Mark Scheme - 4.6 Amines

1. (a) Number of moles of nitrogen = 1.00/23.2 = 0.0431 (1)
thus number of moles of the amine is also 0.0431

M_r of the amine = mass / number of moles = 2.54 / 0.0431 = 58.9 (1)

$R — NH_2$ ⟶ 58.9

16.02 ∴ R = '43' ∴Formula is $CH_3CH_2CH_2NH_2$ or $(CH_3)_2CHNH_2$ (1) [3]

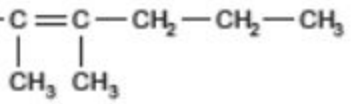
(b) (i) An electron deficient species that seeks out an electron rich / negatively charged / δ- site in a molecule [1]

(ii) 3-methylphenylamine [1]

(iii) These types of group are called **chromophores / azo** (1)
and are responsible for the production of colour in compounds as found in **azo-dyes** (1) [2]

(c) (i) Nucleophilic addition and elimination / condensation (1)
The products are orange/ red/ yellow (1) [2]

(ii) R_f values 2.5 / 7.2 = 0.35 and 3.5 / 7.2 = 0.49 (1)
Ketones are propanone and pentan-2-one (1)

Alkene **W** is  (1)

The name is 2,3-dimethylhex-2-ene (1) [4]

QWC Information organised clearly and coherently, using specialist vocabulary where appropriate [1]

(iii) The equation / information shows that R and R^1 are different alkyl groups.
2-methyl-3-ethylpent-2-ene has both R and R^1 as ethyl groups [1]

(d) (i) $CH_3COOH + CH_3CH_2OH \rightarrow CH_3COOCH_2CH_3 + H_2O$ [1]

(ii) Mass of ethanoic acid = 0.45 × 60 = 27 g [1]

(iii) There is no indication of the time necessary to reflux the mixture / method of heating / mention of dangers from fire [1]

(iv) It acts as a catalyst / dehydrating agent / necessary to remove water / move the position of equilibrium to the right [1]

(v) To react with (any remaining) ethanoic acid [1]

Total [20]

2.

(a) (i) A [1]

(ii) D [1]

(iii) C [1]

(iv) C [1]

(b) (i) Nucleophilic substitution [1]

(ii) The C–Cl bond in chlorobenzene is stronger than in 1-chlorobutane (1) due to delocalization of electron density from the ring with the bond (1)

OR

Delocalised electrons in chlorobenzene (1)
repel lone pair of electrons on nucleophile / ammonia (1)

[2]

(iii) $C_4H_9NH_2 + CH_3COCl \longrightarrow C_4H_9NHCOCH_3 + HCl$ [1]

(iv) I Tin and **concentrated** hydrochloric acid (1)

Add sodium hydroxide (after cooling) (1)

Steam distillation to separate the product (1) [3]

II $C_6H_5NN^+Cl^-$ [1]

III Azo dye / azo compound [1]

Total [13]

3.

(a) (i) (Concentrated) nitric acid / (concentrated) sulfuric acid / Temperature of 40-80°C
(*Any 2 = 1 mark; All 3 = 2 marks*)
Electrophilic substitution (1) [3]

(ii) I. Peak area is proportional to amount of substance (1)
Percentage = (30 / 38) x 100 = 79% (1)
(Can obtain both marks from correct percentage) [2]

II. 45 = $COOH^+$, 46= NO_2^+, 122 = $C_6H_4NO_2^+$ and 167 = $C_7H_5NO_4^+$.
(*Any 2 = 1 mark; All 4 = 2 marks*) [2]

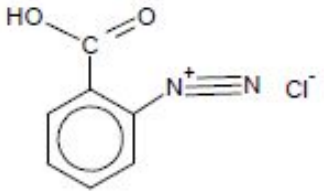
(iii) I. Lower melting point / melts over a range [1]
II. 1 mark for each point.
- Dissolve in the minimum volume
- Of hot water
- Filter hot
- Allow to cool
- Filter
- Dry residue under suction / in oven below 142°C

Max 4 marks [4]

QWC: legibility of text, accuracy of spelling, punctuation and grammar, clarity of meaning.[1]

(b) (i) Tin and concentrated hydrochloric acid [1]

(ii) Below 10°C (1)



(1) [2]

(iii) N=N double bond is chromophore (1)
Compound absorbs blue /green / complementary colours to red / all colours but red (1)
Remaining frequencies are transmitted, giving the red colour seen. (1)
Any 2 out of 3 [2]

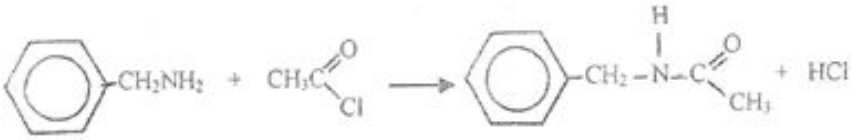
(c) Nitrogen has a lone pair (1) which can accept a proton (1) [2]

[20 marks]

4. (a) (i) (Fractional) distillation / (preparative) gas chromatography / HPLC / TLC column chromatography / solvent extraction [1]

(ii) the fragmentation pattern would be different / valid examples given [1]

(iii) I



[1]

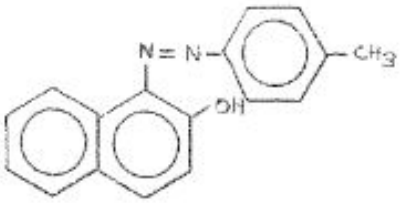
II Heated electrically / by a naked flame with a water bath (1)
Add compound **G** to the ethanol until the hot ethanol will (just) not dissolve any more solute (1)
Filter hot (1)
Allow to cool (1)
Filter (1)
Dry in air / window sill / < 60 °C in an oven (1) [5]

Maximum 4 out of 5 total if second marking point not given
Note 5 marks maximum here

QWC Information organised clearly and coherently, using specialist vocabulary where appropriate [1]

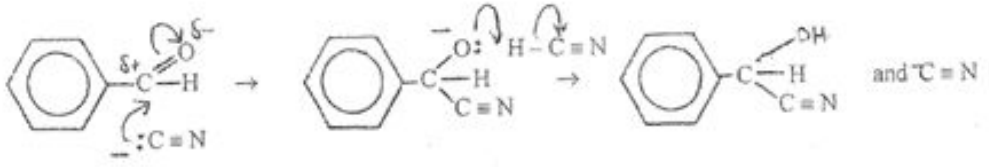
(iv) I The amine is reacted with sodium nitrite / HCl(aq) or nitrous acid (1)
at a temperature of < 10 °C (1) [2]

II



[1]

(b) (i) Nucleophilic addition (1)

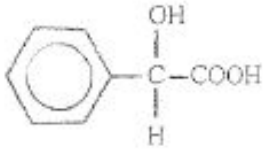


Accept a mechanism that shows HCN polarisation and nucleophilic addition as a concerted process

polarisation / charges shown (1) curly arrows on first structure (1)
regeneration of $^{-}C{\equiv}N$ or capture of H^{+} and curly arrow (1) [4]

(ii) Chromophores (1)
The colour will be black (1) as the compound absorbs blue / other colours (1)
[3]

(iii)



[1]

Total [20]

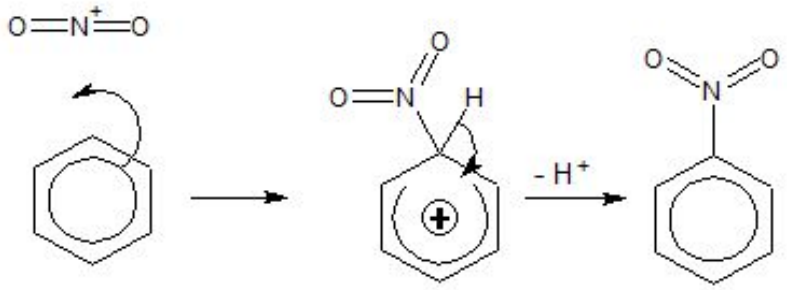
5.

(a) (i) Both molecules have lone pairs on nitrogen (1)

The lone pairs can form (coordinate) bonds with H^+ ions (1) [2]

(ii) Lone pair on N in phenylamine is delocalised over benzene ring (1) therefore less able to accept H^+ (1) [2]

(iii) I Arrow in first step (1)
Cation structure in second step (1)
Arrow in second step (1)

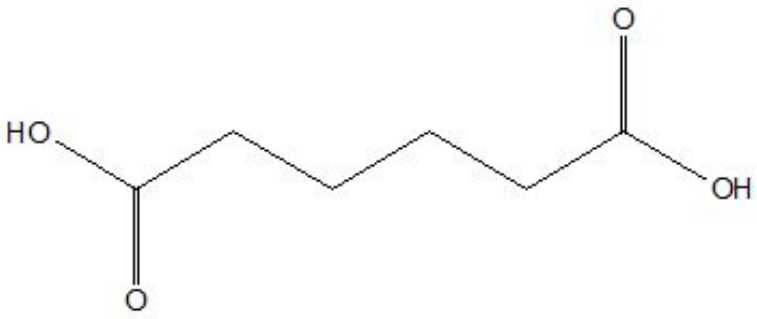


[3]

II (fractional) distillation / steam distillation [1]

III Sn and conc. HCl (1) followed by NaOH (1) [2]

(b) (i)



[1]

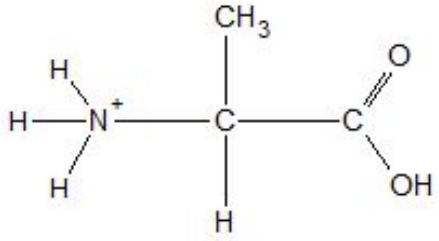
(ii) Addition polymerisation makes one product only /
Condensation produces one product plus a small molecule like water (1)

Addition polymerisation uses one starting material /
Condensation polymerisation has two different starting materials (1)

Addition polymerisation involves monomer with one functional group /
Condensation polymerisation involves monomer with two functional groups (1)

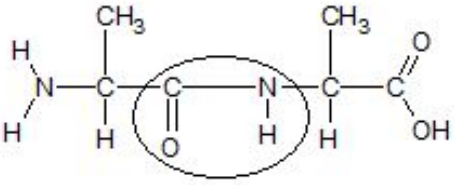
(max 2) [2]

(c) (i)



[1]

(ii)



[2]

(iii) Alanine has strong (electrostatic) forces between the zwitterions (1)

Butanoic acid has hydrogen bonding between molecules /
electrostatic forces in alanine are stronger than forces in butanoic acid (1)

[2]

(iv) Soda lime (1) $CH_3CH_2NH_2$ (1) [2]

Total [20]

6.

(a) ……blue …….. (1) ……higher (1) ……higher (1) [3]

(b) (i)

[1]

accept C_6H_5 in place of the ring accept equations that show the catalyst

(ii) It acts as a halogen carrier / it helps produce the electrophile/CH_3^+ / increases polarity of the halogenoalkane [1]

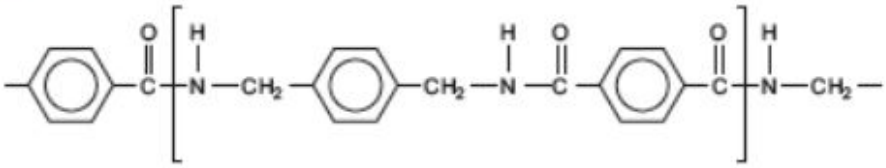
(c) There are 6 methyl protons and 4 aromatic protons, hence a ratio of 3:2 (1)
All the methyl protons are equivalent as are all the aromatic protons (1) [2]

(d) (i) Any 2 from NMR / HPLC / GC / refractive index / mass spectra / boiling temperature [2]

(ii)

[1]

(e) (i)



[1]

(ii) protein / dipeptide / polypeptide [1]

Total [12]