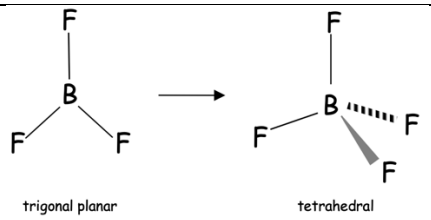
# Past Papers Advanced Higher Chemistry

# 2018 Marking Scheme

| Grade Awarded | Mark Required | | % candidates achieving grade |
|---|---|---|---|
| | (/130) | % | |
| A | 88+ | 67.7% | 31.5% |
| B | 73+ | 56.2% | 27.6% |
| C | 59+ | 45.4% | 23.2% |
| D | 52+ | 40% | 8.1% |
| No award | <52 | <40% | 9.6% |

| Section: | Multiple Choice | Extended Answer | Project |
|---|---|---|---|
| Average Mark: | 18.8 /30 | 39.3 /70 | 19.1 /30 |

# 2018 Adv Higher Chemistry Marking Scheme

| MC Qu | Answer | % Pupils Correct | Reasoning |
|---|---|---|---|
| 1 | A | 97 | ☑A Beta particles which are electrons emitted from the nucleus<br>☒B Gamma rays are a form of electromagnetic radiation with wavelength & frequency<br>☒C Infrared is a form of electromagnetic radiation with wavelength & frequency<br>☒D ultraviolet is a form of electromagnetic radiation with wavelength & frequency |
| 2 | D | 98 | ☒A s-block is found in groups 1+2 of the periodic table<br>☒B p-block is found in groups 2 through to group 0 of the periodic table<br>☒C d-block is found between groups 2+3 of the periodic table (transition metals)<br>☑D f-block is the two groups at the bottom of periodic table (Actinides and Lanthanides) |
| 3 | A | 35 | The d-orbital shown ($d_{xy}$) in the question will hold a maximum of two electrons. |
| 4 | D | 55 |  |
| 5 | B | 38 | Ni atom: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^8\ 4s^2$ ∴ $Ni^{2+}$ ion: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^8$<br>☒A $Ni^{2+}$ ions have 8 electrons in the 3d shell as 4s electrons are removed before 3d<br>☑B The six electrons occupy the three lower 3d orbitals after 3d splits into 2 levels<br>☒C The ligands in the complex split the 3d orbitals into two levels.<br>☒D $Ni^{2+}$ ions have 8 electrons in the 3d shell as 4s electrons are removed before 3d |
| 6 | C | 89 | ☒A Oxidation number of Mn in $MnO_4^-$ = +7<br>☒B Oxidation number of Mn in $MnO_4^{2-}$ = +6<br>☑C Oxidation number of Mn in $MnO_4^{3-}$ = +5<br>☒D Oxidation number of Mn in $MnO_2$ = +4 |
| 7 | A | 65 | ☑A increase in temperature decreases K and decreases concentration of $SO_2$<br>☒B increase in temperature favours reverse endothermic reaction ∴ less products<br>☒C increase in temperature favours reverse endothermic reaction ∴ K decreases<br>☒D increase in temperature favours reverse endothermic reaction ∴ K decreases |
| 8 | D | 65 | $H_2CO_3$ + $CN^-$ ⇌ HCN + $HCO_3^-$<br>Acid (Donates $H^+$) — Base (Accepts $H^+$) — Conjugate Acid (Formed when Base accepts $H^+$) — Conjugate Base (Formed when Acid loses $H^+$) |
| 9 | B | 54 | pH = 8.5 ∴ $-\log_{10}[H^+] = 8.5$ ∴ $\log_{10}[H^+] = -8.5$ ∴ $[H^+] = 10^{-8.5} = 3.16\times10^{-9}$ mol $l^{-1}$<br>$[H^+]\,[OH^-] = 10^{-14}$ ∴ $[OH^-] = \frac{10^{-14}}{[H^+]} = \frac{1\times10^{-14}}{3.16\times10^{-9}} = 3.16\times10^{-6}$ mol $l^{-1}$ |
| 10 | C | 58 | ☒A Catalysts do not change the position of equilibrium<br>☒B $H_3O^+$ ions are a product so adding sulphuric acid will shift equilibrium to left<br>☑C NaOH neutralises $H_3O^+$ ions so removing a product and shifts equilibrium to right<br>☒D $C_3H_7COO^-$ ions are a product so adding sulphuric acid will shift equilibrium to left |
| 11 | D | 48 | ☒A sodium sulphate solution is neutral pH=7 (strong acid v strong alkali)<br>☒B lithium chloride solution is neutral pH=7 (strong acid v strong alkali)<br>☒C ammonium nitrate solution is acidic pH<7 (strong acid v weak alkali)<br>☑D potassium propanoate solution is alkaline pH>7 (weak acid v strong alkali)<br>$H^+$ ions join up with propanoate ions to form molecules of propanoic acid. Water molecules then split into ions to replace $H^+$ ions but concentration of $OH^-$ builds up as $H^+$ is removed. |

**12 B 74**

☒A sodium chloride is made from a strong alkali so no buffer forms
☑B buffers form when salt of a weak alkali (ammonium chloride) dissolves in a weak acid (ammonia)
☒C sodium hydroxide is a strong acid and no buffer forms
☒D sodium hydroxide is a strong acid and no buffer forms

**13 D 54**

$\Delta G = \Delta H - T\Delta S \therefore \Delta G - \Delta H = -T\Delta S$

If $\Delta G - \Delta H$ is approximately zero then $-T\Delta S$ must also be approximately xero. This means $\Delta S$ must be approximately zero then there must be little change to disorder during the reaction.

☒A $CO_2$ gas released which increases disorder and increases $\Delta S$
☒B Two gases formed from a solid which increases disorder and increases $\Delta S$
☒C $H_2$ gas released which increases disorder and increases $\Delta S$
☑D Solid and an ion turning into a solid and an ion keeps disorder level ($\Delta S$) similar

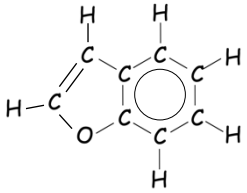
**14 B 66**

☒A The overall order is the sum of the individual orders ∴ overall order = 1+2 =3
☑B This reaction must have second step as equal no. of moles of P + Q are used up in the equation but the rate determining step has two particles of Q reacting with one particle of P. A second particle of P must react in the other step.
☒C Rates of reaction always decrease as concentration of reactants decreases
☒D As P is first order then doubling [P] will double the rate of reaction

**15 B 57**

| Bond | C–H | C–C | C≡C |
|---|---|---|---|
| Type of hybridisation | $sp^3$ hybridisation | $sp^3$ hybridisation | sp hybridisation |

**16 C 63**



formula $C_8H_6O$

gfm = (8x12) + (6x1) + (1x16) = 96+6+16 = 118g

**17 A 39**

☑A W and X in same position in both diagrams but Z and Y in opposite positions
☒B XYZ on bottom are in in same anti-clockwise as comparison diagram.
☒C XYZ on bottom are in in same anti-clockwise as comparison diagram.
☒D XYZ on bottom are in in same anti-clockwise as comparison diagram.

**18 A 27**

☑A sodium + butan-1-ol react to form sodium butoxide $CH_3CH_2CH_2CHO^-Na^+ + H_2$
☒B sodium + butanoic acid would form sodium butanoate + hydrogen
☒C sodium hydroxide does not react with alcohols
☒D sodium hydroxide + butanoic acid would form sodium butanoate + hydrogen

**19 C 44**

☒A Hydration: Adding water across a double or triple bond
☒B Oxidation: Increasing the oxygen : hydrogen ratio in a compound
☑C Hydrolysis: spitting into two molecules with water added at break
☒D Hydrogenation: Adding hydrogen across a double bond or triple bond

**20 B 72**

| Element | Cu | O |
|---|---|---|
| Mass | 16g | 2g |
| No. of moles (divide % by gfm) | $\frac{16}{63.5}$ = 0.252 | $\frac{2}{16}$ = 0.125 |
| Mole ratio (divide through by smallest value) | $\frac{0.252}{0.125}$ = 2.02 | $\frac{0.125}{0.125}$ 1.00 |
| Round to Whole Number | 2 | 1 |

**21 C 81**

☒A gfm $CH_3OCOCH_3$ = (3x12)+(6x1)+(2x16) = 36+6+32 = 74g
☒B gfm $CH_3CH_2COOH$ = (3x12)+(6x1)+(2x16) = 36+6+32 = 74g
☑C gfm $CH_3CH_2CH_2CH_2NH_2$ = (4x12)+(11x1)+(1x14) = 48+11+34 = 73g
☒D gfm $CH_3CH(OH)CH_2CH_3$ = (4x12)+(10x1)+(1x16) = 48+10+16 = 74g

**22 C 84**

☒A Absorption peak at 3100 – 3000$cm^{-1}$ due to C-H stretch in benzene ring
☒B Absorption peak at 2962 – 2853$cm^{-1}$ due to C-H stretch in an alkane
☑C No absorption peak at 1730 – 1717$cm^{-1}$ as there is no C=O aromatic ester in eugenol
☒D Absorption peak at 1150 – 1070$cm^{-1}$ due to C-O stretch in alkyl ether

| | | | |
|---|---|---|---|
| 23 | A | 96 | ☑A Agonist: Binds to the receptor and causes an internal response in the cell<br>☒B Antagonist: Bind to the receptor but does not cause internal response in the cell<br>☒C Inhibitor: Block the substrate from entering the receptor<br>☒D Receptor: Protein in membrane of cells that allows molecules to bind with it. |
| 24 | B | 54 | **n**o. of mol = **v**olume x **c**oncentration = 0.05litres x 2 mol $l^{-1}$ = 0.1mol<br>**c**oncentration = $\frac{\textbf{n}\text{o. of mol}}{\textbf{v}\text{olume}} = \frac{0.1\text{ mol}}{0.25\text{litres}} = 0.4\text{ mol } l^{-1}$ |
| 25 | B | 75 | ☒A $CH_3CH_2CH_2CH_2CHO$ is an aldehyde and is miscible with water<br>☑B $CH_3CH_2OCH_2CH_2CH_3$ is an ether and is immiscible with water<br>☒C $CH_3CH_2CH_2CH_2COOH$ is an carboxylic acid and is miscible with water<br>☒D $CH_3CH(OH)CH_2CH_2CH_3$ is an alcohol and is miscible with water |
| 26 | D | 52 | ☒A This is a step in a recrystallisation technique<br>☒B This is a step in a recrystallisation technique<br>☒C This is a step in a recrystallisation technique<br>☑D This is a step in gravimetric analysis to show all dissolved ion has precipitated. |
| 27 | B | 62 | ☒A Purification should give a melting point over a narrower range<br>☑B Recrystallisation raises the melting point and narrows the temperature range<br>☒C Impurities lower the melting point so purification raises the melting point<br>☒D Impurities lower the melting point so purification raises the melting point |
| 28 | C | 82 | ☒A Desiccators remove moisture from the atmosphere not oxygen<br>☒B Heating the sample removes water from the sample, not the desiccator.<br>☑C While sample is cooling in desiccator, moisture cannot be reabsorbed by the sample<br>☒D Desiccators do not prevent decomposition of sample, probably in the heating stage |
| 29 | D | 33 | ☒A The distance moved by the solvent does not alter the value of the $R_f$ value<br>☒B The sample will move the same distance regardless of concentration<br>☒C The length of TLC plate is not a factor in the $R_f$ value<br>☑D The solvent used decides how far the sample moves and the $R_f$ value. |
| 30 | C | 63 | ☒A Distillation separates the chemicals while refluxing returns the chemical to flask<br>☒B Distillation separates the chemicals while refluxing returns the chemical to flask<br>☑C Coldest water (from tap) should be nearest hot vapours entering condenser<br>☒D If the water travels against the flow in condenser arm then the hottest water is nearest the flask and the vapour will travel further up the condenser |

# 2018 Adv Higher Chemistry Marking Scheme

## 1a(i)

**Answer:** sodium

**Reasoning:** From page15 of data booklet: FLAME COLOURS

| Element | Barium | Calcium | Copper | Lithium | Potassium | Sodium | Strontium |
|---|---|---|---|---|---|---|---|
| Wavelength /nm | 554 | 620 | 522 | 671 | 405 | 589 | 650 |
| Colour | green | orange-red | blue-green | crimson | lilac | orange-yellow | red |

## 1a(ii)

**Answer:** 425nm

**Reasoning:**

$$E = \frac{L \times h \times c}{\lambda} \quad \therefore \lambda = \frac{L \times h \times c}{E} = \frac{6.02\times10^{23}\,mol^{-1} \times 6.63\times10^{-34}\,J\,s \times 3\times10^{8}\,m\,s^{-1}}{282 \times 1000\,J\,mol^{-1}}$$

$$= 4.25 \times 10^{-7}\,m$$

$$= 425\,nm$$

## 1a(iii)

**Answer:** 87

**Reasoning:**

Relative Intensity 375 ⟷ 435mg $kg^{-1}$

Relative Intensity 75 ⟷ 435mg $kg^{-1} \times {}^{75}/_{375}$

$= 87mg\ kg^{-1}$

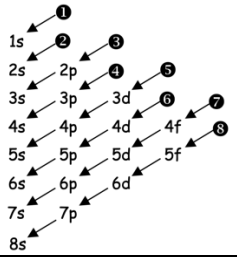
## 1b(i)

**Answer:** Orbitals fill up in order of increasing energy

**Reasoning:**

Aufbau Principle:
Electrons fill up in order of increasing energy:

1s 2s 2p 3s 3p 4s 3d 4p 5s 4d 5p 6s 4f 5d 6p 7s 5f 6d 7p 8s




## 1b(ii)

**Answer:**

| n | l | $m_l$ | $m_s$ |
|---|---|---|---|
| 3 | 1 | -1 or 0 or +1 | $+\frac{1}{2}$ or $-\frac{1}{2}$ |

**Reasoning:**

| | | |
|---|---|---|
| n | Principal Quantum Number | n = Electron Shell Number |
| l | Angular Momentum Quantum Number | l = Type/Shape of subshell where l goes from 0 up to n-1 |

| l = 0 | l = 1 | l = 2 | l = 3 |
|---|---|---|---|
| s subshell | p subshell | d subshell | f subshell |

$m_l$ is the orientation of the subshell where $m_l$ goes from -l to +l

| $m_l$ | Magnetic Quantum Number | Value of l | Subshell type | Value of $m_l$ | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 0 | s | | | | 0 | | | |
| | | 1 | p | | | -1 | 0 | 1 | | |
| | | 2 | d | | -2 | -1 | 0 | 1 | 2 | |
| | | 3 | f | -3 | -2 | -1 | 0 | 1 | 2 | 3 |

| | | |
|---|---|---|
| $m_s$ | Spin Quantum Number | $m_s$ is the spin direction of an electron and has either value of $+\frac{1}{2}$ or $-\frac{1}{2}$ |

## 2a(i)

**Answer:** $K_a = \frac{[HOOCCH_2CH(OH)COO^-]\,[H_3O^+]}{[HOOCCH_2CH(OH)COOH]}$

**Reasoning:**

$H_2O$ is both a reactant and the solvent $\therefore [H_2O] = 1$

$$K_a = \frac{[HOOCCH_2CH(OH)COO^-]^1 \times [H_3O^+]^1}{[HOOCCH_2CH(OH)COOH]^1 \times [H_2O]^1} = \frac{[HOOCCH_2CH(OH)COO^-]\,[H_3O^+]}{[HOOCCH_2CH(OH)COOH]}$$

## 2a(ii)

**Answer:** Equation showing:

**Reasoning:**

$$HOOCCH_2CH(OH)COO^- + H_2O \rightleftharpoons {}^-OOCCH_2CH(OH)COO^- + H_3O^+$$

## 2b(i)

**Answer:** 2.90

**Reasoning:**

$$pH = \tfrac{1}{2}pK_a - \tfrac{1}{2}\log_{10} c$$
$$= -\tfrac{1}{2}\log_{10}K_a - \tfrac{1}{2}\log_{10} c$$
$$= -\tfrac{1}{2}\log_{10}(3.2\times10^{-4}) - \tfrac{1}{2} \times \log_{10}(0.0051)$$
$$= (-\tfrac{1}{2} \times -3.49) - (\tfrac{1}{2} \times -2.29)$$
$$= 1.75 - (-1.15)$$
$$= 2.90$$

## 2b(ii)

**Answer:** Hydrogen bonding between chains

**Reasoning:** Each unit within a pectin chain has two hydroxyl -OH groups which would allow hydrogen bonding between the pectin chains and thicken the jam.

## 3a

**Answer:** All four of the following required:

| | | | |
|---|---|---|---|
| Dissolve sodium carbonate in deionised water | Transfer the solution and the rinsings | Use of a 250$cm^3$ standard/volumetric flask | Make up to the line flask with deionised water |

## 3b(i)

0.0348mol

Average titre = $\frac{19.5 + 19.4}{2}$ = 19.45 $cm^3$

**no.** of mol = **v**olume x **c**oncentration = 0.01945 litres x 0.358 mol $l^{-1}$ = $6.97 \times 10^{-3}$ mol

$$Na_2CO_3 + 2HCl \longrightarrow 2NaCl + H_2O + CO_2$$

1mol : 2mol

$3.48 \times 10^{-3}$ mol : $6.97 \times 10^{-3}$ mol

$25cm^3$ sodium carbonate solution $\longleftrightarrow$ $3.48 \times 10^{-3}$ mol

$250cm^3$ sodium carbonate solution $\longleftrightarrow$ $3.48 \times 10^{-2}$ mol

## 3b(ii)

7

gfm $Na_2CO_3$ = (2x23)+(1x12)+(3x16) = 46+12+48 = 106g

**m**ass = **n**o. of mol x **gfm** = 0.0348 x 106 = 3.69g

mass of water = mass of hydrated sodium carbonate - mass of unhydrated sodium carbonate

mass of water = 8.10g - 3.69g

mass of water = 4.41g

| Chemical | $Na_2CO_3$ | $H_2O$ |
|---|---|---|
| Mass | 3.69g | 4.41g |
| no. of mol (divide by gfm) | $\frac{3.69}{106}$ = 0.0348 | $\frac{4.41}{18}$ = 0.245 |
| Divide by smallest value | $\frac{0.0348}{0.0348}$ = 1 | $\frac{0.235}{0.0348}$ = 7.04 |

Formula of hydrated sodium carbonate: $Na_2CO_3 \cdot 7H_2O$

## 3c

Open Question to include:

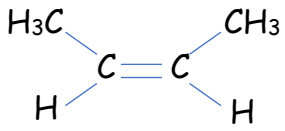
| 3 mark answer | 2 mark answer | 1 mark answer |
|---|---|---|
| Demonstrates a **good understanding** of the chemistry involved. A good comprehension of the chemistry has provided in a logically correct, including a statement of the principles involved and the application of these to respond to the problem. | Demonstrates a **reasonable understanding** of the chemistry involved, making some statement(s) which are relevant to the situation, showing that the problem is understood. | Demonstrates a **limited understanding** of the chemistry involved. The candidate has made some statement(s) which are relevant to the situation, showing that at least a little of the chemistry within the problem is understood. |

## 4a

One answer from:

| Unpaired d electrons | Empty/half-filled/incomplete d orbitals | Variable oxidation states | Donating and accepting electrons |
|---|---|---|---|

## 4b




structural formula

Skeletal formula

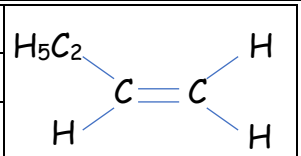
## 4c

One answer from:

But-1-ene has two hydrogens on one end of C=C

But-1-ene has three hydrogens attached to C=C

Swapping any of the groups on the C=C always results in the same structure




## 4d(i) PART A

-126 kJ $mol^{-1}$

$\Delta H^\circ$ = $\Sigma \Delta H_f^\circ$(products) - $\Sigma \Delta H_f^\circ$(reactants)

= (1x-6.99) - ( (1x119)+(1x0) )

= -6.99 - ( 119 + 0 )

= -6.99 - 119

= -125.99 kJ $mol^{-1}$

## 4d(i) PART B

-23.2 J $K^{-1}$ $mol^{-1}$

$\Delta G^\circ$ = $\Sigma \Delta G^\circ$(products) - $\Sigma \Delta G^\circ$(reactants)

= (1x-65.9) - ( (1x185)+(1x0) )

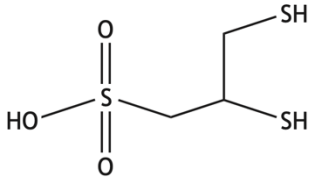
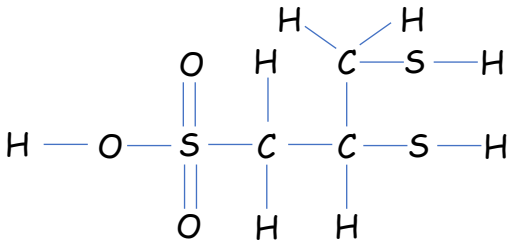
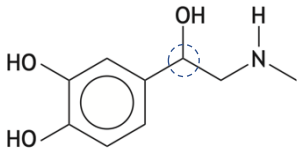
= -65.9 - ( 185 + 0 )

= -65.9 - 185

= -119.1 kJ $mol^{-1}$

$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$ $\therefore \Delta S^\circ = \frac{\Delta G^\circ - \Delta H^\circ}{-T} = \frac{-119.1 - 126}{-298}$ = -0.0232 kJ $K^{-1}$ $mol^{-1}$

= -23.2 J $K^{-1}$ $mol^{-1}$

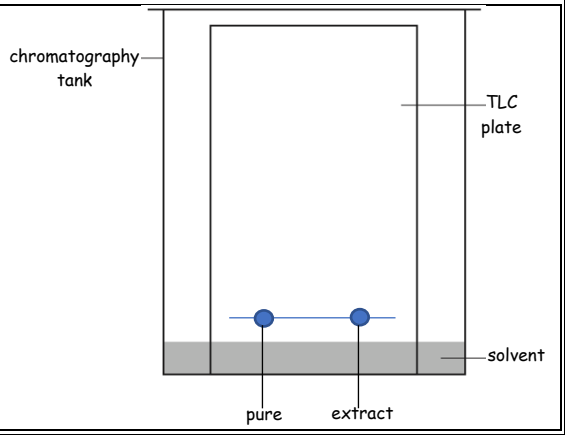
| | | |
|---|---|---|
| **4d(ii)** | 5431 | The reaction becomes thermodynamically feasible when $\Delta G^\circ = 0$<br>$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ = 0 \quad \therefore T\Delta S^\circ = \Delta H^\circ \quad \therefore T = \frac{\Delta H^\circ}{\Delta S^\circ} = \frac{-126 \times 1000 \text{ J mol}^{-1}}{-23.2 \text{ J K}^{-1} \text{ mol}^{-1}} = 5431\text{K}$ |
| **5a** | Conjugated system | A conjugated system is a section of a compound with alternating C=C double bonds and C-C single bonds. |
| **5b** | Answer to include: | 1st Mark: Electrons move from HOMO (Highest Occupied Molecular Orbital) to LUMO (Lowest Unoccupied Molecular Orbital)<br>2nd Mark: Absorption of light (from the visible part of the spectrum) means that light of the complementary colour is seen |
| **5c** | Answer to include: | 1st Mark: One from: less conjugation; a shorter sequence of alternating double and single bonds; a smaller chromophore<br>2nd Mark: Larger gap between HOMO and LUMO and greater energy (absorbed) as shorter wavelength has greater energy |
| **6a** | One answer from: | Ligands donate pairs of electrons to metal atom (lone pairs or non-bonding pair) / Ligands form dative covalent bonds with metal ion |
| **6b(i)** | $C_3H_8O_3S_3$ |  <br>Skeletal Formula<br>  <br>Full Structural Formula |
| **6b(ii)** PART A | Bidentate | An electron pair on each Sulphur in the thiol -SH groups donate one of their lone pairs to the Mercury ion and forms a dative covalent bond. |
| **6b(ii)** PART B | 4 | Each DMPS ligand molecule donates lone pairs of from two of its sulphur atoms to give four dative covalent bonds on the Mercury ion in the centre. |
| **6c(i)** | Gravimetric | Gravimetric analysis involves measuring the mass accurately to calculate the number of moles of substances. |
| **6c(ii)** | 96.1% | $\text{no. of mol} = \frac{\textbf{mass}}{\textbf{gfm}} = \frac{4.82\text{g}}{388.7 \text{ g mol}^{-1}} = 0.0167\text{mol}$<br>0.0167mol complex contains 0.0167mol Ni ions<br>$\textbf{mass of Ni} = \textbf{no. of mol} \times \textbf{gfm} = 0.167\text{mol} \times 58.7\text{g mol}^{-1} = 0.98\text{g}$<br>$\%\text{ mass} = \frac{\textbf{mass of Ni}}{\textbf{mass of Alloy}} \times 100 = \frac{0.98}{1.02} \times 100 = 96.1\%$ |
| **7a(i)** | Electrophilic Substitution | Adding onto a benzene ring is electrophilic substitution. The H on the benzene ring is joins to the Cl and the remainder of that molecule joins onto the benzene ring. |
| **7a(ii)** | Secondary | Primary Amine: $H{-}N{-}C_3H_7$ (H); 1 Carbon attached to the Nitrogen<br>Secondary Amine: $H_3C{-}N{-}C_2H_5$ (H); 2 Carbons attached to the Nitrogen<br>Tertiary Amine: $H_3C{-}N{-}CH_3$ ($CH_3$); 3 Carbons attached to the Nitrogen |
| **7a(iii)** | lithium aluminium hydride | Step 3 converts a ketone into a secondary alcohol. This reaction is reduction and a reducing agent like lithium aluminium hydride $LiAlH_4$ will carry out this reaction. |
| **7a(iv)** | Step 3 | A chiral centre is when the carbon has four different groups attached.<br>  <br>Groups attached to chiral carbon (circled)<br>• -OH group<br>• -H group<br>• $-CH_2NHCH_3$ group<br>• $-C_6H_3(OH)_2$ group |

**7b** — 0.15mg

500ppm = 500mg per litre
$\therefore$ 1 litre of adrenaline solution contains 500mg adrenaline
1000cm$^3$ of adrenaline solution contains 500mg adrenaline
0.3cm$^3$ of adrenaline solution contains 500mg adrenaline x $^{0.3}/_{1000}$ = 0.15mg

**7c** — Diagram showing:

Labelled start positions of the extract and pure samples on a horizontal line. This line must be above the level of the solvent.




**8a** — 0.97

In Step 1, 13% ethanol is produced 13cm$^3$ ethanol and 87cm$^3$ water
1cm$^3$ ethanol = 0.79g $\therefore$ 13cm$^3$ ethanol = 10.27g
1cm$^3$ water = 1.00g $\therefore$ 87cm$^3$ ethanol =87.00g

$$d = \frac{m_1 + m_2}{100} = \frac{10.27+87.00}{100} = 0.9727 \text{ g cm}^3$$

**8b** — One answer from:

| | | |
|---|---|---|
| Boiling points are similar | (some) water evaporates at ethanol's boiling point | Any mention of attraction or forces between water and ethanol |

**8c** — One answer from:

| | | | | |
|---|---|---|---|---|
| Water molecules are smaller than ethanol molecules | ethanol molecules are too large to pass through | ethanol molecules are larger than water molecules | water molecules pass through but ethanol molecules cannot | water molecules are trapped in the sieve |

**8d** — Open Question to include:

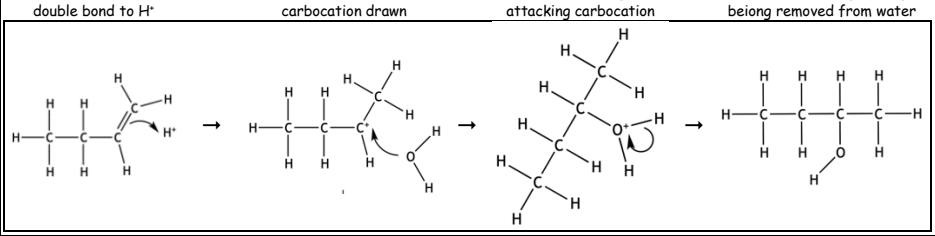
| 3 mark answer | 2 mark answer | 1 mark answer |
|---|---|---|
| Demonstrates a **good understanding** of the chemistry involved. A good comprehension of the chemistry has provided in a logically correct, including a statement of the principles involved and the application of these to respond to the problem. | Demonstrates a **reasonable understanding** of the chemistry involved, making some statement(s) which are relevant to the situation, showing that the problem is understood. | Demonstrates a **limited understanding** of the chemistry involved. The candidate has made some statement(s) which are relevant to the situation, showing that at least a little of the chemistry within the problem is understood. |

**9a** — (Base-induced) Elimination

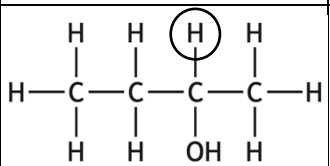
Elimination reactions involve the removal of a small water leaving behind a C=C double bond. Elimination reactions are the opposite reactions to addition reaction.

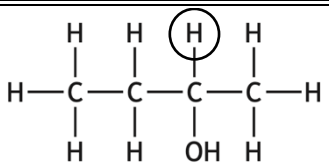
**9b** — Mechanism showing:

1st Mark: Curly arrow from double bond to H$^+$
2nd Mark: Correct carbocation drawn
3rd Mark: Curly arrow showing water attacking carbocation
Curly arrow showing hydrogen beiong removed from water



**9c**





Multiplet has 6 peaks
Conclusion: 5 Hydrogen atoms on adjacent carbons
Chemical Shift at 3.7ppm
Conclusion: Group has oxygen in Alcohol/ether

**9d(i)** — Rate = k [$C_4H_9Br$] [$OH^-$]

| | |
|---|---|
| Order of 1-bromobutane is [$C_4H_9Br$]$^1$ | Rate = k [$C_4H_9Br$]$^1$ [$OH^-$]$^1$ |
| Order of hydroxide ion is [$OH^-$]$^1$ | $\therefore$ Rate = k [$C_4H_9Br$] [$OH^-$] |

<table>
<tr><td>9d(ii)</td><td>$1.32 \times 10^{-4}$ l mol$^{-1}$ s$^{-1}$</td><td>$\text{rate} = k[C_4H_9Br][OH^-]$<br>$k = \dfrac{\text{rate}}{[C_4H_9Br] \times [OH^-]}$<br>$= \dfrac{3.3 \times 10^{-6} \text{ mol l}^{-1} \text{ s}^{-1}}{0.25 \text{ mol l}^{-1} \times 0.10 \text{ mol l}^{-1}}$<br>$= 1.32 \times 10^{-4}$ l mol$^{-1}$ s$^{-1}$</td></tr>
<tr><td>10a</td><td>Delocalised electrons</td><td>Benzene rings have six delocalised electrons which provide the stability in a benzene molecule.</td></tr>
<tr><td>10b</td><td>$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^7$</td><td>Co atom: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^7\ 4s^2$ $\therefore$ $Co^{2+}$ ion : $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^7$</td></tr>
<tr><td>10c(i)<br>PART A</td><td>All fours sections required:</td><td><table><tr><td>solutions of known concentration are prepared</td><td>suitable filter/wavelength/colour used</td><td>Mention of a blank or solvent only measurement</td><td>Absorbance/transmittance of each solution is measured/plotted</td></tr></table></td></tr>
<tr><td>10c(i)<br>PART B</td><td>Both sections required:</td><td><table><tr><td>The absorbance/transmittance of the unknown is measured</td><td>mention of using the graph to turn unknown's absorbance/transmittance back into concentration</td></tr></table></td></tr>
<tr><td>10c(ii)</td><td>Propan-1-ol</td><td>Propanal is an aldehyde and will reduce to for the primary alcohol propan-1-ol.<br>Other reduction reactions:<br>carboxylic acid → aldehyde → primary alcohol<br>ketone → secondary alcohol</td></tr>
<tr><td>10d</td><td>1</td><td>Every bond in the decamethylcobaltocene is identical<br>i.e. aromatic carbon with a methyl -$CH_3$ group attached</td></tr>
</table>