ADVICE TO EXAMINERS ON THE ANNOTATION OF SCRIPTS

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

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

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

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

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

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

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

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

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

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

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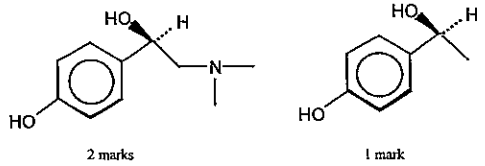
Question	Expected Answers	Marks
1 a	A = benzene; B = propene;	2
1 b	Advantage = sale of co-product adds to profit/less waste to dispose of; Disadvantage = separation of co-products is costly/different demands for each product;	2
1 c i	Electrophilic; substitution;	2
1 c ii	$AlCl_3$ polarises the propene molecule; the δ+ carbon; reacts with the benzene ring; (clearly labelled diagram acceptable)	3
1 d i	Tube connected with no leaks; Production of vapour; Vapour contacts catalyst; Liquid product is condensed/H_2(g) collected or vented safely;	4
1 d ii	Acidified; potassium dichromate; reflux; (allow formulae if correct)	3
1 d iii	Orange; to green-blue;	2
1 e	Infra-red: C=O; at ~ 1700 cm^{-1}; n.m.r.: only one signal; implies only one type of ^1H; OR peak at 2.2; suggests $-CO-CH_3$; Mass spec: molecular ion peak at 58; matches M_r of propanone (allow loss of $-CH_3$; to give fragment at 43;)	6
1 f i	Same type of bonds present so same absorptions; Strong absorption at 1700 cm^{-1} for C=O; Both have C-H and C=O bonds; (2 marks for 2 points made)	2
1 f ii	Mass spec/^1H nmr/^{13}C nmr/glc;	1

Question	Expected Answers	Marks
2 a	+5; +3; -3; max 2 if signs after numbers	3
2 b i	Powerful proton (H^+) donors (AW);	1
2 b ii	pH = -log[H^+(aq)] / measure of [H^+(aq)];	1
2 b iii	[H^+] = 0.015 mol dm^{-3} (stated or implied); pH = 1.82;	2
2 c i	$2HNO_3(aq) + Ca(OH)_2(aq) \rightarrow Ca(NO_3)_2(aq) + 2H_2O(l)$ right hand side correct; balanced; state symbols;	3
2 c ii	[OH^-] = 2 x 0.00250 = 0.005 mol dm^{-3}; $K_w = 1 \times 10^{-14} = [H^+][0.005]$; [$H^+$] = 2 x 10^{-12} mol dm^{-3}; pH = 11.7;	4
2 d i	Layered structure; Silicate/aluminate sheets; Surface of layers negatively charged; Charges on NH_4^+ and NO_3^- identified; NH_4^+ attracted to surface but NO_3^- passes through; (+ 1 mark for QWC)	5 + 1
2 d ii	Na^+(aq) shown; NH_4^+ shown attached to the clay surface; → Na^+ attached to the clay surface and NH_4^+(aq) shown;	3
2 d iii	Ion exchange/elution	1

Question	Expected Answers	Marks
3 a i	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 5s^2$	1
3 a ii	Al; gains oxygen/loses electrons/oxidation state becomes more positive;	2
3 a iii	Allow Cl_2 produced in electrolysis method - toxic Heat energy needed to make $SrCl_2$ molten is expensive /cost of electricity is high; (NOT just 'expensive')	1
3 b	For each example there should be a description of the structure (arrangement of atoms relative to each other) and the bonding (how the atoms are held together). Max 3 marks for each substance to include 1 mark each for structure, bonding, relevant detail. (1 mark for QWC) Structure: Al – metallic (giant); SrS – ionic (giant); CO_2 – simple molecular/ simple covalent Bonding: Al – attraction of nuclei for deloc. e⁻s; SrS – attraction between ions (+/-); CO_2 – weak intermol. forces between molecules, strong cov. bonds betw. atoms within mols	9 + 1
3 c i	$Sr^+(g) \rightarrow Sr^{2+}(g) + e^-$ equation; state symbol;	2
3 c ii	1st & 2nd ionisation enth. - low (removal of $3s^2$ & $5s^2$ e⁻s); Sharp increase between 2nd and 3rd because it is more difficult to remove e⁻s from inner core (2p and 4p);	2
3 c iii	Sum of the 1st and 2nd ionisation enthalpies is less for Sr than for Mg; Indicates that Sr forms 2+ ions more readily than Mg;	2
3 c iv	Positive Sr ion labelled; surrounded by more than two water molecules; correct structure of water shown with Oδ- shown at least once;	3
3 d i	ΔH_2; ΔH_5; ΔH_6 (or $\Delta H_6/2$); ΔH_1;	4
3 d ii	$\Delta H_{LE} = \Delta H_1 - \Delta H_2 - \Delta H_3 - \Delta H_4 - \Delta H_5 - \Delta H_6$	1
3 d iii	= -829 –[+164 + 550 + 1064 + (2 x 122) + (2 x –349)] = -2153 kJ mol^{-1}	2

Question	Expected Answers	Marks
4 a i	 2 marks 1 mark	2
4 a ii	Group of atoms conferring pharmacological activity on a molecule; (AW)	1
4 b i	Optical isomer/non-superimposable mirror image	1
4 b ii	Mirror image drawn correctly; Chiral centre clearly indicated;	2
4 b iii	3 out of the following 4 points:- one isomer/enantiomer fits precisely; into shape of receptor/active site; functional groups correctly positioned; for reaction;	3
4 b iv	Are compounds which show promise as new drugs/medicines but which need modification;	1
4 b v	Molecular modelling	1

Question	Expected Answers	Marks
5 a	Two from: Monitoring is expensive; Distillation expensive because heat energy required; Reactant/feedstock/Cl_2 is expensive/dangerous; Disposal of waste gases (acid/toxic);	2
5 b i	Simple molecular structure; Strong covalent bonds between Ti-Cl; Weak intermolecular attractions (instantaneous – induced dipole) between molecules; Little energy required to overcome; Reason why non-conducting; (1 mark for QWC)	5 + 1
5 b ii	$TiCl_4(l) + 2H_2O(l) \rightarrow TiO_2(s) + 4HCl(aq)$ Products; balanced; state symbols; (allow correct equation showing $Ti(OH)_4$)	3
5 c	Excited electrons; Drop back to lower energy levels; Emitting energy in the form of electromagnetic radiation/light/photon; $\Delta E = h\nu$ stated/implied; the frequencies/wavelengths emitted are characteristic for each element;	5
5 d i	Ester link correct (at least one); Rest of molecule correct; Water shown; Balanced;	4
5 d ii	Condensation/esterification;	1
5 d iii	Presence of oxygen; Generation of radicals; Cross-linking of unsaturated groups;	3
5 d iv	Different components have different retention times; Peak height/area gives measure of amount of each component; Ratio of palmitate:stearate esters in unknown oil measured; Compared to ratio in known oils;	4