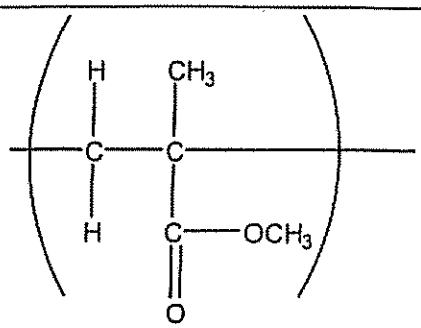
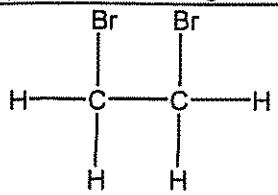
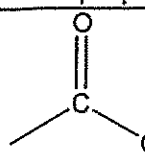
1 (a) (i)	C=C bond /alkene (1); *Allow 'carbon-carbon double bond' but* ***not*** *'double bond' alone.*	1
1 (a) (ii)	Ester (1). ecf	1
1 (a) (iii)	 *correct repeating unit* (1); *ester group may be written as* -$COOCH_3$. *Allow if incorrectly bonded ester group is joined to chain by correct C atom.*	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*; (2.50×10^{-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

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**

<table>
<tr><td>3 (a)</td><td>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.</td><td>1</td></tr>
<tr><td>3 (b) (i)</td><td>Moles of NiS in 1000 kg of ore = (2/100) x 10^6 / 91 (mass/91 for 1 mark);
(= 220 mol) (1).</td><td>2</td></tr>
<tr><td>3 (b) (ii)</td><td>Moles of Ni in 1000 kg of ore = 220 mol (1) ecf for moles of NiS.</td><td>1</td></tr>
<tr><td>3 (c) (i)</td><td><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</td><td>4</td></tr>
<tr><td>3 (c) (ii)</td><td>S (1)
oxidation state has increased/lost electrons (1).</td><td>2</td></tr>
<tr><td>3 (d) (i)</td><td>Selenium or uranium (1).</td><td>1</td></tr>
<tr><td>3 (d) (ii)</td><td>$3d^8$, $4s^2$ accept $4s^2$ $3d^8$
10 electrons added (1);
the rest correct (1).</td><td>2</td></tr>
<tr><td>3 (e) (i)</td><td>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.</td><td>2</td></tr>
<tr><td>3 (e) (ii)</td><td>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.</td><td>2</td></tr>
<tr><td>3 (f) (i)</td><td>(Molecules/bonds) vibrate/ bonds stretch (1); faster/more/higher energy (1).
These marks are linked.</td><td>2</td></tr>
<tr><td>3 (f) (ii)</td><td>Different bonds vibrate at specific frequencies / vibrations are quantised / energy levels are discrete or quantised (1).</td><td>1</td></tr>
<tr><td>3 (f) (iii)</td><td>Size of peak / amount of energy (or IR AW) absorbed is proportional to the amount of carbon dioxide (1).</td><td>1</td></tr>
<tr><td></td><td>Total mark</td><td>21</td></tr>
</table>

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)	$\bullet CF_3$ (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**