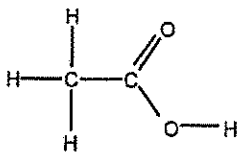
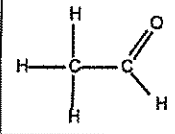
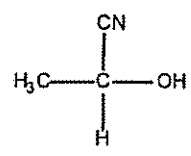
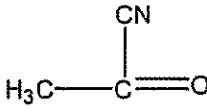
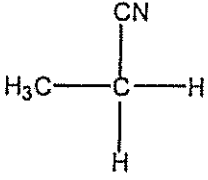
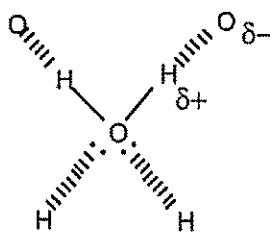
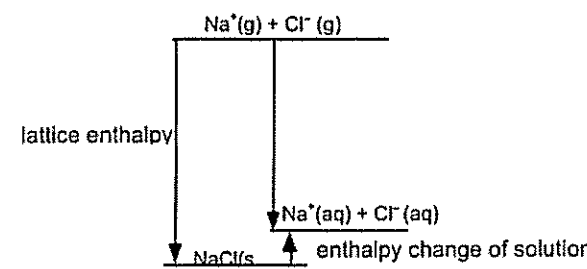
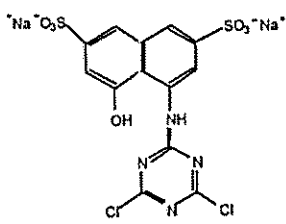

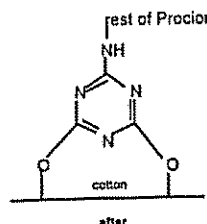


Question	Expected Answers	Marks
1 a i	ethanoic acid;(1) <span style="float: right;">(1) Allow -OH</span> 	2
1 a ii	potassium/sodium dichromate;(1) sulphuric acid ( <i>allow conc</i> ) (1) <i>Allow dichromate, acid, correct formulae of ions or substances</i>	2
1 b i	C-H	1
1 b ii	Water contains O-H bonds;(1) water is present in breath(1)	2
1 b iii	(the atoms in the O-H) bond(s);(1) vibrate;(1) more (vigorously) (1)	3
1 c i	oxidation <i>ALLOW redox</i>	1
1 c ii		1
1 c iii	NaBH <sub>4</sub>	1
1 c iv	 -CN and rest of molecule;(1) -OH(1)   score (1) <i>Allow any clear type of structural formula</i>	2
1 d	1720 – 1740 ( <i>NOT other ranges</i> );(1) C=O (1)	2
1 e	Ethanal – M <sub>r</sub> worked out (44) (or some reasoning related to fragments);(1) Mention of M <sup>+</sup> peak or some indication of how 44 deduced from spectrum;(1) A CH <sub>3</sub> CO <sup>(+)</sup> or C <sub>2</sub> H <sub>3</sub> O <sup>(+)</sup> (or "loss of H");(1) B CHO <sup>(+)</sup> ;(1) positive charges on ions. (1) If ethanol chosen, can score last three marks A as above, B C <sub>2</sub> H <sub>5</sub> <sup>+</sup> , positive charges  QWC: at least two sentences, logical. Correct use of at least two of the following technical terms: (molecular) ion, (relative) mol(ecul)ar mass/RMM/M <sub>r</sub> , fragmentation/fragment(s)	6

Question	Expected Answers	Marks
2 a i	+3 Allow 3+ here but mark "s" and check at 3bii	1
2 a ii	O-H polar (or partial charges shown);(1) H <sup>+</sup> formed (1)	2
2 b i	in equilibrium/ partial dissociation/ionisation	1
2 b ii	$K_a = \frac{[H^+][H_2BO_3^-]}{[H_3BO_3]}$ top(1); bottom (1) missing [ ] scores max 1	2
2 b iii	$[H^+] = (K_a[H_3BO_3])^{1/2} = 7.6 \times 10^{-6}$ ;(1) pH = 5.1 (1) accept "5" if working shown	3
2 b iv	$H_3BO_3(aq) + NaOH(aq) \rightarrow NaH_2BO_3 \text{ (or ions) (aq) + H}_2O(l)$ reactants and products;(1) balancing;(1) state symbols (provided water formed) (1) Accept equations forming other salts.	3
2 c i	pH 8.5 gives $[H^+] = 3.16 \times 10^{-9}$ ;(1)  then either: $\frac{[salt]}{[acid]} = \frac{5.8 \times 10^{-10}}{3.16 \times 10^{-9}}$ ;(1)  = 0.184;(1)  Thus 0.018 mol of H <sub>2</sub> BO <sub>3</sub> <sup>-</sup> must be added. (1)  or $[salt] = K_a \times [acid]/[H^+]$ (1);  = $5.8 \times 10^{-10} \times 0.1/3.16 \times 10^{-9}$ (1) subsumes last mark  = 0.018 (1)	4
2 c ii	acid/alkali in eye causes damage/irritation/harm (1);  buffers maintain pH/ neutralise (1);  in presence of (small amounts of) acid/alkali/at/near 8.5/neutral pH/same pH as eye/ natural pH (1)	3
2 c iii	Indication that acid is H <sup>+</sup> /alkali is OH <sup>-</sup> (1);  (on adding acid) equilibrium moves to left/ buffer accepts H <sup>+</sup> /or equation (1);  (on adding alkali) equilibrium moves to right/forms H <sup>+</sup> to neutralise(AW) (1);  Because [H <sub>3</sub> BO <sub>3</sub> ] and [H <sub>2</sub> BO <sub>3</sub> <sup>-</sup> ] large, pH remains constant. (1)  QWC SPAG: spelling (allow one error), punctuation and grammar correct.	5

Question	Expected Answers	Marks
3 a i	Two FROM nitrogen unreactive/high $E_a$ ; strong bond between atoms of nitrogen/much energy to break bond/stable molecule/; triple bond (1)	2
3 a ii	TWO FROM to replace nitrogen removed; nitrogen is plant nutrient; nitrogen needed for (plant) growth; nitrogen taken in soluble form/through roots; nitrogen supplied in fertilizers/stored in soil	2
3 b i	another product formed by the (main) <u>reaction</u>	1
3 b ii	0;(1) -3;(1) +2;(1) (max 2 if signs after numbers and "s" recorded in 2 a (i))	3
3 c	catalyst	1
3 d	$M_r$ values of $N_2$ (28) and $NH_3$ (17) stated or used correctly/ $1000/28 = 35.7$ ;(1) Ratio 4/5 stated or used correctly;(1) $4/5 \times 1/28 \times 17 = 0.49$ (kg) (1) (0.61/607 (no 4/5) scores two without working) Allow 2/3 sf (486). If >3 sf mark "sf" and see 4b(v)	3
3 e i	molecules move faster/more KE (1); more collisions;(1) with energy greater than activation enthalpy/energy/successful collisions (AW);(1) therefore faster (1)  QWC 2 sentences, logical, correct use of terms <i>collisions</i> and <i>activation enthalpy/energy</i> (1)	5
3 e ii	Endothermic;(1) increased temperature moves equilibrium position to right/ favours endothermic reaction;(1) because opposes change (AW);(1) more product (1) <i>ecf from exothermic or equilibrium moving wrong way.</i>	4
3 f	(effect of pressure depends on) difference in no. of moles (of gas) on each side of equation (AW);(1) this is small/ 11 molecules to 10.(1)	2
3 g i	400 – 500 °C;(1) 25 – 150 atm;(1) iron (1)	3
3 g ii	One for each advantage and disadvantage. One for each explanation (only when linked to valid advantage/disadvantage)  Advantage: low pressure/low temperature – cheaper/safer No need for hydrogen – saves money Water used – cheaper/safer  Disadvantage: Slow reaction (at room temperature) – expensive Much nitrogen into co-product – waste/ less efficient NO produced - toxic/expensive to separate	4

Question	Expected Answers	Marks
4 a	UK is warmer	1
4 b i	 <p>one water molecule showing four hydrogen bonds between H and O;(1) two adjacent lone pairs shown on (at least one) oxygen;(1) +, - shown either side of at least one hydrogen bond;(1) -H-----O straight (1)</p>	4
4 b ii	CH <sub>3</sub> -CH <sub>2</sub> -CH <sub>2</sub> -CH <sub>2</sub> -CH <sub>2</sub> -CH <sub>3</sub> or more displayed	1
4 b iii	instantaneous dipole – induced dipole(2) "induced dipole/ instantaneous – induced dipole" score (1)	2
4 b iv	<i>THREE from:</i> at any instant, electrons not evenly distributed;(1) causes instantaneous dipole ;(1) which induces dipole in another molecule;(1) attraction between dipoles (1)	3
4 b v	4.18/2.26 = 1.9 times (Accept 2 or 1.85(0)) If >4 sf and "sf" recorded at 3d, do not award mark	1
4 c i		2
4 c ii	the number "14" scores (1); +14 kJmol <sup>-1</sup> with sign and unit scores (2).	2
4 d	Mg <sup>2+</sup> smaller/higher charge density than Ca <sup>2+</sup> ;(1) more water molecules round Mg <sup>2+</sup> ;(1) more bonds formed/ stronger attraction/ more energy released(1).	3

Question	Expected Answers	Marks
5 a	Circle round -OH group on structure. ALLOW circle including the ring bearing the -OH	1
5 b	-SO <sub>3</sub> <sup>-</sup> (Na <sup>+</sup> ) IGNORE words which attempt to qualify. NOT -OH	1
5 c i	 <p>lack of any group at coupling position (provided some other correct detail added);(1) rest of structure correct (1)</p>	2
5 c ii	NaNO <sub>2</sub> (1) HCl/H <sub>2</sub> SO <sub>4</sub> (NOT conc);(1) below 5 <sup>0</sup> C (1) Mark separately. Addition of alkali is "CON" for acid mark	3
5 d i	benzene NOT benzene ring	1
5 d ii	conc (+ one correct acid)(1); nitric and sulphuric acids(1); temp below 55 °C (1) Mark separately	3
5 d iii	 <p>;(1) Sn, conc HCl, reflux (1)</p>	2
5 e i	aromatic/ arenes ALLOW benzene(s)/benzene rings	1
5 e ii	electrons are not associated with particular bonds/atoms (NOT atom)/spread out over several atoms/over compound.	1
5 f i	condensation/ nucleophilic substitution	1
5 f ii	 <p>correct points connected;(1) by O atoms (1)</p>	2
5 g i	hydrogen bonding;(1) appropriate H atom specified(1); bonded to appropriate atom on other structure. (1)	3
5 g ii	Direct Red would wash out more easily/ more red colour in Direct Red beaker/ cotton gets paler in Direct red beaker;(1) hydrogen bonds are broken by water/heating/dye hydrogen bonds to water;(1) covalent bonds are not (1) ALLOW (1) of last (2) for "procion bonds stronger" (AW)	3