GCE MARKING SCHEME

CHEMISTRY
AS/Advanced

SUMMER 2013

GCE CHEMISTRY – CH4

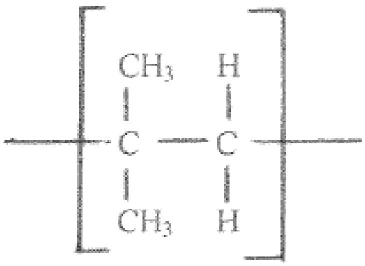
SUMMER 2013 MARK SCHEME

Q.1 (a) (i) (2-)Methylpropan-2-ol **[1]**

(ii) 30.1 / 30 **[1]**

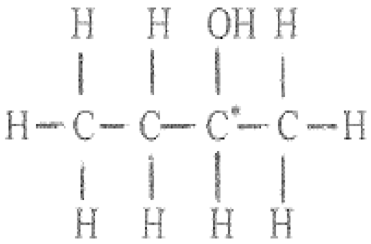
(iii) (Concentrated) sulfuric acid / phosphoric acid / aluminium oxide / pumice **[1]**

(iv)



(with or without n) **[1]**

(v)



(1) for structure, (1) for asterisk **[2]**

(vi) I acidified potassium dichromate / H^+, $Cr_2O_7^{2-}$(aq) **[1]**

II ethanal has a C = O bond at 1650-1750 cm^{-1}
(metaldehyde does not have this bond) (1)

metaldehyde has a C – O bond at 1000-1300 cm^{-1}
(ethanal does not have this bond) (1) **[2]**

(b) (i) **Reagent** 2,4-dinitrophenylhydrazine / 2,4-DNP OR iodine / NaOH or KI / NaOCl (1)

Observation yellow / orange / red precipitate OR yellow precipitate (1) **[2]**

(ii) **Reagent** ethanol / sulfuric acid OR $NaHCO_3$ OR Ag^+/NH_3 / Tollens' (1)

Observation sweet smelling liquid OR effervescence OR silver mirror (1) **[2]**

Total [13]

Q.2 (a) React with iron(III) chloride solution
Purple solution with phenol, no reaction with methyl propenoate

OR

React with aqueous bromine / bromine water
White precipitate with phenol (and bromine decolourised), bromine decolourised with methyl propenoate

(1) for reagent and (1) for observation with compound **[2]**

(b) (i) It absorbs all colours except yellow / absorbs the blue end of the spectrum and reflects yellow – do not accept 'emits' **[1]**

(ii) Tin / iron and concentrated hydrochloric acid **[1]**

(c) (i) Moles of 2,4-dinitrophenol = 7.36/184 = 0.040 (1)

Moles of 2,4-dinitrophenyl ethanoate = 7.91/226 = 0.035 (1)

Percentage yield = 0.035 × 100 / 0.040 = 87.5 /88 % (1) **[3]**

(ii) R_f value is given by $\frac{\text{distance travelled by the 2,4-dinitrophenol}}{\text{distance travelled by the solvent front}}$ (1)

$= \frac{2.8}{5.0} = 0.56$ (1) **[2]**

(d) (i) Nickel / platinum **[1]**

(ii) The –OH groups are able to hydrogen bond with water (1)
but these are a very small part of the 'urushiol' molecule (1) **[2]**

Total [12]

Q.3 (a) (i) 48.5 / 49 % **[1]**

(ii) Find a use for the calcium sulfate **[1]**

(b) Total volume of aqueous sodium hydroxide needed = $\frac{26.40 \times 250}{25.00} = 264.0\ \text{cm}^3$ (1)

from the graph this is equivalent to 0.011 mole of the acid (1)

$\therefore$ M_r of the acid = $\frac{\text{mass}}{\text{no. of moles}} = \frac{2.31}{0.011} = 210$ (1)

$$C_6H_8O_7.\ n\,H_2O = 210$$

$$\underset{192}{\uparrow} \quad \therefore n = 18 \qquad (1)$$

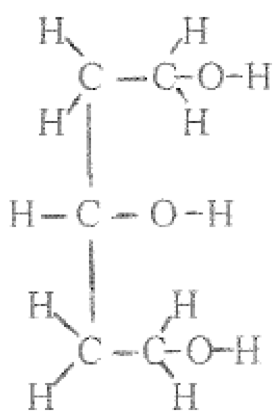
since M_r of water is 18 n = 1 (1) **[5]**

(c) The two 'ends' of the double bond have different groups bonded to the carbon atoms (of the double bond) / they have different structural formulae, so cannot be stereo / geometric isomers **[1]**

(d) eg sodium ethanoate / ethanoic acid (1) methane (1) **[2]**

(e) $C_5H_6O_5 \rightarrow CH_3COCH_3 + 2CO_2$ **[1]**

(f)



[1]

(g) (Fractional) distillation / (preparative) gas chromatography / HPLC **[1]**

(h) (i) eg An optically active isomer that will rotate the plane of polarised light / an isomer with a chiral centre **[1]**

(ii) An equimolar mixture of both enantiomers (that has no apparent effect on the plane of polarised light) **[1]**

Total [15]

Q.4 (a) Benzene is a compound whose molecules contain six carbon atoms bonded in a (hexagonal) ring (1)
All the carbon to carbon bond lengths are equal / intermediate (1)
Each carbon atom is bonded to two other carbon atoms and a hydrogen atom (1) by σ-bonds (1)
All the C – Ĉ – C angles are the same / 120° (1)
The remaining p electron of each carbon atom / overlap of p orbitals forms a delocalised cloud of electrons / π-system (1) above and below the plane (1)
Credit can be gained from labelled diagram
[*Candidates can gain a maximum of (4) for this part*]

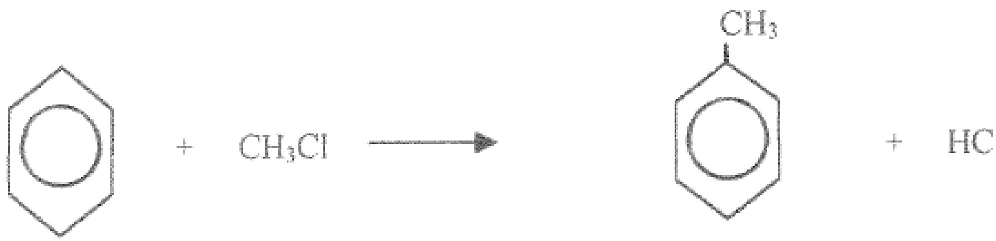
This delocalisation increases the **stability** (1) of the molecule and this stability is maintained by benzene undergoing substitution reactions in preference to addition reactions (that would destroy the delocalised system)
The π-cloud is **electron rich** and will be attracted to electron deficient electrophiles (1)
[*Candidates can gain (2) for this part*]

[6]

QWC Selection of a form and style of writing appropriate to purpose and to complexity of subject matter (1)

Legibility of text; accuracy of spelling, punctuation and grammar; clarity of meaning. (1) *QWC* **[2]**

(b)



(1)

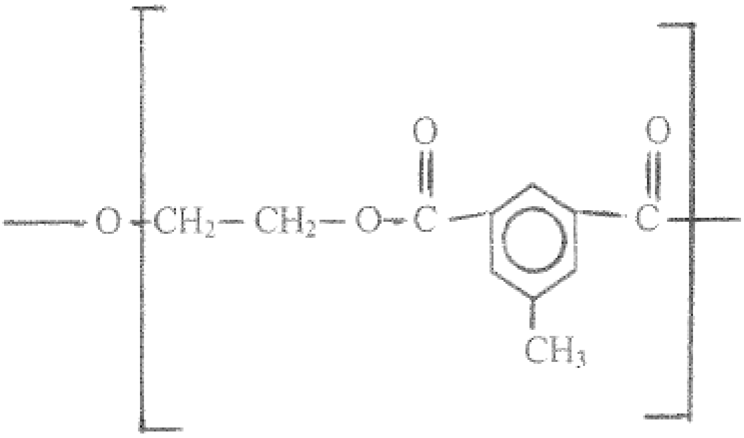
catalyst eg $AlCl_3$ (anhydrous) (1) **[2]**

(c) (i) (There are two environments for the protons), the 3 aromatic protons at ~6.8 δ and the 9 methyl / aliphatic protons at ~ 2.3 δ (1)
These give a peak area of 3:9, ie.1:3 (1)
These environments are separate / discrete (1) therefore no splitting pattern **[3]**

(ii) Dissolve in the minimum volume (1)
Of hot water (1)
(Filter hot) (1)
Cool (1)
Filter (1)
Dry (1)

(*up to 4 max but candidates must give the first two points in order to gain full credit*) **[4]**

(iii)



[1]

(iv) Reagent **S** is alkaline potassium manganate(VII) (1)

Reagent **T** is eg hydrochloric acid (1) **[2]**

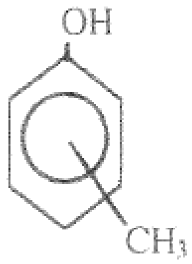
Total [20]

Q.5 (a) (i) The **nitrogen atom** has a **lone pair** of electrons making it an electron pair donor / proton acceptor **[1]**

(ii) Compound **L** must contain the grouping  (1)

The nitrogen atom must be bonded directly to the ring as a (primary) aromatic amine is formed on hydrolysis (1)

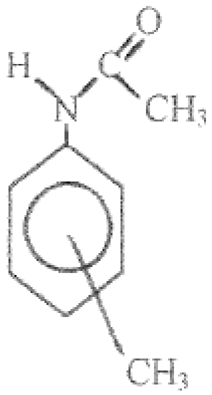
As the hydrolysis compound is a phenol (and has an OH group directly bonded to the ring) a methyl group must also be bonded directly to the ring, as the molecular formula is C_7H_8O / the compound has the structure



(1)

The compound is likely to be an amide, as these are hydrolysed by bases to amines (1)

A suggested formula is



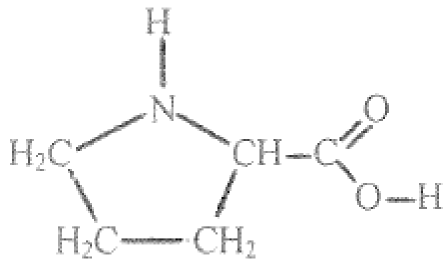
(1)

which is $C_9H_{11}NO$, an isomer of cathinone / has M_r of 149(1)

[6]

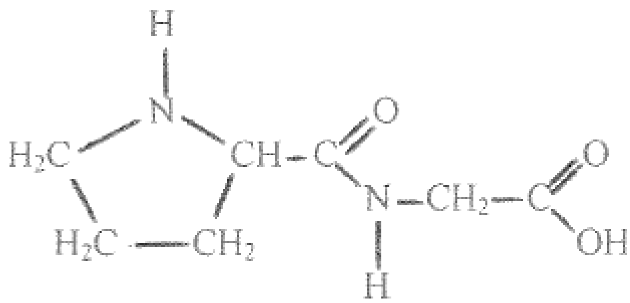
QWC *Information organised clearly and coherently, using specialist vocabulary where appropriate* *QWC* **[1]**

(b) (i)

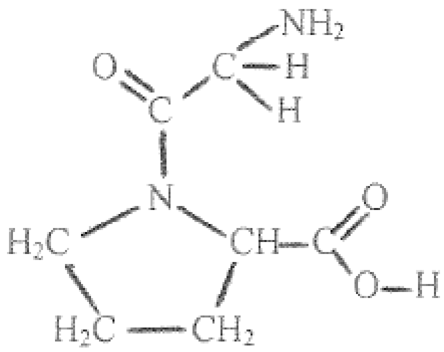


[1]

(ii)

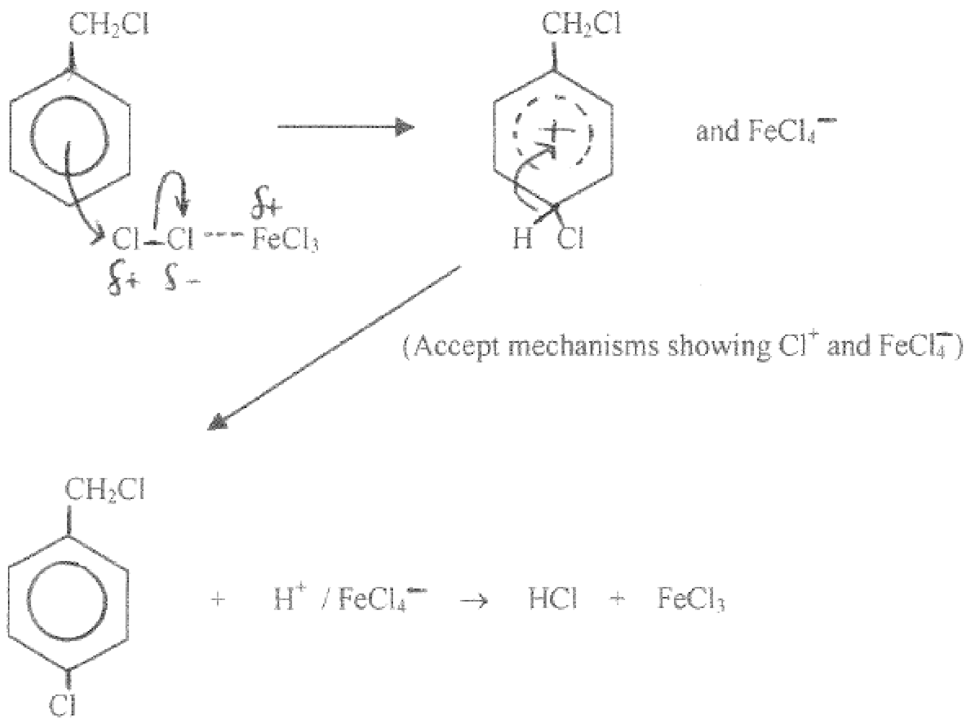


OR



[1]

(c) (i)



Correct catalyst (1)

Correct curly arrows and polarisation / formation of Cl^+ (1)

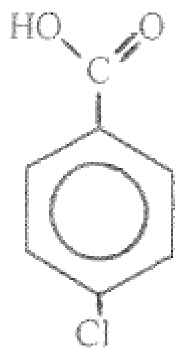
Wheland intermediate (1) Production of HCl and regeneration of $FeCl_3$ (1)

[4]

(ii) Volume of sodium hydroxide solution needed (1)
How long to reflux (1) **[2]**

(iii) The aromatic C – Cl bond is stronger than the aliphatic C – Cl bond (1)
This is because a p-electron(s) of the chlorine atom in the aromatic compound becomes part of / incorporated into the delocalised π system of the ring (1) **[2]**

(iv)



(1)

chlorine has two isotopes 35/37 in a 3:1 ratio (1)

[2]

Total [20]