GCE MARKING SCHEME

INTRODUCTION

The marking schemes which follow were those used by WJEC for the Summer 2013 examination in GCE CHEMISTRY. They were finalised after detailed discussion at examiners' conferences by all the examiners involved in the assessment. The conferences were held shortly after the papers were taken so that reference could be made to the full range of candidates' responses, with photocopied scripts forming the basis of discussion. The aim of the conferences was to ensure that the marking schemes were interpreted and applied in the same way by all examiners.

It is hoped that this information will be of assistance to centres but it is recognised at the same time that, without the benefit of participation in the examiners' conferences, teachers may have different views on certain matters of detail or interpretation.

WJEC regrets that it cannot enter into any discussion or correspondence about these marking schemes.

GCE CHEMISTRY - CH1

SUMMER 2013 MARK SCHEME

SECTION A

Q.1 number of protons 6

number of neutrons 8

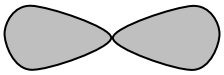
number of electrons 6 (all correct 2 marks, 2 correct 1 mark) **[2]**

Q.2 electron (1)

β-particle (1) (max 1 if three circled, 0 if four or more) **[2]**

Q.3 Provides an alternative pathway (1)
with lower activation energy / more particles have energy above E_A (1) **[2]**

Q.4 **[1]**



Q.5 nitrogen / phosphorus (or any other Group 5 element) **[1]**

Q.6 (a) (dissociates to) release H^+ ions **[1]**

(b) 2.5-6.0 **[1]**

Total [10]

SECTION B

Q.7 (a) percentage Be by mass = 5.03% (1)

division of percentage by A_r for Be and at least one other element as shown below (1)

Al 10.04 ÷ 27 = 0.3719 → 1.00

Be 5.03 ÷ 9.01 = 0.5583 → 1.50

O 53.58 ÷ 16 = 3.3488 → 9.00

Si 31.35 ÷ 28.1 = 1.1566 → 3.10

molecular formula = $Al_2Be_3O_{18}Si_6$ or x=3 (1) **[3]**

(b) (i) Hess' Law states that where a reaction can occur by more than one route the total enthalpy **change** for each route will be the same **[1]**

(ii) ΔH = –393.5 – (–395.4) (1) = +1.9 kJ mol^{-1} (1) **[2]**

(iii) Kyran is **incorrect** as diamond is not the **standard state** of carbon **[1]**

(iv) I mass of diamond = 7.30 g **[1]**

II mass of graphite = 7.30 ÷ (93/100) (1) = 7.85 g (1) **[2]**

Total [10]

Q.8 (a) (i) all ionisation energies showing gradual increase and one large jump (1)

large jump after 8 electrons (1) **[2]**

(ii) eighth and ninth electrons come from different shells (1)

ninth electron is closer to nucleus / has less or no shielding / has greater effective nuclear charge (1) **[2]**

(b) the compound formation has the noble gas atom being ionised (1)

ionisation energy of argon is much higher than that of xenon (1)

because the outer electron in argon is closer to the nucleus / has greater effective nuclear charge / shielding (1) - 2 max **[2]**

(c) electrons move from lower energy levels to higher energy levels (1)

by absorbing **specific frequencies** of light (1) **[2]**

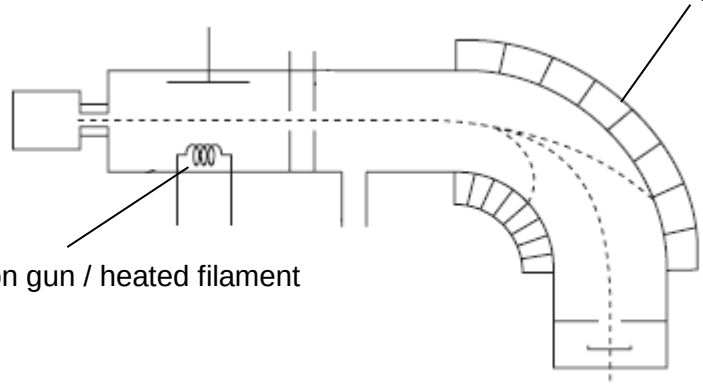
(d) 1 mol of XeO_3 released 2.5 mol gas products (1)

2.5 mol of gas occupies 24.0 x 2.5 = 60.0 dm^3 (1) – follow through error (ft)

if candidates calculate the volumes of the two gases separately, then (1) for one gas volume correct and (1) for total volume correct **[2]**

Total [10]

Q.9 (a) (i) both needed



[1]

(ii) electron gun bombards sample and **ionises** atoms/molecules (1)

negatively charged plates / electric field **accelerates** (positive ions in) sample (1)

electromagnet **deflects** ions according to mass and charge / m/z (1)

current in electromagnet / electromagnetic field is varied so different mass ions hit detector (1)

[4]

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

QWC: legibility of text, accuracy of spelling, punctuation and grammar, clarity of meaning (1)

QWC **[2]**

(b) A_r = (78 x 12.2) + (79 x 26.4) + (80 x 61.4) ÷ 100 (1) [for method] = 79.5 (1)

(1) for 3 sig figs for sensible answer (above 79.0 and below 80.0) (1) **[3]**

(c) (i) a 81

X Br /bromine both needed **[1]**

(ii) 75 minutes = 4 half-lives (1)

2.72g → 1.36g → 0.68g → 0.34g → 0.17g (1) – no ft **[2]**

Total [13]

Q.10 (a) $x = 10$ **[1]**

(b) (i) number of moles = 250 x 0.200 ÷ 1000 = 0.05 mol (1) – ft

mass of sodium carbonate = 0.05 x $M_r(Na_2CO_3)$ = 0.05 x 286.2
= 14.31g (1) **[2]**

(ii) any two points from:

weigh by difference (1)

add less water initially (1)

wash out beaker / glass rod / funnel and put water into volumetric flask (1)

add water up to mark in volumetric flask (1)
- 2 max **[2]**

(c) add few drops of indicator (1) do not accept 'universal indicator'

take initial and final reading on burette (1)

swirl the conical flask (1)

add acid until the indicator changes colour (1) **[4]**

QWC: organisation of information clearly and coherently; use of specialist vocabulary where appropriate. *QWC* **[1]**

Total [10]

Q.11 (a) (i) $\Delta H = 9 \times (-394) + 10 \times (-286) - (-275)$ (1)

$= -6131$ kJ mol^{-1} (1) for correct value and (1) for correct sign **[3]**

(ii) temperature 298K, 25°C (1) pressure 1 atm, 101 kPa (1) **[2]**

(b) (i) $M_r = (9 \times 12) + (20 \times 1.01) = 128.2$ (1)

number of moles = 1.56×10^{-3} mol (1) **[2]**

(ii) $\Delta H = -50 \times 4.18 \times 42 \div 1.56 \times 10^{-3}$ (1)

$= -5626698$ J mol^{-1} = -5627 kJ mol^{-1} (1) **[2]**

(iii) heat loss to environment / incomplete combustion / not standard conditions **[1]**

Total [10]

Q.12 (a) killing marine life / killing trees **[1]**

(b) (i) either gas syringe or inverted burette attached to sealed vessel **[1]**

(ii) different surface area would affect rate of reaction **[1]**

(iii) concentration / volume / nature of acid (1)

temperature (1) **[2]**

(c) (i) increasing pressure will shift the reaction to side with fewer gas molecules (1)

increasing yield of SO_3 (1) – reason must be given **[2]**

(ii) I increasing temperature shifts equilibrium in endothermic direction (1)

as SO_3 yield is decreased forward reaction must be exothermic (1) **[2]**

II increasing temperature increases energy of particles (1)

more collisions have energy above activation energy (1)

successful collisions occur more frequently (1)

c*an gain first two points from labelled Boltzmann distribution curve* **[3]**

III e.g. iron in production of ammonia or any valid example **[1]**

(d) (i) atom economy = 100% **[1]**

(ii) any two points from:

lower pressure used in B (1)

methanol is a renewable starting material (1)

higher atom economy in B or less waste in B (1)

[ignore reference to cost]
2 max **[2]**

(iii) no effect on position of equilibrium **[1]**

Total [17]

Section A

Q.1 C **[1]**

Q.2 B **[1]**

Q.3 (a) Calcium chloride **[1]**

(b) Magnesium carbonate **[1]**

(c) Sodium sulfate **[1]**

Q.4

Species	Cl●	NH_3
Classification	Radical	Nucleophile

(1 for each box) **[2]**

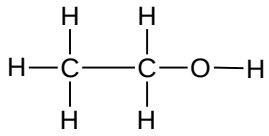
Q.5 e.g. wound dressing/sterilising sprays/deodorant socks/ refrigerator surfaces/anti-perspirants **[1]**

Q.6 Potassium and chlorine (1)

They have the largest electronegativity difference (1) **[2]**

Section B

Q.7 (a) (i) **[1]**

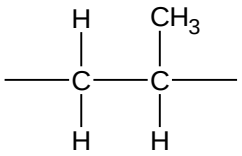


(ii) Nickel / platinum / palladium **[1]**

(iii) Potassium / sodium hydroxide (1)
in ethanol and heat (1) **[2]**

(iv) Elimination **[1]**

(b) (i) **[1]**



(ii) M_r poly(propene) unit = 42 (1)

Number of units = $\frac{1.05 \times 10^6}{42}$ = 25000 (1) **[2]**

(c) (i) Percentage hydrogen = 4.6% (1)

C	H	Br	
22.0	4.6	73.4	(1)
12	1.01	79.9	
1.83	4.55	0.92	
2	5	1	

Formula = C_2H_5Br (1) **[3]**

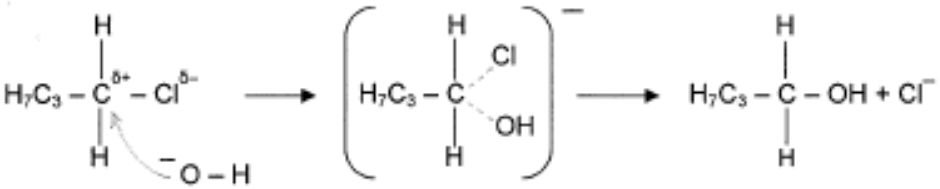
(ii) M_r of compound / number of atoms of any element in compound **[1]**

Total [12]

Q.8 (a) e.g. damages liver/ damages pancreas/causes cancer/causes skin disorders/ short-term effects (1)

e.g. more traffic accidents/violent behaviour/criminal behaviour (1) **[2]**

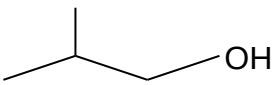
(b) (i) Nucleophilic substitution / hydrolysis (1)



Reactants: Intermediate (1)
Polarisation (1) (accept curly arrow to show
curly arrow (1) C – Cl breaking instead of intermediate) **[4]**
(Incorrect starting material or product maximum 2 marks from 3 for mechanism)

(ii) Peak at 650–800 cm^{-1} due to C – Cl bond will be gone (1)
Peak at 2500–3500 cm^{-1} due to O – H bond /
1000–1300 cm^{-1} due to C – O bond will be present (1) **[2]**

(c) (i)



[1]

(ii) Structural / positional / chain **[1]**

(iii) Colour change from orange to green **[1]**

(iv) Concentrated sulfuric acid / aluminium oxide (1)
$CH_3CH_2CH_2CH_2OH \longrightarrow CH_3CH_2CHCH_2 + H_2O$ (1) **[2]**

(d) (i) C – F bond stronger than C – Cl bond (1)
C – Cl bond breaks (in stratosphere) forming Cl● which
reacts with ozone (1) **[2]**

(ii) Some CFCs still being used / CFCs take a very long time to reach the ozone layer / other substances deplete the ozone layer **[1]**

Total [16]

Q.9 (a) A mixture of (many) hydrocarbons / alkanes **[1]**

(b) $C_4H_{10} + 6\frac{1}{2}O_2 \longrightarrow 4CO_2 + 5H_2O$ **[1]**

(c) 109½° **[1]**

(d) H_2O has 2 bonding and 2 lone pair of electrons (1)

CH_4 has 4 bonding pairs only (1)

Repulsion between lone pairs and bond pairs is greater than between bond pairs and bond pairs (1) **[3]**

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

(e) (i) Butane is higher because it has more van der Waals' forces between molecules **[1]**

(ii) Regular array of metal ions surrounded by a 'sea' of delocalised valence electrons (1)

Strong attraction between the positive ions and the delocalised electrons (1) (Can be obtained from labelled diagrams)

Malleable because when a force is applied the layer of metal ions slide over each other forming a new shape (1)

Conduct electricity since under a potential difference the delocalised electrons flow / the delocalised electrons flow towards the positive potential (1)
[4]

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

Total [13]

Q.10 (a) (i) Chlorine – gas
Iodine – solid **[1]**

(ii) Chlorine – brown/orange solution (1)
Iodine – no change / no reaction (1)
$Cl_2 + 2KBr \longrightarrow Br_2 + 2KCl$ (1) **[3]**
(Accept ionic equation)

(b) Oxygen loses electrons therefore oxidised / oxidation state changes from -2 to 0 therefore is oxidised (1)

Chlorine gains electrons therefore reduced / oxidation state changes from 0 to -1 therefore is reduced (1) **[2]**

(c) (i) Boiling temperatures increase as relative molecular mass increases / number of electrons increases / down group (1)

HF has a higher boiling point than expected (1) **[2]**

(ii) Group 7 hydrides contain more dipole–dipole forces as group descended (1)
but HF contains hydrogen bonding between molecules (1)

Hydrogen bonds are stronger therefore HF's boiling temperature is greater / need more energy to break (1) **[3]**

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

(iii) HCl more polar than SiH_4 therefore intermolecular forces are stronger / dipole greater in HCl / Cl more electronegative than Si **[1]**

Total [13]

Q.11 (a) (i) $2Ca + O_2 \longrightarrow 2CaO$ **[1]**

(ii)

(1)

forming Ca^{2+} and O^{2-} ions (1) **[2]**

(b) (i) $Ca(OH)_2$ **[1]**

(ii) 8 – 14 **[1]**

(c) $Ca^{2+}(aq) + CO_3^{2-}(aq) \longrightarrow CaCO_3(s)$ **[1]**

(d) (i) Magnesium disappears / gets smaller (1)
Effervescence / bubbles (of hydrogen) (1)
Heat given off (1) **[2]**
(Accept any 2 points)

(ii) Moles Mg = $\frac{0.503}{24.3}$ = 0.0207 (1)
Moles HCl = 0.0414 (1)
Volume HCl = $\frac{0.0414}{1.6}$ = 0.0259 dm^3 (1) **[3]**

(iii) Volume H_2 = 0.0207 × 24 = 0.497 dm^3 **[1]**

(iv) Add aqueous silver nitrate (1)
White precipitate forms (1) **[2]**

(e) Less reactive (1)

Electrons in beryllium more difficult to lose / ionisation energy is higher (1) **[2]**

(Need reason to get first mark but accept less reactive as reactivity increases down group / outer electron has less shielding etc. for 1 mark)

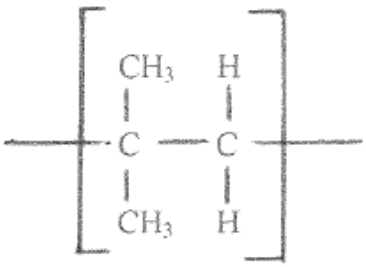
Total [16]

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

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

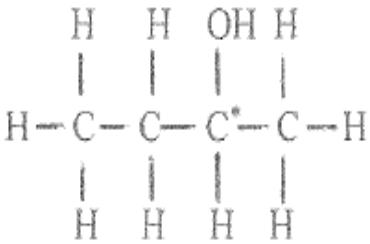
(iii) (Concentrated) sulfuric acid / phosphoric acid / aluminium oxide / pumice **[1]**

(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 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

↑

192 $\therefore$ n = 18 (1)

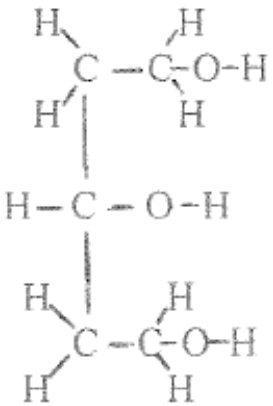
since M_r of water is 18 n = 1 (1) **[5]**

(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 – $\hat{C}$ – 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

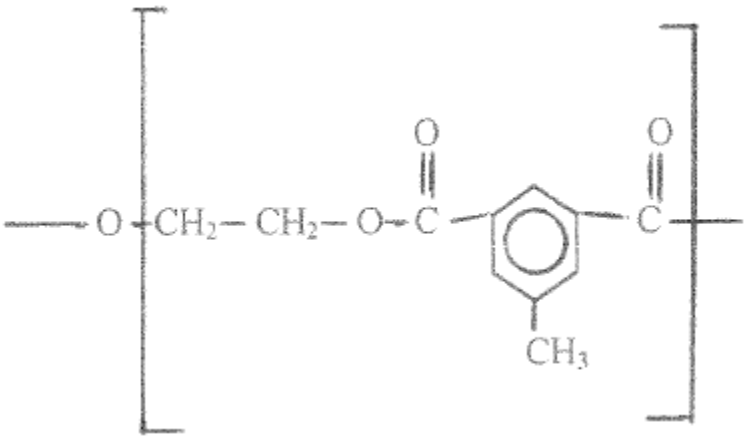
[3]

(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)

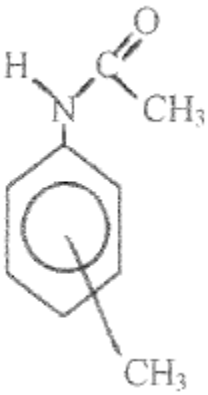
The nitrogen atom must be bonded directly to the ring as a (primary) aromatic amine is formed on hydrolysis (1)

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



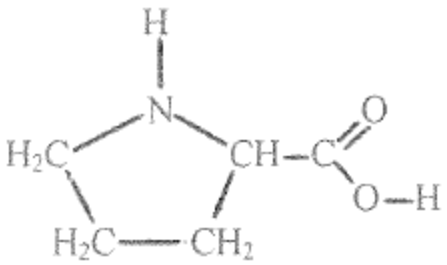
(1)

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

[6]

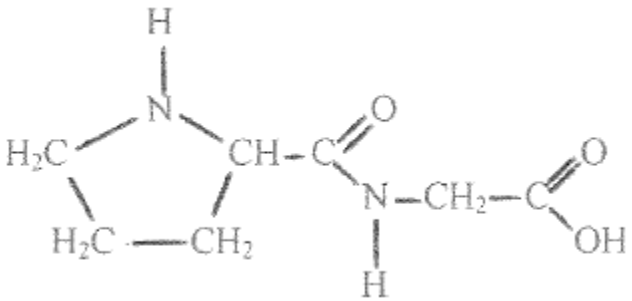
QWC Information organised clearly and coherently, using specialist vocabulary where appropriate *QWC* **[1]**

(b) (i)

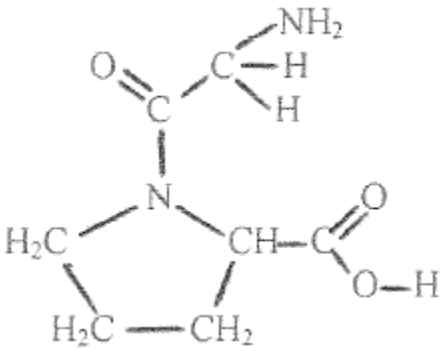


[1]

(ii)

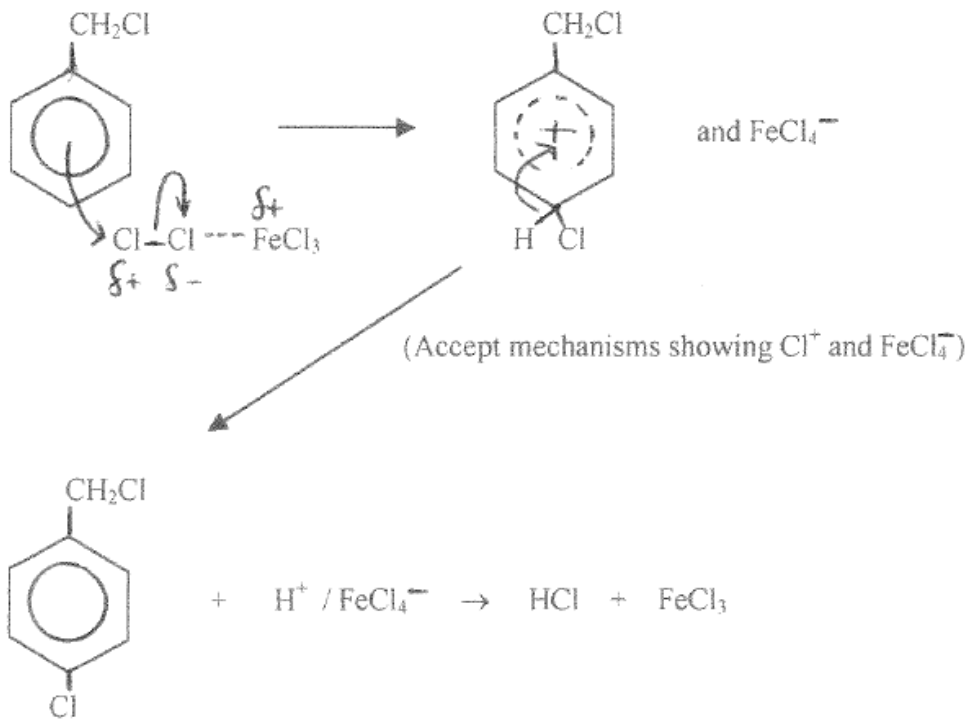


OR



[1]

(c) (i)



Correct catalyst (1)

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

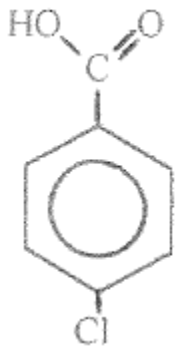
Wheland intermediate (1) Production of HCl and regeneration of $FeCl_3$ (1)

[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]

Q.1 *(a)* Name of any commercially/ industrially important chlorine containing compound e.g. (sodium) chlorate(I) as bleach/ (sodium) chlorate(V) as weedkiller/ aluminium chloride as catalyst in halogenation
- do not accept CFCs **[1]**

(b) (i) $K_c = \frac{[HI]^2}{[H_2][I_2]}$ must be square brackets **[1]**

(ii) $K_c = \frac{0.11^2}{3.11^2} = 1.25 \times 10^{-3}$ follow through error (ft) **[1]**

(iii) K_c has no units ft **[1]**

(iv) when temperature increases K_c increases (1)

this means equilibrium has moved to RHS
/ increasing temperature favours endothermic reaction (1)

therefore ΔH for forward reaction is +ve (1)
(mark only awarded if marking point 2 given) **[3]**

(c) (i) +2 **[1]**

(ii) co-ordinate/ dative (covalent) **[1]**

(iii) pink is $[Co(H_2O)_6]^{2+}$ **and** blue is $[CoCl_4]^{2-}$ (1)

(ligand is) Cl^- (1)

(addition of HCl sends) equilibrium to RHS (1) **[3]**

(iv) $[Co(H_2O)_6]^{2+}$ shown as octahedral [with attempt at 3D] (1)

$[CoCl_4]^{2-}$ shown as tetrahedral/ square planar (1) **[2]**

Total [14]

Q.2 *(a)* (i) tangent drawn at t = 40 (1)

rate calculated 0.017 to 0.027 (ignore units) (1) **[2]**

(ii) as reaction proceeds less collisions (per unit time) occur **[1]**

(b) (i) 1st order shown by:

calculation of rates at at least 2 concentrations (1)

statement rate α concentration (1)

OR

constant half-life (1)

half-life is 24 minutes (1) **[2]**

(ii) rate = $k[N_2O_5]$ (1) **[1]**

(iii) k = rate (from (i))/ $[N_2O_5]$ (from graph) (1)
(mark correct numbers – no need to check evaluation)

units = $minutes^{-1}$ (1) ft from (ii) **[2]**

(iv) (student A more likely to be correct) reaction is 1st order and 1 $[N_2O_5]$ involved in rate determining step **[1]**

(c) correct curve starting at 100 kPa and becoming horizontal (1)

horizontal at 250 kPa (1) **[2]**

Total [11]

Q.3 *(a)* an acid is a proton / H^+ donor **[1]**

(b) pH = -log[H^+] / negative log of hydrogen ion concentration **[1]**

(c) a low pH corresponds to a high concentration of H^+ (1)

a strong acid is totally dissociated whilst a weak acid is partially dissociated (1)

need to consider concentration (of acid solution) as well as strength of the acid (1)

a concentrated solution of a weak acid could have a lower pH than a dilute solution of a strong acid (1) **[4]**

QWC Accuracy of spelling, punctuation and grammar *QWC* **[1]**

(d) (i) $K_a = \frac{[HCOO^-][H^+]}{[HCOOH]}$ **[1]**

(ii) $1.75 \times 10^{-4} = \frac{x^2}{0.1}$ (1)

$x = 4.183 \times 10^{-3}$ (1)

pH = 2.38 (1) **[3]**

(e) (i) buffer **[1]**

(ii) $RCOOH \rightleftharpoons RCOO^- + H^+$ and $RCOONa \rightarrow RCOO^- + Na^+$ (1)

added H^+ removed by salt anion/ $A^- + H^+ \rightarrow HA$ (1)

added OH^- removed by acid/ $OH^- + HA \rightarrow A^- + H_2O$ (1) **[3]**

Total [15]

Q.4 *(a)* diagram with labels to show

H_2/H^+ shown in electrode (1)

platinum (in both electrodes) (1)

Fe^{2+}(aq) and Fe^{3+}(aq) (1)

high resistance voltmeter (1)

salt bridge (1)

gas at 1atm pressure, solutions of concentration 1 mol dm^{-3}, temperature 298K (1)

[any 5] **[5]**

(b) (i) successive ionisation energies increase gradually/ the energies of the d orbitals are similar **[1]**

(ii) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10}$ / $3d^{10} 4s^2$ **[1]**

(iii) after 4s electrons lost 3d is full/ stable/ d electrons ionisation energy very high **[1]**

(c) (i) violet solution contains V^{2+} (1)

SEP Zn^{2+}/ Zn is more negative than VO_3^-/ VO^{2+} and VO^{2+}/ V^{3+} and therefore

releases electrons/ VO_3^-/ VO^{2+} and VO^{2+}/ V^{3+} are more positive than

Zn^{2+}/ Zn and are stronger oxidising agents (1)

V^{2+} cannot be reduced (to V) since SEP is more negative than Zn^{2+}/ Zn (1) **[3]**

(ii) 1.1V (ignore sign) **[1]**

(iii) $Zn(s) \rightarrow Zn^{2+}(aq) + 2e$ / $Zn(s) \rightleftharpoons Zn^{2+}(aq) + 2e$ with some indication of direction **[1]**

(iv) if Zn^{2+}(aq) concentration increased equilibrium moves to LHS (1)

so electrode potential becomes less negative (1) **[2]**

(d) (i) 2.74×10^{-3} (mol) **[1]**

(ii) 1.37×10^{-3} (mol) **[1]**

(iii) M_r KIO_3 = 214.1

moles KIO_3 = 0.978/ 214.1 = 4.57×10^{-3} in 250 cm^3

4.57×10^{-4} in 25 cm^3 **[1]**

(iv) $1.37 \times 10^{-3}/4.57 \times 10^{-4}$ = 3 (1)

equation 1 is correct since 3 moles of iodine formed (mark awarded for reason) (1) **[2]**

Total [20]

Q.5 *(a)* (i) atomisation of magnesium / vaporisation of magnesium **[1]**

(ii) increased ratio positive charge on nucleus: number of electrons **[1]**

(iii) is positive because the (negative) electron is repelled by negative species **[1]**

(iv) lattice enthalpy is –3835(kJ mol^{-1}) numerical value (1) negative sign (1) **[2]**

(b) (i) gases are more random/ have more disorder / move more freely and therefore have a higher entropy **[1]**

(ii) $\Delta S = 21.8$ ($JK^{-1}mol^{-1}$) **[1]**

(iii) $\Delta G = \Delta H - T\Delta S$ (1) ft from (ii)

ΔG must be –ve if reaction to be spontaneous/ to calculate T make $\Delta G = 0$ (1)

0 = 318000 – T 21.8 T = 14587/14600 (K) (1) **[3]**

(c) use of aqueous sodium hydroxide (1)

white precipitate for all possible ions (1)

excess aqueous sodium hydroxide – precipitate dissolves for Pb^{2+} and Al^{3+} (1)

use of aqueous (potassium) iodide/ hydrochloric acid/ sulfuric acid / soluble

chloride/ soluble sulfate (1)

result – yellow ppt for Pb^{2+} + I^- and no ppt for Al^{3+} / white ppt for Pb^{2+} + Cl^- or SO_4^{2-}

and no ppt for Al^{3+} [result for both needed] (1) **[5]**

QWC Organisation of information clear and coherent (1)

Use of specialist vocabulary (1) *QWC* **[2]**

(d) (i) diagram to show central Al, 4 Cl^- and 4 shared pairs of electrons, all Cl outer electrons, dative pair identifiable **[1]**

(ii) chlorination of benzene (1) produces Cl^+ as electrophile (1)

OR gives ionic liquids (1) with low vapour pressure/ non-volatile/ do not evaporate

in use (1)

OR catalyst (1) in polymerisation of alkenes (1) **[2]**

Total [20]

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