Chemistry Solutions (Practical)

1.

a. i) Any **three** from:

A method of weighing by difference / wash the solid from its weighing container into the beaker

Wash the (wet) rod into the flask / beaker after use

Wash the (wet) beaker into the flask after transfer

Wash the filter funnel (after transfer) into the flask

Use a teat pipette to make up to the mark on the volumetric flask

Ensure the bottom of the (liquid) meniscus is on the graduation mark

Mix / shake the final solution in the flask / invert flask [1 mark for each]

ii) Do (a) further titration(s) [1 mark] to obtain concordant results [1 mark]

b. i) Space will fill during titration / titres or volumes added are too high [1 mark]

ii) Less chance of losing liquid on swirling / liquid doesn't splash on swirling [1 mark] - *Do not accept 'easier to swirl' on its own.*

iii) Returns reagent on the sides of the flask to the reaction mixture (to ensure that all of the acid / alkali reacts) [1 mark] This does not change the number of moles of reagents / water is not a reagent / water is one of the products. [1 mark]

iv) (idea that) a single titration could be flawed / anomalous. *or* To obtain concordant results. [1 mark]

c. Pipette = 0.05 × 100 / 25.0 = 0.2% [1 mark]
Burette = 0.15 × 100 / 24.25 cm^3 = 0.6% [1 mark]

2.

a. Measured volume would be greater [1 mark]
Level in burette falls as tap is filled before any liquid is delivered [1 mark]

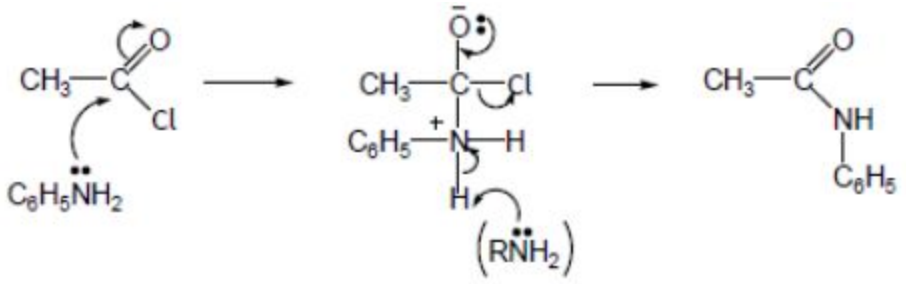
b. Drop sizes vary *or* percentage error for amount of oil will be large as the amount used is so small [1 mark]

c. Use a larger single volume of oil [1 mark]
Dissolve this oil in the organic solvent [1 mark]
Transfer to a conical flask and make up to 250 cm^3 with the solvent [1 mark]
Titrate (25 cm^3) samples from flask [1 mark]

d. Mass of oil = 0.92 * (0.05 * 5) = 0.23 g [1 mark]
Moles of oil = 0.23 / 885 = 2.6 x 10^{-4} mol [1 mark]
Moles of bromine = 0.02 * 0.0394 = 7.9 x 10^{-4} mol [1 mark]
So reacting ratio is 7.9 / 2.6 = 3.03 : 1 → 3 : 1 [1 mark]
So there are 3 C=C bonds [1 mark]

3.

a. Mechanism name: nucleophilic addition-elimination [1 mark]
Reagent: ethanoyl chloride *or* ethanoic anhydride [1 mark]
Mechanism:



[1 mark: arrow from N-lone pair to C and from C=O bond to O]
[1 mark: arrow from O^- lone pair to C-O and from N-H to N^+]
[1 mark: fully correct intermediate structure including charges and lone pair(s)]

b. i) To ensure the hot solution would be saturated / crystals would form on cooling [1 mark]

ii) Yield lower if warm / solubility higher if warm [1 mark]

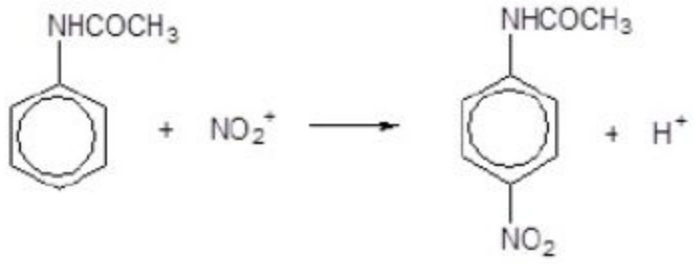
iii) Air passes through the sample not just around it / better drying [1 mark]
not water squeezed out

iv) To wash away soluble impurities [1 mark]

c. Water [1 mark]
Press the sample of crystals between filter papers / give the sample time to dry in air [1 mark]

d. M_r of product = 135.0 [1 mark]
Expected mass = 5.05 * (135/93) = 7.33 g [1 mark]
Percentage yield = 4.82 / 7.33 * 100 = 65.8% [1 mark, must be 3 s.f.]

e. i)



or using structural formula:
$C_6H_5NHCOCH_3 + NO_2^+ \rightarrow C_6H_4(NHCOCH_3)NO_2 + H^+$ [1 mark]

not formation equation:
$(HNO_3 + 2\ H_2SO_4 \rightarrow NO_2^+ + 2\ HSO_4^- + H_3O^+)$

ii) Electrophilic substitution [1 mark]

f. Hydrolysis [1 mark]

g. (Sn *or* Fe) / HCl *or* H_2 / Ni [1 mark for either pair]
not $LiAlH_4$

4.

a. $2\ NaBr + 2\ H_2SO_4 \rightarrow Na_2SO_4 + Br_2 + SO_2 + 2\ H_2O$
or ionic equation:
$2\ Br^- + 2\ H_2SO_4 \rightarrow Br_2 + SO_2 + SO_4^{2-} + 2\ H_2O$ [1 mark]

Br^- ions are larger (have greater ionic radius) than Cl^- ions [1 mark]
Therefore Br^- ions are more easily oxidised / lose an electron more easily (than Cl^-). [1 mark]

b. Stage 1: formation of precipitates

- Add silver nitrate
- To form precipitates of AgCl and AgBr
- $AgNO_3 + NaCl \rightarrow AgCl + NaNO_3$
- $AgNO_3 + NaBr \rightarrow AgBr + NaNO_3$

Stage 2: selective dissolving of AgCl

- Add excess of dilute ammonia to the mixture of precipitates
- The AgCl precipitate dissolves
- $AgCl + 2\ NH_3 \rightarrow Ag(NH_3)_2^+ + Cl^-$

Stage 3: separation and purification of AgBr

- Filter off the remaining AgBr precipitate
- Wash to remove soluble compounds
- Dry to remove water

[8-10 points, including all equations → 5-6 marks]
[5-7 (from all three stages) points → 3-4 marks]
[3-4 points → 1-2 marks]
[Must show clear, concise, logical order to gain full marks]

c. $Cl_2 + 2\ OH^- \rightarrow ClO^- + Cl^- + H_2O$ [1 mark]
ClO^- is +1, Cl^- is -1 [1 mark for both]
[Accept HO^- for hydroxide and OCl^- for chlorate(I)]

5.

a. Compound 1 [1 mark]
No visible change with H_2SO_4, [1 mark]
gives white precipitate with NaOH [1 mark]

b. $BaCO_3$ [1 mark; allow name 'barium carbonate']
The carbonate ion released CO_2 [1 mark]
But the $BaSO_4$ formed is highly insoluble. [1 mark]

c. Compound 4 [1 mark]
$Sr(OH)_2 + H_2SO_4 \rightarrow SrSO_4 + 2\ H_2O$ [1 mark; allow ionic eqn, ignore states]

6.

a. **Q**: calcium bromide *or* magnesium bromide / $CaBr_2$ *or* $MgBr_2$
R: aluminium chloride / $AlCl_3$
S: iron(III) sulfate / $Fe_2(SO_4)_3$
[1 mark for each correct metal; 1 mark for each correct anion]

b. $Ba^{2+} + SO_4^{2-} \rightarrow BaSO_4$ [1 mark]
$[Fe(H_2O)_6]^{3+} + 3\ OH^- \rightarrow Fe(H_2O)_3(OH)_3 + 3\ H_2O$ [1 mark]
$2\ [Fe(H_2O)_6]^{3+} + 3\ CO_3^{2-} \rightarrow 2\ Fe(H_2O)_3(OH)_3 + 3\ H_2O + 3\ CO_2$ [1 mark]
$[Fe(H_2O)_6]^{3+} + 4\ Cl^- \rightarrow [FeCl_4]^- + 6\ H_2O$ [1 mark]

7.

a. i) Propanone evaporates [1 mark]
and removes water (from the precipitate) [1 mark]

ii) Add NaOH / NH_3 / Na_2CO_3 [1 mark]
No green precipitate / no visible change [1 mark]

iii) Any one reason from:
Some salt dissolves (in propanone)
Some lost in filtration
Some Fe^{2+} gets oxidised (to Fe^{3+} in air) [1 mark]
not reversible/incomplete reaction

iv) Moles Fe^{2+} = 0.5 * 0.05 = 0.025 mol [1 mark]
M_r of salt = 179.8 [1 mark]
Mass of salt = 0.025 * 179.8 * 0.95 = 4.27 g [1 mark]

v) 1.67 moles *or* 5 FeC_2O_4 : 3 MnO_4^- [1 mark]

b. $C_2O_4^{2-} + Ca^{2+} \rightarrow CaC_2O_4$ [1 mark]

c. (Insoluble) calcium ethanedioate coats surface [1 mark]

d. Any one reason from:
Small amount of tea used / consumed
Concentration of acid in tea is low
High temperature decomposes the acid
Calcium ions in milk form a precipitate with the acid
[1 mark]
not tea is not consumed often

e. Mass of acid = 180 and mass of reagents = 450 [1 mark]
Atom economy = 180 / 450 * 100 = 40%. [1 mark]

8.

a. M_r = 164.0 [1 mark]
% N = 28 / 164 * 100 = 17.1 % [1 mark]

b. i) Absorption depends on (is proportional to) path length / distance travelled through solution [1 mark]

ii) To select the colour / frequency / wavelength that is (most strongly) absorbed (by the solution) *or* filter is chosen to complement the colour of the solution [1 mark]

iii) Quicker to analyse extracted samples than by titration *or* uses smaller volumes of solution [1 mark]

9.

Step 1: (ester → alcohol)
Name: (acid/base) hydrolysis
Reagents: water and dilute HCl *or* NaOH (aq) then HCl
[1 mark for both name and reagents]
Apparatus: reflux condenser, round bottomed flask, bunsen burner [2 marks]

Step 2: (decarboxylation)
Apparatus: distillation apparatus (condenser, flask, thermometer) [1 mark]

Step 3: (benzene → nitro)
Name: nitration
Reagents: conc H_2SO_4 and conc HNO_3
[1 mark for name and reagents]
Apparatus: ice bath, thermometer [1 mark]

Step 4: (nitro → amine)
Name: reduction
Reagents: Sn / HCl *or* Fe / HCl *or* H_2 / Ni *or* $NaBH_4$
[1 mark for both name and reagents]

Step 5: (amine → amide)
Name: acylation
Reagents: ethanoyl chloride *or* ethanoic anhydride
[1 mark for both name and reagents]
Apparatus: Buchner flask, Buchner funnel, vacuum/suction apparatus [2 marks]