JABchem

Past Papers
Advanced Higher Chemistry

2004
Marking Scheme

Grade Awarded	Mark Required		% candidates achieving grade
	(/125)	%	
A	87+	70%	20.9%
B	71+	57%	23.9%
C	56+	45%	27.5%
D	48+	38%	10.5%
No award	<48	<48%	17.1%

2004 Adv Higher Chemistry Marking Scheme

MC Qu	Correct Answer	% Correct	Reasoning
1	D	88	☒A 4s fills then 3d then 4p ☒B 3s fills then 3p then 4s then 3d ☒C 3p fills then 4s then 3d then 4p ☑D 1s → 2s → 2p → 3s → 3p → 4s → 3d → 4p
2	C	65	☒A Boron has no lone pairs in outer shell as it is group 3 ☒B Nitrogen has a lone pair but it is already donated the pair in NH_4^+ ☑C Phosphorus is in group 5 and has a lone pair of electrons to donate in PH_3 ☒D Co^{3+} ions will not be attracted to H^+ ions as the Co^{3+} ion has a positive charge.
3	B	64	☒A NaCl has 6:6 co-ordination ☑B CsCl has 8:8 co-ordination ☒C NaCl has 6:6 co-ordination ☒D CsCl has 8:8 co-ordination
4	D	83	Aluminium oxide is amphoteric as it acts as both a basic oxide and an acidic oxide
5	D	74	☒A NH_3 is polar covalent not ionic ☒B $HCl_{(g)}$ is polar covalent and $HCl_{(aq)}$ cantains the H^+ hydrogen ion not the H^- hydride ion ☒C H_2S is non-polar covalent ☑D CaH_2 is ionic and contains the hydride H^- ion
6	B	57	No. of electron pairs = $^{(\text{no. of outer electrons in central atom + no. of bonds})}/_2 = {}^{(5+3)}/_2 = {}^{8}/_2$ = 4 pairs of electrons ∴ tetrahedral electron pair shape
7	C	56	No. of electron pairs = $^{(\text{no. of outer electrons in central atom + no. of bonds})}/_2 = {}^{(7+3)}/_2 = {}^{10}/_2$ = 5 pairs of electrons ∴ trigonal bipyrimidal electron pair shape
8	B	47	Ni atom has electron arrangement: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^8$ Ni^{2+} ion has electron arrangement: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^8$ (NB: 4s before 3d) $3d^8$ in Ni^{2+} has 3 pairs and 2 unpaired electrons
9	D	54	Zn^{2+} ion has a complete $3d^{10}$ subshell so there is no room for d→d transitions and hence no visible wavelength light absorbed for the complementary colour to be viewed by the human eye.
10	C	77	1. Balance all atoms other than O + H: $ClO_3^- \rightarrow Cl^-$ 2. Balance O by adding H_2O to other side: $ClO_3^- \rightarrow Cl^- + 3H_2O$ 3. Balance H by adding H^+ to the other side: $ClO_3^- + 6H^+ \rightarrow Cl^- + 3H_2O$ 4. Balance charge by adding e^- to most positive side: $ClO_3^- + 6H^+ + 6e^- \rightarrow Cl^- + 3H_2O$
11	B	52	**n**o. of moles of Na^+ ions = **v** x **c** = 1 litre x 0.2 mol l^{-1} = 0.2mol Na^+ ions But 2 Na^+ ions per Na_2CO_3 formula unit ∴ **n**o. of moles of Na_2CO_3 = 0.1 mol $\text{volume} = \frac{\text{no of moles}}{\text{concentration}} = \frac{0.1}{0.5} = 0.2\text{ litres} = 200\text{cm}^3$
12	D	83	☒A For this equilibrium, if K=1 then [reactants] = [products] which rarely happens ☒B At equilibrium, concentrations of reactants and products are rarely equal ☒C At equilibrium, both forward and reverse reaction proceed equally ☑D Rate of forward reaction (esterification) = rate of reverse reaction (hydrolysis)
13	A	77	*Pressure*: forward reaction increased pressure ∴ *low pressure* favours forward reaction. *Temperature*: forward reaction is endothermic ∴ *high temperature* favours forward reaction.
14	C	74	☒A Adding more cyclohexane does not change the proportion of Iodine in each layer. ☒B Adding more iodine does not alter partition coefficient as iodine splits between layers in the same ratio ☑C Temperature does change partition coefficient ☒D Shaking the mixture thoroughly achieves partition faster but still the same coefficient.

15	B	54	❶x-2 $2NO_2 \rightarrow N_2 + 2O_2$ $\Delta G^o = -103.6 kJ\ mol^{-1}$ ❷ $N_2 + 2O_2 \rightarrow N_2O_4$ $\Delta G^o = +97.7 kJ\ mol^{-1}$ Add ❶'+❷ $2NO_2 \rightarrow N_2O_4$ $\Delta G^o = -5.9 kJ\ mol^{-1}$
16	B	68	☒A reactant $Sr_{(g)}$ must be a solid at standard conditions for enthalpy of formation ☑B Enthalpy of formation: Forming one mole of a substance from its elements in their natural state ☒C This is the enthalpy of lattice formation ☒D This equation is the reverse of the enthalpy of solution
17	B	69	$\Delta H^o = +1944 kJ\ mol^{-1}$ ∴ 4x C – F bonds must be broken to be endothermic (4x+486kJ mol^{-1}) ☒A In addition to 4x C-F bonds being broken, $C_{(g)} \rightarrow C_{(s)}$ and $4F_{(g)} \rightarrow 2F_{2(g)}$ which are both exothermic ☑B Only 4xC-F bonds being broken in this equation. ☒C In addition to 4x C-F bonds being broken, $4F_{(g)} \rightarrow 2F_{2(g)}$ which is exothermic ☒D In addition to 4x C-F bonds being broken, $C_{(g)} \rightarrow C_{(s)}$ which is exothermic
18	C	77	Each ionisation energy involves the removal of 1 electron so add 1st + 2nd + 3rd ionisation energies ΔH^o = 1st + 2nd + 3rd ionisation energies for Cr = 659 + 1600 + 3000 = +5259kJ mol^{-1} (Current data booklet is Cr = 653. +. 1591. +. 2987 = +5231kJ mol^{-1})
19	A	59	☑A Chlorine atoms do not lose electrons to become positive ions, they gain electrons to become negative ☒B enthalpy of formation is required to calculate the lattice enthalpy (and vice versa) ☒C Gaseous sodium atoms need to become 1+ positive ions ☒D Bonds in Cl_2 need to break before Chlorine atoms can be negative ions.
20	C	76	☒A Enthalpy of Formation for LiBr: $Li_{(s)} + \frac{1}{2}Br_{2(l)} \rightarrow Li^+Br^-_{(s)}$ ☒B Enthalpy of solution for LiBr: $Li^+Br^-_{(s)} \rightarrow Li^+_{(aq)} + Br^-_{(aq)}$ ☑C Hydration Enthalpies a) Lithium ion: $Li^+_{(g)} \rightarrow Li^+_{(aq)}$ b) Bromide ion : $Br^-_{(g)} \rightarrow Br^-_{(aq)}$ ☒D Li^+ and Br^- are already ions so do not need to further ionised
21	C	41	☒A Gases have a higher degree of disorder than liquids ☒B Gases have a higher degree of disorder than liquids ☑C Liquid Water is the least disordered as it has hydrogen bonding and polar attractions ☒D Non-polar liquid bromine molecules are more disordered than polar liquid water molecules
22	A	43	$\Delta G^o = \Delta H^o - T \times \Delta S^o$ $\underbrace{\text{(positive } \Delta H^o)}$ $\underbrace{-T \times \text{(negative } \Delta S^o)}$ ΔG^o = (positive value) + (positive value) = positive value (thermodynamically not feasible)
23	C	60	If K is large and positive then equilibrium lies well to the right and ΔG^o is negative for forward reaction ☒A ΔG^o is positive for reverse reaction ☒B ΔG^o is large and negative as K is very large ☑C Equilibrium lies so far to right side that very little reverse reaction occurs ☒D K is temperature dependent
24	A	59	❶x-1 $Ti^{2+} \rightarrow Ti^{3+} + e^-$ $E^o = +0.37V$ ❷ $V^{3+} + e^- \rightarrow V^{2+}$ $E^o = -0.26V$ Add ❶'+❷ $Ti^{2+} + V^{3+} \rightarrow Ti^{3+} + V^{2+}$ $E^o = +0.11V$ $\Delta G^o = -nFE^o = -1 \times 96500 \times 0.11 = -10615\ J\ mol^{-1} = -10.615 kJ\ mol^{-1}$ = negative K > 1 as ΔG^o is negative and reaction is feasible and equilibrium lies to right
25	A	66	N=2 as 2 moles of electrons are transferred in equation: $X + 2Y^+ \rightarrow X^{2+} + 2Y$ $\Delta G^o = -nFE^o = -2 \times 96500 \times 1.5 = -289500 J\ mol^{-1} = -289.5 kJ\ mol^{-1}$
26	B	70	❶ $MnO_4^- + 4H^+ + 2e^- \rightarrow MnO_2 + 2H_2O$ $E^o = 2.26V$ ❷x-2 $2Fe^{2+} \rightarrow 2Fe^{3+} + 2e^-$ $E^o = -0.77V$ E° reverses but does not double Add ❶+❷' $MnO_4^- + 4H^+ + 2Fe^{2+} \rightarrow MnO_2 + 2H_2O + 2Fe^{3+}$ $E^o = +1.49V$
27	B	68	Rate kinetics are decided by the (slow) rate determining step: $A + B \rightarrow AB$ Order of reactant A = 1 and Order of reactant B = 1 ∴ rate = k $[A]^1[B]^1$ ∴ rate = k [A][B]

28	A	63	☑A This reaction is an elimination reaction (C=C formed as HBr is eliminated) ☒B Nucleophilic substitution (CN^- on and Br^- off) ☒C Nucleophilic substitution ($C_2H_5O^-$ on and Cl^- off) ☒D Nucleophilic substitution (OH^- on and Br^- off)
29	B	65	☒A Addition if HI across C=C double bond ☑B Light require to homolytically split Br_2 into free radicals and free radical chain reaction begins ☒C Nucleophilic substitution (OH^- on and Br^- off) ☒D Electrophilic substitution (nitration of benzene)
30	D	66	☒A Addition if HI across C=C double bond ☒B Light require to homolytically split Br_2 into free radicals and free radical chain reaction begins ☒C Nucleophilic substitution (OH^- on and Br^- off) ☑D Electrophilic substitution (nitration of benzene)
31	A	51	☑A NH_3 has lone pair of electrons which seeks out centres of positive charge ☒B NH_4^+ is not a nucleophile as it has no negative charge or lone pair of electrons ☒C Br_2 has pure covalent bonding and cannot act as a nucleophile ☒D CH_3I has a polar C – I bond and the $\delta+$ charge on the C atom attracts nucleophiles
32	A	94	☑A $CH_3CH(CH_3)CH(OH)CH_2CH_3$ → 2-methylpentan-3-ol ☒B $CH_3CH(OH)CH(CH_3)CH_2CH_3$ → 3-methylpentan-2-ol ☒C $CH_3CH(CH_3)CH(OH)CH_3$ → 3-methylbutan-2-ol (incorrect as it has 5 carbons) ☒D $CH_3CH_2C(CH_3)_2CH_2CH_2OH$ → 3,3-dimethylpentan-1-ol (incorrect as it has 7 carbons)
33	C	65	☒A Primary Alcohol → would react with acidified dichromate solution ☒B Secondary Alcohol → would react with acidified dichromate solution ☑C Dehydrates to 2-methylpropene which would react with Br_2 to form 1,2-dibromo-2-methylpropane ☒D 5 carbons on structure D and 1,2-dibromo-2-methylpropane has 4 carbons
34	D	64	☒A The derivative must be stable and not decompose at its melting point ☒B Too low a relative molecular mass would mean the derivative is not a solid at room temp. ☒C Melting points are used to identify the derivative. ☑D A sharp melting point is required to identify the derivative by melting point.
35	D	43	☒A Both substances are alcohols → Only aldehydes and ketones make derivatives ☒B Both substances are carboxylic acids → Only aldehydes and ketones make derivatives ☒C Both substances are ethers → Only aldehydes and ketones make derivatives ☑D ethanal and propanal are aldehydes → Only aldehydes and ketones make derivatives
36	A	33	Ester compound would hydrolyse with NaOH to form: a) diol: $HO\text{-}CH_2CH_2\text{-}OH$ b) 2xCH_2COOH but CH_3COOH would be neutralised by NaOH to form $CH_3COO^-Na^+$
37	D	80	☒A CH_3COCH_3 is an alkanone which have a neutral pH ☒B CH_3CH_2CN is a nitrile compound with a high pKa value which means little acid/base activity ☒C CH_3CH_2CHO is an alkanal which have a neutral pH ☑D $CH_3CH_2NH_2$ is an amine which have an alkaline pH
38	A	42	☑A Benzene group is planar and the single *Chloro* group lies in the same plane as benzene ring ☒B Methyl group on methylbenzene in non-planar as three H in -CH_3 lie outside plane of ring ☒C Cyclohexane is non-planar as the carbon ring have a 3D shape *chair* shape ☒D Hexane is non-planar as the carbons have a tetrahedral 3D shape
39	C	65	☒A Proton NMR spectroscopy: the alignment of hydrogen nuclei spin in a magnetic field ☒B Emission Spectroscopy: Measuring the wavelengths produced when excited electrons drop down energy levels ☑C Infra-red Spectroscopy: Adsorption of IR wavelengths as energy is absorbed as groups within molecules vibrate ☒D Mass Spectroscopy: Separating charged particles through a magnetic field
40	D	64	☒A Butan-1-ol and butan-2-ol are drawn and are different structures. ☒B trans-1,2-dibromoethene and cis-1,2-dibromoethene are drawn and are different 3D structures ☒C 2-methylbutane and 2,2-dimethylpropane are drawn and are different structures. ☑D both structures are 1,1,2-trichloroethane and are the same structure.

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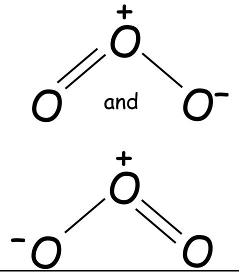
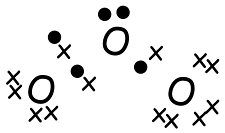
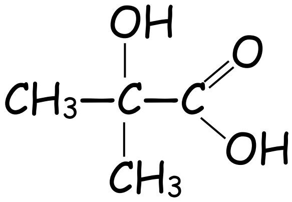
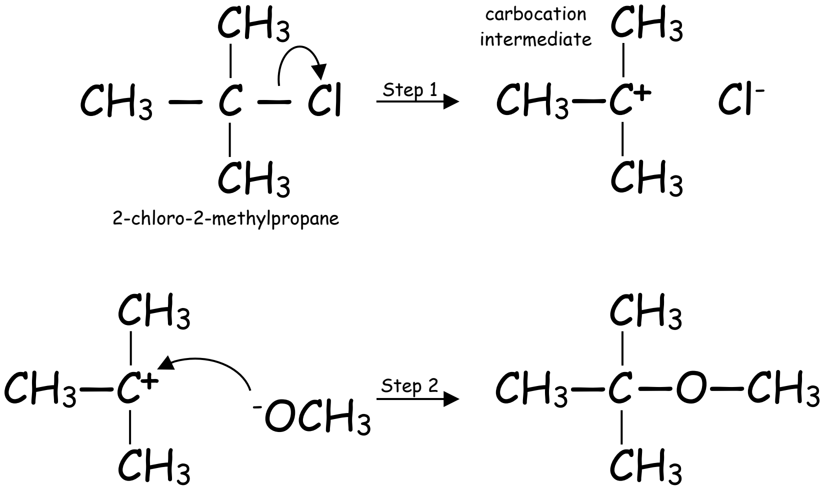
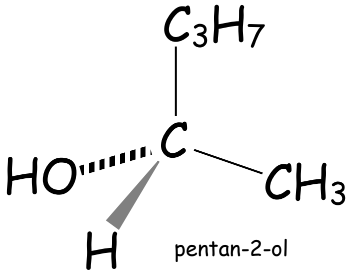
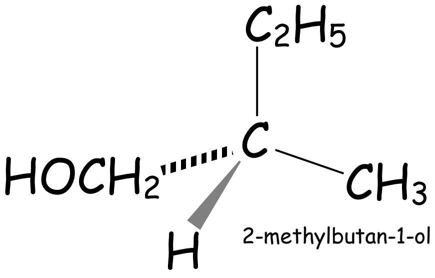
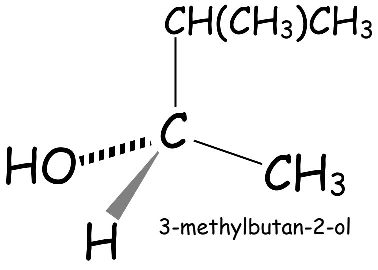
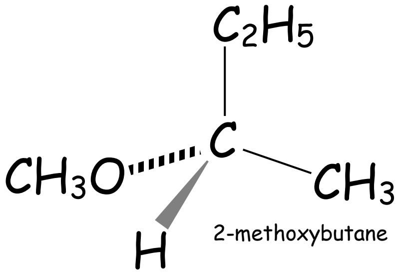
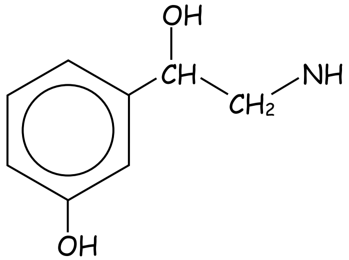
Long Qu	Answer	Reasoning
1a(i)	Atoms get smaller or increasing nuclear charge on outer electrons	Across a period, the atoms get smaller due to the same outer shell being pulled in by the increasing nuclear charge. The outer electrons are harder to remove so the ionisation energy increases.
1a(ii)	N is higher as it already has half-filled 2p orbital or O is lower as removing an electron creates a half filled 2p-orbital	Nitrogen is $1s^2\ 2s^2\ 2p^3$. Half filled p-orbitals are relatively stable and require more energy to remove an electron. Oxygen is $1s^2\ 2s^2\ 2p^4$. Removing one electron creates $2p^3$ on oxygen.
1b	Removing an electron from Li^+ breaks into a full electron shell	2nd Ionisation energy of Li: $\underset{2}{Li^+(g)} \rightarrow \underset{1}{Li^{2+}(g)} + e^-$ Removing an electron from Li^+ breaks a stable, complete outer shell of electrons which requires more energy.
2a	-286 kJ mol^{-1}	Bond Breaking Steps: 1x$C\equiv C$ 1x838 = 838kJ; 2xC-H 2x412 = 824kJ; 2xH-H 2x436 = 872kJ; =2534kJ Bond Forming Steps: 1xC–C 1x-348 = 348kJ; 6xC-H 6x-412 = 2472kJ; = 2820kJ $\Delta H^o = +2534 - 2820 = -286\ kJ\ mol^{-1}$
2b	Bond enthalpies used are mean bond enthalpies and not measure directly	The bond enthalpies for $C\equiv C$, C–H and C-C are averages and not the measured values from the experimental route described.
3a	+129	$\Delta H^o = \sum\Delta H^o(\text{products}) - \sum\Delta H^o(\text{reactants})$ $= (-1131) + (-394) + (-242) - (2x-948)$ $= -1767 - (-1896) = +129\ kJ\ mol^{-1}$
3b	385.1K	The reaction becomes thermodynamically feasible when $\Delta G^o = \Delta H^o - T\Delta S^o = 0$ $\therefore T\Delta S^o = \Delta H^o \quad \therefore T = \frac{\Delta H^o}{\Delta S^o} = \frac{129 \times 1000\ J\ mol^{-1}}{335\ J\ K^{-1}\ mol^{-1}} = 385.1K$
3c	378-380K	When reaction becomes feasible, the product gases CO_2 and steam are produced. From the graph, gases are produced at 378-380K.
3d	Any answer from:	Oil bath heated too quickly Oil bath not stirred Impure/wet sample Unequal distribution of temperature in the powder S^o valid at 25°C rather than room temperature Not carried out at standard conditions Gas leaks Sticky gas syringe
4a	2-phenylpropane has more van der Waals attractions	More atoms in 2-phenylpropane than benzene so stronger van der Waals intermolecular attractions between 2-phenylpropane molecules.
4b	Benzoic acid contains hydrogen bonding	The –OH bond in the carboxyl group gives benzoic acid hydrogen bonding to raise the boiling point of benzoic acid.
4c	Any 2-halopropane	2-fluoropropane, 2-chloropropane, 2-bromopropane or 2-iodopropane
5a	$1s^22s^22p^63s^23p^63d^7$ or [Ne] $3s^23p^63d^7$	Electron arrangement of Co atom: $1s^22s^22p^63s^23p^63d^74s^2$ 4s electrons are removed before 3d electrons on ionisation to Co^{2+} ion Electron arrangement of Co^{2+}ion: $1s^22s^22p^63s^23p^63d^74s^2$ NB [Ar]$3d^7$ is not acceptable answer as there are no s or p orbitals in answer.
5b	Hexaamminecobalt(II) or hexamminecobalt(II)	NH_3 ligands are called ammine not amine or amino Complex has overall positive charge so complex name does not end in –ate Co^{2+} ion has oxidation number =2 so (II) after cobalt in name
5c	Oxidising agent for oxidation of $Co^{2+} \rightarrow Co^{3+}$	$K_4[Co(CN)_6]$ 4xK^+ $\therefore$ complex must be $[Co(CN)_6]^{4-}$ 6xCN^- $\therefore$Co ion must be Co^{2+} ion as -6+2=-4 Oxidation Step: $Co^{2+} \rightarrow Co^{3+} + e^-$ $K_3[Co(CN)_6]$ 3xK^+ $\therefore$ complex must be $[Co(CN)_6]^{3-}$ 6xCN^- $\therefore$Co ion must be Co^{3+} ion as -6+3=-3 Reduction Step: $Cl_2 + 2e^- \rightarrow 2Cl^-$

5d	d→d splitting different due to different ligand field strength	The degree of splitting of the d-orbitals is dependent on the field strength of the ligand available
5e	217.7	$E=\frac{Lhc}{\lambda}=\frac{6.02\times10^{23}mol^{-1}\times 6.63\times10^{-34}\ J\ s\times 3\times10^{8}m\ s^{-1}}{550\times10^{-9}\ m}=217705\ J\ mol^{-1}$ $=217.7\ kJ\ mol^{-1}$
6a	$MnO_4^- + 8H^+ + 5Fe^{2+}$ ↓ $Mn^{2+} + 4H_2O + 5Fe^{3+}$	❶ $MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$ ❷x5 $5Fe^{2+} \rightarrow 5Fe^{3+} + 5e^-$ Add ❶+❷' $MnO_4^- + 8H^+ + 5Fe^{2+} \rightarrow Mn^{2+} + 4H_2O + 5Fe^{3+}$
6b(i)	1.204×10^{-5} mol	**no.** of mol Fe^{2+} = **v**olume x **c**oncentration = 0.0301 x 0.0020 = 6.02×10^{-5} mol $MnO_4^- + 8H^+ + 5Fe^{2+} \rightarrow Mn^{2+} + 4H_2O + 5Fe^{3+}$ 1mol 5 mol 1.204×10^{-5} mol 6.02×10^{-5} mol **no.** of mol MnO_4^- ions in 25cm^3 = 1.204×10^{-5} mol
6b(ii)	0.24%	**no.** of mol MnO_4^- ions in 100cm^3 = 4.816×10^{-5} mol **mass** = **no.** of mol x **gfm** = 4.816×10^{-5}mol x 54.9 = 2.64×10^{-3}g $\%Mn=\frac{\text{mass of Mn}}{\text{mass of sample}}=\frac{2.64\times10^{-3}g}{1.11g}\times100=0.24\%$
6c	Colorimetry	The purple colour of MnO_4^- is proportional to the concentration of the MnO_4^- ion.
7a		dots and cross Lewis diagram also correct
7b(i)	$O_3 + O \rightarrow 2O_2$	❶ $NO + O_3 \rightarrow NO_2 + O_2$ ❷ $NO_2 + O \rightarrow NO_2 + O_2$ Add ❶+❷ $O_3 + O \rightarrow 2O_2$
7b(ii)	Catalyst	Speeds up reaction but is not used in the reaction
7c(i)	2nd order	<table><tr><th>Experiments</th><th>Change in conditions</th><th>Effect on Rate</th><th>Order</th></tr><tr><td>1+2</td><td>[O] x 2</td><td>x2</td><td>1</td></tr><tr><td>2+3</td><td>[NO₂] x 2</td><td>x2</td><td>1</td></tr></table>Rate = $k\,[O]^1\,[NO_2]^1 = k\,[O][NO_2]$ ∴ Overall order = 1 + 1 = 2
7c(ii)	$5.97\times10^{9}\ l\ mol^{-1}s^{-1}$	Rate = $k\,[O][NO_2]$ $k=\frac{rate}{[O][NO_2]}=\frac{6.10\times10^{-17}\ mol\ l^{-1}s^{-1}}{(9.20\times10^{-15}mol\ l^{-1})\times(1.11\times10^{-12}mol\ l^{-1})}=5.97\times10^{9}\ l\ mol^{-1}s^{-1}$
8a	pH remains same	Buffers are able to maintain a certain pH and resist changes in pH with the addition of acid or alkali.
8b	4.47	1 mol of C_2H_5COOK = (3x12)+(5x1)+(2x16)+(1x39.1) =36+5+32+39.1 = 112.1g **no.** of mol = $\frac{\textbf{mass}}{\textbf{gfm}}=\frac{2.24g}{112.1\ g\ mol^{-1}}$ = 0.020mol **c**oncentration = $\frac{\textbf{no.}\text{ of mol}}{\text{volume}}=\frac{0.020\ mol}{0.25\ mol\ l^{-1}}$ = 0.080mol l^{-1} $pH = pK_a - \log\frac{[acid]}{[salt]} = 4.87 - \log\frac{0.20}{0.080} = 4.87 - \log(2.5)$ $= 4.87 - (-0.398)$ $= 4.47$

9a(i)	Al_2O_3 or conc H_2SO_4 or phosphoric acid	$\underset{\text{propan-2-ol}}{CH_3CH(OH)CH_3} \xrightarrow{\text{dehydration}} \underset{\text{propene}}{CH_3CH{=}CH_2 + H_2O}$
9a(ii)	Hydrogen cyanide HCN	$\underset{\text{propanone}}{CH_3COCH_3 + HCN} \xrightarrow{\text{addition}} \underset{\text{cyanohydrin compound}}{CH_3C(CH_3)(OH)C{\equiv}N}$
9b		$\underset{\text{cyanohydrin compound}}{CH_3C(CH_3)(OH)C{\equiv}N} \xrightarrow{\text{hydrolysis}} \underset{\text{hydroxycarboxylic acid}}{CH_3C(CH_3)(OH)COOH}$
9c	reduction	Oxidation: propan-2-ol → propanone ∴ Reduction: propanone → propan-2-ol
10a	Ethers	Ethers contain the group C–O–C and are also known as alkoxyalkanes
10b	Add sodium metal	Add a group 1 metal to methanol: $2CH_3OH + 2Na \rightarrow H_2 + 2Na^+CH_3O^-$
10c(i)	**Step 1** Heterolytic fission of C-Cl bond to form carbocation **Step 2** Nucelophilic attack of methoxide ion	 2-chloro-2-methylpropane 2-methoxy-2-methylpropane
10c(ii)	Too many bulky methyl groups around C-Cl bond which provide steric hindrance	S_N2 reactions occur when a nucleophile attacks the δ+ of the polar carbon-halogen(X) bond. In tertiary halogenalkanes, the bulky alkyl groups reduce the likelihood of a successful collision by the nucleophile. This makes the S_N1 reaction more likely via heterolytic fission of the C-X bond forming a carbocation intermediate.
10d	Any one from:	 pentan-2-ol  2-methylbutan-1-ol  3-methylbutan-2-ol  2-methoxybutane

<table>
<tr><td>11a</td><td>Agonists produce the same response as the body's natural active compound</td><td>Agonists bind with the active site and produces a biological response in the cell.
Antagonists bind with the active site and do not produce a biological response in the cell.</td></tr>
<tr><td>11b</td><td>Structure showing:</td><td></td></tr>
<tr><td>11c</td><td>Secondary amine</td><td>Primary Amine: 1 carbon attached to the N in the amine
Secondary Amine: 2 carbons attached to the N in the amine
Tertiary Amine: 3 carbons attached to the N in the amine</td></tr>
<tr><td>12a(i)</td><td>Carbonyl group or C=O bond</td><td>C=O causes a strong absorption at $1745cm^{-1}$</td></tr>
<tr><td>12a(ii)</td><td>ester</td><td>C=O in an ester bond causes a strong absorption at $1745cm^{-1}$</td></tr>
<tr><td>12b(i)</td><td>0.058g</td><td>Mass of carbon = 0.478g x $^{12}/_{44}$ = 0.130g
Mass of hydrogen = 0.196g x $^{2}/_{18}$ = 0.022g
Mass of oxygen = original mass – mass of hydrogen – mass of carbon
= 0.210g – 0.130g – 0.022g
= 0.058g</td></tr>
<tr><td>12b(ii)</td><td>C_3H_6O</td><td>
<table>
<tr><td>Elements</td><td>C</td><td>H</td><td>O</td></tr>
<tr><td>Mass of element</td><td>0.130</td><td>0.022</td><td>0.058</td></tr>
<tr><td>Divide mass by RAM</td><td>$= \frac{0.130}{12}$
=0.01083</td><td>$= \frac{0.022}{1}$
=0.0218</td><td>$= \frac{0.058}{16}$
=0.0036</td></tr>
<tr><td>Divide through by smallest value</td><td>$= \frac{0.01083}{0.0036}$
=3.01</td><td>$= \frac{0.0218}{0.0036}$
=6.06</td><td>$= \frac{0.0036}{0.0036}$
=1</td></tr>
<tr><td>Round To Whole Number</td><td>3</td><td>6</td><td>1</td></tr>
</table>
</td></tr>
<tr><td>12c(i)</td><td>116g
(accept 115-117g)</td><td>Compound is furthest peak to right (the heaviest peak)</td></tr>
<tr><td>12c(ii)</td><td>$C_6H_{12}O_2$</td><td>Mass of C_3H_6O = (3x12)+(6x1)+(1x16) = 36+6+16 = 58g
Heaviest peak (furthest to right) = 116g
$\therefore$ 116g = 2x 58g = 2x (C_3H_6O) $\therefore$ molecular formula is $C_6H_{12}O_2$</td></tr>
<tr><td>12d</td><td>Ethylbutanoate</td><td>As compound is an 6 carbon ester and the alcohol in the ester is 2 carbon ethanol, the carboxylic acid in the ester must have 4 carbons $\therefore$ carboxylic acid is butanoic acid</td></tr>
<tr><td></td><td></td><td></td></tr>
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