that **zinc nitrate** will form no precipitate or remain as a colourless solution.

Give **one mark** for use of the **zinc nitrate**, stating that a **white ppt** will identify **sodium hydroxide.**

Give **one mark** for use of the **sodium hydroxide**, stating that a **white ppt, insoluble in excess** will identify **magnesium sulphate**

Give **one mark** for using the **sodium hydroxide** to identify **aluminium ion (white precipitate, soluble in excess), or** stating that the **aluminium ion** is identified by default.

Carrying out of plan (page 13 of question paper)

Correctly tabulated results, **matching plan on page 12. Do not award marks on p13 if candidates carry out a different set of tests.**

Give **one mark** for each correctly identified solution, for which there is supporting evidence in the table and using no reagents other than **FA** coded solutions and potassium chromate(VI).

As in the plan on p12, Reagents added are valid provided the candidate thinks they have been identified.
If incorrect Chemistry has been used in such an identification it is unlikely to lead to correct identification of ions on p13.

FA 7	FA 8	FA 9	FA 10	FA 11
Barium chloride	Zinc nitrate	Aluminium sulphate	Magnesium sulphate	Sodium hydroxide

10 Marks are available for Question 3 (i). **10**

Mark the sub-total below the table on page 13 of the question paper.

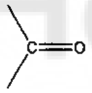
Add the two sub-totals to give the mark for question 3.

Total for Question 3 **25**

OCR

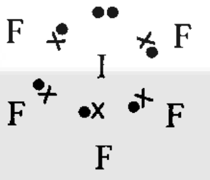
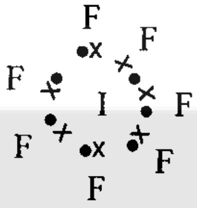
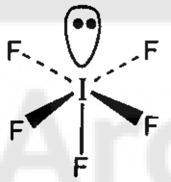
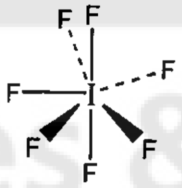
RECOGNISING ACHIEVEMENT

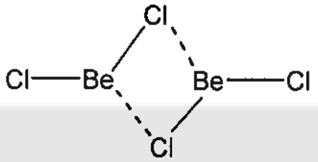
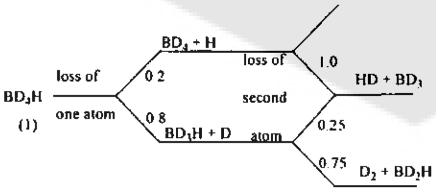
Markscheme 9434
June 2000

Question Number	Expected Answers	Mark
	Section A	
Q.1 (a) (i)	Hydrogen has a small radius (1) Can approach an electron pair closely (1) Has s electrons only (non directional) (1)	
(ii)	Attached to F, O, N (1) So X-H covalent bond has dipole $H^{\delta+}$ (1) Electron pairs bond to $H^{\delta+}$ (1) (polarised)	Max 4
(b)	Van der Waals' forces are due to dipole-dipole interactions (1) Due to disturbances in electron cloud (1) There is no direction to this force eg between nuclei (1) Attraction falls off rapidly with distance (1) As influence of electric clouds on each other diminishes (1)	Max 4
(c)	On melting only some intermolecular forces are broken (1) to give closely packed but random arrangement in liquid (1) On boiling all the intermolecular forces are broken (1) Except in dimers etc (1)	4
(d) (i)	Same M_r therefore approx same number of electrons in each (1) C_5H_{12} only van der Waals' forces (dipole-dipole temporary attractions) (1) $C(CH_3)_4$ is spherical, large intermolecular contact-higher mp +bp (1) ketone  dipole $\overset{\delta+}{C}=\overset{\delta-}{O}$ (1) Since O has 8 neutrons and C has 6 (1) Alcohol shows H-bonding, stronger intermolecular forces (1) Diagram (1)	
(ii)	Spherical molecules can pack more efficiently (1) More energy required to break up lattice in solid (1)	Max 8

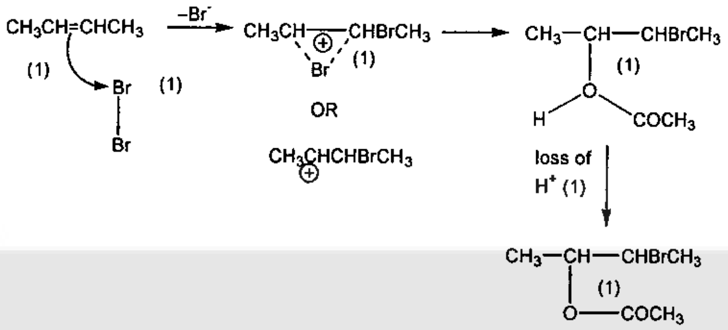
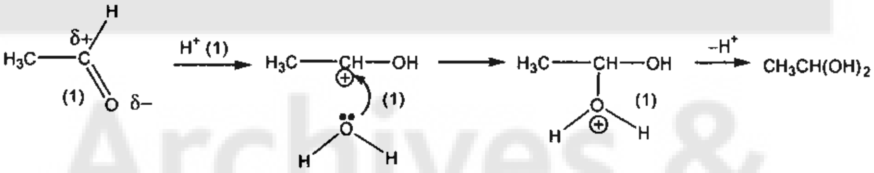
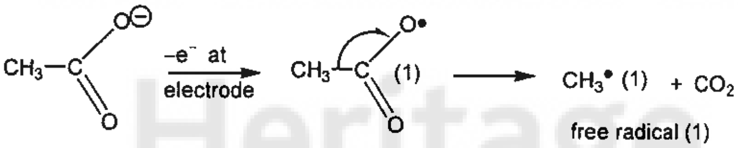
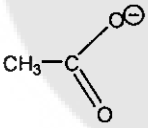
Question Number	Expected Answers	Mark
Q2 (a) (i)	**Section A** $N_2 + 3H_2 \rightleftharpoons 2NH_3$ Initially 1 3 0 moles At equilibrium 0.7 2.1 0.6 moles (1) Total = 3.4 moles (1) Partial pressures / atm $\frac{0.7 \times 200}{3.4}$ $\frac{2.1 \times 200}{3.4}$ $\frac{0.6 \times 200}{3.4}$ (1) = 41.2 = 123.5 =35.3 atm $K_p = \frac{35.5^2}{41.2 \times 123.5^3}$ $= 1.6 \times 10^{-5}$ (1) atm $^{-2}$ (1)	5
(ii)	$K_p = \sqrt{(1.6 \times 10^{-5})} = 4.0 \times 10^{-3}$ (1) atm $^{-1}$ (1)	2
(iii)	Economic reasons, with recycling explained (1)	1
(b) (i)	Use same initial composition as in (a) $N_2 + 3H_2 \rightleftharpoons 2NH_3$ (1) At equilibrium $\frac{(1-\alpha)P}{4-2\alpha}$ + $\frac{3(1-\alpha)P}{4-2\alpha}$ $\frac{2\alpha P}{4-2\alpha}$ (1) Total moles $(4-2\alpha)$ These are approx $\frac{P}{4}$ $\frac{3P}{4}$ $\frac{2\alpha P}{4}$ or $\frac{\alpha P}{2}$ (1) $Kp = \frac{(\alpha^2 P^2)/4}{P/4 \times (3P^3)/4}$ (1) Transformation (1) Thus $\alpha = P\sqrt{(27Kp/64)}$	5
(ii)	$\alpha = 20\sqrt{(27 \times 1.6 \times 10^{-5}/64)} = 0.05$ (1) $NH_3 = 2\alpha = 0.1$ mols (use ecf) (1)	2
(c) (i) (ii)	Gases no longer obey ideal gas law (1) At high P gases are less compressible due to molecular size (1) Volume is less than expected (1) So equilibrium does not move to right (favours less ammonia) (1) *Kp* decreases (1)	5

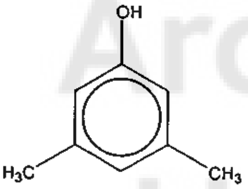
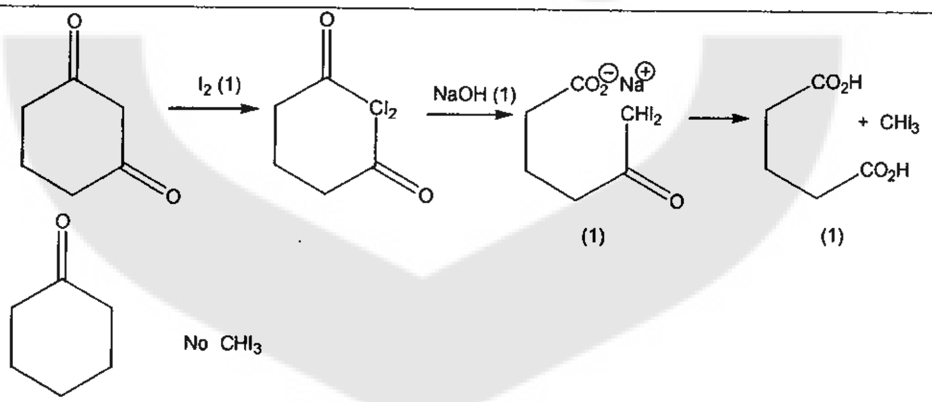
Question Number	Expected Answers	Mark
	Section A	
Q.3 (a)	Conductivity greater at 298 than 283 so more ions present (1) For $H^+ + OH^- \rightleftharpoons H_2O$ equilibrium moves to left (1) Forward reaction is exothermic (1)	3
(b) (i)	Difference of 3.2 μS from start to finish (1) At 3.7 + 1.6 = 5.3 μS, $T^1/_2$ = 25 μS At 5.3 + 0.8 = 6.1 μS, $T^1/_2$ = 50 μS Two values $T^1/_2$ (1) $T^1/_2$ = 25 μs (1)	3
(ii)	$[H^+] = [OH^-] = 10^{-7}$ (1) $k_1 = 0.693/25 \times 10^{-6} \times 2 \times 10^{-7}$ (1) = 1.4×10^{11} (1) $mol^{-1}\ dm^3\ s^{-1}$ (1)	4
(c) (i)	Rate forward = $k_1\ [H^+]\ [OH^-]$ rate backward = $k_{-1}\ [H_2O]$ (1) At equilibrium rates are equal and $K_{298} = k_1/k_{-1}$ (1)	
(ii)	$K_{298} = [H_2O]/K_w$ (1) $[H_2O] = 1000/18 = 55.5\ mol\ dm^{-3}$ (1) $= 5.6 \times 10^{15}\ mol^{-1}\ dm^3$ (1) $K_{-1} = \frac{1.4 \times 10^{11}}{5.6 \times 10^{15}} = 2.5 \times 10^{-5}$ (1) s^{-1} (1)	
(iii)	Forward reaction involves oppositely charged ions reacting, hence faster (1)	Max 5
(d) (i)	Plot lg*Kw* against $1/T$ (1) $1/T$ /m K^{-1} 3.66 3.53 3.36 3.19 3.10 (1) $\lg K_w/10^{-14}\ mol^2\ dm^{-6}$ -2.21 -1.24 0.01 1.07 1.70 (1) Slope is -7.0×10^3 (1) $= \frac{-\Delta H}{8.31}$ (1) $\Delta H = -58\ kJ\ mol^{-1}$ (1)	Max 5
(ii)	It is the same (1)	1
		Max 20

Question Number	Expected Answers	Mark
	Section B	
Q.4 (a) (i)	$5IF_3 \longrightarrow I_2 + 3IF_5$ (1) disproportionation (1) OR $2IF_3 \longrightarrow IF + IF_5$ (1) ditto (1)	Max 2
(ii)	 (1)  (1)	
(iii)	 (1)  (1) octahedral/pyramidal diagram pentagonal bipyramid diagram	
(iv)	IF_5 has a permanent dipole (1) Due to lone pairs (1) IF_7 has only van der Waals' intermolecular forces (1)	Max 6
(b)	I : Cl $\frac{54.4}{127} : \frac{45.6}{35.5} \Rightarrow 1:3$ (1) A is ICl_3 (1) B is ICl (1) C is Cl_2 (1) D is $HICl_4$ (1) E is $NH_4^+ ICl_4^-$ (1) 6.2% is NH_4^+ gives 1:1:4 (1) Solid B added to KI(aq) $ICl + I^- \longrightarrow I_2 + Cl^-$ (1) I_2 soluble in KI brown solution of KI_3 (1) $\frac{1}{2} Cl_2 + I^- \longrightarrow \frac{1}{2} I_2 + Cl^-$ (1) $I_2 + 2Na_2S_2O_3 \longrightarrow 2NaI + Na_2S_4O_6$ (or ionic) (1) ICl is I^+Cl^- (1)	12

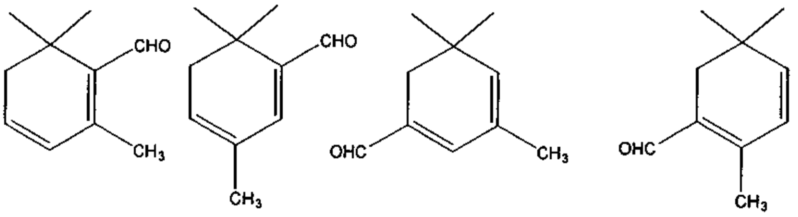
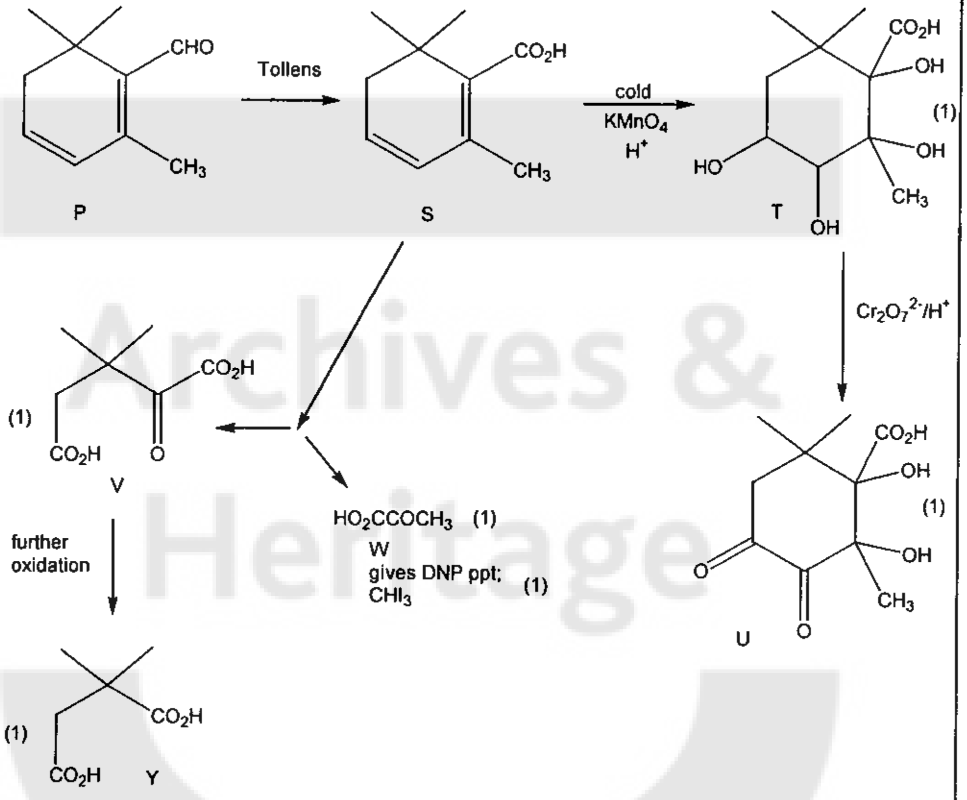
Question Number	Expected Answers	Mark
	Section B	
5 (a) (i)	$Li_2CO_3 \longrightarrow Li_2O + CO_2$ Fairly easily decomposed, as $MgCO_3$ Other Group I carbonates are stable to heat (2)	
(ii)	$BeCl_2$, like $AlCl_3$, should dimerise (1)  (1) (planar) Other Group II chlorides are ionic (1) (3)	
(iii)	pH should be 3-6, due to hydrolysis of $[Be(H_2O)_n]^{2+}$ ion with NaOH: $[Be(H_2O)_4]^{2+} \xrightarrow{-2H^+} [Be(H_2O)_2(OH)_2] \xrightarrow{-2H^+} \underset{\text{soluble}}{[Be(OH)_4]^{2-}}$ Mg^{2+} etc give white ppt. with NaOH aq. (1) (4)	
(iv)	$BCl_3 + 3H_2O \longrightarrow B(OH)_3 + 3HCl$ (1) $AlCl_3$ similar (1) Fumes/fizzes – like $SiCl_4$ (1)	
(v)	$B_2O_3 + Na_2O \longrightarrow 2NaBO_2$ } shows acidic $B_2O_3 + CaO \longrightarrow Ca(BO_2)_2$ } behaviour of oxide (like $SiO_2 \longrightarrow$ slag in the blast furnace) (2)	Max 12
(b)	Li^+ and Mg^{2+} have similar $\frac{\text{charge}}{\text{radius}}$ ratios/polarisabilities B and Si have similar electronegativities	2
(c) (i)	Al is more electropositive than B; (1) $\delta+$ $\delta-$ $\delta+$ $\delta-$ So the Al–H bond is polarised more than the B–H bond.	
(ii)	First mechanism would give only HD (no H_2 or D_2) (1) So second mechanism is supported. PROBABILITIES:  No way H_2 can be formed. Chances of forming HD = 0.2 x 1.0 + 0.8 x 0.25 = 0.4 Chances of forming D_2 = 0.8 x 0.75 = 0.6 Hence ratio = 0:4:6 OR in BD_4H there are no ways of forming H_2;	
	There are 4 ways of forming H–D;	
	There are 6 ways (3+2+1) of forming D–D	6

Question Number	Expected Answers	Mark
	Section B	
(6) (a)	NO NO_2 O.N: +2 +4 paramagnetic(1) N_2O N_2O_3 N_2O_4 N_2O_5 +1 +3 +4 +5 (2)	3
(b) (i)	$NH_4NO_3 \longrightarrow N_2O + 2H_2O$ (1)	
(ii)	m/e species 15 ^{15}N 16 O } therefore $^{15}N{-}^{14}N{-}O$ 29 $^{14}N{-}^{15}N$ (1) 30 $^{14}N{-}O$ (2) Mechanism suggests left hand N-atom comes from NH_3 Therefore $^{15}NH_4{}^{14}NO_3$ (1)	
(iii)	If $^{14}NH_4{}^{15}NO_3$, ⇛ $^{14}N{-}^{15}N{-}O$ Therefore peaks at m/e 14, 16, 29, 31	7
(c) (i)	$2NO \longrightarrow N_2 + O_2$ } both (1) $3NO \longrightarrow N_2O + NO_2$ Since 2nd reaction goes from 3 moles → 2 moles of gas, high pressure would favour it. (1) 1st reaction unaffected by pressure. (1) Both reactions are exothermic, so unfavoured by high T (1). But first reaction needs high T to overcome E_{act}. Low T would hence favour the 2nd reaction. (1)	5
(d)	As T increases, $[N_2O_2]$ decreases (1), because its formation is an exothermic process (1). As $[N_2O_2]$ decreases, rate of reaction decreases (as rate = k_2 $[N_2O_2]$ $[O_2]$) (1). Negative temperature effect on K is greater than the positive temperature effect on k_2 (bonus mark)	3
(e)	Oxide must be N_2O, AS N^{+2} in NO has to go down in ox. no (N in NO_2^- is +3) (1) Equ: $2KOH + 4NO \rightarrow 2KNO_2 + N_2O + H_2O$ N_2O (1) equation (1)	2

Question Number	Expected Answers	Mark
	Section C	
(7) (a) (i)		Max 4
(ii)		4
(iii)	 $2CH_3^\bullet \longrightarrow C_2H_6$ (1)	4
(b)	CH_3 is electron repelling (1) [compared with H] lowers stability of  anion (1) weaker acid (1) lower pK_a signifies weaker acid (1)	4
(c)	C–C bonds are normally 109½ ° (1) Overlap of sp^3 hybrid orbitals (1) In cyclopropane bond angle is 60 ° (1) poor overlap of orbitals (1) In ethane maximum overlap / no strain (1)	Max 4

Question Number	Expected Answers	Mark
	Section C	
Q.8 (a) (i)	PCl_5 + PVA gives HCl fumes (1) no reaction PVC (1)	**Max 2**
(ii)	$CH_3CH_2CHClCO_2H$ is the stronger acid (1) pH paper (1)	**Max 2**
(iii)	$PhCH_2CONH_2$ with OH^- (aq) and heat (1) gives NH_3 (1) $CH_3CONHC_6H_5$ gives phenylamine (1)	**Max 3**
(iv)	Use hot OH^-(aq) (1) Terylene dissolves (1) no reaction polyketone(1) OR use DNPH reagent (1) diketone – orange ppt (1) no reaction polyester (1)	**Max 3**
(v)	Test for Ar–NH_2 (1) eg ice – cold HNO_2 (1) then Na phenate-dye (1) OR warm with NaOH(aq) (1) N_2 bubbles (1)	**Max 3**
(vi)	 Will substitute easily (1) eg Br_2 (aq) (1) white ppt (1) or PhN_2^+ (1) azo dye (1)	**Max 3**
(b)		**4**

Question Number	Expected Answers	Mark
Q.9 (a)	**Section C** Reduction by $NaBH_4$ is carbonyl to alcohol (1) Hydrogenation + 4H shows two double bonds (1) Tollens' oxidises aldehyde to carboxylic acid (1) Cold $KMnO_4$ gives diol (1) here two diols (1) Stronger oxidation splits diols (1) dichromate oxidation secondary alcohols becomes ketones (1) Tertiary alcohols not oxidised (1) Strong oxidation of  (1) is Y (1) W is CH_3COCO_2H (1) DNP evidence used once (1)	12

	P can be any of the following:   	6
(b)	T has 4 chiral centres (1) 2^4 = 16 stereoisomers (1) U has 2 chiral centres (1) 4 stereoisomers (1)	4 **Max 20**