A Level

Chemistry

Session: 1994 June
Type: Mark scheme
Code: 9250

MS12 (UK)

University of Cambridge
Local Examinations Syndicate

GCE Examinations June 1994

MARKING SCHEME
for
CHEMISTRY

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GCE ADVANCED LEVEL EXAMINATIONS
MARKING SCHEME JUNE 1994

1. *General principle: name of force + example* *[1]*} x 4
relating force to example (i.e. the force's effect on properties) [1]} x 4
+ [4] marks for explanations or trends

e.g.

(a) **/van der Waals'/London dispersion/ forces** in neon *or* argon [1]

(these forces are) weak - hence low m.p. [1]

but increase with /no. of electrons/atomic number/ - e.g. argon [1]

(these forces are) due to /oscillating/temporary/instantaneous/ dipoles [1]

(b) **hydrogen bonding** in water [1]

stronger than van der Waals' - hence /higher (than neon)/intermediate/ m.p. [1]

due to $\underset{\delta+}{—H}\cdots\cdots\cdots\underset{\delta-}{:O}<$ [1]

van der Waals' expected to be about same as in neon (same no. of electrons) [1]

(c) **/ionic/electrovalent/ bonding** in NaF [1]

strong electrostatic attraction - hence high m.p. [1]

(d) **macromolecular covalent bonding** in diamond [1]

all strong covalent bonds - hence high m.p. [1]

12 max 10

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2. (a) *any four from:*

m/e	formula
162	$I\,^{35}Cl$
164	$I\,^{37}Cl$
197	$I\,^{35}Cl_2$
199	$I\,^{35}Cl\,^{37}Cl$
201	$I\,^{37}Cl_2$
232	$I\,^{35}Cl_3$
234	$I\,^{35}Cl_2\,^{37}Cl$
236	$I\,^{35}Cl\,^{37}Cl_2$

m/e **and** correct formula: [1] mark each: 4 x [1] **4**

If candidate identifies ICl and ICl_2 (possibly at m/e = 162.5 and 198) => award [1] out of the [4]. for basic idea.

(b) **A** is ICl_3 **and** oxidation number of iodine = (+)3 [1]

M_r = 127 + 3x35.5 = 233.5

=> percentage of iodine = 127 x 100/233.5 = **54.4 *or* 54 %** (2 or 3 s.f.) [1] **2**

(c) (i) $ICl_3 + 3KI \rightarrow 3KCl + 2I_2$ (*or* ionic) [1]

1.00g of ICl_3 is 1/233.5 = 4.3×10^{-3} moles

=> 2 x 4.3×10^{-3} = 8.56×10^{-3} moles of I_2 formed *(use of x2)* [1]

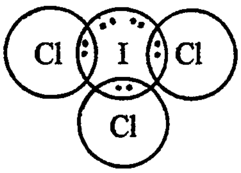
(since $2S_2O_3^{2-} + I_2 \rightarrow S_4O_6^{2-} + 2I^-$),

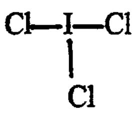
=> 2 x 8.56×10^{-3} = 1.71×10^{-2} moles of thio needed *(use of x2)* [1]

volume of thiosulphate = 1.71×10^{-2} x 1000/1.00 = **17.1 *or* 17 cm³** (2 or 3 s.f.) [1] **4**

(*if candidate has used Mr = 238 or 232 etc., all marks except the last can still be gained)*

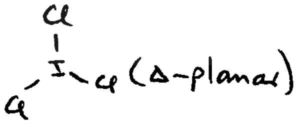
(d)





$$Cl{-}\underset{\displaystyle Cl}{\underset{|}{I}}{-}Cl$$

OR



(T-shaped) [1]
(bonding) [1] **2**

NOT pyramidal **12 max 10**

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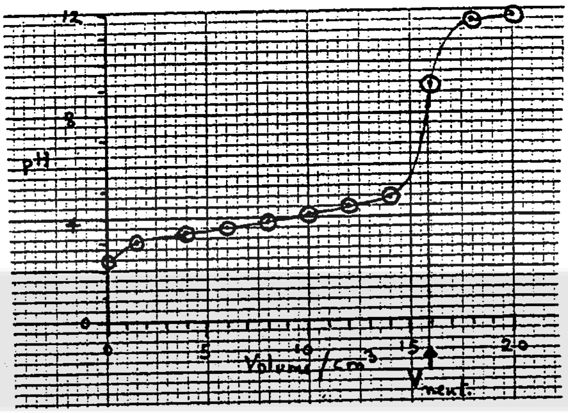
3. (a) Graph:



plotting of points [1]

labelling of axes [1]

comments: *before end point:* gentle slope - buffer region [1]

at end point: steep slope - large pH change for small vol. added [1] **4**

(b) phenolphthalein OR thymol blue OR phenol red [1]

because its pKa is >7 *or* it changes colour /on the alkaline side/at pH 7-11/ [1] **2**

(c) (i) *(from graph)*: neutralisation volume = 16.0 ± 0.2 cm^3

=> moles of NaOH = 0.05 x 16/1000 = **8 x 10^{-4}** moles (7.9 - 8.1 x 10^{-4}) [1]

since moles of NaOH = moles of lactic acid,

[lactic acid] = 8 x 10^{-4} x 1000/10 = **0.080 M** (2 or 3 s.f. between 0.079 - 0.081) [1]

(ii) since M_r (lactic acid) = 90,

0.080 x 90 = **7.2(0) g dm^{-3}** (7.11 - 7.29) *(use of M_r = 90)* [1] **3**

(d) when volume = (neutralisation volume)/2, $[RCO_2H] = [RCO_2^-]$ and pH = pK_a

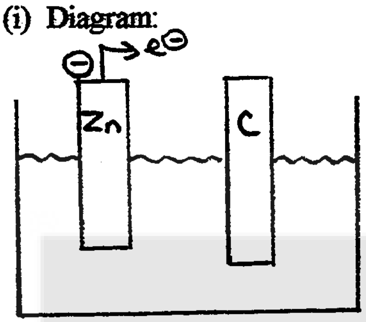
pH at (neutralisation volume)/2, i.e. 8.0 cm^3, = 3.9 *(reasoning, by impression)* [1]

=> Ka = 10^{-pK_a}

= **1.26 x 10^{-4}** mol dm^{-3} (2 or 3 s.f. between 1.0 and 1.5 x 10^{-4}) [1] + [1] (units) **3**

12 max 10

4. (a) (i) Diagram:



identified blocks of Zn and C dipping into a liquid [1]

correct polarity of zinc electrode or correct movement of e^- shown [1] **2**

(ii) $Zn \rightarrow Zn^{2+} + 2e^-$ $E^o = -0.74$ V }

} data [1]

$\frac{1}{2} O_2 + H_2O + 2e^- \rightarrow 2OH^-$ $E^o = +0.40$ V}

overall E_{cell} = **1.16** (V) [1]

(if other O_2 electrodes are used, with $E^o = +1.23$ or $+0.68$, allow [1] for $E_{cell} = 1.99$ or 1.44 V)

$Zn + \frac{1}{2} O_2 + H_2O \rightarrow Zn^{2+} + 2OH^-$ *(or* $Zn(OH)_2$) [1] **3**

(iii) any inert electrolyte, e.g NaOH (aq), Na_2SO_4(aq), NaCl(aq) [1] **1**
$ZnSO_4$, $ZnCl_2$ etc.

(not NH_4Cl or H_2SO_4 - these would react with OH^-)

(b) 20% efficiency means that 36,000 x 100/20 = **1.8 x 10^5** k Joules needed *(use of 20%)* [1]

=> need to burn 1.8 x 10^5/5470 moles = **32.9** moles of octane *(use of ΔH_C)* [1]

C_8H_{18} = 114, => 32.9 x 114 = **3751** g *(use of M_r)* [1]

volume = 3751/0.66 *(use of density)* [1]

= **5.68** dm^3 (2 or 3 s.f.: 5.7, 5.69 also) [1] **5**

11 max 10

5.	(a)		(aq. NaCl is) electrolysed (1) and Cl_2 comes off at the /anode/ (1) + electrode/	[2]	
			$2Cl^- - 2e^- \rightarrow Cl_2$	[1]	**3**
	(b)	(i)	$3Cl_2 + 6OH^- \rightarrow 5Cl^- + ClO_3^- + 3H_2O$ *(or molecular)*	[1]	
			green colour disappears	[1]	
			disproportionation NOT redox	[1]	**3**
		(ii)	$Cl_2 + 2KI \rightarrow 2KCl + I_2$ *(or ionic)*	[1]	
			orange /brown/red/ colour disappears	[1]	
			redox *or* oxidation/reduction OR displacement	[1]	**3**
		(iii)	$Cl_2 + C_2H_4 \rightarrow C_2H_4Cl_2$	[1]	
			oily lquid appears OR green colour disappears	[1]	
			addition	[1]	**3**
					12 max 10

6. (a)

Na (+1)	Mg(+2)	Al(+3)	Si(+4)	P(+3 *or* +5)	*(ox. nos)* [2]	
dissolve with no reaction [1]		hydrolyse to give /HCl/acid solution/ [1]			*(+water)* [2]	
IONIC [1]		COVALENT [1]			*(bonding)*[2]	**6**

(b) (i) (yellow ppt. is sulphur): moles of S = 0.36/32 = **0.01125** [1]

(S_2Cl_2 = 135):=> moles of S_2Cl_2 = 1.00/135 = **0.0074** *(can be awarded in (ii) if not here)* [1]

or: *oxidation no. of S in S_2Cl_2 = +1* }
oxidation no. of S in S = 0 }
oxidation no. of S in H_2SO_3 = +4 } *[1]*

equation: $2S_2Cl_2 + 3H_2O \rightarrow 3S + H_2SO_3 + 4HCl$ [2] **4**

(ii) 2 moles of S_2Cl_2 → 6 moles of H^+ (i.e. 2 in H_2SO_3 and 4 in 4HCl)

=> 0.0074 moles of S_2Cl_2 needs 0.0074 x3 = **0.0222** moles of NaOH [1]
(second mark in (i) can be awarded here if alternative scheme used in answer to (i))

=> 1000 x 0.0222 = **22.2 (22)** cm^3 of NaOH (2 or 3 s.f.) [1] **2**

12 max 10

7. (a) (i) /sodium chloride/NaCl/ [1]

$NaNO_2 + NH_4Cl \rightarrow 2H_2O + NaCl + N_2$ [1] **2**

(ii) N changes from -3 in NH_4^+ to zero **and** from +3 in NO_2^- to zero. [1] **1**

(iii) $(NH_4Cl + NaNO_3 \rightarrow)\ N_2O$ [1]

oxidation no. of N = +1 [1] **2**

(b) (i) e.g.
urea
ammonium nitrate
ammonium chloride
ammonium sulphate
ammonium phosphate
potassium nitrate etc. } but not BOTH
sodium nitrate }
(any two) [2] **2**

(ii) most nitrogen based fertilisers are water soluble [1]

phosphates are less so *or* can be complexed in the soil [1] **2**

(iii) eutrophication of rivers and lakes

due to too much algal growth

cutting out light from photosynthetic plants *or*

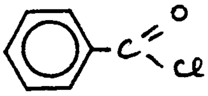
increasing BOD when dead algae decompose

=> less oxygen for animal life

nitrates in drinking water can be harmful (any three points) [3] **3**

12 max 10

8. (a)



[1]

add /PCl_5/$SOCl_2$/ (to benzoic acid) [1]

PCl_3

heat ~~and distil~~ [1] **3**

(b) C_6H_5COCl + ethanol → $C_6H_5COOC_2H_5$

+ NH_3 → $C_6H_5CONH_2$

+ H_2/Pd-$BaSO_4$ → C_6H_5CHO

+ {H_2/Ni − ; $LiAlH_4$} → $C_6H_5CH_2OH$

+ OH^- or H_2O → $C_6H_5CO_2H$

+ RNH_2 → $C_6H_5CO.NHR$

any three reactions
[1] for reagent
[1] for product. 3 x [2] **6**

C_6H_5COCl is more reactive than $C_6H_5CH_2Cl$ [1]

Carbon in C_6H_5COCl is more /δ+/susceptible to nucleophilic attack/ [1]

due to /electron-withdrawing effect/proximity/ of C=O [1] **3**

12 max 10

9\. (a) phenylamine is insoluble due to hydrophobic phenyl ring [1]

benzoic acid is more soluble due to more /H-bonding/polar groups/ [1]

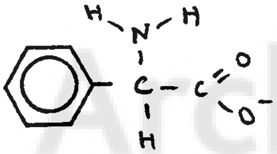
benzoic acid has higher m.p. due to H-bonding (between molecules) [1]

$C_6H_5CH(NH_2)CO_2H$ exists as /zwitterion/$C_6H_5CH(NH_3{}^+)CO_2{}^-$/ [1]

=> ionic attraction in solid (hence high m.p.) [1]

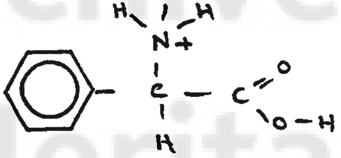
=> /lots of solvation in water/two hydrophilic groups/ [1] **6**

(b) (i)



[1]

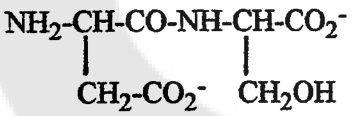
(ii)



[1] **2**

(award [1] out of [2] if not displayed formulae)

(c)



$$\begin{array}{l} NH_2\text{-}CH\text{-}CO\text{-}NH\text{-}CH\text{-}CO_2{}^- \\ \qquad\;\; | \qquad\qquad\quad\;\; | \\ \quad CH_2\text{-}CO_2{}^- \quad CH_2OH \end{array}$$

C-N-C skeleton [1]

one $CO_2{}^-$ group ionised [1]

both $CO_2{}^-$ ionised, but OH not [1] **3**

11 max 10

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10. (a) (i) (+ HBr) → $CH_3CHBrCH_3$ [1]

nucleophilic substitution [1]

(ii) (+ Na) → $(CH_3)_2CHO^- Na^+$ [1]

/redox/reduction/ [1]

(iii) (+ I_2/OH^-) → $CH_3CO_2^-$ + CHI_3 [1]

/iodoform/oxidation/ redox/ [1] **6**

(b) **B** must be a primary alcohol because $K_2Cr_2O_7$ /gives an acid/adds an O atom/ [1]

B → **D** is /a dehydration/loss of water/ [1]

B → **C** is an oxidation [1]

D → 

: C=C bond is broken [1]

B is: $(CH_3)_2CHCH_2CH_2OH$ [1]

C is $(CH_3)_2CHCH_2CO_2H$ [1]

D is $(CH_3)_2CHCH=CH_2$ [1] **7**

13 max 10

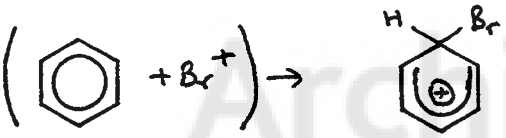
11. (a) *an example of electrophilic substitution:*

also allowed: $+Cl_2$, $+HNO_3$, $+SO_3$, $+RCl$, $+RCOCl$

e.g.	benzene + bromine	*(reagents)*	[1]
	giving bromobenzene	*(products)*	[1]
	using $Br_2(l)$ + $FeBr_3$ + heat	*(conditions)*	[1]

mechanism:

$Br_2 + FeBr_3 \rightarrow Br^+ + FeBr_4^-$ *(formation of electrophile)* [1]



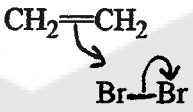
(intermediate cation) [1] **5**

(b) *an example of electrophilic addition:*

e.g.	ethene + bromine	*(reagents)*	[1]
	giving 1,2-dibromoethane	*(products)*	[1]
	$Br_2(aq)$ *or* $Br_2(g)$ *or* Br_2(inert solvent), <u>not</u> /UV/light/	*(conditions)*	[1]

mechanism:

$CH_2{=}CH_2 + \underset{\delta+}{Br}{-}{-}\underset{\delta-}{Br}$ *or*



(attack of electrophile) [1]

$\rightarrow \underset{\oplus}{CH_2}{-}CH_2{-}Br$ *(intermediate cation)* [1] **5**

(c) *comments*: double bond has disappeared in electrophilic addition, but remains in electrophilic substitution. [1]

electrophiles attracted to π-electrons

because the stability of the /benzene ring/delocalised ring of electrons/ ensures that it is re-formed. [1] **2**

<u>or</u> statement of Markovnikov or orientation in ring.

12 max 10

QUESTION 1 FURTHER TRANSITION METALS

(a) (i) Stoichiometry = relative ratio of ion : ligand (1)

(ii) K = 26.8/39 = 0.687/0.2286 = 3(.005)

Fe = 12.8/56 = 0.2286/0.2286 = 1.0

C = 16.5/1 = 1.375/0.2286 = 6(.01)

O = 43.9/16 = 2.744/0.2286 = 12(.00)

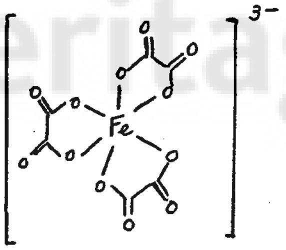
(1)

Therefore $K_3FeC_6O_{12}$ (1)

Thus stoichiometry is 1 : 3, i.e. $K_3Fe(C_2O_4)_3$ (1)

$\triangle 4$

(b) Octahedral (1)



(1)

can show optical isomerism (1)

$\triangle 3$

(c) Red colour is $Fe(SCN)^{2+}$ (1)

$K_3[Fe(CN)_6{}^{3-}]$ > $K_3[Fe(SCN)^{2+}]$ (1)

Stability of $Fe(SCN)^{2+}$ is greater than that for $Fe(C_2O_4)_3{}^{3-}$. (1)

$\triangle 3$

$\boxed{10}$

QUESTION 2 FURTHER TRANSITION METALS

(a) 3d and 4s orbitals have approximately the same energy (1)
successive ionisation energies approximately cancelled by successive hydration energies, therefore, ions of different oxidation numbers have approximately the same energy (1)
In other metals, successive IE's are much higher because of breaking into inner shell (1)

3

(b) (i) MnO_4^- ———— Mn^{2+} $E^\circ = +1.52$
Br^- ———— Br_2 $E^\circ = +1.07$
therefore,
MnO_4^- → Mn^{2+}
Br^- → Br_2 $E^\circ_{cell} = 1.5 - 1.07$
$= +0.45$ (1)

therefore reaction takes place (1)
Mn goes down down 5 in O.N. (1)

(ii) Fe^{3+} ———— Fe^{2+} $E^\circ = +0.77$
Cl_2 ———— Cl^- $E^\circ = +1.36$

Both are in fully oxidised states, so no reaction. (1)

(iii) VO_2^+ ———— VO^{2+} $E^\ominus = +1.0$
VO^{2+} ———— V^{3+} $E^\ominus = +0.34$
Sn^{2+} ———— Sn^{4+} $E^\ominus = +0.15$
therefore,
either
VO_2^+ → VO^{2+}
Sn^{2+} → Sn^{4+} $E^\circ_{cell} = +0.85$ (1)
or
VO^{2+} → V^{3+}
Sn^{2+} → Sn^{4+} $E^\circ_{cell} = +0.19$

reaction takes place (1)

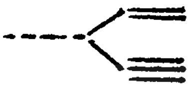
V goes down -1 or -2 in O.N. (1)

7

10

QUESTION 3 FURTHER TRANSITION METALS

(a) (in $Cr^{3+}(aq)$)

d orbitals are split (or ) (1)

spaces in top orbital (1)
electrons can jump from bottom to top (1)
by <u>absorbing</u> a quantum of <u>visible</u> light (1)

(in $Al^{3+}(aq)$)

Energy gap to lowest unfilled orbital too large therefore uv absorption (1)

$\triangle$ 5

(b) (i) A would be yellow/orange/red (absorbs blue) 1
B would be blue green purple (absorbs yellow/red) 1

(ii) (longer λ - smaller energy)

Energy gap between the d orbitals is larger in $CrL_6{}^{3+}$ than in $CrJ_6{}^{3+}$. (2)

(iii) L is the stronger ligand (1)
because in a 50:50 mixture of L and J, spectrum is closer to that of A (1)

$\triangle$ 6

Max. 10

QUESTION 4 - PHASE EQUILIBRIA

(a) Ca Mg
55.5/40 44.5/4

1.3875 : 1.83   1 : 1.32

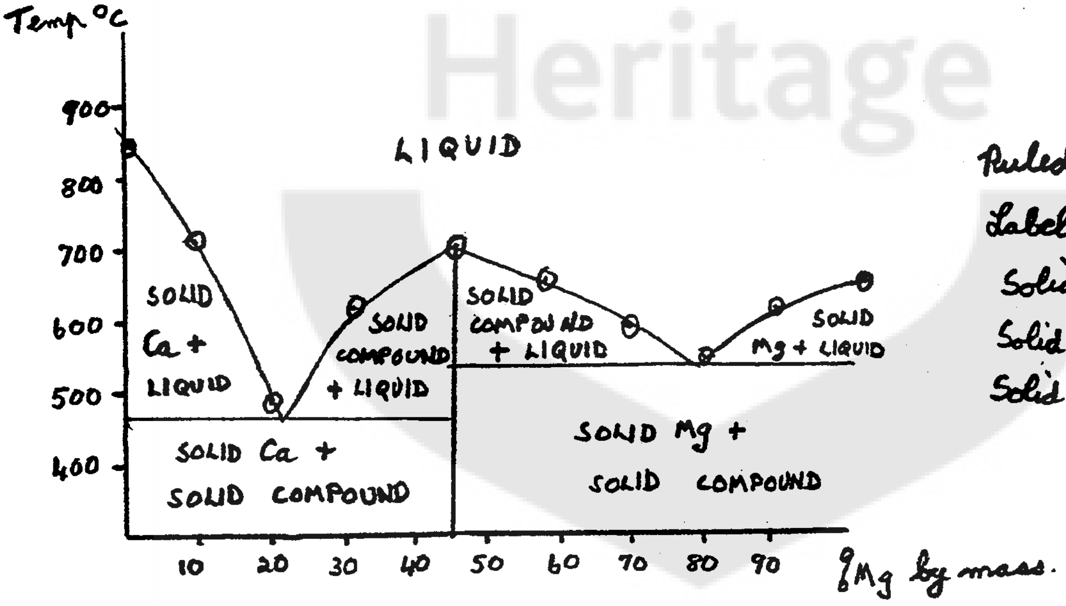
Ca_3Mg_4 (1)

(b) (i) Plot of points (2)

(ii) Eutectics 21% (±1) Mg 465° (±10) (2)
81% (±1) Mg 520° (±10)

5

(iii)



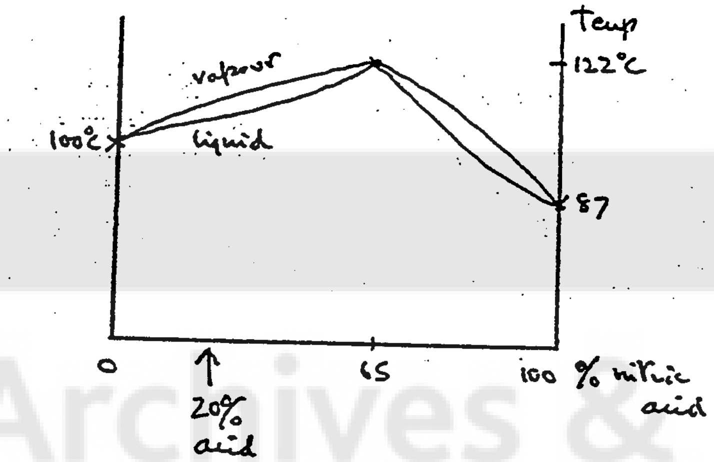
Ruled lines (1)
Label areas correctly once
Solid element + liquid (1)
Solid compound + liquid (1)
Solid element + solid comp. (1)
liquid (1)

5

10

QUESTION 5 - PHASE EQUILIBRIA

(a)



sketch (1)
3 points (1)
vap/liq (1)

$\triangle 3$

(b) Water distils (1)
Residue becomes richer in nitric acid; temperature increases (1)
until composition reaches 65% acid, at 122° C, which then distils. (1)

$\triangle 3$

(c) (i) The partial pressure of a volatile component in a mixture is equal to its full vapour pressure multiplied by its mole fraction.

$$p_A = p^o{}_A \times n_A$$ (2)

$\triangle 2$

(ii) Solution not ideal; components attract each other (1)
Reduces vapour pressure and boiling point higher (1)
H_2O and HNO_3 react - cause ionisation or equation (1)

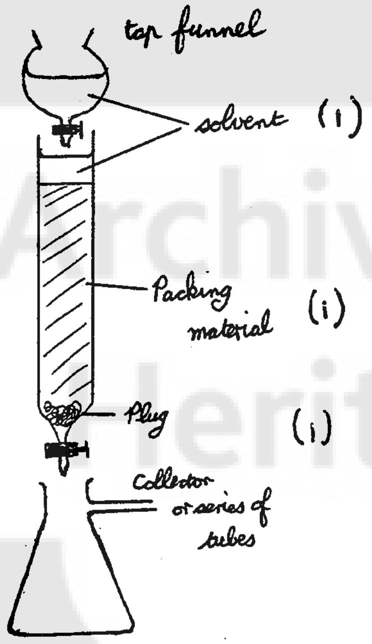
Max. $\triangle 2$

$\boxed{10}$

QUESTION 6 - PHASE EQUILIBRIA

(a) Components travel at different speeds (1)
due to different solubilities in solvent (mobile phase) (1)
and different attraction (affinity) for the stationary phase (1) 3

(b) (i)



Solvent added and each component separately collected (or better) (1)

4

(i) Mixtures of dyestuffs; peptides etc. Must be chemically similar and suitable for column chromatography. (1)

alumina, silica, keiselguhr (1)

any suitable solvent (1)

3

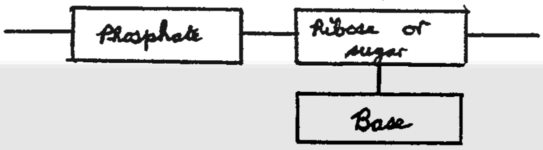
10

QUESTION 7 - BIOCHEMISTRY

(a) Each nucleotide is

deoxyribose

2.1



(1)

The bases are paired; AT GC (1)

Bases linked by hydrogen bonds (1)

DNA is a double helix (or diagram) (1)

Max. 4

(b) The enzyme breaks a particular linkage; (1)
hydrolysis; water molecule required for each break. (1)

2

(c) Sugars and bases are not charged, only the phosphate (1)
which contains P - O⁻ (1)

2

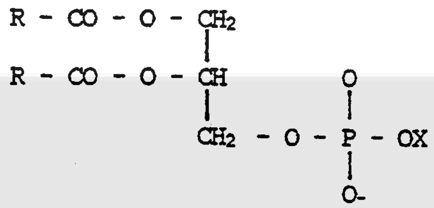
(d) The size of the fragments; the M_r of each fragment (1)
the smaller fragments move farthest. (1)

2

10

QUESTION 8 - BIOCHEMISTRY

phospholipid (1)



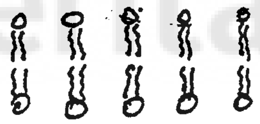
(2)

Abbreviated to

(1)

these form bimolecular layers (1) which are the basis of membranes

water/cytoplasm



(1)

Membranes also contain proteins (1)

both integral and peripheral (1)

Passage through membrane possible only by very small molecules or ions. (1)

by passive transport (1) - no energy required (1)

or by active transport (1) - energy required (1)

Max. 3

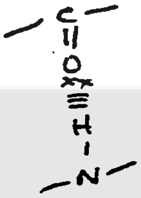
membrane possesses the necessary mechanism to allow passage of molecules or ions. (1)

Max. $\boxed{10}$

QUESTION 9 - BIOCHEMISTRY

(a) α - helix + diagram (1)

hydrogen bonds between groups in one strand in the double helix (1)


(1)

β - pleated sheet (1)
between parallel strands of protein (1)
many strands of protein (polypeptide) or diagram. (1) Max. 3

(b) One quoted example of an R group, which for instance, forms (1) hydrogen bonds
eg - CH_2CO_2H, - CH_2NH_2, $-CH_2OH$, $-CH_2C_6H_4OH$

bond drawn correctly (1) 2

(c) - OH groups in sugars form H-bonds with water (1)


(1)

monosaccharides dissolve completely (1)

polysaccharides disperse/ form colloids (1)

cellulose (fewer OH gps) tends to be insoluble. (1) Max. 3

10

QUESTION 7 FOOD CHEMISTRY

(a) Cadmium - vegetables grown on 'mining waste'/ leached from cooking utensils. (1)

Lead - exhaust gases from internal combustion engines (1)

Mercury - mercury containing fungicides / factory waste discharged into rivers / timber treatment chemicals entering rivers. (1) Max. 2

(b) Hydrolytic rancidity (1) - oxidation of lipid yielding propan-1,2,3-triol and free carboxylic acids. (1)
Prevention - removal of some water and microorganisms which can produce hydrolytic rancidity. (2)

Oxidative rancidity (1) - oxidation of lipid giving rise to aldehydes and ketones. (1)
Prevention - removal of material from contact with oxygen /removal of traces of catalytic agents and the use of antioxidants. (2)

8

10

QUESTION 8 FOOD CHEMISTRY

(a) (i) fats/lipids/oils (1)

(ii) fat soluble vitamins (1) 2

(b) Chromatography (1)

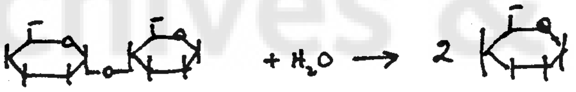
Extract colouring material with suitable solvent; spot onto chromatographic paper (1)

Elute with suitable solvent (1)

Dry using hot air, investigate coloured spots produced. (1) 4

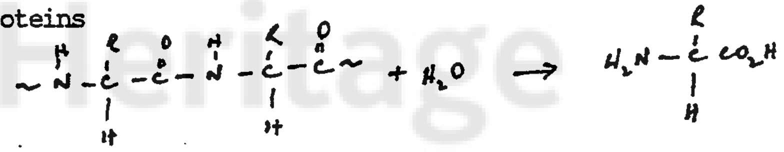
(c) Hydrolysis in both cases (1)

Disaccharides and polysaccharides



(2)

Proteins



(2) 4

10

QUESTION 9 FOOD CHEMISTRY

(a) Protein hydrolysed by heating with 6 mol dm^{-3} (or conc) HCl for prolonged periods. (1)

Chromatography used to separate the components.

Spot hydrolysate on chromatographic paper. (1)

Suspend paper in solvent for about 2 hours (1)

Mark solvent front and dry (1)

Spray with locating agent (ninhydrin) and redry. (1) 5

(b) Essential amino acids either cannot be synthesized by the human body or the body manufactures them too slowly. (1)

Varied diet essential to ensure that the eight essential amino acids are obtained. (1) 2

(c) Denaturation. (1)

Protein unfolds (loss of secondary and teriary structure) (1) and forms hydrogen bonds with adjacent chains bringing about coagulation. (1) 3

10

QUESTION 10 SOIL CHEMISTRY

(a) High charge leads to strong adhesion of the ion. (1)

Small hydrated size allows stronger adhesion ... (1)
because ion is able to be closer to the binding charge at the cation exchange site (1)
The dominant factor is the size of the charge (1)
$Ca^{2+}(aq)$ is smaller than $Mg^{2+}(aq)$ therefore it is held more strongly (1)
Since $K^+(aq)$ has the smaller charge it binds less strongly than the diavalent cations. (1)

Max. 5

(b) 500g of soil can hold 50meq of ions since CEC is 10 (1)
1 meq of Mg^{2+} is 0.5mmol (0.5×10^{-3}) (1)
Therefore soil extracts 80% of $50 \times 0.5 \times 10^{-3}$ = 0.02 mol (1)
Solution is 0.5 mol dm^{-3} and therefore contains 0.05 mol in $100 cm^3$ and hence 0.05 - 0.02 = 0.03 mol remains after the exchange sites become occupied. (1)
Concentration of the remaining magnesium sulphate is 0.3 mol dm^{-3}. (1)

5

10

QUESTION 11 SOIL CHEMISTRY

(a) Phosphorus is mobile in plants (1)
This means that the phosphorus reaches the growing points of the plants most readily (1)
The older leaves are then left deficient and show this by turning yellow. (1) 3

(b) $H_2PO_4^-$, HPO_4^{2-}, PO_4^{3-} (1)
acid $\longrightarrow$ alkali (1) 2

(c) A would tend to precipitate the phosphorus as iron(III) or aluminium phosphates (1)
B would tend to precipitate the phosphorus as calcium phosphate (1)
C although the organic material is likely to contain adequate phosphorus it must be converted to an inorganic form before utilisation by the plant (1)
this process (mineralisation) is normally slow, restricting phosphorus availabilty (inorganic material is likely to contain very little phosphorus). (1) 4

(d) A sulphate deficiency would appear on newer leaves since sulphate is not mobile. (1) 1

10

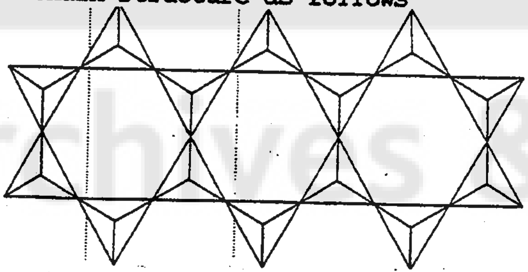
QUESTION 12 SOIL CHEMISTRY

(a) mol Si : mol O is 39/28.1 : 61/16 (1)
= 1.388 : 3.813
= 1 : 2.75
= 4 : 11 (1)

The ion is therefore $Si_4O_{11}{}^{6-}$ (1)

3

(b) It is an amphibole (1)
Double chain structure as follows



(2)

3

(c) 1/2 the $SiO_4{}^{4-}$ units share oxygens at 3 corners and the other 1/2 share oxygens at corners (1)

Therefore the formula is $SiO_{(1+3*1/2)}$ + $SIO_{(2+2*1/2)}$ (1)

This is $Si_2O_{51/2}$ or $Si_4O_{11}{}^{6-}$ (1)

3

(d) Weathering would be relatively slight (1)

1

$\boxed{10}$

QUESTION 13 CHEMICAL ENGINEERING

Any 5 from the following:

- Is the raw material available in a pure enough state to be used?
  Purification may add significantly to the cost, particularly if there is a risk of poisoning the catalyst.

- How exothermic is the reaction?
  This may be a benefit in maintaining the reaction temperature, but it could be a problem since increased temperature will favour the back reaction. (Le Chatelier)

- How easy is it to separate the product from the reaction mixture?
  Since the conversion is only 12%, the reactants will need to be recycled.

- Are there any by-products to this reaction, and if so what are they?
  These could be useful if they can be sold, or may cause increased costs if they need to be disposed of.

- Are there cost benifits in this process over other methods of making cyclohexanol?
  In order to justify the construction of a new plant the process must have financial benefits.

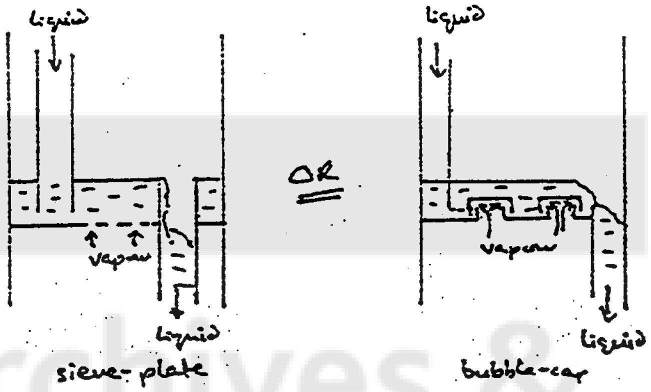
- Is there a sufficient and constant supply of raw material?
  If the process is to be developed supplies of raw material must be guaranteed in order to re-coup development costs.

- Is there a sufficient market for the product?
  In order to pay for the development and plant the product must be able to be sold at a sufficient price.

5x2 10

QUESTION 14 CHEMICAL ENGINEERING

(a)

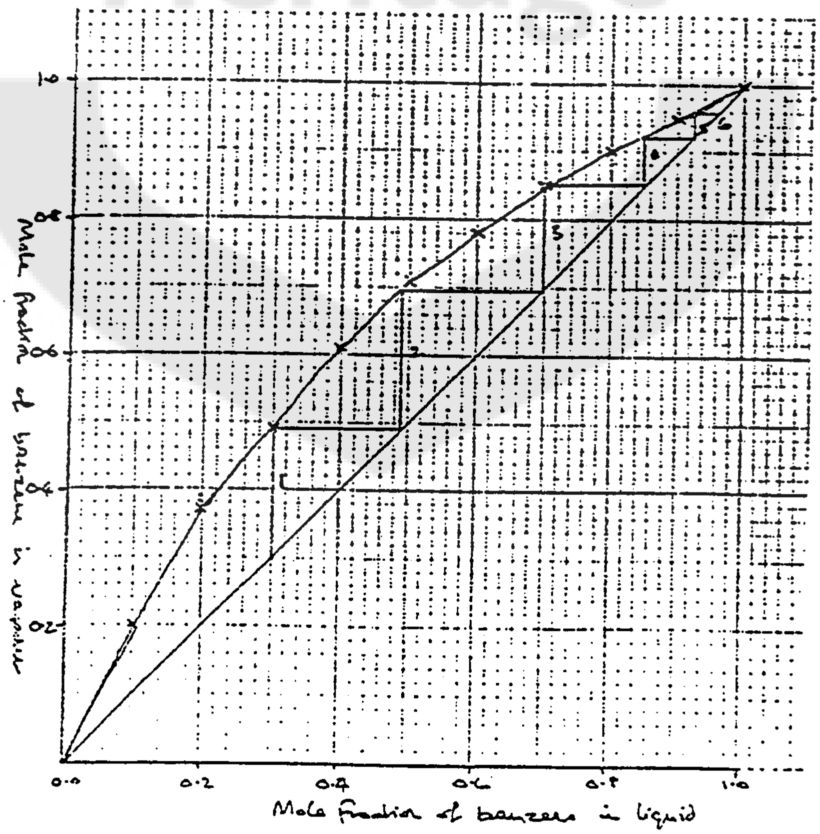


(1)

Vapour rises through the column and condenses at different plates. Rising vapour equilibrates with liquid and carries lower boiling point components up the column. Condensed liquid flows back down to next lower plate. (1) (1) (1)

4

(b)



correct plot (1)
diagonal (1)
plate construction (1)
6 plates needed (1)

4

17(b)

(c) (i) Perfumes, flavourings, natural products, pharmaceuticals (1)

(ii) Reduces possibilty of decomposition of compounds with decomposition temperatures close to their boiling points

Reducing pressure - reduces boiling point (aids vaporisation) (1)

2

10

QUESTION 15 CHEMICAL ENGINEERING

(a) EITHER

(i) Orifice meter, venturi meter, pitot tube (1)
(see *Notes for Guidance pp32/33*)
Diagram
Description of how measurement is made (1)

2

(ii) Rotameter (see Notes p33) - marks as above.

(b)

$$N_{RE} = \frac{D v \rho}{\eta} \quad (1)$$

D = tube diameter   v = fluid velocity
ρ = fluid density   η = fluid viscosity (1)

Reynolds' number is directly proportional to D. (1)
If N_{Re} < 2000 flow is streamline, above this value it becomes turbulent. (1)

4

(c) For streamline flow N_{Re} = 2000

$$2000 = \frac{0.15 \times 880 \times V}{0.0075} \quad (1)$$

$$V = \frac{2000 \times 0.0075}{0.15 \times 880}$$

(2)

$$= 0.1134$$

3

Flow would become turbulent
Increasing temperature - decrease viscosity, more than it decreases the density.

1

$\boxed{10}$

QUESTION 16 POLYMERS

(a) (i) covalent bonds (1)

(ii) hydrogen bonds; dipole-dipole bonds (2)

(iii) two of melting, dissolving, vaporising, adsorption, deformation or flow, creep. (2)

5

(b) (i) Thermoplastic - softens and flows on the application of heat (1)

Thermosetting - reacts irreversibly on heating and does not soften on subsequent heating (1)

(ii) Advantage - broken or rejected articles can be remoulded (1)

Disadvantage - limiting temperture above which they cannot be used as structural elements (1)

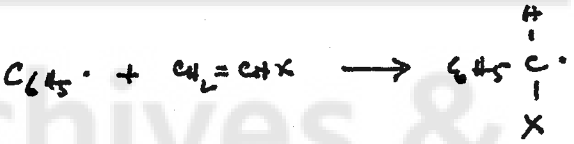
Limiting factor - chemical stability (1)

5

10

QUESTION 17 POLYMERS

(a) Addition polyerisation proceeds by free radical chain mechanism. (1)
Require initiator to provide free radicals. (1)
Free radical formed by thermal or photochemical decomposition of benzoyl peroxide (or suitable alternative). (1)
Free radical, in the presence of vinyl monomer, adds to the C = C with the formation of another free radical. (1)



$$C_6H_5\cdot + CH_2{=}CHX \longrightarrow C_6H_5\overset{H}{\underset{X}{C}}\cdot$$ (1)

this free radical then brings about the chain reaction. (1) 6

(b) Thermal decomposition of the initiator requires heat (1)
Addition reactions (eg C = C ⟶ C - C) following the initiation are strongly exothermic. (1)
Heat must be removed because higher temperatures give (1) relatively {low molecular mass polymers. / short chain} (1) 4

10

18 POLYMERS

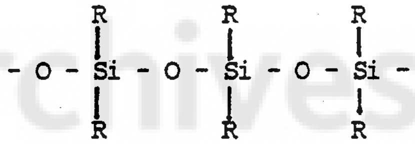
(a) (i) 1,2 dichloroethane with sodium polysulphide (or equation) (1)

in aqueous emulsion with $Mg(OH)_2$ (1)

(ii) Considerable resistance to hydrocarbon oils and solvents. (1)
Used for protective clothing, gaskets and hoses in contact with oils and solvents. (1)

4

(b) (i)



$$-O-\underset{\underset{R}{|}}{\overset{\overset{R}{|}}{Si}}-O-\underset{\underset{R}{|}}{\overset{\overset{R}{|}}{Si}}-O-\underset{\underset{R}{|}}{\overset{\overset{R}{|}}{Si}}-$$

(2)

(ii) cross-linking (1)

introduce trihydroxysilanols to form oxygen bridges (1)

with strong covalent bonds.

(iii) Addition of monchlorotrialkyl compound brings about end stopping of chain. (1)

(iv) When they decompose at high temperature they form non-conducting silica as opposed to carbon from H.C. polymers. (1)

6

10

QUESTION 19 SPECTROSCOPY

(a) From the left in each case

Spectrum 1 1 (singlet)
1 (singlet) (1)

Spectrum 2 1:3:3:1 (quartet)
1:2:1 (triplet) (1)

Spectrum 3 1 (singlet)
1:1 (doublet)
complex (1)
1:1 (doublet)

3

(b) Spectrum 1 : Isolated single hydrogen
9 equivalent hydrogens (or three methyl groups) (1)

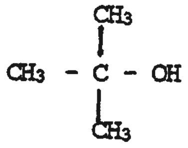
Spectrum 2 : Two - CH_2 - adjacent to two $-CH_3$ groups or two - CH_5 groups) (1)

Spectrum 3 : Isolated single hydrogen, 1 - CH_2 - group two $-CH_3$ groups. (1)
Single hydrogen adjacent to carbon with groups containing many equivalent hydrogens. (1)

4

(c)

Spectrum 1 :

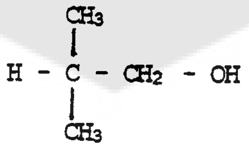


$$CH_3-\overset{\displaystyle CH_3}{\underset{\displaystyle CH_3}{C}}-OH$$

(1)

Spectrum 2 : $C_2H_5 - O - C_2H_5$ (1)

Spectrum 2 :



$$H-\overset{\displaystyle CH_3}{\underset{\displaystyle CH_3}{C}}-CH_2-OH$$

(1)

3

10

QUESTION 20 SPECTROSCOPY

(a) Use methanol labelled with ^{18}O (1)
React this with ethanoic acid to give the ester (1)
Separate the ester and compare its mass spectrum with that of unlabelled ester. (1)
Look at relative heights of peaks corresponding to CH_3O^+ at m/e 31 and 33. (1)

4

(b) (i)

Take nitrogen (Ar) away from 87 obtained from spectrum

87 − 14 = 73

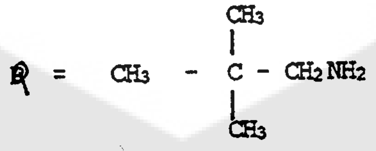
Assume P to be saturated Mr of 73 ∴ must contain 5 carbon atoms

∴ 73 − 60 = 13 hydrogen atoms.

(Q = $C_5H_{13}N$)

(ii) V = M − CH_3 (or $C_4H_{10}N^+$) (1)
U = $^+CH_2NH_2$ (or $^+CH_4N$) (1)

(iii)



$$Q = CH_3 - \underset{CH_3}{\overset{CH_3}{\overset{|}{\underset{|}{C}}}} - CH_2NH_2$$

(1)

6

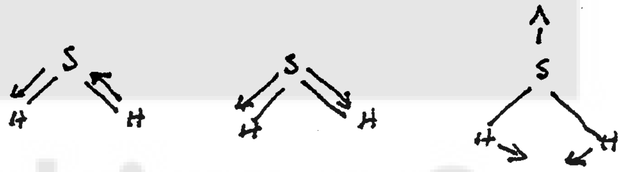
10

QUESTION 21 SPECTROSCOPY

(a) Absorption of ir results from quantisation of vibrational energy (1)
Corresponds to stretching and bending of bonds (1)
Only bonds possessing a dipole which changes during stretching or bending absorb (1)

3

(b)



3

(c) From spectrum S contains

- C = O absorption at 1725 cm^{-1} ($\pm$25 cm^{-1}) (1)

- C - O - absorption at 1275 cm^{-1} ($\pm$25 cm^{-1}) (1)
(also allow 1110 cm^{-1})

C - Cl may have been quoted and was accepted and the rest of the question worked conseqentially.

High carbon:hydrogen ratio suggests benzene ring (C_6H_5) (1)

Possible structure

$C_6H_5CO_2C_2H_5$ (1)

(or isomers but NOT acids)

4

10

GCE ADVANCED LEVEL EXAMINATIONS
MARKING SCHEME JUNE 1994

1.(a)(i) $X_{(g)} \longrightarrow X^{+}_{(g)} + e^{-}$ (1)

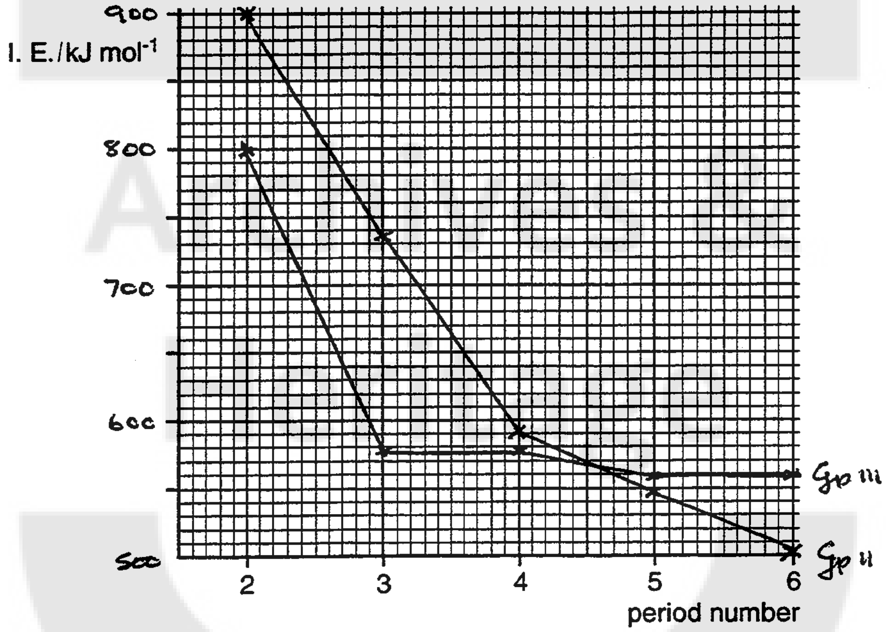
The equation

(ii) outermost electron further from nucleus

OR Effect of increased protons more than balanced by shielding (1)

OR greater shielding down the group. 2

(b) (i)



(1) 1

(ii) Al is [Ne] $3s^2 3p^1$ or e^- lost is single, unpaired electron (1)

leaves complete $3s^2$ subshell or Mg has s^2 subshell (1) 2

Tl

(iii) Tl has higher nuclear charge (1)

OR Effect in (ii) no longer pertains so far from nucleus 1

*

(iv) $Ba_{(g)} \longrightarrow Ba^{2+}_{(g)} + 2e^-$ 502 + 966 = 1468 kJ mol⁻¹ (1) If two are quoted (1)

$B_{(g)} \rightarrow B^{3+}_{(g)} + 3e^-$ 799 + 2420 + 3660 = 6879 kJ mol⁻¹ (1)

lower IE value, ease of ion formation (1)

OR higher IE value, difficulty of ion formation (1)

B^{3+} would have high charge density OR Ba^{2+} low charge density

Polarisation of anion or electron sharing more likely (1) max 4

10

GCE ADVANCED LEVEL EXAMINATIONS
MARKING SCHEME JUNE 1994

Q2. (a) $K_{sp} = [Ca^{2+}][OH^-]^2$ (1) /1

(1) expression

(b) (i) $[OH^-] = \frac{18.2}{20} \times .05 = 0.0455$ mol dm^{-3} (1)

Mark consequentially

(ii) $[pOH = 1.34]$ pH = 12.66 or 12.7 (1)

(iii) $[Ca^{2+}] = \frac{1}{2}[OH^-] = 0.0227$ mol dm^{-3} (1)

$K_{sp} = .0227 \times .0455^2$

$= 4.7 \times 10^{-5}$ (1) mol^3 dm^{-9} (1) /5

(c) lime water reagent (1) to Test for CO_2

COORD in making soil alkaline or curing acidity in soil /1

NOT in cement, mortar etc, anti-acid.

softening (temporary) hard water
acid-rain in lakes.

NOT any medical use.

Total 7

GCE ADVANCED LEVEL EXAMINATIONS
MARKING SCHEME JUNE 1994

Q3

(a)

	tetrachloromethane	silicon tetrachloride	lead(II) chloride	
physical state at room temperature	l	l	s	(1)
electrical conductivity when liquid	✗	✗	✓	(1)
effect of adding water at room temperature	no reaction Two layers	hydrolysis or gives SiO_2, HCl	insoluble or sol. on boiling	(2)+1 (1) each.
type of bonding	covalent		ionic	(1) [5]

NOT dissolves.

(b)(i) eg $2NaOH + CO_2 \longrightarrow Na_2CO_3 + H_2O$

balanced, with a base. (1)

or $CaO + SiO_2 \longrightarrow CaSiO_3$

(ii) eg $PbO + 2HNO_3 \longrightarrow Pb(NO_3)_2 + H_2O$ (1)

balanced, with an acid; accept $PbO + 2HCl \rightarrow PbCl_2 + H_2O$ etc. △2

(c)(i) Any Sn^{2+} salt (1) tin, Sn

(ii) $Sn^{2+} - 2e^- \longrightarrow Sn^{4+}$

$MnO_4^- + 8H^+ + 5e^- \longrightarrow Mn^{2+} + 4H_2O$

$2MnO_4^- + 16H^+ + 5Sn^{2+} \longrightarrow 2Mn^{2+} + 8H_2O + 5Sn^{4+}$ (1) △2

OR $3Sn^{2+} + 2MnO_4^- + 8H^+ \longrightarrow 3Sn^{4+} + 2MnO_2 + 4H_2O$

If lead given for (i), accept balanced equations for $Pb^{2+} \rightarrow Pb^{4+}$ or to PbO_2. $\boxed{9}$ +1

NOT metal → $metal^{++}$

NOT $MnO_4^- \rightarrow MnO_4^{2-}$ (doesn't happen in acid)

Q4.
(a)(i) $CH_3CHOHCH_3$ or $CH_3CH_2CH_2OH$ (1)

(ii) Ans to (i) − H_2O → $CH_3CH=CH_2$ accept C_3H_6 (1) /2

(b) one of: silicon oxide ; aluminium oxide ; iron oxide ; GpII oxides (1)
(i) silica alumina NOT $CaCO_3$

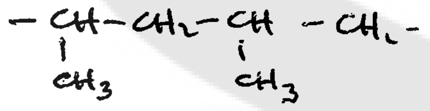
(ii) To effect dehydration on a hot surface (or equiv.) (1)
OR To provide Eactn for the reaction.
NOT To vapourise the alcohol
NOT to activate the catalyst

(iii) carbon (1)
by decomposition from the of organic compound (a)(i) [To $C + H_2O + H_2$] (1)
NOT combustion.

(iv) To avoid sucking-back (1) /5

C_3H_6 → $C_3H_6Br_2$

(c) (i) $CH_3CH=CH_2 + Br_2 \rightarrow CH_3CHBrCH_2Br$ (1)

(ii)

$$-\underset{\displaystyle CH_3}{\underset{|}{CH}}-CH_2-\underset{\displaystyle CH_3}{\underset{|}{CH}}-CH_2-$$
(1)

(iii) Any suitable plastic use (1) /3
CCORD eg packaging, furniture
used in plastics.

10

Q5(a) oil soluble, since (one of)

- ester group (non-polar or hydrophobic)
- aromatic amines are insoluble
- benzene ring
- is a large molecule
- no H-bonding.

Must be chemical reason – not about skin. (1)

(b) I conc HNO_3 conc H_2SO_4 below 60°C (1)

II alk. or acidic MnO_4^- reflux or boil (1)

III C_2H_5OH conc H_2SO_4 reflux heat (1)

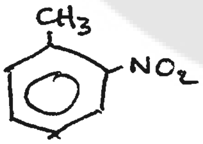
IV Sn cHCl or Fe c HCl reflux hot (1)
H_2 metal eg Ni
allow Zn/Hg.

NOT $LiAlH_4$ which reduces the ester group.

Two points, including the underlined reagent gets the mark.
Three extra points in (b) gets a mark.

$\boxed{4}+1=\boxed{5}$

(c)



(1)

$\boxed{7}$

9250 | 4

JUNE 1994

CHEMISTRY

GCE

9250

Paper 9250/04

Question Number	*Key*	*Question Number*	*Key*
1	C	26	B
2	A	27	C
3	D	28	D
4	A	29	C
5	A	30	D
6	C	31	D
7	A	32	C
8	A	33	B
9	C	34	B
10	B	35	A
11	C	36	B
12	C	37	D
13	D	38	C
14	A	39	B
15	B	40	C
16	C		
17	B		
18	A		
19	C		
20	A		
21	D		
22	C		
23	C		
24	B		
25	C		

STANDING INSTRUCTIONS FOR 9250/5 (Practical Chemistry A)

(a) 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 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.

(b) Temperature Tables.

Candidates are expected to read temperatures to 1 d.p. The principles used in awarding marks are similar to those for weighings

(c) Tables of Burette Readings for the Main Titration.

Candidates are expected to record their final burette reading to .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.

Ignore ALL FIGURES under the heading "ROUGH" unless the candidate has crossed out the word "ROUGH" or otherwise indicated that this titration is an accurate one, in which case treat it as such.

Correct any errors of subtraction in the accurate 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..

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.

Give ONE mark for a value of volume used from the burette <u>quoted in the Summary</u> 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 dps. may be omitted here if they are 0.) (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 2d.p.. The examiner working on Supervisor's results will always round up.) Withhold this mark if the candidate performed only one accurate titration (and also see below under spread penalty), if a rough value has been used in calculating the average, if there has been an error in subtraction in the Table of Burette Readings, if the candidate fails to indicate by words and/or figures which titres have been used to obtain the average, or the average is inconsistent with what has been stated. <u>The average being assessed is the one recorded in the summary,</u> which is sometimes different from the one found in the candidates indication of how it was found.

(d) **Accuracy.**

If the candidate earned the mark for correct average (above), use this value in assessing accuracy. If the candidate performed only one accurate titration use the value of that one titre to assess accuracy but deduct four marks from the subsequent accuracy score (No negative marks.) 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 <u>one single value</u> to be obtained from the corrected titres.

1. Follow the candidate's instructions if his only error was in the arithmetic of averaging (not in the subtraction of burette readings).

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 0.20cm^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 0.30cm^3.

3. Take the average of all titres within a range of (i) 0.1cm^3, (ii)0.2cm^3, (iii) 0.3cm^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 <u>one single value</u> 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 0.1cm^3 apart.

A SPREAD PENALTY is applied if the titres <u>used by candidate</u> *<u>and/or the examiner in calculating the average</u>* cover a range greater than 0.20. Titres not used in calculating the average of the titres are not included in the range. *Apply whichever spread penalty is the greater. If the candidate uses a Rough value in calculating an average include the value in calculating the spread.*

(e) **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.

Question 1

> Mark the first weighings table as (d) after checking as (a) discounting the Tare possibility

If no mass of FA1 is recorded and it is not possible to calculate it from the weighings, NIL will be earned for accuracy..Similarly, if the Tare facility has been used (stated or 0.00g for mass of empty tube), give NIL for this weighings table, NIL for accuracy and a maximum of FOUR for the second weighings table (cannot earn 2nd mark). 3

Mark the second weighings table as follows;
Give ONE mark for recording the mass of tube + FA1 after heating to at least 2 dp in the correct space and ONE mark for the correct subtraction from this of the mass of empty tube. Do not give this mark if the mass of empty tube is not identical to that in the first weighings table or the space in the second table has been left blank. If the mass of empty tube is different from that in the first table, use the one from the first table to calculate the mass of FA1 after heating.
Give ONE mark for any evidence of actually reheating and reweighing (not for merely writing about doing it) and TWO further marks if there are two recorded masses of tube + FA1 within 0.05g. If the smallest of these masses has not been used to calculate the mass of FA1 remaining after heating, withhold ONE of these marks and also do this if the average of these two masses is used. 5

Accuracy

Calculate $\frac{\text{mass lost on heating}}{\text{mass of FA1 after heating}}$ from the candidate's results (corrected if necessary) and compare this with the theoretical value of 1.05. Work to 2dp and assign marks as follows;

Mark	Difference
SIX	Up to 0.03
FIVE	0.03+ to 0.04
FOUR	0.04+ to 0.05
THREE	0.05+ to 0.07
TWO	0.07+ to 0.10
ONE	0.10+ to 0.15
NIL	greater than 0.15

If 1.05 is found to be unsatisfactory as a standard for a centre, try the Supervisor's results then

6

1 (a) Give ONE mark for subracting the candidate's mass of FA1 after heating from the mass of FA1 before heating. Ignore arithmetical errors as long as it is clear that these two quantities are being used.
The correct answer alone here is acceptable.

1 (b) Give ONE mark for quoting the mass of FA1 after heating from the second weighings table.

1 (c) Give ONE mark for

$$\frac{\text{answer to (a)}}{18}$$

Ignore evaluation errors.
Working to be shown.

2 (d) Give ONE mark for

$$5 \times \frac{\text{answer to (b)}}{\text{answer to (c)}}$$

Working to be shown

and ONE further mark for evaluation to 1% of a fully correct expression. Mark on FINAL answer quoted.

(Correct answer = 90 ÷ ratio used to calculate accuracy mark)

1 (e) Give ONE mark for

EITHER $\frac{\text{answer to (a)}}{\text{Mass of FA1}} \times \frac{100}{1}$ OR $\frac{5 \times 18}{\text{(d)} + 5 \times 18} \times \frac{100}{1}$ Working to be shown

The expression must have been evaluated. Ignore arith errors.

20 Total for Q1

Question 2
Experiment 1

3 Mark the first table of burette readings as (c).

Accuracy

Derive the candidate's average titre if necessary.

Assign accuracy marks by comparing the candidate's average titre with that of the Supervisor

The spread penalty mentioned in the Standing Instructions may have to be applied using the table below.

Mark	Accuracy marks Difference from Supervisor
TEN	up to 0.01 cm^3
NINE	0.10+ to 0.20
EIGHT	0.20+ to 0.30
SEVEN	0.30+ to 0.40
SIX	0.40+ to 0.50
FIVE	0.50+ to 0.60
FOUR	0.60+ to 0.80
THREE	0.80+ to 1.00
TWO	1.00+ to 1.50
ONE	1.50+ to 2.00
NIL	greater than 2.00

10

Spread Penalty Range used	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 0.50	5
0.50+ to 0.60	6
0.60+ to 0.70	7
0.70+ to 0.80	8
0.80+ to 1.00	9
above 1.00	10

Give NIL if the spread penalty exceeds the accuracy mark.

(a) Give ONE mark for $\frac{25 \times 0.02}{1000}$

Working need not be shown here. Ignore evaluation errors if working is shown.

1

(b) Give ONE mark for $\frac{\text{titre} \times 0.12}{1000}$

Working must be shown. Ignore evaluation errors.

1

(c) Give ONE mark for $\frac{\text{answer to (b)}}{\text{answer to (a)}}$

Working must be shown. Ignore evaluation errors.

1

Experiment 2

2 Give the first mark for burette readings as (f) after checking as (a)

Give ONE mark for two titres within 0.30cm^3
Use candidate's quoted value of the titre to assess accuracy mark as follows

Accuracy mark ranges will be decided on after scripts have been seen

6

Mark	Difference from Supervisor
SIX	up to 0.20
FIVE	0.20+ to 0.30
FOUR	0.30+ to 0.40
THREE	0.40+ to 0.60
TWO	0.60+ to 0.80
ONE	0.80+ to 1.00
NIL	greater than 1.00

(d)(i) Ignore

2 (ii) Give ONE mark for each correctly plotted point. (An error of half a square or more in either volume forfeits the mark.)

Deduct one of these marks if the line has not been drawn, if the line is not straight or if it misses either point.

1 (e) Give ONE mark for the volume of FA4 read off from an extrapolated graph to within half a square (0.25 cm^3) Graph must have been drawn.

(f) Give ONE mark for

1 $\dfrac{\text{answer to (e)} \times 0.05}{1000}$ Working must be shown. Ignore evaluation errors.

(g) Give ONE mark for

$\dfrac{\text{answer to (f)}}{\text{answer to (a)}}$ Working must be shown.

2 and ONE further mark for the correct evaluation, to 1%, of a fully correct expression. Mark on the FINAL answer quoted.

(Correct answer is ans to (e) ÷ 10)

30 Total for Q2

GCE ADVANCED LEVEL EXAMINATIONS
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Question 3

FA5 is a mixture of $K_2CrO_4(aq)$ and $Cu(NO_3)_2(aq)$.

Apply (e) to all parts of this question

3	(a) H_2SO_4 + $FeSO_4$	green(not ppt) (ONE) not brown	CrO_4^{2-}(ONE) nor NO_2^- (one)
4	(b) NaOH + Al	Ignore any ppt here NH_3(ONE) test(ONE)	NO_2^-(ONE) NO_3^-(ONE) From either observation
	(c) KI	orange/mustard/brown/red mixture or ppt or I_2(ONE)	Cu^{2+}(ONE) from either of these observations
5	$Na_2S_2O_3$	pink/grey/any pale coloured ppt(ONE) (this mark can be earned if ppt is described alongside KI) ppt sol in xs(ONE) yellow soln or brown/red etc colour disappears(ONE)	
4	(d) NH_3	orange/yellow/red/brown ppt(ONE) green ppt(ONE)soluble giving green soln(ONE) (ONE)	Ignore deductions.
	(e) NaOH	orange/yellow/red/brown ppt(ONE) green ppt(ONE) insol in xs(ONE) yellow filtrate(ONE) here or subs.	Ignore deductions.
	(i) HNO_3	orange(not ppt)(ONE)	CrO_4^{2-}(ONE)
	(ii) $AgNO_3$	Ignore obs apart from red ppt	
	HNO_3	red ppt(ONE) soluble (one)	CrO_4^{2-}(ONE) From red ppt if NOT given in (i)
	(iii) $BaCl_2$	yellow ppt(ONE)	
	HCl	ppt dissolves(ONE)	Give (one) from first observation if NOT given in (i) or (ii)

(e)(iv) H_2SO_4	green or blue filtrate (one)	Ignore deductions.
NH_3	blue ppt(ONE) sol (ONE) deep/dark blue soln(ONE)	Cu^{2+}(ONE) from any two obs.

If no blue ppt mark give ONE for any mention of a solution that is bluer than the filtrate.

15

1 Cation is Cu^{2+} or 'copper'(ONE)

1 Anions are CrO_4^{2-} and NO_3^- (no others)(ONE)

1 Give ONE mark here if ALL work that has had to be marked throughout the paper has been in ink

34 Marking points available for Q3,but award a maximum of 25