GCE MARKING SCHEME

CHEMISTRY
AS/Advanced

JANUARY 2012

(b) (i) It contains an unpaired electron [1]

(ii) I $\bullet CH_3 + Cl_2 \rightarrow CH_3Cl + Cl\bullet$ [1]

II A radical reacts to produce a new radical (that can continue the process) [1]

(iii) C_7H_{16} [1]

(iv) (Bond fission where a covalent bond breaks) and each atom receives an electron [1]

Total [13]

Q.9 (a) Hydrogen bonding occurs between (1) oxygen, nitrogen or fluorine (1) of one molecule and hydrogen, which is bonded to oxygen / nitrogen / fluorine of another molecule (1)
Alkanes do not contain an O-H, N-H or F-H bond and cannot therefore hydrogen bond to water molecules (1) [4]

QWC *Candidates should have use 'a selection and form of writing appropriate to purpose and to complexity of subject matter'* [1]

(b) (i) The (purified) petroleum is separated by heating (1) due to the different boiling temperatures of different fractions (1)

OR the mixture is vaporised (1) and then condensed according to boiling temperatures (1) (as at the oil refinery) [2]

(ii) $CuCl_2$ Cu +2 CuCl Cu +1 (1)

(reduction occurs when) the oxidation number becomes less positive (1) [2]

(c) (i) Same molecular formula but a different structural formula / structure [1]

(ii) Both of the carbon atoms of the double bond have different atoms / groups bonded to them (1)
There is no free rotation about the double bond (1) [2]

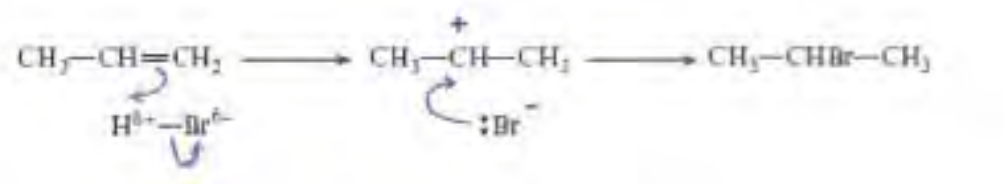
(iii) M_r of compound **A** is 146.3 / 146 (1)

Cost per mole is $\frac{146.3 \times 48 \times 100}{100 \times 73}$ = £96.20 (1)

(Accept £96.00 per mole if M_r of 146 has been used) [2]

Total [14]

Q.10 (a) (i)



curly arrows (1)
charges (1) [2]

(ii) Nucleophile hydroxide ion / OH^- / water (1)

Substitution the replacement of one functional group by another (1) [2]

(iii)

$CH_3CH_2Br + NaOH \rightarrow CH_2\ CH_2 + \mathbf{NaBr} + \mathbf{H_2O}$

(accept $\mathbf{Na^+}$ and $\mathbf{Br^-}$ in place of NaBr) [1]

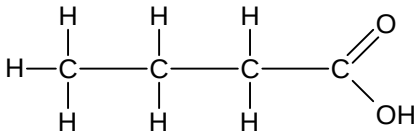
(b) M_r = 88 (1)

'M_r' R = 88 - (45) = 43 (1)

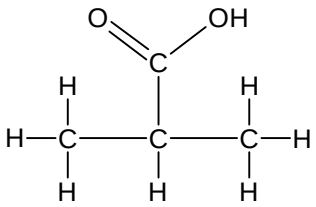
COOH

∴ R (an alkyl group) is C_3H_7

thus acid is



or



(1) [3]

(c) In graphite each carbon atom is bonded to three other carbon atoms (1) (using covalent bonding)
The other (outer) electron for each carbon atom is delocalised (1), throughout the structure and is able to move (1), conducting electricity
In iodine the two iodine atoms are bonded together (using covalent bonding) and there are no free electrons to carry the charge (1)
Mention of covalent bonding for either element (1) [5]

QWC Legibility of text; accuracy of spelling, punctuation and grammar; clarity of meaning (1)
Organisation of information clearly and coherently; use of specialist vocabulary where appropriate (1) [2]

Total [15]

SECTION B TOTAL [70]

GCE Chemistry – CH4

SECTION A

Q.1 (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]

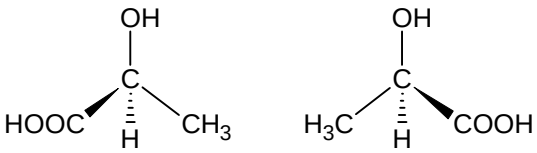
III Azo dye / azo compound [1]

Total [13]

Q.2

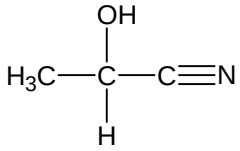
(a) (i) A compound that can rotate the plane of polarised light. [1]

(ii)



[1]

(iii)



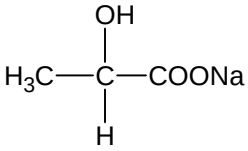
[1]

(iv) Reflux / heat with H_2O/H^+ [1]

(v) It contains an equal amount of the two enantiomers / it is a racemic mixture (1)

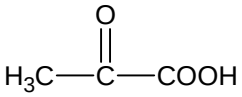
The rotating effect of one form exactly cancels out the effect of the other (1) [2]

(b) (i)



[1]

(ii)



[1]

(c) (i) 2-aminopropanoic acid [1]

(ii) Nitrous acid / nitric(III) acid / HNO_2 [1]

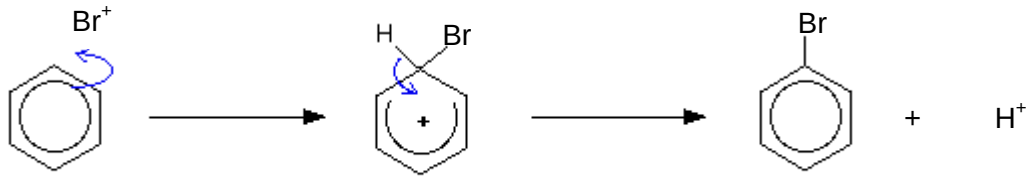
(iii) It exists as a zwitterion (1)

strong electrostatic attractions / ionic bonds between different zwitterions (1) [2]

Total [12]

Q.3 (a) (i) Electrophilic substitution [1]

(ii) $Br_2 + FeBr_3 \longrightarrow Br^+ + FeBr_4^-$



Formation of Br^+ (1), curly arrows (1), intermediate (1) [3]

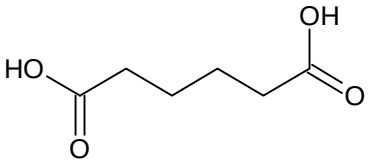
(b) (i) The extra stability in the benzene molecule due to electron delocalisation / the difference in energy between the experimental ΔH^θ reaction for benzene and the ΔH^θ reaction according to the Kekulé structure [1]

(ii) If benzene had 3 double bonds enthalpy change would be 3 x –120 = –360 kJ mol^{-1} (1)

Delocalisation energy is difference between –360 and –208 = 152 kJ mol^{-1} (1) [2]

(c) Benzene is carcinogenic / toxic [1]

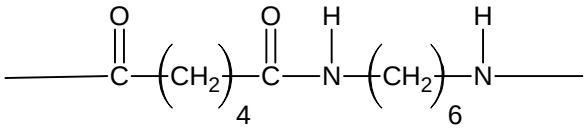
(d) (i) [1]



(ii) Reduction [1]

(iii) 1, 6-diaminohexane [1]

(iv) [1]



(v) Polyamide [1]

(vi) 226 tonnes nylon require 156 tonnes benzene (1)

800 tonnes nylon require 800 x $\frac{156}{226}$ = 552 tonnes (1) [2]

Total [15]

SECTION A TOTAL [40]

SECTION B

Q.4 (a) (i) Moles NaOH = 5.675×10^{-3} (1)

M_r **O** = $\frac{0.50}{0.005675}$ = 88.1 (1) [2]

(ii) **K** contains C=O due to 2, 4-dinitrophenylhydrazine reaction (1)

Contains CH_3CO due to positive iodoform test (1)

From M_r **K** must be CH_3COCH_3 (1)

O contains COOH due to neutralisation / decarboxylation reaction (1)

From M_r **O** must be $CH_3CH_2CH_2COOH$ / $(CH_3)_2CHCOOH$ (1) [5]

(iii) **L** is $CH_3CH(OH)CH_3$ (1)

M is C_3H_6 (1)

N is C_3H_8 (1) [3]

(iv) Concentrated H_2SO_4 / Al_2O_3 / concentrated H_3PO_4 [1]

(b) (i) To form the acid from the salt / to precipitate the acid / the salt is water soluble [1]

(ii) The acid is soluble in hot water but insoluble in cold water [1]

(iii) Moles = 3.2/40 = 0.08 (1)

Concentration = 0.08/0.04 = 2 mol dm^{-3} (1) [2]

(iv) Mass = 2.90 x 1.06 = 3.074 g (1)

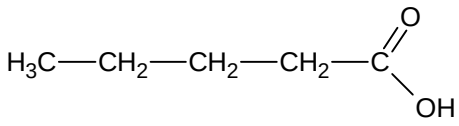
Moles = 3.074/150.1 = 0.0205 (1) [2]

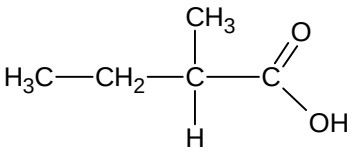
(v) Maximum mass = 0.0205 x 122 = 2.50 g (1)

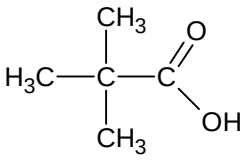
% yield = 1.45/2.50 = 58.0% (1) [2]

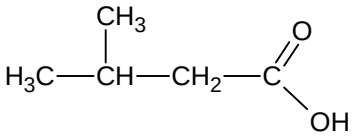
(vi) Hydrolysis not complete / equilibrium forms / C_6H_5COOH slightly soluble in water / two stages so some loss at both / mass lost during recrystallisation [1]

Total [20]

Q.5 (a) **P** is  (1)

Q is  (1)

R is  (1)

S is  (1)

[4]

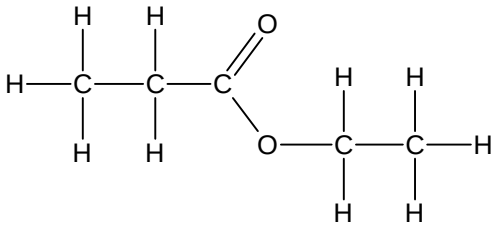
(b) (i) **T** neutral and sweet-smelling therefore an ester (1)

Infrared spectrum at 1750 cm^{-1} shows C=O and at 3000 cm^{-1} shows O–H therefore **X** is an acid (1)

Y is an alcohol, formed from ethanal must be ethanol (1)

5 carbons in ester therefore **X** must be propanoic acid (1)

Structure of **T** is

 (1)

(Maximum 4 marks) [4]

QWC Legibility of text; accuracy of spelling, punctuation and grammar, clarity of meaning (1)

Selection of a form and style of writing appropriate to purpose and to complexity of subject matter (1) [2]

(ii) I Reagent to form **Y** is $NaBH_4$ / $LiAlH_4$ [1]

II Sulfuric acid acts as a catalyst / removes water so pushes equilibrium to right [1]

(c) $CH_3(CH_2)$ 0.1 to 2.0 ppm triplet (1)

$(CH_3)CH_2O$ 3.5 to 4.0 ppm quadruplet (1)

CH_2CO 2.5 to 3.0 ppm singlet (1)

CH_3CO 2.0 to 2.5 ppm singlet (1) [4]

(d) Isomer **P** (1)

Only **P** can form hydrogen bonds between molecules (1)

Hydrogen bonds are the strongest intermolecular bonds / need more energy to break hydrogen bonds (1) [3]

QWC The information is organised clearly and coherently, using specialist vocabulary where appropriate [1]

Total [20]

SECTION B TOTAL [40]