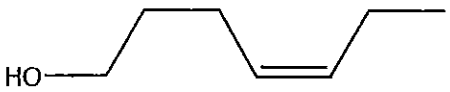
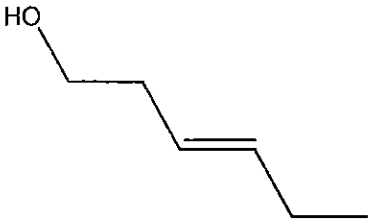
3 (a) (i) Methyl butanoate ✓ [1]

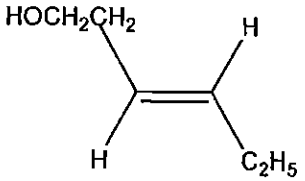
(ii) Warm / hot / boil / reflux ✓
water or aqueous or dilute✓
NaOH / KOH / HCl / H_2SO_4 ✓
} words or formulae
acid/alkali/base H^+ / OH^-
or any strong acid, **NOT** HNO_3 [3]

(b) (i) 

[1]

ONLY ✓

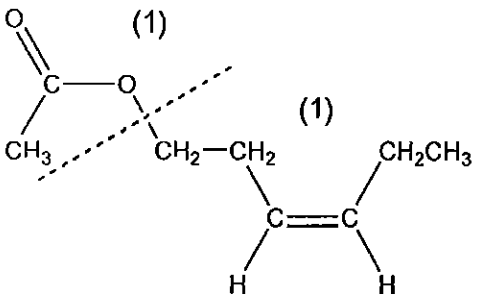
(ii) 

or 

[1]

✓

not necessarily skeletal, but MUST show the C=C stereochemistry
(right angles not penalised)

(iii) 

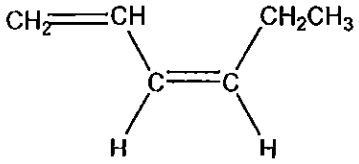
[2]

correct left of O-C bond✓
correct right of O-C bond✓
must show bonding in ester and alkene;
structure with CH_3COO... gets (1) only if rest is correct;
structure with trans double bond gets (1) if rest is correct

(c) (i) M_r B: $C_6H_{12}O$ 72 + 12 + 16 = 100 ✓ **[1]**

(ii) Mass spectroscopy / spectrometer / spec / spectrum ✓ **[1]**

(iii) Structure of C: **[2]**



✓

or any other correct drawing of hexa-1,3-diene C_6H_{10}
or any hydrocarbon of M_r 82 correctly drawn

Type of reaction:
dehydration ✓
or loss of water or elimination
NOT condensation

Total = 12

6 (a) (i) propanone ✓ **[1]**
accept acetone or propan-2-one

(ii) propanal ✓ **[1]**
accept propanaldehyde but **not** ethanal

(b) (i) *reagent(s):* e.g. 2,4-dinitrophenylhydrazine ✓ **[2]**
in words or formula

observation: e.g. orange / red / yellow precipitate / crystals ✓

no mark for observation if no reagent given

(ii) *reagent(s):* e.g. ammoniacal $AgNO_3$ ✓ or Ag_2O or Ag^+ or Tollens **[3]**
*observation for **D**:* No change ✓
*observation for **E**:* silver (mirror) ✓ grey ppte

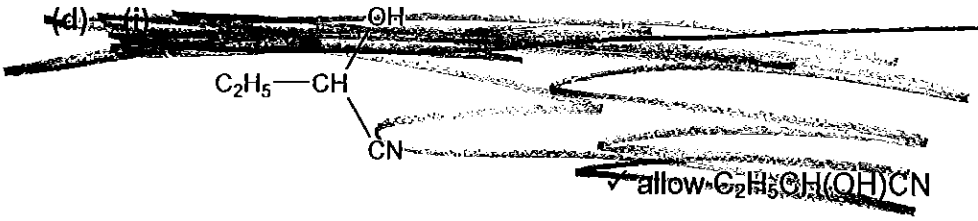
or similarly for another **chemical** test that works e.g. acid dichromate, Fehlings or CHI_3 test

(c) (i) Marked cross at ν ~ 1700 ✓ **[2]**
D has carbonyl group or ketone or C=O ✓

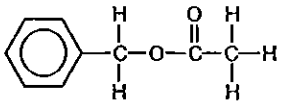
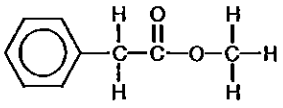
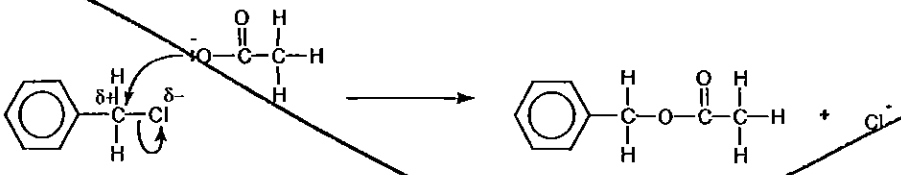
(ii) e g Reduction $CH_3COCH_3 \rightarrow CH_3CHOHCH_3$ (1) **[2]**
(or product is an alcohol)

new (broad) peak at ~3230 – 3550 cm^{-1} (1)
loss of peak at ~ 1700 cm^{-1} (1)

any two good points ✓ ✓

(d) (i) 

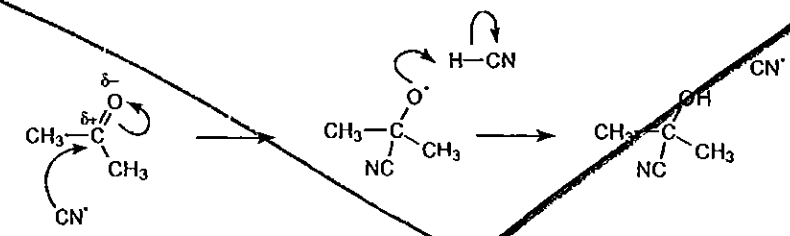
✓ allow $C_2H_5CH(OH)CN$ **[1]**

Qu.	Expected answers:	Marks
3 (a) (i)	$NaOH$ / KOH / OH^- / H_2O ✓	[1]
(ii)	nucleophilic ✓ substitution ✓	[2]
(iii)	$C_6H_5CH_2Cl + NaOH \longrightarrow C_6H_5CH_2OH + NaCl$ ✓ / $OH^- \longrightarrow Cl^-$ if water in (i), then: $H_2O \longrightarrow HCl$	[1]
(b) (i)	allow either  or  ✓	[1]
(ii)	$C_6H_5CH_2OH + CH_3COOH \longrightarrow CH_3COOCH_2C_6H_5 + H_2O$ ✓ allow $C_6H_5CH_2COOCH_3$ as the ester	[1]
(iii)	perfumes / flavourings / solvents ✓	[1]
(iv)	suggested mechanisms could be S_N1 or S_N2 type (such as the example shown below)  look for diagram or words describing: nucleophilic ✓ substitution / ester + Cl^- as products ✓ dipole on C-Cl bond ✓ curly arrow from COO^- to C ✓ curly arrow from bond to Cl ✓ **ANY 3** out of **5** (allow anything reasonable producing $C_6H_5CH_2COOCH_3$)	max [3]
		[Total: 10]

Qu.	Expected answers:	Marks
6 (a) (i)	C_7H_8O ✓	[1]
(ii)	M_r = 108 so m/e of molecular ion = **108** / ecf from **(i)** ✓	[1]
(iii)	%C = (84.0)/(108) x 100% = **77.8%** ✓ %H = (8.0)/(108) x 100% = **7.4%** ✓ / ecf from **(i)** or **(ii)**	[2]
(b)	***K*** has OH group ✓ ***K*** has peak at 3230 - 3550 cm^{-1} ✓ (ignore reference to any other bonds) ***L*** does not have OH group / peak at 3230 - 3550 cm^{-1} ✓	[3]
(c) (i)	peak at δ = 7.3ppm / with area 5, is due to the benzene ring (protons) ✓ peak at δ = 4.5ppm / with area 2, is due to the $-CH_2-$ (protons) ✓ peak at δ = 3.2ppm / with area 1, is due to the OH (proton) ✓	[3]
(ii)	peak at δ = 3.2ppm / with area 1 disappears / ecf from *(i)* ✓	[1]
(iii)	expect peak at δ = 7.1-7.7 ppm ✓ 5 protons responsible / area = 5 ✓ expect peak at δ = 3.3-4.3ppm ✓ 3 protons responsible / area = 3 ✓	[4]
		[Total: 15]

(7)

Qu.	Expected answers:	Marks
7 (a)	CH_3CH_2COOH ✓	[1]
(b)	$C_6H_5NO_2$ ✓	[1]
(c)	CH_3Cl / CH_3Br ✓ $AlCl_3$ / $FeCl_3$ / $FeBr_3$ etc ✓	[2]
(d)	$C_6H_5NH_3^+$ / $C_6H_5NH_2$ ✓	[1]
(e)	$CH_3COOC_2H_5$ ✓	[1]
(f) (i)	$(CH_3)_2C(OH)CN$ etc ✓	[1]
(ii)	nucleophilic ✓ addition ✓	



Look for the following in a diagram as above or description: (dipoles **not** required)

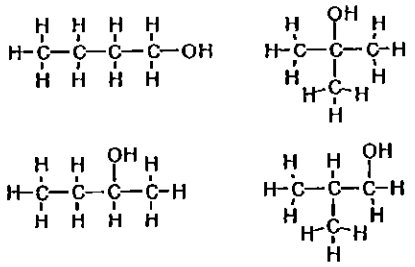
CN^-/nucleophile attacks (δ)+ carbonyl C / curly arrow from CN^- to carbonyl C ✓
(curly arrow) breaking C=O ✓
correct structure of the intermediate ✓
curly arrow from O^- to HCN / H_2O ✓

***ANY* 5** out of the **6** marks above — **max [5]**

(curly arrows must be clearly from and to the correct bond / atom to gain the mark)

[Total: 12]

5 (a)



any unambiguous type of formula ✓✓✓✓ [4]

(b) (i) butan-1-ol gives butanal /butanoic acid / an aldehyde / a carboxylic acid
butan-2-ol gives butanone / a ketone
2-methylpropan-2-ol gives no reaction ✓✓✓

3 marks for the alcohol reactions

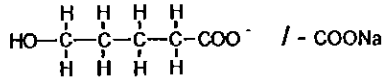
D is methylpropan-1-ol ✓
E is methylpropanoic acid ✓✓
(where any carboxylic acid for E gets the first mark)

3 marks for identifying D and E

Quality of Written Communication
information is organised clearly and coherently using at least **two** specialist terms not mentioned in the question (eg correct names of compounds, primary, secondary, aldehyde, ketone, oxidised etc) ✓ [6]

(ii) $(CH_3)_2CHCOOH + C_2H_5OH \longrightarrow (CH_3)_2CHCOOC_2H_5 + H_2O$
/ $C_4H_8O_2 + C_2H_6O \longrightarrow C_6H_{12}O_2 + H_2O$
/ ecf from (i) ✓ [1]

(c)

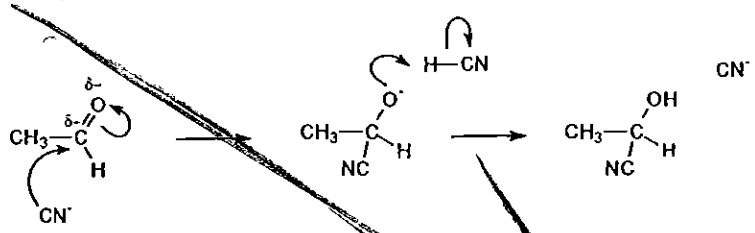


where

-OH ✓
$-COO^-$ / $COO^- Na^+$ / COONa ✓ 2]

[Total: 13]

6 (a) (i) nucleophilic addition ✓



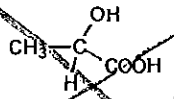
CN⁻ ✓ intermediate ✓ and X ✓

both curly arrows / arrow from nucleophile and dipole ✓ both curly arrows ✓

ANY 4 out of 6 [4]

(ii) HCl / H_2SO_4 / H^+ / acid ✓
hydrolysis ✓ [2]

(iii)

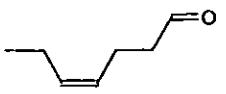


✓ [1]

(b) 1 doublet and 1 quadruplet / 1 3 3 1 and 1.1 ✓
correct reason for at least one peak ✓
(eg 1,3 3,1 due to 3 neighbours / next to CH_3 / use of n+1 rule) [2]

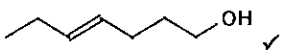
(c) (i) $C_7H_{12}O$ ✓ [1]

(ii)



✓ [1]

(iii)



✓

✓ [2]

[Total: 13]

8 **to detect the presence of C=O ...**

2,4-dinitrophenylhydrazine / 2,4-DNPH ✓
red/orange/yellow ppt/solid/crystals ✓

or

ir spectrum ✓
has peak at 1680-1750 cm^{-1} ✓

2 marks

to confirm it is a ketone not an aldehyde ...

Tollens' reagent /(acidified) $K_2Cr_2O_7$ ✓
aldehyde: silver mirror / green colour ✓
ketone: no silver mirror / no green colour ✓

or

n m r. spectrum ✓
aldehyde: peak at 9.5-10 ✓
ketone: no peak at 9.5-10 ✓

3 marks

a chemical method to identify the ketone ...

use the product / solid / ppt from 2,4-DNPH / 2,4-dinitrophenylhydrazine ✓
(re)crystallise / purify (the product) ✓
measure the melting point ✓
compare with known compounds / data book ✓

4 marks

ANY 8 marks out of **9** **[8]**

Quality of Written Communication

at least two sentences with legible text, accurate spelling, grammar and punctuation, so the meaning is clear ✓ **[1]**

[Total: 9]

1 (a) (i) ethanal ✓ [1]

(ii) aldehyde / carbonyl ✓ [1]

(iii) CH_3CH_2OH / C_2H_5OH ✓ | allow displayed formulae, but penalise poor connections to the OH, sticks etc

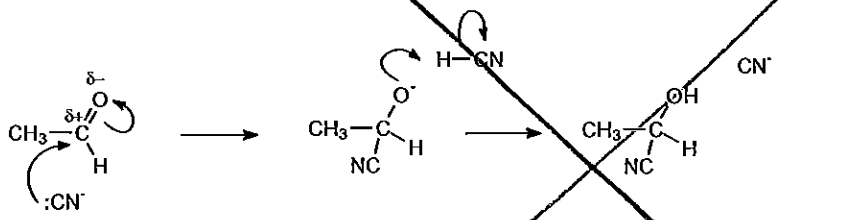
CH_3COO^- / CH_3COOAg / CH_3COOH ✓ [2]

(4)

(b) (i) (nucleophile/CN^-) is an electron/lone pair donor ✓ **ESSENTIAL MARK**

then look for the following points:

in the diagram ...	**or a written alternative ...**	
CN	the nucleophile is CN^-	✓
curly arrow clearly starts from a lone pair drawn on the C	the electron/lone pair is donated from the C of the CN^-	✓
curly arrow towards $C^{\delta+}$ and breaking C=O	(nucleophile/ CN^-) is attracted to an electron deficient carbon	✓
correct structure of the intermediate	(nucleophile/ CN^-) forms a covalent/dative bond (to the carbon)	✓
correct structure of the product	HCN is added	✓



ANY 4 out of **5** [5]

(ii) HCN / KCN / CN^- is toxic / **AW** **NOT** dangerous or explosive [1]

(iii) Yes, because ... **NOT** "four different atoms" or "molecules"

(the product) has a chiral centre/carbon ✓

four different groups around the carbon ✓

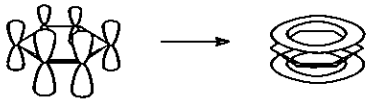
assymetric ✓

cannot be superimposed on its mirror image ✓ allow ecf from b(i)

ANY 2 out of **4** [2]

[Total: 12]

5 (a) planar molecule (or shown in diagram) ... ✓



p-orbitals (or shown in diagram) ✓
... overlap (or shown in a diagram) ✓

(p-orbital ovelap forms) π-bonds ✓
electrons are delocalised ✓
C-C bonds are all the same length ✓

ANY 5 out of **6**

Quality of Written Communication
mark for spelling, punctuation and grammar. Look for at least two sentences with legible text, accurate spelling, grammar and punctuation, so the meaning is clear ✓ **[6]**

(b) (i) $C_6H_5CHBrCH_2Br$ ✓ **[1]**

(ii) phenylethene has a double bond ✓

benzene (π) electrons are:
spread out / delocalised / lower electron density
✓ **ora** for **2** marks

then either ...
so the bromine molecule gets less polarised / needs the catalyst to help polarise it ... ✓

and the bromine/electrophile is less strongly attracted (to the π electrons) ✓
ora and AW for **2** marks

or ...
(delocalised (π) electrons make) benzene stable ... ✓

so more energy is needed (to overcome it) / higher E_a / it is not easily disrupted ✓
ora and AW for **2** marks

TOTAL 2 + 2 marks **[4]**

(c) (to make) poly(phenylethene) / polymers / plastics / a named use of poly(phenylethene) ✓
eg packaging, insulation, toys, moulded casings etc **[1]**

[Total: 12]

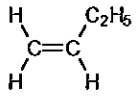
6 (a) 184 **[1]**

(b) (i) identification of the compounds ...
any type of formula that unambiguously identifies the compound – eg

B

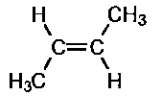
$CH_3CHICH_2CH_3$ ✓

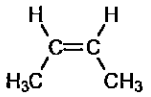
C



✓

D and **E**



and


✓✓

F

$CH_3CH_2CH_2CH_3$ ✓

5 marks

reasoning ...
H can be taken from either carbon 1 or carbon 3 ✓ **AW**

D and **E** are cis-trans/geometric (isomers) ✓

double bond does not rotate ✓

explanation why but-2-ene gives cis/trans isomers or why but-1-ene doesn't ✓

ANY 3 out of **4** marks **[8]**

(ii) addition / hydrogenation / reduction ✓ **[1]**

[Total: 10]