JABchem

Past Papers Nat 5 Chemistry

2015

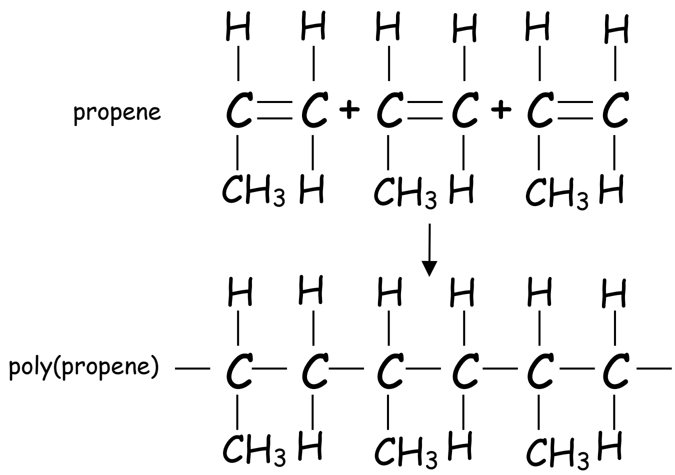
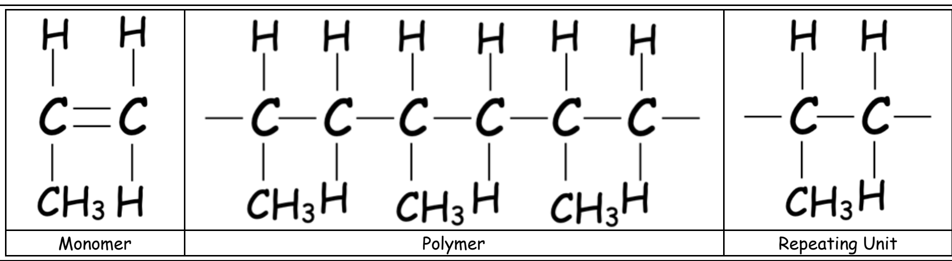
Marking Scheme

Grade Awarded	Mark Required (/100)	Mark Required %	% candidates achieving grade
A	68+	68%	32.3%
B	58+	58%	20.8%
C	48+	48%	19.4%
D	43+	43%	8.5%
No award	<43	<43%	19.0%

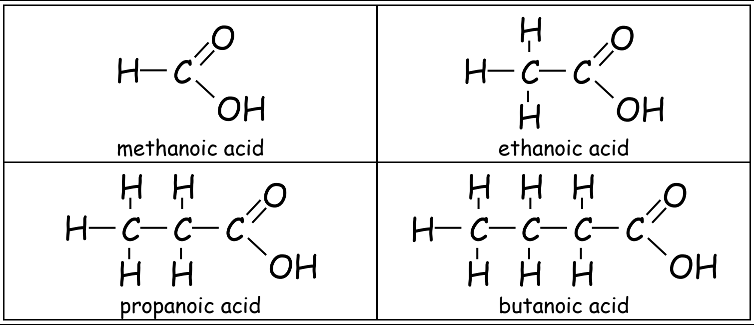
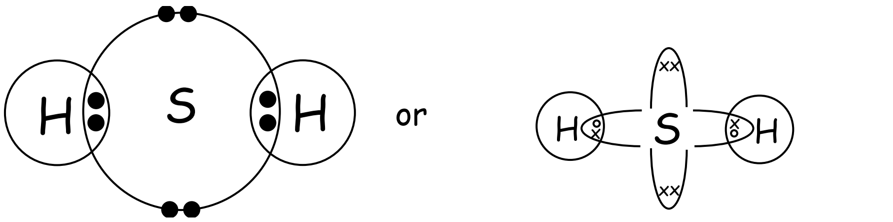
Section:	Multiple Choice	Extended Answer	Assignment
Average Mark:	13.4 /20	31.1 /60	14.1 /20

2015 National 5 Chemistry Marking Scheme

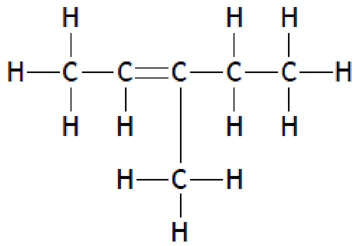
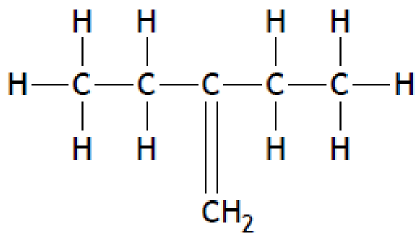
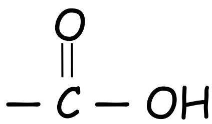
MC Qu	Answer	% Pupils Correct	Reasoning
1	A	92	Atomic number = number of protons ∴ atomic number = 26 Mass number = number of protons + number of neutrons ∴ mass number = 26 + 30 = 56
2	B	88	Isotope Definition: same number of protons / atomic number, different number of neutrons / mass number ☒A W and X have different numbers of protons ∴ W and X not isotopes ☑B W and Y have same number of protons but different numbers of neutrons ☒C X and Y have different numbers of protons ∴ X and Y not isotopes ☒D Y and Z have different numbers of protons ∴ Y and Z not isotopes
3	D	67	☒A Cl^- ions have an electron arrangement of 2,8,8 ☒B S^{2-} ions have an electron arrangement of 2,8,8 ☒C Ar atoms have an electron arrangement of 2,8,8 ☑D Na^+ ions have an electron arrangement of 2,8
4	C	55	☒A Gas would not need to pass through water to escape ☒B Gas would not pass through water (test tube would explode as pressure builds) ☑C Gas passes through water and escapes test tube through tube at top ☒D Gas would pass through water but test tube would explode as pressure builds
5	D	78	☒A this structure shows metallic bonding ☒B this structure shows ionic bonding ☒C this structure shoes molecular covalent bonding ☑D this structure shows covalent network bonding
6	C	51	Chromium chloride has the formula: $CrCl_3$ Chloride ions have the formula: Cl^- 3 chloride ions per chromium chloride: $Cr^{n+}(Cl^-)_3$ Chromium ion must have 3+ charge to balance charge: $Cr^{3+}(Cl^-)_3$
7	C	46	☒A Calcium at surface as it is less dense (1.54g cm^{-3}) than calcium chloride (2.15g cm^{-3}) ☒B Calcium would be a solid at 800°C as it melts at 842°C ☑C Solid calcium would float on the surface of the molten calcium chloride ☒D Calcium would be a solid at 800°C as it melts at 842°C
8	B	90	$2Al_{(s)} + 3Br_{2(l)} \longrightarrow 2AlBr_{3(s)}$
9	A	69	☑A **gfm** SO_2 = (1x32)+(2x16) = 32+32 =64g ∴ **mass** = **n** x **gfm** = 0.2 x 64 = 12.8g ☒B 1mol CO = (1x12)+(1x16) = 12+16 =28g ∴ **mass** = **n** x **gfm** = 0.2 x 28 = 5.6g ☒C 1mol CO_2 = (1x12)+(2x16) = 12+32 =44g ∴ **mass** = **n** x **gfm** = 0.2 x 44 = 8.8g ☒D 1mol NH_3 = (1x14)+(3x1) = 14+1 =17g ∴ **mass** = **n** x **gfm** = 0.2 x 17 = 3.4g
10	B	59	☒A carbon dioxide is a non-metal oxide and forms an acid when added to water ☑B copper (II) oxide is insoluble in water and does not change the pH of water ☒C sodium oxide is a metal oxide and forms an alkali when added to water ☒D sulphur dioxide is a non-metal oxide and forms an acid when added to water
11	B	46	☒A hydrochloric acid + sodium carbonate ⟶ sodium chloride + water + carbon dioxide ☑B sodium chloride does not react with acids as it is a salt not a base ☒C hydrochloric acid + sodium hydroxide ⟶ sodium chloride + water ☒D hydrochloric acid + sodium oxide ⟶ sodium chloride + water
12	C	88	☒A longest chain has five carbons ∴name ends in pentane ☒B longest chain has five carbons ∴name ends in pentane ☑C 5 carbons in main chain (pentane), two methyl groups on C_2 and C_3 ☒D numbering of carbons from right to left to give side groups lower numbering

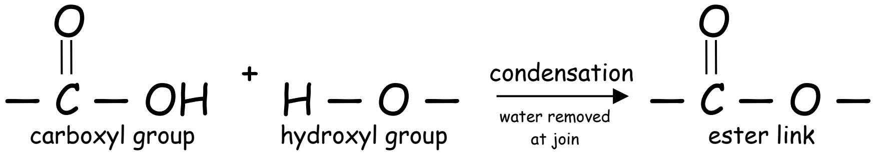
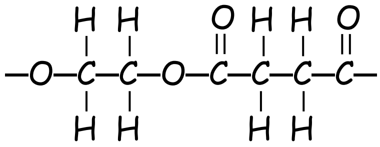
<table>
<tr><td>13</td><td>A</td><td>81</td><td>☑A correct structure is drawn.
☒B Shortened structural formula would be: $CH_3CH_2CH_2CH(OH)C(CH_3)_3$
☒C Shortened structural formula would be: $CH_3CH(CH_3)CH(OH)CH(CH_3)CH_2CH_3$
☒D Shortened structural formula would be: $CH_3CH(CH_3)CH(OH)CH_2CH_2CH_2CH_3$</td></tr>
<tr><td>14</td><td>D</td><td>77</td><td>Molecular formula of structures: $\mathbf{C_4H_6}$ $\mathbf{C_5H_8}$ $\mathbf{C_6H_{10}}$
<table>
<tr><th>Answer</th><th>General Formula</th><th>Formula if n=4</th><th>Formula if n=5</th><th>Formula if n=6</th></tr>
<tr><td>A</td><td>C_nH_{2n-4}</td><td>C_4H_4</td><td>C_5H_6</td><td>C_6H_8</td></tr>
<tr><td>B</td><td>C_nH_{2n+2}</td><td>C_4H_{10}</td><td>C_5H_{12}</td><td>C_6H_{14}</td></tr>
<tr><td>C</td><td>C_nH_{2n}</td><td>C_4H_8</td><td>C_5H_{10}</td><td>C_6H_{12}</td></tr>
<tr><td>D</td><td>C_nH_{2n-2}</td><td>$\mathbf{C_4H_6}$</td><td>$\mathbf{C_5H_8}$</td><td>$\mathbf{C_6H_{10}}$</td></tr>
</table></td></tr>
<tr><td>15</td><td>C</td><td>67</td><td>☒A negative and positive ions are only found in ionic bonding
☒B a shared pair of electrons and two nuclei are only found in covalent bonding
☑C metallic bonding has positive ions (nucleus & inner shells) and delocalised electrons
☒D metallic bonding has delocalised electrons not delocalised protons</td></tr>
<tr><td>16</td><td>D</td><td>76</td><td>☒A zinc & tin give lower voltage as they are closer together on electrochemical series
☒B electrons would flow from Y (zinc) to X (tin)
☒C electrons would flow from Y (magnesium) to X (copper)
☑D magnesium and copper would give the biggest voltage as they are further apart on electrochemical series and electrons flow from X (magnesium) to Y (copper) as magnesium is higher up ECS</td></tr>
<tr><td>17</td><td>A</td><td>79</td><td>
</td></tr>
<tr><td>17</td><td>A</td><td>79</td><td>
</td></tr>
<tr><td>18</td><td>A</td><td>38</td><td>Spectator ions appear chemically unchanged on both sides of a chemical equation:
Na^+ appears on both sides of equation
$2Na^+_{(aq)} + SO_4^{2-}{}_{(aq)} + Ba^{2+}_{(aq)} + 2Cl^-_{(aq)} \rightarrow BaSO_{4(s)} + 2Na^+_{(aq)} + SO_4^{2-}{}_{(aq)}$
SO_4^{2-} appears on both sides of equation</td></tr>
<tr><td>19</td><td>D</td><td>33</td><td>☒A swap names: ammonium nitrate and potassium chloride are both very soluble
☒B swap names: zinc sulphate and magnesium nitrate are both very soluble
☒C swap names: calcium chloride and nickel chloride are both very soluble
☑D swap names: sodium nitrate is very soluble but silver iodide is insoluble</td></tr>
<tr><td>20</td><td>D</td><td>61</td><td>Potassium chloride is colourless ∴potassium ions and chloride ions are colourless. Potassium chromate is yellow. As potassium ions are colourless, yellow colour must be due to the chromate ion.</td></tr>
</table>

2015 National 5 Chemistry Marking Scheme

<table>
<tr><th>Long Qu</th><th>Answer</th><th>Reasoning</th></tr>
<tr><td>1a</td><td>0.8 $cm^3\ s^{-1}$</td><td>$\text{Rate} = \frac{\Delta\text{quantity}}{\Delta\text{time}} = \frac{120 - 96}{90 - 60} = \frac{24}{30} = 0.8\ cm^3\ s^{-1}$</td></tr>
<tr><td>1b</td><td>Graph showing:</td><td>Both axes labelled with units (1 mark)
Both scales (1 mark)
Graph drawn accurately (1mark)
points must be plotted correctly and line drawn, either by joining the dots or by a smooth curve or curve of best fit
The line must be drawn from the origin.</td></tr>
<tr><td>2a</td><td>Neptunium</td><td>$^{241}_{95}Am \longrightarrow {}^{4}_{2}He + {}^{237}_{93}Np$</td></tr>
<tr><td>2b</td><td>alpha</td><td><table>
<tr><th>Radiation</th><th>Stopped by</th><th>Charge</th><th>Atomic Number</th><th>Mass Number</th></tr>
<tr><td>Alpha</td><td>paper</td><td>Positive</td><td>2</td><td>4</td></tr>
<tr><td>Beta</td><td>aluminium</td><td>Negative</td><td>-1</td><td>0</td></tr>
<tr><td>Gamma</td><td>lead</td><td>No charge</td><td colspan="2">Gamma radiation is a wave not a particle</td></tr>
</table></td></tr>
<tr><td>2c(i)</td><td>1g</td><td><table>
<tr><th>Time (hr)</th><th>Mass (g)</th></tr>
<tr><td>0</td><td>8</td></tr>
<tr><td>16</td><td>4</td></tr>
<tr><td>32</td><td>2</td></tr>
<tr><td>48</td><td>1</td></tr>
</table></td></tr>
<tr><td>2c(ii)</td><td>Longer half-life</td><td>Americium-242 has too short a half-life to be effective in a smoke-detector as the amount of Americium would half every 16 hours. It would not be operational within days of manufacture. Americium-241 has a half-life of 432years and will be working for many lifetimes but must be disposed of carefully.</td></tr>
<tr><td>3a(i)</td><td>hydroxyl</td><td>Hydroxyl groups are the functional group found in all alcohols and have the structure –OH or –O-H</td></tr>
<tr><td>3a(ii)</td><td>Esters or fats or oils</td><td>Fats and oils are triglycerides with three ester bonds between the original glycerol molecule and three fatty acids</td></tr>
<tr><td>3b(i)</td><td>Butanoic acid</td><td>
</td></tr>
<tr><td>3b(ii)</td><td>Bromine decolourises</td><td>Bromine solution is an yellow/orange colour contains molecules of Br_2.
The solution will decolourise as the bromine adds across the double bond.
Only C=C double bonds will decolourise bromine solution.</td></tr>
<tr><td>4a</td><td>Diagram showing:</td><td>
</td></tr>
<tr><td>4b</td><td>hydrogen
hydroxide</td><td><table>
<tr><td>Acids</td><td>Hydrogen ion concentration greater than hydroxide ion concentration</td></tr>
<tr><td>Neutral</td><td>Hydrogen ion concentration equal to hydroxide ion concentration</td></tr>
<tr><td>Alkali</td><td>Hydrogen ion concentration less than hydroxide ion concentration</td></tr>
</table></td></tr>
</table>

<table>
<tr><td>4c</td><td>Answer to include:</td><td><u>1st Mark</u>: Calcium oxide as a base or forms an alkali when dissolved in water (must mention when dissolved in water
<u>2nd Mark</u>: Calcium oxide in water <u>neutralises</u> sulphur dioxide (must mention the word neutralise)</td></tr>
<tr><td>5a</td><td>Iron</td><td>Iron is the catalyst in the Haber Process where nitrogen and hydrogen react to become ammonia NH_3.</td></tr>
<tr><td>5b</td><td>52-56</td><td><table>
<tr><td>Pressure</td><td>100</td><td>200</td><td>300</td><td>400</td><td>500</td><td>600</td><td>700</td></tr>
<tr><td>% Yield</td><td>10</td><td>18</td><td>26</td><td>32</td><td>40</td><td>-</td><td>-</td></tr>
<tr><td>Difference</td><td></td><td>8</td><td>8</td><td>8</td><td>8</td><td>(8)</td><td>(8)</td></tr>
<tr><td>Estimate</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>48</td><td>56</td></tr>
</table></td></tr>
<tr><td>5c</td><td>Higher the temp the lower the yield</td><td>The Haber Process is a reversible reaction where equilibrium is eventually achieved where the rate of the formation of products equals the rate of the breakdown of products.</td></tr>
<tr><td>5d</td><td>Low Temperature
High Pressure</td><td>In top table, the higher the pressure the higher the yield.
In bottom table, the lower the temperature the higher the yield</td></tr>
<tr><td>6a</td><td>3</td><td>99% of carbon dioxide is captured ∴ 1% is released
1% of 300tonnes = $\frac{1}{100}$x300 = 3tonnes</td></tr>
<tr><td>6b</td><td>Fe_2O_3</td><td><table>
<tr><td>Write down Valency below each element's symbol</td><td>Put in Cross-over Arrows</td><td>Follow arrows to get formula</td></tr>
<tr><td>Fe O
3 2</td><td>Fe O
3 2</td><td>Fe_2O_3</td></tr>
</table></td></tr>
<tr><td>6c</td><td>exothermic</td><td><table>
<tr><td>Exothermic</td><td>Chemical reaction which gives out energy</td></tr>
<tr><td>Endothermic</td><td>Chemical reaction which takes in energy from the surroundings</td></tr>
</table></td></tr>
<tr><td>7a</td><td>Boil off the water
(using a Bunsen burner)</td><td>The solution of copper sulphate is boiled in an evaporating basin until almost dry. The Bunsen burner is turned off just before dryness and the remaining heat evaporated the remaining water.</td></tr>
<tr><td>7b</td><td>0.2</td><td>1mol $CuSO_4$ = (1x63.5) + (1x32) + (4x16) = 63.5+32+64 = 159.5g
no. of mol = $\frac{\text{mass}}{\text{gfm}} = \frac{3.19}{159.5}$ = 0.02mol
concentration = $\frac{\text{no. of mol}}{\text{volume}} = \frac{0.02}{0.1}$ = 0.2 mol l^{-1}</td></tr>
<tr><td>8a</td><td>One answer from:</td><td><table>
<tr><td>Method A</td><td>Method B</td></tr>
<tr><td>incomplete combustion/ Less oxygen</td><td>complete combustion/more oxygen</td></tr>
<tr><td>(more) heat loss to surroundings</td><td>less/no heat loss to surroundings</td></tr>
<tr><td>no draught shield/no insulation</td><td>better insulation</td></tr>
<tr><td>glass is a poor conductor</td><td>metal/platinum is a better conductor</td></tr>
<tr><td>flame too far away from beaker</td><td></td></tr>
</table></td></tr>
<tr><td>8b</td><td>14.2 kJ</td><td>$E_h = c \times m \times \Delta T$
Energy = specific heat capacity × mass × change in temperature
$E_h = 4.18 \times 0.1 \times 34$
E_h = 14.212kJ</td></tr>
<tr><td>9a</td><td>ore</td><td>Ores are compounds of metals from which the metal can be extracted.</td></tr>
<tr><td>9b(i)</td><td>$4Al^{3+} + 6O^{2-}$
↓
$4Al + 3O_2$</td><td>$4Al^{3+} + 6O^{2-} \longrightarrow 4Al + 3O_2$</td></tr>
</table>

<table>
<tr><td>9b(ii)</td><td>Ions free/able to move</td><td>Solid ionic compounds are unable to conduct as the ions are locked tightly in an ionic lattice. On melting or dissolving in water, ions become free to move and will conduct.</td></tr>
<tr><td>9c</td><td>Magnesium</td><td>
<table>
<tr><th>Agent</th><th>Oxidation/Reduction</th><th>Electrons</th></tr>
<tr><td>Oxidising Agent</td><td>Agent is reduced itself</td><td>Agent gains electrons</td></tr>
<tr><td>Reducing Agent</td><td>Agent is oxidised itself</td><td>Agent loses electrons</td></tr>
</table>
$Mg \longrightarrow Mg^{2+} + 2e^-$
Magnesium loses electrons, is oxidised itself and acts as a reducing agent</td></tr>
<tr><td>10</td><td>Open Question Answer to include:</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>11a</td><td>2,8,6</td><td>$Cl(g) \longrightarrow Cl^+(g) + e^-$
2,8,7   2,8,6</td></tr>
<tr><td>11b</td><td>$Mg(g) \longrightarrow Mg^+(g) + e^-$</td><td>The symbol for Cl in the example must be substituted with Mg for Magnesium. This must always be in the gas state,</td></tr>
<tr><td>11c</td><td>decreases</td><td>Alkali Metals in group 1: lithium, sodium and potassium:
as you go down group 1 ionisation energy decreases.
<table>
<tr><td>Alkali Metal</td><td>Li</td><td>Na</td><td>K</td></tr>
<tr><td>First Ionisation Energy (kJ mol^{-1})</td><td>526</td><td>502</td><td>425</td></tr>
</table>
Halogens in group 7: fluorine, chlorine and bromine:
As you go down group 7 ionisation energy decreases.
<table>
<tr><td>Halogen</td><td>F</td><td>Cl</td><td>Br</td></tr>
<tr><td>First Ionisation Energy (kJ mol^{-1})</td><td>1690</td><td>1260</td><td>1150</td></tr>
</table></td></tr>
<tr><td>12a</td><td>but-2-ene</td><td>but - 2 - ene
but: 4 carbons; 2: C=C on 2nd carbon; ene: C=C double bond</td></tr>
<tr><td>12b</td><td>Same formula but different structure</td><td>Isomer: same chemical formula but different structural formula.
Both structures have the formula C_4H_8 but belong to different homologous series. Structure A is a alkene with a C=C double bond and Structure B is a cycloalkane with a ring of carbons.</td></tr>
<tr><td>12c</td><td>Any structure of 3-methylpent-2-ene or 2-ethylbut-1-ene</td><td>
3-methylpent-2-ene
or

2-ethylbut-1-ene</td></tr>
<tr><td>13a</td><td>Carboxyl group</td><td>The carboxyl group –COOH is the functional group found in carboxylic acids. Succinic acid contains two carboxyl groups.

carboxyl group</td></tr>
</table>

13b(i)	Condensation	Condensation reactions take place between carboxyl groups and hydroxyl groups with water removed as the groups join together. 
13b(ii)	Diagram showing:	
14a(i)	Carbon monoxide	$TiO_2 + 2Cl_2 + 2C \longrightarrow TiCl_4 + 2CO$
14a(ii)	Covalent	As titanium (IV) chloride is a compound of a metal and non-metal, your first assumption would be that it contains ionic bonding. However, ionic compounds are always solids at room temperature with high melting points and conduct electricity when in the liquid/molten state. Titanium (IV) chloride contains covalent bonding as it is a liquid at room temperature and does not conduct electricity in the liquid state. Metallic bonding can be ruled out as it does not conduct electricity in the liquid state.
14b	Distillation	Distillation separates titanium (IV) chloride from its impurities as distillation separates chemicals with different boiling points. The titanium (IV) chloride would evaporate and then condensed in the distillation apparatus leaving the impurities behind.
14c	recycle/reuse sodium or chlorine	Electrolysing molten sodium chloride would produce sodium metal at the negative electrode and chlorine gas at the positive electrode. Chlorine gas is needed for the reaction where TiO_2 is converted into $TiCl_4$. Sodium metal is required to displacement reaction to extract Ti from $TiCl_4$.
15a	16	Ignore Titration 1 as it is the rough titre and is not designed to be accurate Average titre = $\frac{15.9 + 16.1}{2} = \frac{32.0}{2}$ =16.0 cm^3
15b	0.0032	**n**o. of moles = **v**olume x **c**oncentration = 0.016litres x 0.005mol l^{-1} = 0.00008 mol $C_6H_8O_6 + I_2 \longrightarrow C_6H_6O_6 + 2HI$ 1mol 1mol 0.00008mol 0.00008mol concentration = $\frac{\text{no. of mol}}{\text{volume}} = \frac{0.00008\text{mol}}{0.025\text{litres}}$ = 0.0032 mol l^{-1}
16	Open Question answer containing:	**3 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. **2 mark answer**: Demonstrates a **reasonable understanding** of the chemistry involved, making some statement(s) which are relevant to the situation, showing that the problem is understood. **1 mark answer**: 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.