Victoria School
2021 Chemistry O Levels / 6092
Suggested Answer Key

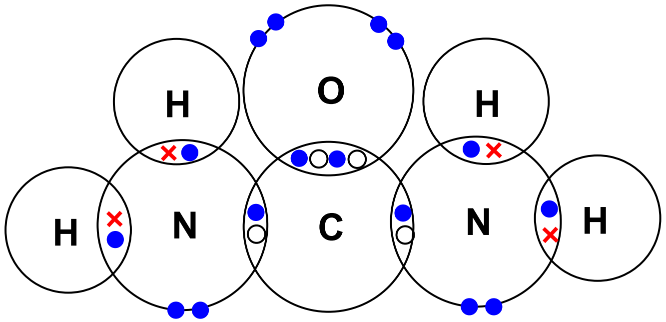
PAPER 1

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

PAPER 2 (SECTION A)

Question		Answer	Mark
A1	**ai**	potassium and chlorine	1
	aii	chlorine	1
	aiii	copper	1
	aiv	aluminium	1
	av	potassium and chlorine	1
	b	True, False, True, True	3
A2	**a**	Petroleum is heated and vapourised in a furnace before it enters the fractionating column. The vapours consist of different fractions, which have different boiling points. The fractionating column is cooler at the top than at the bottom. As the vapours rise up the column, they will cool and condense. Each fractions will condense at different temperatures. The smaller hydrocarbon, propane, has a lower boiling point will be distilled and collected at the top of the fractionating column while the bigger hydrocarbon, octane, has a higher boiling point and will be collected lower in fractionating column.	1 1 1
	b	Propane and butane are of similar sizes and have very similar boiling points.	1

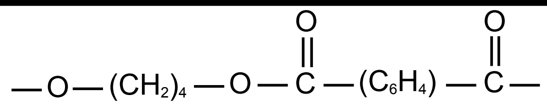
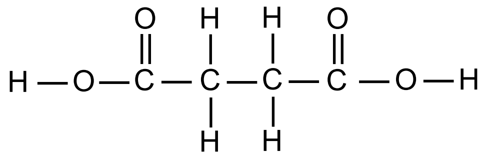
	c	compound / molecular formula / empirical formula propane: C_3H_8 / C_3H_8 octane: C_8H_{18} / C_4H_9	2
	di	Octane has a greater number of carbon and hydrogen atoms than butane. More carbon dioxide and water are formed in the combustion of octane than butane, hence more energy is released in forming of the bonds in water and carbon dioxide than absorbed in breaking the bonds in octane and oxygen. Energy is released in forming 8 more moles of carbon dioxide and 8 more moles of water in octane than butane. The This more than the energy absorbed in the breaking of bonds in the alkanes and oxygen.	1 1
	dii	number of moles of 50 kg octane = 50000 / 114 = 438.60 mol total energy released from 50kg of octane = 438.60 x 5470 = 2399122 kJ number of moles of butane required to produce energy = 2399122 / 2880 = 833.03 mol mass of butane required = 833.03 x 58 = 48300 g = 48.3 kg	 1 1 1
A3	**a**	1: hydrogen, oxygen 2: hydrogen, chlorine 4: copper, copper(II) ions	2
	b	In experiments 1 and 2, carbon electrodes that were inert were used at the positive electrodes. This allowed anions in the solutions to be preferentially discharged and oxidised, forming substances like oxygen and chlorine. In experiment 4, copper electrodes that were not inert were used at the positive electrode. This caused the copper electrode to oxidise, forming copper(II) ions.	1 1
	ci	Reddish brown solid is deposited on the negative electrode.	1
	cii	$4OH^-(aq) \rightarrow O_2(g) + 2H_2O(l) + 4e^-$	1
	ciii	Blue solution turns colourless. The copper(II) ions were preferentially discharged at the negative electrode and concentration of copper(II) ions decreases.	1 1
A4	**a**	calcium silicate	1

		$CaSiO_3$	
	bi	Maximum mass of iron = 112 / 160 x 14000 = 9800 tonnes	3
	bii	Iron ore is a mixture containing iron(III) oxide mixed with impurities like sand and clay. Solid iron(III) oxide cannot be reduced completely with carbon monoxide. Iron could be oxidised back to iron(III) oxide due to presence of oxygen and high temperatures in the blast furnace. *Any 2 of the above.*	1 1
	c	Nitrogen is present from the hot air used to provide oxygen to react with coke. Carbon dioxide is formed from coke reacting with oxygen in the hot air and decomposition of limestone. Carbon monoxide is formed from the reaction between carbon dioxide with coke.	1 1 1
	d	Pure iron is soft and adding carbon will form the alloy steel, which is stronger and harder. Carbon added is of a different atomic size from iron and it disrupts the orderly arrangement of the layers of iron atoms. It is more difficult for the layers of atoms to slide over one another. Amounts of carbon added is carefully controlled as higher amounts of carbon will make steel brittle.	1 1
A5	**a**	 1m: bonding electrons between N and H 1m: bonding electrons between N and C + C and O 1m: non-bonding electrons	3
	bi	At a high temperature, the aqueous solution of DEF will react with water vapour to form the gases, NH_3 and CO_2. As gases occupy a greater volume than liquids, this increases the pressure in the tank.	1
	bii	Ammonia produced from DEF can remove oxides of nitrogen, NO and NO_2, from the exhaust gas, reducing acid rain formation which would otherwise harm aquatic life and plants. Removing oxides of nitrogen would (decrease photochemical smog and) also reduce respiratory difficulties.	1 1

	biii	The DEF does not remove carbon dioxide from the exhaust gas. Carbon dioxide produced traps excess heat in the atmosphere which causes global warming. Global warming causes ice bergs at the poles to melt, sea level to rise and leading to floods in lowlands.	1 1
	biv	$4(NH_2)_2CO + 6NO_2 \rightarrow 7N_2 + 8H_2O + 4CO_2$	2
	c	number of moles of urea = 160 / 60 = 2.6667 mol concentration of urea = 2.6667 / 0.500 = 5.33 mol/dm^3	1 1

PAPER 2 (SECTION B)

Question		Answer	Mark
B6	ai	Hydrochloric acid and ethanoic acid fit the general formula, HA. As hydrogen ion has the formula of H^+, the formula of the anion would be A^-. Hence, Cl^- and CH_3COO^- in hydrochloric acid and ethanoic acid can be represented by A^-. Sulfuric acid does not fit the general formula as the sulfate ion has a formula of SO_4^{2-} and the charge on A^- is incorrect.	1 1
	aii	$2HA + M_2CO_3 \rightarrow CO_2 + H_2O + 2MA$	1
	aiii	$2CH_3COOH + Ca \rightarrow (CH_3COO)_2Ca + H_2$ As the positive charge on calcium is 2+, x = 2 when x =2, Equation 2 will be $2HA + M \rightarrow MA_2 + H_2$	1 1
	bi	The relationship shows that the initial concentration of the acid is inversely proportional to the pH, which is incorrect. It is expected for pH of different acids to be the same when initial concentrations of the acids are the same. Hydrochloric acid, sulfuric acid and ethanoic acid at the same concentration of 0.01 mol/dm^3 have a pH of 2.0, 1.7 and 3.4 respectively, showing that there are other factors that affect pH of an acid.	1 1
	bii	The strength of the acid affects the pH of the acid. Hydrochloric acid is a strong monobasic acid, while ethanoic acid is a weak monobasic acid. At acid concentration of 0.01 mol/dm^3, the complete dissociation of hydrochloric acid produces a higher concentration of hydrogen ions (0.01 mol/dm^3) than the partial dissociation of ethanoic acid (0.0004 mol/dm^3) and a lower pH. The basicity of the acid also affects the pH of the acid. Sulfuric acid is a strong dibasic acid, while hydrochloric acid is a strong monobasic acid. At acid concentration of 0.01 mol/dm^3, the complete dissociation of sulfuric acid (0.02 mol/dm^3) produces double the concentration of hydrogen ions compared to the complete dissociation of hydrochloric acid (0.01 mol/dm^3) and a lower pH. *1m strength, 1m basicity, 1m higher concentration + lower pH*	3 **4**

	bii i	0.04, 1.4 0.10, 1.0	1 1
B7	**ai**	 Relative molecular mass of repeating unit = 16 + 4(14) + 16 + 28 + 76 + 28 = 220	2
	aii		2
	bi	There are ester linkages joining the monomers together.	1
	bii	Both polymerisation processes involve only one type of monomer. Condensation polymerisation of molecule C eliminates a simple molecule like water while addition polymerisation of ethene does not eliminate any molecule. Condensation polymerisation of molecule C involves monomers with functional groups at each end of the molecule while addition polymerisation of ethene involves unsaturated monomers.	1 1 1
EITHER **B8**	**a**	Aluminium is the most reactive, followed by carbon and silicon. Carbon is more reactive than silicon as silicon dioxide can be reduced by carbon. Aluminium is more reactive than carbon as aluminium oxide cannot be reduced by carbon.	1 1
	b	Aluminium oxide has a giant ionic structure with strong ionic bonds between oppositely charged ions. A large amount of energy is needed to overcome the strong ionic bonds in aluminium oxide and it has a high melting and boiling point and exists as a solid with high density. In molten state, the giant ionic structure collapse and the ions are free to move to conduct electricity. Silicon dioxide has a giant molecular structure with an extensive network of strong covalent bonds between the atoms. A large amount of energy is needed to overcome the strong covalent bonds in silicon dioxide and it has a high melting and boiling point and exists as a solid with high density. Carbon monoxide has a simple molecular structure with weak intermolecular forces of attraction between the molecules. A low amount of energy is needed to overcome the weak intermolecular forces of attraction in carbon monoxide and it has a low melting and boiling point and exists as a gas with low density. Silicon dioxide and carbon monoxide have no mobile charged particles available to conduct electricity.	1 1 1 1 1

	c	Mass of aluminium = 2.8 x 27 = 75.6 g Percentage by mass of aluminium = 75.6 / 100 x 100% = 75.6 % In alloy Y, percentage by mass of silicon = 100 – 75.6 – 8 = 16.4 % Hence, the alloy is Y.	1 1 1
OR **B8**	**a**	Experiment 2. Comparing experiment 2 to experiment 1, only the concentration of iodide ions used is changed while other conditions are constant. Comparing experiment 2 to experiment 3, only the temperature used is changed while other conditions are constant. Comparing experiment 2 to experiment 4, only the presence of catalyst added is changed while other conditions are constant.	1 1
	b	When concentration increases from 0.1 mol/dm^3 to 0.2 mol/dm^3, there are more iodide ions per unit volume. Hence, there are more collisions between the reactant particles, leading to a higher frequency of effective collisions, resulting in a faster rate of reaction, and decreasing time taken for blue-black colour to appear. When temperature increases from 20 °C to 40 °C, reactant particles have more heat energy and hence higher kinetic energy. They move faster and there are more collisions between the reactant particles, leading to a higher frequency of effective collisions, resulting in a faster rate of reaction, and decreasing time taken for blue-black colour to appear. When Cu^{2+} ions were added, they provide an alternative pathway of lower activation energy for the reaction to proceed. More iodide ions have the lower minimum activation energy for higher frequency of effective collisions to take place, resulting in a faster rate of reaction and decreasing time taken for blue-black colour to appear.	1 2 2
	c	number of moles of hydrogen peroxide = 0.03 x 0.05 = 0.0015 mol number of moles of aqueous iodide ions in experiment 1 = 0.1 x 0.01 = 0.0010 mol 0.0010 mol of aqueous iodide ions requires 0.0005 mol of hydrogen peroxide to react. Hence, the aqueous iodide ion is the limiting reactant in experiment 1. number of moles of aqueous iodide ions in experiments 2, 3 and 4 = 0.2 x 0.01 = 0.0020 mol 0.0020 mol of aqueous iodide ions requires 0.0010 mol of hydrogen peroxide to react. Hence, the aqueous iodide ion is also the limiting reactant in experiments 2, 3 and 4.	 1 1 1