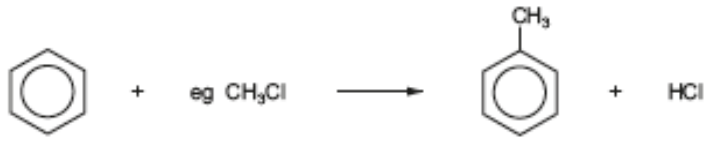
CH4

SECTION A

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

(b) (i)



[1]

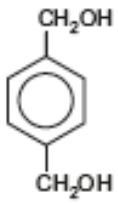
accept C_6H_5 in place of the ring accept equations that show the catalyst

(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]

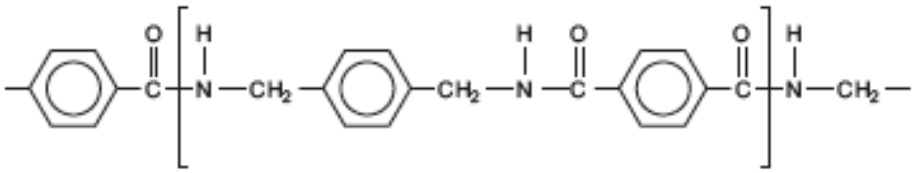
(d) (i) Any 2 from NMR / HPLC / GC / refractive index / mass spectra / boiling temperature [2]

(ii)



[1]

(e) (i)

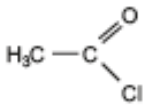


[1]

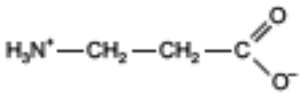
(ii) protein / dipeptide / polypeptide [1]

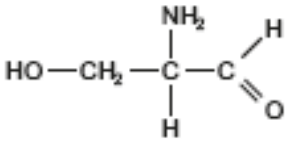
Total [12]

2. (a) (i) Sodium / potassium cyanide [1]

(ii)  [1]

(iii) Sulfuric / hydrochloric acid [1]

(iv)  [1]

(v) eg  [1]

(vi) $LiAlH_4$ / H_2 / sodium, ethanol [1]

(vii) The nitrogen atoms act as electron pair donors / proton acceptors [1]

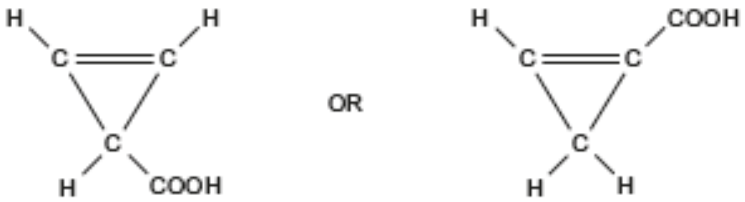
(b) (i) Molecular formula is $C_4H_4O_2$ [1]

(ii) 3 [1]

(iii) C = C / alkene [1]

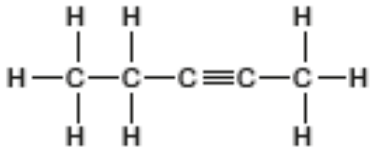
(iv) Two of the (remaining) protons are in equivalent environments (and one is not) / there are CH and CH_2 present [1]

(v) Possibilities

 [1]

Total [12]

3. (a)



[1]

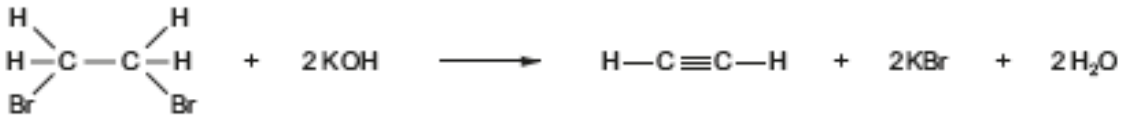
(b) Moles of calcium carbide = 500/64.1 = 7.80 (1)

Moles of ethyne = 7.80

Volume of ethyne = 7.80 × 24.0 = 187 (dm^3) (1) [2]

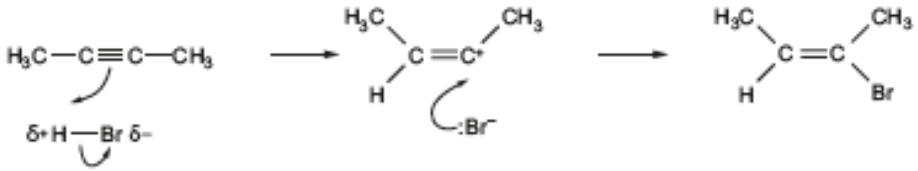
(c) If the process is endothermic left to right then it needs to absorb energy
– hence the high temperature / endothermic reactions need a high temperature [1]

(d)



[1]

(e)

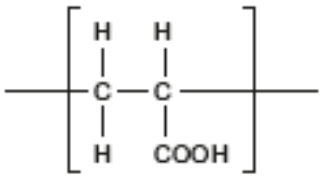


Curly arrows (1), full (1) and partial charges (1) [3]

(f) Any two for (1) each
energy costs / cost of **catalyst** / problems of separation of products / time taken / availability of starting materials / percentage yield / atom economy / relative health and safety [2]

(g) $C_6H_5 – C \equiv C – CH_2 – CH_3$ (1) C_1H_1 (1) [2]

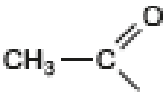
(h) (i)



[1]

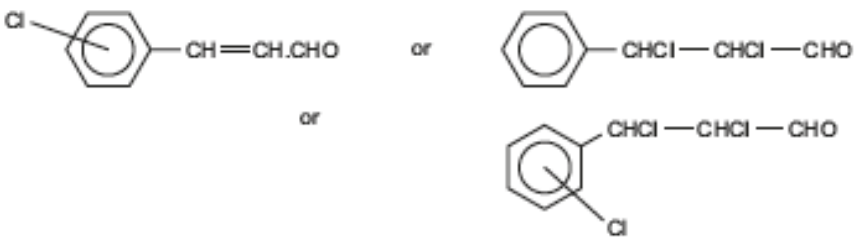
(ii) I sulfuric acid / H_2SO_4 / phosphoric acid / H_3PO_4 / Al_2O_3 [1]

II 3-hydroxypropanoic acid does not show a C = C absorption at **1620–1670** cm^{-1} but this is present in propenoic acid [1]

III The  / $CH_3CH(OH)$ group is absent [1]

Total [16]

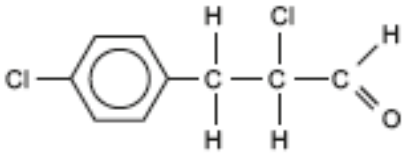
4. (a) (i) Substitution may occur in the ring at a different position (1)
Addition may occur across the double bond (1)



(1)

[3]

(ii)



(1)

In both additions a secondary carbocation is formed therefore 'equal chances' /
the energy for the formation of the carbocation is similar in both cases (1)

[2]

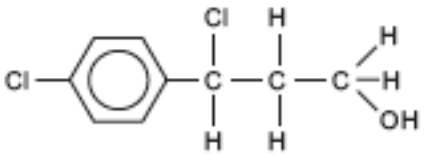
(iii) 'acidified dichromate' / H^+ and $Cr_2O_7^{2-}$ [1]

(iv) Although it contains a chiral centre (1) an equimolar / racemic mixture has been produced in the reaction (1) rotation is (externally) compensated (1)

Any 2 from 3 [2]

QWC *Selection of a form and style of writing appropriate to purpose and to complexity of subject matter* [1]

(v) $LiAlH_4$ / lithium tetrahydridoaluminate(III) / lithium aluminium hydride (1)
Do not accept $NaBH_4$



(1)

[2]

(b) (i) Gas bubbles / effervescence (1) Identifies carboxylic acid group (1) [2]

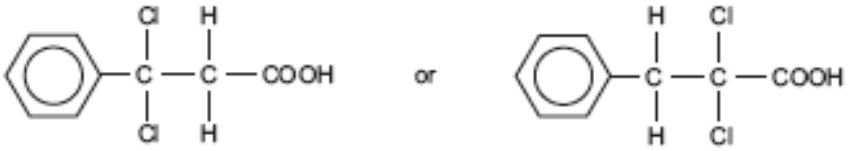
(ii) The bond between the ring and the chlorine atom is stronger than the aliphatic C–Cl bond or vice versa (1)
This is due to interaction between a **lone pair** of electrons on the chlorine atom and the ring electrons (1) [2]

(c) Compound 1 cannot give the m/z fragment value 77 ($C_6H_5^+$) (1)

Compound 2 has a chiral centre (1)

Compound 3 is rapidly hydrolysed by water / has a chiral centre (1)

Possible correct answers



(1)

[4]

QWC *Legibility of text; accuracy of spelling, punctuation and grammar; clarity of meaning* [1]

Total [20]

5. (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]

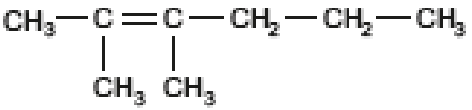
(b) (i) An electron deficient species that seeks out an electron rich / negatively charged / δ- site in a molecule [1]

(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]