Past Papers Advanced Higher Chemistry

2019 Marking Scheme

Grade Awarded	Mark Required (/130)	Mark Required %	% candidates achieving grade
A	90+	69.2%	33.8%
B	77+	59.2%	26.3%
C	64+	49.2%	22.2%
D	57+	43.8%	7.3%
No award	<57	<43.8%	10.4%

Section:	Multiple Choice	Extended Answer	Assignment
Average Mark:	21.0 /30	40.4 /70	19.2 /30

2019 Adv Higher Chemistry Marking Scheme

MC Qu	Answer	% Pupils Correct	Reasoning
1	B		☒A adsorption spectra formed by adsorption of energy as electrons are promoted ☑B emission spectra are formed from the release of energy as electrons drop down ☒C 310nm is a wavelength in the ultraviolet not visible region of EM Spectrum ☒D 310nm is a wavelength in the ultraviolet not visible region of EM Spectrum
2	D		In gravimetric analysis, heating $Na_2CO_3.10H_2O$ will release the 10 water molecules trapped in the structure so that just Na_2CO_3 remains. The substance is heated, cooled in a desiccator and its mass measured. The process is repeated until the mass is constant.
3	C		☒A adding sodium nitrate to magnesium ions does not produce a magnesium precipitate ☒B adding silver(I) nitrate to magnesium ions does not produce a magnesium precipitate ☑C sodium carbonate forms a magnesium carbonate precipitate with magnesium ion solution ☒D silver(I) carbonate is insoluble so carbonate ions cannot precipitate with magnesium ions
4	A		☑A Hund's Rule: electrons occupy degenerate orbitals singly with parallel spins before pairing ☒B Pauli Exclusion Principle: no two electrons in an atom can have the same set of four quantum numbers ☒C Aufbau Principle: electrons occupy orbitals in order of increasing energy ☒D the energy of an electron in an atom is quantised into specific energy levels/electron shells
5	D		☒A $BeCl_2$ is a linear molecule with 180° angles ☒B BCl_3 is a trigonal planar molecule with 120° angles between bonds ☒C CCl_4 is a tetrahedral molecule with 109.5° angles between bonds ☑D PCl_5 is a trigonal pyramidal molecule with 90° (and 120°) angles between bonds
6	D		<table><tr><td>Species</td><td>Fe</td><td>Fe^{2+}</td><td>Fe^{3+}</td></tr><tr><td>Electronic configuration</td><td>$1s^2\ 2s^2\ 2p^6\ 3s^2\ 2p^6\ 3d^6\ 4s^2$</td><td>$1s^2\ 2s^2\ 2p^6\ 3s^2\ 2p^6\ 3d^6$</td><td>$1s^2\ 2s^2\ 2p^6\ 3s^2\ 2p^6\ 3d^5$</td></tr></table>☒A Fe^{2+} and Fe^{3+} both have three occupied energy levels (n=1, n=2 and n=3) ☒B Fe^{2+} has four unpaired electrons in 3d and Fe^{3+} has five unpaired electrons in 3d ☒C Fe^{2+} is higher in ECS than Fe^{3+}. Fe^{3+} is better oxidising agent than reducing agent ☑D Fe^{3+} more stable because Fe^{3+} had 5 unpaired electrons in half-filled d-subshell
7	B		☒A $Cr_2O_7^{2-}$ ions have Cr with an oxidation state of +6 ☑B MnO_4^- ions have Mn with an oxidation state of +7 ☒C VO^{2+} ions have V with an oxidation state of +4 ☒D Sn^{4+} ions have Sn with an oxidation state of +4
8	D		☒A Co-ordination number of the copper 4 as there are four bonds from ligand to Cu ☒B Co-ordination number of the copper 4 as there are four bonds from ligand to Cu ☒C The ligand shares four pairs of electrons with the one metal ion = tetradentate ☑D Four bonds between ligand and central metal ion: co-ordination number equals 4 and is tetradentate
9	A		☑A Decrease in temperature favours the forward exothermic reaction. This gives more products and increasing the numerator on top of the equilibrium constant calculation which increases the value of equilibrium constant. ☒B Increase in temperature favours the reverse endothermic reaction. Lowers K value ☒C Changes in pressure do not alter the equilibrium constant ☒D Changes in pressure do not alter the equilibrium constant
10	C		☒A The reaction is feasible when the value of ΔG is below zero ☒B The reaction is only feasible when the value of ΔG is below zero (above 300K) ☑C The value of ΔG is negative above 300K so reaction is feasible above 300K ☒D The value of ΔG is positive below 300K so reaction is <u>not</u> feasible below 300K
11	C		$\Delta H^\circ = \Sigma\Delta H_f^\circ{}_{(products)} - \Sigma\Delta H_f^\circ{}_{(reactants)}$ $= (2x0) + (3x-242) - (1x-822) + (3x0)$ $= (0 - 726) - (-822 + 0)$ $= -726 - (-822)$ $= +96\ kJ\ mol^{-1}$

12 B

☒A Steam condensing into water gives off heat ∴ ΔH is negative
☑B ΔH is negative as heat is given off. ΔS is negative as molecules are more ordered
☒C Steam condensing into water gives off heat ∴ ΔH is negative
☒D Molecules are closer together and more ordered in water ∴ ΔS is negative

13 A

Experiment	Change	Effect on Rate	Order of reactant
1+2	[X] x2	x2	$[X]^1$
1+2	[Y] x2	No effect	$[Y]^0$

$$\text{Rate} = k[X]^1[Y]^0 = k[X]$$

14 B

$$\text{rate} = k[A]^1[B]^1 \qquad \text{rate} = k[C]^2$$

$$\therefore k = \frac{\text{rate}}{[A]^1[B]^1} \qquad \therefore k = \frac{\text{rate}}{[C]^2}$$

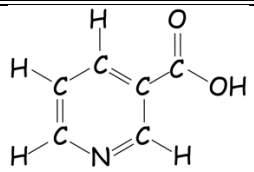
$$= \frac{\text{mol } l^{-1} s^{-1}}{\text{mol } l^{-1} \times \text{mol } l^{-1}} \qquad = \frac{\text{mol } l^{-1} s^{-1}}{\text{mol}^2 l^{-2}}$$

$$= l \text{ mol}^{-1} s^{-1} \qquad = l \text{ mol}^{-1} s^{-1}$$

15 C

Bonds	2x C=C	2x C-C	1x C≡N	2x C-O	3x C-H
Sigma σ bonds	2	2	1	2	3
Pi π bonds	2	0	2	0	0

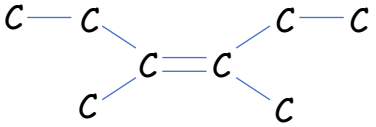
16 A



17 C

☒A The right C in C=C double bond has 2 -H groups ∴no geometric isomerism
☒B The right C in C=C double bond has 2 $-CH_3$ groups ∴no geometric isomerism
☑C Both ends of C=C double bond have different groups ∴has geometric isomerism
☒D The right C in C=C double bond has 2 -H groups ∴no geometric isomerism

18 C



Structure: 3,4-dimethylhex-3-ene
Both ethyl groups are on same side of C=C double bond so this is the CIS geometric isomer.
Name: cis-3,4-dimethylhex-3-ene

19 D

☒A Trimethylamine is a tertiary amine so no hydrogen bonding ∴lower boiling point
☒B Trimethylamine is a tertiary amine so no hydrogen bonding ∴lower boiling point
☒C Trimethylamine has no H-N bonds so lacks any hydrogen bonding ∴less soluble
☑D Trimethylamine has no hydrogen bonding as it lacks a H-N bond. This means trimethylamine molecules are further apart and this lowers the boiling point. The lack of N-H bonds lowers the solubility of trimethylamine in water.

20 B

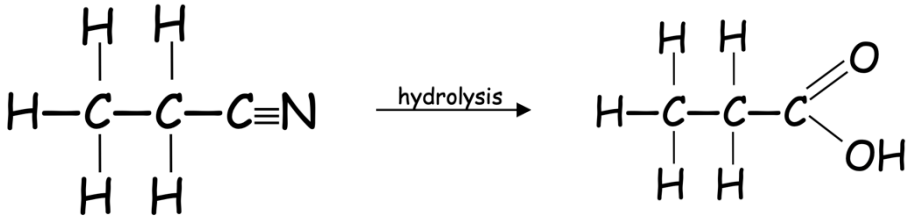
Lithium Aluminium Hydride is a reducing agent for:

carboxylic acid → aldehyde → primary alcohol
ketone → secondary alcohol

21 C

Step 1	Electrophilic substitution: $-NO_2$ group is substituted onto the benzene ring.
Step 2	Reduction: Decrease in the oxygen:hydrogen ratio as $-NO_2$ group is reduced to $-NH_2$ group
Step 3	Condensation: two molecules join together and small molecule removes where they join.

22 B



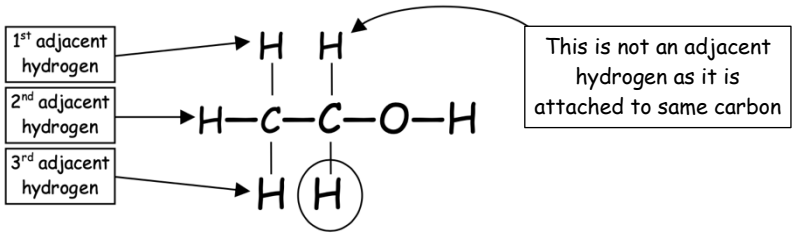
23 B

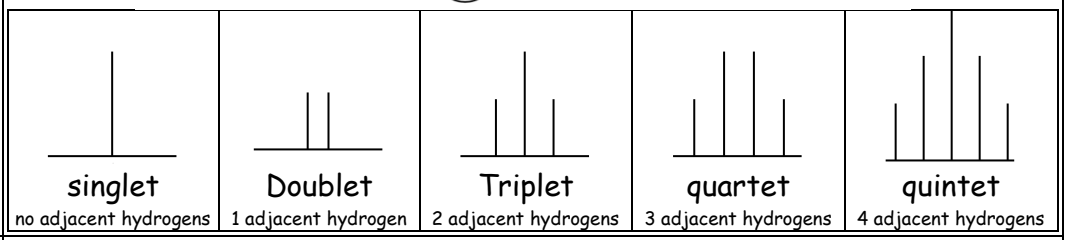
The heaviest $^m/_z$ peak on a mass spectrum is the mass of the original compound.
gfm C_3H_6O = (3x12)+(6x1)+(1x16) = 36+6+16 = 58g

24 **A**

Element	C	H	O
%	80.0	9.3	10.7
No. of moles (divide % by gfm)	$\frac{80.0}{12}$ = 6.67	$\frac{9.3}{1}$ = 9.300	$\frac{10.7}{16}$ = 0.669
Mole ratio (divide through by smallest value)	$\frac{6.667}{0.669}$ = 9.96	$\frac{9.300}{0.669}$ = 13.90	$\frac{0.669}{0.669}$ = 1.00
Round to Whole Number	10	14	1

25 **C**





26 **A**

☑A both are agonists as both bind with a receptor and stimulate a response
☒B Buprenorphine is an agonist as it stimulates receptors and produces a response
☒C Pramipexole is an agonist as it stimulates the nerves cells to make a response
☒D Pramipexole is an agonist as it stimulates the nerves cells to make a response

27 **D**

1 minute = 6litres air ∴ 10minutes = 60litres air
0.03ppm = 0.03mg per 1litre air
1 litre of air ⟷ 0.03mg hydrogen sulphide
60 litres of air ⟷ 0.03mg hydrogen sulphide x $^{60}/_{1}$
= 1.8mg

28 **C**

☒A Thin layer chromatography separates chemicals with different polarities/size
☒B Heating under reflux allows volatile chemicals to react without reactant escape
☑C Recrystallisation allows chemical to be extracted from impurities due to solubility in a second solvent
☒D Distillation separates chemicals with different boiling points

29 **D**

☒A water is less dense so should be the top layer
☒B water is less dense so should be the top layer
☒C K = $^{2}/_{8}$ = 0.25
☑D K = $^{8}/_{2}$ = 4

$$K = \frac{[X]_{dichloromethane}}{[X]_{water}}$$

30 **A**

☑A Complexometric analysis is used to calculate the calcium ions in milk
☒B Gravimetric analysis is used to calculate the chloride ions in sea water
☒C Volumetric analysis is used to calculate ethanoic acid in vinegar
☒D Volumetric analysis is used to calculate ethanol in wine

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Long Qu	Answer	Reasoning
1a	Any <u>one</u> of the 2p electrons circled	**n=2** Electron in Shell 2 | **l=1** Electron in p subshell | **m_l = -1** Electron in orbital -1 (could be any of 3 orbitals in diagram) | **m_s = +½** Electron has +½ spin (could be either up or down in diagram)
1b	103	$\Delta G^o = \Delta H^o - T\Delta S^o$ $= 127 - 298 \times {}^{79.4}/_{1000}$ $= 127 - 23.7$ $= 103.3\ kJ\ mol^{-1}$
1c	3.20×10^{-5}	$\Delta G^o = -2.30 \times R \times T \times \log_{10}K$ $\log_{10}K = \frac{\Delta G^o}{-2.30 \times R \times T}$ $\log_{10}K = \frac{25.6}{-2.30 \times 8.31\times10^{-3} \times 298}$ $\log_{10}K = -4.49$ $K = 10^{-4.49} = 3.20 \times 10^{-5}$
2a	Number of moles of reactant involved in the rate determining step	Rate determining step is the slowest step in reaction mechanism. The number of moles of each reactant in rate determining step decides the order for each reactant 0 moles of reactant in RDS: Zero Order | 1 mole of reactant in RDS: 1st Order | 2 moles of reactant in RDS: 2nd Order
2b(i)	2nd order	1 mol of H_2O_2 in rate determining step ∴ order $[H_2O_2]^1$ 1 mol of I^- in rate determining step ∴ order $[I^-]^1$ Overall order = 1 + 1 = 2
2b(ii)	Rate = k $[H_2O_2]$ $[I^-]$	Rate = k $[H_2O_2]^1$ x $[I^-]^1$ = k $[H_2O_2]$ $[I^-]$
2c	$H_2O_2 + 2I^- + 2H_3O^+$ ↓ $I_2 + 4H_2O$	Step 1 $H_2O_2 + I^- \rightarrow \cancel{IO^-} + H_2O$ Step 2 $\cancel{IO^-} + H_3O^+ \rightarrow \cancel{HIO} + H_2O$ Step 3 $\cancel{HIO} + H_3O^+ + I^- \rightarrow I_2 + 2H_2O$ Overall $H_2O_2 + 2I^- + 2H_3O^+ \rightarrow I_2 + 4H_2O$
3a	Answer to include:	1st Mark: $5cm^3$ — As a $^1/_{10}$ dilution needs to take place, $5cm^3$ is transferred to the 50cm3 flask 2nd Mark: Correct use of pipette — An accurate method of measuring $5cm^3$ need to be used e.g. pipette 2nd Mark: Making Up to line with deionised water — The volumetric/standard flask must be filled to the line for accuracy
3b(i)	Deionised water	The control experiment has a cuvette containing deionised water and the absorbance of this is the setting for zero absorbance.
3b(ii)	Unknown's Absorbance must not be outwith calibration range	The calibration curve is only applicable to concentrations between the highest and lowest concentrations used in the calibration curve. Diluting a sample can bring a more concentrated unknown into the usable range of the calibration curve. It is unknown what happens to concentrations beyond the calibration range with any certainty.
3b(iii)	71%	Absorbance (diluted sample) = 0.34 ∴ concentration of Cu^{2+} = 0.032 mol l^{-1} ∴ concentration of Cu^{2+} in original sample = 0.064 mol l^{-1} **n**o. of mol in $250cm^3$ = **v**olume x **c**oncentration = 0.25litres x 0.064 mol l^{-1} = 0.016mol **m**ass = **n**o. of mol x **gfm** = 0.016 x 63.5 = 1.016g $\%\ mass = \frac{\textbf{m}ass\ of\ Cu}{\textbf{m}ass\ of\ screw} \times 100 = \frac{1.016}{1.43} \times 100 = 71.0\%$

4a(i)

Proton or H^+ acceptor

Acid	Donates H^+
Base	Accepts H^+
Conjugate Acid	Formed when Base accepts H^+
Conjugate Base	Formed when Acid loses H

4a(ii)

Acid	H_2O_2
Conjugate Base	HO_2^-

or

Acid	H_3O^+
Conjugate Base	H_2O

H_2O_2 + H_2O ⇌ H_3O^+ + HO_2^-

Acid (Donates H^+) + Base (Accepts H^+) ⇌ Conjugate Acid (Formed when Base accepts H^+) + Conjugate Base (Formed when Acid loses H^+)

or

H_3O^+ + HO_2^- ⇌ H_2O_2 + H_2O

Acid (Donates H^+) + Base (Accepts H^+) ⇌ Conjugate Acid (Formed when Base accepts H^+) + Conjugate Base (Formed when Acid loses H^+)

4b

One answer from:

$B(OH)_3$ accepts a pair of non-bonding electrons and water donates a pair of non-bonding electrons	$B(OH)_3$ accepts a pair of non- bonding electrons from water.	Water donates a pair of non- bonding electrons to $B(OH)_3$

4c(i)

Increasing number of chlorine increases strength of acid

Increasing the number of chlorines increases the value of K_a. The higher the value of K_a the stronger the acid

(NB The higher the value of pK_a the weaker the acid)

4c(ii) Part A

0.08

gfm CH_2COOH = (2x12)+(3x1)+(2x16)+(1x35.5) = 24+3+32+35.5 = 94.5g

$$\textbf{no. of mol} = \frac{\textbf{mass}}{\textbf{gfm}} = \frac{1.89}{94.5} = 0.02\text{mol}$$

$$\textbf{concentration} = \frac{\textbf{no. of mol}}{\textbf{volume}} = \frac{0.02 \text{ mol}}{0.25 \text{ litres}} = 0.08 \text{ mol } l^{-1}$$

4c(ii) Part B

2.0

$$pH = \tfrac{1}{2} pK_a - \tfrac{1}{2}\log c$$
$$pH = \tfrac{1}{2} \times -\log_{10}K_a - \tfrac{1}{2} \log_{10} c$$
$$pH = -\tfrac{1}{2} \times \log_{10} (1.3\times10^{-3}) - \tfrac{1}{2} \log_{10} (0.08)$$
$$pH = -\tfrac{1}{2} \times (-2.89) - \tfrac{1}{2} \times (-1.10)$$
$$pH = 1.44 - (-0.55)$$
$$pH = 1.99$$

4d

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.

5a

Heat or high temperature

Electrons become excited in sodium by absorbing heat energy which promotes an electron to a higher energy level. Light of specific wavelength is emitted corresponding to the exact energy difference between the upper energy level the electron drops down from to the lower energy level the electron goes in to.

5b(i)

Hexaaquazinc(II)

Hexaaquazinc(II) = $[Zn(H_2O)_6]^{2+}$

no. of ligands | H_2O ligand | metal name | Charge on metal ion

Neutral ligands include:		Negative Ligands include:		Central Ion:	Charge:
Ligand	Name	Ligand	Name	Positive Complex: metals keep their name Negative Complex: Metals end in ATE e.g. Cuprate, Ferrate, Cobaltate	Charge of central ion is converted into roman numerals and put in brackets
OH_2	aqua	Chloride Cl^-	chlorido		
NH_3	ammine	Cyanide CN^-	cyanido		
CO	carbonyl	Nitrite NO_2^-	nitrito		

5b(ii)

Answer to include:

1st Mark	2nd Mark
Full or complete d subshell or 10 d electrons or $3d^{10}$ or no d-d transitions possible	It does not absorb visible light or It only absorbs ultraviolet/UV light

<table>
<tr><td>5c(i)</td><td>2.04×10^{-16} J</td><td>$E = h \times f$
$E = 6.63\times10^{-34}$ J s $\times$ 3.08×10^{17} s^{-1}
$E = 2.04\times10^{-16}$ J
NB: The question does not require you to multiple by L (6.02×10^{23}) as the units required are J not J mol^{-1} or kJ mol^{-1}</td></tr>
<tr><td>5c(ii)</td><td>19</td><td>1 J $\longleftrightarrow$ 6.24×10^{18} eV
2.04×10^{-16} J $\longleftrightarrow$ 6.24×10^{18} eV x 2.04×10^{-16} /1
= 1273 eV
Binding Energy = Energy of electromagnetic radiation - Kinetic Energy of electron emitted
$E_b = E - E_k$
E_b = 1273 eV - 1254 eV
E_b = 19 eV</td></tr>
<tr><td>6a</td><td>6.4</td><td>Total Dichromate in flask:
no. of mol = volume x concentration = 0.025litres x 0.010 mol l^{-1} = 2.5×10^{-4}mol
Dichromate left at end of reaction:
no. of mol = 1.65×10^{-4}mol (in question)
Dichromate which reacted with ethanol:
no. of mol = 2.5×10^{-4} mol – 1.65×10^{-4}mol = 8.5×10^{-5}mol
$3C_2H_5OH + 2Cr_2O_7^{2-} + 16H^+ \longrightarrow 3CH_3COOH + 4Cr^{3+} + 11H_2O$
3mol 2mol
1.28×10^{-4}mol 8.5×10^{-5}mol
1cm^3 diluted vodka $\longleftrightarrow$ 1.28×10^{-4}mol
1000cm^3 diluted vodka $\longleftrightarrow$ 1.28×10^{-4}mol x $^{1000}/_{1}$
= 0.128mol
As 1000cm^3 diluted vodka was made from 20.0cm^3 of vodka
$\therefore$ 20cm^3 undiluted vodka $\longleftrightarrow$ 0.128mol
$\text{concentration} = \frac{\text{no. of mol}}{\text{volume}} = \frac{0.128 \text{ mol}}{0.020 \text{ litres}} = 6.4 \text{ mol } l^{-1}$</td></tr>
<tr><td>6b</td><td>To ensure all ethanol is reacted</td><td>This experiment is a back titration. An excess of acidified potassium dichromate is added to ethanol solution and all the ethanol will react with acidified potassium dichromate solution and the left over acidified potassium dichromate can be determined by volumetric analysis.</td></tr>
<tr><td>6c</td><td>Impurities in vodka reacting with dichromate</td><td>Other chemicals in the vodka may be able to react with acidified dichromate (a powerful oxidising agent).</td></tr>
<tr><td>6d</td><td>Use standard solution of ethanol</td><td>A standard solution of ethanol could be used as a control to measure the experimentally-determined value of this ethanol solution against the known value of the standard solution.</td></tr>
<tr><td>7a</td><td>Under suction/vacuum</td><td>A Buchner funnel and suction pump is used to draw the filtrate through the filter paper in the Buchner funnel quicker than gravity alone.</td></tr>
<tr><td>7b(i)</td><td>End on overlap of two atomic orbitals</td><td>A sigma bond is formed by the end on overlap of two orbitals.
A pi bond is formed by side overlap of two unhybridized p orbitals</td></tr>
<tr><td>7b(ii)</td><td>Mixing an s atomic orbital with two p atomic orbitals</td><td><table><tr><td>Type of Hybridisation</td><td>sp^3</td><td>sp^2</td><td>sp</td></tr><tr><td>Description</td><td>One s and three p orbitals mix</td><td>One s and two p orbitals mix</td><td>One s and one p orbitals mix</td></tr></table></td></tr>
</table>

7c

Answer to include:

1st Mark	2nd Mark
Electrons promoted/move from HOMO to LUMO	Blue/green light is absorbed or Complementary colour to red absorbed

7d(i)

One answer from:

Similar polarities or both polar or similar intermolecular forces	Forms hydrogen bonds with alizarin	Does not react with alizarin	Volatile or low boiling point or evaporates easily	Dissolves alizarin but not other substances (in the root)

7d(ii) Part A

Answer to include:

1st Mark	2nd Mark
IR makes bonds vibrate/bend/stretch	Different bonds/functional groups absorb at different wavenumber/wavelength/frequency/energy

7d(ii) Part B

One or both -OH groups circled

From page 14 of data booklet:

Wave Number Range/cm^{-1}	Type of Compound	Infra-red Absorption due to
3570-3200	Alcohols and Phenols	Hydrogen bonded O – H stretch

The -OH hydroxyl group can be described as phenols as they are attached to a benzene ring.

7d(ii) Part C (I)

2.96×10^{-6}m

$$\text{Wavelength} = \frac{1}{\text{Wavenumber}} = \frac{1}{3395 cm^{-1}} = 2.96 \times 10^{-4} \text{ cm} = 2.96 \times 10^{-6} \text{m}$$

7d(ii) Part C (II)

40.65kJ mol^{-1}

$$E = \frac{L \times h \times c}{\lambda} = \frac{6.02 \times 10^{23} mol^{-1} \times 6.63 \times 10^{-34} \text{ J s} \times 3 \times 10^{8} \text{ m } s^{-1}}{2.96 \times 10^{-6} \text{ m}}$$

$$= 40651 \text{ J } mol^{-1}$$

$$= 40.65 \text{ kJ } mol^{-1}$$

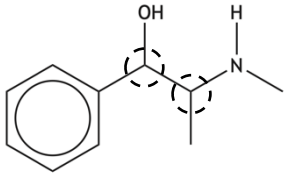
8

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(i)

Either circle on diagram:



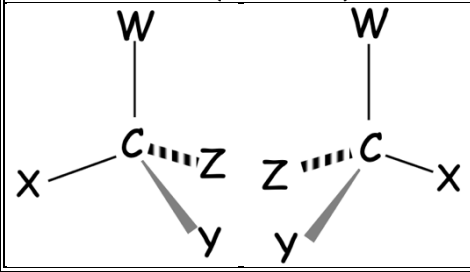
A chiral carbon has four different chemical groups attached to a central carbon. Both circled carbons have four bond but due to being skeletal formula diagrams the 4th bond (a C-H bond) being the 4th different group attached to the central carbon is not drawn as it is a C-H bond.

9a(ii)

Non-superimposable mirror images

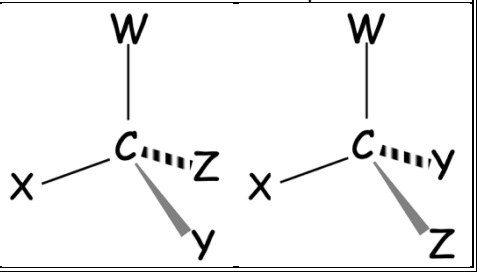
Non-superimposable Mirror Images

Images shown are direct mirror images of each other and are therefore are optical isomers (enantiomers)



Non-superimposable Mirror Images

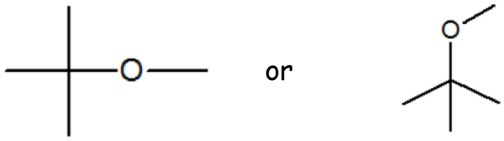
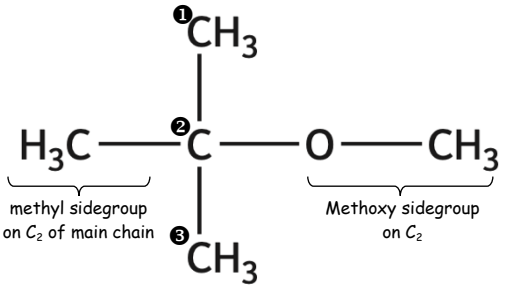
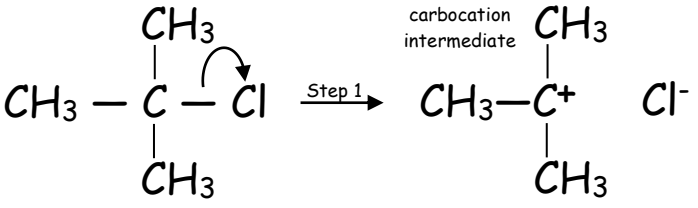
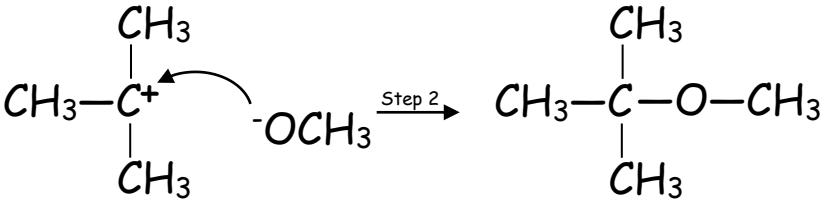
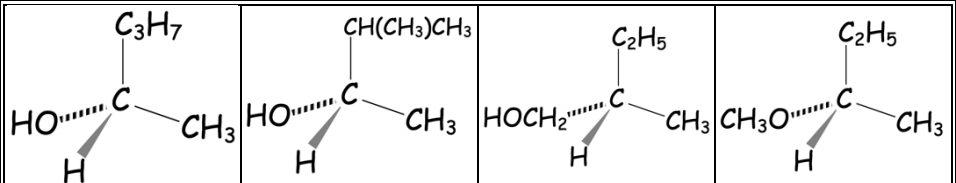
The following are optical isomers as Groups W and X are in the same position but Groups Y and Z are in different position.



9b(i)

(nucleophilic) substitution

The lone pair on the pair of the N in NH_3 is nucleophilicly attracted to the $\delta+$ on the C of the polar C-Br bond.
The NH_3 is added onto the carbon as the Br atom leaves as a Br^- ion.
An H in the $-NH_3^+$ group then leaves as an H^+ ion leaving a $-NH_2$ amine group attached to the carbon the Br previously was attached to.

9b(ii)	7.58g	1-phenylpropanone → [intermediate] → cathinone 1mol 1mol 134g 149g 9.50g 149g x $^{9.50}/_{134}$ = 10.56g %Yield = $\frac{\text{Actual}}{\text{Theoretical}}$ x100 ∴ Actual = $\frac{\text{\% Yield x Theoretical}}{100}$ = $\frac{71.8 \times 10.56}{100}$ = 7.58g
10a	Ether	Ethers have a carbon-oxygen-carbon group as their functional group. Be careful not to confuse a C-O-C group with an ester group which also has a carbonyl C=O group in one end.
10b(i)	One from:	 or
10b(ii)	2-methoxy-2-methylpropane	
10c(i)	methanol	Group 1 metals react with alcohols to produce alkoxides and hydrogen: sodium + methanol → sodium methoxide + hydrogen 2Na + 2CH3OH → 2Na+CH3O- + H2
10c(ii)	1st Mark Correct Carbocation intermediate 2nd Mark Correct use of both curly arrows	 2-chloro-2-methylpropane  2-methoxy-2-methylpropane
10c(iii)	One answer from:	Formation of stable (tertiary) carbocation Steric hindrance of three methyl -CH3 groups prevents nucleophilic attack
10d	Any one from:	 pentan-2-ol | 3-methylbutan-2-ol | 2-methylbutan-1-ol | 2-methoxybutane
10e	One line at 1.5-0.9 with relative intensity 9	The peak drawn is 3.6-3.7 and a relative intensity of 3 ∴ peak caused -O-CH3 group (3xH = relative intensity 3) Other Peak must contain tertiary -C(CH3) group ∴ Line at chemical shift 1.5-0.9 for R3C- from table ∴ Relative intensity of 9 as there are 9 H atoms in group.