Victoria School
2016 Chemistry O Levels / 5073
Suggested Answer Key

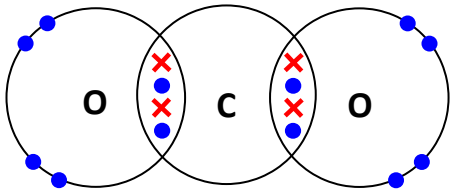
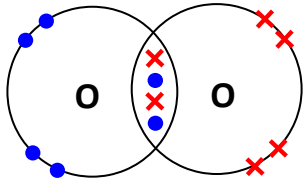
PAPER 1

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20
C	D	B	C	B	D	A	C	B	D	C	A	D	C	C	A	B	B	A	C
Q21	**Q22**	**Q23**	**Q24**	**Q25**	**Q26**	**Q27**	**Q28**	**Q29**	**Q30**	**Q31**	**Q32**	**Q33**	**Q34**	**Q35**	**Q36**	**Q37**	**Q38**	**Q39**	**Q40**
C	B	C	C	A	A	B	D	C	B	C	A	C	B	D	D	D	A	D	C

PAPER 2 (SECTION A)

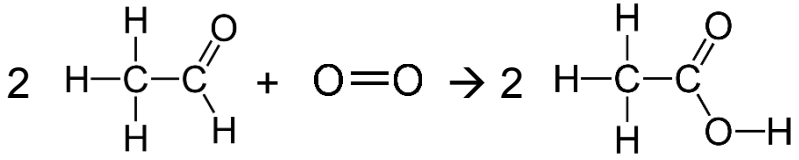
<table>
<tr><th colspan="2">Question</th><th>Answer</th><th>Mark</th></tr>
<tr><td>A1</td><td>a</td><td>
<table>
<tr><th>trend</th><th>only true down a group</th><th>only true across a period</th><th>true for both</th></tr>
<tr><td>The number of electron shells increases.</td><td>✓</td><td></td><td></td></tr>
<tr><td>The number of valency electrons increases.</td><td></td><td>✓</td><td></td></tr>
<tr><td>Proton number increases.</td><td></td><td></td><td>✓</td></tr>
<tr><td>There is a change in character from metallic to non-metallic.</td><td></td><td>✓</td><td></td></tr>
</table>
[2 correct – 1 mark]
</td><td>2</td></tr>
</table>

	bi	Melting point decreases down Group I and increases down Group VII.	1
	bii	Reactivity increases down Group I and decreases down Group VII.	1
	c	Catalysts increase the rate of reaction hence the industrial processes can be completed in a shorter time. This will help to reduce energy usage and save costs. Only a small amount of catalysts is needed and they remain chemically unchanged and unchanged in mass at the end of the reaction, so they can be reused indefinitely and there is no recurring costs. Hence, they reduce costs in the long run.	1 1
A2	**a**	Rusting involves oxidation. The oxidation state of iron increases from 0 in Fe to +3 in Fe_2O_3. Extraction involves reduction. The oxidation state of iron decreases from +3 in Fe_2O_3 to 0 in Fe.	1 1
	bi	An alloy is a homogeneous mixture of metal with (small amounts of) other elements.	1
	bii	The oil, the paint and the plastic coating acts as a protective layer to prevent the iron parts of the bicycle from rusting as they prevent the iron from being exposed to water and oxygen.	1 1
	biii	Zinc is more reactive than iron and hence its atoms will lose electrons more readily and corrodes in place of iron.	1 1
A3	**a**	The actual surface temperature of Mercury is close to its predicted surface temperature as there is no atmosphere of gases. [must state but no marks] The actual surface temperatures of Earth and Venus are higher than their predicted surface temperatures. This is because their atmospheres contain carbon dioxide which is a greenhouse gas. Carbon dioxide traps excess heat which increases the surface temperature. The difference between the actual surface temperature and predicted surface temperature is much higher for Venus than Earth (by 500°C) as the atmosphere of Venus contains 97% carbon dioxide but the atmosphere of Earth contains only 0.04% carbon dioxide.	 1 1

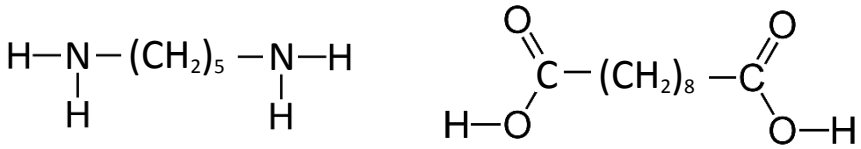
	bi	Volcanic eruptions	1
	bii	The pH of the water will be low/ less than 7.	1
	biii	The surface temperature of Venus is too high at 462°C hence the water would have boiled as its boiling point is 100°C and formed steam/water vapour.	1
	ci	Plants undergo photosynthesis where they take in carbon dioxide and release oxygen. Hence the percentage of carbon dioxide decreased and the percentage of oxygen increased.	1 1
	cii	Increase in industrial activities, use of machinery and vehicles which results in **increased combustion of fossil fuels** or carbon containing fuels which releases (excess) carbon dioxide.	1
	ciii	Carbon dioxide:  Oxygen: 	2 1
A4	**a**	<table><tr><th>name of salt</th><th>formula of salt</th><th>name of acid used to make salt</th><th>name of other compound used to make salt</th></tr><tr><td>potassium sulfate</td><td>K_2SO_4</td><td>**sulfuric acid**</td><td>**potassium hydroxide**</td></tr><tr><td>potassium phosphate</td><td>K_3PO_4</td><td>phosphoric acid</td><td>**potassium hydroxide**</td></tr><tr><td>ammonium nitrate</td><td>NH_4NO_3</td><td>**nitric acid**</td><td>**ammonium carbonate/ aqueous ammonia**</td></tr></table>	4

		calcium phosphate **$Ca_3(PO_4)_2$** phosphoric acid calcium hydroxide [1 mark per row]	
	b	NH_4NO_3 and K_3PO_4	1
	ci	**Salt:** $Ca_3(PO_4)_2$ **Reason**: It contains phosphorus but does not contain nitrogen and potassium.	1 1
	cii	M_r of K_3PO_4 = 3(39) + 31 + 4(16) = 212 % by mass of K = [3(39) / 212] x 100% = 55.2% % by mass of P = [31 / 212] x 100% = 14.6% % by mass of N = 0.00% Ratio of N : P : K = 0 : 15 : 55	 1 1 1
A5	**a**	**Salts:** silver chloride, barium sulfate, lead sulfate [3 correct – 2 marks, 2 correct – 1 mark, 1 correct – 0 marks] **Reason:** They are <u>insoluble salts</u> and hence can be prepared by adding two soluble reactants together.	2 1
	b		3

compound	**use**				
	to make detergents	**to make polymers for packaging**	**for flue gas desulfurisation**	**as a solvent in inks**	**for road surfaces**
bitumen					✓
sulfuric acid	✓				
ethene		✓			
ethyl ethanoate				✓	
calcium carbonate			✓		

		[5 correct – 3 marks, 4 or 3 correct – 2 marks, 2 correct – 1 mark, 1 correct – 0 marks]	
A6	**a**	• They have the same general formula $C_nH_{2n+1}CHO$. • They increase by a $–CH_2$ group down the homologous series. *They have the same functional group –CHO. [first two points are more essential. any two points – 1 mark each]	2
	b	**Formula:** C_3H_7CHO **Predicted boiling point:** 75°C [between 70°C to 80°C]	1 1
	ci	Isomers are <u>compounds with the same molecular formula but different structural formula</u>. Ethanol has a molecular formula of C_2H_6O and structural formula of CH_3CH_2OH. Methoxymethane has a molecular formula of C_2H_6O but different structural formula of CH_3OCH_3 from ethanol. Hence they both are isomers of each other. Ethanal has a molecular formula of C_2H_4O which is different from that of ethanol and methoxymethane hence it is not an isomer of the other two compounds.	1 1 1
	cii	$2C_2H_4O + 5O_2 \rightarrow 4CO_2 + 4H_2O$ Correct reactants and products [1 mark] Balanced equation [1 mark]	2
	ciii		1

PAPER 2 (SECTION B)

Question		Answer	Mark
B7	a	nylon **X**: Nylon 4, 6 nylon **Y**: Nylon 11	2 1
	b	 [1 mark per product]	2
	c	M_r of repeating unit = 2(14) + 12(12) + 2(16) + 22 = 226 Minimum number of repeating units = 10000 / 226 = 45	1 1
	d	Diamine: As the chain length of the diamine increases, the melting point decreases. The melting point nylon 4,6 is 275°C but the melting point of nylon 6,6 is 269°C. Dicarboxylic acid: As the chain length of the dicarboxylic acid increases, the melting point decreases. The melting point of nylon 6,6 is 269°C but melting point of nylon 6,10 and nylon 6,12 is 220°C and 218°C respectively. [Use of data to support reasoning]	1 1 1
	e	M_r of 1 repeating unit of nylon 6 = 6(12) + 11 + 14 + 16 = 113 No. of moles of repeating units of nylon 6 in 1 kg = 1000/113 = 8.8496 mol No. of moles of CO_2 = 8.8496 x 6 = 53.0976 mol M_r of CO_2 = 12 + 2(16) = 44 Carbon footprint = 53.0976 x 44 = 2336.29 g = 2.34 kg (to 3 s.f.)	1 1 1 1
			6
B8	a	$N_2 + 3H_2 \rightleftharpoons 2NH_3$	1

<table>
<tr><td></td><td></td><td>By Avogadro's law, 1 mole of nitrogen reacts with 3 moles of hydrogen to form 2 moles of ammonia. Hence, the mole ratio is 1 : 3.</td><td>1</td></tr>
<tr><td></td><td>bi</td><td>At a lower pressure, there are fewer nitrogen and hydrogen molecules per unit volume.

This decreases the frequency of effective collisions between the molecules and hence the rate of reaction deceases.</td><td>1

1</td></tr>
<tr><td></td><td>bii</td><td>From the graph, the percentage yield of ammonia decreases as pressure decreases. For example, at 500°C, the yield of ammonia is about 24% at 400 atm but is about 8% at 100 atm.

Hence, there will be a smaller volume of ammonia and larger volumes of unreacted nitrogen and hydrogen leaving the main reactor.</td><td>1

1</td></tr>
<tr><td></td><td>biii</td><td>There will be no effect on the final amount of ammonia formed.

This is because the unreacted nitrogen and hydrogen gases will be recycled again to react to form ammonia.</td><td>1

1</td></tr>
<tr><td>EI
TH
ER

B9</td><td>a</td><td>
<table>
<tr><th>solution</th><th colspan="2">name of products of electrolysis</th><th>ionic equation for reaction at each electrode</th></tr>
<tr><td rowspan="2">concentrated aqueous copper(II) chloride</td><td>at negative electrode</td><td>copper metal</td><td>$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$</td></tr>
<tr><td>at positive electrode</td><td>chlorine gas</td><td>$2Cl^-(aq) \rightarrow Cl_2(g) + 2e^-$</td></tr>
<tr><td rowspan="2">dilute copper(II) sulfate</td><td>at negative electrode</td><td>copper metal</td><td>$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$</td></tr>
<tr><td>at positive electrode</td><td>oxygen gas</td><td>$4OH^-(aq) \rightarrow O_2(g) + 2H_2O(l) + 4e^-$</td></tr>
</table>
[1 mark for each correct product + ionic equation]
[State symbols not required for ionic equations]</td><td>1

1

1

1</td></tr>
<tr><td></td><td>bi</td><td>A and D</td><td></td></tr>
<tr><td></td><td>bii</td><td>Reagent A:
When A is added to both copper(II) chloride and copper(II) sulfate, a reddish brown solid will be formed and the solutions turn from blue to colourless.</td><td>2</td></tr>
</table>

		Reagent **B**: When **B** is added to copper(II) chloride, a white precipitate will be formed. When **B** is added to copper(II) sulfate, there is no visible change. Reagent **C**: When **C** is added to copper(II) chloride, there is no visible change. When **C** is added to copper(II) sulfate, a white precipitate will be formed. Reagent **D**: When **D** is added to both copper(II) chloride and copper(II) sulfate, a blue precipitate will be formed.	1 1 1
OR **B9**	**ai**	A reddish brown solid will be formed. The colour of the solution changes from blue to (pale) green gradually.	1 1
	aii	Using a displacement reaction to extract copper is more economical. Scrap iron which is low in cost and may not be useful is used to extract copper metal, which can be made into useful products like wires, pipes, ornaments, etc. These products can then be sold at higher costs. Using a displacement reaction to extract copper is more environmentally friendly as the process does not produce any pollutants such as carbon monoxide as compared to using carbon to reduce the copper ore to copper (in a blast furnace). [Or any other acceptable reasons]	1 1
	b	$Cl_2(g) + 2Br^-(aq) \rightarrow 2Cl^-(aq) + Br_2(aq)$ [1m] – ionic equation; [1m] – state symbols	2
	c	Similarities: • Both reactions involve a more reactive element displacing a less reactive element from its solution. • Both reactions involve a colour change in the solutions. Differences: • In extraction of copper, a solid is formed as one of the products but in extraction of bromine, the products are aqueous. • In extraction of copper, the more reactive element (i.e. Fe) is oxidised but in extraction of bromine, the more reactive element (i.e. Cl_2) is reduced.	1 1 1 1