Solutions

Each answer shows the steps, then the **result**.

2.1

- hot alkaline $KMnO_4$ (potassium manganate(VII)); then dilute acid (acidify)

2.2

- chloroethanoic acid

2.3

- Acidified potassium dichromate(VI); heat; under reflux

2.4

- Effervescence, or bubbles of gas; carbon dioxide

2.5

- The chlorine atom is electron-withdrawing, so it pulls electron density away from the carboxylate ion and spreads the negative charge further, making the anion more stable and the acid stronger

3.1 B

- The carboxylate ion spreads its negative charge over two oxygen atoms

3.2 D

- Three electron-withdrawing chlorine atoms spread the charge most, giving the strongest acid

3.3

- when a carboxylic acid loses H^+, the charge is delocalised over two oxygen atoms, making a very stable carboxylate ion; an alkoxide (RO^-) cannot spread its charge, so it is less stable and the alcohol is far less acidic

3.4

- chlorine is electron-withdrawing and pulls electron density away through the inductive effect; this helps spread out the negative charge on the conjugate base, stabilising the ion; three Cl atoms in CCl_3COOH do this much more than the CH_3 in ethanoic acid, so it is a far stronger acid

3.5

(a)

- Acidified potassium dichromate(VI), heated; reflux returns the vapour to the flask so the oxidation continues to the acid, while distillation would remove the aldehyde as soon as it formed

(b)

- In the ethanoate ion the negative charge is delocalised over two oxygen atoms, so the anion is much more stable; in the ethoxide ion the charge is localised on one oxygen and the alkyl group releases electron density towards it, making it less stable, so the equilibrium lies much further left

(c)

- In the phenoxide ion the charge is delocalised into the benzene ring rather than over two oxygens, which stabilises it less effectively than in a carboxylate

(d)

- Add aqueous sodium carbonate to each; ethanoic acid gives effervescence of carbon dioxide; phenol gives no reaction, because it is too weak an acid to release carbon dioxide from a carbonate

(e)

- Methanoic acid has a hydrogen atom attached to the carbonyl carbon, so it has an aldehyde group and can be oxidised further, reducing the Tollens' reagent

(f)

- Butan-1-ol; lithium tetrahydridoaluminate in dry ether