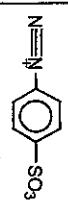
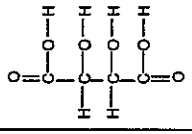
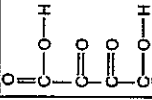


| | | |
|---------|--|---|
| 2 a i | (secondary) amine, alkene, ketone/carbonyl | 3 |
| 2 a ii | 16 | 1 |
| 2 a iii | Idea of groups across double bond (1); | 1 |
| 2 a iv | Lack of free rotation at double bond (1) | 1 |
| 2 b i | d block/transition metal | 1 |
| 2 b ii | $\text{Co}^{2+} + 2\text{OH}^- \rightarrow \text{Co(OH)}_2$, 2+ on Co (1) rest correct (1) $2\text{Al(OH)}_3 \rightarrow \text{Al}_2\text{O}_3 + 3\text{H}_2\text{O}$ Al_2O_3 (1); Rest correct (1) | 4 |
| 2 c i | Idea of quantity being made and then process started again (1); | 1 |
| 2 c ii | Small amounts needed/difficulties of getting precise quantities (1) | 1 |
| 2 c iii | Release of HCl (1); Acidic gas/Irritant (1) | 2 |
| 2 d i | SiCl_4 , PCl_3 , PCl_5 , S_2Cl_2 , SCl_2 element (1); formula (1) | 2 |
| 2 d ii | $M_r \text{ AlCl}_3 = 133.5$ (1); Amount of $\text{AlCl}_3 = (4.5 / 133.5 \text{ (ecf)}) (= 0.0337 \text{ mol})$ (1); $M_r \text{ CoCl}_2 \cdot 6\text{H}_2\text{O} = 238$ (1); Mass of $\text{CoCl}_2 \cdot 6\text{H}_2\text{O} = 0.0337 \times 238 \text{ (ecf)} = 8.0 \text{ g}$ (1); 2 sig figs (mark separately) (1) | 5 |
| 2 e i | indigo is more purple/yellow/green / indigo is lighter (1); it reflects more red/other frequencies or a / more components of white light reflected (1); | 2 |
| 2 e ii | two energy levels (1); electrons excited / absorb energy to be promoted to higher energy level (not awarded if "drop back" included in the answer) (1); plus 2 from: difference corresponds to red/non-blue colours; being absorbed from visible light; blue light reflected (not emitted); or one from: band absorption in compound (1); caused by vibrations in each level (1); blue light higher energy than red (1); energy levels close because of complex structure of molecule (1) $E = hv$ (1) Any of these shown on a diagram should score | 4 |
| 2 f i | $\begin{array}{c} \text{H} & & \text{O} \\ & & \\ \text{H}-\text{C}-\text{O}-\text{C}-\text{R} \\ & & \\ \text{H}-\text{C}-\text{O}-\text{C}-\text{R} \\ & & \\ \text{H}-\text{C}-\text{O}-\text{C}-\text{R} \\ & & \\ \text{H} & & \text{O} \end{array}$ not necessarily full structural glycerol stem correct (1); completely correct | 2 |
| 2 f ii | They have (carbon-carbon) double bonds | 1 |
| 2 f iii | bromine water/solution/aqueous (1) decolorised (1) | 2 |

| | | |
|---------|--|---|
| 3 a i | Red (1); Acid contains H^+ /fully ionised(1); pushes equilibrium to left (1) | 3 |
| 3 a ii | SO_3^- /sulphonate | 1 |
| 3 b i | Incomplete reaction/ionisation /equilibrium (with water) (1); | 1 |
| 3 b ii | $\text{pK}_a = -\log K_a$ | 1 |
| 3 b iii | $K_a = \frac{[\text{H}^+][\text{Yellow form}]}{[\text{red form}]}$ 2 marks if correct. one if wrong way up | 2 |
| 3 b iv | If [yellow] = (red), $K_a = [\text{H}^+]$ (1); ($\text{pK}_a = \text{pH}$) | 2 |
| 3 c i | $\text{pH} = 3.7$ (1) | 1 |
| 3 c ii | sodium hydroxide allow NaOH / below 50°C (1) | 1 |
| 3 d i | benzenesulphonic acid (1); | 1 |
| 3 d ii | concentrated (1) sulphuric acid (1); (heat under) reflux (1) | 3 |
| 3 d iii | electrophilic (1); substitution (1) | 2 |



| | | |
|---------|---|---|
| 4 a i | C ₂ H ₃ O ₃ (2) Molecular formula C ₄ H ₆ O ₆ scores (1) | 2 |
| 4 a ii |  <p>carboxylic acid groups correct (1); fully correct (1)</p> | 2 |
| 4 a iii | (1) for each central carbon atom ringed | 2 |
| 4 a iv | C ₄ H ₆ O ₆ + 2NaOH → C ₄ H ₄ O ₆ Na ₂ + 2H ₂ O or with structural formula ionic representations of salt. Left-hand side correct (1); Idea of a salt formed (1); Completely correct (1) | 3 |
| 4 a v |  <p>not necessarily full structural Reaction at central -OH groups (1); completely correct (1)</p> | 2 |
| 4 b i | Amount = 12.0 x 0.100/1000 (1) = 1.20 x 10 ⁻³ mol (1) | 2 |
| 4 b ii | Amount of H ⁺ in 100 cm ³ wine = 4.80 x 10 ⁻³ mol i.e. factor of four (1) Amount of tartaric acid = 2.4 x 10 ⁻³ mol i.e. divide by two (1) Mass of tartaric acid = 2.4 x 10 ⁻³ x 150 = 0.36g multiply by 150 (1) | 3 |
| 4 c i | aldehyde | 1 |
| 4 c ii | HCN | 1 |
| 4 c iii | nucleophilic (1); addition (1) | 2 |
| 4 c iv | H ⁺ (aq)/H ₂ O Reflux | 1 |
| 4 d | Identified as ethanoic acid (name or structural formula) (1) Plus six marks from the following, TWO from each spectrum Mass spectrum M _r /relative molecular mass = 60; Fragment identified (eg loss of CH ₃ at 45, loss of OH at 43); i.r. two from O-H; C=O; C-O n.m.r two from: two H environments ; ratio 3:1; Identify 2.0 peak as CH ₃ CO. | 7 |

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|--------|--|---|
| 5 a | Statement of Le Chatelier (AW) (1); Reaction trying to restore temperature (1) | 2 |
| 5 b i | [Ca ²⁺] x [CO ₃ ²⁻] Idea of calcium and carbonate ions multiplied together (1); concentrations (1) | 2 |
| 5 b ii | [Ca ²⁺] x [CO ₃ ²⁻] = 10 ⁻¹⁰ (1); this is smaller than K _{sp} (1) thus no pptn (1) | 3 |
| 5 c i | AS _{sys} = - 53.1 - 56.9 - 92.9 (1) = -202.9 J mol ⁻¹ K ⁻¹ (1) ecf from any visible calculation | 2 |
| 5 c ii | AS _{sur} is positive (since reaction is exothermic) (1); becomes more positive at lower temps (1) AS _{tot} must be positive for reaction to occur (1) | 3 |
| 5 d | CO ₂ causes greenhouse effect/global warming (1) Two from effects (1) (1) ice cap melting/ sea level rising; changes to weather patterns; changes to climate; changes to agriculture; Not being done because two from (1) (1) Technology not developed; Expensive; In equilibrium hence CO ₂ would slowly re-appear; Could affect life in deep ocean QWC SPAG - At least 2 consecutive sentences, allow one spelling mistake. | 5 |