GCE MARKING SCHEME

CHEMISTRY (NEW)
AS/Advanced

JANUARY 2010

INTRODUCTION

The marking schemes which follow were those used by WJEC for the January 2010 examination in GCE CHEMISTRY (NEW). 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.

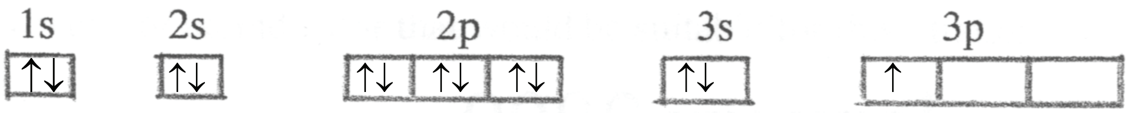
It is hoped that this information will be of assistance to centres but it is recognised at the same time that, without the benefit of participation in the examiners' conferences, teachers may have different views on certain matters of detail or interpretation.

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

CH1

SECTION A

1.



1 mark [1]

2. Letter: B 1 mark

Reason: Three electrons in outer shell, so largest jump between 3rd and 4th Ionisation Energies. 1 mark

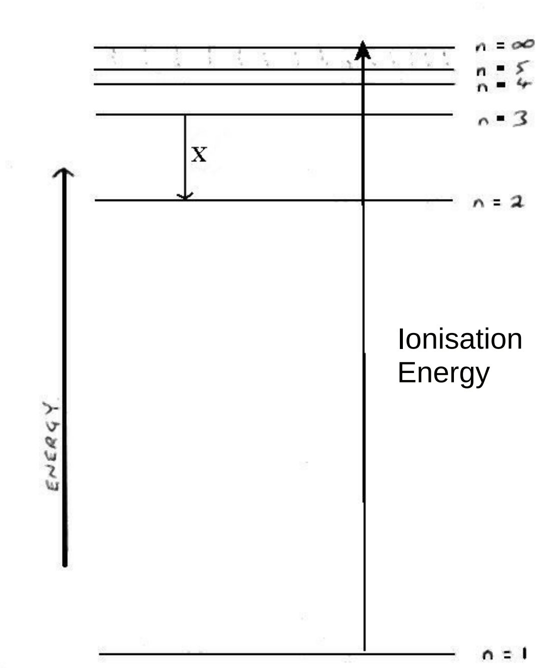
[2]

3 (a) *A mole is the amount of material containing the same number of particles as there are atoms in* 12 g of the ^{12}C isotope. 1 mark [1]

(b) 0.9 mol sulfur atoms. 1 mark [1]

4. (a) C The first line in the Balmer series. 1 mark [1]

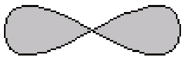
(b) Draw on the energy levels diagram an arrow to represent the transition which occurs when a hydrogen atom is ionised. [1]



(Arrow must be directed upwards for mark).

5. Sketch a diagram to show the shape of a p-orbital. [1]

Dumbbell shape or appropriate diagram 1 mark



6. (a) *Dynamic equilibrium* is when the rate of the forward reaction is equal (and opposite) to the rate of the reverse reaction. 1 mark [1]

(b) A chemical system is in *equilibrium* when:
there is no change in the amount of each species present /
there is no change in the concentrations present /
the physical properties are constant. 1 mark [1]

Section A Total [10]

SECTION B

7. (a) (i) *Isotopes* are atoms with the
same atomic number but different mass number /
same number of protons but different numbers of neutrons.
1 mark [1]

(ii) (^{191}Ir) 77 protons 114 neutrons 77 electrons 1 mark

(^{193}Ir) 77 protons 116 neutrons 77 electrons 1 mark
[2]

(iii) *Height of each peak*: [2]
(^{191}Ir) 19 units (^{193}Ir) 31 units 1 mark
or (by ruler) 38 mm 62 mm
% abundance
(^{191}Ir) $\frac{19 \times 100}{50} = 38\%$ (^{193}Ir) $\frac{31 \times 100}{50} = 62\%$ 1 mark

(b) (i) Loss of an electron (from the nucleus). 1 mark [1]

(ii) Mass number 192 Symbol Pt 1 mark for each [2]

(c) (i) *Half-life* is the time taken for half the amount of material to decay.
1 mark [1]

(ii) Half-life of ^{192}Ir = 73 (± 1) days 1 mark [1]

(iii) 1.25 g left (10 → 5 → 2.5 → 1.25 g)
/ 3 half lives elapsed 1 mark

3 x 73 days = 219 days 1 mark
(2 marks for correct answer with no working. Mark consequentially on the half life obtained in (c) (ii)) [2]

(iv) Rate of decay of ^{192}Ir (g day^{-1}) during the first 20 days.

Mass decayed in 20 days = 10 – 8.3 = 1.7 g 1 mark

(Since for the first 20 days the line is indistinguishable from linear)
rate = 1.7 / 20 = 0.085 g day^{-1} 1 mark [2]
(No penalty if units omitted, but do not allow if wrong units given)

(d)	(i)		Sodium	Iridium	Chlorine	
		Moles	10.2 / 23 = 0.443	42.6 / 192 = 0.222	47.2 / 35.5 = 1.330	
					1 mark	
		Ratio	0.443 / 0.222	0.222 / 0.222	1.330 / 0.222	
		Hence	Na_2IrCl_6		1 mark	
						[2]

(ii) **P** is Na_2IrCl_6

So for $2NaCl + IrCl_x \rightarrow Na_2IrCl_6$

x must be 4 / $IrCl_4$ 1 mark [1]
(Mark consequentially if formula of P is incorrect)

Total [17]

8. (a) (i) **Reaction 1** is the most effective. 1 mark
Lowest number moles Na_2CO_3 needed per mole CO_2 /
Highest number moles CO_2 absorbed per mole Na_2CO_3 /
or equivalent statement 1 mark [2]

QWC The information is organised clearly and coherently, using specialist vocabulary where appropriate.
1 mark awarded if candidate has clearly explained their reasoning with appropriate use of words such as *mole* or *ratio*. [1]

(ii) Le Chatelier's Principle:
When a system in equilibrium is subjected to a change, the processes which occur are such as to oppose the effect of the change. 1 mark [1]
(or equivalent statement)

(iii) More efficient at high gas pressure. 1 mark
(Whichever reaction is used gases only occur amongst the reactants, so by Le Chatelier's Principle) high pressure will favour the forward reaction because of the reduction in the number of moles of gas.
1 mark [2]

(b) (i) Exothermic. 1 mark
As the temperature increases, less product ($NaHCO_3$) / more reactants (Na_2CO_3, CO_2 and H_2O) are present so reverse reaction is favoured and forward reaction must be exothermic
(or any equivalent statement) 1 mark [2]

(ii) I (${NaHCO_3}$ can be used to regenerate sodium carbonate) by heating (to 90°C) 1 mark [1]

II *Either*
Energy must be supplied for heating (with cost implications)
or
CO_2(g) would be released into the environment (unless prevention measures taken, negating the point of using sodium carbonate to absorb CO_2(g)). 1 mark [1]

(c)	(i)	Relative molecular mass CO_2 = 44	1 mark	
		No moles CO_2 = 275 / 44 = 6.25	1 mark	[2]
	(ii)	6.25 x 24.0 = 150 dm^3	1 mark	[1]
	(iii)	150 x 100 / 1000 = 15%	1 mark	[1]
(d)	(i)	An acid is an H^+ / proton donor.	1 mark	[1]
	(ii)	(Although CO_2 does not contain any hydrogen) it reacts with water to produce H^+ ions / to form carbonic acid / to form H_2CO_3.	1 mark	[1]
	(iii)	Carbon dioxide from air will produce H^+ ions / make the water acidic and acids have pH less than 7.	1 mark	[1]

Total [17]

9. *(a)* (i) 1 mark for setting up correctly

$$\Delta H^{\theta} = 243 + 436 - (2 \times 432)$$

1 mark for calculation

$$\Delta H^{\theta} = -185 \text{ kJ mol}^{-1}$$ [2]

(ii) ΔH_f^{θ} HCl (g) = - 185 / 2 = - 92.5 kJ mol^{-1} 1 mark [1]

(Mark consequentially if ΔH^{θ} value incorrect)

(iii) 2 x 1 mark for:

Temperature 25˚C / 298 K

Pressure 1 atm [2]

(iv) Chlorine – chlorine bond (as it is the weakest). 1 mark [1]

(v) Blue and violet light 2 x 1 mark

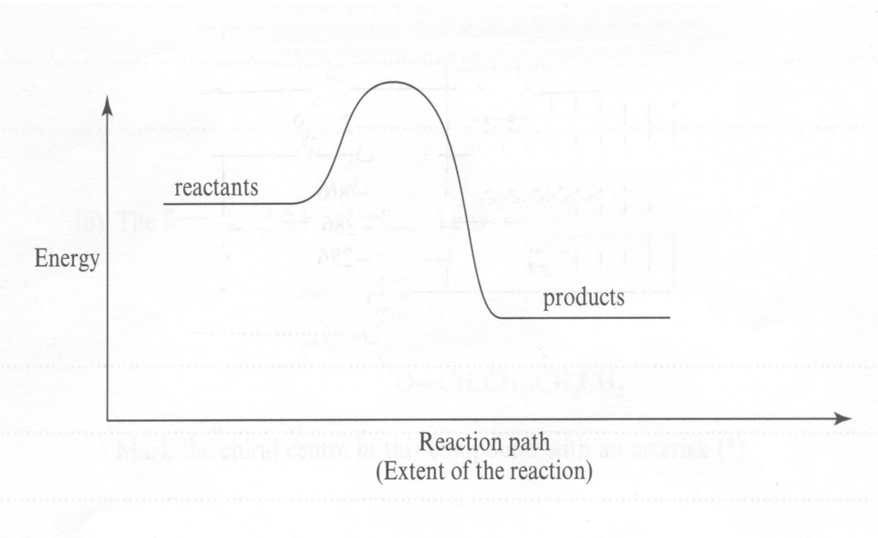
provide sufficient energy to break the

Cl_2 covalent bond 1 mark. [3]

(vi) No visible light has sufficient energy to break

the H-Cl bond. 1 mark [1]

(b)



6 x 1 mark:

- Correct drawing of profile (must be exothermic and show reactants / products)
- Activation Energy is the minimum energy necessary for a reaction to occur
- Increasing temperature increases the (kinetic) energy of molecules
- so more molecules have greater than the activation energy (and reaction speeds up)
- A catalyst lowers the activation energy
- so speeds up the reaction.
  (the points may be made in conjunction with the profile diagram). [6]

QWC Legibility of text; accuracy of spelling, punctuation and grammar, clarity of meaning. 1 mark

Selection of a form and style of writing appropriate to purpose and to complexity of subject matter. In particular, relating text to the profile diagram. 1 mark [2]

Total [18]

10. *(a)* Transfer of H^+ (from HCl to NH_3) 1 mark
HCl acid, NH_3 base 1 mark [2]

(b) (i) $$\Delta H = \frac{- v\ c\ \Delta T}{n}$$

1 mark for total volume = $50 cm^3$

1 mark for converting kJ to J (or vice versa)

1 mark for calculating n (*mark consequentially if set up wrongly above*)

$$-53.4 \times 1000 = \frac{- 50 \times 4.2 \times 0.7}{n}$$

n, no moles NH_3 = 2.75×10^{-3} [3]

(ii) 2.75×10^{-3} mol NH_3 in 25 cm^3

so concentration = 2.75×10^{-3} x 1000/25 = 0.11 mol dm^{-3}
1 mark [1]

(c) (i) Mean titre = 31.23 cm^3 1 mark

Concentration NH_3 = 31.23 x 0.100 / 25 = 0.125 cm^3
1 mark [2]

(ii) Titration will give the more precise value for concentration 1 mark

2 marks for two of the following:

Temperature change only read to one significant figure, titre to three significant figures / titration is a more precise technique than thermometry. 1 mark

The titration is repeated three times (to obtain consistent results), but only one measurement of temperature change. 1 mark

Thermometric method susceptible to heat loss (but no corresponding problem in titrations). 1 mark [3] *(d)* (i) Both already elements in their standard states / no change needed to form them. 1 mark [1]

(ii) I the standard enthalpy change, $\Delta H^{\ominus}$, for the combustion of ammonia

$4NH_3\,(g) + 3O_2\,(g) \rightarrow 2N_2\,(g) + 6H_2O\,(g)$

1 mark for setting up

$\Delta H^{\ominus} = (2 \times 0) + (6 \times -241.8) - (4 \times -46.1) - (3 \times 0)$

1 mark for calculation

$\Delta H^{\ominus} = -1450.8 + 184.4 = -1266.4\ kJ\ mol^{-1}$ [2]

II the standard enthalpy change, $\Delta H^{\ominus}$, for the combustion of methane

$CH_4\,(g) + O_2\,(g) \rightarrow CO_2\,(g) + 2H_2O\,(g)$

1 mark for setting up

$\Delta H^{\ominus} = (1 \times -393.5) + (2 \times -241.8) - (1 \times -74.8) - (1 \times 0)$

1 mark for calculation

$\Delta H^{\ominus} = -393.5 - 483.6 + 74.8 = -802.3\ kJ\ mol^{-1}$ [2]

(iii) Advantage of using ammonia:
No CO_2 / greenhouse gases emitted 1 mark

Disadvantage of using ammonia:
Much less energy produced per mole on combustion (318.6 v $802.3\ kJ\ mol^{-1}$) /more ammonia needed than methane to produce the same amount of energy /sharp smell of ammonia/ ammonia more corrosive. 1 mark [2]

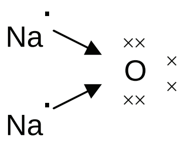
Total [18]

Section B Total [70]

CH2

Section A

1.	D			[1]
2.	D			[1]
3.	$BeCl_2$	2	(1)	
	PCl_3	pyramidal	(1)	
	CCl_4	tetrahedral	(1)	[3]

4. 

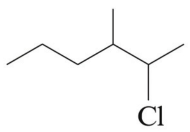
(1)

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

5. Mass in 100 g water = 41 g (1)

Mass in 50 g water = 20.5 g (1) [2]

6.



[1]

Section A Total [10]

Section B

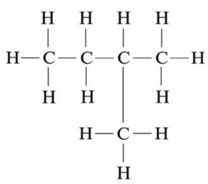
7. (a) Long chain hydrocarbons have more/stronger intermolecular forces (1)
- **van der Waals** forces specified (1)
Higher temperatures/more energy required to break these forces (1) [3]

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

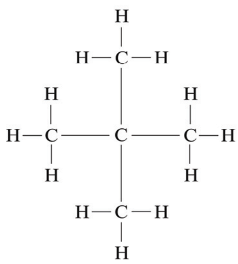
(b) (i) Alkanes [1]

(ii) I Same molecular formula (1)
different structure / arrangement / structural formula / displayed formula (1) [2]

II



(1)



(1)

2-methylbutane (1) 2,2-dimethylpropane (1) [4]

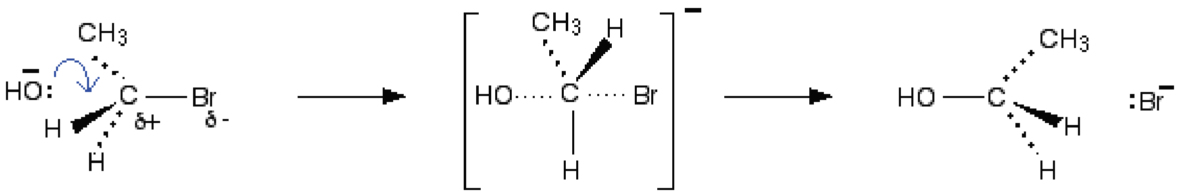
(c) Breaking down of a long chain hydrocarbon into smaller ones (1)

Which are more useful / one of which is an alkene (1) [2]

Total [13]

8.	(a)	(i)	Chlorofluorocarbon		[1]
		(ii)	Anaesthetics / propellants in aerosols / cleaning solvents / blowing plastics / fire extinguishers		[1]
		(iii)	I	A species / atom / molecule with an unpaired electron	[1]
			II	C – F bond stronger than C – Cl bond	[1]
		(iv)	I	To neutralise the sodium hydroxide	[1]
			II	Silver nitrate	[1]
			III	Cream precipitate	[1]
			IV	$Ag^{+} + Br^{-} \longrightarrow AgBr$	[1]

(b)



Reactants: Polarisation (1) curly arrow (1)	Intermediate (1) (accept curly arrow to show C-Br breaking instead of –ve charge)	[3]

(c)	(i)	Ethene	[1]
	(ii)	In alcohol (and heat)	[1]

Total [13]

9. (a)

	C :	H :	O	
%	54.5	9.10	36.4	(1)
moles	4.54	9.01	2.28	(1)
ratio	1.99	3.95	1	

empirical formula = C_2H_4O (1)

molecular formula = $C_4H_8O_2$ (1) [4]

(b) (i) Absorption at about 3300 cm^{-1} characteristic of OH group [1]

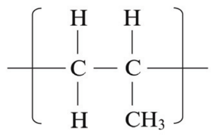
(ii) Propanoic acid (1)

Absorption at around 1700 cm^{-1} due to C = O group (1) [2]

(c) (Concentrated) sulphuric acid / phosphoric acid / aluminium oxide [1]

(d) Add bromine (water) (1)
turns from brown to colourless (1) [2]

(e)



[1]

(f) PVC / Polystyrene / PTFE [1]

Total [12]

10. (a) (i) Ability to attract electrons in a covalent bond/a shared electron pair [1]

(ii) Increases [1]

(iii) Increase in number of protons / charge on the nucleus (1)

But same number of electron shells / no increase in shielding (1)

Greater power to attract (bonding pair of) electrons (1) [2]

(1^{st} marking point + 1 other)

(b) (i) Increases from group I to group IV, large decrease to group V, slight decrease / not much change to group VII [2]
(All three trends 2 marks, any two trends 1 mark)

(ii) 930 – 1650 K [1]

(iii) Mg has more outer electrons (1)

Therefore stronger bonds since it has more delocalised (valence) electrons / stronger metallic bond (1) [2]

(iv) Electron cloud / molecular size increases down group (1)

Greater van der Waals / induced dipole forces need to be overcome (1) [2]

(c) Giant molecular structure (or similar) (1)

with strong covalent bonds between atoms (1) [2]

Total [13]

11. (a) (i) I Stream of bubbles / fizzing (1)
White precipitate / cloudiness (1)
Calcium sinks and rises (1)
(any 2 from 3) [2]

II $Ca + 2H_2O \longrightarrow Ca(OH)_2 + H_2$ [2]

products (1) balancing (1)

III More reactive (1)
Electrons in strontium lost more easily / ionisation energy is less (1)
(Must have reason to obtain 1st mark)
(More reactive as reactivity increases down group – (1) only)
[2]

(ii) I No. moles = $\frac{2 \times 20}{1000}$ = 0.04 [1]

II Moles Ca = 0.02 (1)

Mass Ca = 0.02 x 40.1 = 0.802 g (1) [2]

III Flame test (1)

Flame turns brick-red (1) [2]

(b) Sodium is too reactive to add to acid (1)

Hydrochloric acid + sodium hydroxide / sodium carbonate (1) [2]

(c) Calcium chloride conducts electricity when molten / in solution (1)

Calcium conducts electricity when (molten or) solid (1)

When molten, ions in calcium chloride are mobile (1)

Calcium has delocalised electrons in solid state (1) [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]

Total [19]

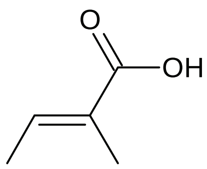
Section B Total [70]

CH4

SECTION A

1. (a) (i) Isomers whose atoms / groups take up different positions in space. [1]

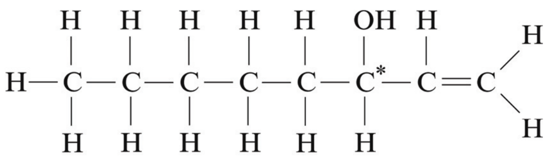
(ii)



[1]

(iii) Ethanol (1) in the presence of (concentrated) sulfuric acid / hydrogen chloride (acting as a catalyst). (1) [2]

(b) (i)



[1]

A carbon atoms that has four different groups / atoms bonded to it [1]

(ii) They rotate the plane of polarised light (in opposite directions) [1]

(iii) An equimolar / equal masses of the two enantiomers (1)

No (apparent) effect on the plane of polarised light (1) [2]

(c) (i) I Groups / atoms that are responsible for the absorption of (visible) light / giving colour [1]

II It absorbs 'blue' light / all other colours of the visible spectrum /transmits orange [1]

(ii) The CH_2 protons 'see' three protons on the adjacent CH_3 group and by the n+1 rule are split into a quartet. (1)
The CH_3 protons 'see' two protons on the adjacent CH_2 group and by the n+1 rule are split into a triplet. (1) [2]

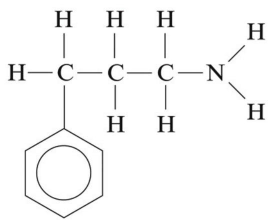
Total [13]

2. (a) (i) (Aqueous) sodium hydroxide – do not allow ‘OH^-’ [1]

(ii) Potassium / sodium cyanide – do not allow ‘CN^-‘ [1]

(iii) Elimination / dehydration [1]

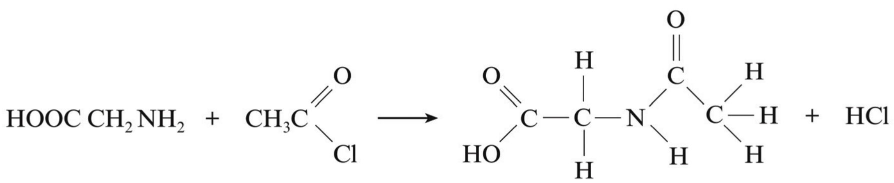
(iv)



[1]

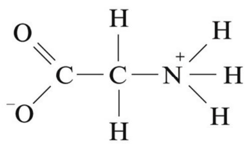
(b) Compound **T** (1); this has protons in only ‘two’ environments, ∴ 2 peaks (1) [2]

(c) (i)



balanced (1) correct displayed structure of ethanoyl derivative (1) [2]

(ii)



[1]

(d) The secondary structure results from hydrogen bonding (1). This occurs between the N – H and C = O groups of the polypeptide chain(s) (1) [2]

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

Total [12]

3. (a) (i) e.g. (Thorough) mixing of the solution [1]

(ii) Number of moles of

NaOH = $\frac{26.25 \times 0.100}{1000}$ = 0.002625 / 2.625 x 10^{-3} (1)

Number of moles of CH_3COOH is also 0.002625 (1)

Concentration of the diluted solution

= $\frac{1000 \times 0.002625}{25.00}$ = 0.105 mol dm^{-3} (1)

Concentration of the undiluted solution

= 10 x 0.105 = 1.05(0) mol dm^{-3} (1) [4]

(b) Conditions although the temperatures are the same / moderate, method 2 needs higher pressures (1) (or vice versa)

Yield / Products Method 1 gives a higher yield / Method 2 gives a lower yield (1)
Method 1 gives few or no co-products / Method 2 gives a number of co-products (1)
The atom economy of the naphtha method is low (1)
There will be problems of the separation of products if method 2 is used (1)

- maximum 4 marks [4]

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

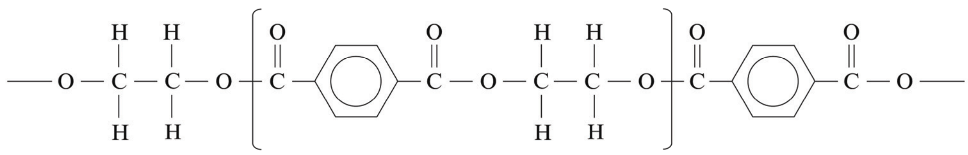
(c)

$CH_3(CH_2)_{10}COOCH_2$
|
$CH_3(CH_2)_{10}COOCH$
|
$CH_3(CH_2)_{10}COOCH_2$ [1]

(d) ethyl palmitate is **c** (1)

because R_f = $\frac{3.6}{6.0}$ = 0.60 (1) [2]

(e)



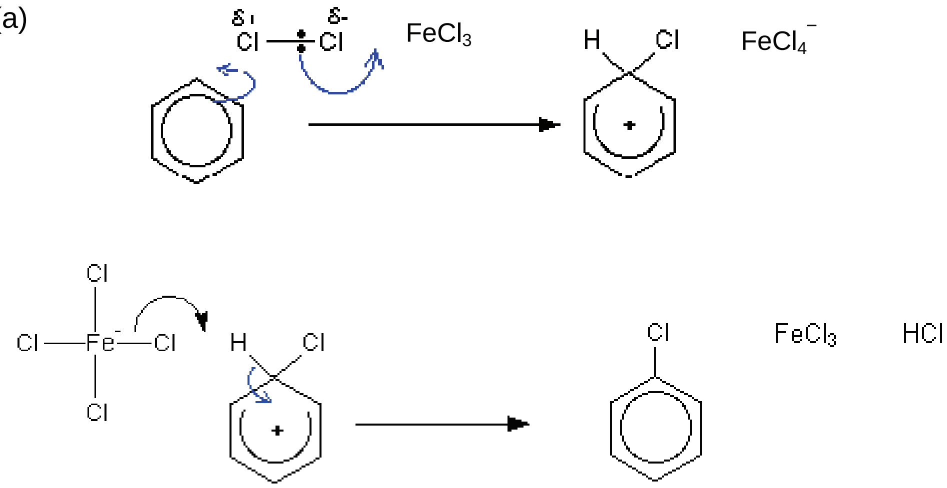
repeating unit (1) structure (1) [2]

Total [15]

Section A Total [40]

SECTION B

4. (a)



correct use of curly arrows (1)
polarisation of chlorine (1)
Wheland intermediate (1)
mechanism shows loss of H^+ or HCl (1)

[4]

(b) The chlorine lone pairs interact with the ring electrons (1)
strengthening the C – Cl bond / decreasing the C – Cl bond polarity (1)
making it less susceptible to nucleophilic attack (1) [3]

(c) (i) 2-propylbenzene / 2-phenylpropane / cumene [1]

(ii) Apart from phenol there is another product (1), the M_r of phenol and propanone are similar / OWTTE (1) [2]

(iii) Propanone would give a peak at ~ 1650 –1750 cm^{-1} (1)
due to the C = O bond (1) [2]

(iv) Purple colour / solution (1)
Ethanol does not react with $FeCl_3$ solution / ethanol is a polar solvent and will dissolve phenol / ethanol does not react with phenol (1) [2]

(v) An orange / red precipitate produced (1)
Melting temperature taken (1) and compared with literature value (1) [3]

(vi)

$CH_3CH_2COCH_2CH_3$	M_r 86 (1)
$CH_3CH_2^+$	m/e 29 (1)
$CH_3CH_2CO^+$	m/e 57 (1)

Total [20]

5. (a) (i)

e.g. $CH_3CH_2CH_2CH_2Br + 2NH_3 \longrightarrow CH_3CH_2CH_2CH_2NH_2 + NH_4Br$ [1]

accept one mole of ammonia as a reactant and one mole of HX as a product

(ii) In the liquid phase butylamine molecules are attracted to each other (mainly) by hydrogen bonding (1). This is because the – NH_2 group is polar / correct mention of electronegativity / polarity shown in a diagram (1).
Attraction occurs between the nitrogen (lone pair) / (atom) of one molecule and the δ+ hydrogen atom of another molecule (could be seen in a diagram) (1).
∴ stronger forces between molecules / more energy needed to separate molecules (and hence a higher boiling temperature). (1) [4]

(iii) The indicator turns blue / purple (1). This is because butylamine / amines are basic (1), as the lone pair on the nitrogen atom is a proton acceptor / or nitrogen is an electron pair donor (could be seen on a diagram) (1). [3]

(b) (i) 105 kg of ammonium butanoate gives 87 kg of butanamide
∴ 1 kg of ammonium butanoate gives $\frac{87}{105}$ kg of butanamide

∴ 50.0 kg of ammonium butanoate gives $\frac{87 \times 50.0}{105}$ kg of butanamide = 41.4 kg (1)

% yield = $\frac{26.9 \times 100}{41.4}$ (1) = 65 (1) [3]

(ii) I To see if the results are reproducible. [1]

II See if the reaction time can be reduced. [1]

(c) (i) The (orange) mixture turns green (1) as the ethanol has reduced the acidified dichromate (to green Cr^{3+} (aq)). (1) [2]

(ii) Ethanol gives a mixture of ethanal (1) and ethanoic acid (1).
The ethanal present will give a silver mirror with Tollens' reagent (1)
The ethanoic acid present will fizz / effervesce / produce CO_2 when sodium hydrogencarbonate or carbonate is added (1) [4]
(Accept responses based on Fehlings' / Benedict's reagents, acidified dichromate, 2,4-dinitrophenylhydrazine and iodoform test.)

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

Total [20]

Section B Total [40]

WJEC
245 Western Avenue
Cardiff CF5 2YX
Tel No 029 2026 5000
Fax 029 2057 5994
E-mail: exams@wjec.co.uk
website: www.wjec.co.uk