JABchem

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Past Papers Advanced Higher Chemistry

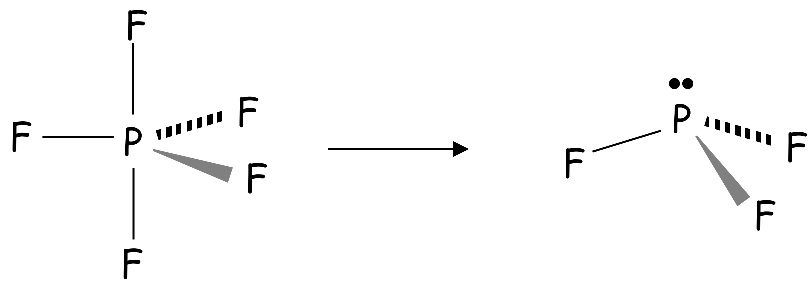
2011

Marking Scheme

Grade Awarded	Mark Required (/125)	Mark Required %	% candidates achieving grade
A	86+	68.8%	32.2%
B	73+	58.4%	25.0%
C	61+	48.8%	21.1%
D	55+	44.0%	7.9%
No award	<55	<44.0%	15.9%

Section:	Multiple Choice	Extended Answer	Investigation
Average Mark:	25.7 /40	34.4 /60	15.7 /25

2011 Adv Higher Chemistry Marking Scheme

<table>
<tr><th>MC Qu</th><th>Answer</th><th>% Pupils Correct</th><th>Reasoning</th></tr>
<tr><td>1</td><td>A</td><td>86</td><td>Group 3 elements have the lowest 3rd ionisation energy as removing the 3rd electron creates a full outer shell. Group 3 elements have the highest 4th ionisation energy as removing 4th electron breaks a full outer shell.</td></tr>
<tr><td>2</td><td>B</td><td>81</td><td>☒A absorbance increases as concentration increases.
☑B the lower the concentration, the lower the absorbance of radiation
☒C the radiation wavelength is chosen externally & not dependent on concentration
☒D the radiation wavelength is chosen externally & not dependent on concentration</td></tr>
<tr><td>3</td><td>A</td><td>77</td><td>☑A Chlorine has 3 non-bonding lone pairs of electrons
☒B Oxygen has 2 non-bonding lone pairs of electrons
☒C Nitrogen has 1 non-bonding lone pairs of electrons
☒D Oxygen has 2 non-bonding lone pairs of electrons</td></tr>
<tr><td>4</td><td>C</td><td>66</td><td>PF_5 PF_3

trigonal bipyramidal pyramidal</td></tr>
<tr><td>5</td><td>C</td><td>67</td><td>Ratio of X:Y = 133:220 = 1:1.65 ∴ Ratio closer to 1:2 of NaCl than 1:1 of CsCl
NaCl has 6:6 co-ordination where each Na^+ ion is surrounded by 6 Cl^- ions
∴ XY will also have 6:6 co-ordination like NaCl</td></tr>
<tr><td>6</td><td>C</td><td>75</td><td>☒A carbon is in group 4 but p-type semiconductors are doped with a group 3 element
☒B arsenic is in group 5 but p-type semiconductors are doped with a group 3 element
☑C aluminium is in group 3 and p-type semiconductors are doped with a group 3 element
☒D phosphorus is in group 5 but p-type semiconductors are doped with a group 3 element</td></tr>
<tr><td>7</td><td>A</td><td>56</td><td>☑A Li_2O dissolves in water to make an alkali and would not lower the pH of NaOH solution.
☒B SiO_2 is insoluble in water Li_2O and would not lower the pH of NaOH solution
☒C P_4O_{10} dissolves in water to form an acid and would lower the pH of NaOH solution.
☒D Al_2O_3 is amphoteric and lowers the pH of NaOH by reacting with the NaOH</td></tr>
<tr><td>8</td><td>D</td><td>56</td><td>☒A PCl_5 hydrolyses in water: $PCl_{5(s)} + 4H_2O_{(l)} \longrightarrow H_3PO_{4(aq)} + 5HCl_{(g)}$
☒B $SiCl_4$ hydrolyses in water to form HCl gas
☒C $AlCl_3$ hydrolyses in water to form HCl gas
☑D $MgCl_2$ dissolves in water to form $MgCl_{2(aq)}$ and HCl gas is not formed.</td></tr>
<tr><td>9</td><td>C</td><td>77</td><td><table>
<tr><th>Test</th><th>sodium oxide</th><th>calcium oxide</th><th>sodium hydride</th><th>calcium hydride</th></tr>
<tr><td>Flame Colour</td><td>orange-yellow colour</td><td>orange-red colour</td><td>orange-yellow colour</td><td>orange-red colour</td></tr>
<tr><td>Addition of Water</td><td>Dissolves to form alkaline solution</td><td>Reacts to form hydrogen gas and leaves alkaline solution</td><td>Dissolves to form alkaline solution</td><td>Reacts to form hydrogen gas and leaves alkaline solution</td></tr>
</table></td></tr>
<tr><td>10</td><td>D</td><td>52</td><td>☒A $Ti(H_2O)_6^{3+}$ contains Ti^{3+} ions and has an incomplete 3d shell ∴ ion has colour
☒B $Cr(NH_3)_6^{3+}$ contains Cr^{3+} ions and has an incomplete 3d shell ∴ ion has colour
☒C $Ni(H_2O)_6^{2+}$ contains Ni^{2+} ions and has an incomplete 3d shell ∴ ion has colour
☑D $Zn(NH_3)_4^{2+}$ contains Zn^{2+} ions and has an complete 3d shell ∴ ion has no colour</td></tr>
<tr><td>11</td><td>B</td><td>47</td><td>no. of mol NO_3^- = volume x concentration = 0.5 litre x 0.1 mol l^{-1} = 0.05mol NO_3^- ions
But 2 NO_3^- ions per $Ca(NO_3)_2$ f.u. ∴0.05mol NO_3^- ions → 0.025mol $Ca(NO_3)_2$ f.u.
$\text{volume} = \frac{\text{no of mol}}{\text{concentration}} = \frac{0.025\ \text{mol}}{0.25\ \text{mol l}^{-1}} = 0.1\ \text{litres} = 100\text{cm}^3$</td></tr>
</table>

<table>
<tr><td>12</td><td>C</td><td>85</td><td>☒A removal of reactant moves equilibrium to left ∴ decreases H_2 concentration
☒B exothermic reverse reaction is favoured ∴ decreases H_2 concentration
☑C Pressure-increasing forward reaction favoured ∴ increases H_2 concentration
☒D no change the position of equilibrium ∴ no change to H_2 concentration</td></tr>
<tr><td>13</td><td>A</td><td>75</td><td>$K=\frac{[CH_4]\times[H_2O]}{[CO]\times[H_2]^3} \quad \therefore \quad [CH_4]=\frac{K\times[CO]\times[H_2]^3}{[H_2O]}=\frac{3.9\times 0.500\times(0.1)^3}{0.040}=0.04875\ mol\ l^{-1}$</td></tr>
<tr><td>14</td><td>C</td><td>88</td><td>☒A iodine dissolves in each layer to the same proportion
☒B more iodine dissolves in cyclohexane layer but partition coefficient is unaltered
☑C solubility of iodine changes with temperature differently in each layer
☒D Thorough mixing does not alter the partition coefficient or the concentrations</td></tr>
<tr><td>15</td><td>C</td><td>48</td><td><table>
<tr><th>Phase</th><th>Answer</th><th>Explanation</th></tr>
<tr><td>Stationary</td><td>Non-polar liquid</td><td>The silica particles in the column are coated in non-polar liquid and the non-polar liquid interacts with the test substance travelling through the column.</td></tr>
<tr><td>Mobile</td><td>Helium</td><td>The mobile phase is a gas which carries the substance through the column. The longer the test substance spends interacting with the stationary phase, the longer the substances take to be carried through the column by the mobile phase.</td></tr>
</table></td></tr>
<tr><td>16</td><td>D</td><td>74</td><td>$NH_{3(aq)} + NH_{3(aq)} \rightleftharpoons NH_4^+(aq) + NH_2^-(aq)$
acid (donates H^+) | base (accepts H^+) | conjugate acid (formed on accepting H^+) | conjugate base (formed after losing H^+)</td></tr>
<tr><td>17</td><td>B</td><td>59</td><td>Equation 1: $H_2 + I_2 \rightarrow 2HI$ has an activation energy of 165kJ
Equation 2: $2HI \rightarrow H_2 + I_2$ has an activation energy of 179kJ
∴ Reaction must be endothermic for reaction 2 as more energy is required to get to activated complex at the top of the hill than is release as H_2 and I_2 are reformed.
∴ ΔH = 179kJ - 165kJ = +14kJ mol^{-1}</td></tr>
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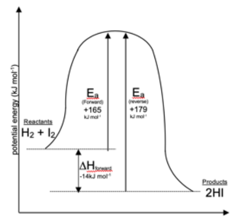
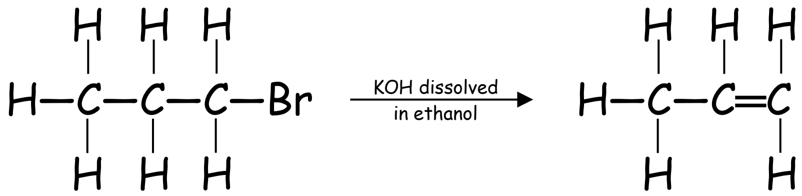
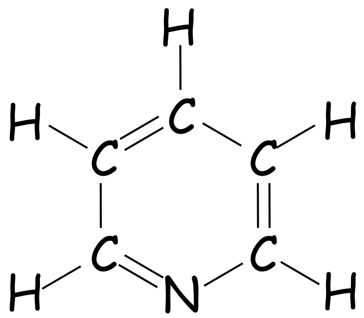
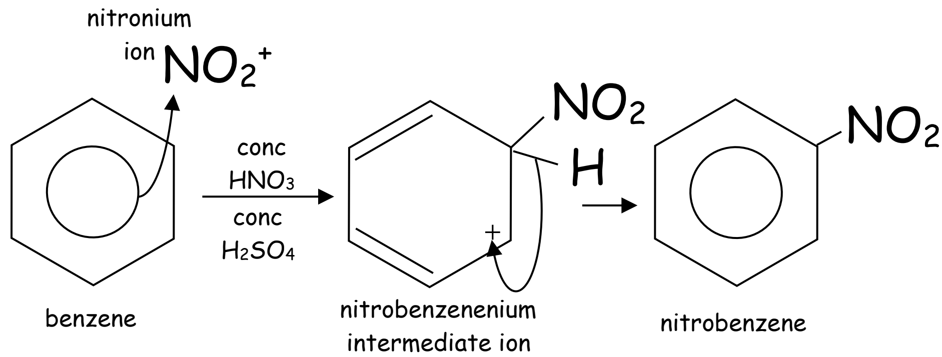
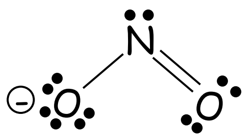
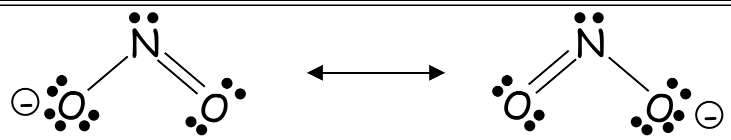

</td></tr>
<tr><td>18</td><td>B</td><td>69</td><td>☒A Reactants must be elements in their natural state (Strontium is a solid at 25°C)
☑B Enthalpy of formation: 1mol of substance formed from its elements in their natural state
☒C Reactants must be elements in their natural state (Strontium must be element not ion)
☒D Reactants must be elements in their natural state (Strontium must be element not ion)</td></tr>
<tr><td>19</td><td>A</td><td>52</td><td><table>
<tr><th>Step</th><th>Reaction</th><th>Enthalpy</th></tr>
<tr><td>❶</td><td>$H_2(g) \rightarrow 2H(g)$</td><td>+432kJ</td></tr>
<tr><td>❷</td><td>$\frac{1}{2}O_2(g) \rightarrow O(g)$</td><td>+248kJ</td></tr>
<tr><td>❸</td><td>$2H(g) + O(g) \rightarrow H_2O(g)$</td><td>-916kJ</td></tr>
<tr><td>❹</td><td>$H_2O(g) \rightarrow H_2O(l)$</td><td>-46kJ</td></tr>
<tr><td>Overall</td><td>$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l)$</td><td>-282kJ</td></tr>
<tr><td>x2</td><td>$2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$</td><td>-564kJ</td></tr>
</table></td></tr>
<tr><td>20</td><td>D</td><td>76</td><td>☒A Cl-Cl bond is neither formed nor broken in this reaction
☒B Cl-Cl bond is neither formed nor broken in this reaction
☑C H-H bond is broken (positive value) and H-Cl bond is formed (negative value)
☒D H-Cl bond is formed so value for H-Cl would be negative (exothermic)</td></tr>
<tr><td>21</td><td>B</td><td>42</td><td>☒A Bromine is a liquid at 25°C not a solid
☑B 1 mole of gaseous atoms formed from its element in their natural state
☒C Bromine is a liquid at 25°C not a gas
☒D Definition is 1 mole of gaseous atoms produced not 1 mole of substance split up.</td></tr>
<tr><td>22</td><td>A</td><td>39</td><td><table>
<tr><th>Enthalpy</th><th>Equation</th><th>Value</th></tr>
<tr><td>❶ Lattice enthalpy $CaCl_2$</td><td>$Ca^{2+}(g) + 2Cl^-(g) \rightarrow CaCl_2(s)$</td><td>-2223kJ</td></tr>
<tr><td>❷ Hydration of Ca^{2+}</td><td>$Ca^{2+}(g) \rightarrow Ca(aq)$</td><td>-1650kJ</td></tr>
<tr><td>❸ Hydration of Cl^-</td><td>$Cl^-(g) \rightarrow Cl^-(aq)$</td><td>-364kJ</td></tr>
<tr><td>2x❸</td><td>$2Cl^-(g) \rightarrow 2Cl^-(aq)$</td><td>-728kJ</td></tr>
<tr><td>Enthalpy of solution of $CaCl_2$</td><td>$CaCl_2(s) \rightarrow Ca(aq) + 2Cl^-(aq)$</td><td>= ❷ + 2x❸ - ❶
-1650 + (-728) - (-2223)
-1650 - 728 + 2223
-155kJ mol^{-1}</td></tr>
</table></td></tr>
</table>

<table>
<tr><td>23</td><td>D</td><td>74</td><td>☒A small decrease in entropy (disorder) as two gases react to become one gas
☒B Increase in entropy (disorder) as gas is released during reaction
☒C Increase in entropy (disorder) as gas is released during reaction
☑D Larger decrease in entropy (disorder) as three reactants (one a gas) become one substance in solution.</td></tr>
<tr><td>24</td><td>B</td><td>61</td><td>☒A Propan-1-ol boils at 97°C and is a liquid at 90°C. Liquids are more ordered than gases
☑B Propan-2-ol boils at 82°C and is a gas at 90°C. Gases are more disordered than gases
☒C butan-1-ol boils at 118°C and is a liquid at 90°C. Liquids are more ordered than gases
☒D butan-2-ol boils at 100°C and is a liquid at 90°C. Liquids are more ordered than gases</td></tr>
<tr><td>25</td><td>D</td><td>52</td><td>☒A Fluorine is more reactive than chlorine as displaces chlorine from solutions
☒B Chlorine is more reactive than bromine as displaces bromine from solutions
☒C Fluorine is more reactive than bromine as displaces bromine from solutions
☑D Iodine is less reactive than Bromine and cannot displace bromine from solutions</td></tr>
<tr><td>26</td><td>C</td><td>82</td><td>

1-bromopropane propene</td></tr>
<tr><td>27</td><td>A</td><td>67</td><td><table><tr><th>Property</th><th>Boiling Point</th><th>Viscosity</th></tr><tr><td>Effect of increasing number of -OH Bonds</td><td>• higher degree of Hydrogen bonding
• molecules closer together
• increase to boiling point</td><td>• higher degree of Hydrogen bonding
• molecules closer together
• alcohol is thicker</td></tr></table></td></tr>
<tr><td>28</td><td>C</td><td>79</td><td>☒A sigma bonds are formed by sp^3 hybridisation
☒B sp^2 hybridisation produced pi bonds only
☑C alkanes have only sigma (single) bonds formed by sp^3 hybridisation
☒D sp^3 hybridisation produces sigma bonds only</td></tr>
<tr><td>29</td><td>A</td><td>51</td><td>☑A There are no $H^{\bullet}$ radicals in this mechanism
☒B two $Cl^{\bullet}$ free radicals could collide and combine to form Cl_2.
☒C two $CH_3^{\bullet}$ free radicals could collide to form C_2H_6.
☒D a $Cl^{\bullet}$ free radical could collide with a $CH_3^{\bullet}$ free radical to form CH_3Cl</td></tr>
<tr><td>30</td><td>C</td><td>62</td><td><table><tr><th>Structure</th><th>Number of sigma bonds</th><th>Number of Pi bonds</th></tr><tr><td></td><td><table><tr><th>Sigma Bond</th><th>Number</th></tr><tr><td>C-C</td><td>4</td></tr><tr><td>C-H</td><td>5</td></tr><tr><td>C-N</td><td>2</td></tr><tr><td>Total</td><td>11</td></tr></table></td><td><table><tr><th>Pi Bond</th><th>Number</th></tr><tr><td>C=C</td><td>2</td></tr><tr><td>C=N</td><td>1</td></tr><tr><td>Total</td><td>3</td></tr></table></td></tr></table></td></tr>
<tr><td>31</td><td>A</td><td>76</td><td>☑A The Cl atom attaches to C_2 and H atom attaches to C_3 (C_3 has the most H atoms on it already)
☒B This is the minor product of Markovnikov's Rule
☒C Only 1 chlorine is added to molecule as H-Cl is added across the C=C double bond
☒D 4-chloro-4-methylpentane should be renumbered to 2-chloro-2-methylpentane</td></tr>
<tr><td>32</td><td>B</td><td>67</td><td>Propan-1-ol (primary alcohol) $\xrightarrow{\text{oxidation}}$ Propanal (aldehyde) $\xrightarrow{\text{oxidation}}$ Propanoic Acid (carboxylic acid)
Propan-1-ol + Propanoic Acid → propyl propanoate + water (ester)</td></tr>
</table>

33	D	89	☒A Primary Amine has N-H bond ∴ hydrogen bonding between molecules ☒B Secondary Amine has N-H bonds ∴ hydrogen bonding between molecules ☒C Primary Amine has N-H bond ∴ hydrogen bonding between molecules ☑D Tertiary Amine has no N-H bonds ∴ no hydrogen bonding between molecules
34	B	41	☒A 1 volume of HCl would react with the N-H group of CH_3NHCH_3 ☑B 2 volumes of HCl would react with both NH_2 groups of H_2N-CH_2-NH_2 ☒C glycerol does not react with hydrochloric acid ☒D 1 volume of HCl would react with the NH_2 group of HO-C_6H_4-NH_2
35	D	72	☒A nucleophiles are not attracted to the delocalised electrons of benzene ☒B nucleophiles are not attracted to the delocalised electrons of benzene ☒C there are no C=C double bonds in benzene for addition reaction to take place ☑D electrophiles are attracted to delocalised electrons and a substitution reaction takes place as an H atoms substitutes with a Cl atom.
36	B	51	Nitronium ion formed by: $HNO_3 + H_2SO_4 \longrightarrow NO_2^+ + H_3O^+ + 2HSO_4^-$ 
37	C	64	☒A This molecule is *trans*-1,2-dibromopropene ☒B This molecule is 1,3-dibromopropene so cannot be a geometric isomer ☑C Molecule is *cis*-1,2-dibromopropene ☒D This molecule is 1,3-dibromopropene so cannot be a geometric isomer
38	A	74	C_2H_4O has mass = 44amu but molecule has mass of 88amu ∴ formula $C_4H_8O_2$ ☑A Ethanal CH_3CHO has a molecular formula of C_2H_4O ☒B Butanoic acid C_3H_7COOH has a molecular formula of $C_4H_8O_2$ ☒C Ethylethanoate $C_2H_5OCOCH_3$ has a molecular formula of $C_4H_8O_2$ ☒D Methylpropanoate $CH_3OCOC_2H_5$ has a molecular formula of $C_4H_8O_2$
39	D	35	☒A X-ray radiation is used during x-ray crystallography ☒B Visible light is not used in proton nmr spectroscopy ☒C Infra-red radiation absorbed as specific bonds vibrate during IR spectroscopy ☑D Radio waves are absorbed in proton nmr spectroscopy
40	D	27	☒A 3 peaks caused by –CH_3, -CH_2 and C-CO-C ☒B 3 peaks caused by –CH_3, -CH_2 and -CHO ☒C 2-methylpropan-2-ol has a formula of $C_4H_{10}O$. ☑D 2 peaks caused by C-CH_2-O and C-CH_2-C

2011 Adv Higher Chemistry Marking Scheme

<table>
<tr><th>Long Qu</th><th>Answer</th><th>Reasoning</th></tr>
<tr><td>1a</td><td>Superconductor</td><td>Superconductors are materials with zero resistance at low temperatures.</td></tr>
<tr><td>1b</td><td>Liquid Nitrogen</td><td>Nitrogen has a boiling point of -210°C (63K) and liquid nitrogen will keep the temperature of the superconductor below the 85K necessary for the material to become a superconductor. There are safety considerations using liquid oxygen and liquid helium is too expensive to use economically.</td></tr>
<tr><td>2a</td><td>Line at 4.6×10^{14}Hz</td><td>$\lambda = \frac{c}{f} = \frac{3\times10^{8}\ m\ s^{-1}}{4.6\times10^{14}\ s^{-1}} = 6.52\times10^{-7}m = 652\times10^{-9}m = 652nm$
The blue/violet end of the visible spectrum is around 450nm.
The red end of the visible spectrum is around 700nm.</td></tr>
<tr><td>2b(i)</td><td>$H_{(g)} \rightarrow H^{+}{}_{(g)} + e^{-}$</td><td>1st Ionisation Energy: The energy change for the removal of 1 mol of electrons from 1 mol of atoms in the gaseous state.</td></tr>
<tr><td>2b(ii)</td><td>91nm or
9.13×10^{-8}m</td><td>$E= \frac{L \times h \times c}{\lambda} \therefore \lambda = \frac{L \times h \times c}{E} = \frac{6.02\times10^{23}mol^{-1} \times 6.63\times10^{-34}\ J\ s \times 3\times10^{8}\ m\ s^{-1}}{1311 \times 1000\ J\ mol^{-1}}$
$= 9.13 \times 10^{-8}$ m
$= 91.3$ nm</td></tr>
<tr><td>3a</td><td>NO: +2
NO_2: +4</td><td><table><tr><th>Compound</th><th>No of O atoms</th><th>Charge from O atoms</th><th>Oxidation State of Nitrogen</th></tr><tr><td>NO</td><td>1</td><td>1 x -2 = -2</td><td>+2</td></tr><tr><td>NO_2</td><td>2</td><td>2 x -2 = -4</td><td>+4</td></tr></table></td></tr>
<tr><td>3b</td><td></td><td></td></tr>
<tr><td>3c</td><td>$NO_2^{-} + H_2O$
↓
$NO_3^{-} + 2H^{+} + 2e^{-}$</td><td>$NO_2^{-} \rightarrow NO_3^{-}$
$NO_2^{-} + H_2O \rightarrow NO_3^{-}$
$NO_2^{-} + H_2O \rightarrow NO_3^{-} + 2H^{+}$
$NO_2^{-} + H_2O \rightarrow NO_3^{-} + 2H^{+} + 2e^{-}$</td></tr>
<tr><td>4a(i)</td><td>$1s^22s^22p^63s^23p^63d^5$</td><td><table><tr><th>Species</th><th>Electron Arrangement</th><th>3d orbital</th></tr><tr><td>Fe</td><td>$1s^22s^22p^63s^23p^63d^64s^2$</td><td>↑↓ | ↑ | ↑ | ↑ | ↑</td></tr><tr><td>Fe^{3+}</td><td>$1s^22s^22p^63s^23p^63d^5$</td><td>↑ | ↑ | ↑ | ↑ | ↑</td></tr></table></td></tr>
<tr><td>4a(ii)</td><td>$1s^22s^22p^63s^23p^63d^4$</td><td><table><tr><th>Species</th><th>Electron Arrangement</th><th>3d orbital</th></tr><tr><td>Mn</td><td>$1s^22s^22p^63s^23p^63d^54s^2$</td><td>↑ | ↑ | ↑ | ↑ | ↑</td></tr><tr><td>Mn^{3+}</td><td>$1s^22s^22p^63s^23p^63d^4$</td><td>↑ | ↑ | ↑ | ↑ | </td></tr></table></td></tr>
<tr><td>4a(iii)</td><td>Fe^{3+} has half-filled d-subshell</td><td>Fe^{3+} ions are $3d^5$ which means each of the d-orbitals are half-filled. A full d-subshell is very stable and a half-filled d-subshell is more stable than an incomplete d-subshell</td></tr>
<tr><td>4b</td><td>1.71kg</td><td>1mol $FeTiO_3$ = (1x55.8) + (1x47.9) + (3x16) = 55.8 + 47.9 + 48 = 151.7g
no. of mol = $\frac{\textbf{mass}}{\textbf{gfm}} = \frac{3250g}{151.7g\ mol^{-1}}$ = 21.4mol
$FeTiO_3 + 3H_2SO_4 \longrightarrow FeSO_4 + Ti(SO_4)_2 + 3H_2O$
1mol ... 1mol
21.4mol. ... 21.4mol
$Ti(SO_4)_2 + 4NaOH \longrightarrow TiO_2 + 2H_2O + 2Na_2SO_4$
1mol ... 1mol
21.4mol ... 21.4mol
1mol TiO_2 = (1x47.9) + (2x16) = 47.9 + 32 = 79.9g
mass = no. of mol x gfm = 21.4mol x 79.9 g mol^{-1} = 1710g = 1.71kg</td></tr>
</table>

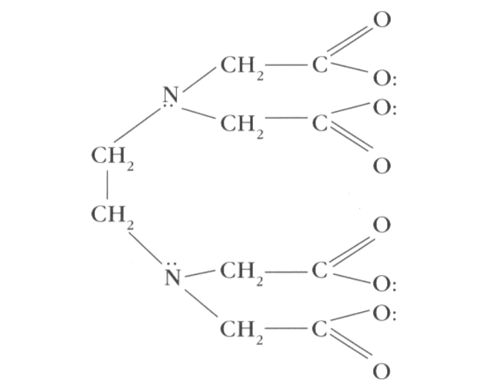
<table>
<tr><td>4c</td><td>$(NH_4)_2[Cu(Cl)_4]$</td><td>

Tetrachloridocuprate (II) = $[Cu(Cl)_4]^{2-}$

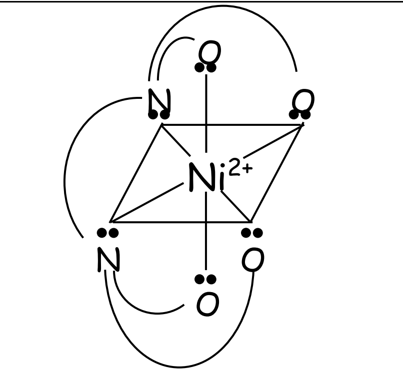
$\underbrace{\text{Tetra}}_{\text{no. of ligands}}\underbrace{\text{chlorido}}_{\text{choride ion ligand}}\underbrace{\text{cupr}}_{\text{metal name}}\underbrace{\text{ate}}_{\text{negative complex}}\underbrace{\text{(II)}}_{\text{Charge on metal ion}}$

<table>
<tr><td>Neutral ligands include:</td><td>Negative Ligands include:</td><td>Central Ion:</td><td>Charge:</td></tr>
<tr><td>
<table>
<tr><td>Ligand</td><td>Name</td></tr>
<tr><td>H_2O</td><td>aqua</td></tr>
<tr><td>NH_3</td><td>ammine</td></tr>
<tr><td>CO</td><td>carbonyl</td></tr>
</table>
</td><td>
<table>
<tr><td>Ligand</td><td>Name</td></tr>
<tr><td>Chloride Cl^-</td><td>chlorido</td></tr>
<tr><td>Cyanide CN^-</td><td>cyanido</td></tr>
<tr><td>Nitrite NO_2^-</td><td>nitrito</td></tr>
</table>
</td><td>Positive Complex:
metals keep their name
Negative Complex:
Metals end in ATE
e.g. Cuprate, Ferrate, Cobaltate</td><td>Charge of central ion is converted into roman numerals and put in brackets</td></tr>
</table>

Ammonium ions need to balance negative charge of complex: $(NH_4^+)_2\ [Cu(Cl^-)_4]^{2-}$
</td></tr>
<tr><td>5a</td><td>Answer to include:</td><td>Step 4: Rinse beaker with deionised water, add washings to standard flask
Step 5: add deionised water up to mark on standard flask</td></tr>
<tr><td>5b(i)</td><td>Murexide</td><td>PPA Technique Question</td></tr>
<tr><td>5b(ii)</td><td>octahedral</td><td>



Ethylenediaminetetraacetic acid (EDTA)



$Ni[EDTA]^{2-}$ complex
</td></tr>
<tr><td>5b(iii)</td><td>22.9%</td><td>Average titre (ignoring rough titre) = $23.55cm^3$ = 0.02355 litres
no. of mol Ni^{2+} in 25 cm^3 = volume x concentration = 0.02355 x 0.110 = 0.00259 mol
no. of mol Ni^{2+} in $100cm^3$ = 0.00259 x $^{100}/_{25}$ = 0.0104mol
mass of Ni = no. of mol x gfm = 0.0104 x 58.7 = 0.608g
%mass of Ni^{2+} = $\frac{0.608g}{2.656g}$ x 100 = =22.90%</td></tr>
<tr><td>6a</td><td>300K
(accept 300K -310K)</td><td>Reaction becomes feasible when ΔG^o=0.
From graph: when ΔG^o=0, T=300K</td></tr>
<tr><td>6b</td><td>400
(accept 380 – 420)</td><td>

$\underset{\text{y-axis value}}{y} = \underset{\text{gradient}}{m}\ \underset{\text{x-axis value}}{x} + \underset{\text{y-axis intercept}}{c}$

$\Delta G^o = -\Delta S^o\ T + \Delta H^o$

Extrapolate the line until line intercepts the y=axis.
</td></tr>
<tr><td>6c</td><td>1325
(accept 1220 – 1400)</td><td>

Gradient = $-\Delta S^o = \frac{y_2 - y_1}{x_2 - x_1} = \frac{-390 - 140}{600 - 200} = \frac{-530 \text{ kJ mol}^{-1}}{400 \text{ K}} = -1.325 \text{ kJ K}^{-1} \text{ mol}^{-1}$

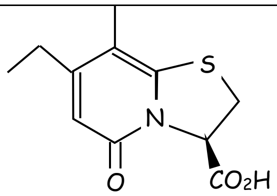
$\therefore \Delta S^o = 1.325 \text{ kJ K}^{-1} \text{ mol}^{-1} = 1325 \text{ J K}^{-1} \text{ mol}^{-1}$
</td></tr>
<tr><td>7a</td><td>3rd order or 3</td><td>Rate = $k[NO]^2[Cl_2]$ $\therefore$ Rate = k x $[NO]^2$ x $[Cl_2]^1$
$\therefore$ Overall order = 2+1 = 3</td></tr>
<tr><td>7b</td><td>Reaction 3 as rate is independent of concentration of reactants</td><td>Reaction 3 has an overall order of reaction = zero.
Changes to the concentration of NH_3 makes no difference to reaction rate.</td></tr>
<tr><td>7c</td><td>$9.15 \times 10^{-5}\ l^2\ mol^{-2}\ s^{-1}$</td><td>

$$\text{rate} = k \times [NO]^2\ [Cl_2]$$

$$k = \frac{\text{rate}}{[NO]^2\ [Cl_2]} = \frac{1.43 \times 10^{-6}\ mol\ l^{-1}\ s^{-1}}{(0.250\ mol\ l^{-1})^2 \times 0.250 mol\ l^{-1}} = 9.15 \times 10^{-5}\ l^2\ mol^{-2}\ s^{-1}$$
</td></tr>
</table>

<table>
<tr><td>8a</td><td>$2Br^- + H_2O_2 + 2H^+$
↓
$Br_2 + 2H_2O$</td><td>$Br_2 + 2e^- \rightarrow 2Br^-$ E^o= 1.07V
$H_2O_2 + 2H^+ + 2e^- \rightarrow 2H_2O$ E^o= 1.77V

$2Br^- \rightarrow Br_2 + 2e^-$ E^o= -1.07V
$H_2O_2 + 2H^+ + 2e^- \rightarrow 2H_2O$ E^o= 1.77V

$H_2O_2 + 2H^+ + 2Br^- \rightarrow 2H_2O + Br_2$ E^o= 0.70V</td></tr>
<tr><td>8b</td><td>-135.1</td><td>2mol of electrons transferred between half reactions ∴ n=2
E^o = 1.77V + (-1.07) = 0.70V (see above)
$\Delta G^o = - n \times F \times E^o$
$= - 2 \times 96500\ C\ mol^{-1} \times 0.70V$
$= - 135100\ J\ mol^{-1}$
$= - 135.1\ kJ\ mol^{-1}$</td></tr>
<tr><td>9a</td><td>Resists pH changes when acid/alkali are added</td><td>A buffer is a solution in which the pH remains (approximately) constant when small amounts of acid, alkali or water are added.</td></tr>
<tr><td>9b</td><td>One from:</td><td>Sodium propanoate or potassium propanoate</td></tr>
<tr><td>9c</td><td>9.30</td><td>gfm NH_4NO_3 = (2x14) + (4x1) + (3x16) = 28 + 4 + 48 = 80g
$\text{no. of mol} = \frac{\text{mass}}{\text{gfm}} = \frac{1.05g}{80g\ mol^{-1}} = 0.0131\ mol$
$\text{concentration [salt]} = \frac{\text{no. of mol}}{\text{volume}} = \frac{0.001875\ mol}{0.1\ litres} = 0.131\ mol\ l^{-1}$
$pH = pK_w - pK_b + \log\frac{[base]}{[salt]}$
$pH = 14 - 4.76 + \log\frac{[0.15]}{[0.131]}$
$pH = 14 - 4.76 + \log [1.145]$
$pH = 14 - 4.76 + 0.059$
$pH = 9.30$</td></tr>
<tr><td>10a</td><td>Pharmacophore</td><td>Pharmacophores are the part of a molecule with the specific shape necessary to exactly fit the relevant receptor</td></tr>
<tr><td>10b</td><td></td><td>The pharmacaphore shape must be common to all the different molecules shown.
At the point where the molecules different, the pharmacaphore shape ends.</td></tr>
<tr><td>11a</td><td>$C_3H_4O_2$</td><td><table>
<tr><td>Element</td><td>C</td><td>H</td><td>O</td></tr>
<tr><td>%</td><td>50</td><td>5.6</td><td>44.4</td></tr>
<tr><td>No. of moles
(divide % by gfm)</td><td>$\frac{50}{12}$
= 4.16</td><td>$\frac{5.6}{1}$
= 5.6</td><td>$\frac{44.4}{16}$
= 2.77</td></tr>
<tr><td>Mole ratio
(divide through by smallest value)</td><td>$\frac{4.16}{2.77}$
= 1.50</td><td>$\frac{5.6}{2.77}$
= 2.02</td><td>$\frac{2.77}{2.77}$
= 1</td></tr>
<tr><td>Double and Round to Whole Number</td><td>3</td><td>4</td><td>2</td></tr>
</table></td></tr>
<tr><td>11b(i)</td><td>$C_6H_8O_4$</td><td>The carbons in either ring structure must have 4 bonds.
Any bonds not shown in the diagrams are C-H bonds.</td></tr>
<tr><td>11b(ii)</td><td>2500 – 3500
or 1700 - 1725</td><td>Molecule A has a carboxyl COOH group not found in molecule B.
Both IR stretches are unique to –COOH group</td></tr>
<tr><td>12a</td><td>Condensation</td><td>Reaction: $C_6H_5CHO + CH_3CHO \longrightarrow C_6H_5CHCHCHO$
(Benzaldehyde, Ethanal, Cinnamaldehyde)
Balanced Equation: $C_7H_6O + C_2H_4O \longrightarrow C_9H_8O + H_2O$
The reaction is a condensation reaction as two molecules join together and water is removed at the join.</td></tr>
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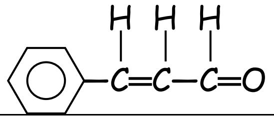
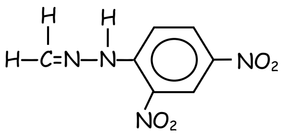
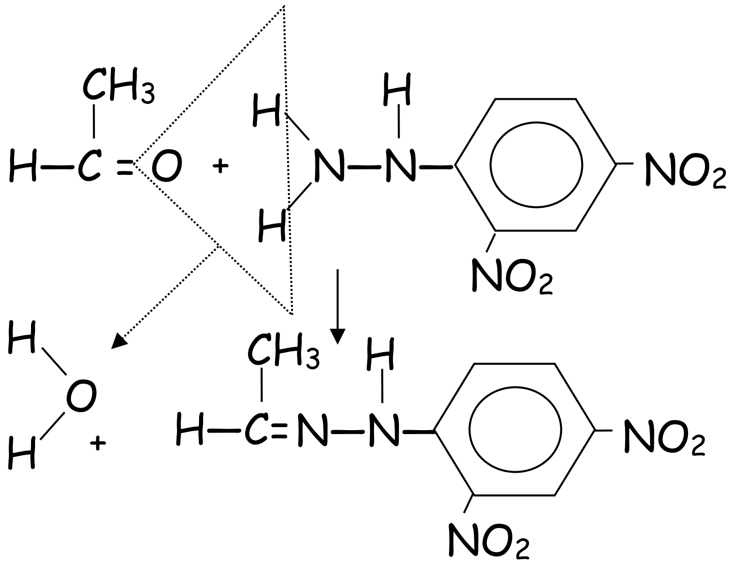
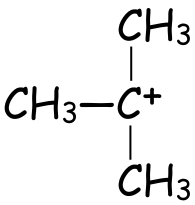
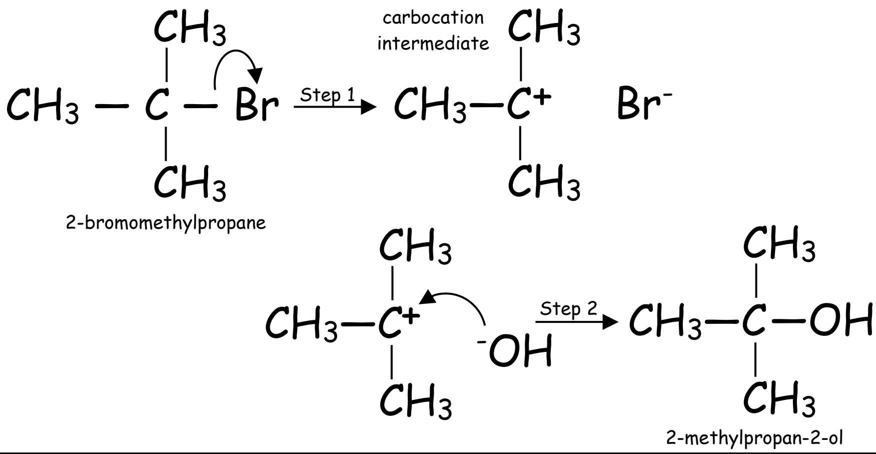
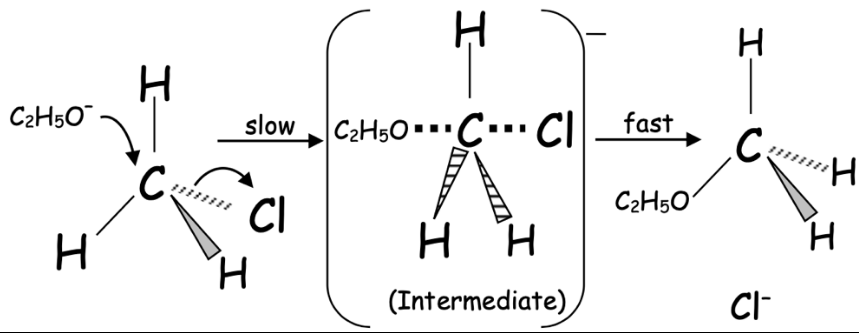
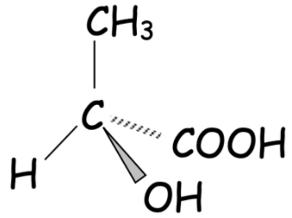
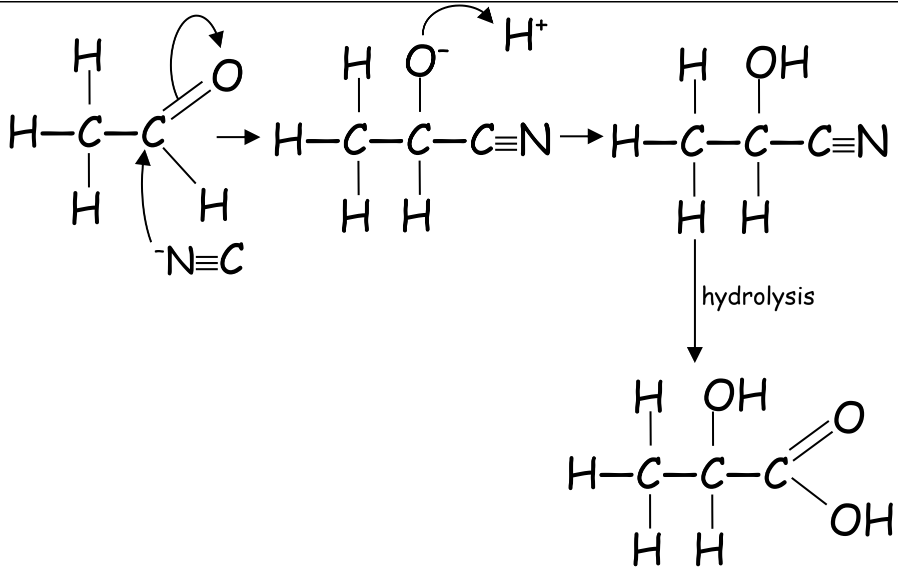
12b		C_6H_5- : phenyl group; -CHCH- : must contain a C=C double bond to ensure 4 bonds on the carbons; -CHO : aldehyde group
12c(i)		
12c(ii)	Recrystallisation	Recrystallisation will remove impurities as the impurities stay in the solvent.
12c(iii)	Measure melting point and compare to known value for ethanal	The products of the reaction of aldehyde/ketone reaction with 2,4-DNPH have a specific melting point and by use of melting point apparatus, the aldehyde/ketone can be identified.
12c(iv)	Yellow/orange/gold	PPA Question
13a(i)	Nucleophilic substitution with 1 molecule involved in rate determining step.	S_N1 reactions have only one molecule involved in the rate determining step (i.e. First Order). The mechanism is a nucleophile involved in a substitution reaction.
13a(ii)		
13b(i)	Sodium added to ethanol	$2Na + 2C_2H_5OH \longrightarrow 2Na^+C_2H_5O^- + H_2$ sodium metal, ethanol, sodium ethoxide, hydrogen gas
13b(ii)	methoxyethane *Or* methylethylether Or ethylmethylether	

14a	2-hydroxypropanoic acid	2-hydroxypropanoic acid -OH group on Carbon 2 · 3 carbons on main chain · Carboxyl -COOH functional group on C_1
14b	carbon number 2 as 4 different groups attached to carbon 2	
14c(i)	Named Cyanide compound e.g. KCN, NaCN, HCN	A cyanide compound that contains the CN^- ion will perform this reaction.
14c(ii)	Hydrolysis or acid hydrolysis	
14c(iii)