ST. PATRICK'S SCHOOL
PRELIM EXAMINATIONS 2021
ANSWER SCHEME

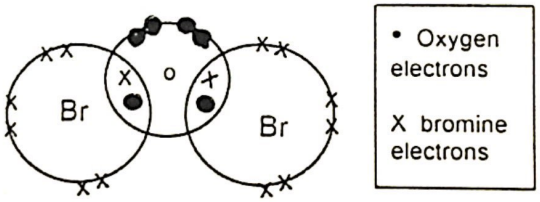
LEVEL : SECONDARY 4 EXPRESS
SUBJECT : CHEMISTRY
6092 /01
6092 /02

PAPER 1

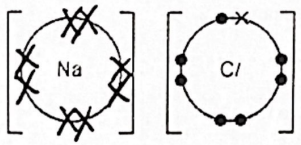
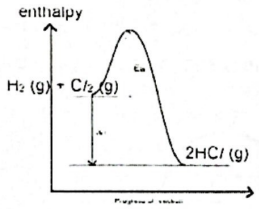
1	2	3	4	5	6	7	8	9	10
D	D	C	D	B	B	C	A	D	D
11	12	13	14	15	16	17	18	19	20
D	D	C	A	A	A	B	D	B	D
21	22	23	24	25	26	27	28	29	30
D	C	A	D	A	C	C	A	A	B
31	32	33	34	35	36	37	38	39	40
A	D	B	D	C	A	B	A	A	C

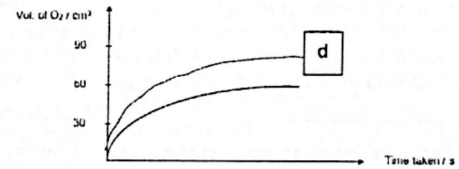
* Q36-40 are removed due to CLT

PAPER 2 Section A

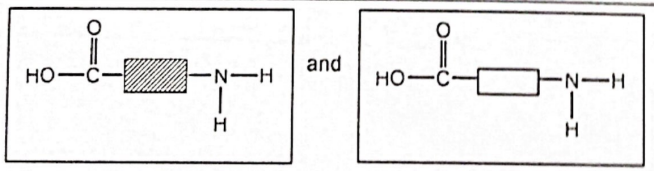
1	(a)(i)	CO	1
	(ii)	ZnO	1
	(iii)	SiO_2	1
	(iv)	H_2O_2 / Na_2O_2	1
	(b)	 correct number of electrons in the overlapping region – 1 m correct number of electrons in individual atoms – 1 m No legend / no 'electron(s)' written in the legend – deduct 1 m	2
2	(a)	Purple/violet	1
	(b)	Light blue – 0.5 (3 s.f.) Dark blue – 1.25 (3 s.f.)	2
	(c)(i)	Any strong alkali e.g. NaOH , KOH	1
	(ii)	20 cm^3 – blue 30 cm^3 - pink	2

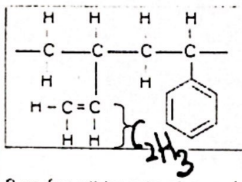
3	(a)	<table><tr><th>statement</th><th>indicate with a tick (√) if true</th></tr><tr><td>Iodine gains electrons more readily than fluorine.</td><td></td></tr><tr><td>Iodine is an element with a simple covalent structure.</td><td>√</td></tr><tr><td>Iodine has strong covalent bonds between molecules.</td><td></td></tr><tr><td>Iodine dissolves in water to form a brown solution.</td><td>√</td></tr></table> correct – ½ m deduct ½ m for the 3rd incorrect answer	1
	(b)(i)	Cl_2 (g) + $2Br^-$ (aq) → Br_2 (aq / l) + $2Cl^-$ (aq) 1m – correct chemical formulae & balanced equation 1m – correct state symbols	2
	(ii)	Colourless solution turns reddish brown	1
	(iii)	Chlorine is reduced as its oxidation state decreases from 0 in Chlorine to −1 in Cl^-. (1m) Meanwhile, bromine is oxidised as its oxidation state of bromine increases from −1 in Br^- to 0 in Br_2. (1m)	2
	(iv)	Bromide ions / zinc bromide	1
4	(a)	Melting point of sodium chloride is higher than chlorine. Sodium chloride is giant ionic lattice / crystal lattice structure (1/2m) while chlorine has a simple covalent / molecular structure (1/2m). Large amount of energy (1/2m) is needed to overcome the strong electrostatic forces of attraction (1/2m) between the oppositely charged ions compared to little amount of energy (1/2m) needed to overcome the weak intermolecular forces of attraction between the chlorine molecules (1/2m).	3
	(b)	In molten state, the ions in sodium chloride are free to move (1m) but in the solid state, the ions are held strongly in fixed positions (1m).	2

	(c)	 X – Na electrons • - Cl electrons 1m – correct valence electrons & the charge on cation 1m – correct valence electrons & charge on anion deduct 1m for no legend & no 'electron(s)' written deduct 1m if no electrons in outershell	2
5	(a)	The reaction is exothermic / heat is released.	1
	(b)	 1m – correct shape of curve with energy of products 1m – correct labelling of products (2HCl), E_a & ΔH	2
	(c)	Energy absorbed to break bonds in H_2 and F_2 = 159 + 436 = 595 kJ (1/2m) Energy released to form bonds in HF = 2 x 569 = 1138 kJ (1/2m) ΔH = −(1138 − 595) = −543 kJ/mol (1m)	2
	(d)(i)	A weak acid partially ionizes to give low H^+ concentration in water while a strong acid completely ionizes to give high H^+ concentration.	1
	(ii)	The bond energy of the H—F bond is 569 kJ which is greater than the bond energy of H—Cl bond which is 432 kJ. (1m) OR More energy is absorbed to break H-F. (1m) Less energy is needed to break H-Cl bond, thus ionize easily. (1m) OR More energy is absorbed / required to break the H—F bond than H—Cl bond. (1m) Therefore HCl ionizes more readily than HF. OR Weaker H-Cl bond, ionize easily / easier for H-Cl to break down into H^+ ions. (1m) Any 2 reasons.	2
6	(a)	$2H_2O_2 \rightarrow 2H_2O + O_2$	1
	(b)(i)	Rate of reaction decreases (at a decreasing rate)	1
	(ii)	Temperature:	2

		An increase in temperature, particles gain kinetic energy (1m) and larger number of particles have minimum activation energy to decompose. So the frequency of effective decomposition of particles is higher (1m) Presence of catalyst: The use of a catalyst (MnO_2) in this case will provide an alternative pathway with a lower activation energy (1m). Larger number of particles with equal or greater activation energy to decompose, thus the frequency of effective decomposition of particles is higher (1m). Surface area of catalyst The particle size of the catalyst decreases, the surface area of the catalyst increases. (1m) The area of contact between the reactant particles increases. Thus the frequency of effective decomposition is higher. (1m) Pressure: Higher pressure, the particles are closer to one another (1m) and will increase the frequency of effective collision. (1m) Therefore, the rate of reaction increases.	
	(c)	The volume of oxygen produce will exceed that of the volume of the 60 cm^3 gas syringe.	1
	(d)		1
7 CLT	(a)	Crude oil is heated and turned into vapours. (1m) The vapour is passed into the fractionating column. (1m) As the hot vapour rises up the column, it begins to cool and condense. (1m) Each fraction is a mixture of hydrocarbons which boils over a certain temperature range. Lighter fractions / smaller hydrocarbons have lower boiling points (1/2m) and they are collected at the top (1/2m) of the fractionating column as gases. Heavier fractions / larger hydrocarbons have higher boiling points (1/2m) and they are collected at the bottom (1/2m) of the fractionating column as solids.	5
	(b)(i)	Cracking is a process where large hydrocarbon molecules are broken down into smaller (1m) hydrocarbon molecules / fractions and hydrogen. This will give a greater supply of smaller hydrocarbons / fractions that are low in supply but in greater demand. (1m)	2
	(ii)	Add aqueous bromine / bromine water to both hydrocarbons separately. (1m) **L** decolourises the reddish-brown aqueous bromine rapidly while **K** cannot.(1m)	2

	(iii)	$C_{17}H_{36} \rightarrow C_4H_{10} + C_3H_6 + 5C_2H_4$	1
PAPER 2 Section B			
8	(a)	The second ionization energy decreases down the group. OR Position of metal lower, lesser is the 2nd ionisation energy. reject: down the series	1
	(b)	Energy required to form 1 mole of Ca^{2+} ions = 589 + 1145 = 1734 kJ/mol (1m) No. of moles of Ca atoms = 1/40 = 0.025 mol (1m) Energy required = 1734 x 0.025 = 43.35 or 43.4 kJ (1m)	3
	(c)	No. (no mark) Strontium carbonate has the highest temperature of decomposition (1m), but the 2nd ionisation energy of strontium is not the lowest/is higher the barium. (1m) OR Barium has the lowest ionisation energy (1m), but the temperature at which barium carbonate is not the highest/is lower than strontium carbonate (1m) OR The 2nd ionisation decreases from beryllium to barium, but the temperature at which the carbonate decomposes only from beryllium carbonate to strontium carbonate, then it decreases. If the statement is true, the temperature should not decrease from strontium carbonate to barium carbonate. (1m for stating the 2 trends, 1m for interpreting the 2 trends)	2
	(d)	The temperature is not high enough to decompose the carbonates / thermally stable	1
	(e)	No of moles of CO_2 = 122/24000 = 0.0050833 mol (1m) No. of moles of XCO_3 = 0.0050833 mol Molar mass of XCO_3 = 1/0.0050833 = 196.72 g/mol (1m) Molar mass of X = 196.72 – (12 + 16 x 3) = 136.7 g/mol = 137 g/mol (3 s.f.) (1m) If student work backwards and find volume of CO_2 produced, 0 m.	3

9	(a)	Petrol engine (1m) The percentage of pollutants in the exhaust of petrol engines is 1% while that of diesel engine is 3%. (1m) The petrol engine produces less pollutants, hence it is more environmental friendly. *Must interpret data.*	2
	(b)	There is oxygen present in the exhaust in the diesel engine but not the petrol engine. (1m) Petrol is likely to undergo incomplete combustion. (1m) OR With the excess oxygen, diesel is more likely to undergo complete combustion than petrol. (1m) *Reject: incomplete combustion of carbon in petrol*	2
	(c)	Water is formed by the combustion of fuel / hydrocarbons. (1m) *Reject: combustion of petrol / diesel*	1
	(d)	The temperature in a diesel engine is higher. (1m) *Reject: less CO in diesel exhaust to react with NO_x (this has already passed through catalytic converter)*	1
	(e)(i)	$2NO + 2CO \rightarrow N_2 + 2CO_2$	1
	(ii)	Carbon dioxide is a greenhouse gas and contributes to global warming.(1m) Trap heat in the atmosphere. (1m) Caused climate change. (1/2 m) Caused extreme climate change. (1m) Rise in sea level. (1m)	1
	(f)(i)	Diesel contains sulfur / sulfur compounds. Combustion of sulfur produces sulfur dioxide. (1m)	1
	(ii)	Sulfur dioxide causes acid rain (1/2 m), which corrodes concrete buildings / kill vegetation / kills aquatic life. (1/2 m) OR Sulfur dioxide irritates eyes and lung / causes respiratory problems. (1m)	1
EITHER			
10	(a)(i)	Polyamide. (1m) It contains amide linkage. (1m)	
CLT	(ii)	 1m each monomer	2
	(b)(i)	Addition polymerisation. (1m)	2

		The monomers are unsaturated(1/2 m), containing C=C bonds. (1/2m) Reject: without elimination / loss of small molecules if no mention C=C.	
	(ii)	 Order of monomer doesn't matter; deduct 1m for giving *n* formula. 2 m for all bonds shown in the repeat unit. (deduct 1m if not all bonds shown)	2
	(iii)	Each monomer molecule could join to a molecule of the same type or a molecule of the other monomer.	1
	(iv)	Problem: Accept any one of these (must have elaboration) - long-term litter problem resulting land pollution. - when burnt, they produce air pollutants such as poisonous carbon monoxide. - water pollution in which aquatic life wrongly consumed plastic and cause death.	
OR			
10	(a)	Cu^{2+} (aq) + 2e → Cu (s) - must have state symbols	1
	(b)	The blue colour becomes less intense (1m) / pH of the solution decreases. (1m) Cu^{2+} is discharged at the cathode (1/2 m) and OH^- is discharged at the anode. (1/2 m) H^+ and SO_4^{2-} are the ions left in the solution forming sulfuric acid. (1m)	3
	(c)	Platinum	1
	(d)	Even if concentrated copper(II) sulfate is used as the electrolyte, only Cu^{2+} and OH^- will be preferentially discharged (1m) OR no change in the product (1m) OR Not affected by concentration as OH^- and Cu^{2+} are still preferentially discharged. Student B is correct. (1m) - Award 2nd mark only if explanation is correct. Or any reasonable explanation with reference to electrochemical series and comparing ease of discharging for the various ions.	2
	(e)(i)	0.2 g	1
	(ii)	To discharge 0.1 g of copper → 300 coulombs (read from the graph)	2

		Charge needed to form 1 g of copper = 300 x 10 = 3000 coulombs (1m) Molar mass of copper = 64 g/mol Hence, charge needed to form 1 mol copper = 3000 x 64 = 192 000 coulombs (1m)	