The following annotations may be used when marking:

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

Abbreviations, annotations and conventions used in the Mark Scheme:

/	=	alternative and acceptable answers for the same marking point
;	=	separates marking points
NOT	=	answers not worthy of credit
( )	=	words which are not essential to gain credit
___ (underlining)	=	key words which must be used
ecf	=	allow error carried forward in consequential marking
AW	=	alternative wording
ora	=	or reverse argument

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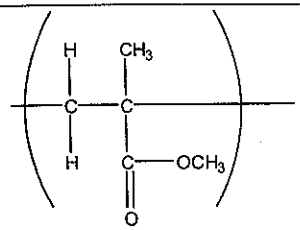
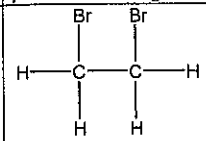
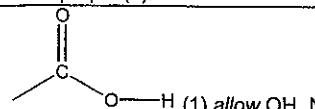
1 (a) (i)	C=C bond /alkene (1); *Allow 'carbon-carbon double bond' but* ***not*** *'double bond' alone.*	1
1 (a) (ii)	Ester (1). ecf	1
1 (a) (iii)	 *correct repeating unit* (1); *ester group may be written as* $-COOCH_3$. *Allow if incorrectly bonded ester group is joined to chain by correct C atom.*	1
1 (b)	**Perspex *chains can not slip past each other so easily* ora** (1); *and* ***3 points*** *from:* stronger forces between *Perspex* chains/molecules AW (*a comparison mark*); reason for stronger forces between *Perspex* chains: polar groups on chain/dipole-dipole forces between molecules; reason for weaker forces between poly(ethene) chains: weak instantaneous dipole-induced dipole forces; *Perspex* chains (have bulkier side groups therefore) get more tangled ora; Perspex molecules/chains fit closer together. *QWC* *At least* ***two*** *readable and clear sentences with no more than one spelling, punctuation or grammatical error. (1)*	5
1 (c) (i)	 *Addition of two Br atoms (1); full structural formula correct (1)*	2
1 (c) (ii)	A particle (*or* molecule *or* positive ion/atom/chemical species) which is attracted / accepts (a pair) of electrons(*accept* attacks, ***but not*** attracted to a positive centre/part of the molecule) (1); to an electron rich carbon(*or* C=C bond) /a negative C/ region of high electron density (*or* charge) (to form a covalent bond) (1).	2
1 (c) (iii)	The Br_2 molecule is polarized AW *or* a slightly positive Br/end of molecule is formed (1); by the C=C bond (1). *These points may be described using 'curly arrow' diagrams.*	2
	Total mark	14

2 (a) (i)	Primary (1).	1
2 (a) (ii)	There are 2 Hs on the C to which the OH is attached *or* C with OH is attached to **one** other C atom *or* OH at end of chain (1).	1
2 (b) (i)	*1 mark for each point seen in* **bold**, *1 mark for any of the other points shown up to a maximum of 5:* Pencil line near bottom; of plate; spot small sample of mixture on line; **solvent in beaker below sample;** **cover beaker with lid/film;** leave until solvent front nears top of plate/ may be shown by line on plate; remove and dry plate; **(UV light or iodine) to locate** *(use of locating agent)*; 2 different spots; one of which is salicyl alcohol.	5
2 (b) (ii)	Iron(III) chloride (solution) *allow any iron(III) salt or yellow iron chloride* (1) *do not allow iron chloride.* turns purple (1).	2
2 (c)	 (1) *allow* OH. Note: *Allow* any or no group bonded to COOH.	1
2 (d) (i)	Look for the peak of highest mass / peak furthest right (1). *Do not allow* 'highest peak'.	1
2 (d) (ii)	H_2O/water (1). *Allow* any combination of two Hs and 1 O. *Do not allow 18.*	1
2 (d) (iii)	$C_7H_4O_2$ *Correct formula* (1); *ignore charge.*	1
2 (e) (i)	Neutralisation/ acid-base(alkali) (1).	1
2 (e) (ii)	(Graduated or bulb) pipette *allow burette* (1).	1
2 (e) (iii)	Moles of NaOH = 0.015 x (33.3/1000) (1); = 0.000500 mol (*or* 5.00×10^{-4}) (1). *Ignore sig. figs.* *Give 1 mark if the only mistake is to miss the 1000 for the conversion of units.*	2
2 (e) (iv)	Moles of salicylic acid = $0.5 \times 5.00 \times 10^{-4}$ mol = (2.50×10^{-4}) (1) *Ignore sig. figs. ecf.*	1
2 (e) (v)	Concentration = moles/volume (dm^3) (1) *even if numbers are incorrect;* $(2.50 \times 10^{-4}) / (25/1000) = 0.0100$ mol dm^{-3} (1). *Ignore sig. figs. ecf.*	2
2 (f)	Hydrogen bonding (1); *Then 2 from 3 other possible answers:* instantaneous (dipole)-induced dipole forces / van der Waal's forces (1); (permanent) dipole-(permanent) dipole forces (1); permanent (dipole)-induced dipole forces (1). The marks are for interactions and answers such as *permanent dipole forces* do not receive credit. If any type of chemical bonding is listed there is a maximum of 2 marks only.	3

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2 (g) (i)	H_2O / water molecule gains / accepts a proton / H^+ (1). *Do not allow* H alone.	1
2 (g) (ii)	Concentration of COO^- is increased (1); (by Le Chatelier's Principle), position of equilibrium moves to left (to counteract change) (1); leads to decrease in concentration of H_3O^+ (1).	3
	Total mark	**27**

3 (a)	Environmental issue described: no holes (*or* resulting heaps) to act as eyesores / less mechanical aids AW / less energy needs to be used (1). *The minimum for credit is:* 'less damaging to the environment'; *Alternatively*, an health and safety issue described can gain the mark.	1
3 (b) (i)	Moles of NiS in 1000 kg of ore = (2/100) x 10^6 / 91 (*mass/91 for 1 mark*); (= 220 mol) (1).	2
3 (b) (ii)	Moles of Ni in 1000 kg of ore = 220 mol (1) *ecf for moles of NiS.*	1
3 (c) (i)	<table><tr><th rowspan="2">Element</th><th colspan="2">Oxidation state</th></tr><tr><th>Reactants</th><th>Products</th></tr><tr><td>S</td><td>-2</td><td>**+4**</td></tr><tr><td>Ni</td><td>**+2**</td><td>**0**</td></tr><tr><td>O</td><td>**0**</td><td>**-2**</td></tr></table> *1 mark for getting 0 for both elemental O and Ni;* *then 1mark for each of the other 3 numbers with correct sign*	4
3 (c) (ii)	S (1) oxidation state has increased/lost electrons (1).	2
3 (d) (i)	Selenium or uranium (1).	1
3 (d) (ii)	$3d^8$, $4s^2$ *accept* $4s^2$ $3d^8$ *10 electrons added* (1); *the rest correct* (1).	2
3 (e) (i)	Carbon dioxide is a 'greenhouse gas'*or* equivalent description in terms of the absorption of energy (1); causes global warming (1). *If **second** mark is gained but not the first, allow description of an effect of global warming for the first mark e.g. sea levels may rise due to melting polar ice caps.*	2
3 (e) (ii)	Carbon dioxide evolved in burning (is replacing) AW (1); the carbon dioxide photosynthesised (*may be described*, 'takes in carbon dioxide' *is not sufficient*) by the plants (1) ora.	2
3 (f) (i)	(Molecules/bonds) vibrate/ bonds stretch (1); faster/more/higher energy (1). *These marks are linked.*	2
3 (f) (ii)	Different bonds vibrate at specific frequencies / vibrations are quantised / energy levels are discrete *or* quantised (1).	1
3 (f) (iii)	Size of peak / amount of energy (or IR AW) absorbed is proportional to the amount of carbon dioxide (1).	1
	Total mark	**21**

4 (a)	Bromotrifluoromethane (1) *ignore spaces, dashes and commas, but order must be correct.*	1
4 (b) (i)	C-Br bond is weaker (than C-Cl) (1); therefore is more easily broken by radiation/light/UV (1).	2
4 (b) (ii)	•CF_3 (bonds may be drawn) and Br• (1 each) *Dots not essential.* *Lone pairs or charges are a* CON.	2
4 (b) (iii)	Radicals (1).	1
4 (c)	*1 mark for the first point in bold and then any 3 others up to a total of 4 marks:* **Br atoms/radicals** (1); are formed when sunlight/UV (breaks C-Br bonds)/photodissociation; Br behave like Cl (and can destroy ozone); by reacting with ozone to form (oxygen) and a radical (*may be specific e.g.* BrO *or general*); Br radicals are reformed/ BrO react to form Br; and so Br/Cl acts as a catalyst/chain reaction *described in which radicals are reformed;* *QWC 1 mark for two sentences / 2 bullet points including correct use of **two** of the following words/phrases:* *radicals, catalyst, photodissociation, homolytic fission, chain reaction.* **Note**: Indicate this mark separately.	5
4 (d) (i)	Methanol (1); CH_3OH (1). *Allow answers if given wrong way round.*	2
4 (d) (ii)	**Any 3 marking points from 4:** a lone pair of electrons (1); on the oxygen atom (of water) (1); forms a (covalent) bond / attacks / attracted to positive (centre AW) (1); (with) the carbon atom in CH_3Br AW (1). *These points may be described using 'curly arrow' diagrams.*	3
4 (e) (i)	activation enthalpy labelled by the hump (1); enthalpy difference between reactants and top of 'hump' indicated by an arrow of some description (1); both reactants and products correct (1).	3
4 (e) (ii)	Products have lower enthalpy/energy than reactants ora (1).	1
4 (e) (iii)	Measure temperature increase/energy given out (with a thermometer) (1).	1
4 (f) (i)	Reactants have more energy / particles move faster (at higher temperatures) (1); more collisions will have energy in excess (1) of activation enthalpy (energy) AW (1); more collisions result in reaction /more collisions are successful (1).	4
4 (f) (ii)	$Ag^+(aq) + Br^-(aq) \rightarrow AgBr(s)$ *(1 mark for bromide ion on LHS, 1 mark for rest correct, allow if balanced with 2s etc., 1 mark for state symbols), allow nitrate ions as spectator ions if (aq)*	3
	Total mark	**28**