Victoria School
2024 Chemistry O Levels / 6092
Suggested Answer Key

PAPER 1

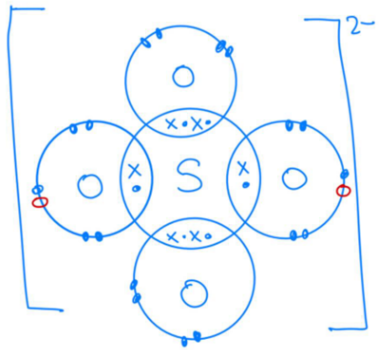
Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20
B	C	D	D	A	B	A	A	C	B	D	D	C	B	C	B	D	C	D	A
Q21	**Q22**	**Q23**	**Q24**	**Q25**	**Q26**	**Q27**	**Q28**	**Q29**	**Q30**	**Q31**	**Q32**	**Q33**	**Q34**	**Q35**	**Q36**	**Q37**	**Q38**	**Q39**	**Q40**
C	A	B	D	D	B	B	D	D	A	A	A	C	B	A	A	A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

PAPER 2 (SECTION A)

Question		Answer	Mark
1	**ai**	A and E	1
	aii	A and D	1
	aiii	A and F	1
	b	colourless; purple	1
	c	$2C_3H_6(g) + 9O_2(g) \rightarrow 6CO_2(g) + 6H_2O(g)$ Since $2C_3H_6 \equiv 9O_2$ Hence, volume of O_2 gas at r.t.p = $\frac{100}{2}$ x 9 = 450 cm^3 Volume of air required = $\frac{100}{21}$ x 450 = 2142 cm^3 ≈ **2140 cm^3** (to 3 sig. fig)	3

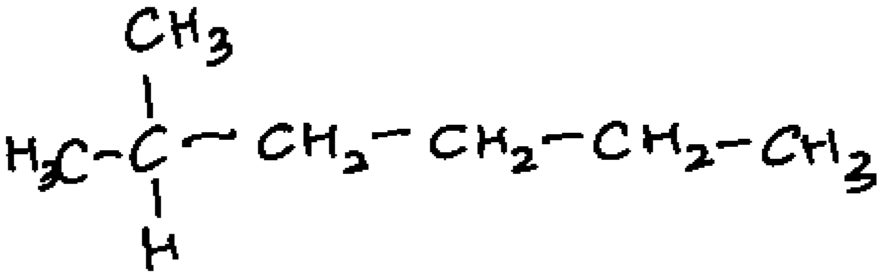
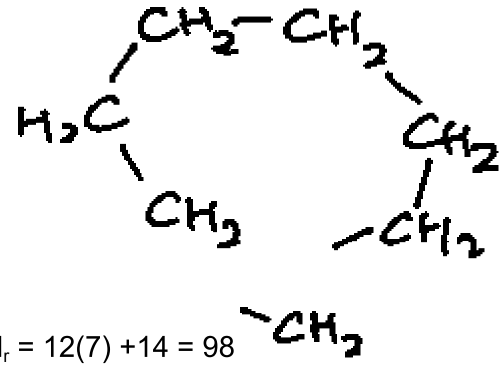
2	a	Iron, chromium and nickel are elements found in the Periodic Table. They are pure substances that cannot be split up into two or more simpler substances by chemical processes or by electricity. Iron(III) oxide (Fe_2O_3) is compound that is made up of two or more elements chemically combined in a fixed ratio of iron and oxygen. Steel is a mixture formed when two or more substances are added together without chemical bonds being formed/physically combined. In this steel, the percentage by mass of the 3 constituents, namely iron, nickel and chromium are different with no fixed ratios / proportions.	1 1 1
	b	To justify this statement, the amounts / number of atoms of the respective metals need to be calculated. Assume 100 g of steel, Amount of Cr = $\frac{15.6}{52}$ = **0.300 mol** Amount of Ni = $\frac{8.9}{59}$ = **0.151 mol** Since the mole ratio of Cr to Ni is approximately 2:1, the statement made by the student is correct.	 1 1
	c	● The atoms of the different metals should have different sizes/atomic radii but the figure shows particles of the same size. ● There are three different types of atoms in this steel but the figure only shows two different types. ● There are different and varying amounts of constituents in the steel but the ratio of the different particles is almost equal due to the alternate arrangement of the two different constituents shown in the figure. ● The arrangement of particles / atoms in alloys should be disorderly but the figure shows orderly arrangement of the particles in steel. (Any three of the above answers are sufficient to score full marks.)	3

	d	Steel is <u>harder, stronger</u>, less malleable and more brittle than iron. When different elements are added to the pure metal, the atoms of the different elements have <u>different atomic radii.</u> The atoms of different atomic radii <u>disrupt the orderly arrangement of the layers of iron atoms</u> within the metal lattice. Hence, it is more <u>difficult for the layers of iron atoms to slide over one another</u> without breaking any metallic bonds when a force is applied. In pure iron, the <u>atoms are of the same size and arranged in orderly layers</u>. When a force is applied, the <u>layers slide past each other easily</u>.	1 1
3	a	silver nitrate and lead : grey coating forms on surface of metal zinc nitrate and lead : no reaction magnesium nitrate and lead : no reaction	2
	b	Zn (s) + 2Ag$^+$ (aq) → Zn^{2+} (aq) + 2Ag (s) [ss not required]	1
	c	Zinc and magnesium are <u>more reactive</u> than iron and undergoes sacrificial protection of iron. Zinc and magnesium atoms <u>lose their valence electrons/oxidised more easily</u> than iron atoms to <u>corrode in place of iron</u>.	1 1
	d	least stable: silver carbonate lead(II) carbonate most stable: magnesium carbonate	1
4	a	Nitrogen is obtained from <u>fractional distillation of liquified air</u>. Hydrogen is obtained from <u>catalytic cracking of crude oil</u> or steam reforming.	1 1
	b	From the graph, the best operating conditions are <u>350 °C and 400 atm.</u> Below 450 °C, the <u>percentage yield is high but the reaction is slow</u>. Above 450 °C, the <u>percentage yield is low</u>.	1 1

		Below 200 atm, the percentage yield is low. Above 200 atm, the percentage yield is high and there is high risk of explosion. Hence, Haber process operates at 450 °C and 200 atm which gives the maximum yield and faster rate of reaction at minimum cost.	1 1
	c	$Ca(OH)_2 + (NH_4)_2SO_4 \rightarrow CaSO_4 + 2NH_3 + 2H_2O$ Calcium hydroxide can be added to soil to neutralise excess acidity in the soil. However, it should not be added to the soil at the same time with ammonium sulfate because ammonium sulfate will react with calcium hydroxide to form ammonia gas which will escape into the atmosphere. Hence, causing nitrogen content in the fertiliser will be lost.	1 1
5	**a**	Manganate(VII) and Vanadate(V) Both oxyanions consists of manganese and vanadium , which are transition metals. Hence, will form coloured transition metal compound.	1 1
	bi	$Al(ClO_2)_3$	1
	bii	Chromate (VI)	1
	biii	SO_3^{2-}	1
	c		3
6	**a**	$PbCl_4$ has a simple covalent structure. Hence, a low amount of energy is needed to overcome the weak intermolecular forces of attractions, resulting in low melting point.	1

		$PbCl_2$ has a giant ionic structure. Hence, a high amount of energy is needed to overcome the strong ionic bonds, resulting in high melting point.	1
	b	Carbon has a giant covalent structure. Each carbon atom can form strong covalent bonds with 3 other carbon atoms (in graphite) or 4 other carbon atoms (in diamond) by sharing three or all the valence electrons. Lead has a giant metallic structure. The lead atoms lose their valence electrons to form cations and a sea of mobile valence electrons. There are strong metallic bonds between the cations and the sea of delocalised valence electrons.	1 1
	c	$SnCl_4$ will be a liquid at 25 °C while $SnCl_2$ will be a solid at 25 °C. Tin is a metal and in Group 14, like lead. Hence, it will have similar chemical properties as lead, forming chlorides of tin that have the same simple covalent structure. Hence, a low amount of energy is needed to overcome the weak intermolecular forces of attractions, resulting in the low melting and boiling points that are similar to that of lead chlorides.	1 1
	d	$PbCl_4(l) \rightarrow PbCl_2(s) + Cl_2(g)$	1
	e	Green solution turns red. Water is neutral with pH of 7. Hence, upon the addition of UI, it will form green solution. When silicon chloride is added, one of the products, i.e. HCl, will dissociate completely to form a high concentration of H^+ ions and Cl^-. Hence, causing the green solution to turn red as it is strong acid. White precipitate of silicon dioxide will also be formed.	 1 1

Question		**Answer**	**Mark**
7	**ai**	Alkanes. Since R = C_nH_{2n+1} , thus the formula of R-H is C_nH_{2n+2} which similar to the general formula of alkanes	1 1
	aii	Hydrogen/H_2 The oxidation state of hydrogen increased from 0 in H_2 to +1 in H_2S.	 1
	bi	Percentage purity of limestone = 98%	

		Mass of pure limestone = 98/100 x 1000 000 = **980 000 g** Amount of SO_2 = 980 000/100 = **9800 mol** Mass of SO_2 = 9800 x 64 = **627 200 g**	1 1 1
	bii	$4NO_2 + 2CaCO_3$ □ $Ca(NO_3)_2 + Ca(NO_2)_2 + CO_2$	1
	ci	The exposed surface area of the catalyst is reduced, hence there are lower frequency of effective collisions between reacting particles and the catalyst which lowers the rate of reaction.	1 1
	cii	catalytic reforming produces branched molecules or cyclic molecules. Each molecule should have 7 carbon atoms.  M_r = 12(7) + 16 = 100  M_r = 12(7) +14 = 98	1 per molecule
8	**a**	(see table below)	
	bi	For concentrated aq. NaCl: Anode: $2Cl^-$ □ Cl_2 +2e For dilute ad. NaCl: Anode: $4OH^-$ □ $2H_2O + O_2$ + 4e [1] For both electrolyes:	2

8 a

	increases	decreases	Stays constant
number of moles of SO_4^{2-}(aq) ions			Yes
Total mass of apparatus and solution		Yes	
pH of solution		Yes	
Mass of negative electrode	Yes		

		Cathode: $2H^+ + 2e \rightarrow H_2$ [1]	
	bii	For concentrated aq. NaCl, Cl^- is of higher concentration, hence they are preferentially discharged and oxidised readily to form chlorine gas at the anode while for dilute aq. NaCl, OH^- ions are preferentially discharged and are oxidised readily to form oxygen gas at the anode. For both electrolyes, H^+ ions are preferentially discharged and are reduced readily to form hydrogen gas at the cathode. Since only gases are produced at both electrodes, the mass of electrodes remains constant. For concentrated aq. NaCl, chlorine and oxygen gases are produced at the electrodes. Hence the total mass of apparatus and solution will decrease. Therefore the pH of electrolyte will increase as the concentration of OH^- becomes greater due to H^+ being discharged at the cathode. For dilute ad. NaCl, hydrogen and oxygen gases are produced at the electrodes. Hence the total mass of apparatus and solution will decrease. Therefore the pH of electrolyte will be constant as the concentration of OH^- and H^+ remains the same.	1 1 1

PAPER 2 (SECTION B)

9	**a**	Ethanoic acid is a weak acid and partially dissociates when dissolved in water to release a low concentration of hydrogen ions, leading to a higher pH. Hydrochloric acid is a strong acid and fully dissociates when dissolved in water to release a high concentration of hydrogen ions, leading to a lower pH.	1 1
	bi	Ethanoic acid and hydrochloric acid both are monobasic acids, where 1 mole of acid dissociates to release 1 mole of hydrogen ions. Hence the same volume is required to neutralise the calcium hydroxide. Sulfuric acid is a dibasic acid, where 1 mole of acid dissociates to release 2 moles of hydrogen ions. Hence the total amount of hydrogen ions released is doubled and only half as much volume is required.	1 1
	bii	$2CH_3COOH + Ca(OH)_2 \rightarrow (CH_3COO)_2Ca + 2H_2O$	1
	biii	Amount of ethanoic acid = 19.8 / 1000 x 0.1 = 0.00198 mol 2 mol CH_3COOH ≡ 1 mol $Ca(OH)_2$ 0.00198 mol CH_3COOH ≡ 0.00099 mol $Ca(OH)_2$ Concentration of $Ca(OH)_2$ = 0.00099 / 25/1000 = 0.0396 = **0.040 mol/dm^3 (to 2 s.f.)**	1 1
	c	Amount of sulfuric acid = 25.0 / 1000 x 0.05 = 0.00125 mol Amount of H^+ = 0.00125 x 2 = 0.0025 mol Energy change = 0.0025 x -57 = **-0.143 kJ (to 3 s.f.)**	1 1 1
10	**a**	Nitric acid: 25 s Ethanoic acid: 45 s Sulfuric acid: 12.5 s Nitric acid is a strong monobasic acid, like hydrochloric acid. Thus it would dissolve and dissociate fully to give the same high concentration of hydrogen ions, giving the same time as hydrochloric acid.	 1 1

		Ethanoic acid is a weak monobasic acid. Thus, it would dissolve and dissociate partially to give a lower concentration of hydrogen ions than hydrochloric acid, resulting in a longer time taken. Sulfuric acid is a strong dibasic acid. Thus it would dissolve and dissociate fully to give a concentration of hydrogen ions twice as high as hydrochloric acid, resulting in half the time taken.	1 1
	bi	$2HCl + Mg \rightarrow MgCl_2 + H_2$ Amount of Mg = 0.75 / 24 = 0.03125 mol 1 mol Mg ≡ 1 mol H_2 0.03125 mol Mg ≡ 0.03125 mol H_2 Mass of H_2 = 0.03125 x 2 = 0.0625 = **0.063 g** (to 2 s.f.)	1 1 1
	bii	Hydrochloric acid, magnesium chloride, water	2
	biii	Zinc has a higher A_r than magnesium, hence there are fewer moles of zinc in 0.75 g. Thus less gas is released during the reaction.	1