Past Papers Nat 5 Chemistry

2016

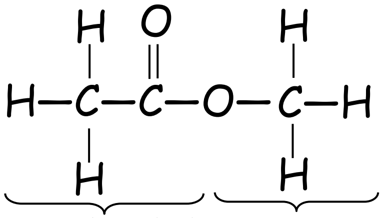
Marking Scheme

Grade Awarded	Mark Required		% candidates achieving grade
	(/100)	%	
A	72+	72%	34.1%
B	61+	61%	23.3%
C	51+	51%	18.7%
D	46+	46%	7.4%
No award	<46	<46%	16.5%

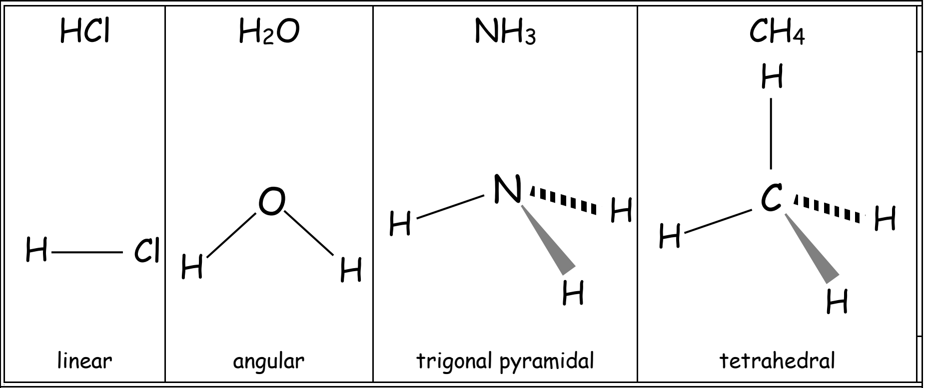
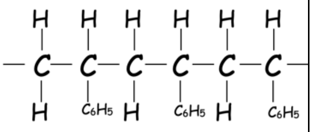
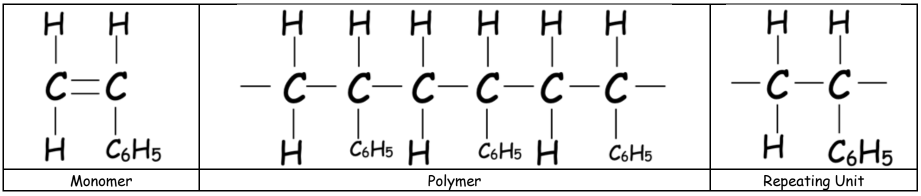
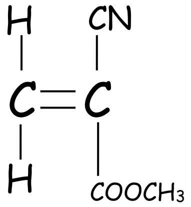
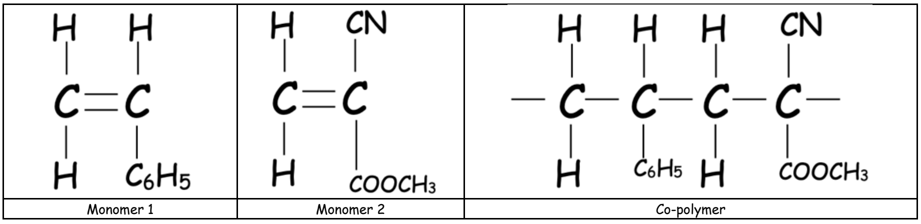
Section:	Multiple Choice	Extended Answer	Assignment
Average Mark:	12.4 /20	36.3 /60	14.3 /20

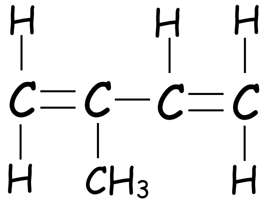
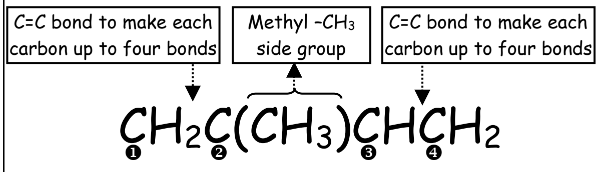
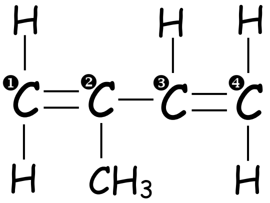
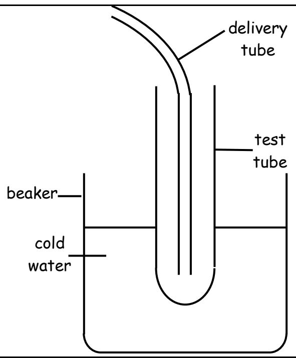
2016 National 5 Chemistry Marking Scheme

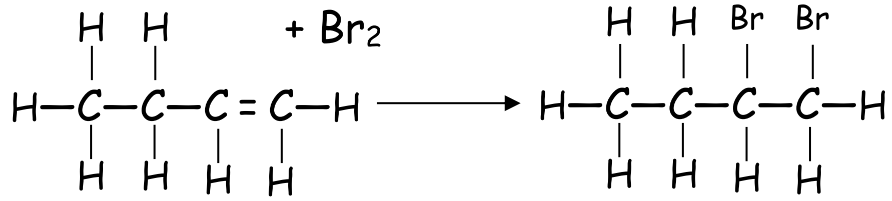
MC Qu	Answer	% Pupils Correct	Reasoning
1	D	62	☒A products of dissolving should be aqueous solutions of $Na^+_{(aq)}$ and $Cl^-_{(aq)}$ ions ☒B correct formula for water should be $H_2O_{(l)}$ as water does not dissolve in water ☒C $NaCl_{(aq)}$ does not exist as $NaCl_{(s)}$ splits up its lattice into $Na^+_{(aq)}$ + $Cl^-_{(aq)}$ ions ☑D $NaCl_{(s)}$ dissolves in $H_2O_{(l)}$ to form the ions $Na^+_{(aq)}$ + $Cl^-_{(aq)}$
2	C	79	☒A temperature would have to be above 40°C to have reaction time less than 10s ☒B temperature would have to be between 30-40°C to have time between 10-20s ☑C temperature is less than 30°C ∴ reaction time must be more than 20s concentration is more than 0.1 ∴ reaction time must be less than 60s ☒D concentration would have to be 0.1mol l^{-1} and temperature below 20°C
3	D	48	☒A electrons have negligible mass so removal of electron has no effect on mass no. ☒B no change to the number of protons so atomic number is unchanged ☒C no change to the number of protons so charge of nucleus is unchanged ☑D atom X (e.g. Na 2,8,1) becomes ion X^+ (e.g. Na^+ 2,8) loses an occupied energy level
4	B	77	☒A sulphur is a non-metal which forms molecules of S_8 with covalent bonds ☑B copper is a metal which contains metallic bonding ☒C oxygen is a non-metal which forms molecules of O_2 with covalent bonds ☒D hydrogen is a non-metal which forms molecules of H_2 with covalent bonds
5	B	78	☒A ionic compounds contain at least one metal and one non-metal in compound ☑B monatomic substances are single atoms with no bonds between them ☒C covalent network compounds e.g. SiO_2 are compounds with many covalent bonds ☒D covalent molecular compounds e.g. H_2O are compounds with covalent bonds inside
6	C	80	☒A covalent molecular as no conductivity and low mpt/bpt ☒B covalent as no conductivity (unclear if network or molecular from mpt) ☑C ionic bonding as no conductivity as solid but conductivity as a liquid ☒D metallic bonding as conductivity as both solid and liquid
7	A	45	☑A silver (I) oxide has the formula Ag_2O ☒B silver (II) oxide has the formula AgO ☒C silver (III) oxide has the formula Ag_2O_3 ☒D silver (IV) oxide has the formula AgO_2
8	C	63	☒A tin is metal, tin oxide is insoluble ∴ no effect on pH ☒B zinc is a metal, zinc oxide is insoluble ∴no effect on pH ☑C sulphur is a non-metal, sulphur dioxide is a soluble non-metal oxide ∴pH<7 (acid) ☒D sodium is a metal, sodium oxide is a soluble metal oxide ∴pH >7 (alkali)
9	B	63	☒A carbon (soot) is formed by incomplete combustion in a limited supply of air ☑B carbon dioxide & water formed by complete combustion in plentiful supply of air ☒C carbon monoxide is formed by incomplete combustion in a limited supply of air ☒D hydrogen is formed by incomplete combustion in a limited supply of air
10	C	79	☒A C_4H_8 fits the general formula C_nH_{2n} but C_3H_8 fits the general formula C_nH_{2n+2} ☒B C_4H_8 fits the general formula C_nH_{2n} but C_3H_8 fits the general formula C_nH_{2n+2} ☑C both C_3H_8 and C_5H_{12} fit the general formula C_nH_{2n+2} ☒D C_5H_{10} fits the general formula C_nH_{2n} but C_3H_8 fits the general formula C_nH_{2n+2}
11	B	75	☒A side groups cannot be placed on C_1 (side groups must be on middle carbons) ☑B 5 carbons in main chain with C=C bon between C_1 & C_2 and –CH_3 groups on C_2 & C_3 ☒C C=C double bond must be given lowest numbering system ☒D same numbering system must be used at all times (starting on right here)
12	B	61	☒A but-1-ene shown is exact same structure as right isomer at top of question ☑B same formula (C_4H_8) but different structure (methylpropene) ☒C cyclobutene C_4H_6 has a different formula from butene C_4H_8 ☒D pent-1,4-diene C_5H_8 has a different formula to butene C_4H_8

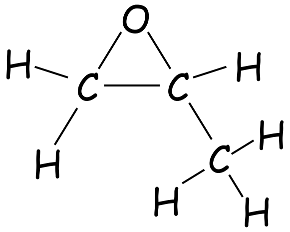
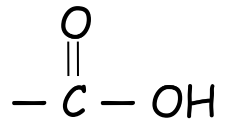
<table>
<tr><td>13</td><td>A</td><td>49</td><td>
2C carboxylic acid side
Ester ends in ETHANOATE
1C alcohol side
Ester begins in METHYL</td></tr>
<tr><td>14</td><td>C</td><td>82</td><td>☒A flash point of octane is 15°C ∴ octane does not ignite at 0°C
☒B hexene and cyclohexane have same molecular mass but different flash points
☑C as boiling point increases, flash point increases
☒D as number of carbons increases, the flash point increases</td></tr>
<tr><td>15</td><td>D</td><td>64</td><td><table>
<tr><td>Method</td><td>Electrolysis</td><td>Heat With Carbon</td><td>Heat Alone</td></tr>
<tr><td>Metals Made This Way</td><td><table><tr><td>Potassium</td><td>Sodium</td></tr><tr><td>Lithium</td><td>Calcium</td></tr><tr><td>Magnesium</td><td>Aluminium</td></tr></table></td><td><table><tr><td>Zinc</td><td>Iron</td></tr><tr><td>Nickel</td><td>Tin</td></tr><tr><td>Lead</td><td>Copper</td></tr></table></td><td><table><tr><td>Mercury</td><td>Silver</td></tr><tr><td>Gold</td><td>Platinum</td></tr></table></td></tr>
<tr><td>Reason</td><td>most reactive metals</td><td>medium reactive metals</td><td>least reactive metals</td></tr>
</table></td></tr>
<tr><td>16</td><td>D</td><td>20</td><td>☒A polyesters are made from two monomers (diacid and diol)
☒B addition monomers contain unsaturated C=C double bonds
☒C monomers with one functional group do not extend the length of the polymer
☑D each monomer in polyester has two functional groups (diacid and diol)</td></tr>
<tr><td>17</td><td>A</td><td>70</td><td>☑A a radioisotope which is alpha emitting and has a long half life
☒B gamma rays are too penetrating to be stopped by a smoke
☒C a smoke detector with a short half life would need to be replace too often
☒D gamma rays are too penetrating to be stopped by a smoke</td></tr>
<tr><td>18</td><td>A</td><td>50</td><td>$^{234}_{90}\text{Th} \longrightarrow {}^{234}_{91}\text{Pa} + {}^{0}_{-1}\text{e}$</td></tr>
<tr><td>19</td><td>C</td><td>45</td><td><table><tr><td>Time (years)</td><td>% ^{14}C Content</td></tr><tr><td>0</td><td>100</td></tr><tr><td>5600</td><td>50</td></tr><tr><td>11200</td><td>25</td></tr></table></td></tr>
<tr><td>20</td><td>B</td><td>50</td><td>☒A no precipitate as lithium carbonate is soluble
☑B turns cloudy as insoluble calcium carbonate precipitate is formed
☒C no precipitate as sodium carbonate is soluble
☒D no precipitate as ammonium carbonate is soluble</td></tr>
</table>

2016 National 5 Chemistry Marking Scheme

<table>
<tr><th>Long Qu</th><th>Answer</th><th>Reasoning</th></tr>
<tr><td>1a(i)</td><td><table><tr><td>1</td><td></td></tr><tr><td></td><td>0</td></tr></table></td><td rowspan="2"><table><tr><th>Particle</th><th>Location</th><th>Charge</th><th>Mass</th></tr><tr><td>Proton</td><td>in nucleus</td><td>+1</td><td>1 amu</td></tr><tr><td>Neutron</td><td>in nucleus</td><td>0</td><td>1 amu</td></tr><tr><td>Electron</td><td>outside nucleus</td><td>–1</td><td>approx zero</td></tr></table></td></tr>
<tr><td>1a(ii)</td><td><table><tr><td>Electron</td><td></td><td>-1</td></tr></table></td></tr>
<tr><td>1b</td><td>14.5</td><td>Relative atomic mass is the average mass of the different isotopes of the same element in a sample. As there are equal quantities of ^{14}N and ^{15}N in the sample, the RAM is half way between 14 and 15.</td></tr>
<tr><td>1c(i)</td><td>pyramidal</td><td>
</td></tr>
<tr><td>1c(ii)</td><td>Haber Process</td><td>$\text{Nitrogen} + \text{Hydrogen} \xrightarrow{\text{iron catalyst}} \text{Ammonia}$</td></tr>
<tr><td>2a</td><td></td><td>
</td></tr>
<tr><td>2b</td><td></td><td>
</td></tr>
<tr><td>3a</td><td>Exothermic</td><td><table><tr><td>Exothermic</td><td>Chemical reaction where heat energy is released to surroundings (temperature of the surroundings increases)</td></tr><tr><td>Endothermic</td><td>Chemical reaction where heat energy is absorbed from surroundings (temperature of the surroundings decreases)</td></tr></table></td></tr>
<tr><td>3b(i)</td><td>0.85</td><td>$\text{Rate} = \frac{\Delta\text{quantity}}{\Delta\text{time}} = \frac{29 - 12}{30 - 10} = \frac{17}{20} = 0.85\ cm^3\ s^{-1}$</td></tr>
<tr><td>3b(ii)</td><td>60</td><td>Maximum volume of hydrogen released = $37cm^3$
Time at which $37cm^3$ is achieved = 60s</td></tr>
<tr><td>3b(iii)</td><td>increased reaction rate</td><td>Zinc powder has a lower particle size than zinc lumps
Lower the particle size the faster the chemical reaction.</td></tr>
<tr><td>3c(i)</td><td>$2Al(NO_3)$</td><td>$2Al + 6HNO_3 \longrightarrow 2Al(NO_3)_3 + 3H_2$
metal + acid ⟶ salt + hydrogen</td></tr>
<tr><td>3c(ii)</td><td>0.36</td><td>$2Al + 6HNO_3 \longrightarrow 2Al(NO_3)_3 + 3H_2$
2mol 6mol 2mol 3mol
0.01mol 0.015mol
1mol gas = 24litres
$0.015\text{mol gas} = 24\text{litres} \times \frac{0.015}{1} = 0.36\text{litres}$</td></tr>
</table>

<table>
<tr><td>4a(i)</td><td>Andalusite + Kyanite</td><td>Both andalusite and kyanite can both exist at temperature of 400°C but which mineral is dependent on the pressure.</td></tr>
<tr><td>4a(ii)</td><td><table><tr><td>Temperature</td><td>500</td></tr><tr><td>Pressure</td><td>4</td></tr></table></td><td>The only temperature and pressure where all three forms of the mineral exist is the point on the graph where all three minerals intersect i.e. 500°C and 4kbar pressure.</td></tr>
<tr><td>4b</td><td>17.3</td><td>gfm Al_2SiO_5 = (2x27) + (1x28) + (5x16) = 54+28+80 = 162g
$\% \text{ Si} = \frac{\text{total mass of Si}}{\text{gfm } Al_2SiO_5} \times 100 = \frac{28}{162} \times 100 = 17.3\%$</td></tr>
<tr><td>5a</td><td>Does not react with water, air, alkalis and most acids</td><td>Problem Solving: retrieval of information from written passage</td></tr>
<tr><td>5b</td><td>118</td><td>Mass number = 197 (from passage) Atomic number = 79 (from data booklet)
Number of neutrons = mass number – atomic number = 197 – 79 = 118 neutrons</td></tr>
<tr><td>5c(i)</td><td>$CO + O_2 \longrightarrow CO_2$</td><td>carbon monoxide + oxygen ⟶ carbon dioxide
Formula is derived directly from name (mono = 1)
oxygen is one of the seven diatomic elements
Formula is derived directly from name (di = 2)
$CO + O_2 \longrightarrow CO_2$</td></tr>
<tr><td>5c(ii)</td><td>catalyst</td><td>A catalyst speeds up a chemical reaction but is not used up in the reaction.</td></tr>
<tr><td>5d</td><td>hydroxide
hydrogen</td><td>Nanorods are grown in a dilute solution of auric acid:<table><tr><th>Solution Type</th><th>Description</th></tr><tr><td>Acidic Solution</td><td>Number of H^+ ions > Number of OH^- ions</td></tr><tr><td>Neutral Solution</td><td>Number of H^+ ions = Number of OH^- ions</td></tr><tr><td>Alkaline Solution</td><td>Number of OH^- ions > Number of H^+ ions</td></tr></table></td></tr>
<tr><td>6a(i)</td><td>Potassium gives a lilac flame test</td><td><table><tr><td>Element</td><td>Barium</td><td>Calcium</td><td>Copper</td><td>Lithium</td><td>Potassium</td><td>Sodium</td><td>Strontium</td></tr><tr><td>Flame Colour</td><td>green</td><td>orange-red</td><td>blue-green</td><td>red</td><td>lilac</td><td>yellow</td><td>red</td></tr></table></td></tr>
<tr><td>6a(ii)</td><td>Ammonium contains nitrogen</td><td>Fertilisers contain soluble compounds of one or more of the following elements<table><tr><td>Nitrogen</td><td>Phosphorus</td><td>Potassium</td></tr></table></td></tr>
<tr><td>6b</td><td>$H_3PO_4 + 3NH_4OH$
↓
$(NH_4)_3PO_4 + 3H_2O$</td><td>$H_3PO_4 + 3NH_4OH \longrightarrow (NH_4)_3PO_4 + 3H_2O$</td></tr>
<tr><td>7</td><td>Open Question answer containing:</td><td><table><tr><th>3 mark answer</th><th>2 mark answer</th><th>1 mark answer</th></tr><tr><td>Demonstrates a <u>good</u> 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.</td><td>Demonstrates a <u>reasonable</u> understanding of the chemistry involved, making some statement(s) which are relevant to the situation, showing that the problem is understood.</td><td>Demonstrates a <u>limited</u> 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.</td></tr></table></td></tr>
<tr><td>8a</td><td> </td><td>  </td></tr>
<tr><td>8b</td><td> </td><td>The vapours from the steam distillation pass through the delivery tube into the test tube. The cold surface of the test tube allows the vapours to condense. The essential oils will float on top of the water in the test tube.</td></tr>
</table>

<table>
<tr><td>8c(i)</td><td>addition</td><td>Bromine adds across a C=C double bond in an addition reaction

$CH_3CH_2CH=CH_2 + Br_2 \longrightarrow CH_3CH_2CHBrCH_2Br$</td></tr>
<tr><td>8c(ii)</td><td>$C_{10}H_{16}Br_4$</td><td>Limonene has two C=C double bonds and 2 molecules of Br_2 will be added to the limonene molecule: $C_{10}H_{16} + 2Br_2 \longrightarrow C_{10}H_{16}Br_4$</td></tr>
<tr><td>9a</td><td>Method A more accurate as heat not lost transferring burner</td><td>It is essential that that heat is not lost during the movement of the lit burner under the beaker.</td></tr>
<tr><td>9b(i)</td><td>-OH on end increases the energy released</td><td>The energy released is consistently higher when –OH group in on 1st/end carbon (-1-ol alcohol) than it is when the –OH is on the 2nd carbon (-2-ol)</td></tr>
<tr><td>9b(ii)</td><td>3971</td><td>
<table>
<tr><td>Alcohol</td><td>Propan-1-ol</td><td>Propan-2-ol</td><td>Butan-1-ol</td><td>Butan-2-ol</td><td>Pentan-1-ol</td><td>Pentan-2-ol</td><td>Hexan-1-ol</td><td>Hexan-2-ol</td></tr>
<tr><td>Energy (kJ)</td><td>2021</td><td>2005</td><td>2676</td><td>2661</td><td>3329</td><td>3315</td><td>3984</td><td>-</td></tr>
<tr><td>Difference</td><td colspan="2">16</td><td colspan="2">15</td><td colspan="2">14</td><td colspan="2">(13)</td></tr>
<tr><td>Estimate (kJ)</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>3971</td></tr>
</table>
</td></tr>
<tr><td>9c</td><td>55.0</td><td>$E_h = cm\Delta T \therefore \Delta T = \frac{E_h}{c \times m} = \frac{23}{(4.18x0.1)} = 55.0^\circ C$</td></tr>
<tr><td>10a</td><td>Electrolyte</td><td>An electrolyte is a solution containing ions which helps to complete a circuit by ions moving to balance the movement of charge</td></tr>
<tr><td>10b(i)</td><td>Arrow showing movement from right to left through wires</td><td>Zinc is higher up the electrochemical series than copper so electrons move from zinc to copper
$Zn_{(s)} \rightarrow Zn_{(aq)} + 2e^-$
$Cu^{2+}_{(aq)} + 2e^- \rightarrow Cu_{(s)}$</td></tr>
<tr><td>10b(ii)</td><td>ion/salt bridge</td><td>Ion bridge is usually filter paper soaked in an ion solution. Ions move through the paper to balance the movement of charge through the wires.</td></tr>
<tr><td>10c(i)</td><td>oxidation</td><td>$Br_{2(l)} + 2e^- \longrightarrow 2Br^-_{(aq)}$ Reduction gain of electrons
$SO_3^{2-}{}_{(aq)} + H_2O_{(l)} \longrightarrow SO_4^{2-}{}_{(aq)} + 2H^+_{(aq)} + 2e^-$ Oxidation loss of electrons</td></tr>
<tr><td>10c(ii)</td><td>$Br_2 + SO_3^{2-} + H_2O$
↓
$2Br^- + SO_4^{2-} + 2H^+$</td><td>$Br_2 + SO_3^{2-} + H_2O \longrightarrow 2Br^- + SO_4^{2-} + 2H^+$</td></tr>
<tr><td>10c(iii)</td><td>carbon/graphite</td><td>Carbon (graphite) is a conductor of electricity and electrodes must be able to conduct electrons from one side to the other is a cell.</td></tr>
<tr><td>11a</td><td>methoxypropane</td><td>One carbon group (methyl CH_3-) on left hand side ∴ methoxy ……
Three carbon group (propyl $-CH_2CH_2CH_3$) on right hand side ∴ ……propane</td></tr>
<tr><td>11b</td><td>$C_nH_{2n+2}O$</td><td>
<table>
<tr><td>Ether</td><td>Methoxyethane</td><td>Ethoxyethane</td><td>Methoxypropane</td><td>propoxybutane</td></tr>
<tr><td>Structural Formula</td><td>CH_3-O-C_2H_5</td><td>C_2H_5-O-C_2H_5</td><td>CH_3-O-C_3H_7</td><td>C_3H_7-O-C_4H_9</td></tr>
<tr><td>Molecular Formula</td><td>C_3H_8O</td><td>$C_4H_{10}O$</td><td>$C_4H_{10}O$</td><td>$C_7H_{16}O$</td></tr>
<tr><td>General Formula</td><td>If n=3
2n+2 = (2x3)+2 = 8
∴ $C_nH_{2n+2}O$</td><td>If n=4
2n+2 = (2x4)+2 = 10
∴ $C_nH_{2n+2}O$</td><td>If n=4
2n+2 = (2x4)+2 = 10
∴ $C_nH_{2n+2}O$</td><td>If n=7
2n+2 = (2x7)+2 = 16
∴ $C_nH_{2n+2}O$</td></tr>
</table>
</td></tr>
<tr><td>11c</td><td>weak
strong</td><td>The bonds inside molecules are strong covalent bonds which required much energy to break them. The bonds between molecules are weak bonds which are easier to overcome and break.</td></tr>
<tr><td>11d(i)</td><td>Ethene</td><td>As the alkene is reacting with oxygen, all the carbon in the product must come from the alkene. As the product has two carbons, the original alkene bust have two carbons ∴ ethene</td></tr>
</table>

<table>
<tr><td>11d(ii)</td><td></td><td>Epoxides have a ring of three atoms but one of the three atoms in the ring must be the oxygen resulting in the third carbon being outside the ring.</td></tr>
<tr><td>12a</td><td>Hydroxyl group</td><td><table><tr><td>—O—H</td><td>
$-\overset{\overset{O}{||}}{C}-OH$</td></tr><tr><td>hydroxyl group</td><td>carboxyl group</td></tr></table></td></tr>
<tr><td>12b</td><td>Weak Acid
Strong Base</td><td>Betanin is the indicator use ∴ pH range of colour change = 9.0 - 10.0
pH at end point is above 7 weak acid and strong base used in reaction
(oxalic acid) (sodium hydroxide)</td></tr>
<tr><td>12c</td><td>15.0cm^3</td><td>Average Volume = $\frac{14.9 + 15.1}{2} = \frac{30.0}{2}$ = 15.0cm^3
NB: Ignore rough titre in the calculation of the average volume as it is inaccurate</td></tr>
<tr><td>12d</td><td>0.02</td><td>no. of mol = $\frac{\textbf{mass}}{\textbf{gfm}} = \frac{1.8}{90}$ = 0.02 mol</td></tr>
<tr><td>13</td><td>Open Question answer containing:</td><td><table><tr><th>3 mark answer</th><th>2 mark answer</th><th>1 mark answer</th></tr><tr><td>Demonstrates a <u>good</u> 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.</td><td>Demonstrates a <u>reasonable</u> understanding of the chemistry involved, making some statement(s) which are relevant to the situation, showing that the problem is understood.</td><td>Demonstrates a <u>limited</u> 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.</td></tr></table></td></tr>
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